Jan. 20, 1942. H. M. BASCOM ET AL 2,270,246

TELEPHONE SYSTEM

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FIG. 1

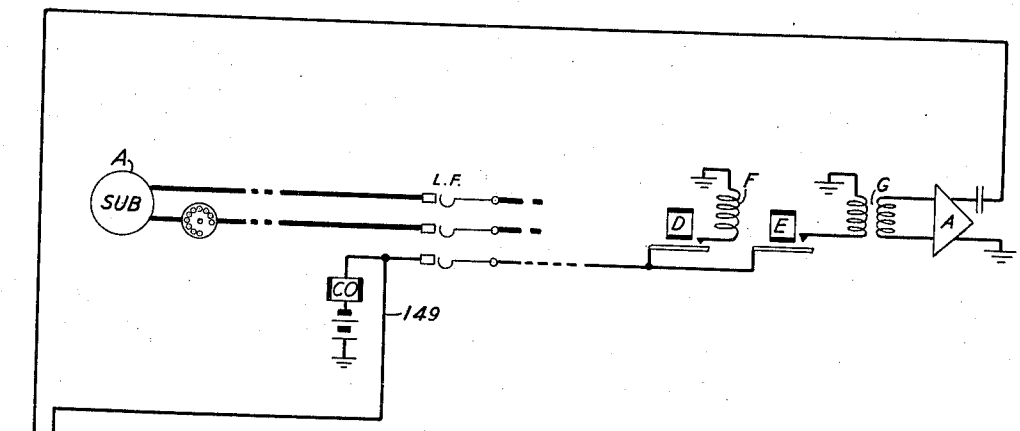
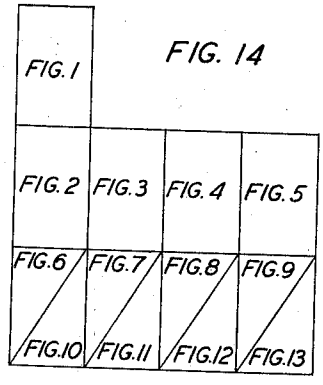



FIG. 14




705

149

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TELEPHONE SYSTEM

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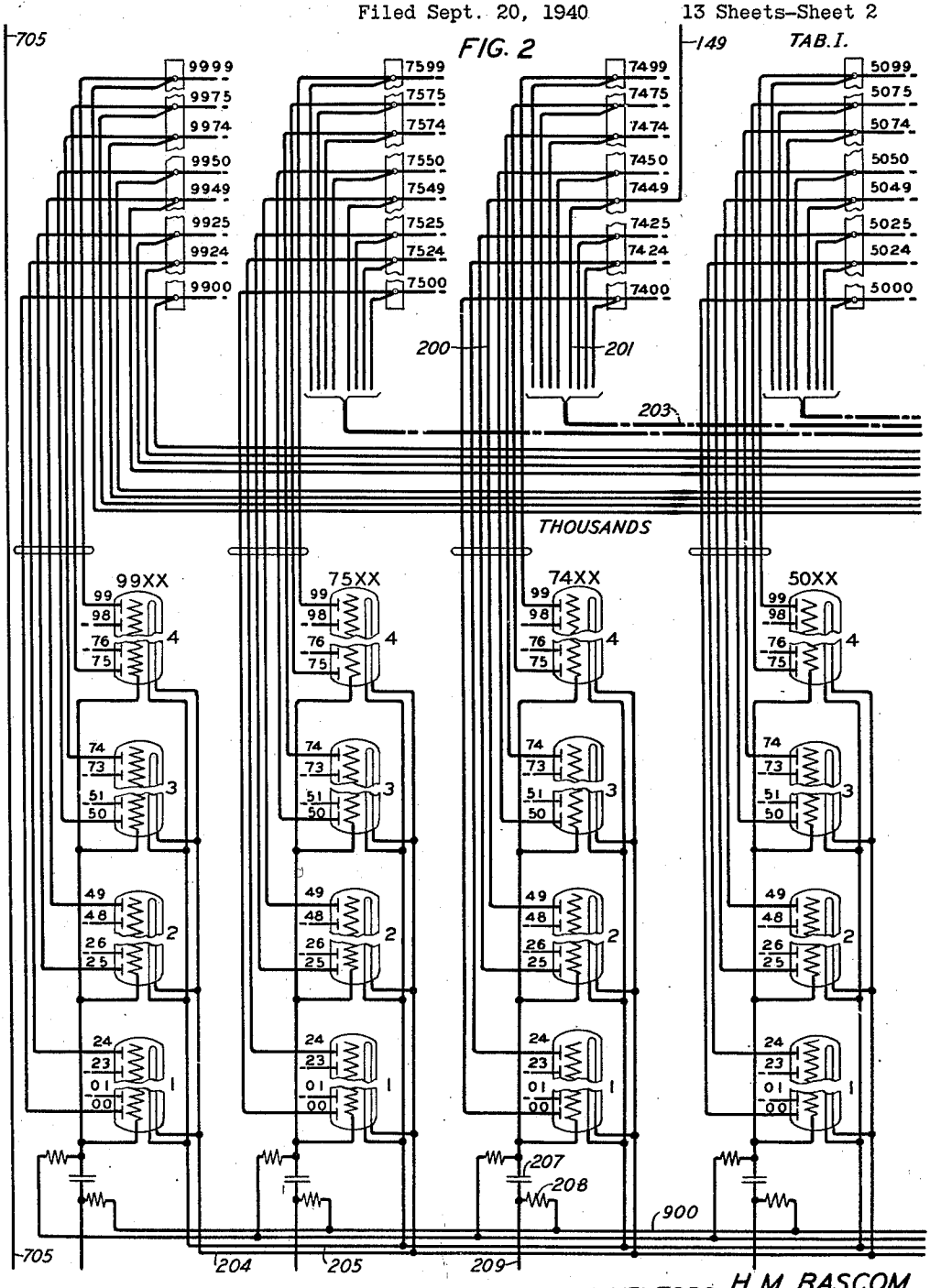
FIG. 2

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TELEPHONE SYSTEM

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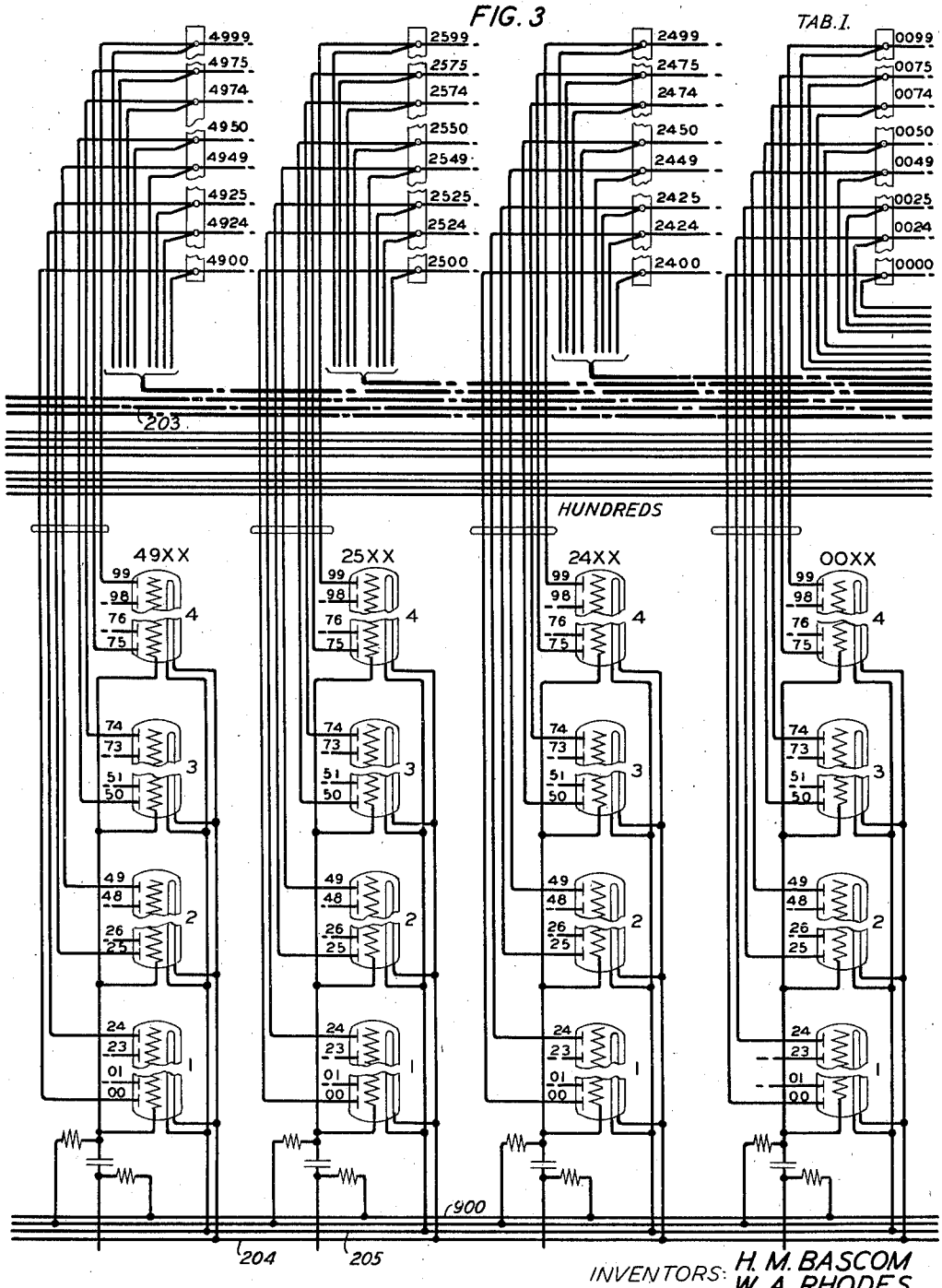
FIG. 3

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TELEPHONE SYSTEM

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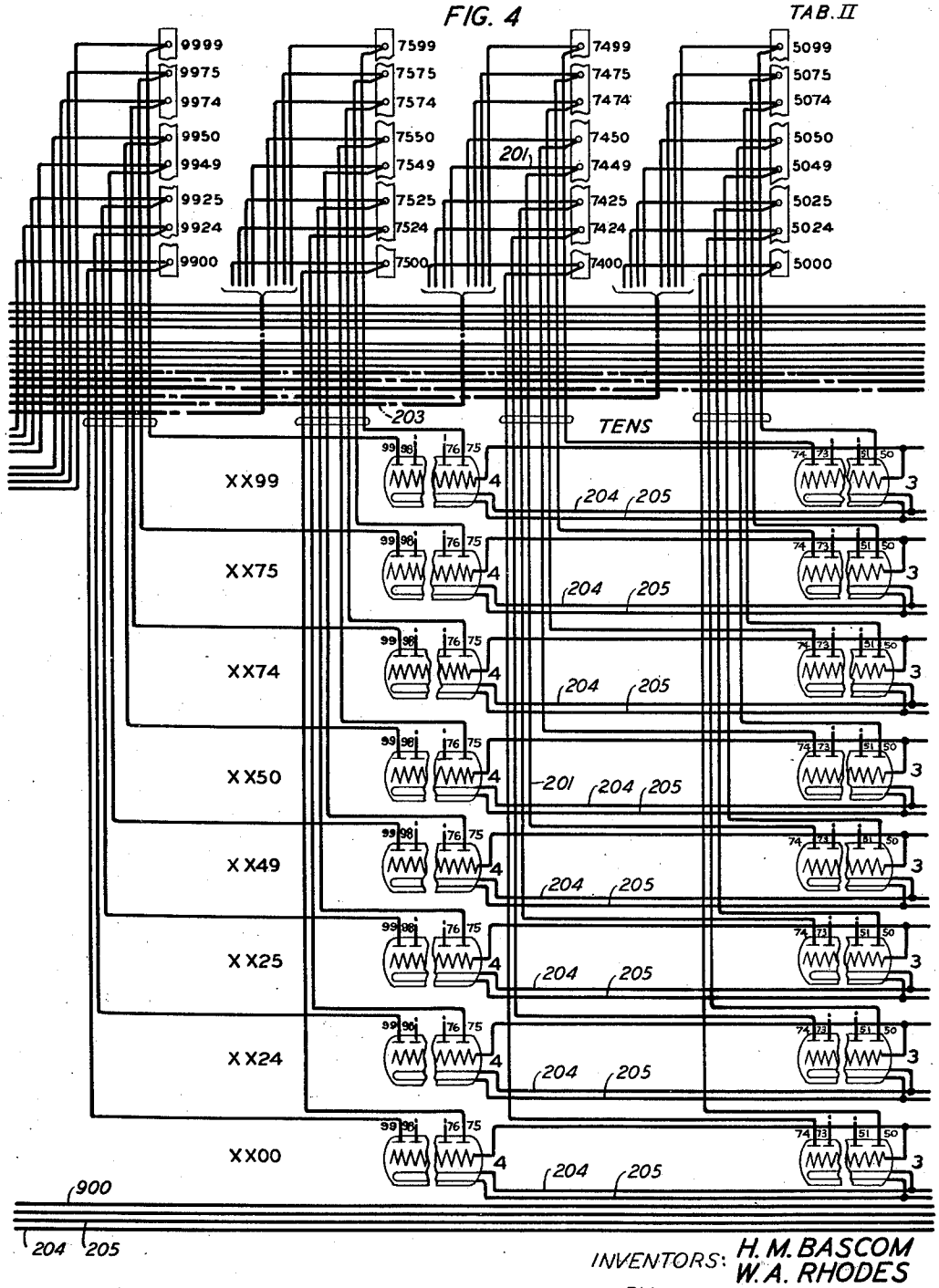
FIG. 4

TAB. II

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TELEPHONE SYSTEM

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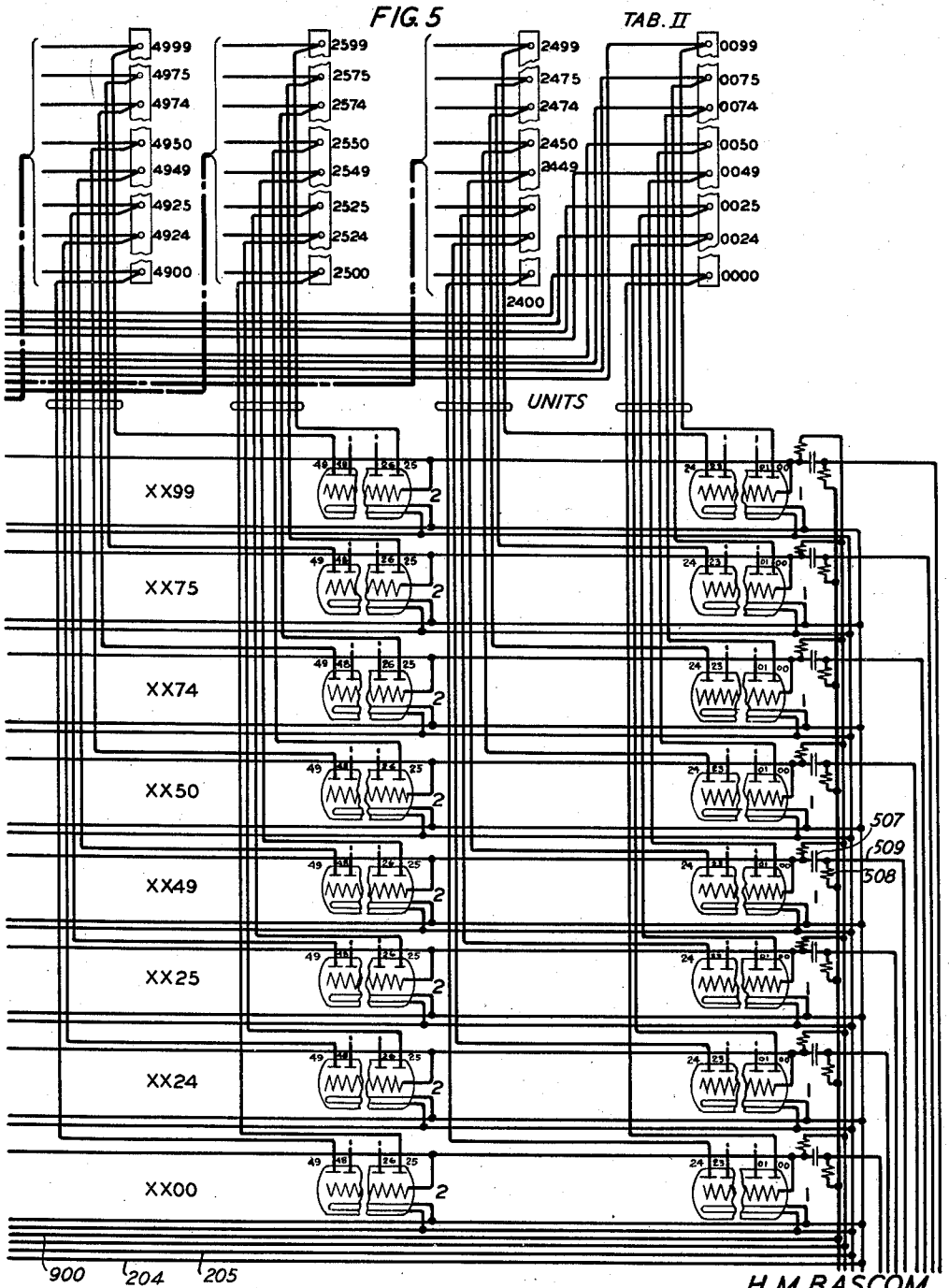
FIG. 5

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TELEPHONE SYSTEM

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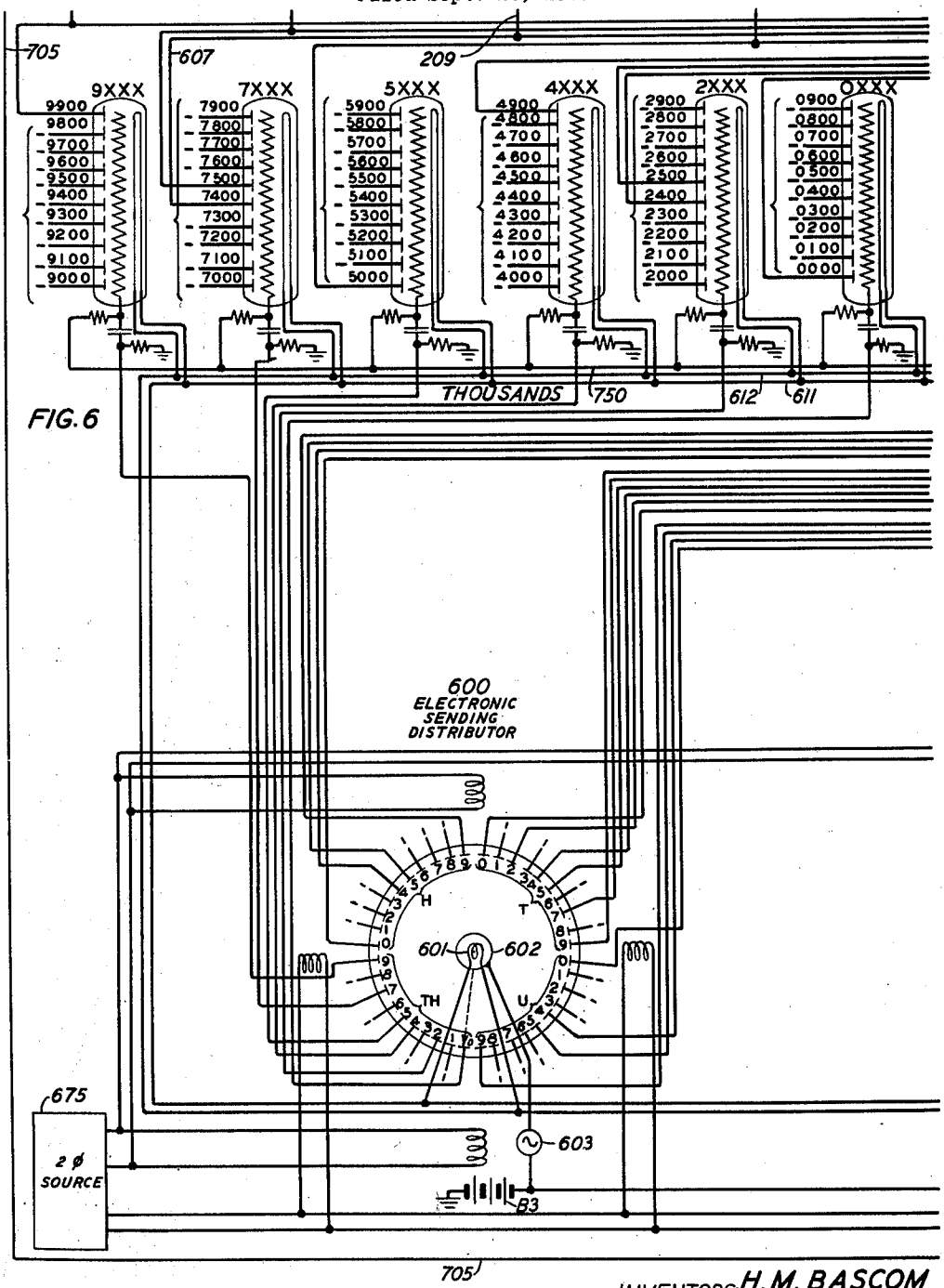


FIG. 6

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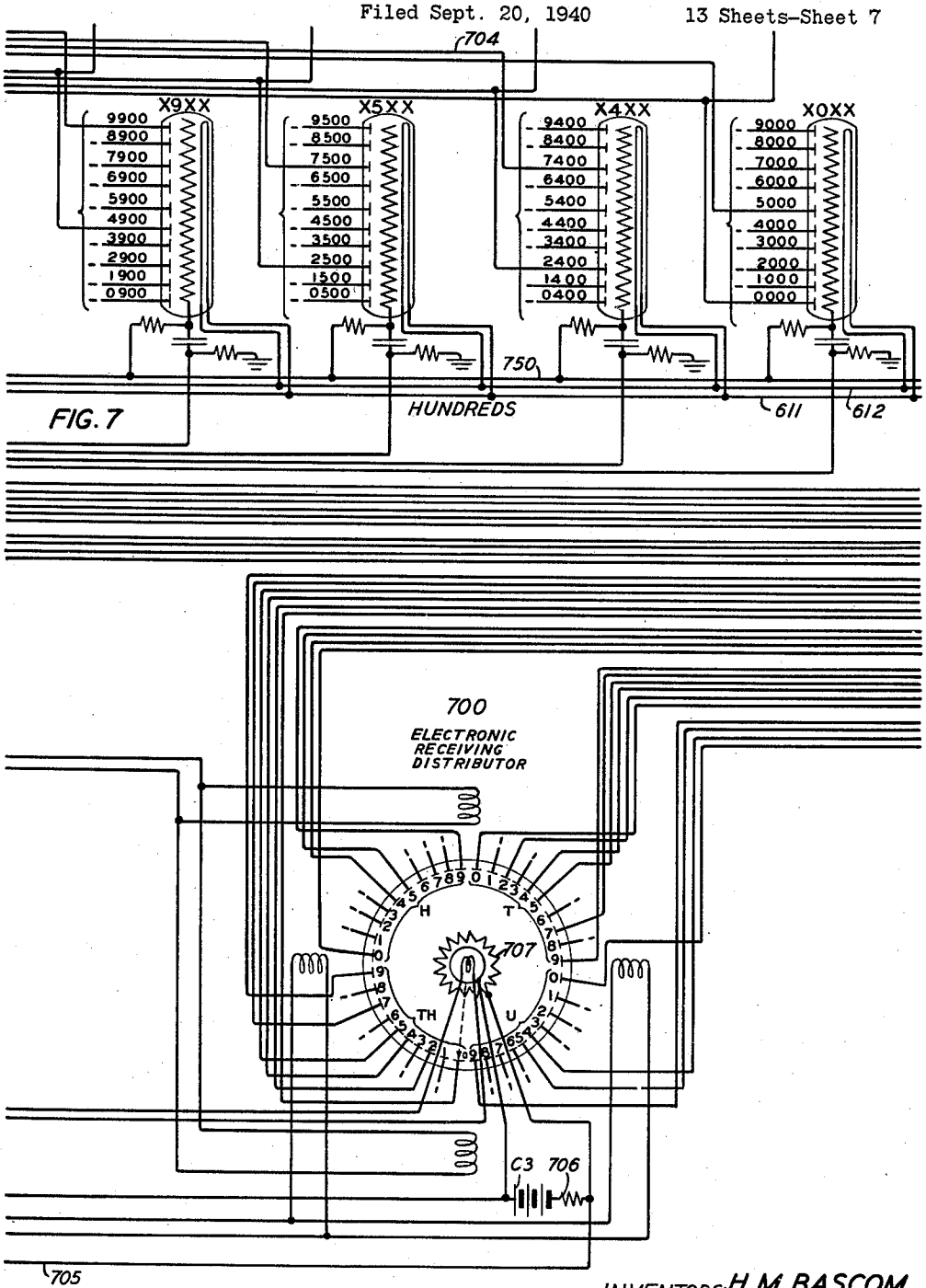


FIG. 7

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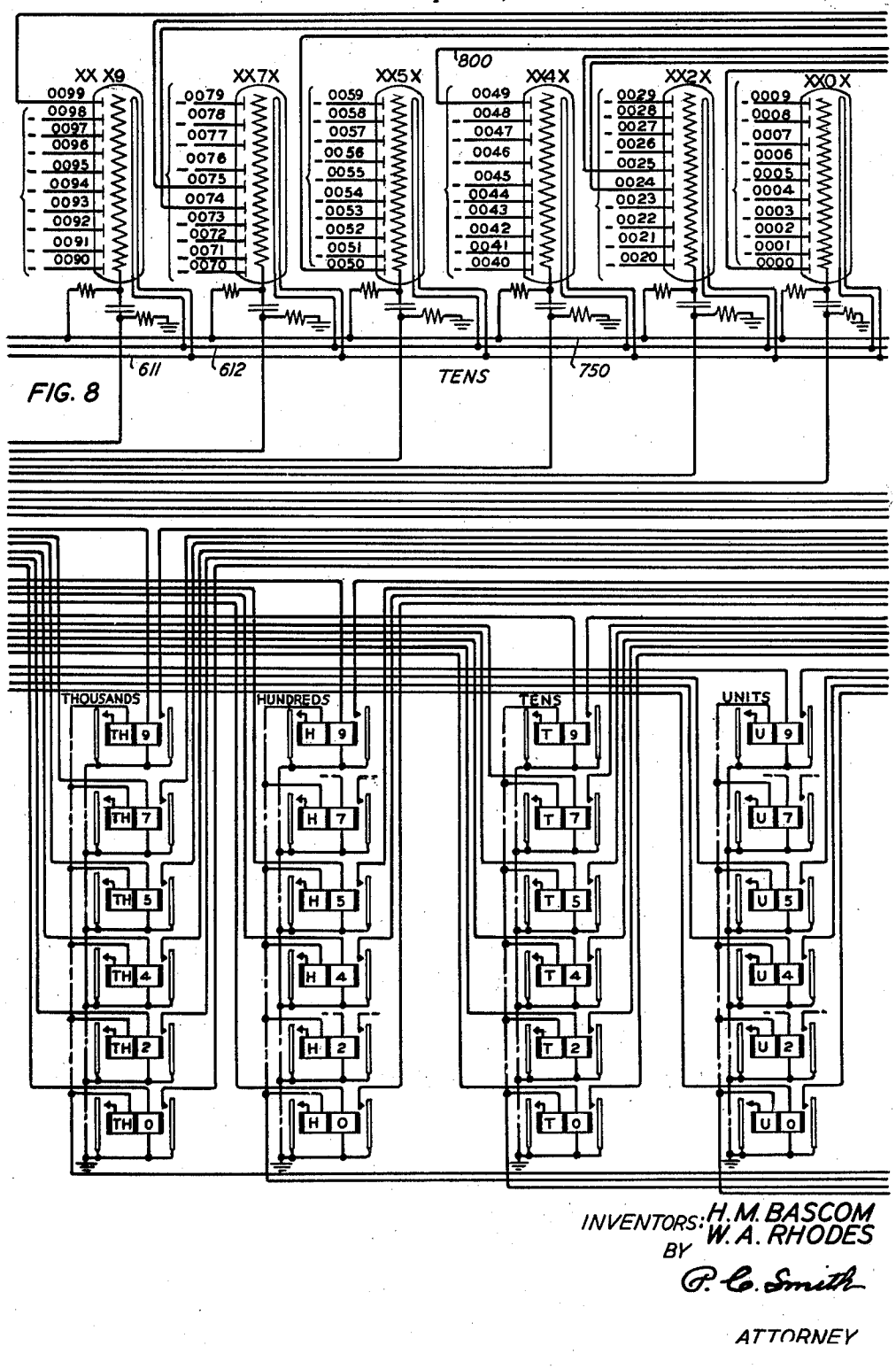


FIG. 8

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TELEPHONE SYSTEM

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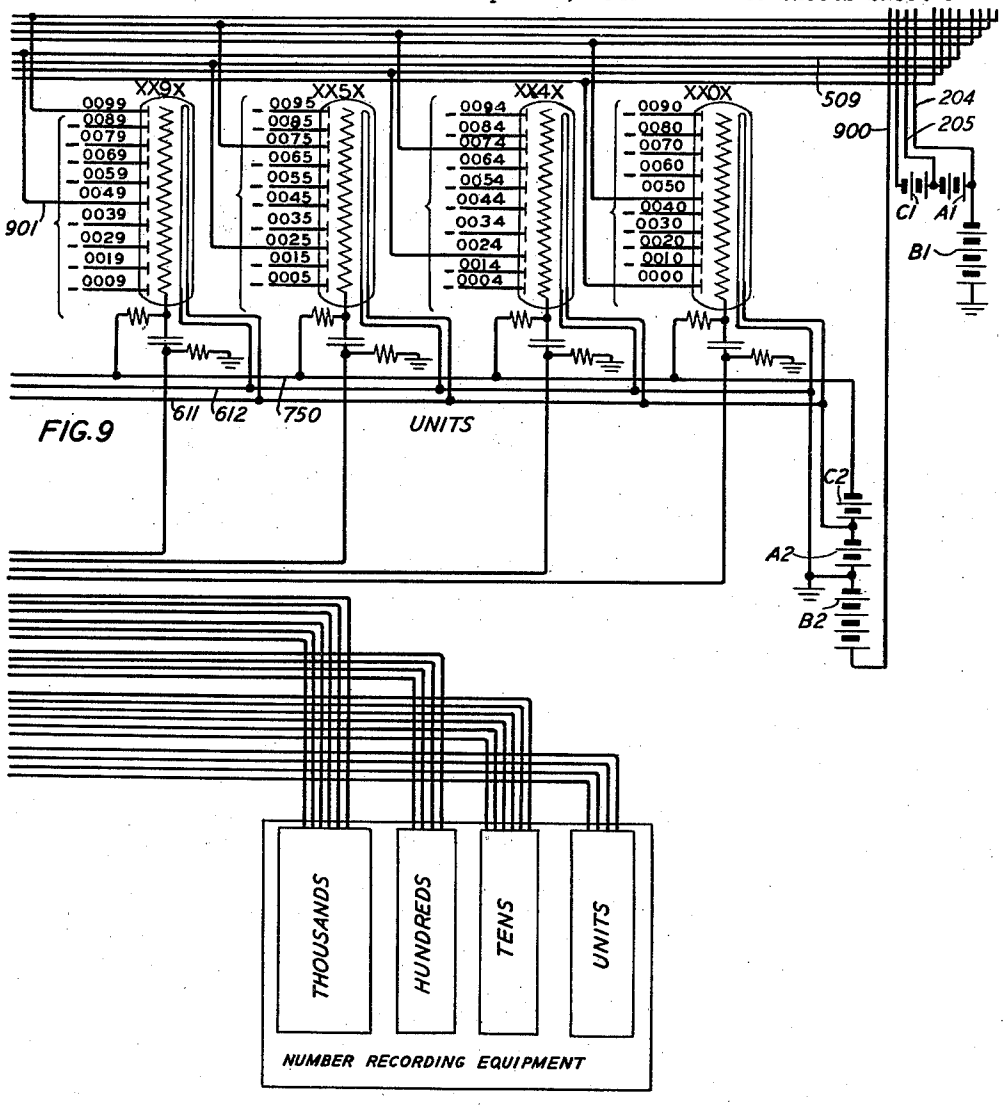
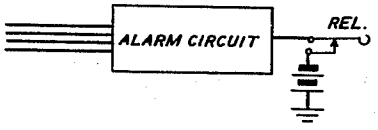



FIG. 9

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TELEPHONE SYSTEM

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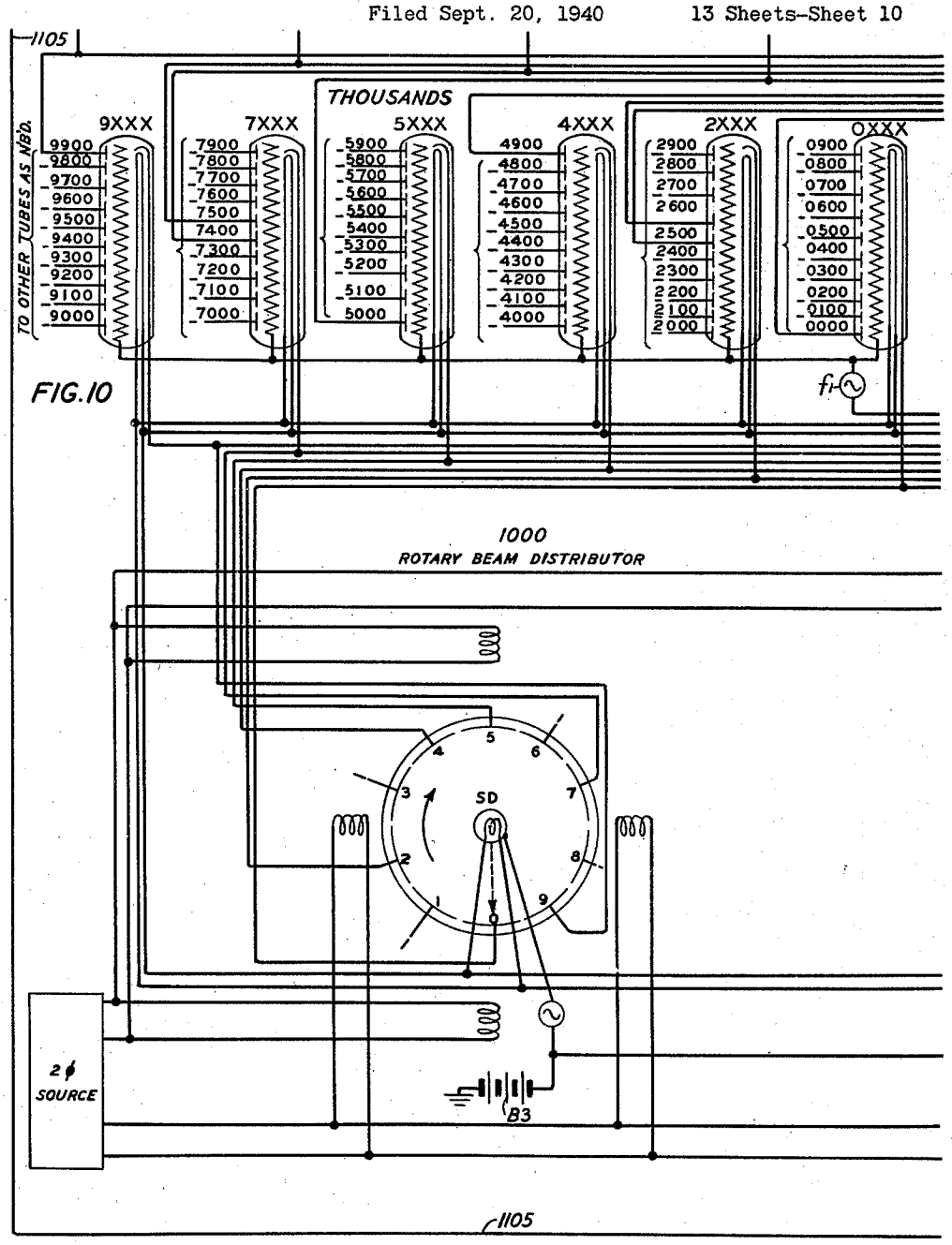


FIG. 10

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TELEPHONE SYSTEM

Filed Sept. 20, 1940 13 Sheets-Sheet 11

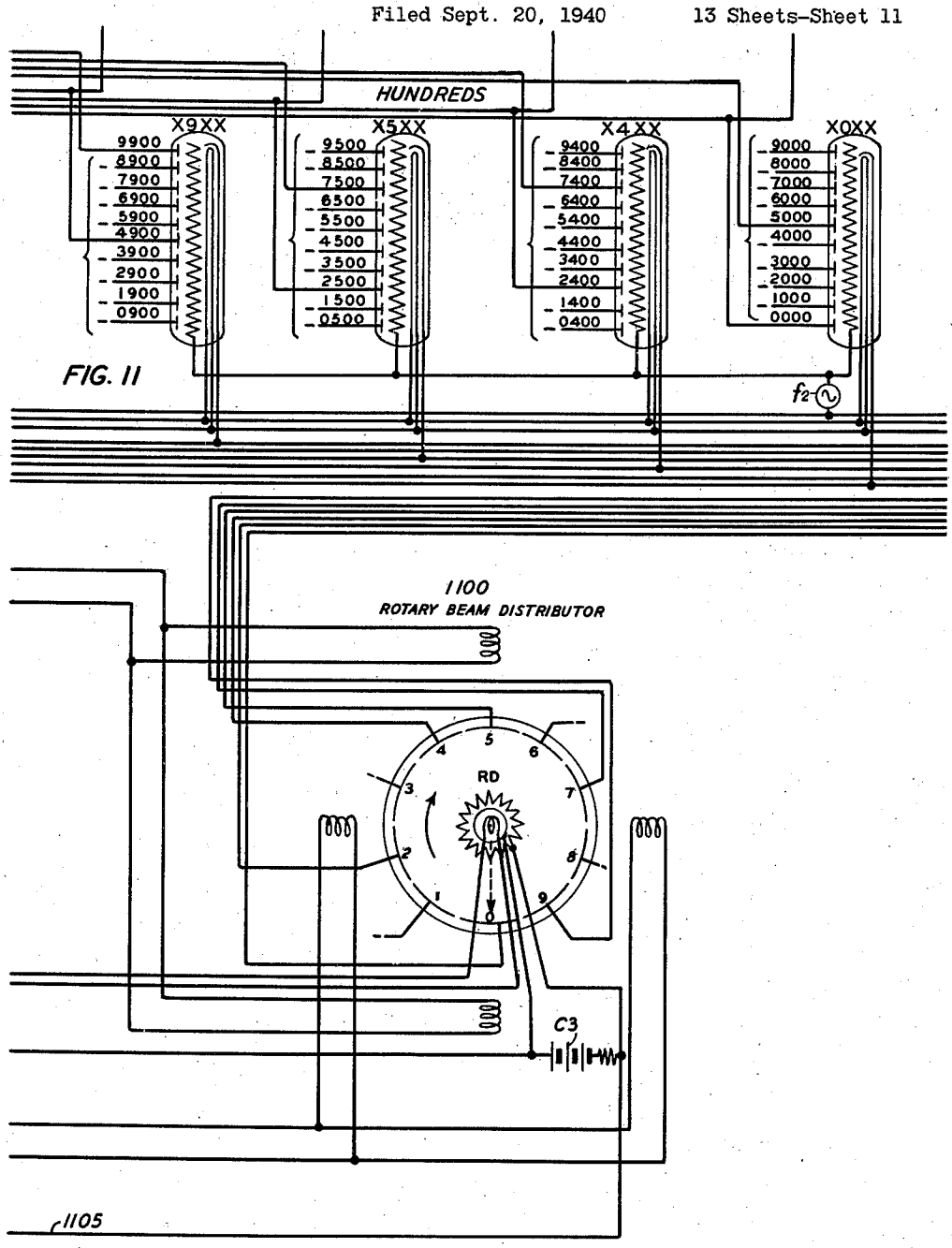


FIG. 11

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TELEPHONE SYSTEM

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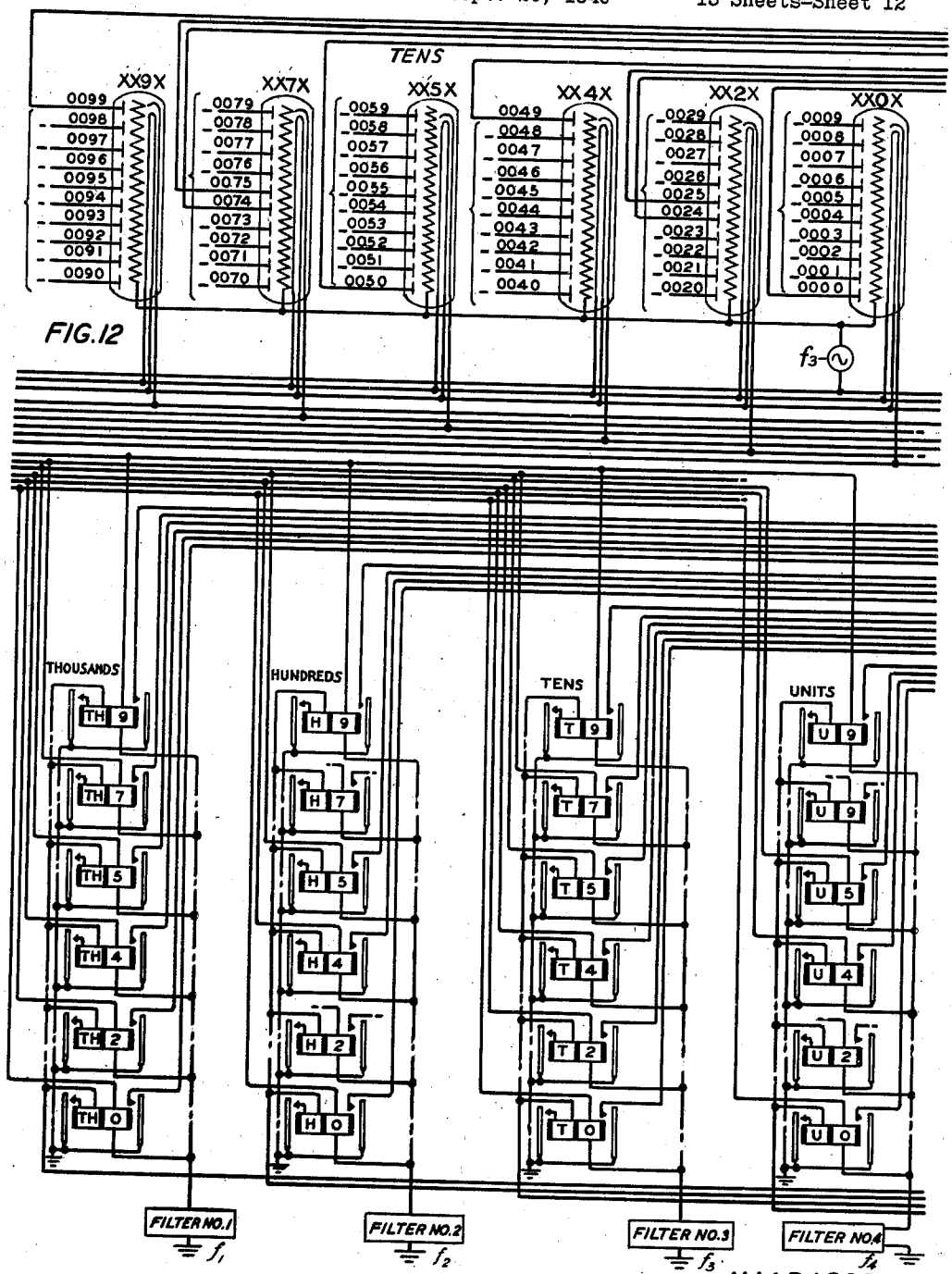


FIG.12

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TELEPHONE SYSTEM

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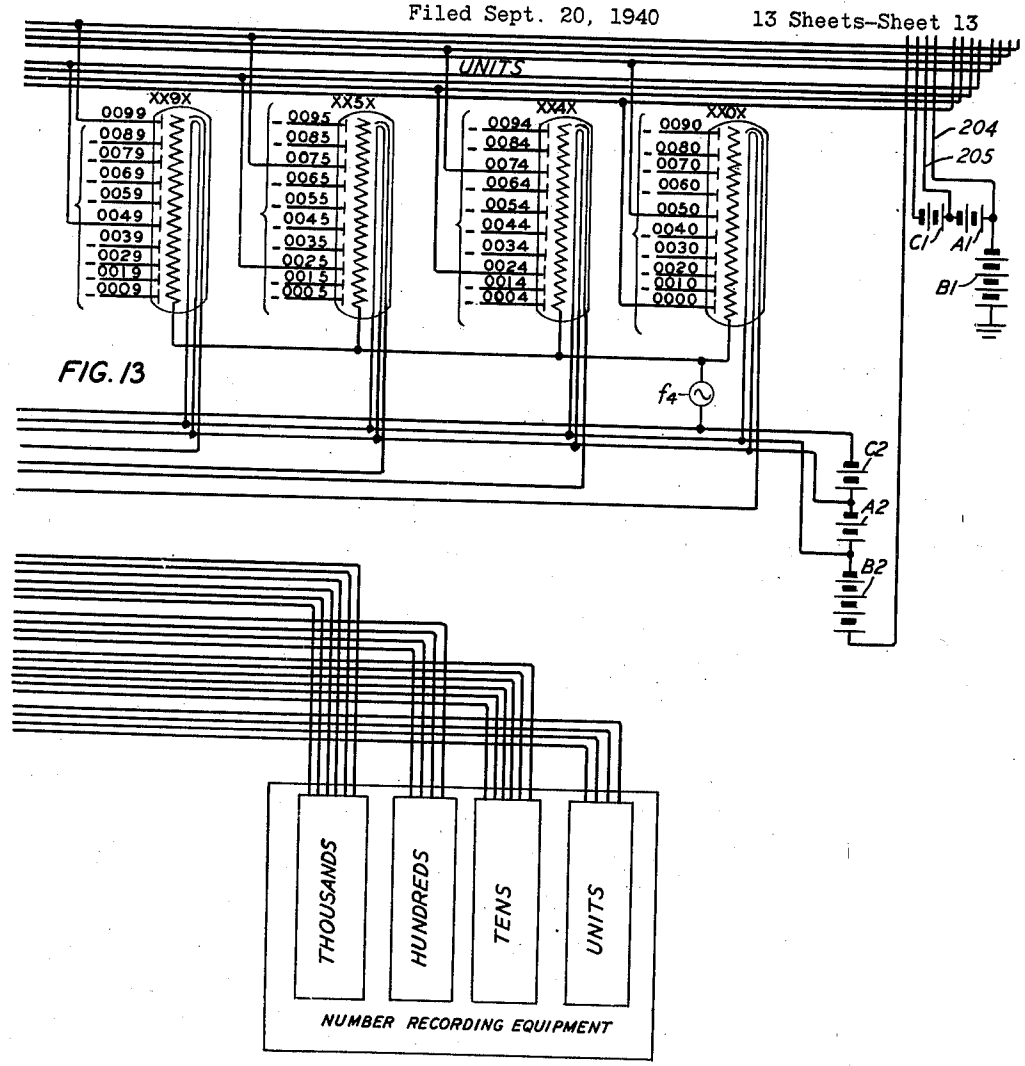
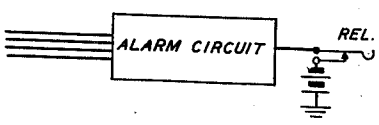



FIG. 13

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Patented Jan. 20, 1942 2,270,246

# UNITED STATES PATENT OFFICE

2,270,246

## TELEPHONE SYSTEM

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Application September 20, 1940, Serial No. 357,519

9 Claims. (Cl. 179—27)

This invention relates to telephone systems and more particularly to those systems in which the numerical indication of a calling line is automatically determined and made available.

It is well known that in certain types of telephone connections such as those, for instance, in which the calling line is extended automatically or otherwise to some remote station, it is necessary to ascertain the number of the calling station in order that charges for the call may be properly assessed to said station. Such connections are known as toll or long distance connections and in some types of automatic telephone systems in which the calling line is routed to its destination via the position of a recording operator where, after the number has been communicated to the operator by the calling subscriber, said number is verified over a so-called checking multiple. This verification is made by touching the tip of a checking cord to that pin in the checking multiple which is assigned to the given number and if the number as given by the calling party is correct, a tone circuit is completed over the checking cord which is heard in the operator's telephone set. On the other hand, if the number as given does not correspond to that of the pin to which the tip of the cord is touched, the tone circuit is not completed and this fact indicates to the operator that the number given by the subscriber does not correspond to that of the station from which he is calling, in which event service may be denied until the discrepancy is rectified.

In automatic telephone systems, it is desirable to have the identity of the calling station ascertained and transmitted automatically to some point at which it may be recorded on settable registers for the visual display of the number, if the call is completed through an operator's position, or for automatic recording if the information is to be utilized for operating printing or other recording devices responsive to the setting of the registers.

Our invention is principally concerned with the automatic identification of the calling line number and its principal feature is an arrangement of two main groups of vacuum tube devices, two auxiliary groups of vacuum tube devices which are arranged with respect to each other, respectively, to produce two coordinate translations of which the first provides an identification of each of the first two digits of the line number and the second provides an identification of each of the second two digits of the line number, suitable registering and recording equipment responsible thereto, and two synchronous electronic devices of which one, functioning as a sending distributor, activates the two auxiliary groups of vacuum tubes the effect of which is to operate one tube in each main group to produce an impulse of current over an identifying conductor of a calling line and the other of which, functioning as a receiving distributor, responds to this impulse to operate the registers for locking therein the numerical designation of the line associated with the identifying conductor. According to one embodiment of our invention as adapted to provide identification for one or more lines in a ten thousand line capacity telephone office, we propose to use two main groups of four hundred vacuum tubes each having twenty-five anodes with each line to be identified connected to one anode in a tube of each group, and two other auxiliary groups of twenty vacuum tubes to a group, each having ten anodes with their respective anodes connected to a source of positive potential and to the grid of a tube in the correlated main group and their respective grids connected to a source of negative potential and to a target in the sending distributor.

Each of the grids of the auxiliary tubes is connected to that target in the sending distributor which identifies that portion of the main group of tubes to which the anodes of said tube are connected which, more specifically, designates a particular thousand subgroup of the ten thousand line numbers to be identified. The cathodes of these auxiliary tubes are all connected to a source of filament current in the usual manner, thus causing said tubes to be normally activated. When the grid potential is suddenly changed by the ray of the sending distributor impinging upon the associated target to produce an impulse in the anodes of the tubes, said impulse is transmitted to the grids of the respective tubes in the main groups to which such anodes are connected. Inasmuch as the anodes of the tubes in each of the main groups are at negative potential during the time when no line is calling, the potential to which the main tube grids are raised by the momentary operation of the auxiliary tubes is productive of no effect. However, when a line calls, the potential of its anode in each tube in the two main groups of tubes to which such line is connected is changed from negative to positive and is of such a value that, with the grid potential at the value determined by the operation of the auxiliary tube or tubes from which said potential is derived, the two tubes in the main groups are rendered conducting, thereby completing an anode circuit through a transformer to which is coupled a suitable amplifier connected to the grid of the sending distributor. Since each of the main tubes bears a digital coordinate relation to the twenty-five lines connected to its anodes, and since the connection between the grids of the main tubes and the anodes of the auxiliary tubes is determined ac-

cording to thousand digit subgroups, there is present in the currents produced through the two operated tubes in the main groups, in consequence of the sending distributor impinging in succession upon the targets connected to the grids of the various auxiliary tubes and particularly upon the tubes therein having anodes connected to the grids of the tube in each of the main groups associated with the identifying conductor of the calling line, a plurality of distinct signals which are amplified through suitable means and applied to the grid of the receiving distributor which causes the sequential operation of suitable registers from which the number may then be displayed or recorded by appropriate apparatus provided for the purpose.

A clearer conception of the scope and purpose of the invention may be obtained from the following description, taken in connection with the appended claims and attached drawings, in which:

Fig. 1 shows a partial conventional layout of an automatic telephone line extension and an amplifying device for amplifying the signals received from the identification circuit;

Figs. 2 and 3 show, in part, one of the two main groups of tubes;

Figs. 4 and 5 show, in part, the other of the two main groups of tubes;

Figs. 6 and 7 show, in part, the twenty vacuum tubes of the auxiliary group operatively associated with the main group of tubes shown in Figs. 2 and 3 and, also, the sending and receiving distributors;

Figs. 8 and 9 show, in part, the twenty vacuum tubes of the other auxiliary group of tubes which are operatively associated with the main group of tubes shown in Figs. 4 and 5 and, also, a conventionalized representation of the receiving equipment;

Figs. 10 to 13, inclusive, show an alternative arrangement of the sending and receiving distributors in relation to the auxiliary groups of tubes and to the receiving equipment; and

Fig. 14 shows the manner in which Figs. 1 to 13, inclusive, should be arranged with respect to each other in order to disclose the invention.

Referring, now, to the drawings, there are provided, in Figs. 2 and 3 as indicated therein, a group of four hundred vacuum tubes in vertical columns of four tubes each, namely, the one hundred columns of tubes indicated by the designations **00XX—99XX**, inclusive, for the thousands and hundreds digit designations of the various lines, and in Figs. 4 and 5 another group of four hundred other tubes in horizontal rows of four tubes each, namely, the one hundred rows of tubes indicated by the designations **XX00—XX99**, for the tens and units designations of said lines. Each tube in each column and row is of known construction and comprises twenty-seven elements, namely, a cathode, a grid and twenty-five anodes. There are, therefore, twenty thousand anodes in the two groups of tubes for an entire circuit which is to perform identifying operations for the calling lines of a ten thousand line telephone office. All of the tubes in these two main groups have their cathodes connected to a source of filament power A*f* through conductors **204** and **205**.

Each line is provided with an identifying conductor as, for instance, conductor **149**, which extends from the terminal side of the winding of the cut-off relay CO of the line, the other side of said relay being connected to negative battery. The other end of the conductor is connected to a punching on the terminal assembly block TAB I assigned to the line of which conductor **149** forms a part and bearing the same thousands, hundreds, tens and units numerical designation as the line number itself. Thus in Figs. 1 and 2 conductor **149** is connected to terminal punching 7449, and line A, therefore, is assumed to have the same numerical designation as this punching. It will be observed that the terminal assembly block TAB I is arranged in vertical sections of one hundred punchings to the section there being, for a ten thousand line office, one hundred such sections each allocated to a particular group of one hundred lines to the punchings of which are connected the identifying conductors of the related lines in the same manner as that already indicated for the conductor **149** of line A (7449).

From the other side of the punchings of terminal assembly block TAB I extend two conductors. Referring more particularly to punching 7449 by way of example, one of the conductors at that punching, namely, conductor **200**, extends to an anode in the second tube of column **74XX** (counting from the bottom up) and the other, namely, conductor **201** included in the bracket line **203**, extends to an anode in the third tube of row **XX49** (counting from right to left) via a punching on terminal assembly block TAB II. The tube in each column and row to which each of the two conductors branching from the identifying conductor is connected depends, in the case of the first group of tubes **00XX—99XX**, upon the thousand and hundreds numerical designation of the line and, in the case of the second group of tubes **XX00—XX99**, upon the tens and units designation of the line. Furthermore, since the twenty-five control anodes in each of the tubes of both groups are themselves numerically designated in consecutive order as a matter of convenience, the particular anode in each tube to which an extension of the identifying conductor is to be connected is made to depend upon the identity between the numerical designation of the anode and the numerical values of the two digits of the line number which are to be identified by a tube in the other main group. This arrangement is plainly shown by the anode designations of the two main groups of tubes in Figs. 2 to 5, inclusive.

Thus, punching 7449 of TAB I which on the one side is connected to conductor **149**, is connected, on its other side, to conductors **200** and **201**, the latter included within bracket line **203**. The line 7449 has a thousands-hundreds digit designation of "**74**" and since the column of four tubes **74XX** is reserved for the identification of the one hundred lines having the numerical designation 74, conductor **200** is connected to an anode in the second tube from the bottom in said column and particularly to the anode labeled **49** therein, anode **49** having been selected because it bears the same numerical designation in the consecutive line-up of the hundred anodes of the four tubes in the column as the tens-units designation of the line. In the same way, conductor **201** extends to terminal punching 7449 in the terminal assembly block TAB II (which is identical with terminal assembly block TAB I) and from thence is connected to an anode in the third tube of row **XX49** and particularly to the anode **74** therein. Here again the particular anode selected for connection to conductor **201** may be determined by the thousands-hundreds designation of the line number which, in the case

of line number 7449 (line A) requires that conductor **201** be connected to the 74th anode.

The identifying conductor of every line in a ten thousand line office is thus similarly extended to an anode in a tube in that column of tubes in the group **00XX—99XX** which is reserved for the thousands-hundreds identification of the particular one hundred lines identified by the column and to an anode in the particular tube in that row of tubes in the group **XX00—XX99** which is reserved for the tens-units identification of said hundred lines. It is obvious that the operation of a tube in each group, each having one of its anodes connected to an identifying conductor of a line through its extension from the punchings on terminal assembly blocks TAB I and TAB II may be utilized to identify the two digits reserved for each row and column in each group, respectively, if the two impulses of current produced through the anode circuit of each tube, operated in consequence of their being activated by the auxiliary tubes as described hereunder, may be properly identified by apparatus responsive thereto.

To provide for the activation of the tubes in the main groups in the proper sequence, an auxiliary group of twenty ten-anode vacuum tubes is provided for each main group of tubes **00XX—99XX**—and **XX00—XX99**. These tubes are subdivided into subgroups of ten tubes for each digit, namely, the ten tubes **0XXX—9XXX** for the thousands digit, as shown in Fig. 6, the ten tubes **X0XX—X9XX** for the hundreds digit, as shown in Fig. 7, the ten tubes **XX0X—XX9X** for the tens digit, as shown in Fig. 8, and the ten tubes **XXX0—XXX9** for the units digit, as shown in Fig. 9. The grid of each tube in each of the auxiliary groups is connected, through a condenser coupling, to one of forty electrodes in the electronic distributor **600** and through its associated resistance and common conductor **750** to a source of negative battery **C2**. Since the cathodes of all tubes in the auxiliary groups are connected permanently to the filament battery source **A2** via conductors **611** and **612**, and since the anodes of all these tubes are likewise permanently connected to a source of positive battery **B2** via conductor **900** and each anode is connected through a condenser to the multipled grids of a group of main tubes, it follows that if the grid bias of any auxiliary tube is momentarily changed, a current flow will be produced through each anode of that tube which will affect the potential of the grid of each of the tubes in the main group to which each anode of the operated tube is connected. The means for supplying this momentary grid bias is the sending distributor **600** and the circuit associated therewith.

The sending distributor **600** and the receiving distributor **700** are of identical construction except for the presence of a grid element **707** in the latter. Both of these distributors are of the type described in Patent 2,217,774, issued to A. M. Skellett on October 15, 1940, and each comprises a cathode, forty anodes to which the grids of the forty auxiliary tubes are connected, said anodes being mounted in a cylindrical boundary coaxial with and encompassing the cathode beam, means for concentrating the electrons emanating from the cathode into a single radial rotating beam focused and impinging upon the anodes in sequence, and a collector ring which acts as a common electrode. The concentrating means comprises a two-phase current supply **675** for producing a magnetic field normal to the cathode and an electrostatic field in step with the magnetic field and phased with respect thereto so that the electric vector is parallel to the lines of force of the magnetic field.

Referring, now, to the sending distributor **600**, the cathode is connected to filament battery **A2** over conductors **611** and **612** and the collector ring **602** is connected to a source of alternating current **603** superimposed upon negative battery **B3**, while the forty targets or anodes are divided into groups of ten and connected to the grids of corresponding subgroups of ten tubes in each of the two auxiliary groups. That is, the ten electrodes numbered 0 to 9 in the third quadrant (and bracketed TH) are connected to the grids of the ten tubes **0XXX** to **9XXX**, inclusive, shown in Fig. 6; the ten electrodes numbered 0 to 9 in the fourth quadrant (and bracketed H) are connected to the grids of the ten tubes **X0XX** to **X9XX**, inclusive, in Fig. 7; the ten electrodes numbered 0 to 9 in the first quadrant (and bracketed T) are connected to the grids of the ten tubes **XX0X** to **XX9X**, inclusive, in Fig. 8, while the electrodes 0 to 9 in the second quadrant (and bracketed U) are connected to the grids of the ten tubes **XXX0** to **XXX9**, inclusive, shown in Fig. 9. Now as the electron beam rotates and impinges successively upon each of these electrodes (the rotating magnetic field of the driving source **675** being in the direction to cause the rotation of the beam in the clockwise direction) an alternating potential is induced thereon which, through the condenser coupling, is communicated to the grid connected thereto. This potential reduces the steady negative bias of the grid due to battery **C2** via conductor **750** and causes a space current to pass between the cathode and all the anodes in the tube which, as pointed out before, are not only connected to the grids of the tubes in a particular column or row of the main groups of tubes through appropriate condenser couplings, but also to positive potential **B2** via conductor **900**. The grids of the tubes in the column or row connected to the grid of the auxiliary tube momentarily "flashed" in virtue of the electron beam impinging upon its associated target, are thus rendered less negative whereupon a space current is caused to be passed between the cathode and one of the anodes in a tube in a column and row of the two main groups of tubes to which positive potential will have been connected by the initiation of a call on the line identified by such anodes.

Now the grids of all the tubes in each column and row of the two main groups of tubes are connected via a separate low resistance for each column or row, to conductor **900** and thence to the positive side of battery **B2**. On the other hand, each separate group of grids in a column or row of tubes is connected via a condenser coupling to an anode in each of two tubes in the auxiliary group associated with one of the main group of tubes. The order of connection is four grids in a column or row of tubes in a main group of tubes to corresponding anodes in the two corresponding tubes in the associated auxiliary group which mark identical numerical values in each of the two digits to be identified by the correlated main group.

Thus as an illustration of the connections between the grids of the tubes in the two main groups and the anodes of the tubes in the two auxiliary groups, consider for example the column of tubes **74XX** to the anode **49** of tube **2** of which is connected conductor **200**, and the row of tubes **XX49** to the anode **74** of tube **3** of which

is connected conductor 201. These conductors, it will be recalled, are extensions of the line identifying conductor 149 of line 7449. Now the column of tubes 74XX identifies the thousands-hundreds digits 74 and this means, assuming that positive potential is connected to anode 74, that the associated tube must be operated when the electron beam of distributor 600 impinges upon electrodes 7 in the third quadrant and must be operated again when it impinges upon electrode 4 in the fourth quadrant. Accordingly, the grids of the four tubes in the column 74XX are all multipled and connected to the condenser 207, the other side of which is connected to resistance 208 and conductor 209. Conductor 209, on the other hand, has two branches. The first branch, branch 607, is connected to anode 7400 in tube 7XXX whose grid is connected to electrode 7 in the third quadrant; the second branch, 704, is connected to anode 7400 to tube X4XX whose grid is connected to electrode 4 in the fourth quadrant. It is clear that under proper conditions of activation as described below, the anode 49 of tube 2 in the column 74XX will have two current impulses passing through it when the electron beam impinges upon electrodes 7 and 4 in the third and fourth quadrant respectively.

In the same manner, the grids of the four tubes comprising row XX49 are multipled and connected to condenser 507 the other side of which is connected to resistance 508 and conductor 509. Since the tens digit 4 is identified by electrode 4 in the first quadrant of the distributor 600 and the units digit 9 by electrode 9 in the second quadrant, conductor 509 likewise has two branches, the first of which, branch 800, is connected to anode 0049 of tube XX4X whose grid is connected to electrode 4 in the first quadrant, and the second of which, branch 901, is connected to anode 0049 of tube XXX9 whose grid is connected to the ninth electrode in the second quadrant. As in the previous case, under proper conditions of activation, anode 74 of tube 3 in row XX49 will pass two impulses of current when the electron beam impinges upon electrodes 4 and 9 in the first and second quadrants, respectively.

As noted from the above, the ten auxiliary tubes 0XXX—9XXX are reserved for the thousands digit; the ten tubes X0XX—X9XX are reserved for the hundreds digit; the ten tubes XX0X—XX9X are reserved for the tens digit, and the ten tubes XXX0—XXX9 are reserved for the units digit. As further noted by the numbering of the anodes of the auxiliary tubes, each anode of the ten anode of such a tube, counting from the bottom upward, is connected to the grids of a column or row of tubes in the main group which characterizes the particular digit identified by the electrode in the distributor to which the grid of said auxiliary tube is connected. Since each digital value of the four digits comprising a line number is identified by an impulse produced in response to the electron beam impinging upon the electrode in the distributor which characterizes a digit, it is clear that the distributor need not have more than forty anodes.

The receiving equipment is schematically indicated in Figs. 7, 8 and 9 and comprises the receiving electronic distributor 700 which is identical in construction to the sending distributor 600 except for the addition of grid element 707 which is connected to a source of potential C3 viz resistance 706 and to one side of a suitable amplifier A through conductor 705. The rotating magnetic field for the electron beam of the sending distributor is also the same two-phase power source 675 or a separate source which runs in synchronism with that of distributor 600 so as to produce synchronous rotating beams. The forty electrodes of the distributor 700 are connected to four groups of registering relays having suitable locking circuit paths through an alarm circuit. The contacts of these registering relays extend into indicating or recording circuit equipment which is adapted to respond to the operation of the relays to produce a visual, oral or permanent record of the digits indicated by the operated relays. Inasmuch as such equipment is commercially available and well known in the signaling arts, it is but schematically indicated.

In Fig. 1, a relay D is adapted in any suitable manner to ground the terminal side of the cut-off relay CO, and a relay E may be operated in any suitable manner when line identification is to be obtained. A transformer G having its primary winding connected to ground and to the terminal side of the cut-off relay receives the current impulses produced by the operation of the identification circuit, as will be shortly described, while its secondary winding is connected to the input side of amplifier A to which the current impulses are transmitted for amplification, whence they are transmitted to the distributor 700 for use in operating the register relays.

Having described the structural arrangement of the invention, its manner of operation will now be set forth in some detail.

When a subscriber such as A, for instance, initiates a call for which line identification is necessary, the line is extended to some central point by means of line-finder switch LF and other line extending switches which are not shown but which, for example, may be of the Strowger step-by-step type or of the panel type or of the cross-bar type. In fact, the manner in which the connection is extended is of no controlling importance to this invention other than the fact that whatever means are used will include a relay D which will be caused to operate and close a circuit that operates the cut-off relay CO.

It will be observed that the identifying conductor 149 has negative potential applied thereto through the winding of the cut-off relay CO. This potential is, of course, further applied to the anodes 49 and 74 in tubes 74XX—2 and XX49—3, respectively. The cathode potential from battery A1, however, is maintained at slightly less negative value than that applied to the identifying anodes of the various lines, when idle, through the winding of their respective cut-off relays CO so that, normally when the lines are idle, no current will flow through any of the tubes in the main groups. When, however, a line, such as line A for example, calls and ground is applied in consequence to conductor 149 by the operation of relay D, relay CO is operated and the potential at anodes 49 and 74 is raised. Since the auxiliary tubes are activated once for every sweep of the electron beam of distributor 600 around the electrode circle, the grids of the four tubes in column 74XX and the four tubes in row XX49 are raised in potential to the point where they will cause current to flow between cathode and any anode in any tube in said column and row which has had its potential

raised by the operation of the correlated cut-off relay CO; that is, whenever the electron beam, in its rotation, impinges upon electrode 7 in the third quadrant, electrode 4 in the fourth quadrant, electrode 4 in the first quadrant and electrode 9 in the second quadrant. This means that since the grids of the tubes in the column and row concerned are connected to an anode in each of two tubes in each of the auxiliary groups, the tubes in the column and row, respectively, to whose anodes positive potential has been applied by the operation of relay CO, will be operated twice for each sweep of the electron beam. Hence the tube 74XX—2 operates twice to pass a current impulse between cathode and anode 49 and the circuit path is completed via conductor 200, terminal 7449 on TAB I, conductor 149, to ground on the contacts of relay D. In the same way, the third tube XX49—3 is operated twice to pass a current between its cathode and anode 74 and the circuit path is completed via conductor 201, terminal 7449 of TAB II, conductor 201 in bracket line 203, conductor 201, terminal 7449 of TAB I and thence as traced to ground on the contacts of relay D.

When the line indication is desired, relay E is operated and relay D is released, whereupon the primary winding of transformer G is connected in circuit to hold the cut-off relay CO operated and to transfer the circuit of the line indicating current impulses through the primary winding of said transformer. These current impulses are induced into the secondary winding of said transformer, pass and are amplified through amplifier A, and thence are applied to conductor 705 which is connected to the grid of the receiving distributor 700.

The electron beam of the receiving distributor rotates in synchronism with that of the sending distributor 600 but, unlike it, is normally suppressed because of the negative grid bias applied thereto through negative battery C3 and resistance 706. When an impulse arrives over conductor 705, the beam of distributor 700, though suppressed, is aimed to impinge on an electrode in its electrode circle which corresponds to an identical electrode in the sending distributor 600 the impingement upon which resulted in the impulse transmitted over conductor 705. Thus when the electron beam of sending distributor 600 is impinging upon electrode 7 in the third quadrant of the electrode circle, the electron beam of receiving distributor 700 is aimed at electrode 7 in the third quadrant of its electron circle. When, therefore, the current impulse on conductor 705 is applied to the grid 707, the grid bias is reduced, the beam is activated and impinges upon electrode 7. Since this electrode is grounded through the right winding of relay TH7 of the thousands register, and a potential is induced at the electrode in consequence of the impingement, a current flow is established through the right winding of said relay which causes it to operate over its right winding and then lock over its left winding and contacts to battery on release key REL serially through the alarm circuit. When the impulse terminates, the receiving beam is suppressed by the reapplication of the high negative bias by battery C3 through resistance 706. When the sending beam has advanced into contact with electrode 4 in the fourth quadrant of the electrode circle, the direction of the receiving beam is similarly in coincidence with the electrode 4 in the fourth quadrant of the electrode circle of the receiving distributor, and since this electrode is connected to ground through the right winding of relay H4, then, upon the arrival of the impulse, a circuit is completed through the right winding of said relay causing it to operate and then lock over its left winding and contacts, serially through the alarm circuit to battery through the contacts of key REL.

In the same manner, when the two beams reach electrodes 4 and 9 in the first and second quadrants of their respective electrode circles, the two impulses applied successively therewith to the grid 707 of the receiving distributor will cause the receiving beam to be activated and complete circuits for relays T4 and U9 in the tens and units registers, respectively.

With each revolution of the two synchronous electron beams the above operations are repeated and the operating circuits of the above-mentioned relays are again closed, and if these relays have not been previously operated they are operated and locked. These relays, when operated, ground signaling conductors connected with indicating, oral or recording equipment in which suitable apparatus operatively responds to the grounded signaling conductors to register the line designation.

It will be observed that in our invention there is no limit to the number of simultaneous line identifications which can be made. Since the auxiliary tubes are activated once per revolution of the sending electron beam, and since all the tubes of the two main groups can all become correspondingly activated upon the raising of one or more of their anode potentials by the grounding of the identifying conductors respectively connected to them, it is obvious that, so far as the line identification circuit itself is concerned, there can be as many simultaneous identifying operations going on as there are anodes in a main group of tubes, each operation taking place over the separate line identifying conductor of a calling line.

Figs. 10 to 13, inclusive, when arranged below Figs. 2 to 5, inclusively and respectively as shown in Fig. 14, show a modification of the invention in which the arrangement of main and auxiliary groups of tubes are the same as before but the signaling code is made up of timed intervals of four frequencies and the auxiliary tubes are of the so-called "heater" type.

The four sources of alternating potentials are source *f*1 connected to the grids of the ten auxiliary tubes 0XXX—9XXX; source *f*2 connected to the grids of the ten auxiliary tubes X0XX—X9XX; source *f*3 connected to the grids of the ten auxiliary tubes XX0X—XX9X and source *f*4 connected to the grids of the ten auxiliary tubes XXX0—XXX9.

Cathode potentials for the forty tubes of the two auxiliary groups, ten tubes for each of the four digits, is supplied by a ten-plate rotary beam distributor 1000 of similar construction to the sending distributor 600 except that the forty electrodes in the latter are replaced by ten single continuous electrode "plates," the 0 plate being connected to the cathode of the 0 auxiliary tube in each of the four subgroups of ten (that is, tubes 0XXX, X0XX, XX0X and XXX0), the No. 1 plate to the No. 1 tubes and so on to the No. 9 plate which is connected to the four "9" tubes (that is, tubes 9XXX, X9XX, XX9X and XXX9).

Thus all the grids in the forty tubes of the two auxiliary groups are actuated at all times by the separate frequency sources shown, but space current flows in a tube only when the electron beam of the distributor 1000 is impinging upon a plate connected to the cathode of the tube. Since the anodes of the auxiliary tubes are coupled to the grids of the tubes in the two main groups in the identical manner already described for the auxiliary tubes shown in Figs. 6 to 9, inclusive, it is obvious that when, for instance, the beam is impinging upon plate 0, tubes 0XXX, X0XX, XX0X and XXX0 will be activated to produce an impulse through whatever tubes in the main groups have positive potential connected to their anodes, which impulse is composed of two frequencies *f1f2* for the thousands and hundreds digit. The second impulse, for the tens and units digits, is of course composed of frequencies *f3* and *f4*.

For receiving purpose, a second ten-plate distributor 1100 is shown which is similar in construction to the receiving distributor 700 except for the ten plates that take the place of the forty electrodes, which plates are disposed around the beam circle in the same relative position as the plates of the sending distributor 1000. The beams are also synchronously rotated by the same or synchronously operated two-phase power sources, and the relays of the numerical registers are the same as before except that one side of their respective right windings is connected to ground through a filter that is opaque to all frequencies except the one frequency assigned to a particular digit and the other side of the right winding of corresponding relays in each register is connected to the plate indicating the numerical value which each of the relays in the register is adapted to designate. Since the sending and receiving electron beams operate in synchronism, corresponding relays in each register are connected in circuit with the plate when the receiving beam is directed thereon for impingement. If the receiving beam is not released because of the absence of current along conductor 1105, no relays will be operated. On the other hand, if the beam is released, the relays that will operate will depend upon the frequency present. Thus the forty register relays translate the code into the line number, passing it into the visual, oral or recording equipment by grounding the proper four in a group of forty leads.

When line identification operations are completed to the extent that a record of the line is registered in the visual, oral or recording equipment, relay E is released, negative battery is again applied to anode 49 of tube 74XX—2 and anode 74 of tube XX49—3 causing these tubes to cease conducting. Key REL is operated to release the register relays. The line identification circuit is now in the normal condition prevailing when no lines are calling.

While we have described the principle of our invention in connection with its specific application to a typical telephone connection and with reference to a specific arrangement of vacuum tube devices, 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.

What is claimed is:

1. An identification circuit for the lines of a telephone system comprising in combination an electron distributor, a plurality of vacuum tube devices disposed coordinately relative to the lines of said telephone system, and means responsive to the operation of said electron distributor for altering the steady state grid potential of said devices whereby a potential applied to any one of said lines causes the operation of any two of said devices in coordinate relation to each other to identify the line to which said potential was applied.

2. A calling line identification circuit for the lines of a telephone system comprising a plurality of electronic devices having control elements connected to said lines according to their numerical designation, means for applying a potential to the control elements associated with calling lines, an electron distributor, and means responsive to the operation of said electron distributor for operating the electronic devices to whose elements potential was applied to simultaneously indicate the separate identities of said calling lines.

3. An identification circuit for the lines of a telephone system comprising in combination an electron sending distributor and an electron receiving distributor, both of said distributors having an electron beam adapted for operation to impinge synchronously upon a plurality of electrodes, a plurality of vacuum tube devices disposed coordinately relative to the lines of said telephone system, means for electrically coupling the grids of said vacuum tube devices to the electrodes of said sending distributor, and settable means connected to the electrodes of said electron receiving distributor, whereby a potential applied to any one of said lines causes the operation of any two of said vacuum tube devices in coordinate relation with each other to identify the line to which said potential was applied when the electron beam of said electron sending distributor impinges upon the electrodes coupled to the grids of said devices, and whereby the settable means connected to the electrode of said electron receiving distributor impinged upon by the synchronously operated electron beam is caused to operate in partial identification of the line to which the potential was applied.

4. An identification circuit for the lines of a telephone system comprising in combination an electron distributor, two groups of electronic devices having a plurality of electrodes connected to a steady source of potential and responsive to said electron distributor whereby said potential is altered, two other groups of electronic devices disposed coordinately relative to the numerical designations of the lines of the system and electronically coupled to the electrodes of the devices of the first two groups, means for applying a signaling potential through one of said lines when calling to an electronic device in each of said other groups whereby said devices are rendered conducting upon the alteration of potential on the electrodes coupled to said devices to produce a plurality of current impulses indicative of the calling line number, an electron receiving distributor responsive to said impulses, and means responsive to said electron receiving distributor for registering the numerical designation of said calling line.

5. A calling line identification circuit for the lines of a telephone system comprising two main groups of electronic devices having electrodes connected to said lines, an auxiliary group of electronic devices for each of said main group of devices having electrodes connected to the grids of the devices in the associated main group, an

electron distributor connected to the grids of all said devices in the auxiliary group of devices and adapted to alter the potential of said grids at every operation of said distributor whereby the potential of the grids in the devices of the main groups are correspondingly altered, means responsive to the application of a potential to the electrodes of the devices in the two main groups for operating said devices each time that the potential of their respective grids is altered, an electron receiving distributor responsive to each operation of said devices in said main groups, and means responsive to each operation of said electron receiving distributor for registering a part of the numerical designation of said calling line.

6. A calling line identification circuit for the lines of a telephone system comprising in combination two main groups of electronic devices having electrodes connected to said lines, an auxiliary group of electronic devices for each of said main group of devices having electrodes connected to the grids of the devices in the associated main group, an electron distributor connected to the grids of all said devices in the auxiliary groups of devices and adapted to alter the potential of said grids at every operation of said distributor whereby the potential of the grids in the devices of the main groups are correspondingly altered, means responsive to the application of a potential to the electrodes of the devices in the two main groups for operating said devices each time that the potential of their respective grids is altered, and means including settable registers selectively responsive to each of a definite number of operations of said devices in the two main groups for setting said registers to indicate the identity of said line.

7. A calling line identification circuit for the lines of a telephone system comprising in combination two main groups of electronic devices having electrodes connected to said lines, an auxiliary group of electronic devices for each of said main group of devices having electrodes connected to the grids of the devices in the associated main group, an electron distributor connected to the grids of all said devices in the auxiliary groups of devices and adapted to alter the potential of said grids at every operation of said distributor whereby the potential of the grids in the devices of the main groups are correspondingly altered, means responsive to the application of a potential to the electrodes of the line initiating a call for causing the associated electronic devices to become operative each time that the potential of their respective grids is altered, an electron receiving distributor, responsive to each operation of said associated electronic devices, and settable registers connected to receiving distributor whereby the same are set by a definite number of said operations for identifying the calling line to the electrodes of which said potential was applied.

8. An identification circuit for the lines of a telephone system comprising in combination an identifying conductor for each line, two groups of electronic devices disposed in coordinate pattern in relation to the numerical designation of each of the lines in the system, each electronic device in each group having a plurality of electrodes connected to as many line identifying conductors for identifying two digits of the associated line number and to an electrode in a device of the other group for identifying two other digits of the same line number, an electron sending distributor adapted to impinge an electron beam successively upon a plurality of electrodes, a plurality of auxiliary electronic devices having their grids connected to the electrodes of said electron sending distributor and to a source of biasing potential, each of said auxiliary electron devices having a plurality of electrodes each connected to the grids of a number of electronic devices in one of said two groups of devices whereby the impingement of the electron beam upon an electrode of said distributor lowers the biasing potential of the grid connected thereto to permit current through its plurality of electrodes and whereby a potential is applied to the grids of the electronic devices connected thereto, means for applying a signaling potential to the identfying conductor of one of said lines when calling and therethrough to the electrode in a device in each group connected thereto whereby said devices are rendered conducting at the instant their respective grids are altered in potential by the passage of current through the electrodes of the auxiliary electronic devices to which they are connected, a receiving electron distributor comprising a grid and a source of electrons and a plurality of electrodes, said receiving distributor being adapted to direct an electron beam synchronously with the beam of said sending electron distributor and successively upon each of said electrodes, a source of biasing potential normally applied to said grid for suppressing said electron beam, settable registers connected to the electrodes of said receiving distributor, and means for completing the current path of said conducting electron devices in said two groups to the grid of said electron sending distributor whereby said biasing potential is reduced to permit the activation of the electron beam for impingement upon an electrode and whereby the settable register connected to said electrode is operated in partial identification of the numerical designation of the line to whose identifying conductor the signaling potential was applied.

9. An identification circuit for the lines of a telephone system comprising in combination an electron sending distributor, four groups of electronic devices, each device in each group having a plurality of electrodes connected to a steady source of potential and a grid, each grid of each device in a group being connected to a source of alternating potential of specific frequency, whereby the potential on said electrodes is altered to said frequency in response to the operation of said sending distributor, two other groups of electronic devices disposed coordinately relative to the numerical designations of the lines of the system and electronically coupled to the electrodes of the devices of the first two groups, means for applying a signaling potential through one of said lines when calling to an electronic device in each of said other groups whereby said devices are rendered conducting upon the alteration of potential on the electrodes coupled to said devices to produce a plurality of current impulses of the frequencies of the sources connected to the grids of the devices in said four groups of devices, an electron receiving distributor responsive to said impulses, and settable registers responsive to said receiving distributor for registering the numerical designation of said calling line.

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