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FIG. 8

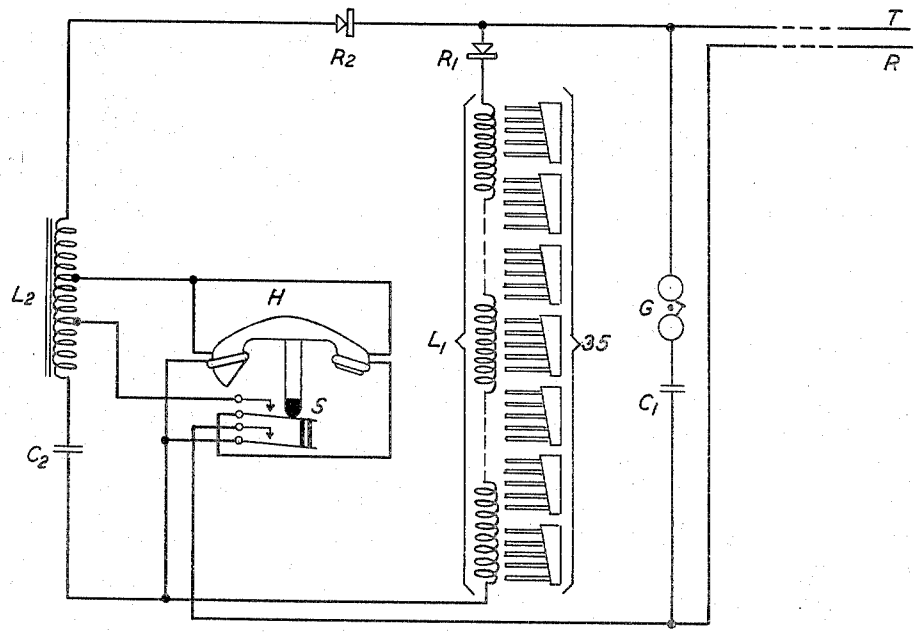

FIG. 1

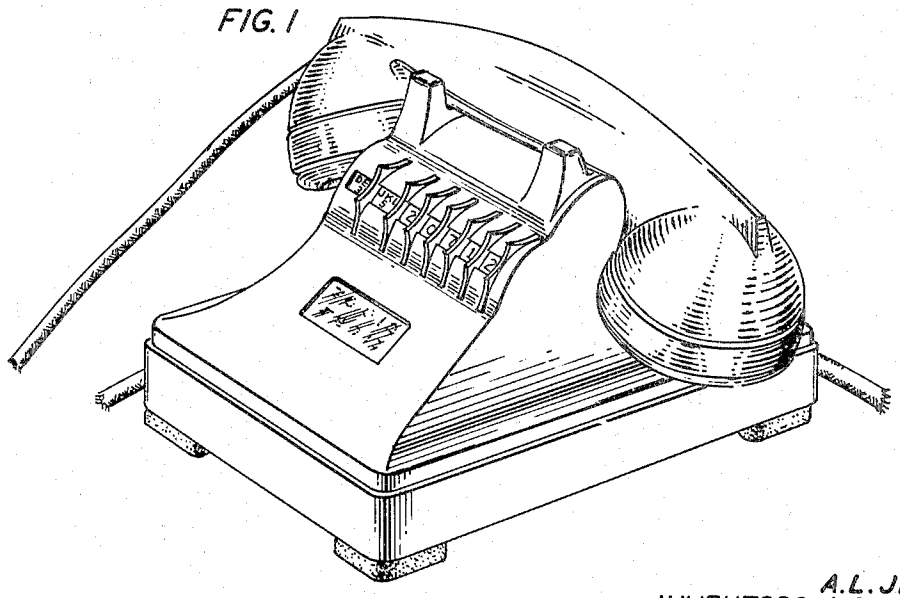

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FIG. 2

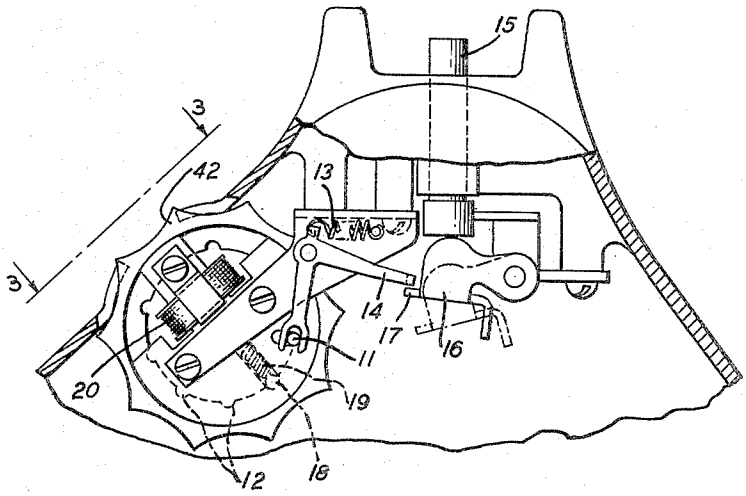

FIG. 3

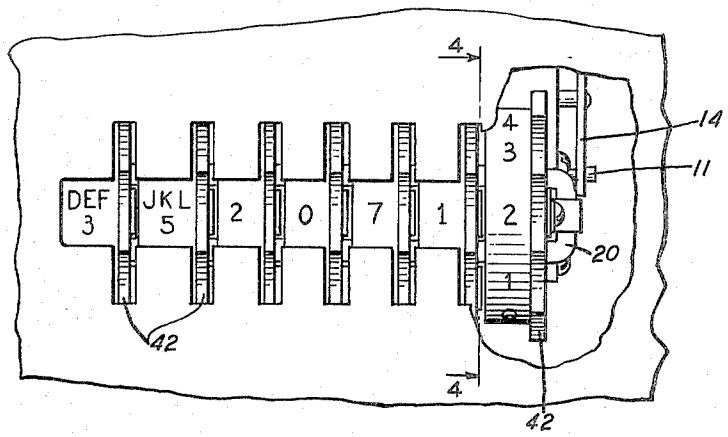

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FIG. 4

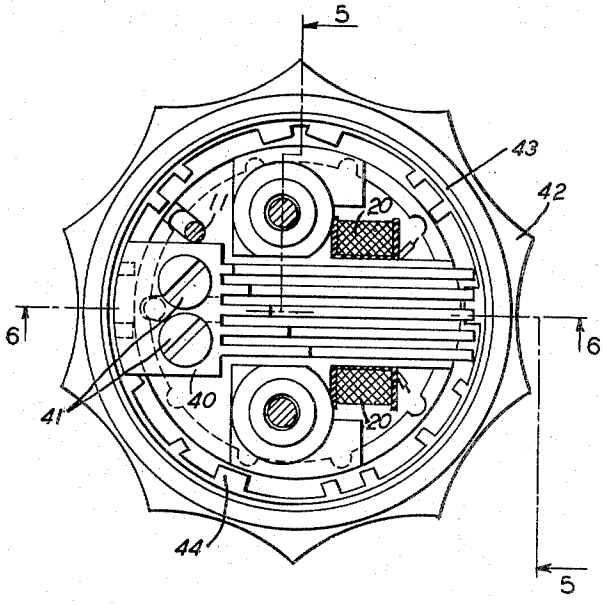

FIG. 5

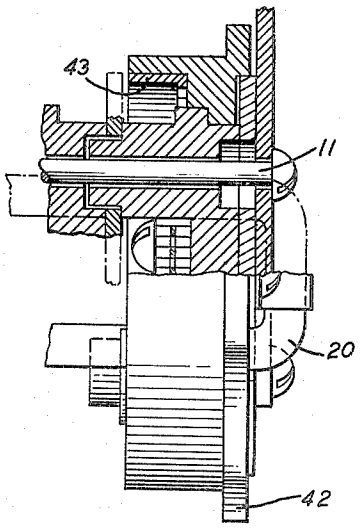

FIG. 6

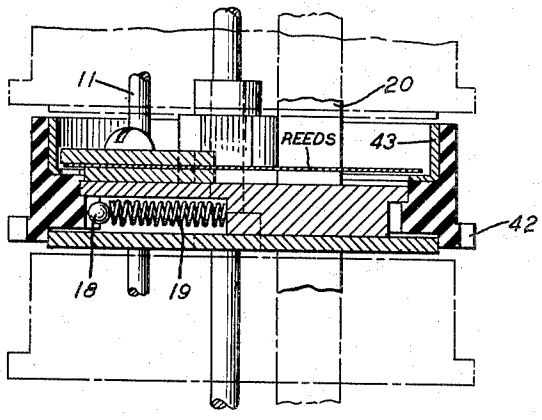

FIG. 7

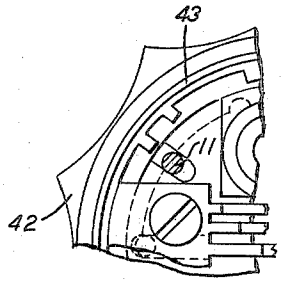

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FIG. 9

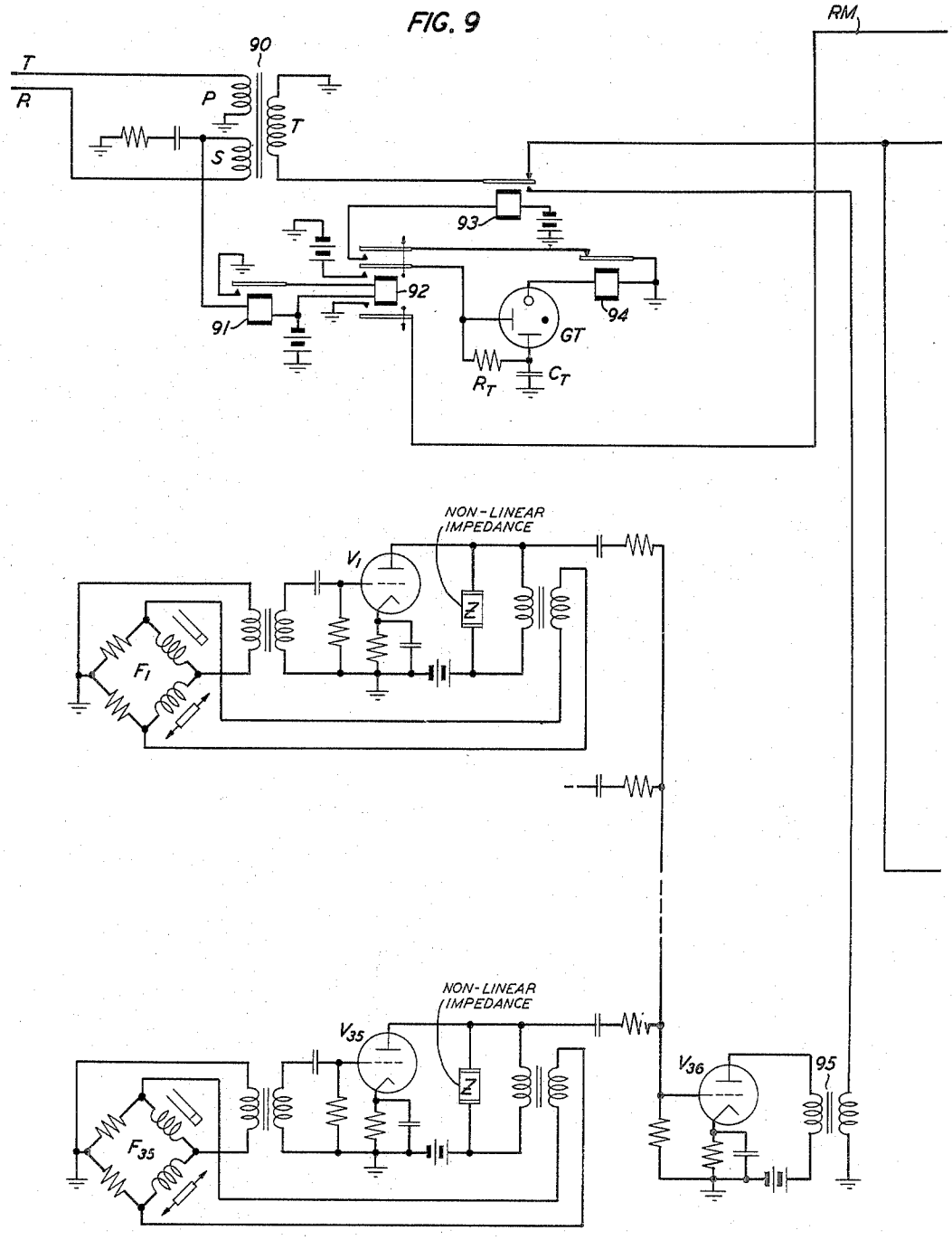

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FIG. 10

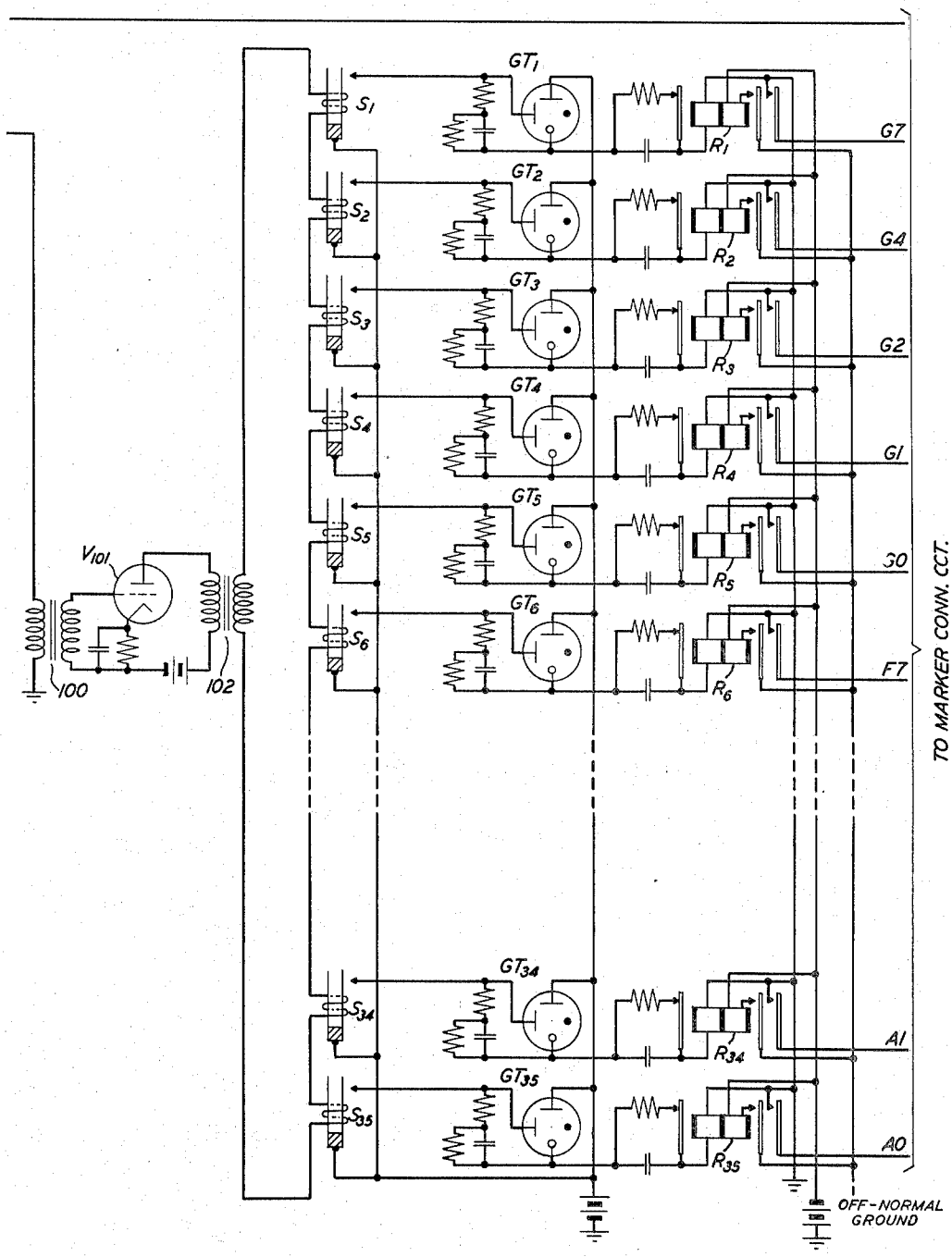

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FIG. 11

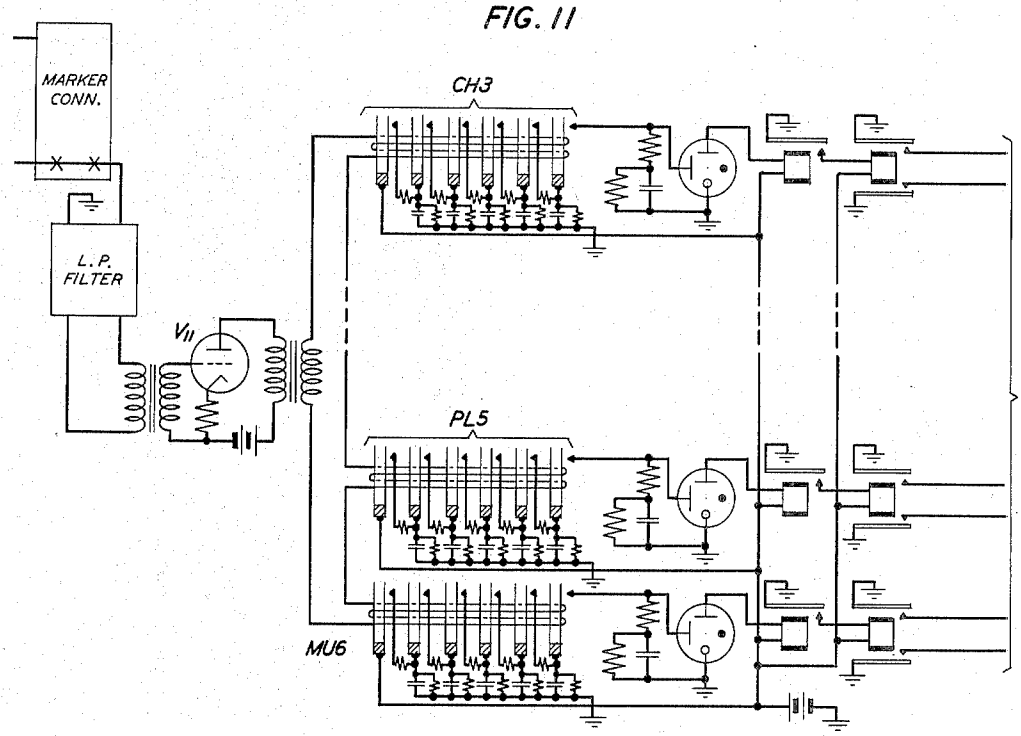

FIG. 12

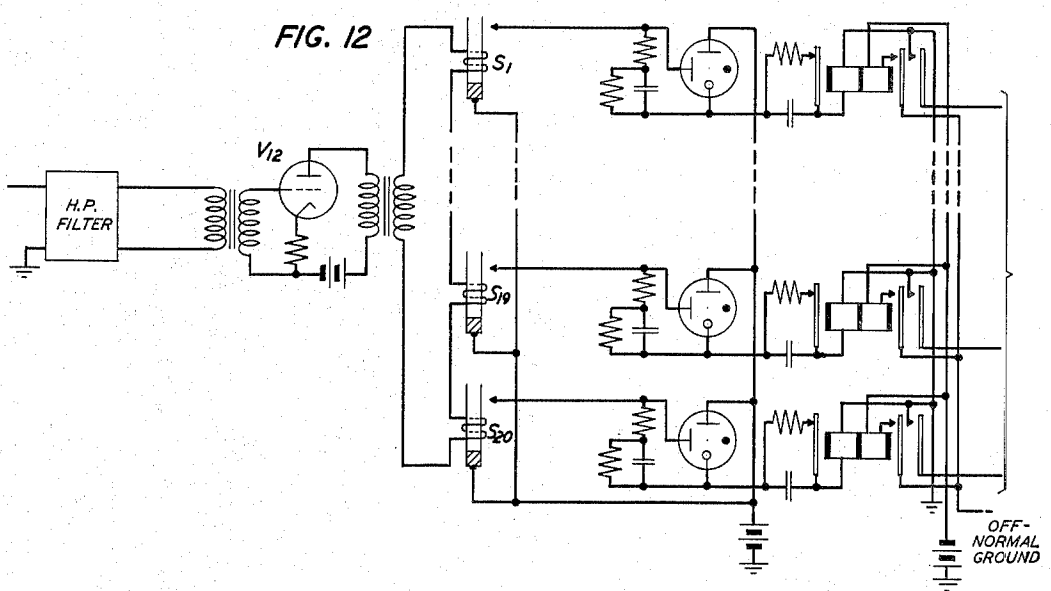

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FIG. 13

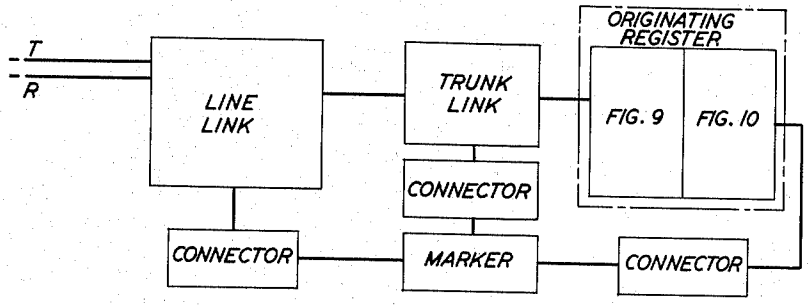


FIG. 15

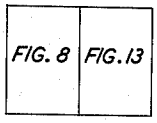
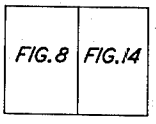


FIG. 16



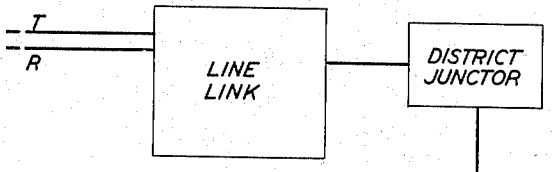


FIG. 17

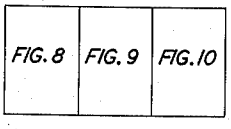


FIG. 14

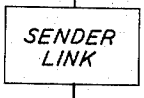
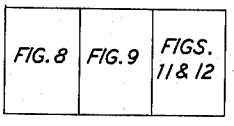
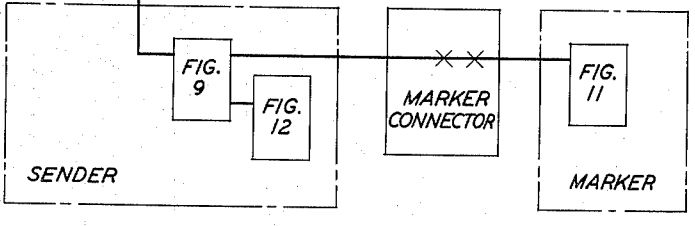


FIG. 18





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United States Patent Office 2,731,517 Patented Jan. 17, 1956

2,731,517

PRESET CALL TRANSMITTER

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Original application June 20, 1951, Serial No. 232,642, now Patent No. 2,697,749, dated December 21, 1954. Divided and this application July 16, 1954, Serial No. 443,788

3 Claims. (Cl. 179—90)

This invention relates to telephone signaling systems and particularly to telephone call transmitters for use therewith. More particularly, this invention relates to telephone signaling systems and to telephone call transmitters of the preset, key operated type for use therewith in which all characters of a called station designation may be automatically transmitted simultaneously to a central office and there be instantaneously registered. The present application is a division of copending application Serial No. 232,642, filed on June 20, 1951, now Patent No. 2,697,749, granted to A. E. Jeanne, A. C. Keller and S. D. White on December 21, 1954.

In automatic telephone systems heretofore known to the art, the characters of a called station designation generally have been transmitted from the calling station in the form of a plurality of successive groups of electrical impulses generated by operation of well-known dialing means. In some variations push-buttons have been provided as a means of transmitting successive impulse groups, and in the well-known key-pulsing systems these push-buttons operate to transmit selective combinations of signal tones for each successive digit. In most of these automatic systems, registers are employed at the central office to store the various digits of the called station designation, and in busy offices where a large number of different calling subscribers may originate calls at the same time a large number of expensive registers must be provided in order to assure the subscribers prompt service.

The number of registers necessary in any office is a function not only of the volume of originating traffic but also of the length of time required for each subscriber to complete his dialing operation, since one register can service only one subscriber at any given time. Therefore, it is apparent that any means for increasing the calling subscriber's speed of dialing, and reducing the time required for transmitting the called station designation to the central office, may reduce the over-all cost of the telephone plant by reducing the total number of registers necessary in each office and thus enable speedier and more economical service to be given telephone subscribers. In the prior art systems, since the dialing operation is performed after a register at the central office has been seized, a dilatory subscriber may thus monopolize a costly segment of central office switching equipment for an unduly long period of time, thereby necessitating the provision of a greater number of registers in the central office at a corresponding increased cost.

One of the objects of the present invention is to provide a preset type call transmitter for a telephone signaling system wherein the dialing operation may be completely performed by the subscriber prior to the seizure of a register in the central office.

Another object of the invention is to provide a call transmitter for a telephone signaling system in which the entire called station code designation may be transmitted from a calling subscriber's station to a central office register in a very brief instant of time, as by a single short group of frequencies.

Still another object of the invention is to provide a call transmitter for a telephone signaling system in which all of the digits of a called station code designation may be simultaneously registered at the central office within a fraction of a second.

Another object of the invention is to provide a telephone subscriber's station capable of transmitting simultaneously all digits of a called station code designation under the control of power supplied from the central office.

The manner in which the objects of the invention are achieved is by the simultaneous, rather than sequential, transmission from the calling subscriber's station of all the required information necessary to identify the called subscriber's station, and by simultaneous registration of this calling information in the central office with which the calling subscriber's station is connected. This is accomplished by means of a plurality of differently tuned audio frequency generators, various code combinations of which are selected by the preset dialing operation of the calling subscriber.

Further features and advantages of the invention may be apparent from a reading of the detailed description which follows in reference to the accompanying drawings wherein:

Fig. 1 is a perspective drawing representing an external view of a telephone station set as comprehended by the invention;

Fig. 2 is a partial cut-away end section of the station set shown in Fig. 1 illustrating the manner in which the signal generating components are assembled;

Fig. 3 is a plan view taken parallel to the line 3—3 of Fig. 2 illustrating the preset dials as they appear to a subscriber using the set. A portion of the cover plate is cut away in this view to better illustrate the manner in which the plurality of drum dials, each with its associated finger-wheel, is placed beneath the viewing window and operating slots within the enclosing station case;

Fig. 4 is a sectional view of a single dial drum taken along the line 4—4 of Fig. 3 and showing a set of tuned reeds, code wheels and section of encompassing coil, all enclosed within the drum;

Fig. 5 is a partial end section of the drum wheel illustrated by Fig. 4 taken along the line 5—5;

Fig. 6 is a top sectional view of the drum wheel shown in Fig. 4 as viewed along the line 6—6;

Fig. 7 is a detail of the upper left quarter of the drum wheel illustrated by Fig. 4 showing the code wheel lock in operated position;

Fig. 8 is a schematic diagram illustrating the electrical circuit of the station set the external appearance of which is disclosed by the perspective drawing of Fig. 1;

Fig. 9 and Fig. 10 when placed side by side disclose in schematic circuit diagram the essential elements of a central office multifrequency power supply and originating register circuits for a central office as comprehended by the present invention when adapted to a cross-bar telephone switching system of the general type disclosed in Patent No. 2,585,904 granted to A. J. Busch on February 19, 1952. A plurality of individually tuned signal sources together with connecting relays and coupling coils appear in Fig. 9 while a plurality of reed selectors tuned to the same frequencies as the signal sources, with their associated gas discharge tubes and register relays appear in Fig. 10;

Fig. 11 and Fig. 12 taken together comprise an additional circuit, alternative to the circuit of Fig. 10, illustrating how the invention may be utilized to reduce the holding time of a cross-bar marker and also to eliminate the necessity for a part of the marker translator in a

cross-bar system of the general type disclosed by Patent 2,235,803 to W. W. Carpenter, March 18, 1941;

Fig. 13 is a block diagram which may be connected with the subscriber station of Fig. 8 to illustrate the general manner in which the invention may be incorporated into a modern cross-bar type of telephone switching system as disclosed in Patent 2,585,904 granted to A. J. Busch on February 19, 1952;

Fig. 14 is another block diagram which may be connected with the subscriber station of Fig. 8 and illustrates an alternative arrangement in which the invention is adapted to a telephone switching system as disclosed by Patent 2,235,803 to W. W. Carpenter, March 18, 1941;

Fig. 15 shows the order in which Fig. 8 and Fig. 13 are to be combined;

Fig. 16 shows the order in which Fig. 8 and Fig. 14 are to be combined;

Fig. 17 shows the order in which Fig. 8, Fig. 9 and Fig. 10 are to be arranged to disclose one embodiment of the invention; and

Fig. 18 shows the order in which Fig. 8, Fig. 9, Fig. 11 and Fig. 12 are to be combined to disclose another embodiment of the invention.

In the preferred embodiments illustrated by the accompanying drawings the subscriber's station and associated central office circuits are adapted to a seven-digit numbering system as may be required in large metropolitan areas where as many as ten million stations may be served by a common numbering system. Thirty-five different signal frequencies are employed in seven separate groups of five distinct frequencies for each group. By selecting two out of five frequencies in each group any one of ten different values may be secured for each digit. Thus, since only two frequencies are required to designate any one digit, all seven digits may be designated by the transmission of only fourteen frequency tones out of the total of thirty-five different frequencies available. These fourteen distinctive signals are simultaneously transmitted from the calling subscriber's station to the central office where they are simultaneously registered by suitable frequency selective detector circuits which control the operation of register relays to apply ground to fourteen selected leads.

From the register circuit on to the final operation of connecting the called station, the switching operations of the central office may be the same as those now employed in any one of a number of well-known telephone switching systems, such as the cross-bar systems disclosed by the aforementioned W. W. Carpenter Patent 2,235,803 and A. J. Busch Patent 2,585,904. It will be realized, of course, that the improvement in speed of subscriber dialing, and speedly registration of dialed information, as provided by the present invention, may be employed with any type of telephone switching system and is not limited only to those systems which are now known and in use.

For a more detailed understanding of the invention we refer now to the appended drawings. The operation of the system may best be understood by a study of the circuit diagrams. Therefore, we refer first to the schematic drawing of Fig. 8 wherein it is seen that the conventional telephone dial which in other types of station sets serves to provide open and closed pulses in the telephone line is here omitted, and in lieu thereof a coil L_1 in series with a unidirectional current device, such as varistor R_1, is connected across the line T—R when the switchhook S is closed by removal of the handset from its cradle. The coil L_1 surrounds and is inductively coupled to all of the thirty-five tuned reed vibrators which are arranged in seven separate groups of five reeds each as shown at 35. Small permanent magnets, not shown in the schematic of Fig. 8, but associated with the manually adjustable code wheels as illustrated by other figures of the structural drawings, enable the subscriber to provide closer coupling between selected pairs of reeds in each set and the encompassing inductance coil L_1. Thus, those selected reeds which are close coupled by the subscriber's dialing manipulation are conditioned to be energized and set in vibration by alternating electrical energy of the corresponding frequency which may be impressed upon the coil L_1 from the central office power supply. Conversely, when the closely coupled selected reeds are thus set in vibration and the power supply from the central office removed from connection with coil L_1, the mechanical vibration of selected reeds will produce an induced alternating-current voltage of corresponding frequency in the surrounding coil L_1.

A second unidirectional current device such as varistor R_2 is connected in series with the talking circuit of the station handset H, as shown in Fig. 8. R_2 is oppositely poled from R_1 so that when positive battery is connected to the tip side of the line at the central office, the talking circuit of the station set is effectively blocked by the high impedance of R_2, while the reed coil signaling circuit L_1 presents a relatively low impedance to the line and is thus rendered conductive when a calling signal is originated. After the called station information has been transmitted from the subscriber's station and registered at the central office, and when the calling connection has been established, automatic switching means (not shown) in the central office would reverse the line polarity so that the signaling circuit L_1, R_1 presents a high impedance to the line while L_2, R_2 presents a relatively low impedance to render the talking circuit conductive. Condenser C_1 in series with the ringer G which may be a conventional gong type ringer, blocks direct current from flowing through the ringer, while condenser C_2 in series with the telephone induction coil L_2 forces direct current through the transmitter where it may be modulated by speech in a manner well known to the art.

For the sake of simplicity in understanding the operation of the invention, the subscriber's station of Fig. 8 is shown connected by tip and ring conductors of the line designated T—R to the register circuit of Figs. 9 and 10. Of course, it will be understood that in order for a large number of subscribers' stations, such as the one illustrated by Fig. 8, to have access to the register, as illustrated by Figs. 9 and 10, some appropriate form of automatic switching means must be provided between the two circuits. This may be accomplished by any type of automatic machine switching apparatus such as line finders, cross-bar switches, or any other type of appropriate switching device.

The manner in which the signaling system of the invention may be embodied in cross-bar type switching systems is herein disclosed in two forms. First, the invention may be used to effect the transmission and registration of the called number information from a calling station, this information being stored until a common control circuit becomes available. This use of the invention is illustrated by the arrangement of Fig. 13 which shows how the invention may be adapted to a cross-bar system of the type disclosed in Patent 2,585,904 granted February 19, 1952, to A. J. Busch, the full disclosure of which is incorporated herein by reference.

The second embodiment of the invention is illustrated by Fig. 14 of the drawings wherein the invention has been adapted to a cross-bar system of the type disclosed by Patent 2,235,803 to W. W. Carpenter, the disclosure of which is likewise herewith incorporated by reference thereto. In this form the signaling system of the invention works directly into the common control equipment without the necessity of first registering the called office code information. Thus, in this arrangement, immediate translation of the input signals affords a saving in central office switching equipment as otherwise required for interpreting the information in the system of the aforesaid Busch application.

Referring now in greater detail to Fig. 13 and its relation to the disclosure of the copending application

of A. J. Busch, the T—R leads of Fig. 13 are to be connected with the calling subscriber's station of Fig. 8, as shown by the arrangement of Fig. 15. When the subscriber removes his receiver from the hook, relays in the line link circuit function as described in the aforesaid application of Busch to request a connection to an originating register termination on the trunk link frame. A line appearance on the line link frame for a line is similar to one of the line appearances shown in Fig. 5 of the Busch application. An appearance of an originating register on the trunk link frame is similar to that shown in Fig. 70 of the Busch application, in which conductors 7007 and 7706 correspond to the tip and ring conductors, respectively, interconnecting the trunk link and Fig. 9 of the system represented in Fig. 13. Responsive to initiation of the call, a marker is associated with the line link frame on which the calling line terminates and with a line link frame on which an idle originating register terminates, and the marker thereupon effects operation of the switches on these frames to establish a connection between the calling line and an originating register. It is to be understood that other relays required to assist the trunk link frame and marker in establishing a connection to the register will be similar to those shown for the originating register in the Busch application. This connection between the calling line and an originating register is known as the dial tone connection because, in the prior art systems, dial tone is supplied thereby to the calling subscriber. However, in this embodiment of the present invention this connection supplies a composite signal comprising thirty-five combined tones from the signal generators of Fig. 9, as will hereinafter be described more fully in detailed reference to the circuit of Fig. 9 when arranged with Fig. 8 and Fig. 10 in the manner shown by Fig. 17. All of the digits of the called number will be received simultaneously by the register relays of Fig. 10, as hereinafter described in greater detail. The register output conductors A0 through G7 in Fig. 10 of the accompanying drawings, terminate on multicontact relays of a marker connector, such as Fig. 144 of the copending Busch disclosure, and the desired connection is established as described by the disclosure of Busch.

Fig. 14 of the appended drawings illustrates the manner in which the signaling system of the invention may be incorporated into the sender and marker of another cross-bar telephone system as disclosed by Fig. 29 to Fig. 43 of Carpenter Patent 2,235,803, wherein the called office code portion of the called number is transmitted through the sender and marker connector directly into the marker for immediate action in translating the office code to a route. When the receiver is removed from the switchhook a connection is established as described in Patent 2,235,803 from the line link through a district junctor and a sender link into the sender. The tip and ring conductors of the sender, conductors 2450 and 2451 in the Carpenter patent, are connected to a receiving circuit such as Fig. 9 of the appended drawings in place of the dial pulse receiving relays as shown in Fig. 36 of the Carpenter patent. The numerical portion of the called number is recorded on the register relays shown in Fig. 12 of the appended drawings which replace the verticals of the cross-bar switch shown in Fig. 32 and Fig. 33 of the Carpenter patent. As soon as a call reaches the sender, the sender will request the service of a marker by grounding the RM lead, seen in Fig. 9 of the appended drawings. The RM lead herein corresponds to lead 3132 of the Carpenter patent. In this embodiment of the invention each marker contains a signal receiver such as Fig. 11 of the appended drawings, only the office code portion of the called number being received. This signal receiver functions as a translator thereby making it possible to eliminate that portion of the marker shown in Figs. 49 to 76 of the Carpenter patent which are needed to operate the required route relay. When the called office code signals are received by the circuit of Fig. 11 herein, the required route relay is operated, which relay is equivalent to relay 6902 in the disclosure of the Carpenter patent. The operation of the required route relay determines how the call will be established and controlled in the originating office, and also controls the actual setting up of the linkages from the district junctor to an out trunk.

We now refer in greater detail to Fig. 9 of the drawing where the subscriber's line T—R is connected to the register circuit. This register circuit operates in the following manner. When the subscriber's station has been connected to the register through coupling coil **90** as shown in Fig. 9, the relay **91** is operated through the tip and ring connections, the subscriber's loop and the windings of coupling coil **90**. Relay **91** closes a circuit to operate relay **92**. Relay **92** operated completes a circuit to operate relay **93** and also applies a positive potential to the timing circuit R_T and C_T connected with the gas discharge tube GT.

Operation of the relay **93** applies tone from the multifrequency power supply shown in the lower portion of Fig. 9 to the T winding of coupling coil **90** from whence the tone power is induced to the P and S windings and thus transmitted to the subscriber's station of Fig. 8 in much the same manner that ordinary dial tone is supplied in other types of machine switching systems. However, in the present invention the tone applied to the subscriber's station is not ordinary dial tone but instead is a signal comprising all thirty-five frequencies to which the thirty-five individual station set reeds are tuned. When this signal is received at the subscriber's station, the particular fourteen preselected reeds which have been closely coupled to the inductance coil by manipulation of the subscriber's dialing wheels as will hereinafter be explained in greater detail, are set into vibratory motion, while the remaining unselected reeds at the station are not so energized. After a very short interval of time, which is determined by the value of resistance and capacitance in R_T and C_T, a time which is only long enough to insure that the fourteen selected reeds at the subscriber's station have reached substantially full amplitude of vibration, the gas discharge tube GT becomes conductive and operates relay **94** which releases relay **93**. With the release of relay **93** the T winding of the coupling coil **90** is disconnected from the multifrequency tone sources and transferred to the input coil of transformer **100** in the register circuit of Fig. 10. In this condition, the fourteen vibrating reeds in the subscriber's station set induce a signal in the coupling coil L_1 of Fig. 8 which comprises all fourteen different frequency components. This composite signal is now transmitted from the subscriber's station to the central office where it is impressed as a fourteen-frequency alternating-current voltage upon the register input **100** of Fig. 10.

Detailed reference is now made to the circuit of Fig. 10. Here the fourteen-frequency signal received from the subscriber's station as amplified by vacuum tube V_{101} and connected through transformer **102** to the windings of the thirty-five separate vibrating reed selectors S_1 through S_{35}. These thirty-five selectors are tuned to the same thirty-five frequencies to which the subscriber's set reeds are tuned, and those fourteen selectors which are tuned to the fourteen frequencies in the received signal from the subscriber's station will be energized and caused to vibrate, while the remaining reeds in the selector circuit are unenergized. When any one of these selectors is vibrated the closure of its vibrating contacts applies a potential to its associated gas discharge tube, such as GT_1 through GT_{35}, to cause that connected gas tube to become conductive. In this manner fourteen of the gas tubes GT_1 to GT_{35} are operated and the current flow therethrough operates the corre-

sponding fourteen register relays of the group R_1 through R_{35} as seen in Fig. 10.

Each operated relay in the bank R_1 through R_{35} locks itself up through a secondary winding, a make contact, and a lead to ground on an off-normal relay, and extinguishes its associated gas tube in the bank GT_1 through GT_{35}. Each operated relay also grounds one of the register output leads A0 through G7, which terminates on multicontact relays such as Fig. 144 of the copending Busch disclosure, whence the called connection is established as disclosed by Busch.

We now refer in greater detail to the multifrequency power supply sources disclosed by the bottom portion of the circuit drawing of Fig. 9. In the preferred form of multifrequency power supply disclosed in Fig. 9 of the drawing, a total of thirty-five separate vacuum tube oscillators, as illustrated by V_1 through V_{35}, are connected in parallel to the input circuit of a vacuum tube amplifier, as shown at V_{36}, the output of which is coupled through an appropriate transformer 95, through relay 93 operated, to the T winding of subscriber's coupling coil 90. The oscillators, as illustrated by V_1, are preferably amplifiers each of which has in its feedback circuit a vibrating reed selector filter, as shown by F_1, which is sharply tuned to a single frequency corresponding to the resonant frequency of one of the subscribers' station set reeds. These vibrating reed selector filters F_1 through F_{35} are preferably of the type disclosed in Patent 2,630,482 granted March 3, 1953, to L. G. Bostwick, although other suitable forms of narrow pass filters may be employed. With the circuit shown in Fig. 9 there is a phase shift of other than 0 or 180 degrees between the voltages in the bridge filter input and the filter output. The negative of this phase shift is provided in the resistance and capacitance input circuit to the grid of the amplifier tube so that the total phase shift of the circuit is 0 at the resonant frequency of the reed selector.

Of course, it will be understood that other forms of multifrequency generators may be employed as tone sources for the system without departing from the invention. For example instead of providing thirty-five reed selector controlled oscillators as illustrated by the circuit of Fig. 9 the system could be operated with thirty-five separate RC or LC controlled vacuum tube or transistor oscillators, or the necessary number of frequencies might be magnetically recorded on one or more tone wheels rotated at constant speed.

Another possible variation of the system would be to produce the desired multifrequency signaling tone directly at the subscriber's station without requiring multifrequency power from the central office. In such an arrangement, for example, the seven preset dials at the subscriber's station, could be adapted to unblock or select the fourteen reeds from the total of thirty-five therein provided, and those selected reeds could then be plucked mechanically by the subscriber pushing a button, or the fourteen unblocked reeds might be plucked by an electromagnet in the subscriber's station set which could be energized by a simple pulse from the central office at the proper time.

In order to provide automatic calling subscriber station identification for billing purposes, or for automatic message accounting, additional reeds may be built into the subscriber's station set in a manner to be energized during the origin of every call, and a corresponding set of additional selectors provided at the central office solely to identify the calling station. This arrangement will be particularly useful in identifying a calling subscriber on a multiparty line.

It will be obvious that the register need not be of the specific type illustrated by the circuit of Fig. 10, but that, for instance, vacuum tubes or transistors may be employed in lieu of the gas discharge tubes which are illustrated, or other circuit changes may be made within the scope of the invention.

Reference is now made to Fig. 11 and Fig. 12 of the drawings wherein is disclosed an alternative circuit which may be substituted for the circuit of Fig. 10 to adapt the invention to more rapid switching of both intra-office and outgoing calls by reducing the marker holding time, improving the method of translation, and by eliminating the need for a separate office code register in each sender. The manner in which these economies are achieved will be best understood by a brief recapitulation of the normal sequence of operations involved in office code translation by a cross-bar type of telephone switching system.

When a cross-bar marker is first seized on a dial tone call, by the act of a calling subscriber lifting his handset, the first major action of the marker is to determine the means of access to the originating register group for purposes of locating an idle register to which the connection may be established. In similar fashion, on intra-office and outgoing calls after the called and calling station information has been registered, the marker must determine the means of access to the various trunk groups applicable to the call and, in addition, obtain certain other trunk group information required for completing the connection. The major input signals consist of either a request for a register from the line-link frame, or the complete number dialed by a subscriber into the originating register, in the case of both intra-office and outgoing calls. As pointed out above, in reference to Fig. 8 through Fig. 10 of the drawings, much of the time now required for signaling and switching by sequential dial impulses may be saved by the means disclosed herin for transmitting the entire calling signal simultaneously.

With a telephone system as represented by the combination of Fig. 8, Fig. 9, Fig. 11 and Fig. 12 connected together, when the marker (of which Fig. 11 is a part) is seized by and connected to the subscriber's line T—R, of Fig. 8, through the marker connector, the marker has access to the thirty-five frequency tone supply of Fig. 9 which is applied to the subscriber's station of Fig. 8 as hereinbefore described. However, since with this system the process of registration is practically instantaneous, it is not necessary or feasible to follow the ordinary sequence of cross-bar switching operations in which the expensive marker is dropped during registration of called station information only to be recalled later to complete the call as directed by the registered information. Instead, the initial three digits which constitute the called office code, may be registered and translated directly in the marker. This is accomplished by means of a plurality of groups of vibrating reed selectors, as llustrated by CH3, PL5, MU6, etc. in Fig. 11. With this arangement a call to a station served by the Chelsea 3 office, for example, will contain fourteen simultaneous signal tones, six of which designate the called office code, on a two-out-of-five frequency basis for each digit, and these six tones will simultaneously energize all six vibrating reed selectors of CH3 to instantaneously select a trunk route from the originating office to the Chelsea 3 office. The remainder of the called station designation, i. e., the last four digits of the called party's number, comprises eight distinctive tones which are registered simultaneously by eight of the twenty vibrating reed selectors S_1 through S_{20}, each with its associated gas tube and register relay, seen in Fig. 12.

Since the circuits of Fig. 11 and Fig. 12 function substantially in two separate parts, with the circuit of Fig. 11 showing means for directly selecting an appropriate trunk route, and the circuit of Fig. 12 showing means for registering the last four digits of the called number, separate amplifiers may be provided for both parts of the signal as illustrated by V_{11} in Fig. 11 and V_{12} in Fig. 12. If the tones allocated to the first three digits, or office code portion of the signal, are the fifteen lowest frequencies of the thirty-five frequencies employed, a low-pass filter may be placed ahead of the first amplifier, V_{11} as seen in Fig. 11 to pass only this frequency band into the office code

circuit of Fig. 11, while a high-pass filter ahead of V_{12} excludes these lower frequencies from the station code circuit but permits the remaining twenty tones to pass through to V_{12}. Of course, it will be obvious that the band frequency allocations may be reversed and the higher frequencies may be employed for the office code designations and the lower frequenices for the station code, merely by interchanging the positions of the low-pass and high-pass filters, seen in Fig. 11 and Fig. 12, respectively. The system may even be operated without any band-pass filters and with but a single amplifier driving the reed selectors of both the office code and station code detection circuits, although the frequency division circuit disclosed in Fig. 11 and Fig. 12 is considered preferable.

In order better to understand the internal construction of the subscriber's station set, a preferred embodiment of which is illustrated by the perspective drawing of Fig. 1 and the schematic circuit diagram of Fig. 8, reference is now made to the structural details of Fig. 2 through Fig. 7.

Fig. 2 illustrates one possible method of providing a mechanical lock to prevent rotation of the dialing wheels after the handset is removed from the cradle. As was mentioned in the introductory portion of this specification, one of the objects of the invention is to provide a system wherein by preset dialing means the subscriber is enabled to complete his entire dialing operation at his own leisure before calling in a central office register. This is done by rotating the finger wheels, which are clearly illustrated in Figs. 1 and 3, until the number of the station to be called appears in the window slot. In the preferred embodiment herein disclosed this must be done with the receiver handset resting normally in its cradle. When the handset is lifted the station is instantly connected with the central office, and if an idle register is immediately available the selected reeds in the subscriber's station set are instantaneously energized by reception of the multifrequency signal source over the line. Within a fraction of a second thereafter this energizing signal is automatically removed from the line, as previously explained in reference to Fig. 9, and the vibrating reeds in the subscriber's station set have transmitted the selected fourteen frequency signal back to the office where it is instantaneously registered. Since this entire signaling operation may be completed in a fraction of a second, in those instances when a register is immediately available, it may not be necessary to provide the code wheel locking mechanism illustrated by the drawing of Fig. 2, because any manipulation of the code wheel after the handset has been lifted would occur too late to affect the calling signal already transmitted.

However, because an idle register may not be immediately available it may be considered desirable to provide some such locking device as that illustrated by rod **11** which extends along a line perpendicular to the plane of the drawing in Fig. 2 and is common to all the code wheels, being adjacent to one of the notches **12** in each wheel but normally disengaged from said notches by the tension of spring **13** acting through rocker arm **14**. It will be apparent from Fig. 2 that when the handset is removed from its cradle the handset pin **15** rises in response to spring pressure upon rocker arm **16**, the extension **17** of which interacts with rocker arm **14** in its upward traverse to move the locking rod **11** into engagement with all the code wheels. Fig. 2 also illustrates how a detent ball **18** is forced by compression spring **19** into various of the notches **12** as the code wheel is revolved thus centering the code wheel properly in any selected position. An end view of the common inductance coil represented by L1 in the schematic drawing of Fig. 8 is seen at **20** in Fig. 2. A top view of the same end of this coil **20** may be seen in Fig. 3.

Referring now in greater detail to Fig. 4 of the drawing we see the assembly of one set of five magnetic reeds **40** within a single code wheel, as shown here in the preferred arrangement held rigidly positioned by mounting screws **41**. The surrounding inductance coil **20** is here seen in cross-section as it encompasses all the reeds of the set. Adjacent to the free end of these magnetic reeds, and enclosed in the molded finger wheel **42**, is a magnetic code ring **43** having a plurality of coded protrusions as shown at **44**. These protrusions are so arranged that in each successive position of the finger wheel as it is rotated, two out of five of the tuned reeds are brought into close magnetic proximity to adjacent protrusions on the magnetic ring. In this way a lower reluctance magnetic path is established between the magnetic code ring **43** and a different pair of tuned reeds within the drum for each of the ten different rotational positions of the finger wheel **42**.

The selected pair of reeds thus closely coupled respond to the multifrequency alternating-current energy, which is supplied from the central office to the inductance coil **20**, by vibrating at their resonant frequencies. The remaining reeds in the set which are not so closely coupled do not receive the same magnetic driving force from the energy flowing through coil **20** and therefore do not attain any appreciable amplitude of vibration. Accordingly, when the multifrequency power supply at the central office is removed from the line and the line is instantly connected to the multifrequency register disclosed by the schematic drawing of Fig. 10, the selected pair of reeds in each code wheel which have attained their maximum amplitude of vibration continue to vibrate for a brief interval and in so doing vary the reluctance of their magnetic circuits with the code ring **43** at a frequency corresponding to their vibratory periods. This variation of magnetic field induces an electrical current of corresponding frequency in the coil **20**, which now acts as a pick-up device rather than as a driving coil, and the electrical currents thus induced are transmitted from the subscriber's station over the line to the central office where they are registered in the manner previously described in reference to the schematic drawings of Figs. 8, 9 and 10.

The partially cut-away detail drawings of Figs. 5, 6 and 7 illustrate in greater detail portions of the drum wheel components discussed above in reference to Fig. 4, showing the assembled relation of the various parts.

It is to be understood that the invention is not limited to the particular preferred embodiment of the subscriber's station set illustrated herein but that many other arrangements of structural elements may be made within the scope of the invention. For example, the tuned reeds may be plucked mechanically rather than electrically, or they may be set in motion by sharply defined direct-current pulses rather than by the plurality of alternating-current tones as herein proposed. Many other variations of structure and circuit may be made without departing from the scope of the invention as defined by the appended claims.

What is claimed is:

1. In a telephone system, a subscriber's station set comprising a plurality of differently tuned vibratile members of magnetic material arranged in a plurality of separate groups, manually adjustable means associated with each group of members for conditioning selected combinations of said members to vibrate, an electromagnetic pick-up coil inductively coupled with all of said members so as to have an electrical potential induced therein when said selected members are vibrated, and means under the control of a subscriber for causing a selected plurality of members in each group to vibrate simultaneously.

2. A station signal generator comprising a plurality of vibratory members of magnetic material, said members arranged in a plurality of groups of equal numbers, each of said members tuned to vibrate at a different natural frequency, separate manually settable means associated with each of said groups for restraining selected members in each group from vibrating and for conditioning unre-

strained members to vibrate, electromagnetic means inductively coupled with said unrestrained members, and means for causing said unrestrained members in each group to vibrate simultaneously in such manner that a plural frequency electrical signal comprising frequency components corresponding to the natural vibratory frequencies of said unrestrained members is induced in said electromagnetic means.

3. A station signal generator comprising a plurality of number wheels arranged adjacent each other and manually rotatable about a common axis, within each of said wheels a plurality of tuned magnetic reed vibrators each having one end thereof fixedly mounted and the other end free to vibrate in proximity to the internal periphery of said wheel, each of said vibrators tuned to vibrate at a different natural period from all other of said vibrators in all of said wheels, a magnetic code ring having a plu-

rality of distinctive groups of magnetic protrusions around the internal periphery of each of said number wheels in close proximity to the free ends of said vibrators and rotatable with said wheel, detent means for positioning said number wheel in any one of a predetermined plurality of positions to which said wheel may be rotated, said magnetic protrusions being brought into proximity with different combinations of said reeds in each rotational position of said wheel, and an electromagnetic coil surrounding all of said vibrators and inductively coupled therewith through magnetic protrusions of said code ring as rotated into positions adjacent the free ends of said vibrators.

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