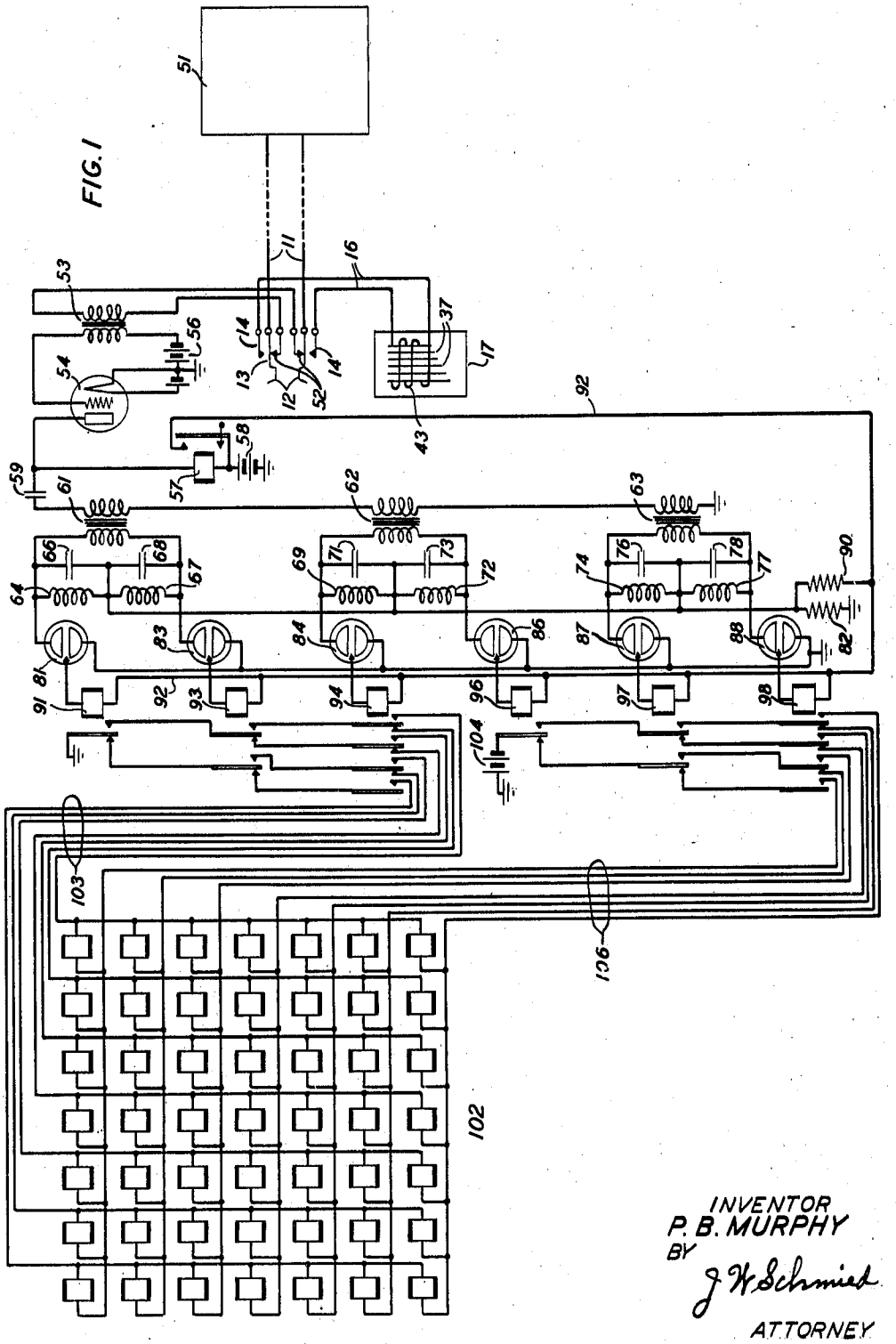
Feb. 29, 1944. P. B. MURPHY 2,342,886

PRINTING TELEGRAPH APPARATUS AND SYSTEM

Filed Feb. 25, 1941 3 Sheets-Sheet 1

FIG. 1



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PRINTING TELEGRAPH APPARATUS AND SYSTEM

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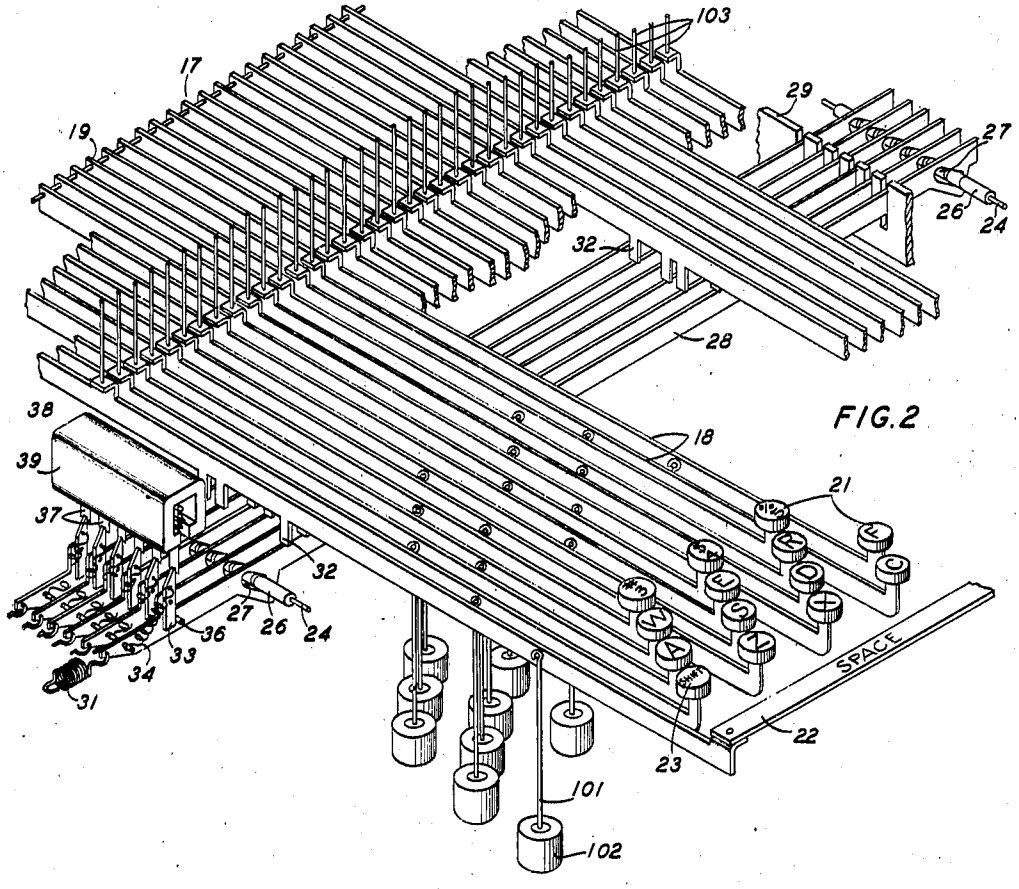


FIG. 2

FIG. 4

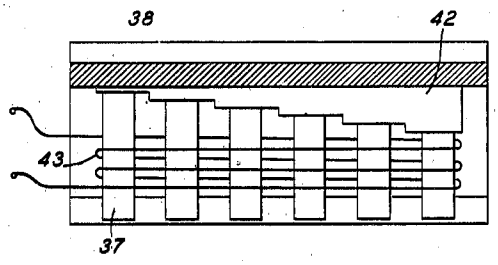
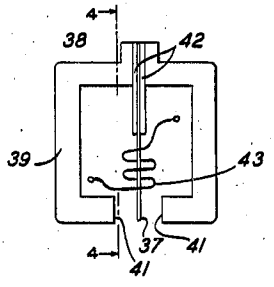


FIG. 3



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PRINTING TELEGRAPH APPARATUS AND SYSTEM

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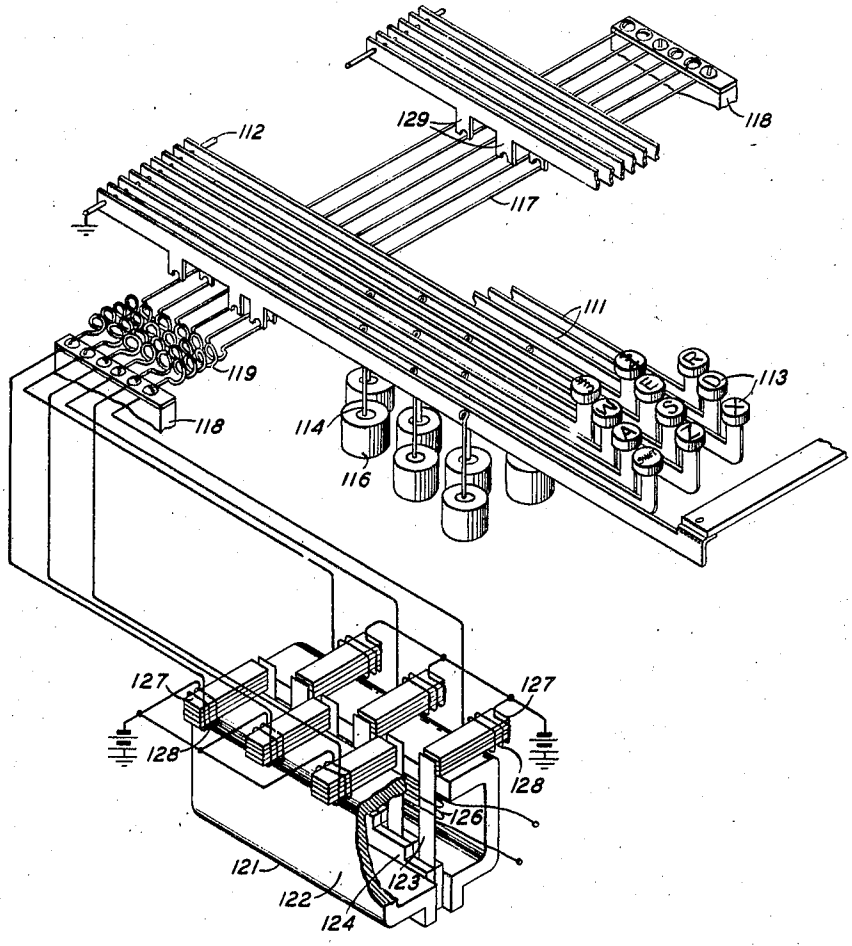
FIG. 5



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UNITED STATES PATENT OFFICE

2,342,886

PRINTING TELEGRAPH APPARATUS AND SYSTEM

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Application February 25, 1941, Serial No. 380,433

18 Claims. (Cl. 178—47)

This invention relates to telegraph apparatus and systems and particularly to printing telegraph signal transmission and reception.

An object of the invention is to generate oscillatory signaling current at audible frequencies by means of a vibrating reed generator.

Another object of the invention is to set in vibration simultaneously variably selectable ones of a plurality of vibratory reeds according to signals to be transmitted.

A further object of the invention is to receive simultaneously transmitted oscillatory signaling current and to channel those currents to individual signal responsive devices for effecting the selection and operation of a recording element such as a type bar of a printing recorder.

In general, the invention contemplates a transmitter including code elements and code element operating means such as key levers for operating the code elements in various combinations according to signals to be transmitted. A magnet structure supports a plurality of vibratory reeds, equal in number to the number of code elements, of different effective dimensions so as to have different natural frequencies of vibration. The reeds are set in vibration in combinations simultaneously by their individual code elements, and the vibrating reeds generate in a pick-up coil, oscillatory currents at frequencies corresponding to the frequencies of vibration of the reeds. These oscillatory currents are impressed upon a telegraph signaling channel.

At the receiver, the oscillatory currents are amplified, are separated by individual filters tuned to the several frequencies and are rectified by individual rectifiers. Each of the rectified currents operates an individual selector relay and two or more of the relays in combinations cooperate to effect the energization selectively of electromagnets individually connected to the key levers of a printing recorder which has its type bars connected directly to the key levers for operation thereby. The key levers are the same ones which control the code elements of the transmitting mechanism local to the receiving printer, so that home recording of a message to be transmitted is accomplished mechanically through the manual operation of the key levers. A send-receive switch selectively connects the transmitter or the receiver of a combined set to the communication channel, so that when a message is being transmitted the signals do not operate the local selecting and printing mechanism, such operation of the selecting and printing mechanism not being necessary in view of the direct production of the home record through operation of the key levers.

For a complete understanding of the invention reference may be had to the following detailed description to be interpreted in the light of the accompanying drawings wherein:

Fig. 1 is a schematic view of a signal transmitting and receiving system in accordance with the present invention;

Fig. 2 is a diagrammatic perspective view of a keyboard transmitter and recorder indicated schematically in Fig. 1;

Fig. 3 is an elevational view taken at one end of the vibrating reed generator shown in Fig. 2;

Fig. 4 is a vertical sectional view taken on the line 4—4 of Fig. 3; and

Fig. 5 is a diagrammatic perspective view of a modified form of keyboard transmitter.

Referring now to the drawings and particularly to Fig. 1, the reference numeral 11 designates a pair of conductors which serve as a communication channel. At the left-hand end of the line 11, which may be designated as the west end, the line conductors are connected to the swinger springs 12 of a send-receive key designated generally by the reference numeral 13. Key 13 is of the double pole, double throw type and its outer stationary springs 14 are connected by conductors 16 to a transmitter 17 indicated schematically in Fig. 1 and in detail in Fig. 2.

The transmitter 17 (Fig. 2) is provided with a bank of key levers 18 pivoted at the rear of the machine on a common pivot rod 19. The key levers 18 are individually provided with finger key tops 21 and in Fig. 2 four rows of such key tops have been shown. This arrangement corresponds to the key top arrangement of common species of commercially available typewriting machines. The communication system according to the present invention is adaptable to operation by a keyboard of the type provided on typewriting machines which includes four rows of key tops, the typing of figures being accomplished without interposing a shift function, and thus such machines may be employed as telegraph transmitters and printers. As shown in Fig. 2 the keyboard mechanism includes a space bar 22, and keys not involved directly in the selection of a character or symbol but involved instead in the selection of a function, as exemplified by the shift key 23.

At the opposite sides of the keyboard mechanism, rods 24 extending parallel to the key levers 18 are stationarily supported and the rods 24 ro-

tatably support antifriction rollers 26. The antifriction rollers 26 are disposed in obliquely extending slots 27 near the opposite ends of code bars 28 which extend transversely of the key levers 18 and below them. The code bars 28 are maintained in the desired spaced positions along the rods 24 by one or more comb plates 29 which restrict lateral movement of the code bars but which freely permit vertical movement and endwise movement of those bars. By means of the obliquely extending slots 27 code bars 28 are permitted to undergo endwise movement and vertical movement in their own planes, and the code bars are biased by tension springs 31 to their left-hand and uppermost positions as determined by slots 27.

Key levers 18, including the levers by which space bar 22 is supported, are provided with depending code lugs 32 which are variously presented above the code bars 28 in accordance with the signaling code, it being understood that no two key levers have the same combinational arrangement of lug 32. Upon the depression of any one of the key levers 18 its associated code lugs 32 press downwardly on the upper edges of the code bars 28 that are disposed beneath them and the slots 27 in the code bars cause them to move rightwardly as viewed in Fig. 2 as well as downwardly. Upon the release of a depressed key lever 18 the springs 31 associated with those of the code bars 28 which were depressed by the key lever restore their code bars to normal position which is the extreme upper and left-hand position.

Near their left-hand ends as viewed in Fig. 2 the code bars 28 pivotally support short plucking levers 33 that are individually biased in counterclockwise direction by tension springs 34 into engagement with stop pin 36 individually carried by the code bars 28. The upper ends of the plucking levers 33 are disposed to the left of and above the lower ends of vibratory reeds 37 contained in a signal generator indicated generally by the reference numeral 38.

Structural details of the signal generator 38 are shown in Figs. 3 and 4. The signal generator includes a permanent magnet 39 which in cross-section is C-shaped to provide opposed magnetic poles 41. The magnet 39 is of sufficient length to span transversely the code bars 28. Supported inside magnet 39 approximately in a central position with respect to the opposed poles 41 are clamping plates 42 for the vibratory reeds 37 extending longitudinally of magnet 39 and parallel to the poles 41. The width of the clamping plates 42 preferably is graduated in steps from end to end so as to leave graduated lengths of the reeds 37 free to vibrate. Thus the reeds 37 may all be identical, but as they are damped at varying distances from their lower ends they will have different natural frequencies of vibration. As six vibratory reeds 37 are shown in the drawings it may be convenient to dimension and damp the reeds so that they shall vibrate at the frequencies 700, 900, 1100, 1300, 1500 and 1700 cycles per second, these being frequencies that certain well-known telephone apparatus is adapted to accommodate. By employing frequencies that are contemplated by known telephone apparatus, telephone circuits may be employed for the transmission and reception of the telegraph signals which the apparatus in accordance with the present invention generates. However, the invention is not limited to these frequencies and any convenient combination of frequencies may be employed. As viewed in Fig. 4 the left-hand reed would vibrate at 700 cycles per second and the right-hand reed would vibrate at 1700 cycles per second, with the intermediate reeds vibrating at the intermediate frequencies mentioned above.

The vibratory reeds 37 are of magnetic material and serve as driving armatures for a pick-up coil winding 43 which extends around all of the reeds 37. It will be understood that instead of a single pick-up coil to be energized by the vibration of any or all of the reeds 37 a plurality of pick-up coils individual to the reeds could be provided.

In the operation of the transmitter shown in Figs. 2, 3 and 4 the key levers 18 are operated in succession by finger operation of the key tops 21 in accordance with the message to be transmitted. As a key lever is depressed its lugs 32 depress certain of the code bars 28 in accordance with the signal to be transmitted and the slots 27 cause the code bars to move rightwardly as well as downwardly. Since the plucking levers 33 are estopped from rotating counterclockwise by pins 36 the upper ends of the levers 33 move into engagement with the associated ones of the vibratory reeds 37 and flex those reeds in the direction of endwise movement of the code bars. The levers 33 are moved bodily in an oblique direction corresponding to that of the code bars 28 but the overlap between the levers 33 and the reeds 37 is sufficient that the reeds will be deflected to the right before the upper ends of the levers 33 are moved clear of the lower ends of reeds 37 and permit the reeds to escape. When the reeds 37 have escaped they will vibrate at their natural frequencies and will induce in the pick-up coil 43 oscillatory currents at frequencies corresponding to the frequencies of vibration of the reeds.

As the reeds 37 vibrate their amplitude of vibration decreases and the strength of the signaling currents generated correspondingly decreases. However, the reeds will vibrate at a sufficient amplitude to generate effective signaling currents for a sufficient length of time to effect the transmission of the signals, but the transmission of signaling current will not continue indefinitely if the key lever is held depressed. The system in accordance with the invention is adapted to accommodate the generation of signals at a rate as fast as that attained by expert keyboard operators, so that the key levers need not be held depressed for excessive lengths of time.

Upon the release of pressure on the key levers the springs 31 connected to those of the code bars 28 which have been depressed restore the code bars to their extreme left-hand and upper positions. The plucking levers 33, in returning to their normal positions, encounter the right-hand faces of the reeds 37 and damp out vibration of the reeds. As movement of levers 33 to the right continues, the springs 34 yield and permit levers 33 to be rocked clockwise for the purpose of moving past the lower ends of reeds 37. When the levers 33 have escaped from the lower ends of the reeds, springs 34 restore the levers to extreme counterclockwise position with their lower ends in engagement with stop pins 36.

Referring again to Fig. 1, it is to be understood that the rectangle 51 represents a station at the right-hand or east end of communication channel 11 including transmitting and receiving apparatus duplicating that shown connected to the left-hand or west end of communication

channel 11. Assuming that the station 51 is to transmit message material westwardly over channel 11 the key 13 at station 51 would be operated to bring its swinger springs 12 into engagement with the outer stationary contacts 14 to connect the transmitter 17 at station 51 to channel 11. The normal or idle condition of key 13 at either of the stations connected to channel 11 is that shown in Fig. 1 with the swinger springs 12 in engagement with the inner stationary contacts 52. These contacts are connected to the ends of the primary windings of an input transformer for an amplifier stage and the ends of the secondary winding of transformer 53 are connected to the grid and to the cathode of an electronic amplifier tube 54. A grid biasing battery 56 is connected between the cathode and the secondary of transformer 53 to bias the grid of the tube below the cut-off value so that plate current will not flow in the tube when signaling currents are not being received.

The plate of amplifier tube 54 is connected through the winding of a slow-operating relay 57 to one pole of a plate battery 58, the other pole of which is connected to ground. An output circuit from the plate of tube 54 includes the condenser 59 and the primary windings of output transformers 61, 62 and 63 in series. The free end of the primary winding of transformer 63 is connected to ground.

The secondary winding of transformer 61 is connected across two filter circuits, one of which includes the inductance 64 and capacitance 66 and the other of which includes the inductance 67 and capacitance 68. Similarly, the secondary winding of transformer 62 is connected across filter circuits consisting of the inductance 69 and capacitance 71, and of the inductance 72 and capacitance 73, and the secondary of transformer 63 is connected across two filter circuits including inductance 74 and capacitance 76, and inductance 77 and capacitance 78. The inductances and capacitances in the six filter circuits have such values that each filter circuit responds to and passes oscillatory current at the frequency generated by one of the vibratory reeds 37 and rejects the oscillatory currents generated by the other five reeds. Thus the oscillatory currents at the six different frequencies which may appear in the output circuit of amplifier tube 54 are separated by the six filters. One side of the filter which comprises the inductance 64 and capacitance 66 is connected to one of the cathodes of a cold cathode electron discharge tube 81 and the other side of the filter is connected through resistor 82 to ground. Similarly, one side of each of the other filter circuits is connected to one cathode of a discharge tube, the tubes being designated by the reference numerals 83, 84, 86, 87 and 88. The other side of each of the remaining five filters is connected through the resistor 82 to ground and the second cathode in each of the six discharge tubes 81, 83, 84, 86, 87 and 88 is connected to ground.

The output electrode or anode of tube 81 is connected to one end of the winding of a relay 91 and the other end of the relay is connected through conductor 92 to the front contact of slow-operating relay 57 previously identified as being included in the plate current circuit of amplifier tube 54. Similarly, the output electrodes of the discharge tubes 83, 84 and 86 to 88 are connected to one terminal of the respective relays 93, 94, 96, 97 and 98 and the other terminal of each of those relays is connected to conductor 92. A resistor 90 has one end connected to conductor 92 and the other end connected to the upper end of resistor 82, and the resistors 90 and 82 form a potentiometer by means of which a positive biasing potential becomes connected to each of the discharge tube cathodes, that is, connected to and controlled by an associated filter. Thus a potential difference is impressed between the two cathodes in each tube which is equal to the potential difference across the resistor 82.

The relays 91, 93, 94, 96, 97 and 98 constitute selector relays for controlling the selection of a character to be printed or a function to be performed by the receiving printing recorder.

Referring again to Fig. 2 is is to be noted that each of the key levers 18, whether it is a character, function or spacing key lever, is connected by a link 101 to the armature of a magnet 102. The magnet 102 has been shown as being of the solenoid type, with a coaxial armature movable endwise or axially through the magnet winding upon energization of the magnet. It will be understood that these magnets could be of other types, but the solenoid magnet is a convenient form to be used where space considerations are involved, as they might be in the case of closely grouped magnets for operating key levers, since it is not necessary to afford space for pivoted armatures. Each of the key levers is provided with a connection, indicated in Fig. 2 symbolically by the fragments of rods or links 103, for operating the particular element or mechanism in the printing recorder to which the key lever pertains. The element or mechanism to which a key lever pertains and which it is arranged to control may be a type bar for printing letters, figures, punctuation marks or other symbols, may be the spacing mechanism or may be a function mechanism, such as shift, unshift, carriage return, line feed and any other function which the printing recorder may include.

It may be noted at this point that typewriting machines controlled by keyboards are well known which have key lever controlled power actuated means for performing those functions which are not ordinarily adaptable to direct operation by key levers, outstanding examples of which are the carriage return and line feed functions. Well-known types of printing telegraph recorders also have power actuated means for performing these functions, although such means are not generally controlled directly by key levers but are controlled instead by signal combinations generated through the operation of the key levers. The signal responsive function controlling elements of such printing telegraph recorders are usually of such simplicity that they could readily be controlled directly by key levers and, accordingly, it is presumed to be unnecessary to specifically illustrate or describe herein power actuated means for performing the more complex of the functions but that function controlling and operating means of the form known in power actuated or partially power actuated typewriting machines and of the form known in printing telegraph receiving records, could be employed in the present apparatus and the controlling means actuated by the connectors 103 associated with the key levers 18.

The key lever operating magnets 102 are shown at the left of Fig. 1 in horizontal and vertical rows of seven magnets, giving a total of forty-nine magnets which the arrangement of six selecting relays responsive to six oscillatory

current frequencies is readily adapted to control. As shown in Fig. 2 the magnets 102 would in all probability not be arranged as shown in Fig. 1 but the arrangement in Fig. 1 affords a convenient means of illustrating the selecting principle involved.

Selecting relays 91, 93 and 94 are provided with one, two and four contact tongues respectively which are operable between back and front contacts with the exception that the extreme left-hand contact tongue of relay 94 has no back contact. The single contact tongue of relay 91 is connected to ground and by the operation of the three relays in permutational combinations ground may be applied through fan circuits controlled by the contact tongues to any one of the seven conductors 103 extending from the seven contacts with which the contact tongues of relay 94 cooperate. Each of the conductors 103 is connected to one end of the winding of every magnet in one of the vertical rows of magnets 102 and as there are seven vertical rows, each conductor 103 serves to prepare energizing circuits for seven magnets in any vertical row of the forty-nine magnets 102.

Relays 96, 97 and 98 are provided with one, two and four contact tongues respectively, and each of the contact tongues is operable between back and front contacts with the exception of the extreme left-hand contact tongue of relay 98 which has only a front contact. The single contact tongue of relay 96 is connected to grounded battery 104 and the contact tongues of the relays 96, 97 and 98 control fan circuits identical with those controlled by the relays 91, 93 and 94 to apply battery to the seven conductors 106 connected to the seven contacts of relay 98. Each of the conductors 105 is connected to the opposite ends, from those to which the conductors 103 are connected, of the windings of the seven magnets in one of the horizontal rows of magnets 102. Since there are seven horizontal rows of the magnets, each of the conductors 106 serves one of the rows.

In the operation of the receiving system shown in Fig. 1, code combinations of two or more oscillatory currents at different frequencies are received from station 51 over communication channel 11 through key 13 positioned in the receiving condition, which is the condition shown in Fig. 1 and the received frequencies are impressed upon the primary winding of transformer 53. Corresponding oscillatory currents are induced in the secondary of transformer 53 and are impressed between the grid and cathode of the amplifier tube 54. Unidirectional current pulsations corresponding to the oscillatory currents appear in the plate circuit of amplifier tube 54 and corresponding pulsating potentials are impressed upon the output circuit which includes the condenser 69 and the primary windings of transformers 61, 62 and 63 in series. The pulsations induce corresponding currents in the secondary windings of the three transformers and these currents are impressed upon the six filter networks. Those of the filters that are tuned to the frequencies of the received oscillatory currents apply oscillatory potentials to their associated ones of the cathodes of discharge tubes 81, 83, 84, 86, 87 and 88 and the remaining filters reject the received frequencies. The cathodes which receive oscillatory potentials serve as control electrodes for the tubes, and in the positive half cycles they seek to cause the tube to break down and become conductive. The potentials may be insufficient to cause breakdown of the tube, or they may cause breakdown between the two cathodes, but until slow-operating relay 57 operates and applies positive battery to the output anodes of the tubes, current for operating the selector relays cannot flow. The path for energizing the selector relays, when completed by relay 57, is from grounded battery 58 through the contacts of relay 57, conductor 92, selecting relays, anodes of the discharge tubes, ionizable discharge path in the tubes and grounded cathodes of the tubes to ground.

Slow-operating relay 57 which is included in the plate current circuit of amplifier tube 54 responds to the flow of current in that circuit resulting from the reception of signals and attracts its contact tongue into engagement with the single front contact, thus connecting battery 58 over battery conductor 92 and through the selecting relays 91, 93, 94, 96, 97 and 98 to the anodes of the discharge tubes. Thus the output circuits for the discharge tubes are completed. At the same time, a biasing potential is applied to the control cathode of each tube, this potential being insufficient to break down the tubes except those influenced and assisted by the oscillatory potentials, and in the latter tubes current for energizing the selector relays flows from battery and will continue to flow even after the oscillatory potentials have been removed from the control cathodes. The received signal includes a frequency to cause the energization of at least one of the relays 91, 93 and 94 and a frequency to cause the energization of at least one of the relays 96, 97 and 98. As a result of the selective operation of the relays 91, 93 and 94 ground is connected through one of the seven conductors 103 to the windings of the magnets 102 in one of the seven vertical rows. Through the selective operation of the relays 96, 97 and 98 battery 104 is connected through one of the conductors 106 to the seven magnets 102 in one of the horizontal rows. Accordingly, that one of the magnets 102 which is connected to the selectively grounded conductor 103 and to the selectively battery connected conductor 106 will have its energizing circuit completed and will be energized to effect the operation of its associated key lever 18 (Fig. 2) and the operation of the type bar or function controlling element to which the key lever is connected. Only one of the magnets 102 will be energized because no two of the magnets are connected to the same ones of the conductors 103 and 106.

The purpose in making relay 57 slow to operate is to withhold anode battery from the discharge tubes momentarily so that all required tubes shall be receiving the oscillatory controlling potentials before the tubes are permitted to fire, whereupon they fire simultaneously. This prevents momentary impulses, or signals, in which some of the oscillatory currents may suffer slight delays in reaching and influencing the control electrodes of their respective discharge tubes, from firing one or more tubes less than the full code, which might cause an incorrect one of the magnets 102 to operate. Since the control cathodes have no control over the tubes after they have fired, and the tubes can be rendered inactive only by substantially reducing or removing the anode potential, selecting conditions initiated by extremely short impulses may be prolonged, for a sufficient interval to assure operation of a magnet 102, by making relay 57 also slow to release,

which will delay removal of the anode potential from the discharge tube.

The selecting system herein disclosed takes full advantage of the selective possibilities of a code involving six signaling conditions representing two groups of three selecting signals wherein at least one signal from each group is employed for effecting a selection. The blank signal is not employed as a selective condition, since the normal deenergized condition of the selecting relays **91, 93, 94, 96, 97** and **98** corresponds to the blank signal, and this accounts for the fact that the extreme left-hand contact tongue of each of the relays **94** and **98** has no back contact, and no magnet corresponding to the magnets **102** is to be energized in the idle condition of the receiving printer.

The forty-nine selections that are afforded by the forty-nine magnets **102** fully accommodate the operation of a typewriting machine. Standard commercially available typewriters usually have forty-two printing type bars and forty-two key levers for controlling the type bars. The spacing function and the shift, unshift, carriage return, and line feed functions require five additional codes and bring the total to forty-seven. This leaves two codes which may be assigned to other special functions such as back space and tabulating functions. If a smaller number of selective possibilities is required, such as for the control of recording printers corresponding to certain commercially available telegraph printers, which are sometimes controlled by keyboards having three banks of keys, which do not print lower case letters, and which record figures and certain punctuation characters as shift selections. the number of magnets **102** may be reduced and certain of the conductors **103** and **106** and their associated paths through the fan circuits controlled by the selecting relays may be omitted.

With the selecting system above described, several key levers **18** of the transmitter will operate two of the code bars **28**, the majority will operate three or four code bars, a few will operate five code bars, and one may operate six. The touch of the keyboard probably will vary according to the number of code bars operated. The codes involving the operation of greater numbers of code bars will preferably be assigned to the key levers pertaining to the characters or functions having the lower frequencies of use, so that the average keyboard effort may be kept at a minimum.

A modified form of keyboard transmitter for generating code combinations of oscillatory signaling current is shown in Fig. 5. Key levers **111** are pivoted on common pivot rod **112**, are provided with key tops **113** and are connected by links **114** to operating magnets **116**, this portion of the structure being identical with that shown in Fig. 2. Key levers **111** are made of electrically conductive metal and are supported in electrically conductive relation to the pivot rod **112**, which is grounded.

Below the key lever **111** and extending transversely thereto from one side of the keyboard to the other a plurality of conductive wires **117** equal in number to the number of oscillatory currents involved in the code is supported by non-conductive blocks **118**. Tension springs **119** are interposed between one end of each of the wires **117** and one of the blocks **118** for maintaining the wires **117** yieldably taut.

The signaling current generator, designated generally by the reference numeral **121**, includes an elongated permanent magnet **122**, vibratory reeds **123** supported by clamping blocks **124** within magnet **122**, and a pick-up or current generating winding **126** for which the vibratory reeds **123** serve as driving armatures. The signaling current generator **121** may be substantially identical with the signaling current generator **38** shown in Figs. 2, 3 and 4, as far as the elements thus far identified in the generator **121** are concerned.

Adjacent to the free ends of the vibratory reed **123** the permanent magnet **122** supports a plurality of laminated electromagnet cores **127** each of which is provided with an energizing winding **128**. One terminal of each of the windings **128** is connected to grounded battery and the other terminal is connected to one of the conductive wires **117**. Each of the magnet cores **127** has an end presented adjacent to the flat surface near the free end of its associated vibratory reed **123** as a pole face and the reeds **123** serve as armatures for the electromagnets **127**.

The key levers **111** are provided with variously disposed depending lugs **129** which, upon the operation of a key lever, engage and slightly depress and thereby firmly contact corresponding ones of the taut wires **117**, thus completing energizing circuits for corresponding ones of the electromagnets **127** from ground through the key lever **111** and its lugs **129**, wires **117**, springs **119**, and windings of the corresponding ones of electromagnets **127** to grounded battery. Thus certain of the electromagnets **127** are energized according to the code to be transmitted and they attract and hold the corresponding vibratory reeds **123**. The attracted reeds **123** are held by the electromagnets **127** until the operated key lever **111** is released and the energizing circuits for the electromagnets **127** interrupted. Due to the fact that the cores **127** are laminated the magnetism induced therein dies out with such rapidity that the vibratory reeds which had been attracted and held are immediately released and these reeds vibrate at their natural frequencies to generate the signaling currents that are to be transmitted. Thus the reeds **123**, instead of being plucked and allowed to vibrate for the generation of the signaling currents while the key levers are held depressed, as in the embodiment of the invention shown in Figs. 2, 3 and 4, are merely flexed and held upon the depression of a key lever and are released to permit free vibration upon the release of the key lever.

Although the vibratory reed type of signaling current generator has been shown herein as adapted to be controlled by a keyboard mechanism, it will be understood that the signal generator may readily be controlled from a tape sensing mechanism or other type of stored signal sensing device. For example, the vibratory reeds **37** of the signal generator **38** shown in Figs. 2, 3 and 4 may be plucked by the sensing levers of a tape sensing mechanism as the sensing fingers of the levers enter code perforations in a perforated tape. In the case of the signal generator **121**, the transmitting contacts of the well-known perforated tape controlled transmitter may be connected directly to the electromagnets **127** of the signal generator **121** and under these circumstances the vibratory reeds **123** will be attracted when the tape sensing pins enter the perforations in the tape and will be released for generation of the signaling currents when the sensing pins are with-

drawn preparatory to advancement of the tape to bring the next set of code perforations into position to be sent.

Although certain specific embodiments of the invention have been illustrated in the drawings and described in the foregoing specification, it will be understood that the invention is not limited to such specific embodiments, but is capable of modification and rearrangement without departing from the spirit of the invention and within the scope of the appended claims.

What is claimed is:

1. In a telegraph system, a signaling channel, a plurality of normally deactivated means for generating different frequencies, means for selectively activating combinations of at least two of said frequency generating means simultaneously to generate a telegraph signal code combination, means for impressing the frequencies generated thereby on said channel, means connected to said channel for receiving and amplifying said frequencies, means for separating said amplified frequencies, relay means individually responsive to said separated frequencies, a plurality of printing elements, and means selectively operable by combinations of said relay means for operating said printing elements individually.

2. In a telegraph system, a signaling channel, a plurality of normally deactivated means for generating different frequencies, means for selectively activating combinations of at least two of said frequency generating means simultaneously to generate a telegraph signal code combination, means responsive to said frequency generating means for generating oscillatory currents corresponding to said frequencies and for impressing said oscillatory currents on said channel, means connected to said channel for receiving and amplifying said currents, means for separating said amplified currents according to frequencies, electronic relay means responsive to said separated oscillatory currents, electromagnetic relay means controlled by said electronic relay means, a plurality of printing elements, and means operable by combinations of said electromagnetic relay means for operating said printing elements individually.

3. In a telegraph system, a signaling channel, a plurality of normally deactivated means for generating different frequencies, means for selectively activating the two or more frequency generating means involved in any selecting code simultaneously, means responsive to said frequency generating means for generating oscillatory currents corresponding to said frequencies and for impressing said currents on said channel, means connected to said channel for receiving and amplifying said currents, means for separating said amplified currents according to frequencies, first relay means responsive to said separated currents, second relay means controlled by said first relay means, a plurality of printing elements, and electromagnets operable by two or more of said second relay means in combination for operating said printing elements individually.

4. In a telegraph system, a signaling channel, a plurality of vibratory elements having different natural frequencies of vibration, means for selectively setting at least two of said vibratory elements in vibration simultaneously for generating at least two different frequencies, means controlled by said vibratory elements for generating oscillatory currents corresponding in frequency to the frequency of vibration of said elements and for impressing said currents on said channel, means connected to said channel for receiving and amplifying said currents, means for separating said amplified oscillatory currents according to their frequencies, relay means responsive to said separated oscillatory currents, a plurality of printing elements, and electromagnets individual to said printing elements and operable by combinations of said relay means for operating said printing elements.

5. In a telegraph system, a signaling channel, normally inactive means for generating a plurality of frequencies in the audible range, means for selectively activating simultaneously only the two or more of said frequency generating means involved in any selecting code, means for generating oscillatory currents corresponding to the audible frequencies generated by the operated ones of said frequency generating means and for impressing said currents on said channel, an electronic amplifier connected to said channel for receiving and amplifying said oscillatory currents, a plurality of oscillatory current filters having characteristics to pass said amplified oscillatory currents individually and connected to the output of said electronic amplifier, first relay means responsive individually to the current passed by said filters, a second relay means controlled by each of said first relay means and operable by current therefrom, a plurality of printing elements, and an electromagnet individually associated with said printing elements and operable by two or more of said second relay means in combination for operating said printing elements.

6. In a printing telegraph system, a plurality of manually operable key levers, a plurality of code bars, means associated with said key levers for operating said code bars in combinations, a plurality of vibratory elements equal in number to the number of code bars, means carried by each code bar for setting in vibration one of said vibratory elements, means associated with said vibratory elements for generating oscillatory signaling currents at frequencies corresponding to the frequency of vibration of said vibratory element, means for selectively dividing said signaling currents, and a printing mechanism selectively controlled by said divided currents.

7. In a printing telegraph system, a plurality of manually operable key levers, a plurality of code bars less in number than the number of key levers, means associated with said key levers for operating said code bars in combinations, a plurality of vibratory elements equal in number to the number of code bars and having different natural frequencies of vibration in the audible range, means associated with each code bar for setting one of said vibratory elements in vibration, means common to all of said vibratory elements for generating signaling currents at frequencies corresponding to the frequencies of vibration of said vibratory elements, means for selectively dividing said signaling currents, and a printing mechanism selectively controlled by said divided currents.

8. In a printing telegraph system, a plurality of code elements operable in various combinations, a plurality of vibratory elements equal in number to the number of code elements and having different natural frequencies of vibration in the audible range, means associated with said code elements for setting said vibratory elements in vibration, means for generating oscillatory signaling currents at frequencies correspondnig to the frequencies of vibration of said vibratory elements, means for selectively dividing said sig-

naling currents, and a printing mechanism selectively controlled by said divided currents.

9. In a printing telegraph system, a plurality of code elements operable in combinations, a plurality of vibratory elements equal in number to the number of code elements and having different natural frequencies of vibration, means controlled by said code elements for setting corresponding ones of the vibratory elements in vibration, means controlled by said vibratory elements for generating oscillatory signaling currents at frequencies corresponding to the natural frequencies of vibration of said vibratory element, means for selectively dividing said signaling currents, and a printing mechanism selectively controlled by said divided currents.

10. In a printing telegraph system, a plurality of code elements operable in combinations, means for generating a magnetic field, a plurality of armatures mounted to vibrate in said magnetic field, said armatures having different natural frequencies of vibration, means controlled by said code elements for setting individual ones of said vibratory elements in vibration, an electrically conductive winding associated with said armatures for generating oscillatory signaling currents at frequencies corresponding to the natural frequencies of vibration of said armatures in response to vibration thereof, means for selectively dividing said signaling currents, and a printing mechanism selectively controlled by said divided currents.

11. In a telegraph transmitter, a plurality of manually operable key levers, a plurality of yieldably supported conductive strands extending transversely of said key levers, a corresponding plurality of electromagnets connected individually to said conductive strands, a source of electrical potential having one side connected to said electromagnets and the other side connected to said key levers, means associated with said key levers for selectively engaging said conductive strands to complete the circuits of said electromagnets in various combinations, a vibratory armature for each of said electromagnets having a natural frequency of vibration different from the frequency of vibration of each other armature, and means responsive to vibrations of said armatures for generating oscillatory signaling currents at frequencies corresponding to the frequency of vibration of said armatures.

12. In a telegraph transmitter, a plurality of manually operable key levers, a plurality of yieldably mounted conductive strands, less in number than the number of key levers, extending transversely of said key members, a plurality of electromagnets corresponding to the number of said conductive strands and individually connected to said strands, a source of potential having one side connected to said electromagnets and the other side connected to said key levers, means conductively associated with said key levers for conductively engaging said strands in various combinations to complete the energizing circuits of said electromagnets, a vibratory armature for each of said electromagnets movable into engagement therewith upon the energization of the electromagnet and releasable upon the deenergization of the electromagnet for free vibration, each armature having a natural frequency of vibration different from those of the other armatures, and pick-up coil means associated with said armatures for generating oscillatory signaling currents at frequencies corresponding to the frequency of vibration of said armatures.

13. In a printing telegraph apparatus including a plurality of printing elements, a plurality of manually operable key members connected to said printing elements, a plurality of code elements controllable selectively in combinations by said key levers, a plurality of vibratory elements corresponding in number to the number of said code elements and having different natural frequencies of vibration, means controlled by said code elements for setting said vibratory elements in vibration, a communication channel, means associated with and controlled by said vibratory elements for generating oscillatory currents at frequencies corresponding to the frequencies of vibration of said vibratory elements and for impressing said currents on said channel, means for receiving oscillatory currents from said channel, means for separating said received oscillatory currents, relay means individually controlled by said separated currents, and a plurality of electromagnets individually connected to said key levers and operable under the control of combinations of said relay means to operate said key levers and thereby to operate the printing elements associated with said key levers.

14. In a printing telegraph apparatus including a plurality of printing elements, a plurality of manually operable key members connected to said printing elements, a plurality of code elements controllable selectively in combinations by said key levers, a plurality of vibratory elements corresponding in number to the number of said code elements and having different natural frequencies of vibration, means controlled by said code elements for setting said vibratory elements in vibration, a communication channel, means associated with and controlled by said vibratory elements for generating oscillatory currents at frequencies corresponding to the frequencies of vibration of said vibratory elements and for impressing said currents on said channel, means for receiving oscillatory currents from said channel, means for separating said received oscillatory currents, relay means individually controlled by said separated currents, a plurality of electromagnets individually connected to said key levers and operable upon the control of combinations of said relays to operate said key levers and thereby to operate the printing elements associated with said key levers, and means for alternatively and selectively connecting said oscillatory current generating means or said oscillatory current receiving means to said channel.

15. A printing system comprising a reed frequency transmitter adapted to produce combinations of alternating current frequencies in accordance with the character to be printed, means for amplifying said frequencies, means for selectively dividing said frequencies, and a printing mechanism selectively controlled by said divided frequencies.

16. In a telegraph transmitter, a plurality of manually operable key levers, a plurality of electromagnets less in number than the number of key levers and controllable in combination thereby, a vibratory armature for each of said electromagnets having a natural frequency of vibration different from the frequency of vibration of each other armature, and means responsive to vibrations of said armatures for generating oscillatory signaling currents at frequencies corresponding to the frequency of vibration of said armatures.

17. In a telegraph transmitter, a plurality of manually operable key levers, a plurality of elec-

tromagnets less in number than the number of key levers operable in combinations by said key levers, a vibratory armature for each of said electromagnets having a natural frequency of vibration different from the frequency of vibration of each other armature, and means responsive to vibrations of said armatures upon release thereof by said electromagnets for generating oscillatory signaling currents at frequencies corresponding to the frequency of vibration of said armatures.

18. A printing system comprising a vibratory reed transmitter adapted to produce combinations of mechanical vibrations in accordance with the character to be printed, means for generating oscillatory currents corresponding to said vibrations, means for selectively dividing said currents, and a printing mechanism selectively controlled by said divided currents.

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