June 18, 1940. F. A. HUBBARD 2,204,759

TELEPHONE SYSTEM

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FIG. 2

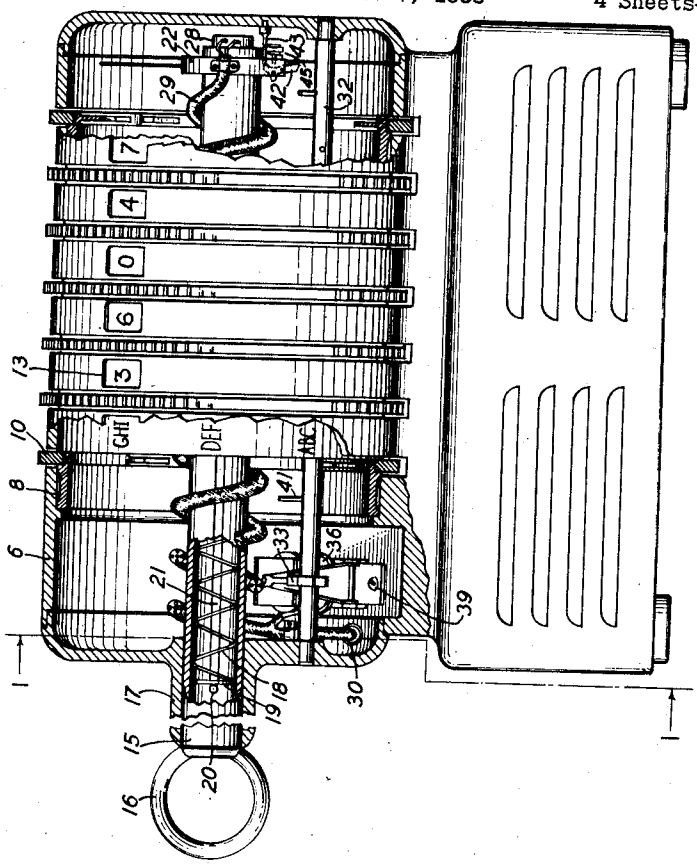
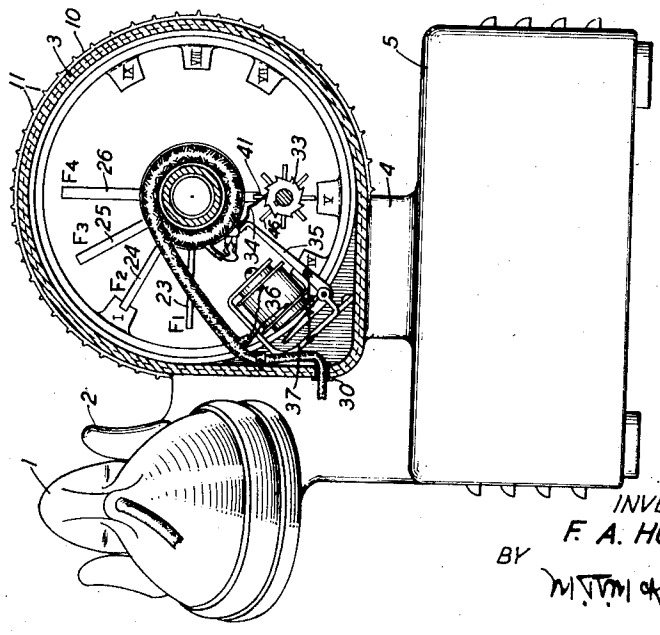


FIG. 1



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TELEPHONE SYSTEM

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FIG. 7

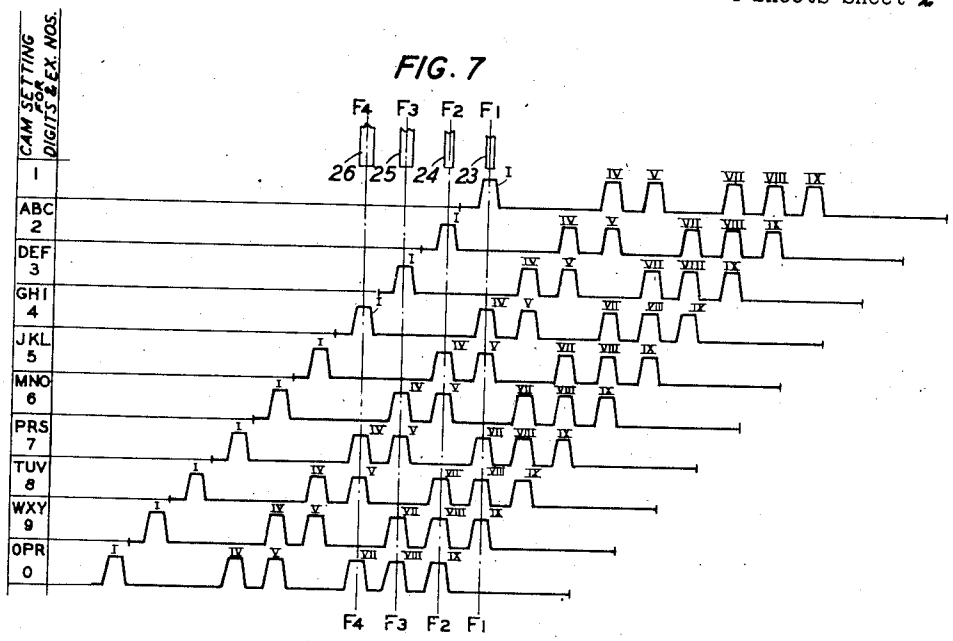


FIG. 3

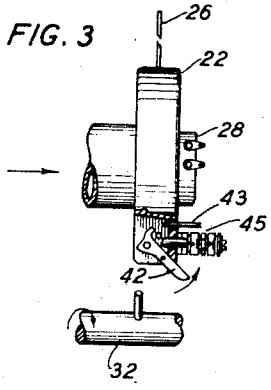


FIG. 4

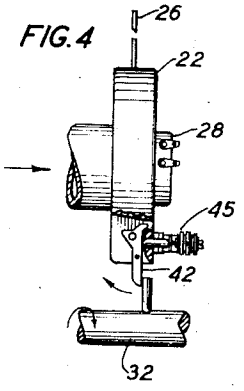


FIG. 5

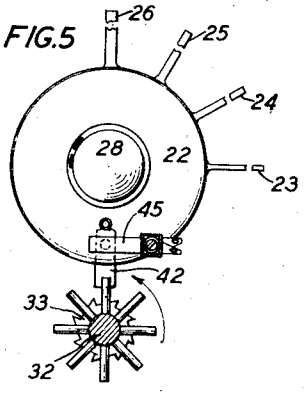
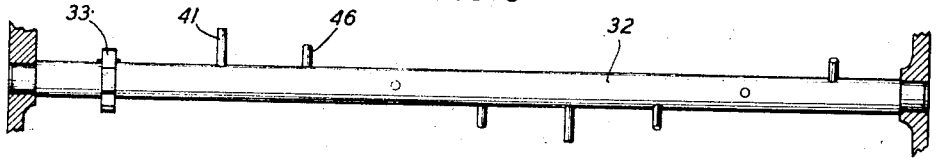


FIG. 6



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TELEPHONE SYSTEM

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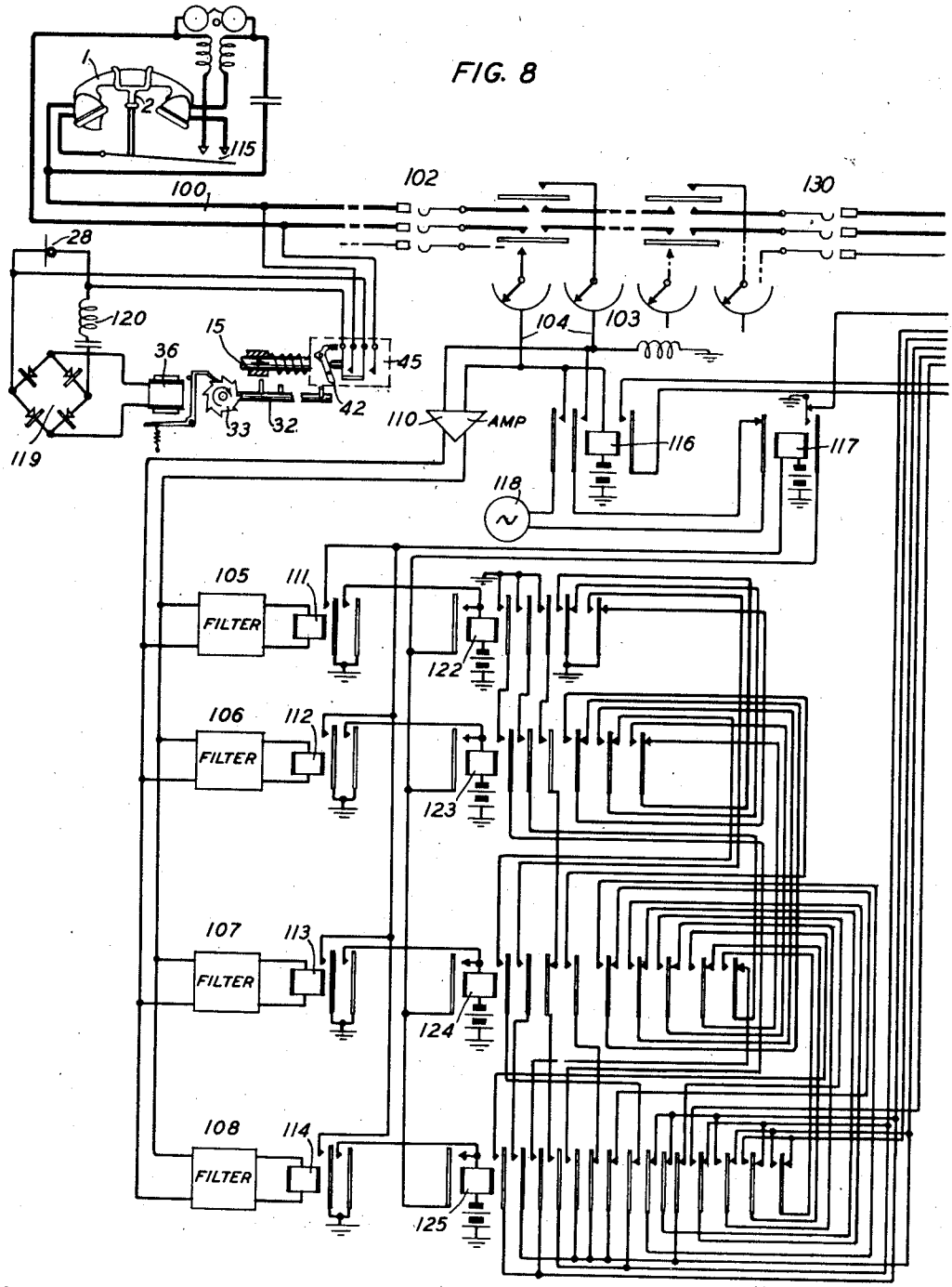
FIG. 8



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TELEPHONE SYSTEM

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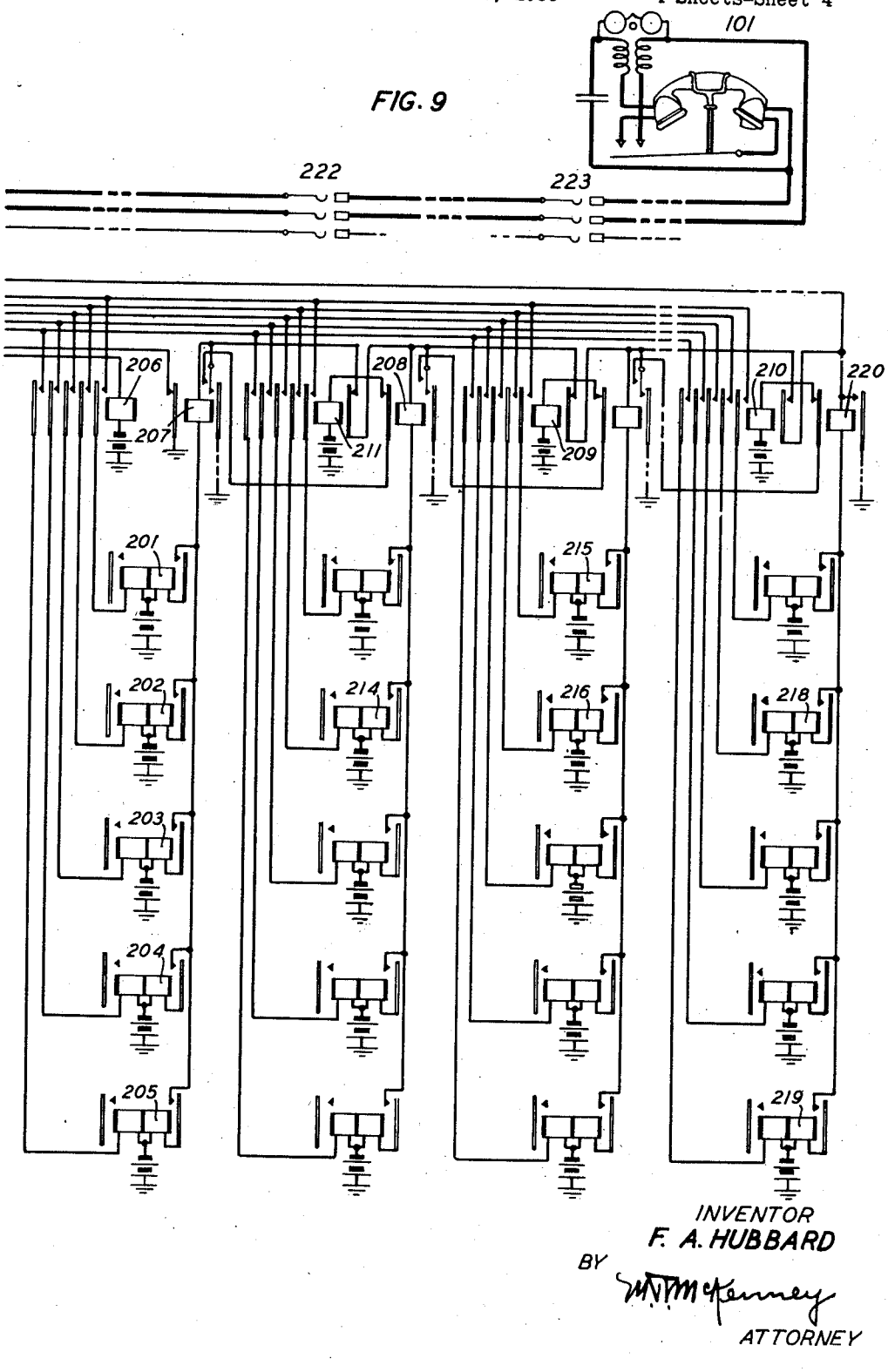
FIG. 9



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Patented June 18, 1940

2,204,759

UNITED STATES PATENT OFFICE

2,204,759

TELEPHONE SYSTEM

Francis A. Hubbard, Maplewood, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application October 7, 1938, Serial No. 233,706

10 Claims. (Cl. 179—16)

This invention relates to telephone systems and particularly to signaling systems for use in automatic telephone systems.

Objects of the invention are to simplify the transmission of signals for the control of telephone connections and to generally improve the efficiency and speed of operation of such signal transmitting system.

Heretofore systems have been provided in which code signals comprising different frequencies representing different digits have been selected by transmitting devices at subscribers' stations and transmitted over telephone lines to control automatic switches at the central offices to establish corresponding telephone connections. In such systems the different digit designations were selected and transmitted one digit at a time by the subscriber manipulating his transmitting device. Other systems have been used in which direct current impulses have been combined to represent different digits and selected on a transmitting device in succession, and when a complete telephone number was selected, these combinations were transmitted to a central office in succession to control the selection of a telephone connection. In some cases the combinations were first recorded and stored in registers which are then operated to control the selecting switches. Of the signaling systems employed for transmitting a code signal or digit comprising different frequency combinations, such frequencies have been produced by means including reeds that may be plucked in corresponding combinations, and microphonic means for picking up the resulting different resonant frequencies which are then transmitted over a line to control selecting switches.

It is a feature of the present invention to provide a frequency dialing system comprising means for setting up a complete number of digits, each digit comprising a particular combination of current frequencies, and transmitting the whole number over a line digit by digit. The arrangement may be such that a plurality of vibrating reeds are plucked in combinations for each digit. These combinations are selected by preset number rings that pluck the corresponding reeds and the resulting reed vibrations representing the successive digits are picked up by a microphonic device for transmission over the line in the form of corresponding groups of current frequencies. The reeds may be shifted in unison past the succeeding preset number rings by an escapement mechanism operated by a special frequency applied between the digits as received at the central office.

This invention has been illustrated in the accompanying drawings in which:

Figs. 1 to 6 show various details of a substation apparatus disclosing the applicant's invention in regard to the selection and transmission of the digits comprising groups of current frequencies;

Fig. 1 is a front view of the transmitting device partly in section taken on the line 1—1 of Fig. 2;

Fig. 2 is the side view of the device taken on the line 2—2 of Fig. 1;

Figs. 3, 4, 5 and 6 show the details of the device and particularly the escapement mechanism;

Fig. 7 is a diagram showing the frequency combinations that may be selected and transmitted by the device shown in the preceding figures; and

Figs. 8 and 9 show the applicant's invention applied to a telephone system. Fig. 8 shows primarily a calling subscriber's line, associated switches and a part of a register for reception of the various digits and Fig. 9 shows groups of registering relays on which the digits may be recorded.

Referring now to the drawings and particularly to the substation apparatus as disclosed in Figs. 1 to 6, a description will be made of the construction of this device. It consists, as shown, of a hand telephone set 1 in a cradle 2 and a transmitting or dialing mechanism 3, being part of a housing 4, the lower part 5 of which may contain the usual apparatus of a standard subscriber's set such as an induction coil, ringer and condenser, and various switchhook mechanisms. The transmitting or dial mechanism 3 consists of an outside housing 6 in which are located seven number rings for recording seven successive digits in any required telephone number. These number rings consist of an inside ring member 8, as shown in cross-section for the first number ring, which is journaled in a bearing inside the housing 6. To this ring 8 is threaded an outside washer or thumb wheel 10 that extends through a slot outside the housing and having knobs 11 to facilitate the rotation of the number ring by hand. On the inside surface of ring 8 a plurality of plucking knobs or flat projections extend radially toward the center of the ring for a short distance. There are six of these projections on each ring located in various positions for plucking combinations of reeds depending on the setting of the number rings, as will be explained hereinafter. In the

housing 6 are windows 13 through which the various designations of the digit selections may be seen. These designations may be engraved on the outer surface of the ring 8. As shown in Fig. 1, the number set up, leaving out the first number ring which is broken across, is GHI-3-6047.

Centrally located in the housing 6 is a hollow shaft or sleeve 15 having a ring 16 at the left end and journaled in bearing 17 at the left-hand side of the housing. Inside this shaft is a helical spring 18 resting at its right-hand end on the bottom formed by the closed right-hand end of the sleeve 15 and at its left-hand side on a washer 19 which is held by a pin 20 extending through longitudinal slots 21 in the sleeve 15 and secured to the housing 6. At the right-hand end of the sleeve 15 is also connected a ring or collar 22 that carries four vibratory reeds 23, 24, 25 and 26 of different fundamental frequencies. To the collar 22 is also connected a microphone 28 of any well-known type and the leads from this microphone are connected to a flexible cable 29, which is wrapped around sleeve 15 and passed out through an opening 30 at the left-hand side of the housing. Below this sleeve 15 is a shaft 32 running parallel with the sleeve 15 and rotatably secured in the side walls at the right-hand and left-hand ends of the housing 6. On this shaft 32 is located a ratchet wheel 33 which may be engaged by the pawl 34 on an armature 35 which is actuated by a magnet 36 secured on a bracket 37, which bracket in turn is attached to the inside of the housing by means of a screw 39. Helically arranged on shaft 32 opposite to the seven number rings are seven pins. The first pin 41 is shown at the left-hand side inside the housing, which is cut away. When the shaft rotates these pins may engage a pawl 42 on the collar 22 and this pawl actuates contacts 45 in a manner as will hereinafter be described.

The operation of the dial mechanism is as follows:

Normally a pin 43, secured in the wall of housing 6, engages the pawl 42 so that the contacts 45 are normally open. If the subscriber inserts a finger in ring 16 and pulls the sleeve 15 towards the left as far as it will go, the pawl 42 eventually passes pin 41 and if then the subscriber removes the finger from ring 16 the sleeve will be held in this position by the pawl 42 engaging the pin 41 on the left-hand side thereof. The contacts 45 are thereby closed and remain closed until they are again opened by the pin 43 when the sleeve is returned to normal. The number rings may then be set in different positions to register any desired number and the magnet 36 may then be operated in a manner which will hereinafter be described to rotate the shaft 32 one step so that pin 41 will disengage the pawl 42. The sleeve 15 is thereby released and the tension in the spring 18 causes the sleeve to be pulled toward the right and as the vibrating reeds 23 to 26 pass the first number ring 8, the projections that happen to be in position to pluck off any of the reeds will cause these reeds to vibrate. The sleeve will then be stopped in front of the second number ring by the second pin 46 engaging the pawl 42. The magnet will then again be operated to rotate the shaft 32 another step to permit the sleeve 15 to move toward the right and reeds will again be plucked according to the setting of the second number ring by the projections that happen to be set to engage the reeds. Similarly the magnet will then take another step and the sleeve 15 will be permitted to move towards the right to cause reeds to be plucked by the projections on the third number ring that happens to be in their paths. These operations are continued until the sleeve 15 has returned to normal position when the pin 43 acts on pawl 42 to open the contacts 45. As the reeds pass the projections on different number rings, they will vibrate at their natural resonant frequencies and the composite of these frequencies will be picked up by the microphone 28 which will cause corresponding combinations of current frequencies to be transmitted over a line to a central office to record the number set up by each number ring, each digit being identified by the composite current frequencies as picked up by the microphone each time the reeds are plucked when passing a number ring.

The positions of the projections on the number rings and the different combinations of reeds that may be plucked by the different digits have been diagrammatically illustrated in Fig. 7. The ends of the reeds 23, 24, 25 and 26 have been shown at the top of this diagram and towards the left of this figure boxes with markings have been shown indicating the settings of a number ring to cause the projections thereon to pluck corresponding combinations of reeds. In the first box the numeral 1 is marked to indicate that the number ring should be set to transmit the digit 1 and the projections that are opposite the reeds are indicated towards the right of this box on the number ring when the ring is set for this digit. The projections are marked I, IV, V, VII, VIII, IX, indicating their relative position. In the position indicated the number ring has been moved one step from a normal position and it should be noted that the projection I will be the only one that will pluck a reed and the reed that it will pluck is the first or reed 23. Thus when the number ring is set to send digit No. 1, the resonant frequency of reed 23 will be picked up by the microphone. In case digit No. 2 is to be dialed, the setting is indicated opposite this numeral in the record box of the first column and the position of the number ring indicates that reed 24 will be plucked by the first projection. Thus this digit will be represented by resonant frequency of reed 24. It is further seen from this diagram that when digit 3 is to be sent, the resonant frequency of reed 25 will be transmitted by projection I. If digit 4 is to be sent, resonant frequencies of reeds 23 and 26 will be transmitted by projections I and IV. If digit 5 is to be sent, resonant frequencies of reeds 23 and 24 will be transmitted by the projections IV and V. If digit 6 is to be sent, resonant frequencies of reeds 24 and 25 will be transmitted by projections IV and V. If digit 7 is to be sent, resonant frequencies of reeds 23, 25 and 26 will be transmitted by projections IV, V and VII. If digit 8 is to be sent, the resonant frequencies of reeds 23, 24 and 26 will be transmitted by projections V, VII and VIII. If digit 9 is to be sent, the resonant frequencies of reeds 23, 24 and 25 will be transmitted by projections VII, VIII and IX and if digit 0 is to be sent, the resonant frequencies of reeds 24, 25 and 26 will be transmitted by projections VII, VIII and IX. The number ring set in these ten various positions will, therefore, produce ten different combinations of resonant frequencies and by setting the seven number rings in any positions desired, seven digit codes may be produced by the reeds for transmission in the form of seven successive combinations of current frequencies.

The applicant's invention will now be described

as applied to the telephone systems shown in Figs. 8 and 9. The subscriber's line 100 is shown extended through a series of switches to a called subscriber's line 101. These switches have been indicated merely by brushes and terminals as any well-known system for establishing connections through an automatic system may be employed and needs no further description except that when a subscriber of line 100 is calling, a line-finder switch 102 seizes the calling subscriber's line and extends a connection through a sender connector 103 which finds an idle sender of the type shown in these figures over the conductors 104. To the subscriber's line 100 is connected the dialing mechanism as hereinbefore described and which has been symbolized in Fig. 8 in diagrammatic form. The stepping magnet 36 has been shown with the ratchet wheel 33, the shaft 32, the sleeve 15, pawl 42, contacts 45 and microphone 28 and the associated circuits. In the sender connected through the conductors 104 have been shown filters 105, 106, 107 and 108, and amplifier 110 all in diagrammatic form as any well-known apparatus of these types may be used. The filters 105 to 108 are designed to pass current frequencies produced in the microphone 28 by the resonant frequencies as produced by the reeds 23 to 26, respectively. When any of these current frequencies are received over conductors 104, the corresponding relays 111, 112, 113 and 114 will operate and the digits represented by such frequencies will be recorded and registered, as will hereinafter be described.

When the subscriber of line 100 desires to make a call he proceeds as follows: He first sets the various number rings to the desired number as hereinbefore described and operates sleeve 15 all the way towards the left on the dial mechanism. When this is done the pawl 42 will pass pin 41 as described and when the subscriber releases the sleeve 15 the pawl 42 closes contacts 45. This closes a circuit over the microphone 28 and causes the line finder 102 to connect the line 100 through the sender connecter 103 to conductors 104. When this takes place a circuit is completed for the operation of relay 116 from battery, winding of this relay, the left-hand conductor of the pair 104 through the sender connector and line finder over the microphone 28 and contacts 45 back over line finder, sender connector, the right-hand conductor of the pair 104 through an impedance to ground. The closing of contacts 45 and operation of relay 116 now permits alternating current of a particular frequency from source 118 to be transmitted back over contacts of relays 116 and 117 over the conductors 104, sender connector 103 and line finder 102, contacts 45, the rectifier equipment 119 and winding of magnet 36 to cause this magnet to operate. The tuned circuit 120 comprising an inductance and a condenser is designed to pass this particular frequency of the source 118 only to the magnet 36. It should be noted that the microphone 28 is connected across the line conductors so that the tuned circuit will prevent any frequencies produced by the microphone from passing through the magnet 36. Magnet 36 now operates on the ratchet wheel 33 to turn the shaft 32 one step and thus release the sleeve 15 so that the reeds will pass by the projections on the first number ring. If it is assumed that this numbering was set for the digit 5 and referring to Fig. 7, reeds 23 and 24 will be operated. Thus the microphone 28 will pick up the resonant frequencies from these reeds and transmit corresponding current frequencies out over the line through contacts 45, line finder 102, sender connector 103, conductors 104, amplifier 110. These frequencies now operate through filters 105 and 106, relays 111 and 112. Relays 122 and 123 are now operated over obvious circuits and locked through contacts of relay 117 to ground at their left-hand armatures and front contacts as it should be noted that relay 117 operates over obvious circuits any time any of the relays 111 to 114 are operated. The relays 122 and 123 as well as 124 and 125 are provided with series of contacts and armatures for the operation of the register relays in different combinations. In Fig. 9 four sets of register relays have been shown for recording the first, second, third and the last of the seven digits produced by the dialing mechanism, intermediate register relays having been omitted. As relays 122 and 123 are operated, in response to the first digit, the armatures and contacts of these relays close a circuit for the operation of relay 204 of the first group of register relays 201 to 205. The circuit for relay 204 in this case may be traced from battery, left-hand winding of relay 204, contacts of relay 206, which was operated when relay 116 was operated over an obvious circuit, normal contacts of relays 125 and 124, operated contacts of relays 123 and 122 to ground. When the register relay 204 operates, it provides a locking circuit for itself through its right-hand winding and right-hand armature and front contact through the winding of relay 207, contacts of relays 211, 209, 210 to ground at the normal contacts of relay 117 when this relay releases. This will take place when the current frequencies causing the operation of relays 111 and 112 cease and these two relays release. Relay 207 operates in this circuit and closes a locking circuit for itself and the register relay 204 through its right-hand armature and front contact to ground. Thus the register relay 204 is maintained operated to retain the registration of the first digit. It should be noted that on the operation of relay 207 relay 206 is released and relay 211 is operated from battery through the winding of this relay, contacts of relays 208 and 207 to ground. This disconnects the first group of register relays and connects the second group of register relays to the armatures and contacts of the relays 122 to 125.

It should be noted that on the first operation of relay 117 the connection for the source 118 was opened at its left-hand armature and back contact but this circuit is now again closed on the release of relay 117 as the current frequencies caused by the first digit ceased. Consequently at this time an impulse from the source 118 is again transmitted over the line to cause the operation of the magnet 36 a second time and this magnet again actuates the ratchet wheel 33 and rotates shaft 32 to permit the sleeve 15 to be advanced towards the right for another step to cause the reeds to pass by the projections on the second number ring. If the second digit is 2, reed 24 will be plucked and the resulting frequency will operate relay 112 through filter 106. Relay 112 operates relay 123 and the second register relay in the second group will be operated, that is relay 214. The circuit for register relay 214 may be traced from battery, left-hand winding of this relay, contact of relay 211, normal contacts of relays 125 and 124, operated contacts of relay 123 to ground at normal contacts of relay 122. Register relay 214 provides a locking circuit for itself over a circuit from

battery through the right-hand winding of this relay and the right-hand armature and front contact, winding of relay 208, contacts of relays 209 and 210 to ground at relay 117 when the latter relay releases. Relay 208 operates in this circuit, releases relay 211, operates relay 209 and provides a locking circuit for itself and register relay 214 over its right-hand armature and front contact. Relays 112, 123 and 117 are again released as the frequency from the line ceases and a third impulse from the source 118 is now transmitted over the line to again operate magnet 36. If the third digit is 3, reed 25 is plucked, relays 113 and 124 are operated and it should be noted that in this case the first and the second register relays in the third group will be operated. The circuit for these register relays which may be numbered 215, 216, may be traced from battery through the left-hand windings of these register relays, contact of relay 209, normal contacts of relay 125, operated contacts of relay 124 and normal contacts of relays 123 and 122 to ground. Similarly, register relays of the intermediate fourth, fifth and sixth groups are operated as the digits 6, 0 and 4 are transmitted. In the case of the digit 6, relays 112 and 113 are operated, causing the first and fourth register relays of the fourth group to be operated; when the digit 0 is transmitted, relays 112, 113 and 114 are operated, causing the fifth register relay in the fifth group to be operated and when the digit 4 is transmitted, relays 111 and 114 are operated, causing the operation of the third register relay in the sixth group to be operated. Then when the seventh or last digit 7 is transmitted, relays 111, 113 and 114 are operated, causing the operation of relays 122, 124 and 125, and the second and fourth register relays in the seventh group, that is relays 218 and 219 are operated. The circuits for these relays may be traced through the left-hand winding of these relays, contacts of relay 210, operated contacts of relays 125, 124, normal contacts of relay 123, and operated contacts of relay 122. When relays 218 and 219 are operated, they provide locking circuits for themselves, which extend through their right-hand windings and right-hand armatures and front contacts, winding of relay 220 to ground at relay 117. Relay 220 operates and releases relay 210 and no more digits are registered. Relay 117 will not again operate and consequently locking circuits for register relays will be maintained to ground at the contacts of this relay.

Following the registration of the designation the sender proceeds to control the selective operation of the switches indicated at 130, 222, 223 in accordance with the setting of the register relays as is well known in the art and the called subscriber at line 101 will be called in the usual manner. The register sender is then released in any well-known manner from the established connection and reverted to common use. At the end of conversation between the calling subscriber and called subscriber, the release of the established connection takes place in any well-known manner.

The switches illustrated and the manner in which they are controlled by the registers of the common sender may be the same as described in the patent to F. A. Stearn et al. 1,395,977 of November 1, 1921.

What is claimed is:

1. In a telephone system, a subscriber's station, a central office, a line extending from said station to the central office, a designation transmitter at said station comprising a plurality of differently tuned reeds, a plurality of reed-operating elements each of which is capable of assuming different positions to represent different values of a designation character, all of said elements being preset by the subscriber to represent the whole designation, a source of current at the central office, means responsive to the flow of current over said line from said source to cause the vibration of said reeds in accordance with the settings of the successive reed-operating elements to transmit to the central office currents of frequencies representing the preset designation, and means at the central office for registering said designation.

2. In combination, a line, a source of direct current associated with said line, a source of alternating current associated with said line, a signaling mechanism comprising a plurality of differently tuned vibrating devices, a plurality of independently operable presetting means for the subsequent control over said devices in groups determined by the settings of said means, each group representative of a telephone designation, means responsive to current from said alternating current source for thereafter automatically causing succeeding presetting means to control said devices in groups in accordance with individual settings thereof, and means for translating the vibrations of said devices when controlled into corresponding frequencies of current from said direct current source in said line.

3. In combination, a line and a signaling device, said device comprising a plurality of differently tuned reeds, a plurality of members having combinations of projections and adapted to be set in various positions to cause the selection of combinations of projections to act on said reeds to cause them to vibrate, a source of alternating current associated with said line, means controlled by current from said alternating current source for moving said reeds in unison past the selected projections of succeeding members to be actuated thereby, and means for translating the resonant frequencies of the actuated reeds into succeeding groups of current frequencies, each group corresponding to the particular combination of resonant frequencies produced by the reeds as they are acted upon by the selected projections on each member.

4. In combination, a line, a signaling device, said signaling device comprising a plurality of differently tuned reeds, means for selecting combinations of reeds for operation, a source of current on said line, means responsive to current from said source for operating selected reeds to cause them to vibrate at their different resonant frequencies, means for translating said resonant frequencies into corresponding current frequencies on said line, and means for recording said current frequencies.

5. In a signaling system, a line, a plurality of differently tuned reeds, means for selecting different combinations of reeds for operation, a source of current, means for applying current from said source at intervals, means responsive to current from said source for operating, during each interval it is applied to the line, a different combination of selected reeds to cause them to vibrate at their respective frequencies, and means for translating said resonant frequencies into corresponding current frequencies on said line.

6. In combination, a line and a signaling device, said signaling device comprising a plurality of differently tuned reeds, a plurality of members

capable of being set to select for vibratory operations different combinations of reeds, a source of current on said line, means responsive to current from said source for moving said reeds in unison past the set members in succession for the vibratory operation of said reeds by said members in accordance with their respective settings, means for translating the resonant frequencies of the actuated reeds into current frequencies on said line, and recording means associated with said line responsive to said current frequencies.

7. In an impulse sender, a shaft, a plurality of differently tuned reeds slidably mounted on said shaft, a plurality of number-selecting rings for plucking said reeds in different combinations depending on the respective settings of said rings, a stepping magnet, means for actuating said stepping magnet in steps, means controlled by said magnet when stepping for moving said reeds along said shaft in unison and in steps past said rings for the plucking of said reeds by corresponding rings in succession and combinations depending on the respective settings of said rings, and means for translating the resonant frequencies of the plucked reeds into corresponding combinations of current frequencies.

8. In a telephone system, a line, an impulse sender associated with said line and comprising a shaft, a plurality of differently tuned reeds slidably mounted on said shaft, a plurality of number-selecting rings for plucking said reeds in different combinations depending on the respective settings of said rings, an electrically operable device for shifting in steps said reeds along said shaft in unison past said rings for the plucking of said reeds by corresponding rings in succession in combinations depending on the respective settings of said rings, means for translating the resonant frequencies of the plucked reeds into corresponding combinations of current frequencies in said line, a source of current, and means for connecting said source of current to said line at intervals to step said device to cause the reeds to be shifted past one of said rings during each interval.

9. In an impulse sender, a shaft, a sleeve on said shaft, a plurality of differently tuned reeds mounted on said sleeve, a plurality of number-selecting rings having projections in various combinations for the plucking of combinations of said reeds depending on the manual setting of said rings, an electromagnet, a line associated with said magnet, a step-by-step device responsive to the operation of said magnet for moving said sleeve on said shaft in a longitudinal direction on said shaft so arranged in relation to the number rings that combinations of reeds are plucked by each ring in succession in combinations depending on the different settings of said rings, means for translating the resonant frequency of the plucked reeds into corresponding combinations of current frequencies in said line, a source of current associated with said line, and means for applying current from said source to said line to operate said magnet in steps.

10. In an impulse sender, a shaft, a plurality of differently tuned reeds slidably mounted on said shaft, a plurality of number selecting rings for plucking said reeds in different combinations depending on the setting of said rings, a source of direct current, a source of alternating current, a magnet, means for actuating said magnet in steps under control of current from said alternating current source, means controlled by said magnet for sliding said reeds along said shaft in unison past one ring at a time for each step taken by said magnet for the plucking of said reeds in unison by succeeding rings in combinations depending on the respective settings of said rings, and means responsive to the resonant frequency of the plucked reeds for producing corresponding combinations of frequencies of current from the fundamental current from said direct current source.

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