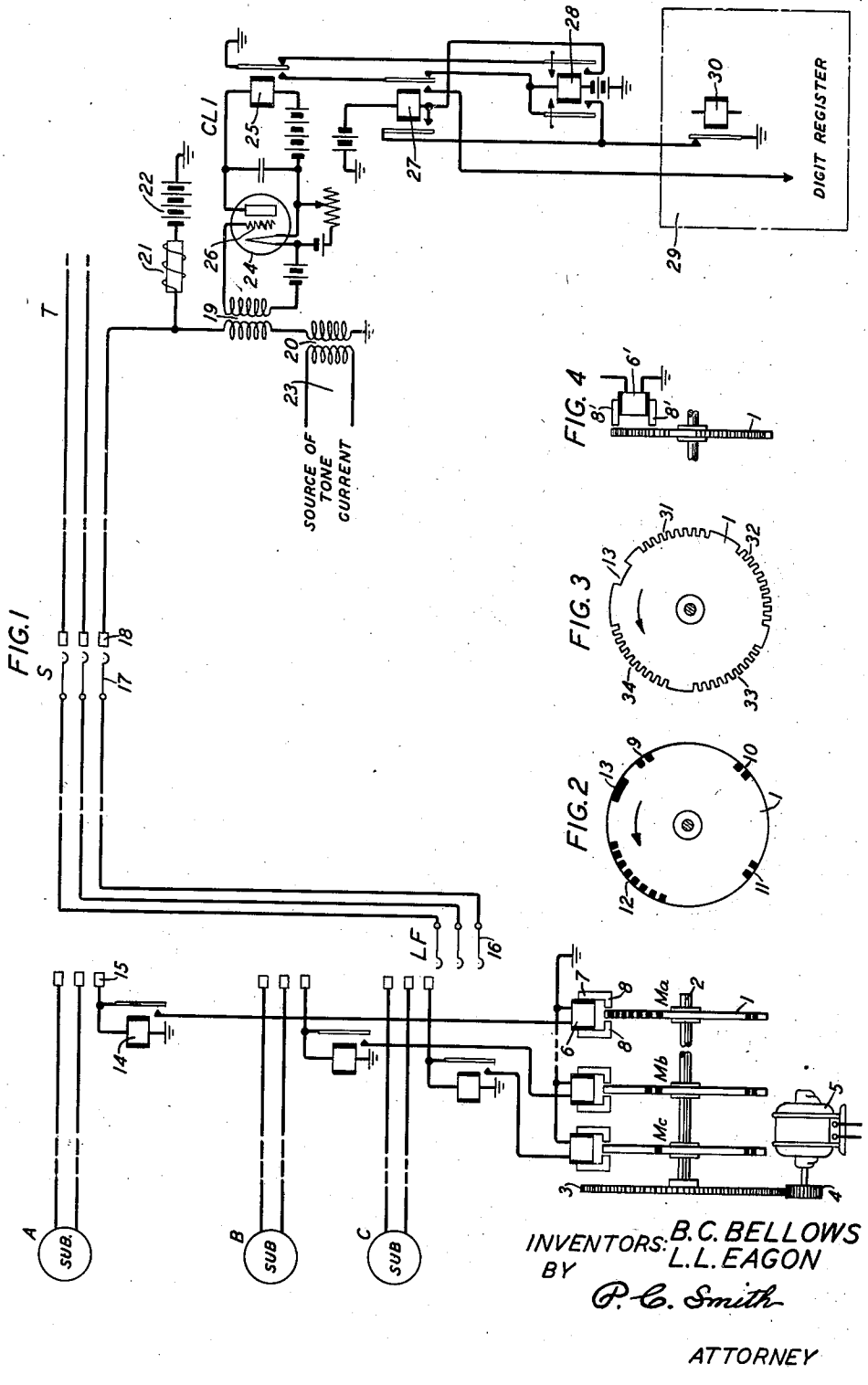
May 20, 1941. B. C. BELLOWS ET AL 2,242,640

TELEPHONE SYSTEM

Filed Nov. 2, 1939 2 Sheets-Sheet 1



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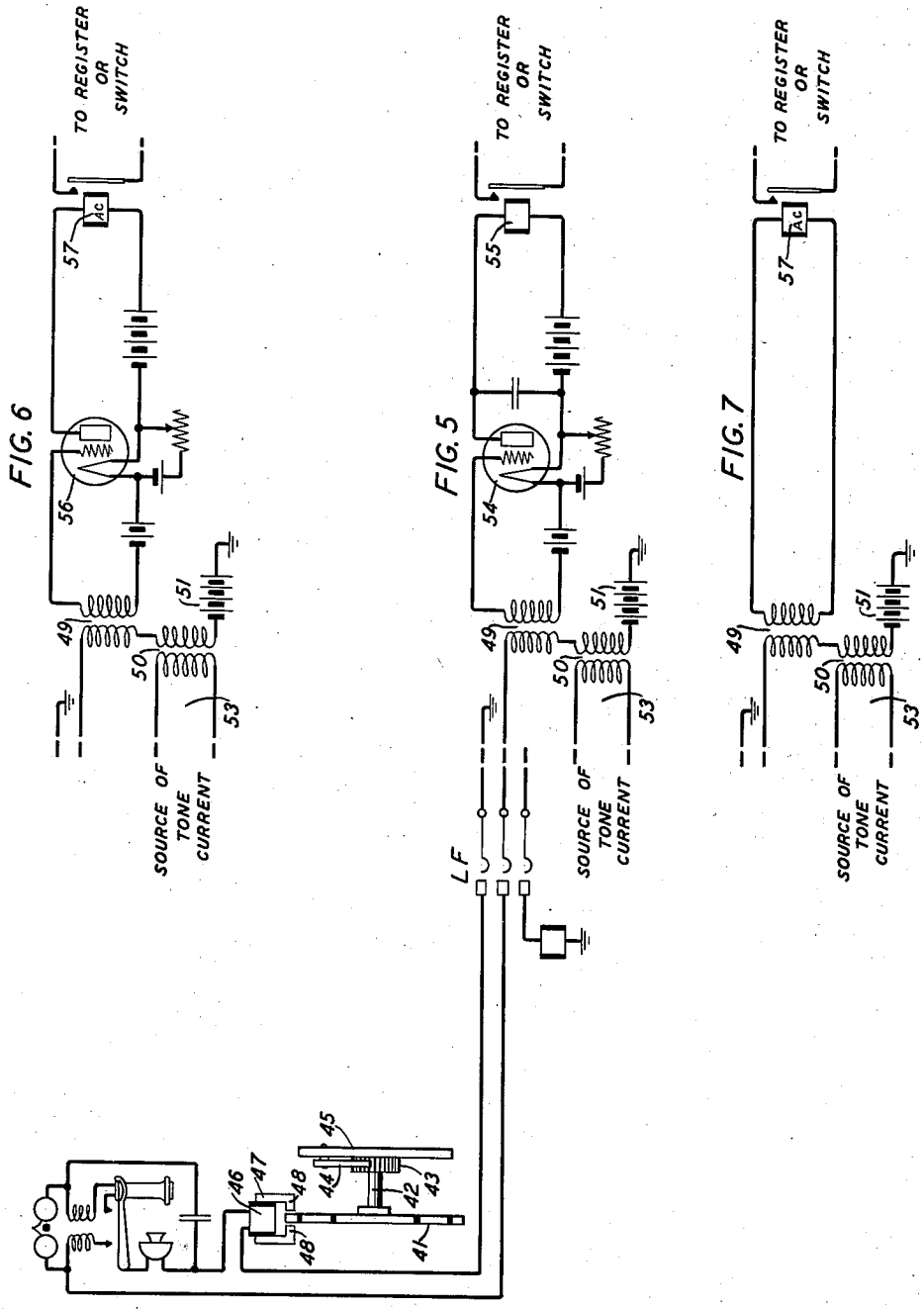

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TELEPHONE SYSTEM

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6 Claims. (Cl. 179—27)

This invention relates to telephone systems and more particularly to circuits and apparatus applicable thereto for controlling the registration at a central office of the identification of either a calling or called subscriber's line.

In the establishment of connections to toll points, it is sometimes desirable that the toll operator be enabled to check the number of the calling subscriber's line as given to her by the subscriber in order that a ticket for the connection may be accurately made out and the subscriber who made the call be billed therefor. Also in systems in which calls are automatically ticketed by mechanism located at a central office of the exchange area, it is essential that the ticketing mechanism be supplied with the identification of the calling subscriber's line. It is therefore the object of the present invention to provide means of a simple and reliably operating character which will transmit line identifying information to an operator's position or to a registering device.

One embodiment of the invention for controlling the transmission and registration of calling line identifying information comprises a plurality of impedance modifiers, one for each line of an exchange area, each modifier comprising an impedance coil and a constantly rotating rotor disc associated with the poles of the magnetic circuit of said coil. The disc is provided with as many groups of notches in its edge as there are identifying digits in the calling line designation, each group of notches corresponding to one of the digits of the number. For convenience the discs of modifiers allocated to each subgroup of lines are mounted on a common shaft driven at a constant speed by a motor, as many of such assemblies of modifiers being supplied as are necessary to serve all lines of the office. The impedance coils of the modifiers are normally open-circuited but the coil of the modifier of any line is connected to the sleeve terminal of such line following the initiation of a call from the line by the operation of the line cut-off relay.

The sleeve terminal of the calling line is extended, following the establishment of a connection from the calling line, to a calling line identifying equipment at which equipment a source of high frequency tone current is applied to the incoming end of the extended sleeve circuit. At the equipment, a vacuum tube detector is inductively coupled to the sleeve circuit for controlling a digit registering device.

When a calling subscriber has initiated a call, and the subscriber's line has been extended to the equipment, tone current is applied over the sleeve circuit of the established connection through the impedance coil of the modifier allocated to such calling line, the rotor of which in completing a revolution modulates the tone current in accordance with the groups of notches in the edge of the rotor. These modulations are then detected by the tube at the equipment which tube controls relays to transmit register controlling impulses to a registering mechanism.

In accordance with a further embodiment, the invention is also applicable to the transmission of impulses under the control of a subscriber's dial for setting a selector switch or for setting a register mechanism to register dialed digits.

For a better understanding of the invention, reference may be had to the following detailed description taken in connection with the accompanying drawings in which:

Fig. 1 schematically discloses one embodiment of the invention;

Fig. 2 shows the rotor of one of the impedance modifiers disclosed in the lower left portion of Fig. 1;

Fig. 3 shows a further modification of a rotor;

Fig. 4 shows an alternative form of an impedance modifier;

Fig. 5 shows the invention as applied to a dialing system;

Fig. 6 shows a further modification of the impulse receiving apparatus in which the impulses are amplified to operate an alternating current impulse responsive relay; and

Fig. 7 shows a further modification of the impulse receiving apparatus in which the impulses are received directly by an alternating current impulse responsive relay.

Referring first to Fig. 1, a plurality of subscribers' lines A, B and C of a subgroup of lines is disclosed, each having an impedance modifier allocated thereto and each terminating in the bank of a line finder LF. The line finder is associated with the first group selector S which in turn has access to a trunk circuit T assumed to terminate in a toll operator's position. The line finder LF and selector switch S may be of any well-known type. At the operator's position, a calling line identifying equipment CLI, disclosed in the right portion of the figure is provided for controlling the registration of the digits of the calling line identification number transmitted thereto over the connection established over the selector switches by the impedance modifier allocated to the calling line.

Each impedance modified, for example, the

modifier Ma allocated to the calling line A comprises a disc 1 of magnetic material mounted on a shaft 2 which is driven at a constant speed through gears 3 and 4 by a motor 5. As illustrated, the discs of the modifiers allocated to a subgroup of lines, for example, all of the lines accessible to a group of line finders, are mounted on a common shaft, as many of such assemblies being provided as there are line-finder groups. Associated with each disc is an impedance or field coil 6 having a core 7, the pole-pieces 8 of which are positioned adjacent to the faces of the disc 1 near the periphery thereof.

As disclosed more clearly in Fig. 2, each disc 1 is provided with groups of notches in its periphery which are filled with any suitable dielectric material. The disc 1 shown in Fig. 2 appertaining to the impedance modifier Ma, allocated to the calling line A whose directory number is assumed to be 2228, is thus provided with four groups of notches 9, 10, 11 and 12 comprising respectively 2, 2, 2, and 8 notches. The disc is also provided with a longer preliminary starting notch 13 for a purpose to be later described. From this construction it will be noted that when a metallic portion of the disc 1 is interposed between the pole-pieces 8 of the impedance coil 6, the magnetic reluctance of the magnetic circuit of the coil 6 is relatively low, but that when a dielectric portion of the disc is interposed, the reluctance will be raised, thus as the disc rotates between the pole-pieces, the impedance of the coil 6 will be modified in accordance with the dielectric insertions in the periphery of the disc and consequently in accordance with the directory number of the subscriber's line to which the disc is allocated.

When a subscriber, for example, the subscriber on line A initiates a call, the line finder LF is started and seizes the calling line whereupon the cut-off relay 14 of the line is operated. These operations are performed in the well-known manner. It will be assumed that the calling subscriber desires a toll connection and therefore dials the digit zero to obtain a connection with the toll operator's position and that in response to dialing the selector switch S is positioned to seize an idle trunk T terminating at a toll operator's position. Upon the seizure of the trunk the cut-off relay 14 is operated over the extended sleeve connection by current supplied from the source 22 through retard coil 21 and a circuit is established from ground through the winding of coil 6 of the impedance modifier Ma, over the contacts of relay 14, sleeve terminal 15 of the calling line, sleeve brush 16 of the line finder LF, sleeve brush 17 of selector switch S, sleeve terminal 18 of the trunk T, primary winding of input transformer 19 and the secondary winding of tone coil 20 to ground. High frequency tone current from the tone current source 23 is thereupon applied through the windings of the tone coil 20 through the winding of impedance coil 6 of impedance modifier Ma.

The secondary winding of input transformer 19 is connected to the input circuit of detector tube 24, the output circuit of which is connected to the winding of the anode or pulsing relay 25. During the negative half cycles of the tone source 23, the potential impressed therefrom upon the input circuit of tube 24, through the windings of input transformer 19 will be negative and the tube 24 which has its grid 26 negatively biased will not become conducting. During the positive half cycles of the tone source 23, the potential impressed upon the input circuit of tube 24 will be positive tending to overcome the negative bias on the grid 26. During such positive half-wave cycles, if the impedance of the coil 6 is high as when metallic portions of the disc 1 are interposed between the pole-pieces 8, the positive potential impulses applied from the source 23 are of such a value that the tube 24 will not become conducting, but if the impedance of the coil 6 is low as when dielectric portions of the disc 1 are interposed between the pole-pieces 8, the positive half-wave impulses from the source 23 will render the grid 26 of tube 24 sufficiently positive to cause the tube to become conducting.

It will now be assumed that at the time the previously traced circuit for coil 6 was established, the disc 1 was in such a rotational position that the group of notches 12 with their dielectric inserts are passed between the pole-pieces 8 during the continued rotation of the disc and that as a consequence eight modulating impulses are transmitted to the input circuit of tube 24 causing the tube to become conducting in response to each impulse to operate relay 25. Upon each operation, relay 25 establishes a circuit from ground over its front contact, over the back contact of relay 27 through the winding of slow-to-operate relay 28 and battery to ground. Since each operation of relay 25 is of short duration, the closures of the circuit of relay 28 are of too short duration to cause the operation of relay 28 and the transmission of such impulses is without effect on the registration equipment of the calling line identification circuit.

As soon, however, as the disc 1 rotates to position the longer starting notch 13 between the pole-pieces 8, a modulating impulse of a longer duration is transmitted and relay 25 responding thereto is maintained operated for a sufficient interval to permit slow-to-operate relay 28 to operate and lock over its left contacts to ground supplied by the digit registering equipment 29. When this long impulse terminates, relay 25 releases and with relay 28 operated, establishes a circuit from ground over its back contact, the right contacts of relay 28 through the winding of relay 27 to battery and ground whereupon relay 27 operates, locks over its left contacts to ground supplied by the digit registering equipment 29, opens at its right back contacts the initial operating circuit of relay 28 and at its right front contacts prepares an impulsing circuit over which impulses may thereafter be transmitted to the digit registering equipment by the following energizations and releases of relay 25.

As disc 1 continues to rotate, two modulating impulses are transmitted as the two notches of the group 9 pass between the pole-pieces 8 and relay 25 is operated and released twice to transmit two register controlling impulses to the thousands register of the digit registering equipment. When the transmission of the two impulses is terminated and relay 25 remains deenergized for the interval measured by the time required for the disc 1 to position the succeeding group of notches 10 between the pole-pieces 8, the usual transfer operation is performed in the digit registering equipment preparatory to registering the next or hundreds digit. In a similar manner as the notches of groups 10, 11 and 12 of disc 1 pass between pole-pieces 8, series of modulating impulses are transmitted to operate relay 25 for controlling the registration of the hundreds digit 2, the tens digit 2 and the units digit 8, by the hundreds, tens and units registers of the digit

registering equipment. As soon as all of the digits of the calling line identification number have been registered, relay **30** in the digit registering equipment is operated in any desired manner to open the locking circuits of relays **27** and **28** which relays thereupon release.

By the provision of the starting notch **13** in the disc **1** and the relays **27** and **28**, the circuit insures that no digit impulses can be registered until the disc reaches its starting position and therefore the impulses transmitted to designate the thousands, hundreds, tens and units digits will be correctly registered in the proper order by the registers of the digit registering equipment **29**.

The digit registers may cause the lighting of lamps to display the line number registered to enable the toll operator to check the number given to her by the calling subscriber or may cause the printing of the number on a toll ticket if the identification circuit is used in connection with automatic ticketing mechanism.

As disclosed in Fig. 3, the dielectric material may be omitted from the notches in the edge of disc **1**. As illustrated in this figure, groups of notches **31**, **32**, **33** and **34** are formed to transmit series of modulating impulses to identify a line whose number is 9000. If desired the pole-pieces of the impedance coil may be associated with the disc **1** as shown in Fig. 4, one pole-piece **8'** of the impedance coil **6'** being associated in close relationship to one face of the disc **1** near its center and the other pole-piece **8'** being closely associated with the same face of the disc near its periphery.

Fig. 5 shows the invention as applied to a telephone system in which an impedance modulator controlled by a subscriber's dial is employed to transmit impulses to a central office for controlling the setting of a selector switch directly in response to such impulses or for controlling the setting of a registering mechanism which may be used for any desired purpose. In accordance with Fig. 5, the usual substation dial mechanism is replaced with an impedance modulator which comprises a disc **41** of magnetic material mounted on a shaft **42** to which is secured a ratchet wheel **43**. Cooperating with the ratchet wheel is a pawl **44** pivoted on the spring returned dial **45**. The disc **41** is provided with ten equally spaced notches in its periphery. Associated with the disc is an impedance coil **46** having a core **47**, the pole-pieces **48** of which are positioned adjacent to the faces of the disc near the periphery thereof. It is to be understood that the dial controlled modulator would be equipped with contact springs, not shown, for shunting out the substation apparatus during the operation thereof.

At the central office an impulse responsive equipment is provided comprising the detector tube **54** and the impulse responsive relay **55** which equipment becomes associated with the calling line through the windings of input transformer **49** when the calling subscriber initiates a call and causes the line finder LF to connect with the terminals of the calling line. The primary winding of transformer **49** is connected serially in the calling line loop, through the secondary winding of tone coil **50** and the negatively poled battery **51**, and the secondary winding is connected to the input circuit of detector tube **54**. The primary winding of tone coil **50** is connected to a source **53** of high frequency tone current.

When the subscriber moves the dial **45** off normal to the finger stop to dial a digit, the pawl **44** connected to the dial moves freely over as many teeth of ratchet wheel **43** as correspond to the finger hole in which the subscriber has inserted his finger and when thereafter the dial is released and returns to normal under control of its return spring, the pawl causes the rotation of the ratchet wheel and the associated disc **41**. The disc **41** will thus cause a number of its peripheral notches corresponding to the value of the digit dialed to pass between the pole-pieces **48** thus transmitting modulated impulses over the loop circuit including the winding of impedance coil **46** and the primary winding of transformer **49** which impulses are effective to cause the tube **54** to become conducting in response to each impulse and to operate and release the impulse responsive relay **55** in the manner previously described. Relay **55** may control any desired digit registration apparatus as previously stated.

If desired the detector tube **54** may be replaced by an amplifier tube **56** as disclosed in Fig. 6 havin an alternating current impulse responsive relay **57** associated with its output circuit or the tube may be omitted as disclosed in Fig. 7 in which case the alternating current relay **57** would be directly responsive to the impulses transmitted by the modulator. It will be obvious that the modified impulse receiving circuits disclosed in Figs. 6 and 7 could equally well be applied to the circuit disclosed in Fig. 1.

To prevent inductive interference between the sleeve circuits of trunks which may be included in the same cable, the tone sources of the several impulse receiving equipments may be of different frequencies and the detector tube circuits may be tuned to be responsive only to the frequency of their respective tone sources.

What is claimed is:

1. In a signaling system, a line circuit, an impulse responsive device comprising a detector tube having its input circuit associated with one end of said line circuit and having an impulse responsive relay in its output circuit, means for applying a high frequency current to said line circuit and an impulse transmitting means associated with the other end of said line circuit comprising a yoke of magnetic material, a field coil on said yoke connected in series with said line circuit and a notched disc of magnetic material rotatable between the poles of said yoke whereby the rotation of said disc transmits modulating impulses over said line circuit to cause the operation of said responsive relay in synchronism with said impulses.

2. In a signaling system, a line circuit, an impulse responsive device comprising a detector tube having its input circuit associated with one end of said line circuit and having an impulse responsive relay in its output circuit, means for applying a high frequency current to said line circuit and an impulse transmitting means associated with the other end of said line circuit comprising a yoke of magnetic material, a field coil on said yoke connected in series with said line circuit and a notched disc of magnetic material rotatable between the poles of said yoke, a dial movable from its normal position in accordance with different digital values, means for returning said dial to normal, and means operable in the return movement of said dial for rotating said disc to generate a number of modulating impulses in said line circuit proportional to the movement of said dial to cause the operation of said relay in response thereto.

3. In a calling line number identifying system,

a calling line, means for extending a connection from said line to a central office, an impulse responsive means and a registering equipment responsive thereto at said central office, said impulse responsive means comprising a detector tube the input circuit of which is associable with a conductor of said established connection and the output circuit of which is provided with an impulse responsive relay for controlling said registering equipment, means for applying a high frequency current to said conductor, and means individual to said calling line for transmitting modulating impulses over said conductor in accordance with the designation of said calling line comprising a yoke of magnetic material, a field coil thereon associable with said conductor and a disc of magnetic material rotatable between the poles of said yoke and having groups of notches in its periphery corresponding to the digits of the calling line number.

4. In a calling line number identifying system, a plurality of calling lines, means for extending a connection from any one of said lines to a central office, an impulse responsive means and a registering equipment responsive thereto at said central office, said impulse responsive means comprising a detector tube, the input circuit of which is associable with a conductor of said established connection and the output circuit of which is provided with an impulse responsive relay for controlling said registering equipment, means for applying a high frequency current to said conductor, and means individual to each of said lines for transmitting modulating impulses over said conductor in accordance with the designation of the calling line associated with the outgoing end of said conductor, comprising a yoke of magnetic material having a field coil thereon associable with the outgoing end of said conductor and a disc of magnetic material rotatable between the poles of said yoke and having groups of notches in its periphery corresponding to the digits of the number of the calling line to which it is individual and a common driving shaft upon which the discs of a plurality of said transmitting means are mounted for simultaneous rotation.

5. In a calling line number identifying system, a calling line, means for extending a connection from said line to a central office, an impulse responsive means and a registering equipment responsive thereto at said central office, said impulse responsive means comprising a detector tube the input circuit of which is associable with a conductor of said established connection and the output circuit of which is provided with an impulse responsive relay, a slow-operating pick-up relay operable only upon a long operation of said impulse responsive relay, a register conditioning relay operable upon the operation of said pick-up relay and the subsequent release of said impulse responsive relay whereby the subsequent operations and releases of said impulse responsive relay are effective to operate said registering equipment, means for applying a high frequency current to said conductor, and means individual to each calling line for transmitting modulating impulses over said conductor in accordance with the designation of said calling line, comprising a yoke of magnetic material, a field coil thereon associable with the outgoing end of said conductor and a disc of magnetic material rotatable between the poles of said yoke and having in its periphery a relatively wide pick-up notch and groups of narrower notches corresponding to the digits of the calling line number.

6. In a calling line number identification system, a calling line, means for extending a connection from said line to a central office, an impulse responsive means and a registering equipment responsive thereto at said central office, said impulse responsive means comprising a detector tube the input circuit of which is associable with the sleeve conductor of said established connection and the output circuit of which is provided with an impulse responsive relay for controlling said registering equipment, means at said central office for applying a high frequency current to said sleeve conductor, means individual to said calling line for transmitting modulating impulses over said conductor in accordance with the designation of said calling line comprising a yoke of magnetic material, a field coil thereon and a disc of magnetic material rotatable between the poles of said yoke and having groups of notches in its periphery corresponding to the digits of the calling line number, and means responsive to the extension of said calling line for connecting said field coil to the outgoing end of said conductor.

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