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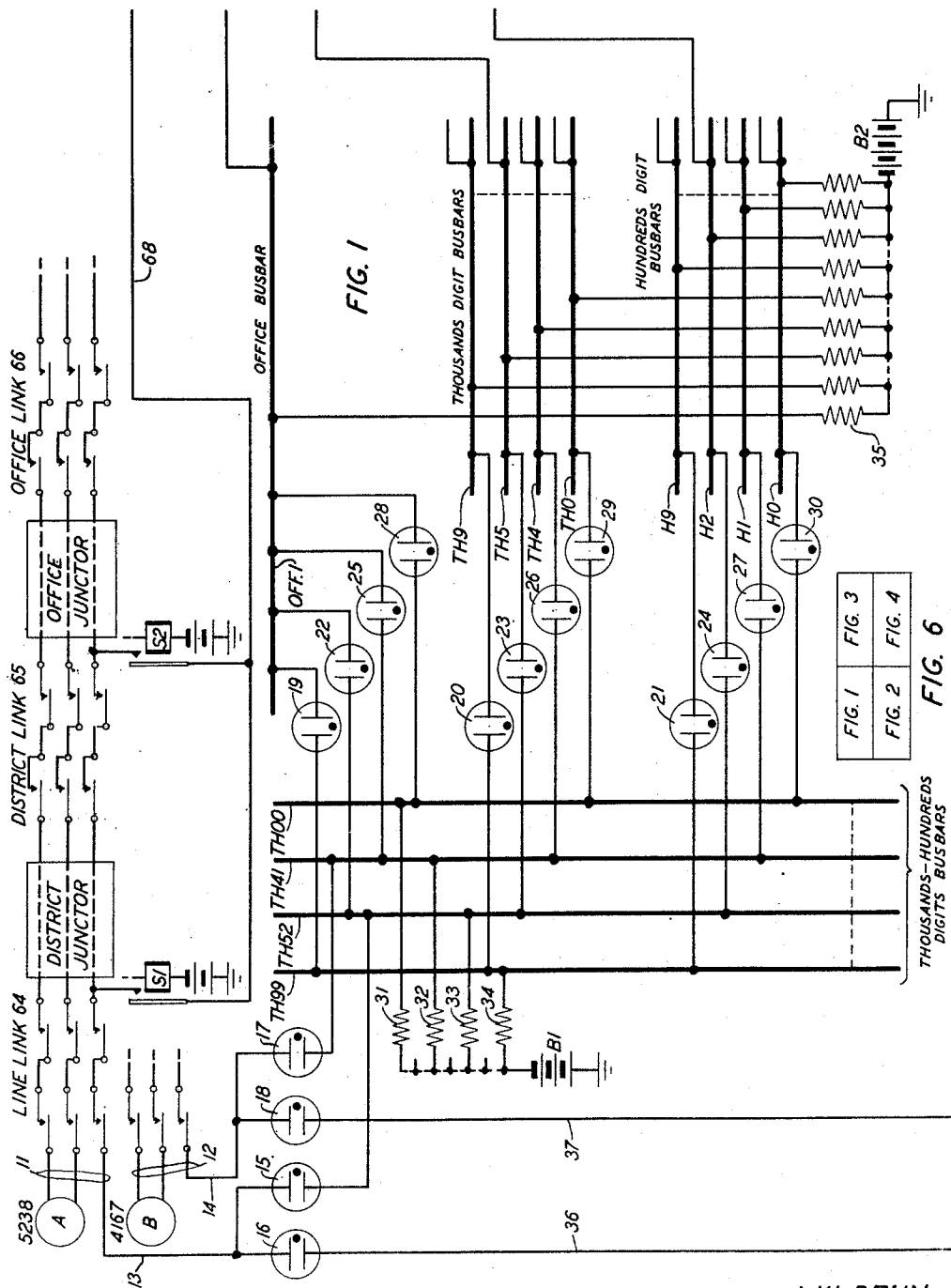
J. W. DEHN ET AL

2,484,612

DIRECTORY NUMBER CALLING LINE IDENTIFIER

Filed May 17, 1946

4 Sheets-Sheet 1



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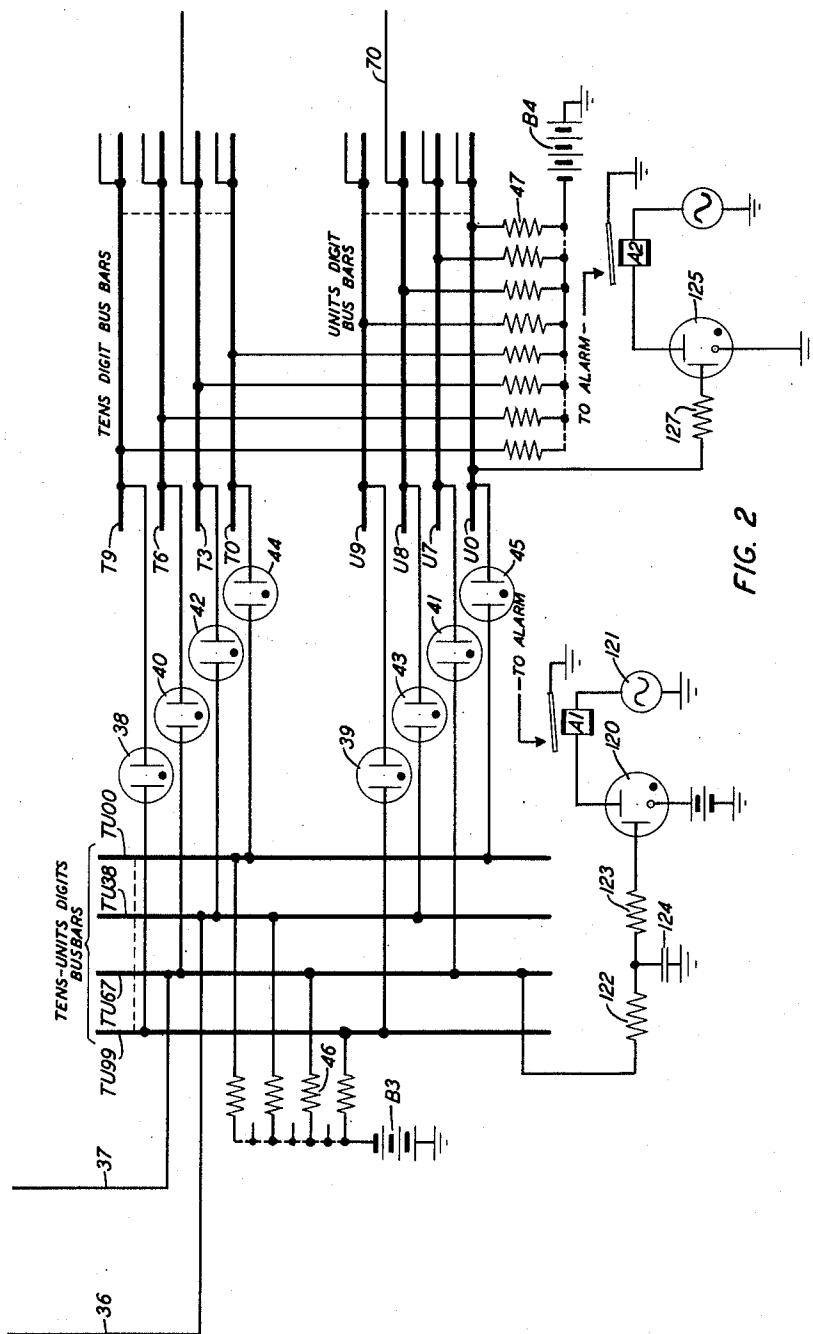
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DIRECTORY NUMBER CALLING LINE IDENTIFIER

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4 Sheets-Sheet 2



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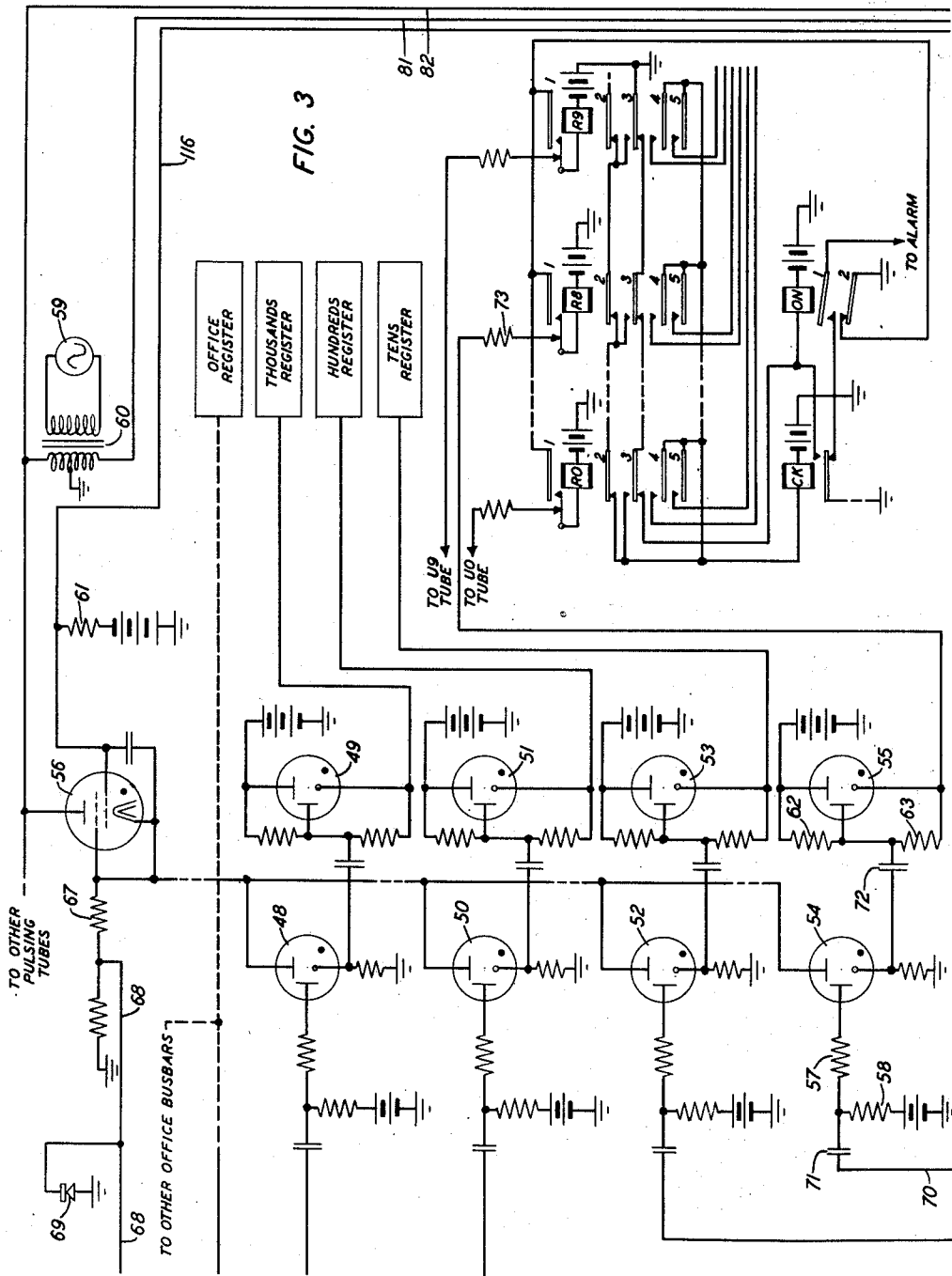
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DIRECTORY NUMBER CALLING LINE IDENTIFIER

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4 Sheets-Sheet 3



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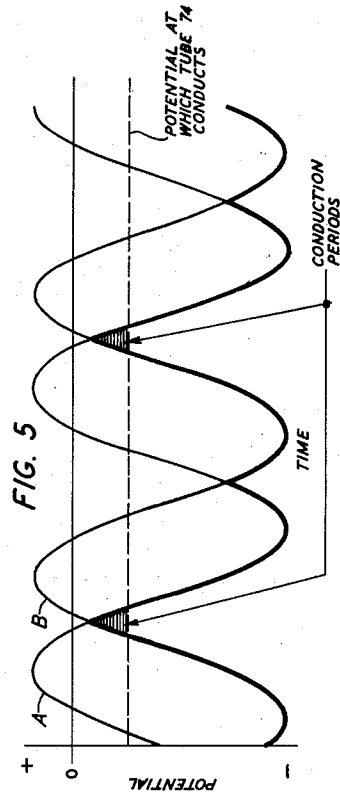
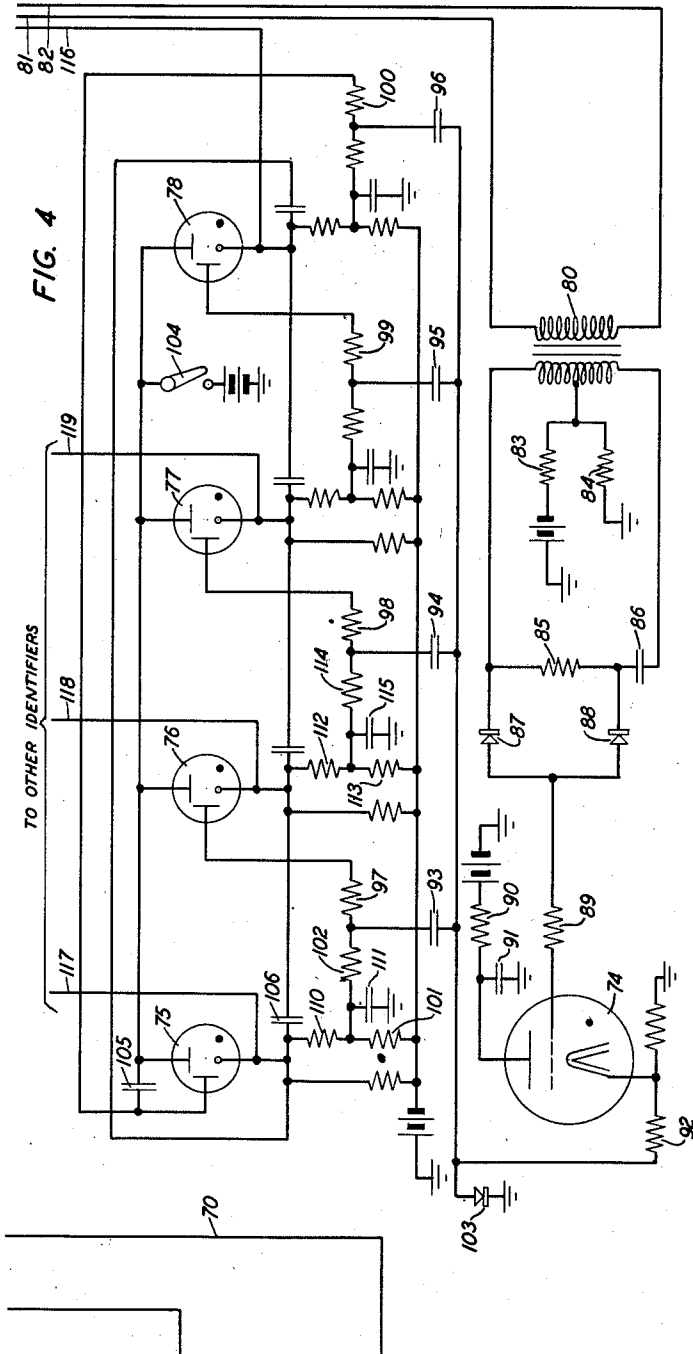
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DIRECTORY NUMBER CALLING LINE IDENTIFIER

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4 Sheets-Sheet 4



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2,484,612

DIRECTORY NUMBER CALLING LINE
IDENTIFIER

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Application May 17, 1946, Serial No. 670,358

20 Claims. (Cl. 179-18)

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This invention pertains to telephone systems and more particularly to systems for identifying calling lines to determine their directory numbers. Calling-line-identifying devices are necessary in connection with the automatic recording of telephone calls and it is desirable, for this purpose, that calling lines be identified by their directory numbers rather than by terminal numbers, to avoid the further operations necessary to obtain the directory numbers for billing purposes. Identification of lines by their directory numbers presents difficulties, particularly in systems of the cross bar type where there is no direct relation between the terminal number or physical location of a line and its directory number. The present invention discloses an economical and simple system for obtaining the directory numbers of calling lines directly and rapidly. While particularly valuable in connection with cross bar systems, it is not limited in its application to systems of that type nor to the purposes of automatic message recording, but is applicable to any type of telephone system and to any purpose for which it is desirable to ascertain the directory numbers of calling lines.

A feature of this invention is the use of electronic devices, which are inexpensive, not subject to rapid deterioration, and readily replaceable.

Another feature of the invention is the use of a unidirectional pulse of extremely short duration to effect identification, with the consequent saving in time and equipment. The pulse may be extremely short because the indicating devices responsive to said pulse are affected by the rate of change of the pulse as it increases from zero to its maximum value rather than by the specific magnitude of the pulse.

Another feature of the invention is an arrangement whereby a plurality of identifiers may each be connected for identification of calling lines at any time without interfering with one another.

Another feature of the invention is a novel form of pulse generator for actuating identifiers of the type disclosed.

Still another feature of the invention is the use of equipment to serve a large number of subscribers' lines, not only in one central office but, if desired, in a plurality of central offices.

These and other features of the invention will be apparent from the following description, the appended claims, and the drawings, in which:

Fig. 1 shows two subscribers' lines, the extension of one of said lines by switching means, and a portion of the common circuit networks provided for identifying these and other lines;

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Fig. 2 shows another portion of the common circuit networks;

Fig. 3 shows the circuit of an identifier;

Fig. 4 shows circuits for actuating a plurality of identifiers;

Fig. 5 is a graphical representation of the potentials supplied to a pulse generating tube shown in Fig. 4; and

Fig. 6 shows how the above figures (except Fig. 5) should be placed with relation to one another to disclose the invention.

We will first describe the arrangement of the common circuit networks provided for identification purposes, from which description the general mode of operation of the invention will be apparent. For the purpose of illustration, two subscribers' lines 11 and 12 are shown in Fig. 1 and it is assumed that both of these lines are in the same central office, designated office No. 1, and that the directory number of line 11 is 5238, while that of line 12 is 4167.

In accordance with the present invention, the sleeve conductor of each subscriber's line the directory number of which may be required to be identified is connected to one element of each of two gas-discharge cold cathode tubes. For example, the sleeve conductor 13 of line 11 is connected to one element of each of tubes 15 and 16, while the sleeve conductor 14 of line 12 is connected to one element of each of tubes 17 and 18. The other element of each of the tubes associated with each line is connected to one of 100 common conductors or bus-bars, in accordance with the thousands and hundreds digit combination of the directory number of said line. For example, bus-bars TH00, TH41, TH52 and TH99 are four of the 100 bus-bars provided for office No. 1 in which lines 11 and 12 are located, and are the bus-bars assigned to the thousands and hundreds digit combinations 00, 41, 52, and 99, respectively. Accordingly, an element of tube 15, associated with line 11 the directory number of which is 5238, is connected to bus-bar TH52, to which are also connected corresponding elements of tubes associated with other lines (not shown) in the same central office having directory numbers the thousands digit of which is 5 and the hundreds digit of which is 2. Likewise, an element of tube 17, associated with line 12 the directory number of which is 4167, is connected to bus-bar TH41, to which are also connected elements of tubes associated with other lines (not shown) in the same central office having directory numbers the thousands digit of which is 4 and the hundreds digit of which is 1.

To each of the thousands-hundreds-digits bus-bars TH00 to TH99 is connected one element of each of three gas-discharge cold cathode diode tubes. For example, one element of each of tubes 19, 20, and 21 is connected to bus-bar TH99, one element of each of tubes 22, 23, and 24 is connected to bus-bar TH52, one element of each of tubes 25, 26, and 27 is connected to bus-bar TH41, and one element of each of tubes 28, 29 and 30 is connected to bus-bar TH00. The other element of one of the tubes connected to each thousands-hundreds-digits bus-bar is connected to a bus-bar individual to the central office served by said thousands-hundreds-digits bus-bar. For example, one element of each of tubes 19, 22, 25, and 28 is connected to bus-bar OFF1, which is individual to office No. 1.

The other element of the second of the tubes associated with each thousands-hundreds-digits bus-bar is connected to one of 10 thousands-digit bus-bars TH0 to TH9 in accordance with the thousands digit of the thousands-hundreds-digit combination, while the other element of the third tube associated with each thousands-hundreds-digits bus-bar is connected to one of 10 hundreds digit bus-bars H0 to H9 in accordance with the hundreds digit of the thousands-hundreds-digit combination. For example, one element of tube 23, associated with bus-bar TH52 assigned to the digit combination 52, is connected to bus-bar TH5, to which are also connected corresponding elements of tubes associated with other thousands-hundreds-digits bus-bars (not shown) assigned to digit combinations the first digit of which is 5. Likewise, an element of tube 24, associated with bus-bar TH52, is connected to bus-bar H2, to which are also connected corresponding elements of tubes associated with other thousands-hundreds-digits bus-bars (not shown) assigned to digit combinations the second digit of which is 2.

The thousands-hundreds-digits bus-bars are each supplied with negative potential, for example, from battery B1 through resistances 31, 32, 33, and 34, and each of the office, thousands-digit and hundreds-digit bus-bars are supplied with a higher negative potential, for example, from battery B2 through resistance 35 to bus-bar OFF1. The difference of potential of batteries B1 and B2 is approximately that necessary to maintain conduction in each tube, such as tube 19, but is insufficient to initiate conduction in said tube. None of the gas-discharge diode tubes connected to the bus-bars, therefore, normally conduct but will conduct if the difference of potential between their elements is slightly increased.

It is now evident that, owing to the arrangement of bus-bars and gas-discharge tubes, if a potential is applied to the sleeve conductor of any line sufficient to cause the gas-discharge tubes connected thereto to conduct, said potential will be transmitted through said tubes to certain of the office, thousands-digit and hundreds-digit bus-bars, and, upon tracing the path of said transmission, it will be apparent that the particular bus-bars on which said potential appears indicate a part of the directory number of said subscriber's line. For example, if a potential is applied to the sleeve conductor 14 of line 12, causing tube 17 to conduct, said potential will be transmitted through the conduction of tube 17 to bus-bar TH41 thence to tubes 25, 26 and 27, causing said tubes to conduct, and through the latter tubes to bus-bars OFF1, TH4 and H1. If suitable indi-

cating means are provided, the presence of said potential on bus-bars OFF1, TH4, and H1 will indicate that line 11, to the sleeve conductor of which potential was applied, is in office No. 1, that the thousands digit of its directory number is 4, and that the hundreds digit is 1.

It is also evident that a set of 100 thousands-hundreds-digits bus-bars TH00 to TH99 and an office bus-bar, such as bus-bar OFF1, must be provided for each central office, since these bus-bars are used to indicate the central office in which the line being identified is located, but that the thousands-digit bus-bars TH0 to TH9 and the hundreds-digit bus-bars H0 to H9 may be used to serve the lines of any number of central offices, since these bus-bars are used only to indicate digits of directory numbers.

A similar arrangement of bus-bars and gas-discharge tubes is used to indicate the tens and the units digits of directory numbers. The other element of the above-mentioned second gas-discharge diode tube associated with the sleeve conductor of each subscriber's line is connected to one of 100 tens-units-digits bus-bars, of which bus-bars TU00, TU38, TU67 and TU99 are four, in accordance with the tens-units-digits combination of the directory number of said line. For example, an element of tube 16 associated with line 11 the directory number of which is 5238, is connected over conductor 36 to bus-bar TU38, to which are also connected corresponding elements of tubes (not shown) associated with other lines the directory numbers of which comprise the tens-units digit combination 38, while an element of tube 18, associated with line 12 the directory number of which is 4167, is connected over conductor 37 to bus-bar TU67, to which are also connected corresponding elements of tubes (not shown) associated with other lines the directory numbers of which comprise the tens-units digit combination 67.

To each of the tens-units-digits bus-bars TU00 . . . TU99 is connected one element of each of two gas-discharge cold cathode diode tubes. For example, one element of each of tubes 38 and 39 is connected to bus-bar TU99, one element of each of tubes 40 and 41 is connected to bus-bar TU67, one element of each of tubes 42 and 43 is connected to bus-bar TU38, and one element of each of tubes 44 and 45 is connected to bus-bar TU00. The other element of one of the tubes associated with each tens-units-digits bus-bar TU00 . . . TU99 is connected to one of 10 tens-digit bus-bars T0 . . . T9 in accordance with the tens digit of the tens-units-digits combination, and the other element of the second tube associated with each tens-units-digits bus-bar is connected to one of 10 units-digit bus-bars U0 . . . U9 in accordance with the units digit of said combination. For example, an element of tube 40 associated with bus-bar TU67, assigned to the digit combination 67, is connected to bus-bar T6, to which are also connected corresponding elements of tubes (not shown) associated with other tens-units-digits bus-bars assigned to digit combinations the tens digits of which is 6, and an element of tube 41, also associated with bus-bar TU67, is connected to units bus-bar U7, to which are also connected corresponding elements of tubes (not shown) associated with other tens-units-digits bus-bars assigned to digit combinations the units digit of which is 7. Each bus-bar is supplied with suitable potential, the tens-units-digits bus-bars NU00 . . . TU99 with negative potential from battery B3 through resistances,

such as resistance 46, and the tens-digit and units-digit bus-bars T0 . . . T9 and U0 . . . U9, respectively, with higher negative potential from battery B4 through resistances such as resistance 47, such that the gas-discharge diode tubes connected to said bus-bars do not normally conduct but will conduct if the potential difference between their elements is slightly increased.

It is evident that if a potential is applied to the sleeve conductor of any line sufficient to cause the gas-discharge tubes connected thereto to conduct, said potential will be transmitted through said tubes to certain of the tens-digit and units-digit bus-bars and the presence of potential on those bus-bars will indicate the tens and units digits of the directory number of said line. For example, if potential is applied to sleeve conductor 14 of line 12, causing tube 18 to conduct, said potential will be transmitted through said tube, over conductor 37 to bus-bar TU67, thence to tubes 40 and 41, causing said tubes to conduct, and through said tubes to bus-bars T6 and U7, indicating that the tens and units digits of the directory number of line 12 are 6 and 7, respectively.

It is also evident that the tens-units-digits bus-bars TU00 . . . TU99, the tens-digit bus-bars T0 . . . T9, and the units-digit bus-bars U0 . . . U9 may be used to serve any number of lines located in any number of central offices since they are employed to indicate digits of directory numbers of lines irrespective of the central offices in which said lines are located.

By the use of additional bus-bars and additional gas-discharge tubes connected in the manner described, the system may be extended to provide means for indicating directory numbers of more than four digits or other information in regard to a line identified, such as the class of the line or its rate zone.

For utilizing the means provided by the common circuit networks for the identification of calling lines, an identifier circuit (shown in Fig. 3) is employed which comprises an indicating tube and an associated registering tube connected through a condenser, to each of the office, thousands-digit, hundreds-digit, tens-digit, and units-digit bus-bars, a pulsing tube, and registers for the office number and for each of the four digits of the directory number. For example, tube 48 is an indicating tube and tube 49 a registering tube associated with thousands-digit bus-bar TH5; tube 50 is an indicating tube and tube 51 a registering tube associated with hundreds-digit bus-bar H2; tube 52 is an indicating tube and tube 53 a registering tube associated with tens-digit bus-bar T3, while tube 54 is an indicating tube and tube 55 a registering tube associated with units-digit bus-bar U8. Tube 56 is the pulsing tube of the identifier comprising the above-mentioned indicating and registering tubes and the other indicating and registering tubes associated with each of the digital bus-bars TH0 . . . TH9; H0 . . . H9; T0 . . . T9 and U0 . . . U9. In the present embodiment of the invention, the indicating tubes and the registering tubes are gas-discharge triode tubes of the cold cathode type and the pulsing tube is a gas-discharge tetrode tube of the heated cathode type. The registers may be of any suitable type and may each be similar to the register for the units digits, comprising relays R0, R8, R9, CK, and ON, disclosed in Fig. 3.

The control anode of each of the indicating tubes, for example, tube 54, is supplied with posi-

tive potential by positive battery through resistances 57 and 58 and this potential is of such value that said tube will not normally conduct even when its main anode is also supplied with positive potential, but will conduct if, at the same time, the potential of its control anode is slightly raised. The main anodes of all the indicating tubes of an identifier, such as tubes 48, 50, 52 and 54, are connected to the cathode of the associated pulsing tube, in this case, tube 56. The anode of the pulsing tube 56 is supplied with alternating potential from the source 59 through transformer 60. The control grid of said tube is biased by negative battery through resistance 61 so that said tube does not normally conduct, but will conduct if the potential of its control grid is made slightly less negative. The main anode of each of the registering tubes, for example, tube 55, is supplied with positive potential and the control anode biased by potential from the voltage divider composed of resistances 62 and 63, so that said tube does not normally conduct but will conduct if its control anode is made slightly more positive.

To identify a calling line, for example, line 11 extended by line link 64, district link 65, and office link 66, the cathode of the pulsing tube of an identifier, for example, tube 56, of the identifier shown in Fig. 3, is connected through resistance 67 and conductor 68 to sleeve conductor 13 of said line, as extended, at any convenient point in the partially established connection by suitable means, such as relay S1 or relay S2. The control grid of tube 56 is then made, by suitable means such as that hereinafter described, momentarily sufficiently less negative to cause said tube to conduct during the positive half of one cycle of alternating current.

The sleeve conductor of a subscriber's line, for example, conductor 13, is used in automatic telephone systems for other purposes, chief among which is the holding of the magnets of the various switches by which the line is extended. Rectifier 69 provides a path to ground for the negative potential by which said magnets are held but opposes the passage of positive potential. The positive pulse from the cathode of tube 56 will not, therefore, pass through rectifier 69 but will be transmitted over conductor 68 through contacts of relay S1 or relay S2 to sleeve conductor 13 as extended and to tubes 15 and 16, causing said tubes to conduct, thence by the conduction of tube 15, to bus-bar TH52 and by the conduction of tube 16, to bus-bar TU38. The pulse of positive potential on bus-bar TH52 will cause tubes 22, 23, and 24 to conduct and, by the conduction of tube 22, will be transmitted to bus-bar OFF1, by the conduction of tube 23, to bus-bar TH5, and by the conduction of tube 24, to bus-bar H2. Likewise, the positive pulse on bus-bar TU38 will cause tubes 42 and 43 to conduct. By the conduction of tube 42, said positive pulse will be transmitted to bus-bar T3 and, by the conduction of tube 43, to bus-bar U8.

The positive pulse on bus-bar U8 will be transmitted over conductor 70 and will produce, through condenser 71 a pulse, the magnitude of which will depend upon the rate of change in potential of the pulse applied to said condenser. The pulse from condenser 71 will be transmitted through resistance 57 to the control anode of tube 54, causing said tube to conduct momentarily since, at the same time, a pulse of positive potential is received on the main anode of said tube from the cathode of tube 56. The rise of potential

at the cathode of tube 54, due to the conduction of said tube, will be transmitted through condenser 72 to the control anode of tube 55, causing tube 55 to conduct over a circuit extending from positive battery, through the anode-cathode space of tube 55, resistance 73, No. 1 normal contact of relay R8, and the winding of said relay to negative battery.

In like manner, the positive pulse on bus-bars OFF1, TH5, H2, and T3 will cause conduction of a tube (not shown) similar to tube 55 associated with bus-bar OFF1, and of tubes 49, 51 and 53. Conduction of said tube (not shown) associated with bus-bar OFF1 indicates that line 11 is in office No. 1, while conduction of tubes 49, 51, 53, and 55 indicate that the four digits of the directory number of line 11 are 5, 2, 3 and 8, respectively.

The indication given by the conduction of each of the registering tubes, for example, tube 55, may be registered by means of a relay circuit such as that shown in Fig. 3 for registering the units-digit indication. Only three register relays R0, R8 and R9 are shown, but it will be understood that the circuit comprises 10 such relays, each connected to a corresponding register tube in the manner shown for relay R8 and tube 55.

The current which normally flows from positive battery through resistances 62, 63 and 73, No. 1 normal contacts of relay R8, and the winding of said relay to negative battery is not sufficient to operate relay R8. When tube 55 conducts, however, as described above, the decreased resistance in the circuit causes additional current to flow, operating relay R8 which locks up through its own No. 1 front contact and No. 2 contacts of normally-operated relay ON. The operation of relay R8 opens at the No. 1 normal contact, the circuit of tube 55, causing said tube to cease to conduct and, at the No. 3 back contact of said relay, opens the normal operating circuit of relay ON, which extends from battery through the winding of relay ON, and No. 3 back contacts of relays R0 to R9 inclusive, (relays R0, R8, and R9 only being shown) to ground. However, relay CK now operates over a circuit extending from battery through the winding of said relay, No. 2 contacts of relays R0 to R7 (relay R0 only being shown), No. 3 front contact of relay R8 and No. 3 back contact of relay R9 to ground, providing an obvious additional circuit through its contacts for relay ON which prevents release of relay ON.

If, through some fault in the circuits, more than one of the register relays R0 to R9 are operated at the same time, the circuit of relay CK will not be completed. Relay CK will, therefore, not operate and relay ON will release. A circuit will then be completed from ground through back contact of relay CK and No. 1 contacts of relay ON to an alarm (not shown) actuating said alarm.

A plurality of identifiers of the type described may be associated with the same bus-bars in the manner described for the identifier comprising the tubes shown in Fig. 3. If the respective pulsing tubes 56 of these identifiers are actuated repeatedly and in succession, no two pulsing tubes being actuated at the same moment, then any or all of said identifiers may be connected to calling lines for identification at the same time and each identifier will identify the line to which it is connected. For example, assume two identifiers to be associated with bus-bars U0 to U9. Then to each of bus-bars U0 to U9 will be con-

nected two indicating tubes similar to tube 54 and in the manner shown for tube 54. The main anode of one of said tubes associated with each bus-bar will be connected to the cathode of a pulsing tube, similar to tube 56, of a first identifier, while the main anode of the other of said tubes associated with each bus-bar will be connected to the cathode of a pulsing tube, similar to tube 56, associated with the second identifier. If the cathode of said first pulsing tube be connected to the extended sleeve conductor of a line having a directory number the units digit of which is 6 and the cathode of said second pulsing tube be connected to the extended sleeve conductor of a line having a directory number the units digit of which is 7, and the two pulsing tubes be energized in succession, a positive pulse will appear on bus-bar U6 when said first pulsing tube is energized and will reach both indicating tubes connected to said bus-bar, while a positive pulse will appear on bus-bar U7 when said second pulsing tube is energized and will reach both indicating tubes connected to bus-bar U7. But the first-mentioned positive pulse will affect only the first of the two indicating tubes connected to bus-bar U6, since the main anode of said tube is, at the moment, supplied with potential from the cathode of said first pulsing tube, while the main anode of the second indicating tube is not supplied with potential. Likewise, the second-mentioned positive pulse will affect only the second of the two indicating tubes connected to bus-bar U7, since the main anode of said tube is, at the moment, supplied with potential from the cathode of said second pulsing tube, while the main anode of the first indicating tube is not supplied with potential. In like manner, other indicating tubes, and consequently the associated registering tubes, are affected by pulses produced by the associated pulsing tube but are unaffected by pulses produced by the pulsing tubes of other identifiers.

A circuit arrangement for actuating identifiers in rapid succession for the purpose described above is shown in Fig. 4. It includes a pulse generating tube 74 and a circuit of the type known as a thyatron ring, comprising tubes 75, 76, 77, and 78. This circuit is arranged for actuating four identifiers but, by extension of the thyatron ring, may be adapted to the actuation of any number of identifiers.

One winding of transformer 80 is supplied with alternating current over conductors 81 and 82 through transformer 60 from the same source 59 which supplies anode potential to tube 56 and to pulsing tubes (not shown) of three other identifiers to be actuated. Alternating potential from the other winding of transformer 80 is biased by negative potential from the voltage divider composed of resistances 83 and 84 and supplied to the network composed of resistance 85 and condenser 86, the values of which are so chosen that the potentials at rectifiers 87 and 88 have a phase difference of nearly but not exactly 180 degrees. Curves A and B in Fig. 5 show graphically the relative potentials applied to rectifiers 87 and 88, respectively. Said rectifiers are poled so that they oppose transmission of positive potentials. The resultant potential transmitted through rectifiers 87 and 88 and thence through resistance 89 to the control grid of tube 74, which, in the present embodiment of the invention is a gas-discharge triode tube of the heated cathode type, is shown by the heavy line curve of Fig. 5. It will be observed that said

control grid is maintained sufficiently negative to prevent conduction in tube 74, except during a short period in each cycle when its potential approaches zero sufficiently to permit tube 74 to conduct. The anode of tube 74 is supplied with operating potential through the self-clearing anode circuit comprising resistance 90 and condenser 91, the values of which are so chosen in relation to the value of the anode potential and the characteristics of tube 74 that the discharge of condenser 91, due to the drop of potential through resistance 90 when tube 74 conducts, maintains conduction until the control grid of tube 74 again goes negative, when the potential between the main anode and the cathode of said tube is insufficient, due to the potential drop in resistance 90, to maintain conduction.

Tube 74, therefore, conducts for a very short period in each cycle of alternating current, producing, at its cathode, short positive pulses which are transmitted through resistance 92, thence through condensers 93, 94, 95, and 96 and resistances 97, 98, 99 and 100 to the control anodes of the gas-discharge cold cathode triode tubes 75, 76, 77 and 78. The control anodes of said tubes are each negatively biased. For example, the control anode of tube 76 is biased by negative battery through resistances 101, 102, and 97. The amplitude of the pulses from the cathode of tube 74 is limited by rectifier 103 to a value insufficient in itself to overcome said negative bias and cause tubes 75, 76, 77, and 78 to conduct. Upon the closure of switch 104 to apply anode potential to tubes 75, 76, 77 and 78 the sudden rise of potential at the main anode of tube 75 is transmitted through condenser 105 to the control anode of said tube, said rise of potential in addition to a positive pulse received at said control anode from the cathode of tube 74 being sufficient to cause tube 75 to conduct. A part of the resultant rise of potential at the cathode of tube 75, the amount being determined by the voltage divider composed of resistances 101 and 110 is, however, transmitted through the network composed of resistances 102 and 97 and condenser 111 with a time delay due to the characteristics of said network, to the control anode of tube 76, raising the potential of said control anode so that the additional potential of the next positive pulse from the cathode of tube 74 is sufficient to cause tube 76 to conduct. The resultant sudden rise of potential at the cathode of tube 76 is transmitted through condenser 106 to the cathode of tube 75, raising the potential of said cathode to a point where tube 75 ceases to conduct. A part of said rise of potential at the cathode of tube 76, the amount being determined by the voltage divider composed of resistances 112 and 113, is transmitted through the network composed of resistances 114 and 98 and condenser 115 with a time delay due to the characteristics of said network to the control anode of tube 77 so that, upon receipt of the next positive pulse from the cathode of tube 74, tube 77 conducts, causing conduction in tube 76 to cease and preparing tube 78 for conduction on the next pulse from tube 74 in the manner described for tube 76.

This action is repeated, tubes 78, 75, 76, 77, 78, . . . conducting in succession indefinitely. Each time tube 73 conducts, a positive pulse is produced at the cathode of said tube which is transmitted over conductor 116 to the control grid of pulsing tube 56 individual to the identifier shown in Fig. 3, actuating said tube in the manner previously described, and each time tubes 75, 76

76 and 77 conduct, positive pulses are produced at the cathodes of said tubes which are transmitted over conductors 117, 118 and 119, respectively to the pulsing tubes (not shown) of three other identifiers. The cathode of tube 56 and similar pulsing tubes of said other identifiers, need only be connected to the extended sleeve conductors of lines, as previously described, during a period sufficient for each of said tubes to receive one pulse to identify each of said lines.

A large number of lines are dependent for identification upon the potentials supplied to the bus-bars for actuating the gas-discharge diode tubes associated with them. Therefore, each bus-bar should be provided with an alarm circuit to give immediate warning of the failure of any of said potentials. Suitable alarm circuits are disclosed in Fig. 2. Each of the thousands-hundreds-digits bus-bars and each of the tens-units-digits bus-bars may be provided with an alarm circuit similar to that shown, as an example, associated with bus-bar TU67. The main anode of tube 120 which, in the present embodiment of the invention is a gas-discharge triode tube of the cold cathode type, is supplied with alternating potential from the source 121 through the winding of relay A1, while the cathode of said tube is supplied with positive potential directly applied thereto. The difference of potential between the anode and the cathode of tube 120 is at no time sufficient to initiate conduction in said tube but is sufficient to maintain conduction on negative cycles of alternating current. Negative potential applied through resistance 46 to bus-bar TU67, thence through resistances 122 and 123 to the control anode of tube 120 causes said tube to conduct on negative cycles of alternating current, operating relay A1. The discharge of condenser 124 through resistance 122 maintains the control anode of tube 120 sufficiently negative when positive pulses are received on bus-bar TU67 so that tube 120 does not cease to conduct during the period of said pulses. If, however, the negative potential through resistance 46 should fail, tube 120 will cease to conduct, releasing relay A1, which completes a circuit to an alarm (not shown) actuating said alarm.

Each of the office, thousands-digit, hundreds-digit, tens-digit, and units-digit bus-bars may be provided with an alarm circuit similar to that shown, as an example, associated with bus-bar U0. Tube 125, which in the present embodiment of the invention is a gas-discharge triode tube of the cold cathode type, is supplied with anode potential in a manner similar to tube 120, its cathode being connected to ground. Negative potential through resistance 47 to bus-bar U0, thence through resistance 127 to the control anode of tube 125 causes said tube to conduct on negative cycles of alternating current, operating relay A2. Positive pulses received on bus-bar U0 are insufficient to overcome the high potential supplied by battery B4 to the control anode of tube 125. However, should the potential through resistance 47 fail, tube 125 will cease to conduct, releasing relay A2 which completes the circuit of an alarm (not shown) actuating said alarm.

All of the tubes shown in the present embodiment of the invention are of the gas-discharge type. However, it will be apparent to one skilled in the electronic art that other forms of tubes such as vacuum tubes or other discharge devices could readily be substituted to perform the functions of the tubes described.

What is claimed is:

1. In a signaling system, a line having an identifying designation, conductors indicative of said designation, means for applying a unidirectional impulse to said line, means for directing said impulse to said conductors, and means for utilizing the change in the magnitude of said impulse on each of said conductors to register the designation of said line.

2. In a signaling system, a line having an identifying designation, conductors indicative of said designation, means for applying a unidirectional pulse of electric energy to said line, gas-discharge devices responsive to said pulse to direct said energy to said conductors, and gas-discharge devices responsive to the variation in the potential of said energy on each of said conductors.

3. In a signaling system, a line having an identifying designation composed of digits, a gas-discharge pulse generator, means for applying a pulse from said pulse generator to said line, gas-discharge devices responsive to said pulse to transmit said pulse over paths indicative of the digits of said designation, other gas-discharge devices responsive to said pulse on each of said paths for indicating the digits of said designation, and means for registering each of said indications.

4. In a signaling system, a line having an identifying designation composed of digits, a gas-discharge pulse generator, means for applying a pulse from said generator to said line, a first group of gas-discharge devices associated with said line for directing said pulse over paths in accordance with combinations of the digits of said designation, a second group of gas-discharge devices associated with said paths for directing said pulse over other paths in accordance with the individual digits of said combinations of digits, and a third group of gas-discharge devices responsive to said pulse on each of said other paths.

5. In a system for identifying telephone lines, the combination with lines each having an identifying designation, of conductors indicative of said designations, means for applying a unidirectional pulse to any one of said lines, means associated with said line for directing said pulse over said conductors in accordance with the designation of said line, and means responsive to the variation in magnitude of said pulse and common to all of said lines for registering said pulse on each of said conductors.

6. In a system for identifying telephone lines, the combination with lines each having an identifying designation, of means for applying a pulse to any one of said lines, means comprising gas-discharge devices for directing said pulse over paths indicative of the designation of said line, and means comprising gas-discharge devices for receiving and registering said pulse on each of said paths.

7. In a system for identifying telephone lines, the combination with lines each having an identifying designation, of a pulse generator comprising gas-discharge devices, means for applying a pulse from said generator to any one of said lines, a first group of gas-discharge devices associated with said line for directing said pulse over paths indicative of the designation of said line, a second group of gas-discharge devices common to all of said lines for directing said pulse over other paths indicative of the designation of said line, and a third group of gas-discharge devices com-

mon to all of said lines for receiving and registering said pulse.

8. In a system for identifying telephone lines, a plurality of lines each having an identifying designation, a plurality of receiving devices, means for applying a unidirectional pulse simultaneously to one of said lines and to all of said receiving devices, means for directing said pulse from said line to said receiving devices in accordance with the designation of said line, and means responsive to the change in magnitude of the pulse applied to said line for registering the coincidence at each of said receiving devices of the pulse applied to said receiving device and the pulse directed to said receiving device from said line.

9. In a system for identifying telephone lines, lines each having an identifying designation composed of digits, a plurality of gas-discharge receiving devices, means for applying a pulse simultaneously to any one of said lines and to all of said receiving devices, gas-discharge devices associated with each of said lines for transmitting said pulse, gas-discharge devices common to all of said lines for transmitting said pulse to said receiving devices in accordance with the designation of the line to which said pulse is applied, and means for registering the coincidence at each of said receiving devices of the pulse applied to said receiving device and the pulse transmitted to said receiving device from said line.

10. In combination, a plurality of lines each having an identifying designation, means for applying a unidirectional pulse to each of said lines in succession, a plurality of groups of receiving devices each responsive to the variation in the magnitude of one of said pulses, and means for directing each of said pulses to said receiving devices to indicate the designation of the line to which said pulse is applied.

11. In a system for identifying telephone lines, in combination with lines having identifying designations, a plurality of identifying circuits each responsive to the variation in the magnitude of a unidirectional impulse of short duration, means for generating such impulses, means for connecting each of said identifying circuits to one of said lines, and means for applying an impulse successively to each of said identifying circuits to indicate the designations of said lines.

12. In a system for identifying telephone lines, in combination with lines having identifying designations, gas-discharge devices associated with each line for identifying said line, gas-discharge devices common to all of said lines for identifying any of said lines, a plurality of identifying circuits each capable of being made responsive to impulses transmitted through said gas-discharge devices from any one of said lines, means for successively making responsive each of said identifying circuits and simultaneously applying impulses to said lines, and means for registering the response of each of said identifying circuits.

13. In a signaling system, individual conductors having arbitrary designations, common conductors, and means for directing and varying the magnitude of a unidirectional impulse applied to one of said individual conductors selectively to said common conductors to identify the arbitrary designation of said individual conductor.

14. In a signaling system, individual conductors having arbitrary designations, common conductors, and electronic devices for directing and varying the magnitude of a unidirectional impulse applied to one of said individual conductors selec-

tively to said common conductors to identify the arbitrary designation of said individual conductor.

15. In a signaling system, individual conductors having arbitrary designations, and common conductors each having an indicating device responsive to the variation in the magnitude of a unidirectional impulse applied to one of said individual conductors and selectably directed to said common conductors to identify the arbitrary designations of said individual conductor by the operation of the indicating devices of the common conductors to which said impulse is directed.

16. In a signaling system, individual conductors having arbitrary designations, common conductors, electronic devices for selectably directing a unidirectional impulse applied to one of said individual conductors to said common conductors in accordance with the arbitrary designation of said individual conductor, and electronic devices responsive to the variation in the magnitude of said impulse to indicate said designation.

17. In a system for identification of telephone lines, lines having numerical designations, common conductors corresponding to digits of said designations, electronic devices selectably connecting said lines to said common conductors, electronic devices interconnecting said common conductors, and means for applying a unidirectional impulse of varying magnitude to one of said lines to indicate the designation of said line.

18. In a system for the identification of telephone lines, a plurality of groups of lines, a common conductor corresponding to each of said groups, electronic devices selectably connecting said lines to said common conductors, and means for applying a unidirectional impulse of varying magnitude to one of said lines to indicate the group of which said line is a part.

19. In a system for identifying telephone lines, lines having numerical designations, a first group of common conductors for combinations of thousands and hundreds digits of said designations, a second group of common conductors for combinations of tens and units digits of said designations, electronic devices connecting said lines to said first group of common conductors in accordance with the thousands and hundreds digits of their respective designations, electronic devices connecting said lines to said second group of common conductors in accordance with the tens and units digits of their respective designations, a third group of common conductors for thousands digital values of said designations, a fourth group of common conductors for hundreds digital values of said designations, electronic devices connecting said first group of common conductors to said third and fourth groups of common conductors in accordance with the thousands and hundreds digits respectively of said designations, a fifth group of common conductors for tens digital values of said designations, a sixth group of common conductors for units digital values of said designations, electronic devices connecting said

second group of common conductors to said fifth and sixth groups of common conductors in accordance with the tens and units digits respectively of said designations, and means for applying potential to one of said lines whereby certain of said electronic devices are operated to indicate the designation of said line.

20. In a system for identifying telephone lines, a plurality of groups of lines having numerical designations, a first common conductor for each combination of thousands and hundreds digits of said designations in each of said groups, electronic devices connecting each of said lines to one of said first common conductors in accordance with the thousands and hundreds digits of the designation of said line and the group in which said line is located, a second common conductor for each of said line groups, a third common conductor for each thousands digital value of said designations, a fourth common conductor for each hundreds digital value of said designations, electronic devices connecting each of said first common conductors to one of said second common conductors, one of said third common conductors and one of said fourth common conductors in accordance with the line group, the thousands digit, and the hundreds digit of said designations, respectively, a fifth common conductor for each combination of tens and units digits of said designations, electronic devices connecting each of said lines to one of said fifth common conductors in accordance with the tens and units digits of the designation of said line, a sixth common conductor for each tens digital value of said designations, a seventh common conductor for each units digital value of said designations, electronic devices connecting each of said fifth common conductors to one of said sixth common conductors and one of said seventh common conductors in accordance with the tens digit and the units digit of said designations, respectively, and means for applying potential to one of said lines whereby certain of said electronic devices are operated to indicate the designation of said line.

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