

July 22, 1941.

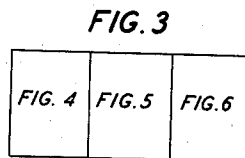
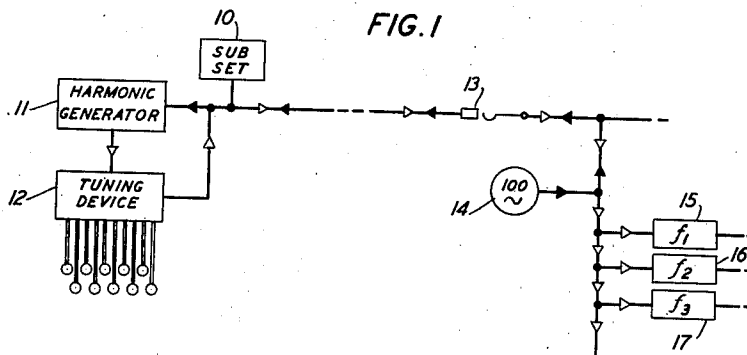
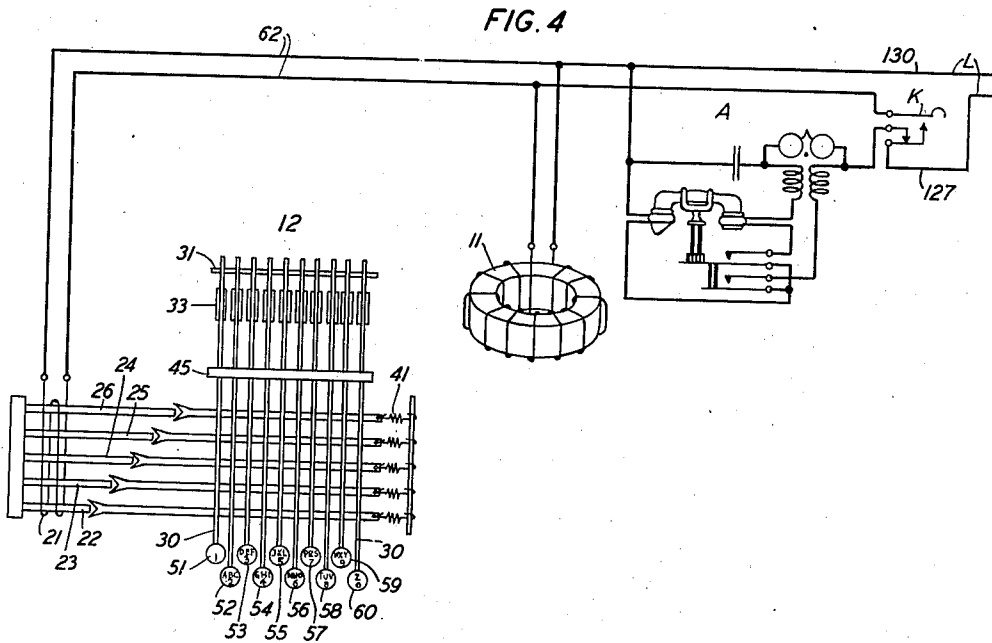
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2,250,100

SIGNALING SYSTEM

Filed Nov. 14, 1939

4 Sheets-Sheet 1



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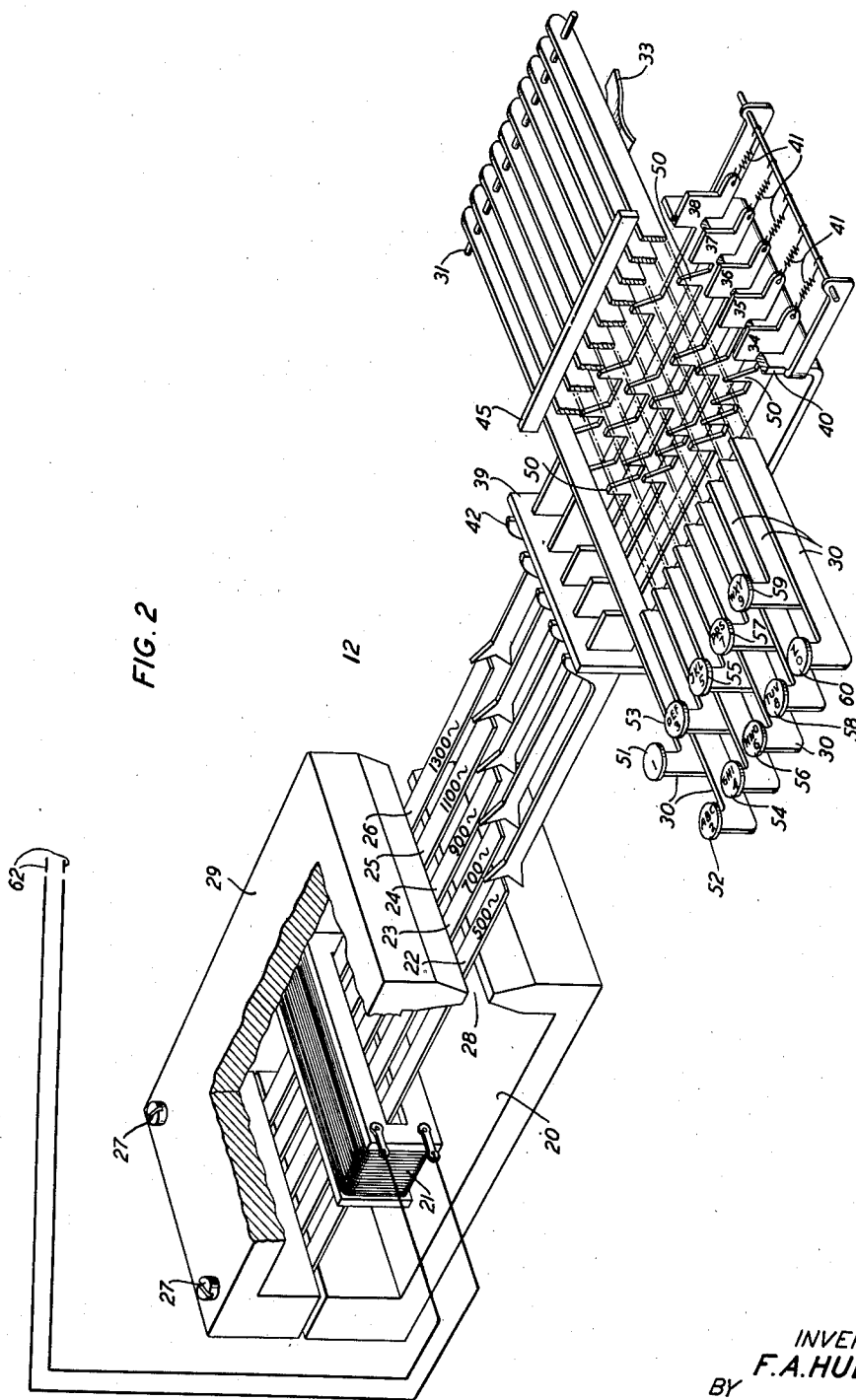
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SIGNALING SYSTEM

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4 Sheets-Sheet 2



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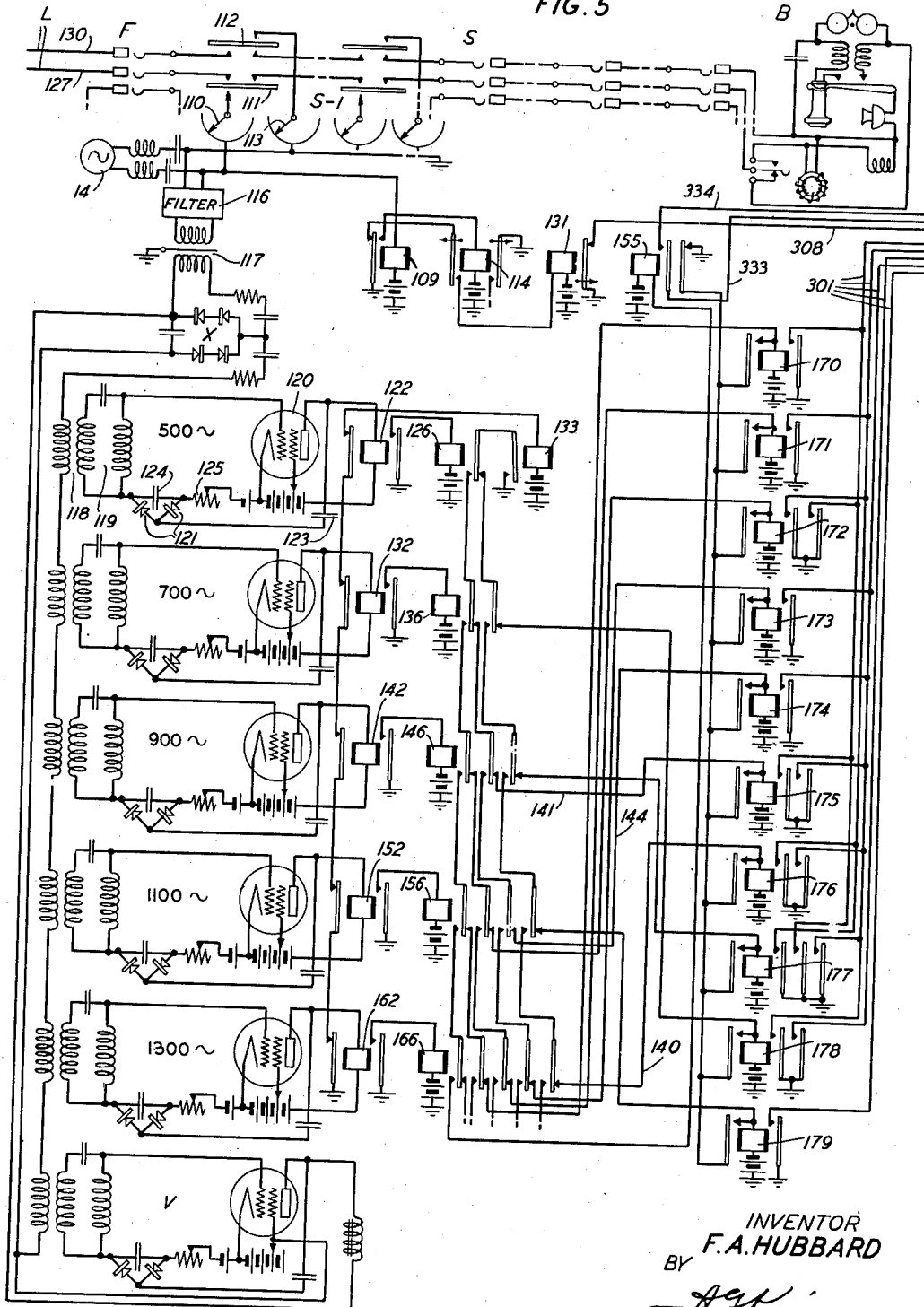
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SIGNALING SYSTEM

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FIG. 5



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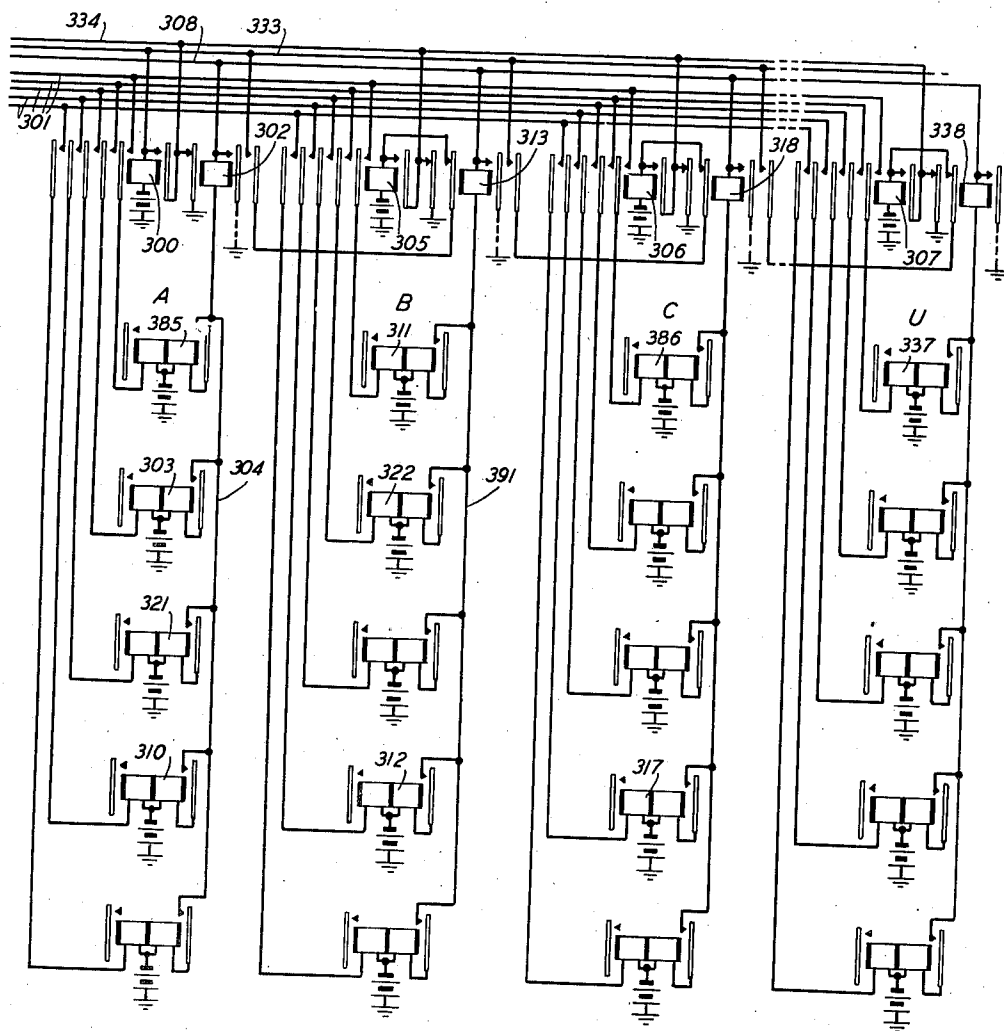
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SIGNALING SYSTEM

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4 Sheets-Sheet 4

FIG. 6



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2,250,100

SIGNALING SYSTEM

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Application November 14, 1939, Serial No. 304,309

9 Claims. (Cl. 179-16)

This invention relates to signaling and communication systems and particularly to telephone designation transmitters.

The objects of the invention are to simplify the acts required of telephone subscribers and operators in initiating automatic telephone calls; to expedite the transmission of telephone designations from one point to another and otherwise to improve automatic telephone systems.

Systems have been proposed heretofore in which the designations of called lines and the like are transmitted from one point to another by means of alternating currents of different frequencies, which singly or in combinations, serve to characterize the different letters and numerals of which the designation is composed. In such systems it is usual practice to provide the subscriber's station with a harmonic generator and with means for selecting the generated harmonics in various combinations for transmission to a central office to control automatic switches thereat.

It also has been proposed heretofore to initially transmit the output of the harmonic generator to the central office and then through the medium of a frequency suppression mechanism to suppress certain of the harmonics in combinations, thereby effecting a change in harmonic content which serves to register at the central office the designation letter or numeral which is characterized by the particular combination of harmonics suppressed. Such a system is disclosed in Patent No. 2,201,296, issued May 21, 1940, to A. A. Lundstrom and E. L. Norton.

According to the present invention, advantages over systems of the prior art are secured by impressing the output of the harmonic generator upon a coil which functions to drive a plurality of vibratile members or reeds, each of which is designed to vibrate at a particular resonant frequency corresponding to one of the frequencies or harmonics developed by the generator. The impedance of the coil at frequencies corresponding to the resonant frequencies of the vibratile members is such when the reeds are free to vibrate that the generated harmonics are transmitted to the central office with little loss. However, when the vibrating members are damped, the impedance of the coil at frequencies corresponding to the resonant frequencies of the damped members is altered so that such frequencies are effectively suppressed. The damping of the vibratile members is effected by manually operable keys which may be operated by the calling party in such a manner that the gen-

erated frequencies are suppressed in combinations, each combination characterizing the designation symbol corresponding to the key depressed.

The invention will be readily understood from the following description made with reference to the accompanying drawings, in which:

Fig. 1 constitutes a diagrammatic representation, in skeletonized form, of the essential equipment employed at a subscriber's station and at the central office and illustrates at a glance the general operation of the system embodying the features of the invention. In this figure the direction of a fundamental frequency current from a source 14, located at the central office, is indicated by the full arrowheads whereas the path for the frequencies generated by the harmonic generator 11, located at the subscriber's station is indicated by the open-head arrows;

Fig. 2 is an enlarged perspective view of the designation sender with which each subscriber's station is equipped and by virtue of which any desired designation may be transmitted to the central office to control automatic switches employed in extending connections from a calling station to a called station;

Fig. 3 is a block diagram illustrating the manner in which certain of the drawings are to be assembled to effect a complete system;

Fig. 4 is a diagrammatic representation of the equipment located at a subscriber's station; and

Figs. 5 and 6 illustrate the central office circuits and equipment which are controlled by the designation sender at the subscriber's station.

Before entering into a detailed description of the subscriber's designation sender and of the system as a whole, a brief description will be made of the general operating features of the system and for this purpose particular reference is made to Fig. 1.

At subscriber's station there are located the usual telephone set indicated by the block 10, a harmonic generator 11 and a keyboard sender consisting of ten keys and a tuning device 12. The telephone line extends to a central office, terminating thereat in the terminals of automatic switches indicated by the numeral 13. At the central office there are located a source 14 of a fundamental frequency current and a plurality of frequency responsive circuits, such as 15, 16 and 17, which selectively respond to harmonics generated by the device 11 in such a manner as to control the operation of automatic switches at the central office and cause them to extend a call to a called station. The operation

of the system, in so far as it is disclosed in Fig. 1, is briefly as follows:

Upon initiation of a call at the calling station, the automatic switch 13 at the central office functions in the well-known manner to seize the calling line and cause to be connected therewith the source 14, of fundamental frequency current. Current from this source traverses the path indicated by the full-head arrows and activates the harmonic generator 11 at the subscriber's station, causing it to generate and reflect back into the line the harmonics of the fundamental frequency. Certain of these frequencies are received at the central office by the frequency selecting circuits 15, 16 and 17. The designation sender at the subscriber's station is then actuated in accordance with a particular designation to suppress certain of the harmonics normally received by the circuits 15, 16, 17, etc., whereupon certain switching operations, characteristic of the suppressed frequencies, ensue, which result in the extension of a call to a station whose assigned designation corresponds to that set up on the designation sender at the calling subscriber's station.

The harmonic generator 11 is of the type fully described in R. C. Mathes Patent 2,164,335, issued July 4, 1939.

The subscriber's designation sender illustrated in Fig. 2 consists essentially of a reed type tuning device, a keyboard and apparatus controlled thereby which acts upon the vibratile members of the tuning device to selectively damp them in various combinations, in accordance with a particular code which is determined by the particular keys of the keyboard which are operated.

The tuning device per se comprises five vibratile reeds, 22 to 26 inclusive, which are held at one end between the abutting ends of a pair of clamping members 20 and 29 which are held together by means of the screws or bolts 27. The reeds are of different lengths and their clamped ends are in alignment so that their free ends project for different lengths beyond the forward spaced ends of the clamping members 20 and 29. A coil 21 wound on a suitable hollow form is supported between the inner faces of the clamping members 20 and 29 in any suitable manner and encircles the reeds 22 to 26 inclusive at a point intermediate their ends. When the coil 21 is energized by the harmonics generated by the device 11, the reeds 22 to 26 inclusive vibrate at their respective resonant frequencies.

The keyboard apparatus by which the vibration of the reeds 22 to 26 inclusive may be controlled is disclosed at the right of Fig. 2. This apparatus consists of ten key-actuated levers 30 and five code bars 34 to 38 inclusive. Each key lever comprises a long strip of metal pivotally mounted on a stationary rod 31 and held in a normal unactuated position against the common stop 45 by means of a leaf spring 33, only one of which is visible in Fig. 2. The code bars 34 to 38 inclusive are located beneath the key levers 30 and are coordinately disposed thereto. These bars are supported for longitudinal movement in slots in the two extremities 39 and 40 of a substantially U-shaped support. Each code bar is biased to the right by a separate spring 41, in which position a shoulder 42 on each bar engages the outer face of the support end 39. The code bars are of different lengths and each is aligned with a different one of the reeds 22 to 26 inclusive. The longest code bar 34 is in alignment with the shortest reed 22; the next longest

bar 35 is in alignment with the next shortest reed 23, and so on. The plane of each code bar is at right angles to the plane of its corresponding reed, and the end of each bar facing the free end of a reed is cut away to provide a notch into which the reed end fits when the bar is actuated, as will be more fully described hereinafter.

Those portions of the code bars 34 to 38 inclusive, which are normally located immediately below the key levers 30, are each provided with a set of tooth-like projections 50 which extend upwardly from the upper edge of the levers. The edge of each tooth-like projection facing the spring biased end of its respective bar is inclined and constitutes a camming surface which cooperates with the under edge of the lever in causing the bar to move to the left when the lever is actuated, that is, when the key end of the lever is depressed to cause the lever to pivot about the bar 31 in a direction away from the stop 45 and against the action of a leaf spring 33. The projections 50 of the bars 34 to 38 inclusive are so arranged that a camming surface of each of two code bars is engaged by the underside of a single lever 30 when the lever is actuated, thus causing the bars to move toward the free ends of the reeds in pairs. In the particular arrangement of tooth-like projections disclosed, the actuation of key 51 results in the engagement of a camming surface on each of the bars 38 and 37, causing these bars to move inwardly and engaging the ends of reeds 26 and 25 respectively; key 52, when actuated, causes code bars 38 and 36 to move inwardly and engage reeds 26 and 24 respectively; key 53 moves code bars 36 and 37 into engagement with reeds 24 and 25 respectively; key 54 moves code bars 35 and 38 into engagement with reeds 23 and 26 respectively; key 55 actuates code bars 35 and 37 which engage reeds 23 and 25 respectively; key 56 moves rods 35 and 36 into engagement with reeds 23 and 24 respectively; key 57 operates rods 34 and 38, causing them to engage reeds 22 and 26 respectively; key 58 causes the operation of rods 34 and 36, which in turn engage reeds 22 and 24 respectively; key 59 when actuated causes rods 34 and 35 to engage reeds 22 and 23, respectively; and key 60 operates to move rods 34 and 37 into engagement with reeds 22 and 25 respectively. It is apparent from the foregoing, that if the five reeds 22 to 26 inclusive are vibrated at their respective resonant frequencies, they may be damped in combinations of two's by the actuation of the key levers 30.

When the coil 21 is energized in a manner to be more fully explained hereinafter, the tuned reeds 22 to 26 inclusive will be driven at their respective resonant frequencies when the key levers 30 are in their normal unoperated positions. It is a known fact that a coil which drives a resonant armature presents at the resonant frequency a much higher electrical impedance if the armature is free to vibrate than if the armature is damped. With the key levers in their normal positions, all the reeds 22 to 26 inclusive normally would be free to vibrate when the coil 21 is energized, and the impedance of the coil would be high at all the corresponding frequencies so that the harmonics used for signaling would be transmitted over the wires 62 with little loss. The pressing of one of the ten keys 51 to 60 inclusive would apply dampers to two of the reeds 22 to 26 in a manner previously described. The impedance of the coil 21 at the frequencies corresponding to those of the damped reeds would be greatly lowered and the ampli-

tude of these harmonics sent out on the line would be reduced. Thus the frequencies corresponding to the resonant frequencies of the damped reeds would be effectively suppressed. This change in harmonic content serves to register, at the central office, the number of the key that was depressed, as will be more fully explained later.

The operation of the system involving the designation sender shown in Fig. 2 which functions to suppress, simultaneously, two frequencies for each digit of a telephone designation, will now be described and for this purpose it will be assumed that the subscriber at station A (Fig. 4) desires to call the subscriber at station B (Fig. 5). It will also be assumed that the designation of substation B is SO-5-4321.

In accordance with usual practice the subscriber at station A removes the handset from its cradle mounting to initiate the call. The subscriber's line loop is accordingly closed in the well-known manner and the line finder F (Fig. 5) starts to operate and seizes the calling line L in the usual manner. At the same time the sender selector S-1 becomes effective and extends the calling line through an idle sender. When these operations have been completed, a circuit is closed from battery through the winding of line relay 109 in the sender, over brush 110, contact of spring 111 on a controlling sequence switch, thence over the middle brush and corresponding terminal of finder F, over conductor 127 of the subscriber's line L, through the normal closed contact of key K, through the switchhook contacts at station A, returning over conductor 130, through the uppermost terminal and corresponding brush of finder F and sequence switch contacts 112, brush 113 of sender selector switch S-1 to ground in the sender. The sequence switch referred to herein may be of the type well known in automatic telephone systems of the kind in which panel type selector switches are used. The line relay 109 operates in the circuit just traced and closes an obvious circuit for the slow-release relay 114. At the same time the 100 cycle tone is sent from source 14 to notify the calling subscriber that the central office equipment is ready to receive the desired designation.

It will be noted that the key K at subscriber's station A is provided with make-before-break contacts and normally holds the harmonic generator 11 open and the subscriber's talking circuit closed on the line L. The subscriber at station A, upon receipt of the "dial" tone, actuates the key K to transfer the line L from the talking circuit to the harmonic generator 11 and coil 21 of the designation sender. During the signal transmitting period the direct current path is maintained through coil 21.

The harmonic generator, indicated by the numeral 11, is activated by the base frequency current from source 14 to generate harmonics of the base frequency (100 cycles) and reflect them back into the line circuit L. These harmonics travel back to the central office over line L, through the base frequency elimination filter 116, shielded transformer 117, through the circuit X and thence through the primary winding sections of transformer 118. Associated with each section of the primary winding of transformer 118 is a frequency receiving channel consisting of a secondary winding of transformer 118, a series tuned circuit, such as 119, a single vacuum tube, such as 120, with feedback through

the copper-oxide units, such as 121, and a relay, such as 122. The operation of the circuit just described is briefly as follows: Initially, the vacuum tube is biased nearly to cut-off, a small received signal is amplified and fed back through the condenser 123 and the copper-oxide units 121 to charge the condenser 124. This condenser is poled to reduce the negative bias on the grid of the tube 120 with the result that the gain of the tube is increased and the potential on the grid further increased. The final result is that a relatively feeble signal is sufficient to produce a sharp rise in plate current through the relay 122. The sensitivity of the individual channels is adjusted by means of the variable resistance 125. This method controls the sensitivity by changing the alternating current feedback and does not affect the tuning. It will be noted that the selectivity of each channel is accomplished entirely by a single tuned circuit per channel. The tuning may be made as sharp as desired since the received frequency is always an exact multiple of the carrier or base frequency which may be accurately controlled at the central office.

From the immediately preceding description, it will be apparent that each relay, such as relay 122, in each channel will respond to a single harmonic with a relatively high discrimination against the others. In the present description, it will be assumed that the first channel is tuned to a frequency of 500 cycles; the second channel to a frequency of 700 cycles; the third to 900 cycles; the fourth to 1100 cycles and the fifth to 1300 cycles.

Hereinbefore it was described how the harmonics of the carrier frequency (100 cycles) are generated by the device 11 at the subscriber's station and reflected back into the line circuit to eventually traverse the windings of transformer 118 at the central office. The frequencies 500, 700, 900, 1100 and 1300 cycles are accordingly received by their respective receiving channels to cause the operation of the corresponding channel relays 122, 132, 142, 152 and 162.

It will be noted that relay 133 is normally held operated by way of the left back contacts of relays 122, 132, etc., so that prior to the receipt of the generated harmonics, this relay is in its operated position. When the generated harmonics are received by the individual frequency receiving channels, and relays 122, 132, etc., and their associated relays 126, 136, etc., operate, the circuit for relay 133 is opened so that this relay now releases its armature. In attracting their innermost armatures, relays 126, 136, 146, 156 and 166 complete an operating circuit for relay 155 which relay operates and completes an obvious circuit for relay 300, Fig. 6. Relay 300 operates and connects the register operating conductors 301 to the relays of the first register A. In attracting its right armature, relay 300 locks under control of relay 302 independently of relay 155. The register A is now ready to receive the first character of the selected designation.

The frequencies generated by the device 11 at the subscriber's station are also impressed upon the coil 21 of the designation sender. The reeds 22, 23, 24, 25 and 26 of the sender are designed to have the natural periods of vibration of 500, 700, 900, 1100 and 1300 cycles, respectively, so that in response to the receipt of these frequencies by the coil 21, the said reeds are caused to vibrate. As previously stated, the impedance of the coil 21 at frequencies corresponding to the resonant frequencies of the vibratile members 22 to 26,

inclusive, is such that, when the members are free to vibrate, that is, undamped, the generated harmonics are transmitted to the central office with little loss. However, when the vibrating members are damped, the impedance of the coil at the frequencies corresponding to the resonant frequencies of the damped members is altered so that such frequencies are effectively suppressed.

In accordance with the assumption that the desired designation is SO-5-4321, the calling subscriber actuates corresponding keys of the designation sender in a manner which will be now described.

Key 57 which bears the characters "PRS7" is actuated, causing the shaft or lever 30 associated therewith to rotate or pivot about the bar 31 against the action of a leaf spring 33. In so doing, the under edge of the lever engages the inclined edge of the innermost tooth-like projection on bar 34 and also the inclined edge of the first tooth-like projection of bar 33 and by virtue of the ensuing camming action causes the bars 34 and 33 to be moved inwardly, so that the vibrating reeds 22 and 26 are engaged by the notched end of the bars 34 and 33, respectively, and are damped. The impedance of the coil 21 at the frequencies 500 and 1300 cycles is accordingly altered and the corresponding frequencies generated by the device 11 are effectively suppressed. Thus, the frequencies 500 and 1300 cycles, which characterize the symbol S of the desired designation are simultaneously suppressed with the result that relays 122 and 162 at the central office are released. These relays thereupon cause the release of relays 126 and 166 respectively, which in turn cause relay 155 to release. A circuit is now established extending from ground at the armature and back contact of relay 133, armature and back contact of relay 126, outer armature and front contact of relay 136, third armature and front contact of relay 146, fourth armature and front contact of relay 156, fifth armature and back contact of relay 166, conductor 143, winding of relay 176, to battery and ground. Relay 176 operates in this circuit, locks to ground at the outer armature and back contact of relay 155 and at its right armatures connects ground potential to two of the register controlling conductors 301, which potential passes by way of corresponding contacts and armatures of relay 302 to cause the operation of register relays 303 and 310 by way of their left windings.

Register relays 303 and 310 operate and establish locking circuits for themselves extending from ground, battery, right windings and right armatures and front contacts of relays 303 and 310, conductor 304, winding of relay 302, conductor 308 to ground by way of the back contact and armature of relay 131. Relay 302 operates in this circuit and, at its left armature, opens the holding circuit for relay 300 which relay releases its armatures, disconnecting the register A from the register control conductors 301. At its inner right armature, relay 302 establishes a locking circuit for itself and for the operated register relays 303 and 310. At its outer right armature, relay 302 prepares an operating circuit for relay 305 which extends by way of the back contact and inner left armature of relay 313, outer right armature and front contact of relay 302 to the conductor 323 which is now disconnected from the conductor 334 at the inner armature and back contact of stepping relay 155 whose circuit was opened when relays 122 and 162 re-

leased and opened the circuits to relays 126 and 166, respectively.

The operated register relays 303 and 310 are now locked in the circuit including the winding of relay 302 as above indicated and serve to store the designation digit "7," or in the case described, the character "S" for subsequent use in controlling the automatic switches shown in Fig. 5 in a manner well known in the art and as described in Patent 1,862,549 issued June 14, 1932, to Raymond et al.

When the key 57 is released by the calling subscriber the associated lever 30 is restored to normal by a leaf spring 33 and the reed damping bars 34 and 33 are restored to normal by the action of their respective springs 41. Reeds 22 and 26 therefore are free to again vibrate. Thus all the harmonics, including those previously suppressed, are again received at the central office and relays 132 and 162 are again operated. Under this condition, relay 155 is again operated and in closing its inner contacts completes the circuit to relay 305 which was partially completed by the operation of relay 302 as already described. Relay 305 accordingly operates and locks to the outer left armature of relay 313 and connects the register control conductors 301 to the register B for the receipt of the next digit, or character "O" of the desired designation. The operation of relay 155 also opens the locking circuit for relay 176 which relay thereupon releases. All relays 122, 132, 142, 152 and 162 as well as their associated relays 126, 136, 146, 156 and 166 are, therefore, operated between digits and, except for the stepping action effected by relay 155, perform no useful function at this time.

The actuation of key 57 by the calling subscriber is followed by the actuation of key 56 which bears the characters "MNO6." The lever 30 associated with the key 56 accordingly pivots about the bar 31, causing its own under edge to engage the inclined edges of the second tooth-like projection of each of the bars 35 and 36, causing the bars 35 and 36 to move inwardly and engage the vibrating members 23 and 24, respectively. These members are accordingly damped and the corresponding frequencies 700 and 900 cycles are suppressed. Relays 132 and 142 at the central office accordingly release and, in restoring their right armatures, cause the release of relays 136 and 146. The release of relays 136 and 146 causes the circuit for stepping relay 155 to be opened whereupon this relay restores its armatures which perform no useful function other than to prepare a locking circuit for the next relay of relays 170 to 179, inclusive, to be operated.

A circuit now exists which may be traced from ground, back contact and armature of relay 133, armature and front contact of relay 126, inner armature and back contact of relay 136, middle armature and back contact of relay 146, conductor 141, winding of relay 175 to battery and ground. Relay 175 operates in this circuit and locks under control of relay 155. In attracting its two right armatures, relay 175 connects ground potential to two other conductors of the register control conductors 301 and thence by way of corresponding left contacts of relay 305, to the left windings of register relays 311 and 312 of register B. These register relays operate and lock in a circuit including their right windings and armatures, conductor 301, winding of relay 313, conductor 308 to ground at the armature and back contact of relay 131. Relay 313

operates in this circuit and at its outer left armature and back contact opens the locking circuit to relay 305 which relay restores its armatures. In releasing its left armatures, relay 305 disconnects the register B from the register control conductors 301. Relay 313, at its inner right armature, establishes a locking circuit for itself and at its outer right armature prepares an operating circuit for relay 306. The register relays 311 and 312 are now locked and store the character "O" of the selected designation SO-5-4321.

The key 56 at the subscriber's station is released and relays 132 and 142 which were released for the transmission of the second digit of the telephone designation are again operated. Corresponding relays 136 and 146 are operated and the circuit to stepping relay 155 again closed. The closure of the inner contacts of relay 155 completes the energizing circuit for relay 306 which was prepared by the operation of relay 313 as previously described. Relay 306 accordingly operates and locks to the outer left armature of relay 318. At its left armatures and front contacts, relay 306 connects the register control conductors 301 to the register C for the receipt of the next digit "5" of the desired designation.

The subscriber now actuates key 55 which causes bars 35 and 37 to move inwardly, in a manner now apparent, and to damp the reeds 23 and 25. Thus the frequencies 700 and 1300 cycles at which the reeds 23 and 25 are designed to vibrate are effectively suppressed to cause the release of relays 132 and 152 at the central office. These relays, in restoring their armatures, cause the release of relays 136 and 156. With these latter relays released, the circuit to stepping relay 155 is opened causing the release of this relay. A circuit now exists which extends from ground, armature and back contact of relay 133, armature and front contact of relay 126, inner armature and back contact of relay 136, middle armature and front contact of relay 146, third armature and back contact of relay 156, conductor 144, winding of relay 174 to battery and ground. Relay 174 operates in this circuit and at its right armature connects ground to another conductor of the register control conductors 301, which passes over a corresponding front contact and left armature of relay 306 and thence to battery and ground through the left winding of register relay 317 of register C. Relay 317 accordingly operates and locks in a manner similar to that described in connection with the now locked-up relays of registers A and B. Relay 318 operates as a result of the operation of relay 317 and opens the locking circuit to relay 306 and establishes a locking circuit for itself. Relay 306 in releasing its left armatures disconnects the register control conductors 301 from register C. Relay 174 operated, locks to the outer back contact of relay 155.

In Fig. 6, only four registers are illustrated, A, B and C for the office codes and U for the units digits. It is to be understood that the thousands, hundreds, and tens registers are included in the complete system. In attracting its outer right armature, relay 318 prepares an operating circuit for the next succeeding relay of the thousands register, such as relays 300, 305 and 306 of registers A, B and C, and in attracting its inner right armature relay 318 locks in an obvious circuit with the register relay 317 of register C.

It is believed unnecessary to describe in detail

the manner in which the remaining digits "4," "3," "2," "1" of the desired designation are transmitted to the central office and stored in the registers thereat since such operations are now apparent from the previous descriptions having to do with the transmission of the designation characters "S," "0" and "5." Suffice it to say that keys 54, 53, 52 and 51 are successively actuated by the calling subscriber whereupon bars 35 and 38, 36 and 37, 36 and 38, and 37 and 38 are successively moved inwardly in pairs, causing the successive damping of the following groups of reeds: 23 and 26, 24 and 25, 24 and 26, and 25 and 26. The frequencies 700 and 1300 cycles are thus suppressed for the digit "4"; 900 and 1100 cycles for the digit "3"; 900 and 1300 cycles for the digit "2" and 1100 and 1300 cycles for the digit "1." The suppression of these frequency combinations causes corresponding relays of the group of relays 122, 132, 142, 152 and 162 to restore their armatures to control the operation of corresponding relays 170 to 179, inclusive, in a manner which is now evident. The circuit arrangement is such that relay 170 operates on the suppression of the 1100 and 1300 cycle frequencies caused by the actuation of key 51; relay 171 operates on the suppression of 900 and 1300 cycle frequencies caused by the actuation of key 52; relay 172 operates on the suppression of 900 and 1100 cycle frequencies caused by the actuation of key 53; relay 173 operates on the suppression of 700 and 1300 cycle frequencies caused by the actuation of key 54; relay 174 operates on the suppression of 700 and 1100 cycle frequencies caused by the actuation of key 55; relay 175 operates on the suppression of 700 and 900 cycles when key 56 is actuated; relay 176 operates when key 57 is actuated to suppress the 500 and 1300 cycle frequencies; relay 177 operates when the frequencies 500 and 900 cycles are suppressed by the actuation of key 58; relay 178 operates when frequencies 500 and 700 cycles are suppressed when key 59 is actuated; and relay 179 operates when key 60 is actuated to suppress the frequencies 500 and 1100 cycles.

It has already been described how the operation of relays 176, 175 and 174 results in the operation of register relays 303 and 310 of register A to store the digit "7," or character "S," of register relays 111 and 112 of register B to store the digit "6," or character "0," and to relay 317 to register C to store the digit "5" of the desired designation. Relay 173 causes the operation of a relay in the thousands register to store the digit "4"; relay 172 causes the operation of two relays in the hundreds register which correspond to the relays 311 and 322 of the B register to store digit "3"; relay 171 causes the operation of a relay in the tens register corresponding to relay 303 of the A register to store digit "2"; and when relay 170 operates, relay 337 in the units register U will operate and lock to store the units digit "1."

Due to the successive operation of keys 51 to 57, inclusive, of the designation sender, the desired designation SO-5-4, 3, 2, 1 is stored in the central office registers.

After the operation of the last key, that is, key 51 in the case described, the calling subscriber restores the key K to normal to transfer the loop from the subscriber's sender to the talking set.

It will be understood that after the registra-

tion of each digit in its particular register, the stepping relay 155 functions to cause the register control conductors 301 to be connected to the next succeeding register as described in connection with the operation of such relays 305 and 306. This stepping function is the immediate result of the release of the designation sender keys 51 to 59, inclusive, which results in the transmission of all the generated harmonics, including those suppressed when the keys are operated, to the central office.

It will be noted that the foregoing description is confined to a system in which each character or digit of a telephone designation is characterized by two frequencies suppressed simultaneously. It is apparent that the designation sender will function as well in a system wherein the designation characters are characterized by other than two frequencies. It is also within the scope of applicant's invention to connect the coil 21 in series with the line instead of in shunt therewith, in which case the reeds would normally all be damped and the keys would function to selectively remove the dampers.

As shown in Fig. 5 an auxiliary control channel V is added to the signal receiving channels and is a duplicate thereof. This channel is made selectively responsive to a frequency just above the frequencies utilized for designation transmission. A frequency of 1500 cycles is suitable in the case described.

With the receiving apparatus used on a short loop, it is obvious that a very high degree of suppression to the harmonics would be necessary at the subscriber's set in order to reduce them well below the level normally received on long loops. To avoid this, the extra harmonic receiving channel V is used which is not affected by the signaling processes and serves only to control the input to the apparatus. As above stated, the volume control channel is a duplicate of the signaling channels and is placed just above them in frequency. The change in plate current is used to change the resistance of a copper oxide shunt circuit. A suitable input circuit X may consist of two 700-ohm resistances and two 10-microfarad condensers in one of the two series arms and four one-quarter inch discs of copper oxide connected to effect a T network as shown. The two condensers referred to as well as the condenser in the other series arms are blocking condensers.

At low levels the direct current through the copper oxide discs is low and the copper oxide resistance is high. The circuit X will therefore cause little loss, but as the level increases, the direct current will increase sharply, reducing the resistance of the copper oxide units and accordingly increasing the loss and thereby reducing the level at which the transmitted signals are received in their respective receiving channels. In this manner the transmitted signals are received at a substantially constant level irrespective of the length of line over which they are transmitted.

In the particular embodiment of the invention disclosed in the drawings, the vibrating reeds are treated as impedance members to be selectively damped and thus suppress certain harmonics generated by the harmonic generator 11, when energized by a base frequency supplied from the central office. It will be apparent to those skilled in the art that the fundamental scheme for alternating current dialing is capable of variations which come within the scope of the present in-

vention. A particular variation which readily suggests itself is one in which the tuned reeds may be used as coupling members between the driving coil, fed from the harmonic generator, and a carbon button or other alternating current generator so that the output of the carbon button will contain only those harmonics represented by the reeds which are free to vibrate. In such a variation and with no keys of the designation sender depressed, all the reeds are free to vibrate and the output of the carbon button will contain all five harmonics corresponding to the five vibrating reeds. Each key when depressed damps two of the reeds thereby suppressing two corresponding harmonics. Thus the designation signals reach the central office in exactly the same form described in connection with the system disclosed in the drawings.

What is claimed is:

1. The combination in a signaling system of a line, a harmonic generator responsive to current of a base frequency on said line for reflecting harmonics of the base frequency into said line for transmission thereon, and means for suppressing certain of the generated harmonics comprising a plurality of vibratile reeds each having a natural period of vibration corresponding to a particular one of the generated harmonics, an impedance coil responsive to the generated harmonics for vibrating said reeds, said coil presenting an impedance during the vibration of said reeds such that the harmonics corresponding to the natural period of the vibrating reeds are transmitted over said line with no appreciable loss and means for damping said reeds whereby said coil presents an impedance at frequencies corresponding to the natural periods of the damped reeds such that the corresponding harmonics are suppressed.

2. The combination in a signaling system of a line, a harmonic generator responsive to current of a base frequency on said line for reflecting harmonics of the base frequency into said line for transmission thereon, and means for selectively suppressing certain of the generated harmonics in pairs comprising a plurality of vibratile reeds each having a natural period of vibration corresponding to a particular one of the generated harmonics, an impedance coil responsive to the generated harmonics for vibrating said reeds, said coil presenting an impedance during the vibration of said reeds such that the generated harmonics are transmitted over said line with no appreciable loss and means for selectively damping said reeds whereby said coil presents an impedance at frequencies corresponding to the natural periods of the damped reeds such that the corresponding harmonics are suppressed.

3. The combination in a signaling system of a line having a station thereon, a source of alternating current of a base frequency, means for connecting said source of said line, a multifrequency generator at said station responsive to current from said source for generating harmonics of the base frequency and reflecting them into said line, and means for controlling the transmission of certain of the generated harmonics over said line comprising an impedance coil connected in said line whose impedance at the frequencies of said certain harmonics controls the transmission thereof over said line, and means for varying the impedance of said coil at the frequencies of said certain harmonics comprising a plurality of vibratile members driven

by said coil and each tuned to vibrate at a frequency corresponding to a particular one of said certain harmonics, and means for selectively controlling the vibration of said vibrating members.

4. The combination in a signaling system of a line, a source of alternating current of a base frequency, means for connecting said source to said line, a harmonic generator responsive to current from said source for generating harmonics of the base frequency and reflecting them into said line for transmission thereof, a plurality of vibratile members each tuned to vibrate at a particular resonant frequency, a driving coil therefor connected to said line responsive to the generated harmonics for vibrating said vibratile members at their respective resonant frequencies, and means for selectively damping the vibrating members in various combinations to cause said coil to present an impedance at the resonant frequencies of the damped members such that the corresponding generated harmonics are excluded from said line.

5. The combination in a signaling system of a line having a station thereon, a source of alternating current of a given frequency at a central office, means responsive to the initiation of a call at said station for connecting said source to said line, a harmonic generator at said station responsive to current from said source for generating harmonics of the given frequency, a tuned reed for each of a given number of the generated harmonics, an impedance coil responsive to the generated harmonics for vibrating said reeds and means at said station for damping said reeds in various combinations to cause the impedance of said coil at frequencies corresponding to the natural periods of the damped reeds to be altered whereby the corresponding generated harmonics are suppressed.

6. The combination in a signaling system of a line having a station thereon, a source of alternating current of a given frequency at a central office, means responsive to the initiation of a call at said station for connecting said source to said line, a harmonic generator at said station responsive to current from said source for generating harmonics of the given frequency and transmitting them over said line, translating devices at said central office selectively operating in response to the transmission of certain of the generated harmonics over said line, a tuned reed at said station for each of said certain harmonics, an impedance coil responsive to the generated harmonics for vibrating said reeds and means at said station for selectively damping said reeds in pairs to cause the impedance of said coil at frequencies corresponding to the natural periods of the damped reeds to be altered, whereby the corresponding generated harmonics are suppressed in pairs and corresponding pairs of said translating devices are released.

7. The combination in a signaling system of a line, a source of alternating current of a base frequency, means for connecting said source to said line, a harmonic generator responsive to

current from said source for generating harmonics of the base frequency and reflecting them into said line for transmission thereof, and means for excluding certain of the generated harmonics from said line comprising a plurality of distinctively tuned vibratile members having natural periods of vibration corresponding to said certain of the generated harmonics, an impedance coil subject to the generated harmonics for driving said vibratile members and presenting an impedance at frequencies corresponding to the natural periods of said vibratile members when driven by said coil such that the corresponding generated harmonics are transmitted over said line with no appreciable loss and means for selectively damping said vibratile members whereby the impedance of said coil at frequencies corresponding to the natural periods of the damped members is altered and the corresponding generated harmonics consequently excluded from said line.

8. The combination in a signaling system of a line, a multifrequency generator for transmitting a plurality of different frequencies over said line, and means for selectively excluding certain of the generated frequencies from said line comprising a plurality of distinctively tuned reeds, a driving coil therefor connected to said line, and responsive to current from said generator and means for selectively damping said reeds to cause said coil to present an impedance at frequencies corresponding to the vibrating frequencies of the damped reeds such that the corresponding generated frequencies are excluded from said line.

9. The combination in a telephone signaling system of a line circuit, a station thereon, a source of alternating current of a base frequency, means responsive to the initiation of a call at said station for connecting said source of current to said line circuit, means at said station responsive to current from said source for generating harmonics of the base frequency in said line circuit, translating devices operated in response to the generation of harmonics at said station, and a designation transmitter at said station comprising a tuned reed for each of a certain number of the generated harmonics, an impedance coil responsive to the generated harmonics for vibrating said reeds, said coil, during the vibration of said reeds, presenting an impedance to the transmission of said certain number of the generated harmonics such that they are transmitted over said line without loss and means for selectively damping said reeds in combinations characteristic of the digits of the telephone designation to cause the impedance of said coil at frequencies corresponding to the natural period of the damped tuned reeds to be altered, whereby corresponding harmonics are suppressed and corresponding translating devices released and means controlled by said translating devices for registering the designation.

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