

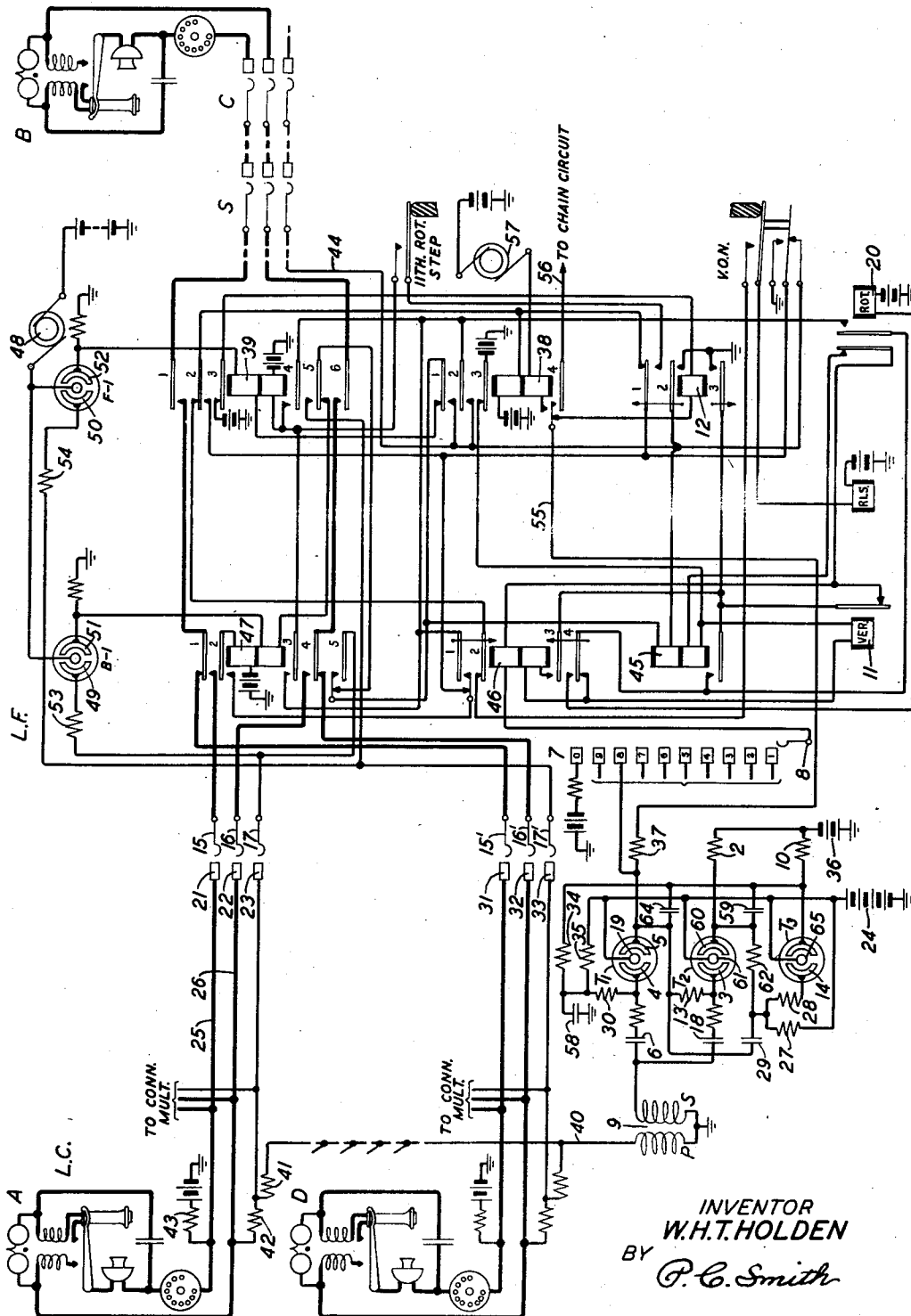
March 26, 1940.

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2,195,309

TELEPHONE SYSTEM

Filed Feb. 24, 1939



UNITED STATES PATENT OFFICE

2,195,309

TELEPHONE SYSTEM

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Application February 24, 1939, Serial No. 258,129

6 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to an improvement in the system disclosed in the copending application of William H. Martin, Ser. No. 258,133, filed Feb. 24, 1939.

The object of the invention is to eliminate some of the individual equipment usually provided for subscribers' lines, especially the line and cut-off relays.

It has been proposed heretofore to eliminate the individual line relays and to replace them by a relay mechanism common to a group of lines. To accomplish this, however, it would be necessary to provide an auxiliary switching mechanism for associating the common relay mechanism with any one of the lines when calling.

It has also been proposed to use a vacuum tube in common to a group of lines, the control element of which is connected through individual resistances to the respective subscribers' lines, thus doing away with the individual line relays, and to utilize the vacuum tube as the signaling means for starting the line-finder switch that is to be used for connecting with the terminals of the calling line. An arrangement of this kind, however, is subject to false operation due to the combined effect of several line leaks, and further does not lend itself readily to a line terminal test which is sufficiently positive and reliable to enable the line finder to distinguish and seize the particular calling line in the group that is calling, especially where a plurality of lines within the same calling group initiate calls in the interval between the origination of the first call by a line and the connection thereof to a line-finder switch therewith.

According to the present invention, these difficulties are overcome by the use of three gaseous conductor tube devices having single control electrodes two of which are inductively coupled to the group of lines to produce an impulse when a line calls that will alter the potential of one of the control electrodes so as to render the associated tube conducting and thereby establish an anode-cathode circuit therethrough which, in turn, will initiate the operation of a line-finder switch that will hunt for the test terminal of the calling line.

Another feature of the invention is a circuit arrangement whereby the drop in potential of the space current of the tube, made conducting by the initiation of a call by one line, is used to render the control electrode of the succeeding tube critical to the slightly weaker impulse produced by a second line in the group initiating a call before the line-finder switch started by the first tube has reached the test terminal of the first

calling line. This arrangement overcomes the possibility, present in other systems of this kind, of the second line stealing the first assigned line finder without itself having the power to produce a sufficiently strong impulse to fire the second tube and thereby initiate the operation of another line-finder switch.

The foregoing and other features of the invention will be described in detail in the following specification, which should be read in conjunction with the attached drawing and accompanying claims.

The drawing represents, schematically, a telephone system in which the features of the invention are embodied in a circuit structure that makes use of automatic switches of the well-known two-motion step-by-step type. It is understood, however, that the embodiment of the invention as herein set forth is given by way of illustration only, and that the invention may be readily applied to any other type of automatic or semiautomatic telephone system.

Referring to the drawing, there are shown two subscriber stations of a group of twenty lines, namely, stations A and D in the group, a line circuit LC associated with station A, a linefinder switch LF, a selector switch S, a connector switch C, and a called subscriber's station B.

The subscribers' stations A, B and D are provided with the usual subscriber's set which is equipped with a dial for controlling the establishment of the desired connections. The selector switch S and the connector switch C are of the well-known step-by-step or Strowger type, and reference may be had to pages 53 to 67, inclusive, of the second edition of "Automatic Telephony" by Smith and Campbell for a detailed description of the operation of the circuits associated with these switches. Only those portions of the circuits of the selector and connector switches are shown as are required for a clear and complete description of this invention, the omitted portions of these circuits being indicated by broken lines.

The line circuit LC and the line-finder switch LF are shown in detail since the features of the invention apply specifically to these circuits. Three cold cathode gaseous discharge tubes T₁, T₂, T₃ are associated in common with a group of line circuits such as those associated with the group of stations A . . . D, for example, the control electrode 4 of tube T₁ and the control electrode 3 of tube T₂ being connected in parallel to the secondary winding S of transformer 9 through condensers 6 and 12 and current limiting resist-

ances, respectively, while the control electrode 14 of tube T₃ is connected to the control electrode of tube T₂, the cathode 5 of tube T₁ and a source of positive potential 24 in a manner and for a purpose more particularly set forth hereinafter. The three tubes are of the type which break down and become conducting when the potential on their respective control electrodes becomes sufficiently positive with respect to the potentials of their associated cathodes. Each individual line circuit of the group, such as line circuit LC, connects with the primary side P of transformer 9 over one line conductor through individual resistances such as, for instance, resistances 42 and 41 for subscriber's line A. The mid-point connection between the two resistances is connected to the test terminal 23 of the line in the bank of terminals accessible to the line-finder switches, such as switch LF.

As already stated, the control electrode 3 of the second tube T₂ is further connected to the secondary S of transformer 9 by way of series condenser 13 and its associated resistance while the cathode 5 of the first tube T₁ is connected directly to the segment on the commutator which designates the horizontal level of the line group controlled by the tubes T₁, T₂ and T₃, and through resistance 37 to the winding of relay 12 via the No. 4 normal contacts of relay 38 in the preferred line finder LF, and also to the control electrode 3 of tube T₂ through resistance 13, to the control electrode 14 of tube T₃ through condenser 29 and resistance 28, and to the source of positive power supply 24 through condenser 29 and resistance 27.

Each line circuit connects to a set of three terminals appearing in the terminal banks accessible to a group of line-finder switches, as indicated by the individual line circuit LC which connects to terminals 21, 22 and 23. The line-finder switch LF is of the well-known step-by-step type provided with two banks each of one hundred sets of terminals of which the upper bank of one hundred terminals is typically represented by the terminals 21, 22 and 23 and the lower bank of one hundred terminals by terminals 31, 32 and 33, said last group of terminals being located in a level corresponding to the level which holds the first group. The two banks of terminal sets are arranged in ten levels, each level consisting of ten horizontal terminal sets, the upper bank sets being selectable by brushes 15, 16, 17 and the lower bank sets by 15', 16' and 17'. These brushes, as well as brush 8, are carried on a common shaft (not shown) which is advanced vertically to the proper lever and then horizontally to the terminals of the calling line under control of the vertical magnet 11 for vertical stepping and the rotary magnet 20 for horizontal stepping, respectively. The line finder is provided with a vertical commutator 7 which has ten conducting segments, one for each two levels of terminals in similar horizontal disposition in each of the two terminal banks. Associated with this commutator is a brush 8 which, as stated before, is mounted on the common brush shaft and advances simultaneously with brushes 15' to 17', inclusive, and 15 to 17, inclusive, during vertical stepping to engage the successive segments of the commutator.

The operations of the circuits controlling the setting of a connection will now be fully set forth in detail in the following description of a call initiated from station A for termination at station B.

When the receiver is removed from the switch-

hook at station A to originate a call, a circuit is completed from ground through the primary winding P of transformer 9, conductor 40, resistances 41 and 42, loop of station A, resistance 43, positive battery to ground. During the build-up of current in this path, a momentary surge of potential is induced in the transformer coupled path which may be traced from ground through the secondary windings of transformer 9, condenser 6, and associated resistance, resistances 30 and 35 to positive battery 24, and in parallel therewith through resistances 34 and 10 to negative battery 36. Control electrode 4 of tube T₁ is normally at a positive bias. This is because the potentiometer resistances 35, 34 and 10 are so calculated as to place a "critical" positive potential on electrode 4 but not sufficient to fire the tube unless a positive impulse is produced through the transformer 9 or tube T₃ is conducting as will be explained later. Control electrode 3 of tube T₂, on the other hand, has no bias of any kind since its control electrode 3 is connected, through resistance 13, to the cathode battery of tube T₁, and will not be able to fire unless such electrode is rendered positive. Hence when the impulse is produced through the transformer, the potential of electrode 4 is raised to the flash point of the tube, causing it to break down between control electrode 4 and cathode 5, after which a current is established between cathode 5 and anode 19, over the following path: positive battery 24, anode 19, cathode 5, resistance 37, conductor 55, No. 4 normal contacts of relay 38, winding of relay 12, No. 3 contacts of relay 38 to negative battery. Relay 12 operates and performs functions noted hereinafter. The full potential drop in resistance 37 and relay winding 12 is further applied to terminal 3 of the vertical marking commutator 7, thus indicating that the calling line is in the group of lines located on the eighth level of terminals either in the upper set or lower bank of terminals.

It will be observed that the inductive surge through transformer 9 is also applied to the control electrode 3 of tube T₂ but that this electrode has no positive bias as in the case of the control electrode of tube T₁. Hence the positive potential created by the surge will not be sufficient to render the control electrode positive enough to cause tube T₂ to break down. However, when tube T₁ has broken down in the manner already described, the potential drop in the resistance 37 and relay winding 12 is available as a positive bias voltage between the control electrode 3 and cathode 5 of tube T₂, through resistance 13. That is to say, tube T₂ now has acquired a positive bias on its control electrode 3 so that a second impulse produced through the transformer 9 will have the effect of rendering control electrode 3 sufficiently positive to cause tube T₂ to break down and perform functions hereinafter described.

Assume that terminals 21, 22 and 23, associated with the line circuit LC of calling station A, are the fifth set of terminals in the eighth level of the upper bank of terminals of the line-finder switch. Tubes T₁, T₂ and T₃ are common to all of the twenty lines appearing in the eighth level of each of the two terminal banks, each of these lines connecting with the control electrodes of the first two tubes through the secondary of transformer 9 as previously explained. Upon the aforementioned breakdown of the tube T₁, in response to the initiation of the call at station A, a potential is placed upon the eighth segment

of commutator 7 and relay 12 is operated as previously described. Relay 12 grounds the sleeve lead 44 to the selector S at its upper inner contacts, and closes a circuit for relay 45 extending from ground on the No. 3 contacts of relay 12, contacts of vertical magnet 11, contacts of rotary magnet 20, lower winding of relay 45, to battery on the No. 3 contacts of relay 38. Relay 45 operates and closes the circuit of vertical magnet 11 from battery on the No. 3 contacts of relay 38, winding of vertical magnet 11, No. 4 back contacts of relay 45, contacts of relay 45 to ground on the lower contacts of relay 12. Vertical magnet 11 operates and lifts the brush shaft one vertical step to the first level of terminals and breaks its own contacts to release relay 45 which, in turn, opens the driving circuit of the magnet which, on releasing and closing its contacts, reestablishes the circuit of relay 45 and the consequent reestablishment of that of magnet 11 which operates to lift brush shaft to the second level of terminals. These operations and circuit interruptions continue until the shaft has been lifted to the eighth terminal level in which the calling line is to be found, as is evidenced by the presence of the potential from cathode 5 of tube T₁ on the eighth segment of the commutator 7. When this segment is reached, a circuit is completed for relay 46 in series with lower winding of relay 45, which circuit extends from positive battery 24, anode 19 and cathode 5 of tube T₁, eighth commutator segment, brush 8, upper winding of relay 46, outer contacts of rotary magnet 20, lower winding of relay 45, No. 3 contacts of relay 38, to negative battery. Relay 46 operates, locks over its lower winding to ground on the contacts of relay 12, and further holds relay 45 operated to prevent further vertical stepping. Relay 46 transfers the locking circuit of relay 47 from the off-normal ground on the vertical off-normal contacts VON, which operates on the first vertical step of the brush shaft, to a circuit path which is partially completed at every rotary step, as subsequently set forth, through the No. 1 operated contacts of relay 46, inner contacts of rotary magnet 20, contacts of relay 45 to ground on the lower contacts of relay 12. Relay 46 is made slow in operating to provide a short interval between the last vertical step and the first rotary step in order to prevent the brush wipers from snagging because of vibration. Relay 46 also transfers the stepping circuit from the vertical magnet 11 to the rotary magnet 20 over the following path: battery through the winding of rotary magnet 20, No. 4 front contacts of relay 46, contacts of relay 45 to ground on the lower contacts of relay 12. The rotary magnet 20 now steps the brush shaft around on the eighth level terminals (causing thereby the disengagement of brush 8 from the eighth commutator segment), and, on the first step, effects a release of relay 45 because the disengagement of brush 8 with the eighth segment of commutator 7 and opens the previously traced holding circuit through the operating winding of relay 46. Relay 45 now reoperates over the previously traced circuit, in turn causing the operation of rotary magnet 20 to effect a second step of the brush shaft, these operations continuing until brush 17 engages terminal 23 of line A, distinguished from all other similar terminals of the level by the presence thereon of a potential produced by battery through resistance 43, line loop and resistance 42 as previously described.

It will be observed that two other gaseous conductor tubes B-1 and F-1 are provided, the anodes of which are paralleled to the positive direct current superimposed upon the source of alternating current 48, while the control electrode 49 of tube B-1 is connected to the upper test brush 17 through current limiting resistance 53 and the control electrode 50 of tube F-1 is connected to the lower test brush 17' through current limiting resistance 54. The cathodes 51 and 52, respectively, of both tubes are kept at ground potential so that neither tube is in a conducting state so long as its control electrode is not rendered positive during the positive half-cycle of the alternator 48. However, when test brush 17 engages terminal 23 of the calling line A, the positive potential on this terminal is applied to control electrode 49 of tube B-1 via resistance 53. Since cathode 51 is at ground potential, the potential difference between cathode 49 and control electrode 51 will cause tube B-1 to break down and become conducting between its anode and cathode as soon as the alternator 48 reaches the positive half-cycle after the electrode 49 has been rendered positive.

If the calling line A had been located in the eighth terminal level at the lower bank, as for instance line D, the line positive potential would have been impressed upon terminal 33 with which brush 17' would have been engaged, whereupon said potential would then be applied via resistance 54 to control electrode 50 of tube F-1. Since cathode 52 of this tube is also kept at ground potential, the potential difference between control electrode 50 and cathode 52 would cause tube B-1 to break down and become conducting.

Assuming, however, that the calling line is line A, located in the upper bank, then the engagement of brush 17 with terminal 23 results in tube B-1 becoming conducting, whereupon a circuit is completed for relay 47 in series with the upper winding of relay 45, extending from positive potential at cathode 51, lower winding of relay 47, No. 5 back contacts of relay 39, No. 5 normal contacts of relay 47, upper winding of relay 45 to ground on the No. 2 contacts of relay 12. Relay 47 operates, at least to the extent of closing its No. 2 contacts.

Since relay 46 is operated and rotary magnet 20 is held through the No. 4 front contacts of said relay to ground on the lower contacts of relay 12 via the contacts of relay 45, the full operating and locking circuit of relay 47 is completed over the inner contacts of rotary magnet 20, contacts of relay 45 to ground on the lower contacts of relay 12. It is necessary to insure a fast auxiliary circuit to completely energize relay 47 because when alternator 48 reaches the negative half-cycle, the anode of tube B-1 becomes negative and the tube extinguishes, thereby opening the initial operating circuit of relay 47. A circuit is now completed for relay 39, extending from battery through its lower winding, No. 3 contacts of relay 47, inner contacts of magnet 20, contacts of relay 45 to ground on the lower contacts of relay 12.

Note that if line D had initiated the call instead of line A, the calling potential would be present, of course, on terminal 33 instead of terminal 23 and tube F-1 would have been rendered conducting instead of tube B-1. Under these assumed circumstances, relay 47 would not operate but relay 39 would in a circuit completed from the positive potential available at cathode

52, upper winding of relay 39, No. 1 back contacts of relay 38, upper winding of relay 45 to ground on the No. 2 contacts of relay 12. Relay 39, upon operating, would then lock over its lower winding through the circuit path already described.

The operation of relay 39 extends the talking conductors from the No. 1 and No. 4 front contacts of relay 47, over its own No. 1 and No. 6 contacts, respectively, to the selector S, opens the initial circuit of relay 47 at its No. 5 back contacts, closes a circuit for relay 38 which extends from battery through its upper winding, No. 2 front contacts of relay 39, to ground on the lower operated contacts of the vertical off-normal contact set VON, opens the circuit of relay 12 at its No. 3 contacts, and further opens the negative battery supply, through the winding of relay 12 and resistance 37, to the cathode 5 of tube T₁, which causes the tube to become non-conducting except under certain conditions to be described later. Relay 12 releases, disconnects ground from the upper winding of relay 45, causing it to release, in turn releasing relay 46.

The operation of relay 38 joins sleeve brush 17 of the line finder LF to sleeve conductor 44 of the selector S over the No. 1 front contacts of said relay and the No. 5 alternate contacts of relay 47, extends the locking ground of relay 39 to said conductor 44 over its No. 2 contacts, advances the starting conductor 55 to relay 12 in the next succeeding idle line-finder switch in the chain over its No. 4 contacts, and removes battery from relays 45 and 46 and vertical magnet 11. Relay 38 further connects alternating potential source 57 superimposed on negative battery to conductor 55 which connects with the cathode 5 of tube T₁. Since the effect of this is to connect negative potential to the cathode 5 on every half-cycle of the alternator 57, then on the positive portion of the wave, cathode 5 is rendered positive. Should another line in the group now initiate a call, tube T₁ will break down by virtue of exactly identical circuit conditions established through relay 12 of the succeeding line finder by the operation of relay 38. However, while the succeeding line finder is hunting for the calling line, the tube T₁ will remain conducting because of the cathode-anode circuit heretofore described but now through the winding of relay 12 of the succeeding line finder. There will be, in addition, a flow of pulsating current from the superimposed source 57 through the lower winding of relay 38 which will prevent this relay from releasing while relay 12 in the succeeding line finder is operated. However, when the circuit through relay 12 is opened in the succeeding line finder as described for the line finder shown in the drawing, pulsating current will continue to flow through both relays 38 to the cathode 5 of tube T₁ which will then become non-conducting in the negative half-cycle after relay 12 in the succeeding line finder has released.

The calling line A is now extended to the first selector S which is then positioned on the terminals of an appropriate connector C by one series of dial impulses, the connector itself being then positioned on the terminals of the called station B by the next two series of dial impulses transmitted from the dial at station A, all in accordance with well-known automatic telephone practice. Since this part of the operation as well as the release of the connection forms no part of this invention, further description thereof is omitted.

If a second line in the group of twenty lines attempts to initiate a call after a previous line has caused tube T₁ to become conducting but before the line-finder operations above described have been completed, the second positive impulse from the surge through transformer 9 will cause tube T₂ to break down and become conducting because of the presence of the positive bias on the control electrode 3 of tube T₂ as previously described. Note that unless tube T₁ is conducting, the surge voltage from transformer 9 will not cause tube T₂ to break down. Tube T₂ is maintained conducting over a cathode-anode circuit extending from positive battery 24, anode 61 and cathode 60, resistance 2 to negative battery 36. The potential drop in resistance 2 applies a critical positive bias to control electrode 14 of tube T₃ via resistance 62 and resistance 28. Now when tube T₁ becomes non-conducting as a result of the operation of relay 39, a positive inductive surge from the winding of relay 12 and that inherent in the internal inductance of tube T₁ will be applied to the control anode 14 of tube T₃ via condenser 29 and resistance 28 causing said tube to break down and become conducting. Tube T₃ is now extinguished by the positive surge applied to its cathode 60 through the commutating condenser 59. But when tube T₃ is conducting, the potentiometer formed by resistances 34 and 35 together with the voltage drop in resistance 10 applies a positive voltage to the control electrode 4 of tube T₁. This voltage, however, is not applied immediately, but only after a delay as required by the charging time of condenser 58 through resistance 34. This delay is introduced to allow time for the operation of relay 38 after the operation of relay 39. The potential thus applied to control electrode 4 of tube T₁ will cause it to break down again to initiate the operation of the next succeeding line finder via conductors 55 and 56. When tube T₁ thus reoperates it extinguishes the discharge in tube T₃ by means of the commutating condenser 64 connected between the cathode 5 of tube T₁ and the cathode 65 of tube T₃. The circuit is now in the same condition as that existing just after a single subscriber such as A has initiated a call and the operations are the same as those described.

While this embodiment of the invention has been described with reference to a line-finder system in which there are three tubes to accommodate the satisfactory initiating of two "overlapping" calls in the same group of lines, it is evident that the tube counting circuit could be adapted to store as many overlapping calls as might be required by the provision of additional tubes similar in function to tube T₂.

What is claimed is:

1. In a telephone system, the combination with a group of lines and a plurality of connecting means therefor, of a plurality of gaseous conducting devices inductively coupled to said group and a network interconnecting said devices whereby the initiation of a call from one of said lines produces an inductive surge that renders one of said devices operative to effect a connection of one of said connecting means to said calling line and renders critical a succeeding one of said devices through said network to the inductive surge following the initiation of another call from another of said lines before said connecting means effects a juncture with said calling line.

2. In a telephone system, the combination with a group of lines and connecting means

therefor of a first starting gaseous conductor device inductively connected to said group of lines and operatively associated with said connecting means, a group of call-storing gaseous conductor devices inductively coupled to said group of lines and a second starting gaseous conducting device connected to all other of said devices through a condenser-resistance network adapted to render each succeeding device critically responsive to an inductive surge by the conductive condition of a preceding device, whereby the initiation of a call by one of said lines produces an inductive surge that renders said first starting device conductive to effect a juncture of said connecting means with said calling line subsequent to which said starting device is reset by the disruption of its operative association with said connecting means, whereby a plurality of succeeding calls initiated before said juncture is affected are recorded in succession on each of said call-storing devices by being rendered conductive, respectively, in response to inductive surges, and whereby said second starting device is rendered conducting by the resetting of said first starting device and said first starting device is rendered conducting by the conductive surge produced through said network.

3. In a telephone system, a group of lines disposed upon the terminals of a line-finder bank, a line-finder switch adapted to hunt thereover, a gaseous conductor starting device for said line finder inductively coupled to said group of lines whereby said device is rendered conducting by the inductive surge produced when one of said lines calls to start said line-finder switch hunting for the terminals of said calling line, means whereby said device is reset when said terminals are found, a gaseous conductor storage device for storing a second call initiated by another line prior to said line finder reaching the terminals of the line which initiated the first call, and another gaseous conductor starting device for rendering said first gaseous conductor starting device conductive after being reset by said line-finder switch, said three gaseous conductor devices being disposed in relation to each other to be rendered critically responsive, in succession, by the conductive condition of a preceding device.

4. In a telephone system, a group of lines disposed upon the terminals of a line-finder bank,

a line-finder switch adapted to hunt thereover, a gaseous conductor starting device for said line finder inductively coupled to said group of lines and adapted to be rendered conducting by the inductive surge produced when one of said lines calls for operating said line finder to hunt for the terminals of the calling line, and a group of gaseous conductor storage devices for storing successive calls initiated prior to said line finder reaching the terminals of said line, said storage devices being inductively coupled to said group of lines and rendered conducting in succession through surges created by other calling lines, said storage devices being adapted in relation to each other and to said starting device to be rendered critically responsive in succession by the conductive condition of a preceding device.

5. In a telephone system, the combination with a group of lines and connecting means therefor of a gaseous conducting device for said connecting means inductively coupled to said lines, and a plurality of gaseous conducting storing devices inductively coupled to said lines and adapted with said starting device to be rendered, in succession, critically responsive by the conducting state of a preceding device, whereby the initiation of a call by one of said lines produces an inductive surge that renders said starting device conducting to effect a connection of said connecting means with said calling line and whereby the initiation of a plurality of successive calls thereafter but before said connecting means is joined to said calling line, produces a succession of inductive surges that renders successive storage devices conducting to store each of said calls.

6. In a telephone system, the combination with a group of lines and connecting means therefor of a gaseous conductor starting device and a group of gaseous conductor storage devices all inductively coupled to said group of lines whereby the initiation of a call by a line in the group produces an inductive surge that renders said starting device conductive to effect a connection of said connecting means to said calling line and whereby the initiation of other calls from other lines in the group before said connecting means effects a connection with said line produces corresponding inductive surges which render each of said storage devices conductive to record the initiation of a call.

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