

April 15, 1941.

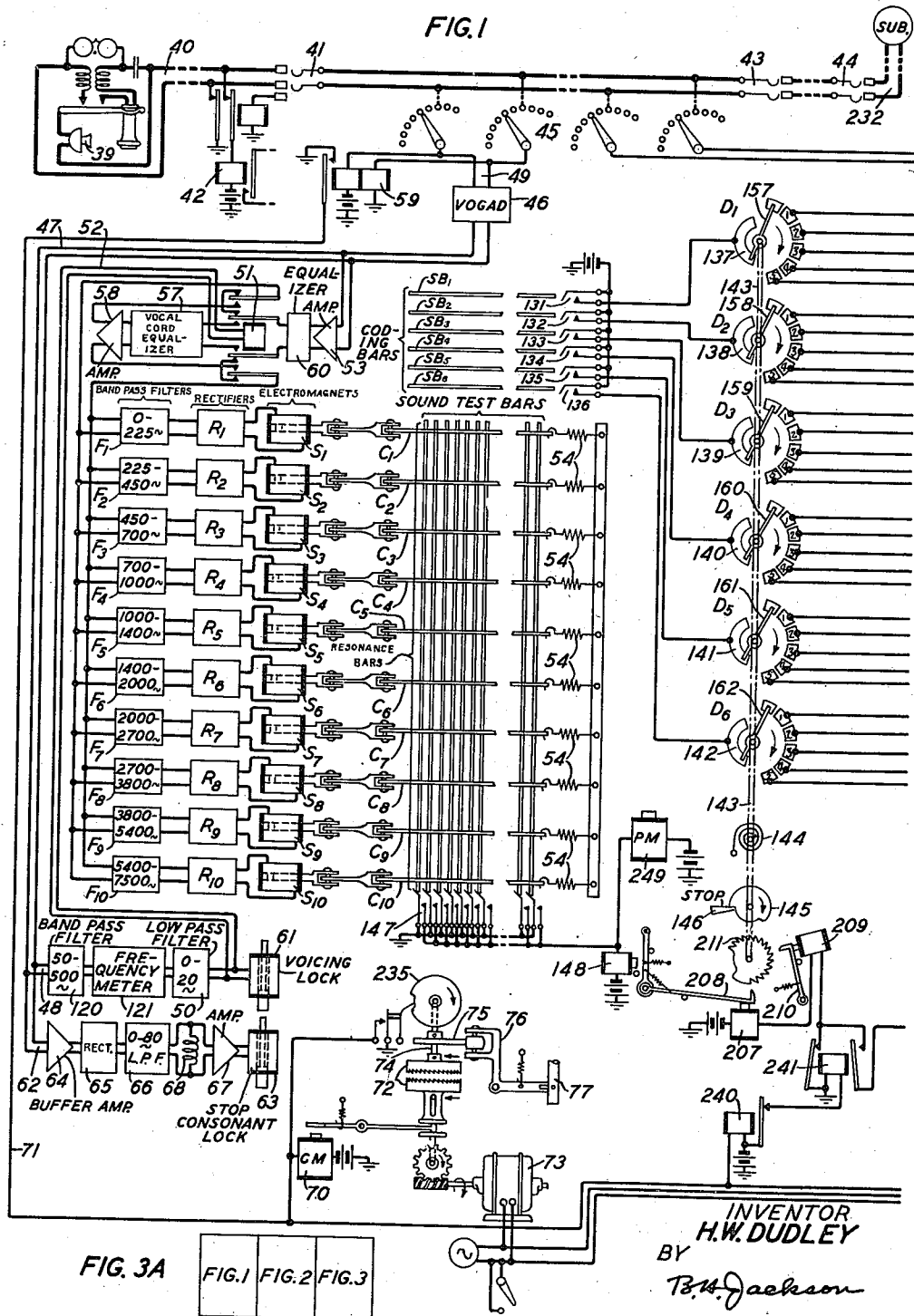
H. W. DUDLEY

2,238,555

VOICE OPERATED MECHANISM

Filed March 31, 1939

15 Sheets-Sheet 1



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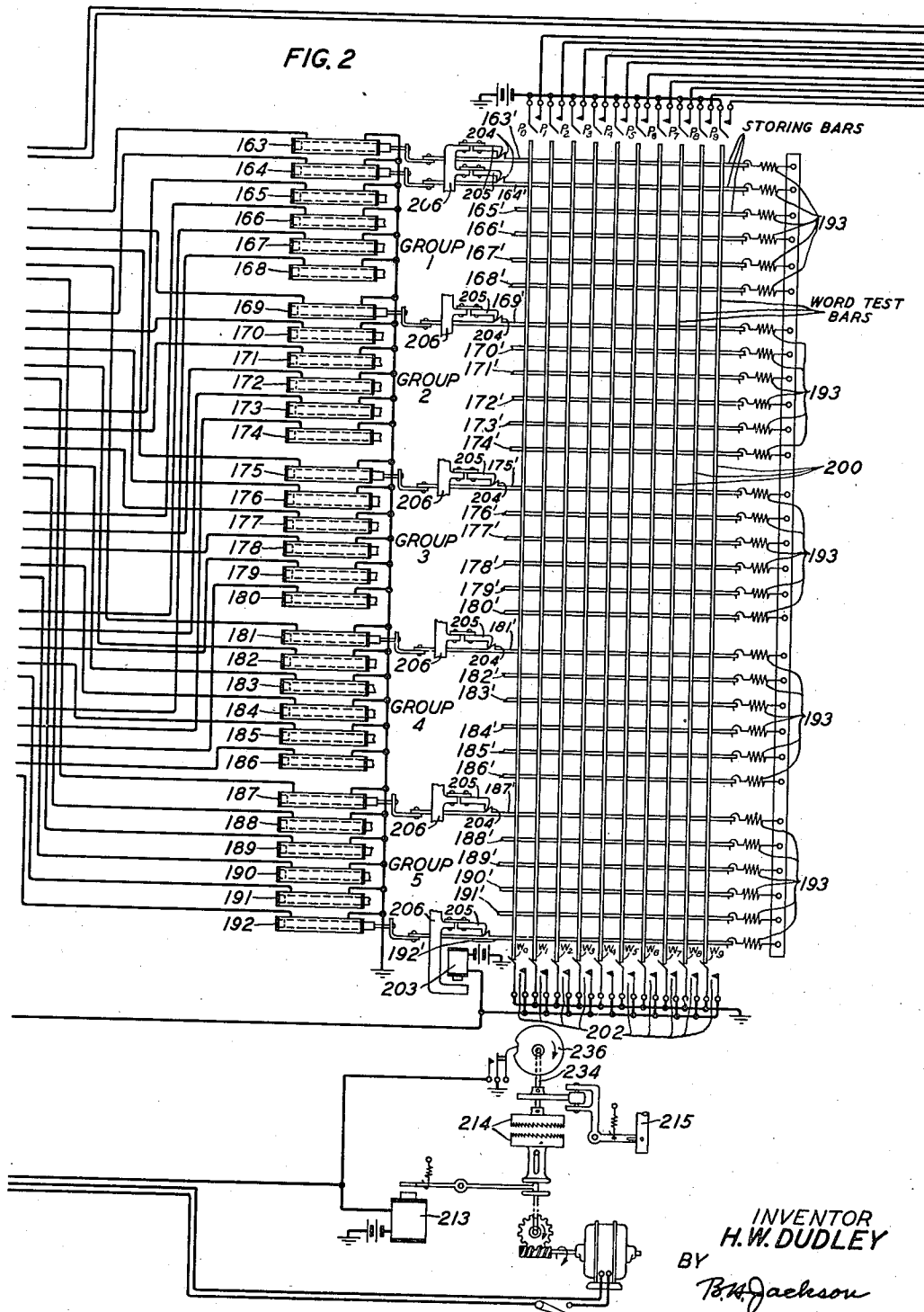
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VOICE OPERATED MECHANISM

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15 Sheets-Sheet 2



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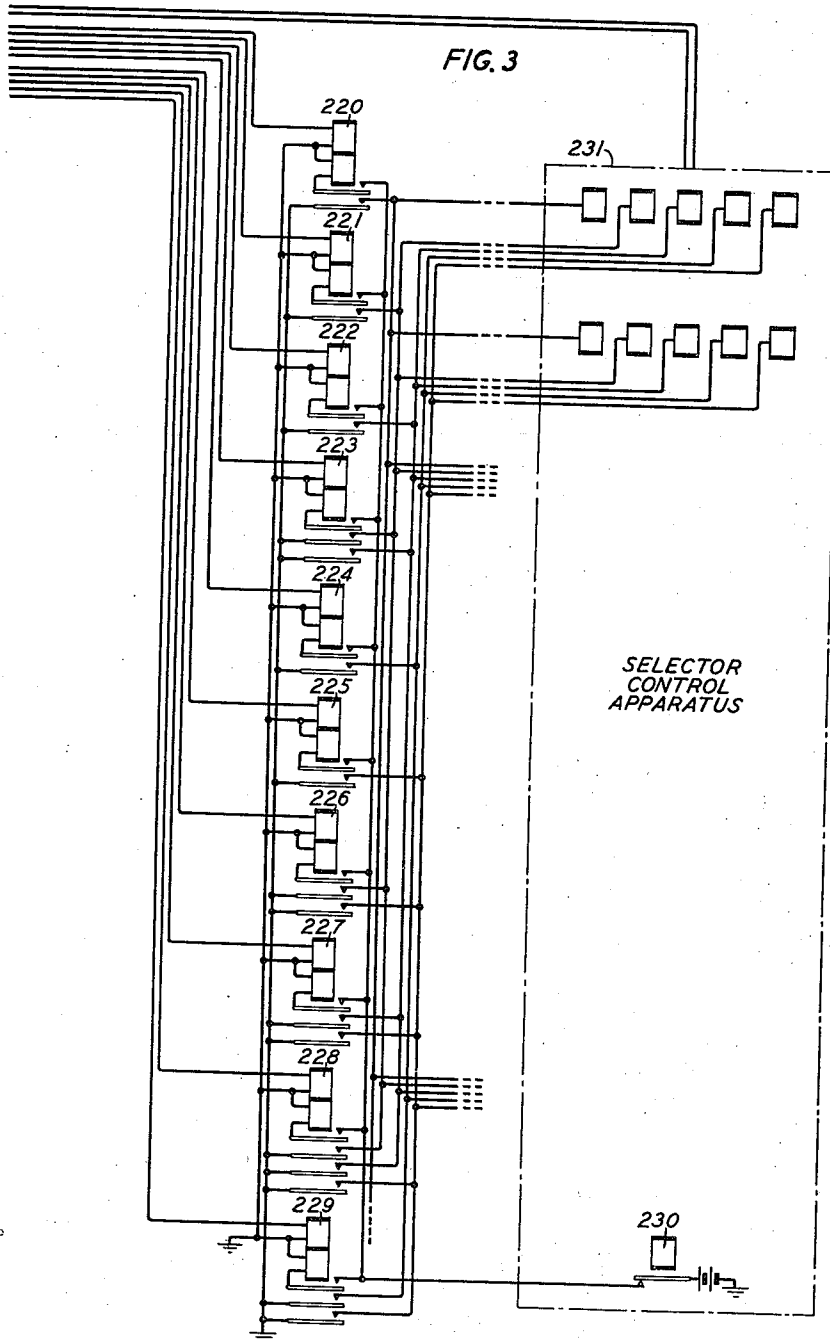
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SELECTOR
CONTROL
APPARATUS

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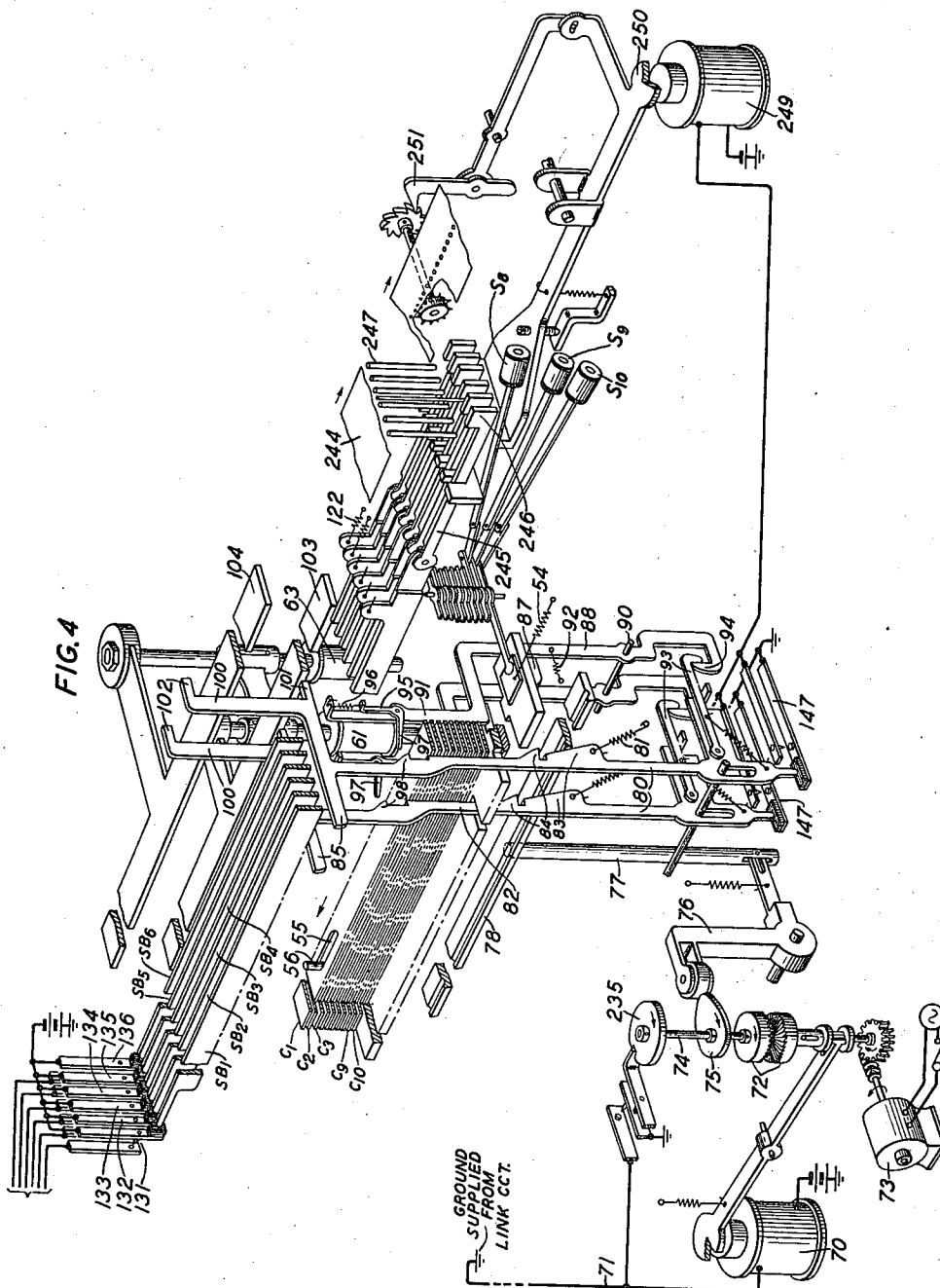
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VOICE OPERATED MECHANISM

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15 Sheets-Sheet 4



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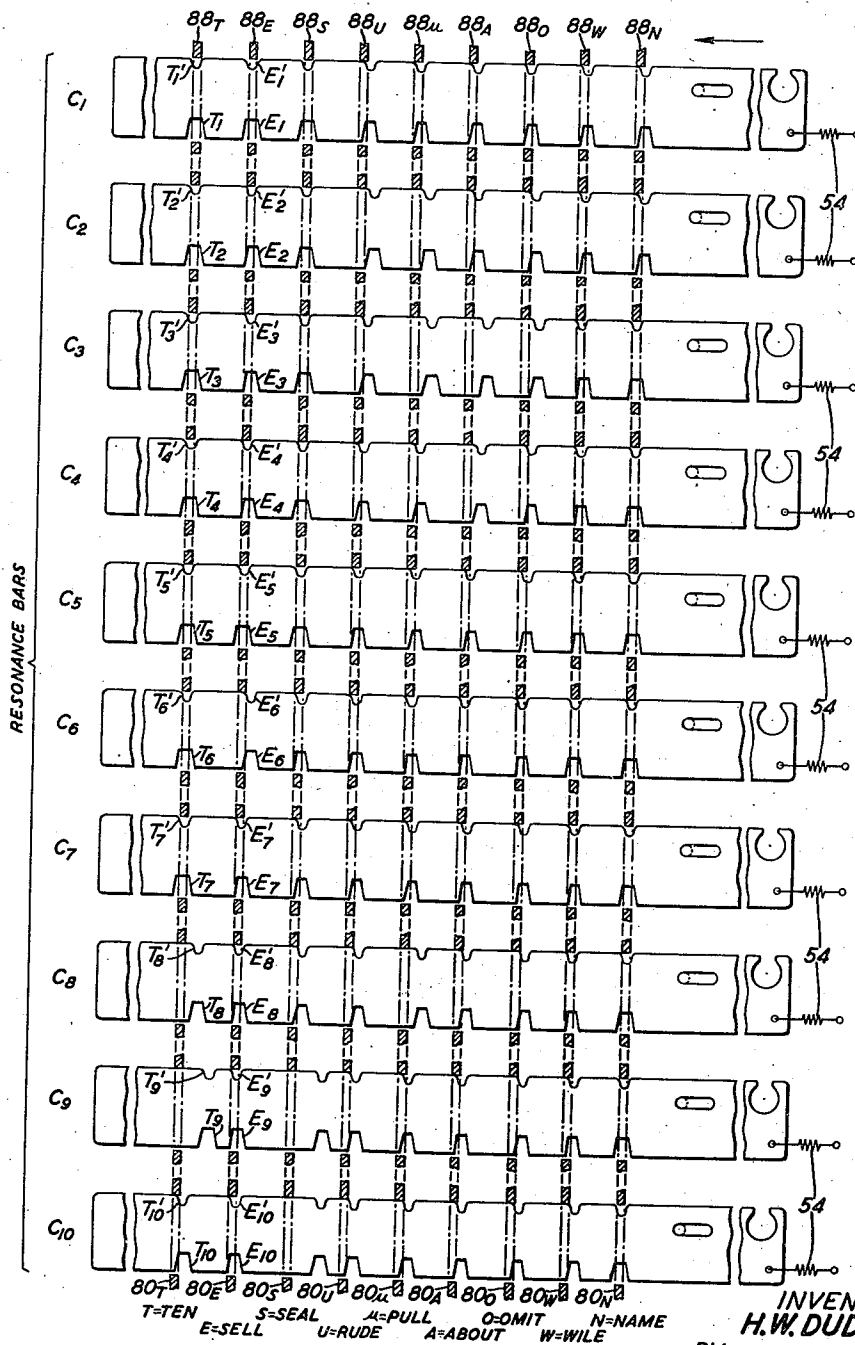
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VOICE OPERATED MECHANISM

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FIG. 5



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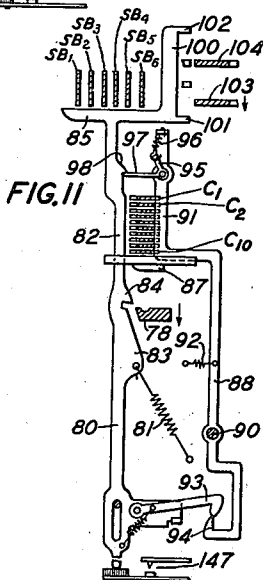
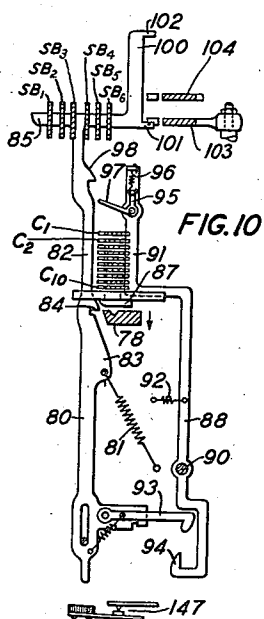
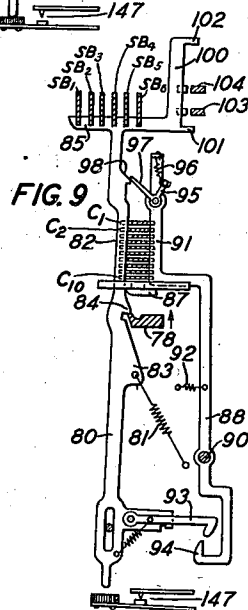
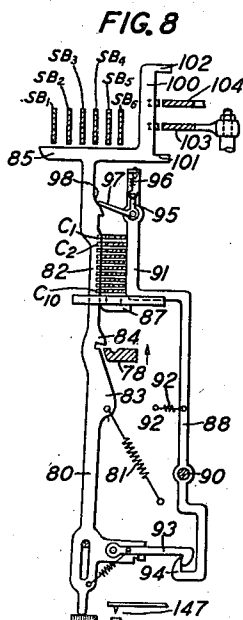
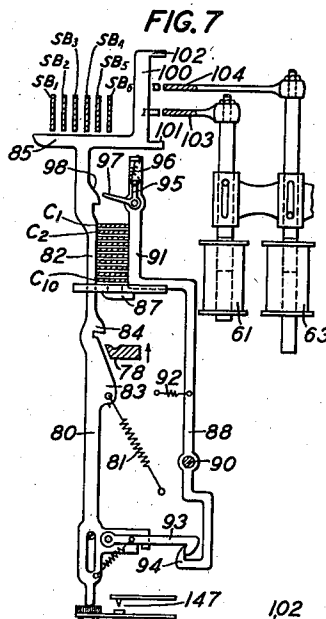
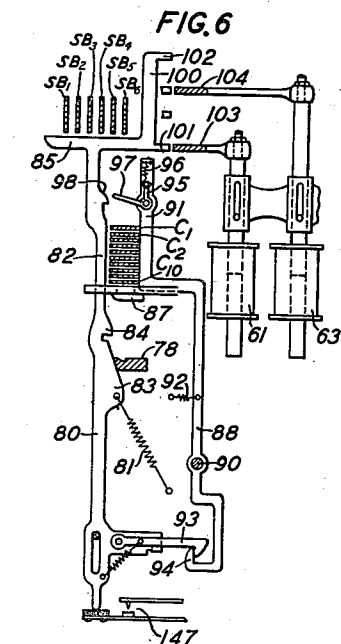
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VOICE OPERATED MECHANISM

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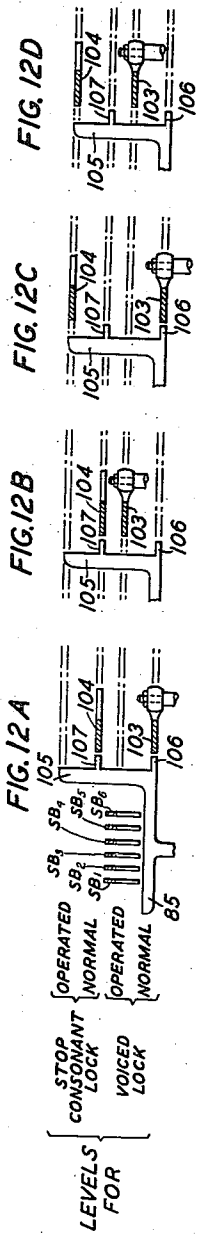


FIG. 12D

FIG. 12C

FIG. 12B

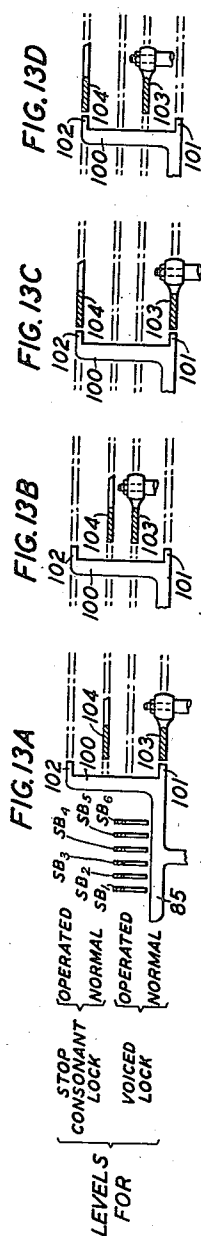


FIG. 13D

FIG. 13C

FIG. 13B

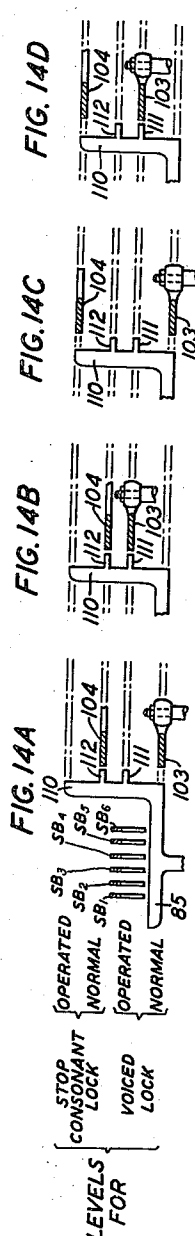


FIG. 14D

FIG. 14C

FIG. 14B

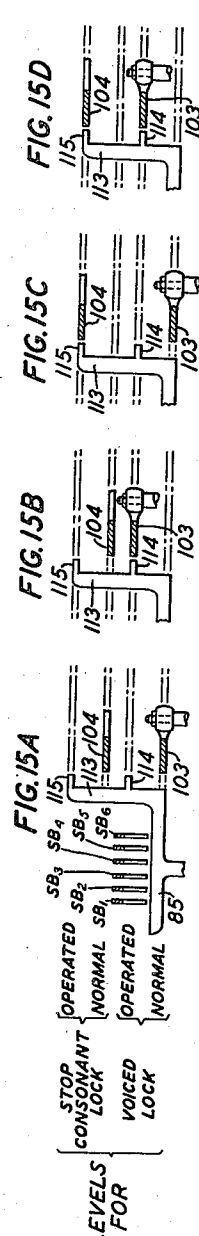


FIG. 15D

FIG. 15C

FIG. 15B

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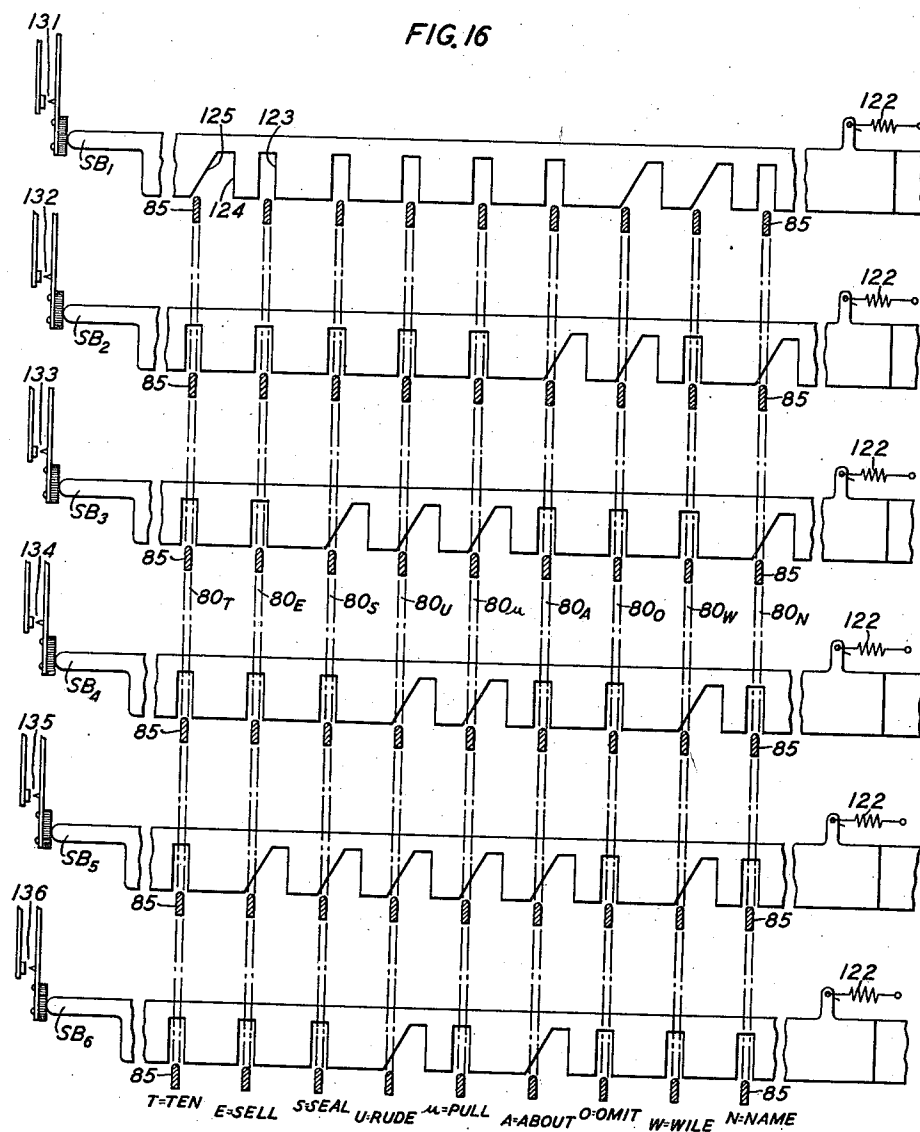
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VOICE OPERATED MECHANISM

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15 Sheets-Sheet 8



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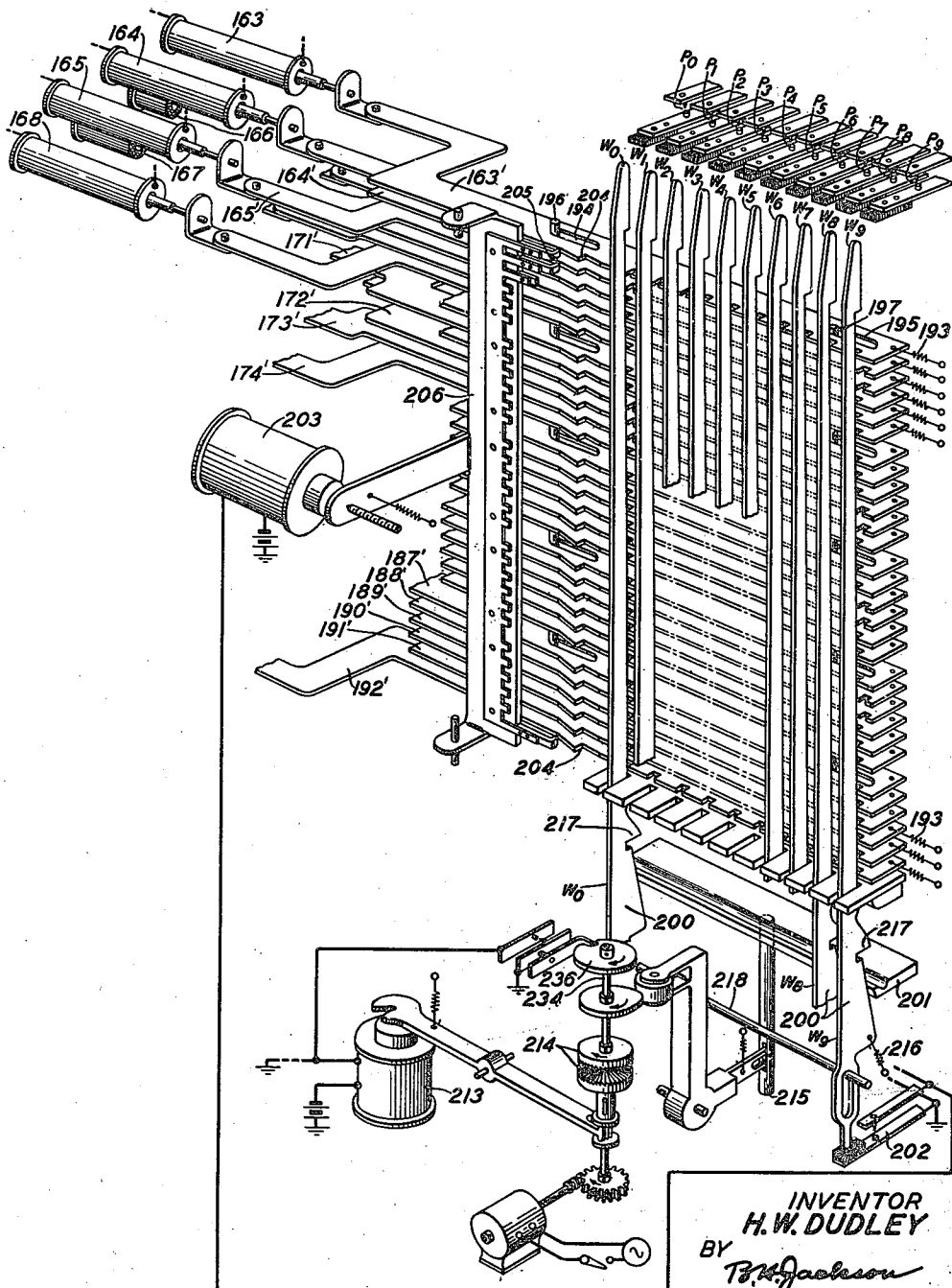
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FIG. 17



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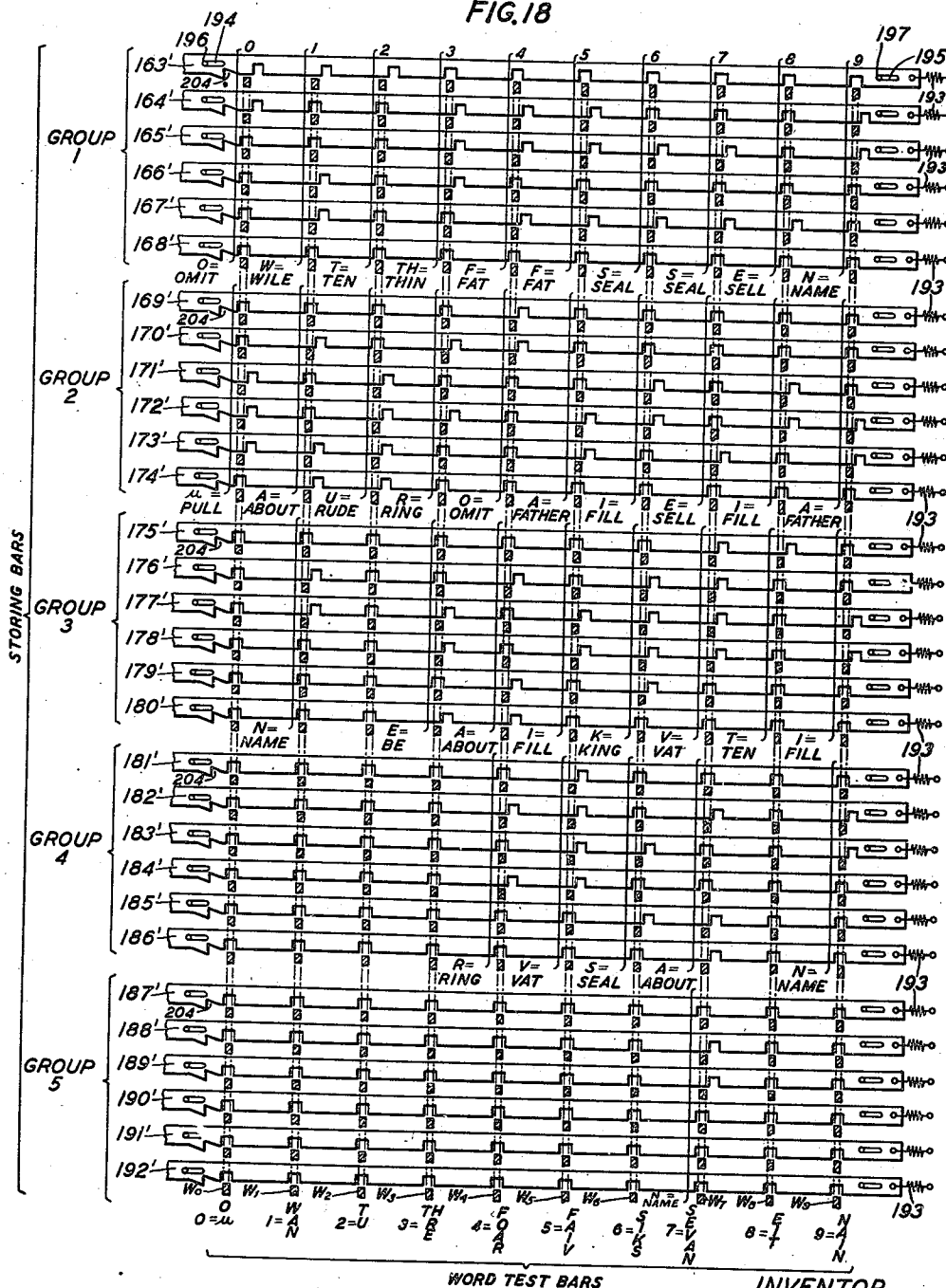
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FIG. 18



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FIG. 19

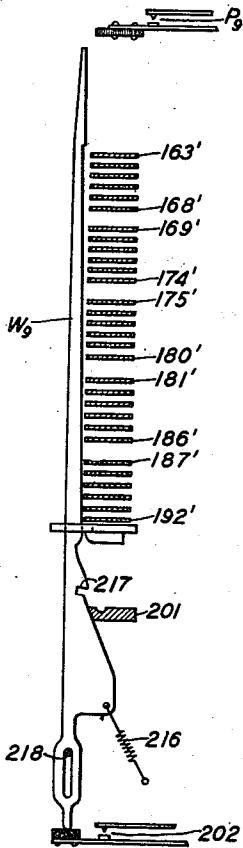


FIG. 20

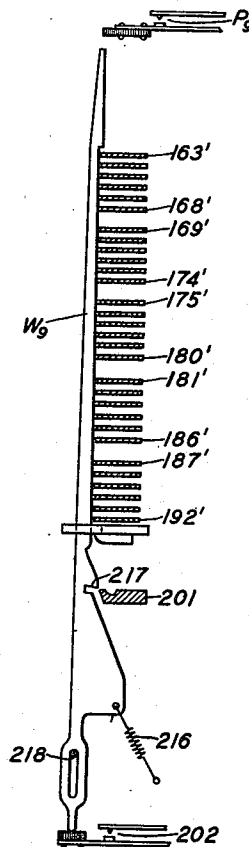
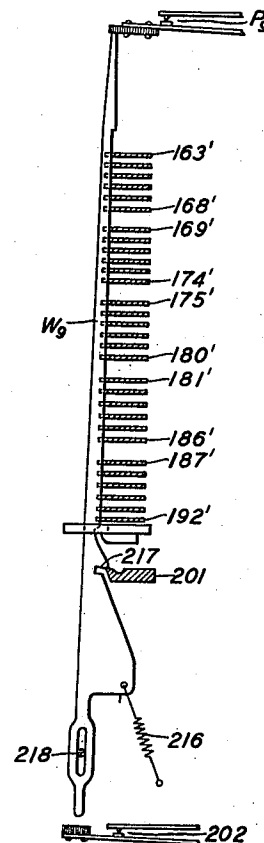


FIG. 21



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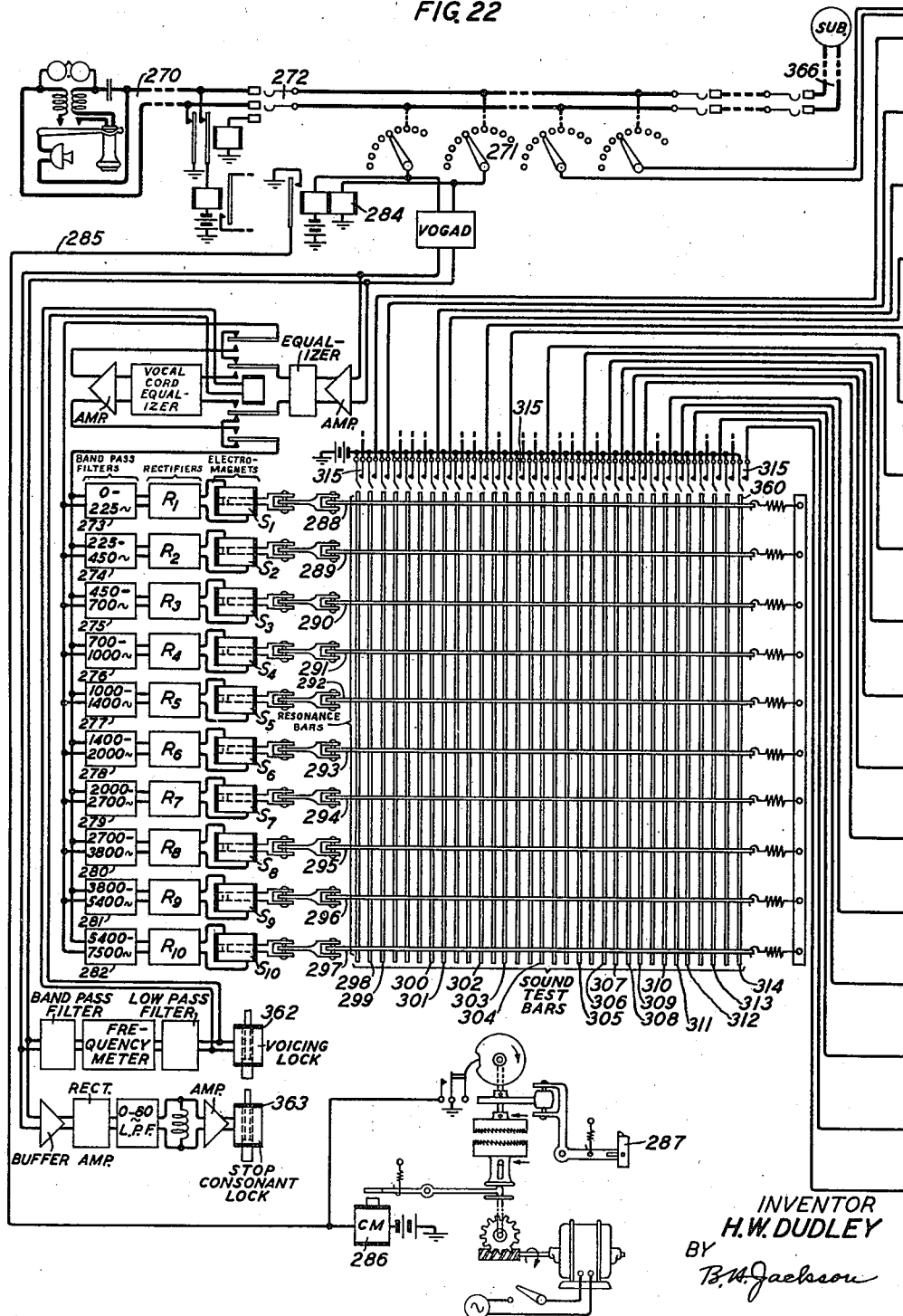
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VOICE OPERATED MECHANISM

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FIG 22



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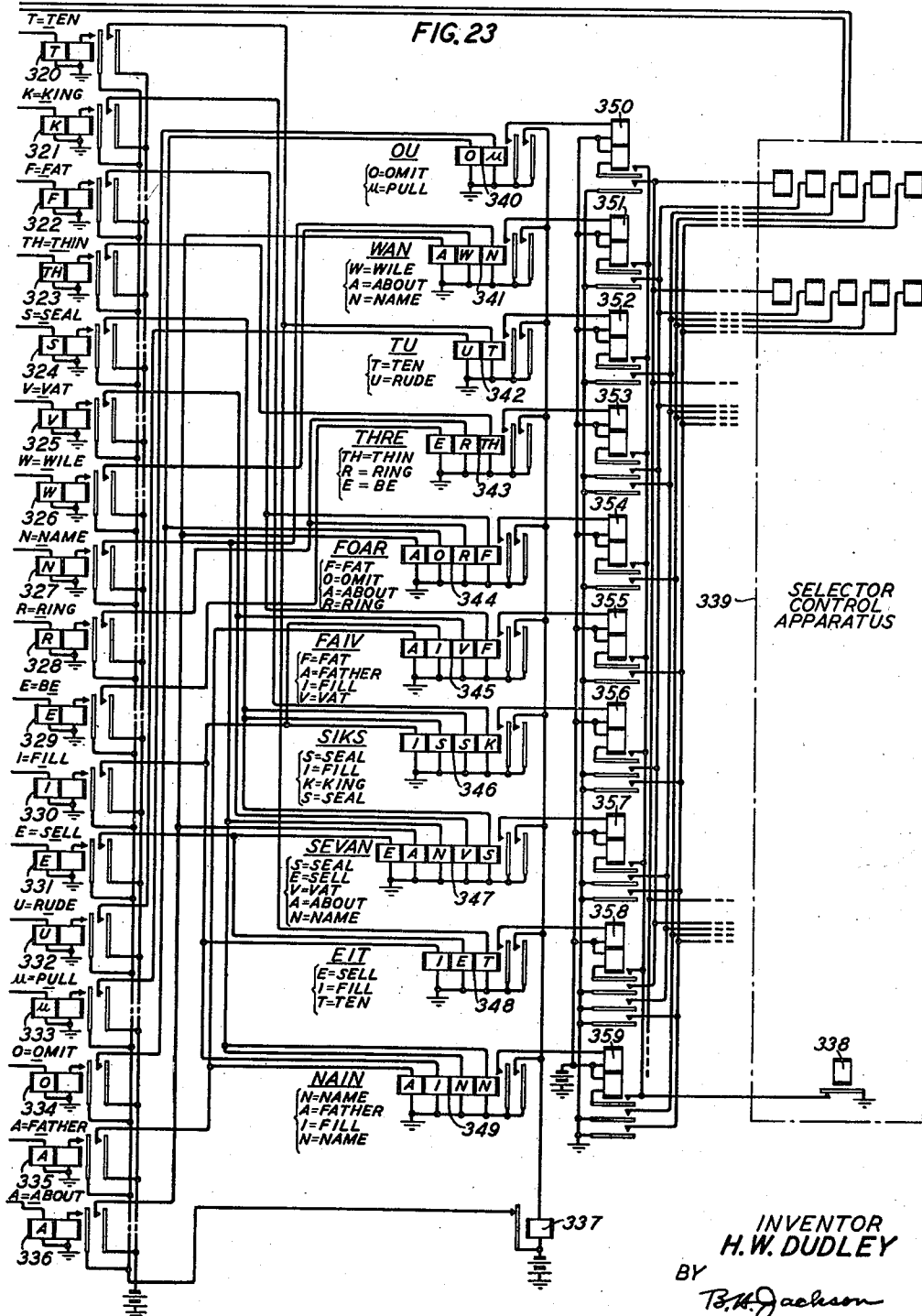
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VOICE OPERATED MECHANISM

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15 Sheets-Sheet 13



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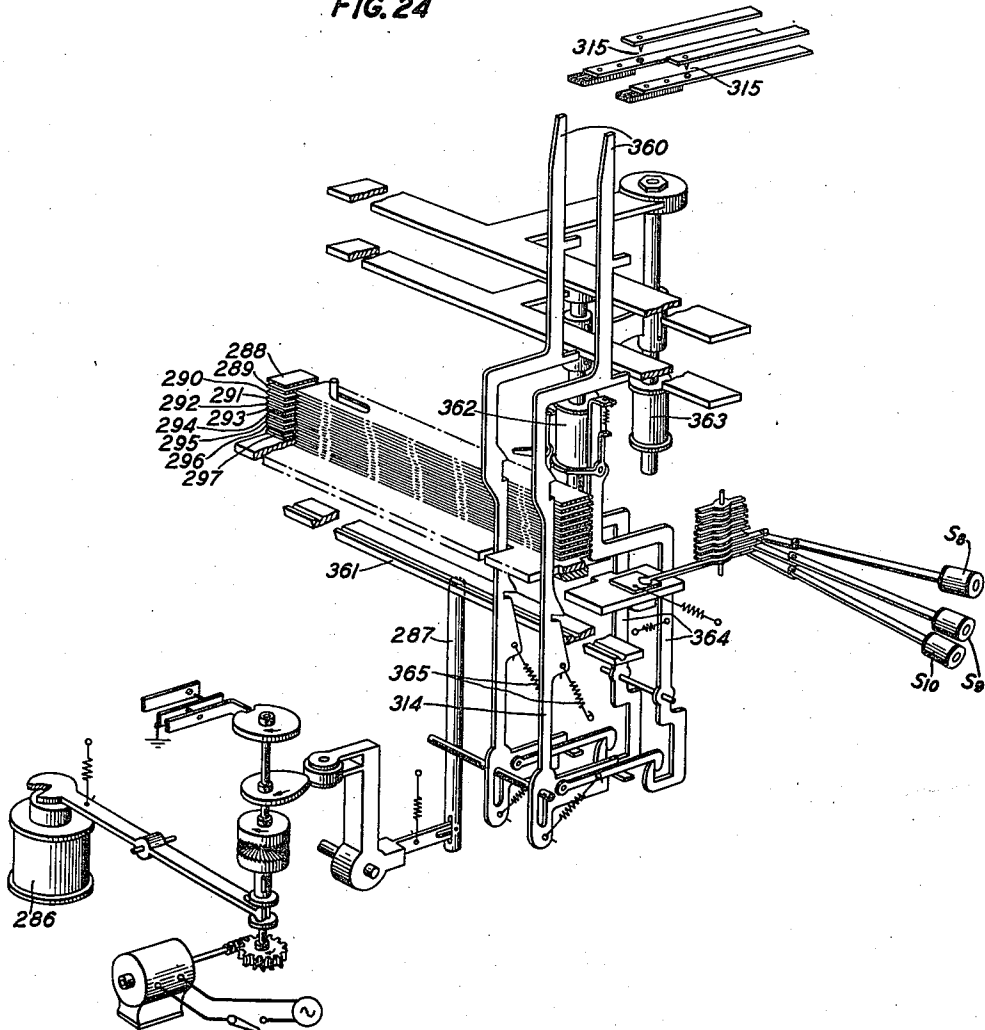
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FIG. 24



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FIG. 25

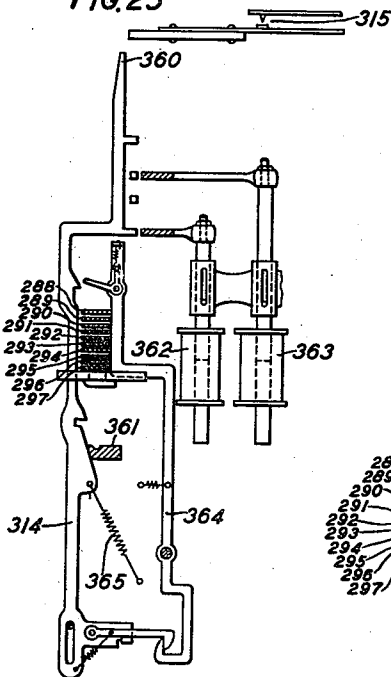


FIG. 27

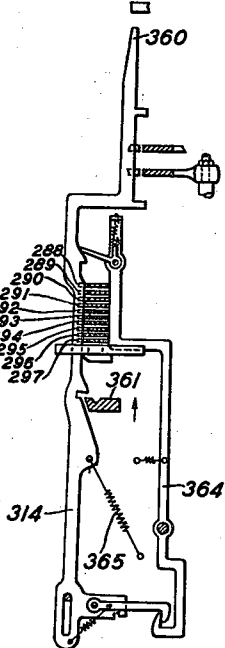


FIG. 26

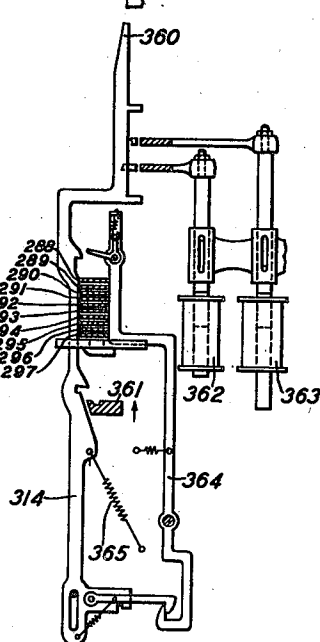


FIG. 29

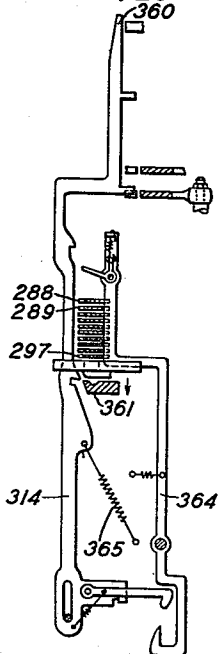


FIG. 30

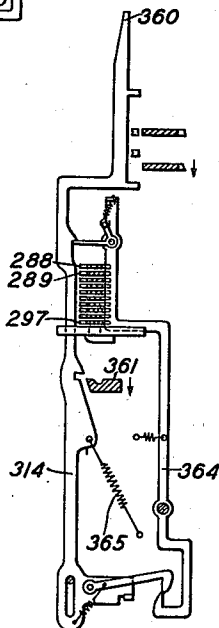
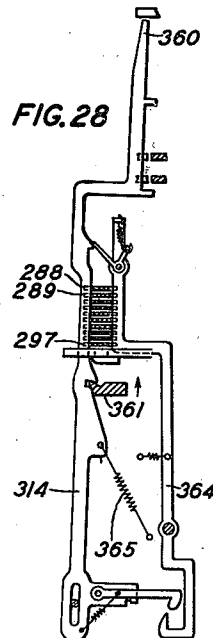


FIG. 28



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UNITED STATES PATENT OFFICE

2,238,555

VOICE OPERATED MECHANISM

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York, N. Y., a corporation of New York

Application March 31, 1939, Serial No. 265,260

35 Claims. (Cl. 179—18)

This invention relates to speech operated devices particularly of the type in which a speech message is analyzed to cause mechanical operations determined by the word content of the message.

In a preferred embodiment the invention relates to an automatic telephone system in which a connection to a wanted subscriber is established by switching devices automatically controlled by voice operated equipment responsive to an oral pronouncement of the office and number of the wanted subscriber. Voice operated dialing in a telephone system may be taken as typical of various applications of the present invention to voice operated mechanisms where each desired mechanical operation is effected only when a combination of sounds in a certain sequence is received by the mechanism.

In order that mechanical operations may be performed directly in response to spoken sounds it is necessary to analyze the sounds and derive therefrom a set of parameters which collectively define each sound and distinguish each sound of importance in speech from all other speech sounds. In choosing the set of parameters to be employed for this purpose use is made of the fact that one set of parameters can be substituted for another set without any loss of definition so long as the number of independent parameters remains unchanged.

As pointed out in my earlier U. S. Patent No. 2,194,298 of March 19, 1940, the number of movable or variable elements of the vocal system that are controlled as parameters to give the desired speech production and are movable or variable substantially independently of one another by the muscles of the vocal system is small. In other words, the number of variables or parameters that can be controlled substantially independently in speech production is small, being of the order of ten. Moreover, for each of the physical elements the minimum time it can go through a complete cycle of change in position is not less than about .1 second. Consequently each independent variable has a fundamental frequency of not over 10 cycles per second while engaged in speech production.

Therefore, the speech defining signals into which the spoken message is translated for producing the desired mechanical operation may be signals derived from the message, providing the derived signals give as many independent variable quantities or parameters as the number of independent variables involved in the production

of speech. Further, the chosen parameters need not be entirely independent provided their number be increased sufficiently to make up for their lack of independence. In accordance with the preferred form of this invention the chosen parameters may be the amounts of power present in selected subbands of the speech frequency range. For example, the speech frequency range by means of band-pass filters may be divided into ten subbands collectively extending over the frequency range of importance in speech and the amount of power in each subband may be selectively utilized to produce the desired mechanical operations.

The mechanism employed in determining the phonetic content of the spoken message may comprise a plurality of slotted resonance bars each controlled in its movement by the amount of power in one of the subbands into which the speech wave is divided so that each slotted bar is capable of assuming any one of several positions depending upon the power level in its assigned subband for each spoken sound. It, therefore, follows that the slotted bars in response to a spoken sound will assume relative positions individual to that sound and means testing for the relative actuated positions of the slotted bars may be utilized in producing the desired mechanical operation.

In accordance with a preferred embodiment of the voice operated mechanism of this invention the speech sounds are picked up by a microphone and transmitted to an amplifier whose gain is automatically adjusted for a constant speech level without, however, disturbing the relative loudness of the sounds making up a given word. The relatively constant volume output of this amplifier is next analyzed by a multiplicity of band-pass filters each passing a different subband of the speech frequency range and collectively passing the important frequency range of speech sound, for example, from 0 to 7500 cycles. The output of each filter then goes to a rectifier to produce a syllabic change in current proportional to the amount of power in the particular frequency band passed by its filter. This syllabic changing power from each rectifier energizes an electromagnet for actuating a resonance bar which may be similar in character to the code bars employed in teletypewriters. These resonance bars, therefore, have deflections varying with the amount of power in the particular subbands. The resonance bars may have slots cut in them in such a manner that the speech cur-

rents for a given sound line up one set of slots in the bars so that a testing device individual to that particular sound can fall into the aligned slots. With the slots so aligned, a sound test bar representing that particular sound will enter the aligned slots to permit the actuation of said sound test bar by a main ball or equivalent construction. Each subsequently spoken sound in a similar manner will cause the actuation of a sound test bar individual to that sound.

In a particular embodiment it may be desired to close a certain electrical contact in response to the spoken key-word "one" and a different contact for each of the other numerals 2 to 9, inclusive, including 0, each contact being closed only when the phonetic sounds received by the mechanism are received in the same sequence as they occur in the key word. In such a case the above-described sound test bars, each defining a separate phonetic sound, are adapted to control a series of groups of movable storing bars whereby the actuation of a sound test bar defining the first sound of a key-word will give the first group of storing bars relative positions defining said first sound, and the subsequent operation of the sound test bar for the second sound of the key-word will give the second group of storing bars relative positions defining said second sound, and so on until all the phonetic sounds of the given key-word are successively registered in the different groups of these storing bars. All of the storing bars for registering the successive phonetic sounds of a key-word may be so notched or slotted that when the registration therein of the phonetic sounds of a given key-word is completed a word test bar defining the said key-word will enter the aligned slots in the actuated groups of storing bars and such a word test bar will thereupon be actuated to operate the desired electrical contact which is individual to the registered key-word. Other spoken key-words can be similarly registered to operate contacts individual to each word or group of sounds.

Thus, in a machine switching telephone system, for example, the calling dial at the telephone station may be eliminated and the subscriber upon initiating a call transmits the office and number of the wanted line by pronouncing the same in the telephone transmitter in the same manner he would if he were calling from a manual station. The register relays at the central office which control the selective movement of the line extension switches instead of being set in response to the impulses of a dialed number are now set in response to the actuation of the above-described contacts which collectively and in the proper sequence define all of the spoken words making up the desired telephone number. These register relays are then locked to control the selective operation of the switches that reach the wanted line and the extent of their movement is, of course, determined by the combination of relays so locked and the selective circuits that can be controlled thereover in accordance with well-known automatic telephone practice.

Referring to the drawings:

Figs. 1, 2 and 3 when placed side by side disclose in schematic form one embodiment of this invention as applied to an automatic telephone system;

Fig. 4 is a view in perspective of part of the mechanism of Fig. 1 employed to analyze a spoken word into its discrete phonetic sounds to

produce mechanical movements defining the respective phonetic sounds;

Fig. 5 is a plan view of the resonance bars of Fig. 4 slotted in such a manner that their relative positions after actuation by the analyzed speech currents may define the individual phonetic sounds represented thereby;

Figs. 6 to 11, inclusive, represent the various stages in the operation of a sound test bar as controlled by the resonance bars in the mechanism of Fig. 1;

Figs. 12—A to 12—D, inclusive, illustrate in schematic form how a sound test bar defining a voiced stop sound may be prevented from operating when the sound set up in the resonance bars is of a different type;

Figs. 13—A to 13—D, inclusive, illustrate in schematic form how a sound test bar defining a voiced non-stop sound may be prevented from operating when the sound set up in the resonance bars is of a different type;

Figs. 14—A to 14—D, inclusive, illustrate in schematic form how a sound test bar defining an unvoiced stop sound may be prevented from operating when the sound set up in the resonance bars is of a different type;

Figs. 15—A to 15—D, inclusive, illustrate in schematic form how a sound test bar defining an unvoiced non-stop sound may be prevented from operating when the sound set up in the resonance bars is of a different type;

Fig. 16 illustrates in schematic form the slotted character of the six coding bars of Fig. 1 arranged so as to be selectively actuated by the sound test bar defining each phonetic sound registered at each instant on the resonance bars;

Fig. 17 illustrates the groups of storing bars of Fig. 2 on which the successive phonetic sounds are registered until the sounds of a complete key-word have been received;

Fig. 18 is a plan view of the groups of storing bars of Fig. 17;

Figs. 19, 20 and 21 are schematic views of part of the apparatus of Fig. 17 showing the operation of a word test bar to close an electrical contact representing the key-word registered on the associated storing bars;

Figs. 22 and 23 when placed side by side represent schematically another form of this invention as applied to a dialless automatic telephone system;

Fig. 24 is an enlarged view in perspective of parts of the resonance bars and sound test bars of Fig. 22; and

Figs. 25 to 30, inclusive, represent various stages in the operation of one of the sound test bars of Fig. 22 as determined by the settings of the associated resonance bars.

Before describing in detail the apparatus disclosed in the drawings it is desirable to list the minimum number of phonetic sounds which must be separately recognized by the voice operated apparatus in performing certain operations in response to the spoken message. For the purpose of this specification speech sounds are divided into four groups, namely, voiced stop sounds, voiced non-stop sounds, unvoiced stop sounds and unvoiced non-stop sounds.

The voice stop sounds of the first group are three in number and correspond to the three sounds which in the English language are designated by the letters B, D and hard G (get).

The voiced non-stop sounds of the second group comprise twenty-four sounds which may be divided into thirteen vowels, five semivowels, four

voiced fricatives and two transitionals. The thirteen vowel sounds are given below by key-words rather than by phonetic symbols, with the vowel sounds printed in bold face type:

be	fat	omit	about
fill	chaotic	tall	
sell	rude	father	
ask	pull	fur	

The five semivowels included in the second group are the consonants of the following words printed in bold face type:

name	lit	ring
------	-----	------

The four voiced fricatives are the portions of the following words printed in bold face type:

zeal	azure	vat	then
------	-------	-----	------

The two transitionals included in the second group are the w sound in wile and the y sound in you.

The third group, namely, the unvoiced stop sounds, comprises three sounds represented in the English language by the three letters P, T and K.

The fourth group, namely, the unvoiced non-stop sounds, comprises a total of six sounds including two unvoiced transitionals, the h sound in here, and the wh sound in what; and four unvoiced fricatives as indicated by the consonants in the following words printed in bold face type:

seal	ash	fat	thin
------	-----	-----	------

This makes a minimum total of thirty-six phonetic sounds which the voice operated mechanism must separately recognize if the character of the key-words is not to be unduly restricted. Certain common sounds have been omitted from this list since they are equivalent to combinations of sounds already given. Thus, the j sound in judge may be registered as two separate sounds, the d sound followed by the z sound in azure, and the ch sound in church may be registered as the t sound followed by the sh sound in she. Similarly, all the vowel diphthongs may be registered as a combination of two vowel sounds already listed. This sound list is for the sole purpose of illustration. In practice more or less sounds may be recognized as found desirable.

Referring to the form of the invention shown in Figs. 1 to 3, inclusive, which show in diagrammatic form so much of the apparatus of cooperating circuits as is necessary to understand the invention, 40 represents a subscriber's line extending to the terminals of a line finder 41, the brushes of which are caused to move into position to connect with said line by circuits that are controlled through the contacts of the line relay 42 which operates at the time that the subscriber removes his receiver from the hook. This line finder is connected to a link circuit which terminates at its other end in a selective switch 43 whose brushes are capable of movement over the terminals of a cooperating terminal bank to which trunk lines extending to other selective switches such as 44 are connected.

The line finder, through a suitable selection switch 45, which is set in motion to select the link circuit as soon as the latter is taken into use by a calling line, has access to an idle voice operated register sender comprising a number of band-pass filters F_1 to F_{10} , inclusive, connected to switch 45 by conductors 49 for receiving the speech currents from line 40 representing the telephone number of the called party as spoken into the transmitter at the calling station. In order to

compensate for variations in the volume of the received sounds so that the analyzed speech currents representing the called line will always be the equivalent of those produced by a person talking with substantially the same degree of loudness and to compensate for variations in the impedance of the calling subscriber's line the speech currents representing the called telephone number are impressed upon an amplifier 46 of the type called a vogad in the communication art as shown in detail, for example, in British Patent 381,831. That is, amplifier 46 has its gain automatically controlled by slow variations in the level of the received currents but with its gain unchanged by syllabic variations in the received volume whereby the output of amplifier 46 gives the speech current for each word at substantially the same level. In addition to the vogad 46, or as a substitute for it, an instantaneous speech control such as a compressor or expander may be found useful in some cases, the former to reduce the operating range needed for adequate speech analysis, the latter to reduce the effect of noise. A particular circuit for such a compressor is given in Crisson Patent 1,737,830 of December 3, 1929, and for the expander is given in the Mathes Patent 1,757,729 of May 6, 1930.

At this point in the circuit of Fig. 1 it is important to distinguish between currents representing voiced sounds and unvoiced sounds and, therefore, a portion of the output of vogad 46 by leads 47 is impressed upon a fundamental frequency discriminating circuit 48 of such a character that the output current from low-pass filter 50 will be substantially zero for all unvoiced sounds, but for voiced sounds will have an amplitude proportional to the pitch of the fundamental frequency. Hence, relay 51 which by leads 52 is connected to the output of filter 50 will be non-operated for unvoiced sounds but will be operated by all voiced sounds.

Therefore, for unvoiced sounds the output from the additional amplifier 53 because of the non-operation of relay 51 will be impressed directly upon ten band-pass filters F_1 to F_{10} , all connected in parallel to the output of amplifier 53. These band-pass filters collectively pass the frequency range of importance in speech, say from 0 to 7500 cycles, with filter F_1 passing the band from 0 to 225 cycles per second; filter F_2 passing the band from 225 to 450 cycles per second; filter F_3 passing the band from 450 to 700 cycles per second; filter F_4 passing the band from 700 to 1000 cycles per second; filter F_5 passing the band from 1000 to 1400 cycles per second; filters F_6 passing the band from 1400 to 2000 cycles per second; filter F_7 passing the band from 2000 to 2700 cycles per second; filter F_8 passing the band from 2700 to 3800 cycles per second; filter F_9 passing the band from 3800 to 5400 cycles per second; and filter F_{10} passing the band from 5400 to 7500 cycles per second. The output from each of the band-pass filters F_1 to F_{10} is rectified by one of the rectifiers R_1 to R_{10} and the rectified current from each subband is impressed upon one of the electromagnets S_1 to S_{10} of the solenoidal type. Therefore, each electromagnet S_1 to S_{10} attracts its armature with a force determined by the power level of that portion of the speech wave transmitted by its associated filter so that electromagnet S_1 attracts its armature with a pull determined by the power level in the frequency range from 0 to 225 cycles per second, electromagnet S_2 attracts its armature with a pull determined by the power level in the

frequency range from 225 to 450 cycles per second, etc.

The armature of each of the electromagnets S_1 to S_{10} is suitably coupled by a multiplying lever to one of the resonance bars C_1 to C_{10} shown more clearly in Fig. 4. Each resonance bar C_1 to C_{10} is biased by means of one of the springs 54 to a normal position whereby the left end of a slot 55 in each code bar lies against a stop pin 56. Hence each of the resonance bars C_1 to C_{10} by means of its associated electromagnet will be moved from its normal position an amount controlled at each instant by the power level in the speech frequency subband passed by the filter associated with the corresponding electromagnet. With the resonance bars actuated in this manner in accordance with the analyzed speech currents of any given phonetic sound, the said resonance bars are in such positions that when they are tested by a mechanism to be described later the resonance bars will permit the actuation of a sound test bar representing the analyzed phonetic sound but will not permit the actuation of a sound test bar representing a different phonetic sound.

The above description has traced the operation of the resonance bars C_1 to C_{10} in response to an unvoiced sound. Their operation for a voiced sound is quite similar except that for a voiced sound, relay 51 will be operated so that the output of amplifier 53 instead of being impressed directly upon the band-pass filters will be transmitted through an equalizer network 57 and another amplifier 58 before reaching the filters. Equalizer 57 is designed to correct the natural falling off of the upper harmonics with frequency in the case of sounds produced by the vocal cords and to make the amplitude of the fundamental and all its harmonics more nearly uniform as is the case with unvoiced sounds. The amount of equalization needed can be obtained from Fig. 2 of my above-mentioned U. S. Patent No. 2,194,298 from which it is apparent that the required equalization varies from a loss of 30 decibels at 100 cycles per second to zero at 3000 cycles per second; and that for frequencies above 3000 cycles per second a gain is needed for the equalizer instead of a loss. However, such a gain would lead to increasing the line noise by amplification, so, from 3000 cycles to the upper end of the speech band it is more desirable to have zero loss and such a condition may be assumed for the circuits of Fig. 1 herein. This equalization produced by network 57 makes each subband of the speech frequency range equally useful in determining what sound test bar representing a given phonetic sound may be operated as otherwise significant amounts of energy in certain of the upper subbands might be at such a small energy level compared to the fundamental that the resonance bar for such an upper subband might be left in normal position and cause a false operation. Equalizer 57, therefore, reduces the amplitude of the fundamental and the major harmonics to a level more nearly equal to the higher harmonics and then amplifier 58 is employed to raise the level of the fundamental and its harmonics to the level desired to secure the selective operation of the resonance bars.

It may be found helpful to insert an equalizer 60 after amplifier 53 to correct for the increasing amounts of energy in the upper subbands as compared with the lower subbands passed by filters F_1 to F_{10} due to the increasing width of

the passed subband as one proceeds from filter F_1 to filter F_{10} ; for example, filters F_1 and F_2 pass bands 225 cycles in width while filter F_{10} passes a band 2100 cycles wide. This correction produced by equalizer 60 may amount to a loss of 1 decibel per channel starting with the channel containing filter F_1 .

As additional aids in preventing false operation, applicant in the preferred embodiment of the invention employs a so-called voicing lock which must be operated before a sound test bar for a voiced sound may be actuated and also a stop consonant lock which must be operated before a sound test bar representing a stop consonant may be actuated. The voicing lock comprises an electromagnet 61 connected to the output of filter 50 and as previously described the output current of filter 50 is substantially zero for unvoiced sounds while its output is of substantial amplitude for all voiced sounds. Hence, electromagnet 61 will be energized only for voiced sounds.

Connected across the output of vogad 46 in parallel with channel 48 is another channel 62 leading to an electromagnet 63 constituting a part of the stop consonant lock. Channel 62 includes an amplifier 64 to isolate channel 62 from the other circuits connected across the output terminals of vogad 46. The output of amplifier 64 is rectified by rectifier 65 and is then impressed on the low-pass filter 66 which passes the band from 0 to 80 cycles per second to eliminate the fundamental frequency of any voiced sound; and the conductors between filter 66 and the input of low frequency amplifier 67 are shunted by a large inductance 68 with electromagnet 63 responsive to the output of amplifier 67. When a sudden change in the received energy level such as caused by a stop consonant sound is received by channel 62 a sudden pulse of energy goes through circuit 62 and builds up a potential across inductance 68 which being amplified by amplifier 67 will cause electromagnet 63 to operate. However, the sustained power level of a voiced sound will not produce sufficient potential across inductance 68 to cause the operation of electromagnet 63. The manner in which electromagnets 61 and 63 function in preventing false operation will be described later.

Referring now to Fig. 4 it will be seen that the resonance bars C_1 to C_{10} are mounted one above the other in a suitable manner to enable each resonance bar to move along a certain path when its associated electromagnet S_1 to S_{10} is energized each resonance bar being biased by a spring 54 to a normal position with the left end of slot 55 against stop pin 56 and with the maximum movement of any resonance bar determined by the length of slot 55.

These resonance bars C_1 to C_{10} and certain parts of the associated apparatus are somewhat similar to teletypewriter apparatus as disclosed in Lang et al. U. S. Patent 2,106,805 of February 1, 1938, or Morgan et al. U. S. Patent 1,745,633 of February 4, 1930, except that the code bars of a teletypewriter are fewer in number and occupy only two possible positions, an operate position and a non-operate position, while each resonance bar C_1 to C_{10} is designed to be advanced over a wide range of positions including not only its normal rest position and its maximum position but also any intermediate position. The arrangements of the slots in the resonance bars C_1 to C_{10} will be described later.

The apparatus of Figs. 1 to 3 begins to func-

tion for analyzing and registering the spoken message as soon as line finder 41 has established connection with the calling line to complete an obvious energizing circuit for the high impedance relay 59 connected across the conductors 49 leading to the voice operated register sender. The energization of relay 59 serves to connect ground to conductor 71 thereby energizing clutch magnet 70 to bring into contact the parts of clutch 72 whereby motor 73 is capable of rotating the drive shaft 74 at the desired speed. The consequent rotation of cam 75 forces lever 76 back and forth thereby causing the main bail plunger 77 to move up and down and cause the main bail 78 of Fig. 4 to execute a similar upward and downward movement. For a more detailed description of the operation of main bail 78 in testing the resonance bars C_1 to C_{10} reference may be had to my U. S. Patent No. 2,195,081 of March 26, 1940, on Sound printing mechanisms. Each upward movement of main bail 78 causes all sound test bars 80 to test the setting of the resonance bars C_1 to C_{10} , there being a sound test bar 80 for each phonetic sound to be registered although for simplification purposes only two sound test bars are completely shown in Fig. 4.

As shown in Fig. 4 each sound test bar 80 has a spring 81 which tends to move the sound test bar downwardly and rearwardly and hold the sound test bar in normal position as shown in Fig. 4 with the sound test bar pressed against the forward edge of the main bail 78 when the main bail is in its normal position. It will also be noted from Fig. 4 that with the sound test bars in normal position an intermediate portion 82 of each sound test bar lies in front of but spaced slightly from the slotted inner edges of the resonance bars C_1 to C_{10} .

Main bail 78 as previously described is continually being raised and lowered by plunger 77 after the energization of clutch magnet 70. As bail 78 starts to move upwardly as in Fig. 7 this upward movement due to cam surface 83 on each sound test bar enables springs 81 to move all sound test bars 80 rearwardly against the notched front edges of the resonance bars C_1 to C_{10} as shown in Fig. 7. It may be assumed that electromagnets S_1 to S_{10} have moved resonance bars C_1 to C_{10} to such positions as to permit one of the sound test bars 80 to drop into the slots (see Fig. 8) far enough to bring its rearwardly projecting lug 84 into the path of movement of the main bail 78. Upon the continued upward movement of main bail 78 its forward edge engages lug 84 of the selected sound test bar and moves the selected sound test bar upwardly (see Fig. 9) thereby causing the horizontal arm 85 of the selected sound test bar to enter slots in the lower edges of the six horizontally arranged coding bars SB_1 — SB_6 and cause the selective longitudinal movement of these six coding bars in a manner which will be described later. The latter part of the upward movement of the selected sound test bar 80 causes lug 84 to engage a stationary lug 87 which throws the selected sound test bar forwardly and out of the notches in the resonance bars as shown in Fig. 10 whereby the resonance bars may be reactuated for another alignment to provide for the later selection of another sound test bar. Spring 81 thereupon lowers the selected sound test bar to its normal position as shown in Fig. 11 in which the main bail 78 is shown as returned to its starting position.

Inasmuch as it is contemplated that the fre-

quency of movement of the main bail 78 may cause its next upward excursion before the resonance bars C_1 to C_{10} have been moved from the alignment which permitted the actuation of a sound test bar by its previous excursion, the preferred form of the invention provides a repetition lockout whereby after one sound test bar 80 has entered the slots in the resonance bars the said one sound test bar cannot reenter the slots until there has been a realignment of at least one of the resonance bars. Associated with each sound test bar 80 is an anti-repeat bar 88 pivoted on a stationary pin 90. The upper portion 91 of each anti-repeat bar 88 is biased towards the rear edges of the resonance bars due to a biasing spring 92. The rear edges of the resonance bars C_1 to C_{10} are also provided with shallow slots as will be described later so that when the resonance bars occupy positions to enable a selected sound test bar 80 to enter slots in the front edges of the resonance bars, all the resonance bars will have aligned slots in their rear edges to permit the entrance of the anti-repeat bar 88 associated with the particular sound test bar. However, as long as each sound test bar 80 is in its normal position as in Fig. 6 the associated anti-repeat bar 88 is prevented from entering any slots in the resonance bars since there is pivoted to the lower end of each sound test bar 80 a spring latch 93 engaging a hook 94 on the lower end of the anti-repeat bar 88.

As soon as any sound test bar 80 after entering the aligned slots in the front edges of the resonance bars has been pulled upwardly due to the main bail 78 engaging lug 84 (Fig. 9) the latch 93 is lifted free of hook 94, and spring 92 then causes the associated anti-repeat bar to enter the aligned slots in the rear edges of the resonance bars. Pivoted to the upper end of each anti-repeat bar 88 is an angular lever 95 biased by spring 96 to the position shown in Fig. 6 with its arm 97 extending towards but not contacting with the associated sound test bar 80 as long as the sound test bar and the anti-repeat bar are in their normal positions of Fig. 6. When the initial movement of the main bail 78 has permitted a sound test bar to enter the aligned slots in the resonance bars this rearward movement of such a sound test bar allows arm 97 to ride on the upper surface of lug 98 as shown in Fig. 8. When any sound test bar 80 is lifted upwardly (Figs. 9 and 10) lug 98 passes above arm 97 and since the associated anti-repeat bar 88 is now allowed to enter the aligned slots in the rear edges of the resonance bars the subsequent lowering of the sound test bar 80 after the selective actuation of the coding bars SB_1 to SB_6 as in Fig. 11 causes arm 97 to be caught by lug 98 as long as the anti-repeat bar 88 lies in the slots in the resonance bars. Arm 97, therefore, prevents the sound test bar 80 from entering the slots in the front edges of the resonance bars a second time as long as its associated anti-repeat bar 88 is lying in the aligned slots in the rear edges of the resonance bars. It will also be noted from Fig. 11 that with the sound test bar 80 retracted after the selective setting of coding bars SB_1 to SB_6 and with the associated anti-repeat bar 88 lying in the slots in the resonance bars, the spring latch 93 rests upon the tip of hook 94.

However, as soon as any one of the resonance bars C_1 to C_{10} is moved to a new position by the energization or deenergization of one of the electromagnets S_1 to S_{10} , such a movement of

a resonance bar will force the anti-repeat bar 88 rearwardly out of the slots in the resonance bars, thereby freeing arm 97 from lug 98 and moving the lower hooked end of the anti-repeat bar 88 inwardly to enable latch 93 to engage hook 94 to thereafter hold the anti-repeat bar out of engagement with the resonance bars until after the cycle of operation is begun again, involving the selection of the sound test bar 80 illustrated in Figs. 6 to 11. That is, the apparatus of Fig. 11 will be restored to their normal positions of Fig. 6 as soon as one of the resonance bars C₁ to C₁₀ has been moved to force the anti-repeat bar out of the slots in the resonance bars.

Applicant's preferred embodiment also includes means for preventing the possibility of a false setting of coding bars SB₁ to SB₆ by dividing the possible speech sounds into groups and at any one time preventing the operation of all sound test bars except those representing the sounds of one group. Thus the mechanism may be arranged to determine whether or not a particular setting of the resonance bars is due to a voiced or an unvoiced sound and if it is due to a voiced sound to automatically lock all sound test bars representing unvoiced sounds.

In the earlier part of this specification the speech sounds were divided into four groups, namely, voiced or unvoiced stops sounds and voiced or unvoiced non-stop sounds. The apparatus of Figs. 1 to 21, inclusive, include means for distinguishing each group from the other three groups and for unlocking the sound test bars for the particular group to which each sound belongs.

Each sound test bar 80 for the twenty-four voiced non-stop sounds previously listed may be of the type disclosed in Figs. 6 to 11 with an upper extension 100 carrying two spaced lugs 101 and 102. The armature of electromagnet 61 (Fig. 1) has a laterally extending arm 103 (Fig. 6) which is adjacent to and aligned with the lugs 101 of all sound test bars for the voiced sounds when the pull bars are in normal position and when electromagnet 61 is deenergized. It, therefore, follows that no sound test bar representing a voiced sound can be actuated by the main ball as long as electromagnet 61 is deenergized since as is apparent from Fig. 6 arm 103 will prevent any sound test bar for a voiced sound from testing the resonance bars. However, when a voiced sound is spoken into microphone 33 and is received by the band-pass filters and while the resonance bars in response to that sound are being set by electromagnets S₁ to S₁₀, electromagnet 61 will also be energized to raise arm 103 to a higher level (Figs. 7 to 11) out of the path of lug 101 when the movement of main ball 73 permits springs 81 to pull all of the sound test bars inwardly to test the resonance bars. The type of control exercised by electromagnet 63 is similar to electromagnet 61 except that as long as electromagnet 63 is deenergized no sound test bar corresponding to a stop sound can engage the resonance bars.

In explaining the type of control exercised by electromagnets 61 and 63 by reference to Figs. 12 to 15, inclusive, it should be noted from Fig. 1 that electromagnet 61 will be operated by all voiced sounds whether non-stop or stop sounds and will remain unoperated for all unvoiced sounds; and that electromagnet 63 will be operated by all stop sounds whether voiced or unvoiced and will remain unoperated for all non-stop sounds.

The upper portion of a sound test bar for one of the twenty-four voiced non-stop sounds is shown in Figs. 13—A to 13—D where the sound test bar has a lug 101 opposite arm 103 for the non-operated position of the armature of the voicing lock electromagnet 61 and has a lug 102 opposite the operated position of the corresponding laterally extending arm 104 connected to the armature of the stop consonant lock electromagnet 63. In Fig. 13—A both electromagnets 61 and 63 are non-operated with arm 103 lying in the path of lug 101 to prevent any selective operation by any sound test bar for a voiced non-stop sound. In Fig. 13—B the arm 104 of the stop consonant lock is in normal position but arm 103 of the voiced lock is in its operated position out of the path of lug 101 so that the condition of the controls shown in Fig. 13—B will permit the actuation of a sound test bar defining any desired voiced non-stop sound. In Fig. 13—C the voiced lock arm 103 is normal and the stop consonant lock arm 104 is in its operated position from which it is obvious that the sound test bar will not be permitted to engage the resonance bars. In Fig. 13—D the voiced lock arm 103 is in its operated position and the stop consonant lock arm 104 is in its operated condition from which it is obvious that the sound test bar cannot engage the resonance bars due to the fact that arm 104 lies in the path of lug 102. Therefore, as shown in Fig. 13—B the biasing arm 103 must be in its operated position and the stop consonant lock arm 104 must be in its normal position in order to secure the operation of any sound test bar defining one of the twenty-four voiced non-stop sounds.

The three sound test bars representing the three voiced stop sounds may have their upper extensions of the type shown, in Figs. 12—A to 12—D where the upper portion 105 of the sound test bar has a lug 106 opposite the normal position of the voiced lock arm 103 and has a lug 107 opposite the normal position of the stop consonant lock arm 104. An examination of Figs. 12—A to 12—D will show that a sound test bar defining one of the voiced stop consonants will engage the resonance bars C₁ to C₁₀, only when both arms 103 and 104 are in their operated positions as shown in Fig. 12—D. When arms 103 and 104 are in their normal positions as shown in Fig. 12—A, such a sound test bar cannot engage the resonance bars because arm 103 lies in the path of lug 106 and arm 104 lies in the path of lug 107. When arm 103 is in its operated position and arm 104 is in its normal position it is apparent from Fig. 12—B that such a sound test bar cannot engage the resonance bars since arm 104 lies in the path of lug 107. When arm 103 is in its normal position and arm 104 is in its operated position it is apparent from Fig. 12—C that such a sound test bar cannot engage the resonance bars since arm 103 lies in the path of lug 106.

The upper portion of a sound test bar for one of the three unvoiced stop consonant sounds may be of the type shown in Figs. 14—A to 14—D where the upper extension 110 of the sound test bar has a lug 111 opposite the operated position of arm 103 and a lug 112 opposite the normal position of arm 104. It will be apparent that a sound test bar representing one of the unvoiced stop sounds will be permitted to engage the resonance bars C₁ to C₁₀ when the voiced lock arm 103 is normal and when the stop consonant lock arm 104 is in its operated position.

as shown in Fig. 14—C. When both arms 103 and 104 are in their normal positions it will be apparent from Fig. 14—A that the illustrated sound test bar will not be permitted to engage the resonance bars since arm 104 lies in the path of lug 112. When arm 103 is in its operated position and arm 104 is in its normal position it will be apparent from Fig. 14—B that the illustrated sound test bar will not be permitted to engage the resonance bars since arm 103 lies in the path of lug 111 and arm 104 lies in the path of lug 112. When arms 103 and 104 are both in their operated positions it will be apparent from Fig. 14—D that the illustrated sound test bar will not be permitted to engage the resonance bars since arm 103 lies in the path of lug 111.

The sound test bars for the six unvoiced non-stop sounds may each have an upper extension 113 as shown in Figs. 15—A to 15—D, the said extension 113 having a lug 114 opposite the operated position of arm 103 and a lug 115 opposite the operated position of arm 104. It will be apparent from Fig. 15—A that the illustrated sound test bar for an unvoiced non-stop sound will be permitted to engage the resonance bars C_1 to C_{10} when both arms 103 and 104 are in their normal positions where they lie out of the path of lugs 114 and 115. When the arm 103 is in its operated position and arm 104 is in its normal position it will be apparent from Fig. 15—B that the illustrated sound test bar will not be permitted to engage the resonance bars since arm 103 lies in the path of lug 114. When arm 103 is in its normal position and arm 104 is in its operated position it will be apparent from Fig. 15—C that the illustrated sound test bar will not be permitted to engage the resonance bars since arm 104 lies in the path of lug 115. When arms 103 and 104 are both in their operated positions it will be apparent from Fig. 15—D that the illustrated sound test bar will not be permitted to engage the resonance bars since arm 103 lies in the path of lug 114 and arm 104 lies in the path of lug 115.

As a summary of the above description it will be apparent that a sound test bar representing a voiced stop sound will be permitted to engage the resonance bars C_1 to C_{10} only when both electromagnets 61 and 63 are energized (Fig. 12—D); that a sound test bar representing a voiced non-stop sound will be permitted to engage the resonance bars only when electromagnet 61 is energized and electromagnet 63 deenergized (Fig. 13—B); that a sound test bar representing an unvoiced stop sound will be permitted to engage the resonance bars only when the electromagnet 61 is deenergized and electromagnet 63 energized (Fig. 14—C); and that a sound test bar representing an unvoiced non-stop sound will be permitted to engage the resonance bars only when both electromagnets 61 and 63 are deenergized (Fig. 15—A).

Various methods may be employed in determining the positions of the slots in resonance bars C_1 to C_{10} in order that for a particular sound the resonance bars will be moved to align their slots for that sound to permit the entrance therein of the sound test bar indicating that sound. Possibly the most direct way to obtain this information is to determine the average energy level in each subband for each phonetic sound by connecting a recording oscillograph to the output of each of the rectifiers R_1 to R_{10} of Fig. 1 so as to measure the output current through

each rectifier for each phonetic sound spoken into the microphone 39, it being understood that for the measurement of voiced sounds equalizer 57 is included in the circuit to make all harmonics of the fundamental frequency of substantially the same amplitude as the fundamental. With the said equalizer 57 effective for voiced but not unvoiced sounds the energy distribution with frequency of thirty-two of the thirty-six sounds above listed are given in the curves of Figs. 3 to 31 of my U. S. Patent 2,194,298, wherein for each curve the loss in decibels is plotted against the frequency. By dividing each of these curves into frequency subbands indicated on filters F_1 to F_{10} of Fig. 1 and integrating the portion of each curve representing each subband the relative amplitude of the output from each rectifier R_1 to R_{10} for each phonetic sound may be readily ascertained. It may be further assumed that electromagnets S_1 to S_{10} are similar, with springs 54 similar, and that the attractive force exerted by each of these electromagnets on its armature is a linear function of the amplitude of the current received from the associated rectifier. Hence it may be assumed for the apparatus of Fig. 1 that the movement of each resonance bar C_1 to C_{10} from its normal position will be a linear function of the amplitude of the output current of its associated rectifier R_1 to R_{10} . However, any other arrangement found desirable may be used. For instance, the displacements may be made on a logarithmic basis instead of a linear one. This would be accomplished by a proper design of the magnetic parts of the electromagnets S_1 to S_{10} .

For illustrative purposes the resonance bars C_1 to C_{10} in Fig. 5 instead of being stacked one upon the other are all shown lying in a common plane so that the relative positions of their slots for certain sounds may be readily ascertained. Only a small portion of each resonance bar is shown in Fig. 5 and although it is assumed that the apparatus of Fig. 4 includes thirty-six sound test bars the disclosure in Fig. 5 includes only nine sound test bars since it is believed that these nine sound test bars will be sufficiently illustrative of the manner of operation of the resonance bars for all of the thirty-six sound test bars contemplated by this invention. In Fig. 5 sound test bar 30t and associated anti-repeat bar 30r are adapted to enter the resonance bars for the sound t; the sound test bar 30e and associated anti-repeat bar 30r are adapted to enter the resonance bars for the e sound in sell; the sound test bar 30s and associated anti-repeat bar 30s are adapted to enter the resonance bars for the s sound in seal; the sound test bar 30v and associated anti-repeat bar 30v are adapted to enter the slots in the resonance bars for the u sound in rude; the sound test bar 30u and the associated anti-repeat bar 30u are adapted to enter the slots in the resonance bars when the resonance bars have been actuated by the u sound in pull; sound test bar 30a and the associated anti-repeat bar 30a are adapted to enter the slots in the resonance bars when the resonance bars are set in response to the a sound in about; the sound test bar 30o and the associated anti-repeat bar 30o are adapted to enter slots in the resonance bars when the resonance bars are set in response to the o sound in omit; the sound test bar 30w and the associated anti-repeat bar 30w are adapted to enter slots in the resonance bars when the resonance bars are set in response to the w sound in wile; and the sound

test bar 80N and associated anti-repeat bar 88N are adapted to enter slots in the resonance bars when the resonance bars are set in response to the n sound in name. In Fig. 5 all of the resonance bars C₁ to C₁₀ are assumed to be in their normal positions with each bar being moved to the left as viewed in Fig. 5 by its associated electromagnet in accordance with the amplitude of the current from each rectifier R₁ to R₁₀ for each phonetic sound. The slots in resonance bars C₁ to C₁₀ which must be aligned by the proper movement of each resonance bar before sound test bar 80T can enter the resonance bars are designated T₁ to T₁₀, inclusive, and the corresponding slots for the associated anti-repeat bar 88T are designated T'₁ to T'₁₀; the slots in the resonance bars which must be aligned for the entrance of sound test bar 80E and the anti-repeat bar 88E are designated respectively E₁ to E₁₀ and E'₁ to E'₁₀. The corresponding slots in the resonance bars for the other sound test bars and anti-repeat bars should be apparent upon inspection.

An examination of the appropriate curves of Figs. 3 to 31 of my above-mentioned U. S. Patent No. 2,194,298, when integrated over each subband for the nine sounds whose sound test bars are shown on Fig. 5 will show that the relative energy values for the various subbands are such that the ten resonance bars in response to these nine sounds will be moved distances proportional to the values given in the following table if we arbitrarily assign the value of 16 units of distance as the maximum distance any resonance bar will be moved for any subband of the designated nine sounds.

Resonance bars

Analyzed sound	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	C ₇	C ₈	C ₉	C ₁₀
t sound in ten.....	0	0	0	0	0	0	0	8	14	3
e sound in sell.....	0	1	1	1	0	4	1	1	1	1
s sound in seal.....	0	0	0	0	0	0	1	3	4	16
u sound in rude.....	3	6	4	2	1	1	3	2	5	5
u sound in pull.....	1	6	8	4	2	1	2	5	5	5
a sound in about.....	1	4	9	7	3	1	3	4	3	4
o sound in omit.....	1	5	6	4	2	1	3	4	3	4
w sound in wile.....	1	2	1	1	1	0	1	5	5	4
n sound in name.....	3	2	0	0	0	0	0	1	0	0

It should be obvious how the values given in the above table can be utilized in the proper location of the various slots in the resonance bars C₁ to C₁₀. Thus, we may assume that when the resonance bars are actuated in response to the sound of t in ten, resonance bar C₈ will be moved $\frac{8}{16}$ of an inch, resonance bar C₉ will be moved $\frac{14}{16}$ of an inch, resonance bar C₁₀ will be moved $\frac{3}{16}$ of an inch, while there will be no appreciable movement in resonance bars C₁ to C₇, inclusive; and hence slots T₁ to T₁₀ for sound test bar 80T and slots T'₁ to T'₁₀ for anti-repeat bar 88T should be so located that they will be aligned when the code bars are moved the distances just specified. A similar observation applies to the other slots illustrated as well as those defining the remainder of the phonetic sounds to be analyzed by the apparatus of Fig. 1.

A few comments may be noted as to the general character of the slots in the resonance bars for receiving the sound test bars and the anti-repeat bars. The width of each sound test bar slot with respect to the width of a sound test bar will be determined by how much tolerance should be allowed for possible variations in the movement of any resonance bar in response to the same phonetic sound. In Fig. 5 it may be

assumed that the mouth of each sound test bar slot is about twice the width of each sound test bar. Each sound test bar slot should have fairly steep side walls. However, for the anti-repeat bars the slot should be relatively shallow with gradually sloping side walls in order to reduce the force required to move one of the anti-repeat bars out of the slots for each new alignment of the resonance bars. In locating the ten slots in the resonance bars for each of the thirty-six phonetic sounds suitable precautions must be taken in their location along the resonance bars whereby when the ten slots for any one sound are aligned, no corresponding alignment will occur for the ten slots for any other sound test bar. This should not present any difficulty as is brought out by the consideration of the phonetic nature of speech and the large number of possible selections available. If we assume we can get ten recognizable steps in energy level in each of the ten frequency bands then we have a total of ten billion recognizable phonetic elements as against only thirty-six needed. Furthermore the nature of speech is such that these thirty-six sounds differ from one another as much as possible. The steps provided in the present embodiment provide for a far greater selection than is needed. This excess may be used advantageously in several ways. Some sounds are spoken a little differently from section to section of the country and by people differing in age, sex and culture. Variations of this nature can be allowed for so that all possible selections are available. Again for certain sounds it may be desirable to have several forms recognized, making the total more than thirty-six but having two or more sound test bars represent the same sound. For example, various pronunciations of r might be thus provided for. With such a large number of selections available further modifications of the mechanism may be made to stress the differences between sounds which are commonly misunderstood such as f and th.

A large amount of the extra selectivity available over what is needed can be taken up in designing for smoother operation of the sound test bars in testing the resonance bars. As the sound test bars come in to test, either all will fail to enter or all but one will fail to enter. The sound test bars that fail to enter will be stopped by having some part of the sound test bar strike a single resonance bar, the first resonance bar encountered by the sound test bar. The sound test bar that enters the resonance bars goes all the way in until stopped by the stationary cam 87 as in Fig. 8 so that it does not contact with any resonance bar. The rejected sound test bars in contacting the resonance bars will offer some resistance to the motion of the resonance bars. This will not be serious, however, because of the fewness of these contacts, because each contact period is of short duration, and finally because the resonance bars are moving at slow syllabic rates so that the amount of travel is small during the normal contacting period. Further consideration should be given to the mechanical design of the sound test bars and the resonance bars to insure smooth operation. In the first place, the sound test bars may be permitted to bounce back slightly after contact with the resonance bars. In the second place, a slight amount of bending in a rejected sound test bar may be permitted when the sound test bar contacts with the resonance bars.

Channel 48 of Fig. 1 will now be briefly explained, whereby there is an appreciable output current from filter 50 only when a voiced sound is received by channel 48. Band-pass filter 120 selects the band from 50 cycles to 500 cycles per second of the speech currents so as to be sure to include the second harmonic of the fundamental frequency for any voiced sound of low pitch, and the fundamental frequency of any voiced sound of high pitch. The output from filter 120 is fed to a frequency meter 122 which may be similar to that described in U. S. Patent 2,183,248 to R. R. Riesz Dec. 12, 1939. The fundamental frequency may be any fundamental frequency of speech say between 50 cycles and 500 cycles per second. As described in the Riesz patent the output of the frequency meter 122 comprises a number of pulses of substantially uniform size, there being one such pulse for each cycle of fundamental frequency, which varies at a syllabic frequency rate. The output from frequency meter 122 is then sent through the low-pass filter 50 cutting off at 20 cycles per second so that the original frequency components are eliminated and only the syllabic changing current preserved. It should be pointed out that unvoiced sounds have insufficient power in the 50-500 cycle band to operate the frequency meter.

There remains to be discussed the frequency of operation of the main bail 78. Tests have indicated that a moderate rate of talking will give about 400 phonetic sounds per minute, which means the operation of sound test bars 80 at the rate of about 400 per minute. This compares favorably with teletypewriter operation where a speed as high as 600 characters per minute has been obtained in page printing and about twice this rate for tape printing. The apparatus of Fig. 1 and Fig. 4 is set up to test the resonance bars at fixed intervals of time and these time intervals should be short enough that the shortest speech sound will be examined and registered. Tests have indicated that the fastest talker speaking intelligibly cannot say more than 1500 sounds a minute. If we assume that the sound test bars should be operated, say twice per sound at this high speed with corresponding increased testing at lower speeds, then the main bail 78 should be operated at the rate of about 3000 operations per minute.

While the apparatus of Fig. 1 has been provided with special auxiliary devices such as an anti-repeat bar 88, a voicing lock electromagnet 61, and a stop consonant lock electromagnet 63, it is to be understood that one or all of these devices may be omitted if desired. While applicant has preferred to divide the frequency band into ten subbands of frequency ranges indicated by filters F_1 to F_{10} it is to be understood that the frequency range of importance in speech may be divided into a greater or a smaller number of channels with substantial modifications of the band transmitted through each channel over the frequencies designated in Fig. 1. For example, in the case of receiving a message over a typical telephone line passing from 250 to 3000 cycles per second, the lowest frequency band and the three highest frequency bands in which the speech range is divided by the band-pass filters of Fig. 1 would contain essentially no energy so that these bands could be omitted and for such use it would be desirable to still divide the speech range from 250 to 3000 cycles per second into

ten subbands differing substantially from those illustrated in the circuit of Fig. 1.

It has now been described how each phonetic sound analyzed by the filters F_1 to F_{10} causes the upward movement of a sound test bar 80 individual to the analyzed sound. The next step to be described is the manner in which the coding bars SB_1 to SB_6 are selectively actuated by the sound test bars 80 to cause the various phonetic sounds making up a key-word to be registered in the apparatus of Fig. 2.

Suitably mounted edgewise and immediately above the horizontal arms 85 of all of the sound test bars 80 are six elongated coding bars SB_1 to SB_6 . Portions of these six coding bars are shown in plan view in Fig. 16 where they are biased against stops (not shown) by means of biasing springs 122 but are adapted to be moved longitudinally to the left as viewed in that figure. Any coding bar which is moved from its normal position by a selected sound test bar 80 serves to close one of the associated pairs of electrical contacts 131 to 136 (Fig. 1) in an obvious manner. The lower edge of each coding bar immediately above the horizontal arm 85 of each sound test bar 80 is slotted whereby the lifting of any sound test bar 80 by the main bail 78 causes the lifted sound test bar to enter a slot in each coding bar. Some of the coding bar slots, such as slot 123, are so shaped that the entrance of a sound test bar arm 85 into the slot will produce no lateral movement of the coding bar. Other coding bar slots, such as slot 124, may have a sloping side wall 125 so positioned that the upward movement of the associated sound test bar arm 85 will cause a lateral movement to the left of any coding bar containing such a slot. The distribution of the two kinds of slots 123 and 124 is arbitrarily chosen in such a manner that each significant phonetic sound represented by a sound test bar 80 results in an actuated or non-actuated condition of the six coding bars SB_1 to SB_6 that is individual to and defines the particular phonetic sound. Thus it will be apparent that the arrangement of the two kinds of slots in the sound bars as shown in Fig. 16 is such that when sound test bar 80_t (Fig. 5) is elevated, coding bar SB_1 will be actuated to close its contact 131 but coding bars SB_2 to SB_6 will remain unactuated so that only contact 131 will be closed in response to the t sound in ten. As another example, it will be noted that when the sound test bar for the e sound in sell is elevated, the coding bar SB_5 will be actuated to close contact 135 but the remaining coding bars will be unactuated. The other sound test bars disclosed in Fig. 16 result in distinctive combinations of the actuated or non-actuated condition of the coding bars as will be apparent from the drawings. It, therefore, results that for the actuation of a given sound test bar 80 there results a different combination of actuated or non-actuated condition of the six coding bars and a different combination of the closed or open condition of the six pairs of electrical contacts 131 to 136. These combinations may, of course, be arbitrarily chosen so long as the receipt of each significant phonetic sound is defined by a different combination of the open or closed conditions of contacts 131 to 136. It will be obvious that after the six coding bars have been selectively actuated by a given sound test bar, the withdrawal of the said sound test bar will permit any actuated coding bar to be restored to normal by its biasing spring 122 ready for selective actuation by the next sound test

bar elevated in response to the next setting of the resonance bars C₁ to C₁₀.

Conductors from the six pairs of contacts 131 to 136 lead to contacts 137 to 142 of the six rotary distributors D₁ to D₆. These distributors have contact brushes 157 to 162 mounted on a common shaft 143 which, due to spring 144, is normally biased with cam 145 against stop 146. As soon as conductor 71 is grounded over the operated contacts of relay 59, this ground in addition to causing the engagement of clutch 72 also provides an energizing circuit for relay 240 which in operating opens the energizing circuit for relay 241, and its left contact in releasing serves to break the energizing circuit for electromagnets 207 and 209 thereby allowing stepping pawl 208 and holding pawl 210 to engage ratchet wheel 211 to prepare shaft 143 for its step-by-step movement by electromagnet 148. As soon as the first selected sound test bar 80 starts its upward path the bottom end of the selected sound test bar releases the lower spring member of the associated spring contacts 147 thereby establishing an obvious energizing circuit for the stepping magnet 148 to cause shaft 143 to be moved one step in a clockwise direction to move each of the brushes 157 to 162 from a neutral segment to a segment marked 1 in Fig. 1.

It will be noted that segments 1 of distributors D₁ to D₆ are connected respectively to the windings of electromagnets 163 to 168 of Fig. 2; segments 2 of the distributors D₁ to D₆ are connected respectively to electromagnets 169 to 174; segments 3 of distributors D₁ to D₆ are connected respectively to electromagnets 175 to 180; segments 4 of distributors D₁ to D₆ are connected respectively to electromagnets 181 to 186; and segments 5 of distributors D₁ to D₆ are connected respectively to electromagnets 187 to 192. The number of live segments on each distributor depends upon the maximum number of phonetic sounds needed to recognize or identify any spoken key-word. In the present embodiment as applied to telephone dialing it is assumed that no key-word will be employed which contains more than five phonetic sounds.

In view of the above description it follows that the initial upward movement of the first selected sound test bar 80 causes segments 1 of distributors D₁ to D₆ to be connected respectively to the windings of electromagnets 163 to 168 so that when the selected sound test bar enters the slots in the coding bars SB₁ to SB₆ any actuated coding bar will cause its associated contact of the group 131 to 136 to establish through one of the distributors a suitable energizing circuit for the associated one of the electromagnets 163 to 168. Thus if the first selected sound test bar 80 represents the t sound it will be apparent from Fig. 16 that only coding bar SB₁ is actuated thereby and hence only electromagnet 163 of group I is energized. Therefore, when electromagnet 163 is energized and electromagnets 164 to 168 are non-energized, the electromagnets of group I are in a condition which defines the t sound but no other phonetic sound.

As soon as this first assumed selected sound test bar 80 is lowered the coding bars SB₁ to SB₆ assume their neutral positions with all contacts 131 to 136 open ready for selective actuation by another sound test bar. When the second selected sound test bar is raised its associated contact 147 causes stepping magnet 148 to remove the distributor brushes to the contacts marked 2, thereby connecting the coding bar contacts 131

to 136 respectively to the windings of electromagnets 169 to 174 of the second group, so that any coding bar actuated by this second selected sound test bar will cause the energization of its corresponding electromagnet in group II. Hence the energized or deenergized condition of the electromagnets of group II gives a registration individual to the phonetic sound indicated by the second selected sound test bar. If it is assumed that the key-word being analyzed comprises five significant phonetic sounds it will be obvious that the sound test bar representing the third phonetic sound of the key-word will cause distributor segments 3, to be connected to the electromagnets of group III whereby the energized or non-energized condition of electromagnets 175 to 180 will define the third phonetic sound; that the sound test bar representing the fourth phonetic sound of the key-word will cause the coding bar contacts 131 to 136 to be connected through distributor segments 4 to the electromagnets 181 to 186 of group IV whereby the energized or deenergized condition of the electromagnets of group IV will indicate the fourth phonetic sound of the key-word; and that the actuation of the sound test bar representing the fifth phonetic sound will cause the coding bar contacts 131 to 136 to be connected through distributor segments 5 to the electromagnets 187 to 192 of group V whereby the energized or deenergized condition of the electromagnets of group V will define the fifth phonetic sound of the key-word.

The armatures of electromagnets 163 to 192 are connected respectively to the longitudinally movable storing bars 163' to 192' as shown in Figs. 17 and 18. These storing bars are arranged in a vertical pile-up each being adapted for longitudinal movement and each biased to a neutral position by one of the springs 193, the neutral position of each storing bar being determined by stationary pins 196, 197 contacting with the left ends of slots 194, 195 (Fig. 17). It, therefore, follows from the previous description that the selective actuation or non-actuation of storing bars 163' to 168' will represent and define the first phonetic sound of a spoken key-word; and the selective actuation or non-actuation of storing bars 169' to 174' will define the second phonetic sound of the key-word. If the spoken key-word being analyzed contains five significant phonetic sounds it will be obvious that the actuation or non-actuation of storing bars 175' to 180' will define the third phonetic sound of the key-word; that the actuation or non-actuation of storing bars 181' to 186' will define the fourth phonetic sound of the key-word; and that the actuation or non-actuation of the storing bars 187' to 192' will define the fifth phonetic sound of the key-word. Each actuated storing bar of the series 163' to 192' will be temporarily locked in its actuated position by reason of the fact that the movement of any storing bar will bring its slot 204 in position to be entered by a spring biased hook 205 mounted on a latching member 206.

Each of the storing bars 163' to 192' is so slotted (Fig. 18) that as soon as all of the significant phonetic sounds of a key-word are registered on these storing bars all of these thirty storing bars 163' to 192' will have slots aligned to receive a word test bar defining the registered key-word. In Figs. 17 and 18 only ten word test bars W₀ to W₉ are disclosed but it is to be understood that applicant's apparatus will have a similar word test bar for each significant key-word to which

the apparatus is intended to respond. These word test bars W_0 to W_9 are adapted to periodically test the storing bars 163' to 192' much in the same manner as the resonance bars C_1 to C_{10} are tested by the sound test bars 80 of Fig. 4, due to the periodic operation of the main bail 201 which is operated in the same manner as main bail 78 of Fig. 4. It will be apparent that when ground is connected to conductor 71 to energize relay 70 and cause the engagement of clutch 72 to start the periodic excursions of main bail 78, the same ground also establishes an energizing circuit for relay 213 to engage clutch 214 and cause main bail 201 connected to plunger 215 to start its periodic testing of the storing bars 163' to 192'.

Main bail 201 in the first part of its upward movement permits a word test bar such as W_0 under the action of a spring 216 (Fig. 19) to be moved towards the storing bars, the movement taking place about a stationary pivot 218 for these word test bars. This movement will change the position of the word test bar W_0 from its position of Fig. 19 to the position of Fig. 20 where the word test bar tests the slot alignment of the storing bars 163' to 192'. If no slot alignment is found as in Fig. 20 the main bail in the remainder of its upward excursion does not contact with shoulder 217 and hence the word test bar W_0 is not elevated to close the associated set of electrical contacts P_0 ; if a slot alignment is found as in Fig. 21 word test bar W_0 will enter the slots to place shoulder 217 in the path of main bail 201 whereby bar W_0 is elevated to close contacts P_0 . The manner in which the word test bar and the main bail are restored to normal is the same as that previously described in detail for the apparatus in Fig. 4 and need not be repeated here.

Whenever the main bail 201 in its upward excursion finds that one of the word test bars W_0 to W_9 has entered aligned slots in storing bars 163' to 192' the selected word test bar is lifted by the main bail whereby the upper end of the lifted word test bar will close a contact individual to that word test bar. In Fig. 17 it is assumed that the ten word test bars W_0 to W_9 define respectively the spoken numerals 0 to 9 and one way in which the storing bars 163' to 192' may be slotted to selectively receive word test bars W_0 to W_9 is shown in detail in Fig. 18. Mounted directly above the word test bars are ten pairs of normally open electrical contacts P_0 to P_9 , each pair being individual to one of the disclosed word test bars whereby, for example, the contacts P_5 will be closed only in response to the spoken key-word "five"; the contacts P_7 will be closed only in response to the spoken key-word "seven"; and the contacts P_2 closed only in response to the spoken key-word "two."

As soon as one of the word test bars W_0 to W_9 has been selectively actuated by the settings of the storing bars 163' to 192' it is obvious that the apparatus of Figs. 1 and 2 must be reset to receive the next key-word. The lifting of the first selected word test bar from the group W_0 to W_9 by the bail 201 causes, in an obvious manner, the closure of a pair of contacts 202 (Fig. 17) associated with the selected word test bar, which contacts are kept open until the associated word test bar is lifted. All ten pairs of contacts 202 disclosed in Fig. 2 are connected in parallel whereby the closure of any one pair of these contacts by the elevation of a selected word test bar closes an obvious energizing circuit for electromagnet 203 to release the latching member

206 (Fig. 2) and free any actuated storing bar notch 204 from the restraining action of a hook 205 so that all actuated storing bars of the series 163' to 192' may return to normal under the action of restoring springs 193. Also as shown in Figs. 1 and 2 the closure of any pair of the series of contacts 202 by means of the closed right-hand contact of relay 241 serves to energize electromagnets 207 and 209 to release pawl 208 and catch 210 from ratchet wheel 211, thereby enabling restoring spring 144 to reset distributor brushes 157 to 162 on their neutral contacts. With brushes 157 to 162 on their neutral contacts as disclosed in Fig. 1 and with all storing bars 163' to 192' in their normal positions the said distributors and the said storing bars are thereby conditioned to receive the next spoken key-word received over telephone line 40 since magnets 207 and 209 are deenergized upon the return of each selected word test bar.

In the cuttings of the storing bars 163' to 192' shown in Fig. 18 it is assumed that the spoken numeral 0 may be represented phonetically by the o sound in omit followed by the u sound in pull; that the spoken word "one" may be represented phonetically by the w sound in wile followed by the a sound in about and the n sound in name; that the word "two" may be represented phonetically by the t sound in ten followed by the u sound in rude; that the spoken word "three" may be represented phonetically by the th sound in thin followed by the r sound in red and the e sound in be; that the spoken word "four" may be represented phonetically by the f sound in fat followed by the o sound in omit and the a sound in about and the r sound in ring; that the spoken word "five" may be represented phonetically by the f sound in fat followed by the a sound in father followed by the i sound in fill and the v sound in vat; that the spoken word "six" may be represented phonetically by the s sound in seal followed by the i sound in fill, the k sound in king, and the s sound in seal; that the spoken word "seven" may be represented phonetically by the s sound in seal followed by the e sound in sell, the v sound in vat, the a sound in about and the n sound in name; that the spoken word "eight" may be represented phonetically by the e sound in sell followed by the i sound in fill followed by the t sound in ten; and that the spoken word "nine" may be represented phonetically by the n sound in name followed by the a sound in father, the i sound in fill and the n sound in name.

From the descriptive matter appearing on Fig. 18 it will be apparent that for the first phonetic sound of the spoken numeral 0, coding bars SB_1 and SB_2 should be actuated by the sound test bar 80₀ to energize relays 163 and 164 to move storing bars 163' and 164' to the left to bring in alignment the slots in bars 163' to 168' that represent the said sound; and that for the second and final phonetic sound of the spoken numeral 0, coding bars SB_3 , SB_4 and SB_5 should be actuated by the sound test bar 80₀ to energize relays 171, 172 and 173 to move storing bars 171', 172' and 173' to the left to bring into alignment the slots of storing bars 169' to 174' that represent said second sound. Since the slots in code bars 175' to 192' opposite the word bar W_0 are in alignment when these storing bars are in their neutral positions, it follows that the above-described actuation of storing bars 163', 164', 171', 172' and 173' completes the alignment of the series of slots in bars 163' to 192' individual to the word test bar W_0 and permits the word test bar W_0 to enter these

slots when actuated by bail 201 whereupon the word test bar W_0 is elevated to close the pair of contacts P_0 individual to and defining the spoken numeral 0. It will be obvious from Figs. 1 and 2 when taken in conjunction with Fig. 18 how other spoken numerals will cause a similar actuation of the other pairs of contacts P_1 to P_9 individual to each spoken numeral.

By suitable wiring the closure of any one pair of the contacts P_0 to P_9 serves to energize a corresponding one of the ten digit relays 220 to 229 (Fig. 3), and such a selected relay is locked to ground at the back contact of relay 230 at the selector control apparatus. For example, assuming numeral 0 is spoken, the analysis of this would cause contacts P_0 to close to energize the J digit relay 220 associated with the control apparatus 231. Relays 220 to 229 by grounding one to three of the set of five conductors extending to the selector control apparatus 231 may selectively operate the relays of the register thereof in the manner disclosed, for example, in U. S. Patent 1,862,549, issued June 14, 1932 to R. Raymond and W. J. Scully. The completion of a digit registration in the control apparatus operates relay 230 to release the digit relays 220 to 229 to prepare for the reception of the next digit of the spoken telephone number. When the registration of the entire called number is complete, the apparatus 231 will control the operation of selective switches such as selector 43 in the usual manner. As soon as a talking connection is established between the calling line 40 and the called line 232 the voice operated register sender is released from the talking connection in the same manner as is usual in the telephone art for releasing a dial operated register sender as shown, for example, in the above-mentioned Raymond and Scully patent. This release of the voice operated register sender connected to leads 49 prevents this sender from being operated by any spoken message after the receipt of the spoken telephone number and, obviously, causes control relay 59 to be deenergized.

When the voice operated register sender has received the complete information for the called number and has been released from the control of the calling line it will, of course, be advisable that main bail 78 and bail 201 should come to rest at the lowermost point of their travel. It will be noted that when electromagnets 70 and 213 have been energized by the application of ground over conductor 71 and clutches 72 and 214 have engaged to rotate shafts 74 and 234, cam wheels 235 and 236 in an obvious manner provide locking circuits for clutch magnets 70 and 213, which locking circuits will be maintained except when the bails 78 and 201 are in their lowermost position if ground over conductor 71 has been removed, clutch magnets 70 and 213 will be deenergized to disengage clutches 72 and 214. The removal of ground from conductor 71 due to the release of relay 59 also serves to deenergize relay 240 to cause the release of relay 241 which in releasing closes an energizing circuit for relays 207 and 209 to insure that shaft 143 is returned to normal.

For supervisory purposes it may be desirable to record the spoken telephone numbers received by the disclosed voice operated register sender. It will be recalled that in response to each phonetic sound of a key-word, the six coding bars SB_1 to SB_6 are caused to assume a predetermined actuated or non-actuated condition collectively defining the said sound, and hence means are

provided for recording on a traveling tape 244 the positions of the six coding bars defining each analyzed phonetic sound, as shown in Fig. 4. Each coding bar has a pivoted extension 245 with an upwardly extending shoulder 246. Suitably mounted above the six arms 245 are six pins 247, one for each coding bar extension and these pins when actuated serve to perforate tape 244 whereby the perforations serve to define each phonetic sound. Each time any selected sound test bar 80 is raised to set the coding bars to define the analyzed sound, one set of contacts 147 as previously described is closed to energize electromagnet 249 and the attraction of its armature 250 serves to lift all of the pivoted extensions 245 of the coding bars. It will be obvious that by the time armature 250 has been attracted by its electromagnet any actuated coding bar will have its shoulder 246 beneath its associated perforating pin 247 and that tape 244 will be perforated by such an elevated pin but will not be perforated by any pin whose coding bar was not actuated by the registered phonetic sound. It, therefore, follows that the portion of the tape 244 immediately above pins 247 will be perforated in a selective manner to produce a record which defines each phonetic sound corresponding to a selected sound test bar 80. It will be apparent that pawl 251 upon the release of electromagnet 249 will cause the tape 244 to be moved one step to be ready for the next series of perforations defining the next analyzed sound so that upon the receipt of the complete telephone number the record on tape 244 will define the called telephone number.

For simplification purposes the specific apparatus disclosed in Figs. 1 to 21 is shown as being capable of responding to only the spoken numerals 0 to 9, inclusive. It will be apparent, however, that the ten sets of contacts P_0 to P_9 of Fig. 17 may be selectively actuated in response to receipt of other key-words besides the spoken numerals just designated. For example, it is common practice in large telephone exchange areas to use a name as well as a number to designate a subscriber's telephone line, such as Chelsea 3-1000. It will be obvious that the apparatus of Fig. 17 may include a word test bar defining the spoken word "Chelsea" whereby the selection and raising of such a word bar may cause the closure of one or more pairs of contacts added to the series P_0 to P_9 to produce the desired actuation of one or more of the digit relays 220 to 229 which will define the received word "Chelsea." It may also be desirable to provide a word test bar in the apparatus of Fig. 17 for each possible pronunciation of each numeral so that, for example, contacts leading to winding of digit relay 220 will be closed whether "0" is pronounced "ought" or is pronounced "ou." Also as an example of another modification the telephone number 1000 might be pronounced by saying "one thousand" or by speaking each numeral separately; it may, therefore, be desirable to provide a word test bar in the apparatus of Fig. 17 which will respond to the spoken word "thousand" to close contacts to operate digit relay 220 three times. It will be obvious that the apparatus of Figs. 1 to 21, inclusive, may be readily modified to produce a desired operation in response to any predetermined key-word as long as the resonance bars C_1 to C_{10} are properly slotted to receive a sound test bar defining each significant sound of the key-word and as long as the storing bars 163' to 192' are properly

slotted and controlled to select a word test bar individual to and defining the spoken key-word.

An alternative form of the invention is disclosed in Figs. 22 to 30 where the preliminary part of the voice operated register sender shown in Fig. 22 is identical with that of Fig. 1. As soon as a link circuit is taken into use by the calling line 270 a suitable selection switch 271 is set into motion to select the seized link circuit whereby line finder 272 has access to the ten band-pass filters 273 to 282 to transmit to these filters the speech currents representing the number of the called telephone line. At the same time relay 284 is energized to place ground on conductor 285 to operate clutch magnet 286 to start the oscillating movement of the main bail plunger 287 and prepare the apparatus for the receipt of the voice currents. The rectified currents from each of the band-pass filters 273 to 282 are impressed upon ten electromagnets for selectively moving resonance bars 288 to 297 an amount dependent upon the power level of the currents passed by each filter for each phonetic sound of the telephone number spoken into the transmitter at the subscriber's substation for calling line 270. Associated with the selected resonance bars 288 to 297 are a number of sound test bars 298 to 314, together with others unnumbered, one for each phonetic sound present in any spoken key-word to which the apparatus is intended to be responsive. As in the earlier embodiment of the invention, it is assumed that the key-words to be received are the spoken numerals 0 to 9, inclusive, and, therefore, there is a sound test bar in the apparatus of Fig. 2 for each different phonetic sound present in these ten numerals. The various phonetic sounds for these ten numerals are listed on Fig. 23 from which it will be apparent that these ten numerals may be represented by various combinations of seventeen phonetic sounds, and, therefore, the slots in the resonance bars 288 to 297 should be so arranged that the selective actuation of these resonance bars in response to the voice currents representing one of these phonetic sounds will result in such an alignment of the slots that only one of the sound test bars will enter the aligned slots. Such a selected sound test bar indicates the received phonetic sound and its actuation by main bail 361 may be utilized to perform its part in preparing the apparatus to accomplish the desired switching function. More than seventeen sound test bars are disclosed in Fig. 22 and the additional sound test bars may be utilized to define other phonetic sounds present in other key-words to which it may be desired to have the apparatus respond.

Mounted above each sound test bar and individual thereto is a pair of normally open electrical contacts 315 so positioned that the elevation of a selected sound test bar by the main bail 361 will cause the upper end 360 of the sound test bar to temporarily close its associated pair of contacts. The seventeen pairs of contacts 315 that are associated with the seventeen sound test bars 298 to 314 are connected respectively to the windings of relays 320 to 336 (Fig. 23) whereby the elevation of any one of the sound test bars 298 to 314 will close its associated pair of contacts 315 to supply energizing current to a winding of that relay of the series 320 to 336 which is individual to the phonetic sound indicated by the selected bar. Since any sound test bar 298 to 314 is elevated only upon the receipt

of a definite phonetic sound it follows that each of the relays 320 to 336 indicates a different one of the phonetic sounds present in the spoken numerals 0 to 9 and the particular phonetic sound indicated by each of these relays is given on the drawing adjacent each relay. It may, therefore, be assumed each sound test bar 298 to 314 indicates or defines that sound marked on the drawing adjacent the relays 320 to 336 controlled thereby. Thus the elevation of the sound test bar 298 indicating the t sound in ten will close a pair of the contacts 315 to operate relay 320 and the elevation of the sound test bar 310 indicating the u sound in rude will close its pair of contacts 315 to operate relay 332.

Each of the relays 320 to 336 not only has a winding for operating the relay when its associated pair of contacts 315 is closed by the elevation of a selected sound test bar but each of these relays also has a holding winding which is connected to battery over the left contact of the said relay and the normally closed contact of relay 337, so that any one of the relays 320 to 336 after operation remains operated until its holding circuit is broken by the operation of relay 337.

Controlled by certain combinations of the relays in the phonetic sound group 320 to 336 is another group of relays 340 to 349 each of which is adapted to be operated only upon the receipt of the significant phonetic sounds of a different one of the key-words or numerals 0 to 9. That is, as shown on the drawing, the successive operation of relays 340 to 349 would indicate respectively the ten spoken numerals 0 to 9. Each relay 340 to 349 is of the marginal type and comprises a plurality of windings, one winding for each significant sound in the key-word represented by the relay. Thus, relay 340 which stands for the spoken word "ou" has one winding which is connected to battery by the closure of the outer contact of relay 334 which latter relay is operated in response to the o sound in omit; and has a second winding which is connected to battery by the closure of the outer contact of relay 333 which latter relay is operated in response to the u sound in pull. When both of the windings of relay 340 are connected to battery, relay 340 will operate to inform the selector control apparatus 339 of the receipt of the spoken digit 0. In a similar manner relay 341 which stands for the spoken word "one" has a separate winding adapted to be connected to battery upon the operation of the three sound relays 326, 336 and 327 which represent the three phonetic sounds of the spoken word "one." It will be apparent that each of the other word relays 342 to 349 has a separate winding adapted to be energized by the operation of one of the sound relays indicating one of the phonetic sounds present in the spoken word represented by any particular word relay. Whenever any one of the word relays 340 to 349 has had all of its windings connected to battery such a relay in operating closes its inner contact to convey the information to the selector control apparatus 339 and also closes its outer contact to operate relay 337 and release any of the operated sound relays 320 to 336 through the locking windings to prepare the sound relays for the receipt of the next spoken digit or key-word.

The operation of any key-word relay 340 to 349 controls the selector control apparatus 339 in identically the same manner as is done by the closure of any pair of the contacts P₀ to P₉ of

Fig. 2 and hence this operation needs only a brief reference at this point. The operation of any relay 340 to 349 serves to energize the corresponding one of the ten digit relays 350 to 359 and such a selected relay is locked to ground at the back contact of relay 338 in the selector control apparatus. Relays 350 to 359 by grounding one to three of the set of five conductors extending to the selector control apparatus 339 may selectively operate the relays of the register thereof in the manner disclosed, for example, in the above-mentioned Raymond and Scully patent. The completion of a digit registration in the control apparatus operates relay 338 to release the digit relays 350 to 359 to prepare for the reception of the next digit of the spoken telephone number. When the registration of the entire called number is complete apparatus 339 will control the operation of selective switches to establish a talking connection between the calling line 270 and the called line 366 in the usual manner. As soon as this talking connection is established the voice operated register sender is released from the talking connection in the usual manner, thereby deenergizing control relay 284.

As an example of the operation of the apparatus of Figs. 22 and 23 it will be obvious that if the telephone number "three-four-seven-eight" is spoken into the transmitter of line 270 the resonance bars 288 to 297 will in rapid succession cause the selective operation of the sound test bars 298 to 314 representing the various phonetic sounds to close corresponding contacts of the series 315 to first operate those sound relays of series 320 to 336 which represent the phonetic sounds of "three" to operate word relay 343; will then energize the relays of the series 320 to 336 representing the phonetic sounds of "four" to operate word relay 344; will then energize the relays of the series 320 to 336 representing the phonetic sounds of "seven" to operate word relay 347; and then will energize those relays of the series 320 to 336 representing phonetic sounds of "eight" to operate the relay 348. In the manner just described the selector control apparatus 339 will receive complete information as to the desired telephone number and will connect the desired called line 366 to calling line 270 after which control relay 284 will be released and the disclosed voice operated register sender prepared for being seized by another calling line.

If desired, the apparatus of Fig. 22 may comprise a sound test bar individual to each phonetic sound found in the English language and as stated in my U. S. Patent 2,195,081 this would require a minimum number of thirty-six sound test bars with a pair of contacts 315 individual to each bar, with a sound relay added to series 320 to 336 for each added phonetic sound and a word relay in the series 340 to 349 for each additional key-word to be employed in producing the desired switching operation. Such a modification would obviously enable the word relay series 340 to 349 to have included therein a relay or a relay combination indicating each of the name designations usually constituting a part of the telephone number to which line 270 might wish to have access.

The sound test bar and resonance bar construction disclosed in perspective in Fig. 24 will be described only briefly since the construction and movements of the various parts are essentially the same as in the apparatus of Fig. 4 except for the omission of the coding bars SB₁ to SB₆, the

omission of the tape record 244 and the omission of the series of contacts 147. There is the further difference, since each sound test bar such as bar 314 of Fig. 24 has an extension 360 which when elevated by the main bail 361 closes in an obvious manner its associated pair of contacts 315. The voicing lock relay 362 and the stop consonant lock relay 363 operate in the same manner as relays 61 and 63 of Fig. 4 to aid in the prevention of the false operation of a sound test bar.

The series of Figs. 25 to 30, inclusive, show the various steps in the operation of a representative sound test bar 314 of Figs. 23 and 24, and these figures correspond to Figs. 6 to 11 of the other disclosed embodiment of the invention. In Fig. 25 the sound test bar 314 and its associated anti-repeat bar 364 are in their normal non-actuated positions. In Fig. 26 the main bail 361 has released sound test bar 314 to test for a slot alignment in the resonance bars 288 to 297. In Fig. 27 the sound test bar has entered the aligned slots in the resonance bars whereby the main bail 361 elevates the sound test bar to the position of Fig. 28 to close contacts 315. The final upward movement of a sound test bar throws the bar out of the resonance bar slots as in Fig. 29 with extension 360 releasing contacts 315 whereupon the sound test bar under the action of spring 365 returns to the position of Fig. 30 which is normal except that the anti-repeat bar 364 will prevent a second entrance into the resonance bars of the disclosed bar 314 until a subsequent resetting of any one of the resonance bars permits anti-repeat bar 364 to release sound test bar 314 from its position of Fig. 30 to its original condition of Fig. 25.

The apparatus of Figs. 1 to 21, inclusive, or Figs. 22 to 30, inclusive, therefore, provides a mechanism for carrying out spoken orders as expressed in a sentence or other word groups. The desired mechanical operation to be produced by the spoken message is accomplished by a step-by-step analysis of the message in which the first step is the power-frequency analysis of the voice currents produced, for example, by filters F₁ to F₁₀ and the associated rectifiers. The second step is the phonetic sound analysis accomplished by the selection of a particular sound test bar in response to a particular slot alignment of the resonance bars C₁ to C₁₀. The third step is the word analysis accomplished by the selection of one of the word test bars W₀ to W₉ by the proper alignment of the slots in storing bars 163' to 192'; and the fourth or final step is the analysis of the complete sentence or group of words as is accomplished in the selector control apparatus 231. The apparatus of this invention is not limited in its application to dialing automatically with the voice but can be used for any general purpose of remote control based on the spoken word where the mechanical movements "ordered" by the spoken message may be in fields widely different from the telephone field.

The apparatus of Figs. 22 to 30 discloses a simplified word analyzing mechanism over that in the earlier figures in that it does away with the storing mechanism and the sounds are set up regardless of the order in which they are received, so that in the second embodiment of the invention suitable precautions must be taken to avoid two key-words using the same group of phonetic sounds. Thus if one of the key-words happens to be "ton" it will be observed that "ton" and "nut" use the same three phonetic sounds in different order, but in the apparatus

of Figs. 22 to 30, inclusive, these two words would be registered as the same word. Although this limitation can be easily avoided by a proper choice of the key-words it should be noted that this limitation is not present in the apparatus of Figs. 1 to 21, inclusive, where "ton" and "nut" would be properly registered as two different words.

What is claimed is:

1. In combination, a plurality of mechanisms each represented by a different group of words and means responsive to the pronouncement of one of said word groups for selecting the mechanism defined by the spoken word group, said means comprising a transmitter for transforming the spoken words into electrical waves, means for analyzing said waves to determine the successive phonetic sounds represented by said waves, means responsive to said analyzing means for temporarily storing indications of the phonetic sounds present in successive portions of said waves, means controlled by said first storing means for storing indications of the words defined by the stored phonetic sounds, and means responsive to the registration in said second storing means of the words of one of said word groups for selecting said mechanism represented by said word group.

2. In combination, a plurality of mechanisms each represented by a different group of words and means responsive to the pronouncement of one of said word groups for selecting the mechanism defined by the spoken word group, said means comprising a transmitter for transforming the spoken words into electrical waves, means for analyzing said waves to determine the successive phonetic sounds represented by said waves, means responsive to said analyzing means for temporarily storing representations of the phonetic sounds present in successive portions of said waves, means controlled by said first storing means for storing representations of the words defined by the stored phonetic sounds, and means controlled by the arrival at said second storing means of representations of the phonetic sounds defining one of said words for removing said sound representations from said first storing means to prepare the same for the registration of other phonetic sounds, means responsive to the registration in said second storing means of the words of one of said word groups for selecting the mechanism represented by said group and means responsive to the selection of one of said mechanisms for removing said word representations from said second storing means.

3. In combination, a plurality of mechanisms each represented by a different group of spoken words and voice operated means for selecting one of said mechanisms by the oral pronouncement of one of said word groups, said means comprising means for transforming the vocal sounds into electric waves defining said sounds, means for analyzing said waves to determine the phonetic sounds represented by successive portions of said waves, a plurality of members each defining a different word, means controlled by said analyzing means for actuating one of said members upon receipt of wave portions defining the significant phonetic sounds of the word defined by said one member and for actuating other of said members upon receipt of the wave portions defining the significant phonetic sounds of the words defined by said other members, and means controlled by the actuation of those members collec-

tively defining one of said word groups for selecting the mechanism defined by said word group.

4. Voice operated mechanism comprising means for producing a complex electrical wave representing a series of phonetic sounds, a plurality of movable elements each representing a separate one of said sounds, means for selecting a number of substantially independent characteristics of that portion of said wave representing a separate phonetic sound and for utilizing said characteristics in selectively actuating that one of said elements corresponding to that particular sound, a plurality of movable members each representing a different series of phonetic sounds uttered in a predetermined order, and means responsive to the selection of a group of said elements representing the separate sounds collectively defined by one of said members for actuating said one member.

5. Voice operated mechanism comprising means for producing a complex electrical wave representing a series of spoken words whereby successive portions of said wave represent the various phonetic sounds composing said spoken words, a plurality of movable elements each representing a separate one of said phonetic sounds, means controlled by said wave for successively actuating the elements corresponding to the sounds represented by said wave, a plurality of movable members each representing a separate one of said words, and means responsive to the actuation of those elements representing all the phonetic sounds of a certain word for actuating that member representing said certain word.

6. Voice operated mechanism comprising means for translating a succession of phonetic sounds into a complex electrical wave, means for dividing said wave into a plurality of frequency subbands, means for deriving from each subband a low frequency current of a fundamental frequency of less than 10 cycles per second whose amplitude defines the power level in the subband, whereby said low frequency currents collectively define each portion of said wave representing a separate phonetic sound, a plurality of movable elements each representing a separate one of said phonetic sounds, means for causing said low frequency currents representing each phonetic sound to select that one of said elements representing the particular sound, a plurality of movable members each representing a different combination of phonetic sounds, and means responsive to the successive selection of a group of said elements collectively defining the combination of sounds represented by one of said members for actuating said one member.

7. Voice operated mechanism comprising means for translating spoken words into a complex electrical wave, a plurality of movable elements each representing a separate phonetic sound occurring in one of said words, means responsive to that portion of said wave representing a certain word for successively actuating those elements representing the sounds composing said certain word, a plurality of movable members each representing a separate one of said words, means effective upon the actuation of those elements representing all the significant phonetic sounds of a certain word for actuating that movable member defining said certain word, and means responsive to the actuation of said certain member for restoring to normal the actuated elements representing the sounds of said certain word.

8. Voice operated mechanism comprising means for translating certain spoken words into a com-

plex electrical wave, means for dividing said wave into a plurality of frequency subbands, means for deriving from each subband a low frequency current of a fundamental frequency of less than 10 cycles per second whose amplitude defines the power level in the subband whereby said low frequency currents collectively define each portion of said wave representing a separate phonetic sound, a plurality of movable elements each representing a separate one of the phonetic sounds present in said certain words, means for causing said low frequency currents representing a separate phonetic sound of a spoken word to actuate that one of said elements representing that particular sound, a plurality of movable members each representing a separate one of said certain words, and means responsive to the actuation of a group of said elements representing the various phonetic sounds composing one of said words for actuating that one of said members representing said one word.

9. Voice operated mechanism comprising means for translating spoken words into a complex electrical wave, means for analyzing said wave to produce a number of control currents which collectively define that portion of said wave representing each phonetic sound, a plurality of movable elements each representing a separate one of said phonetic sounds, means controlled by said currents defining that portion of said wave representing the phonetic sounds composing a certain word for successively actuating the said elements representing the sounds composing said certain word, a plurality of sets of movable members, means responsive to the actuation of that element representing the first sound of said certain word for actuating one of said sets to positions defining said first sound, means responsive to the actuation of other elements representing other sounds of said certain word for actuating other of said sets to positions defining said other sounds, a plurality of additional movable elements each representing a separate one of said words and means effective when said sets of members are actuated to positions defining a certain word for actuating that additional element representing said certain word.

10. Voice operated mechanism comprising means for translating spoken words into a complex electrical wave, means for deriving from said wave a simple set of parameters having approximately the number of degrees of freedom of the variable elements of the vocal system, means for deriving from said parameters a set of defining waves that respectively define the variations of said parameters for the various phonetic sounds composing the spoken words, a plurality of movable elements each representing a separate one of said phonetic sounds, means collectively controlled by said defining waves for successively selecting those elements representing the phonetic sounds defined by said defining waves, a plurality of movable members each representing a separate one of said spoken words, and means responsive to the successive actuation of said elements for the various sounds of a certain word for actuating said member representing said certain word.

11. Voice operated mechanism comprising means for translating spoken words into a complex electrical wave of a wide band of frequency, means for selecting a set of substantially independent parameters corresponding in number to the number of the important individual movable parts of the vocal system involved in speech pro-

duction, means for assigning to each parameter a value individually controlled by the syllabic rate of change of a characteristic of said wave, a plurality of movable code bars each controlled in position in accordance with the value of one of said parameters whereby said bars assume positions successively defining the various phonetic sounds represented by said wave, a plurality of movable members each representing a separate one of said spoken words, and means responsive to the successive actuation of said bars for the various sounds composing a certain word for actuating said member representing said certain word.

12. Voice operated mechanism comprising means for translating spoken words into a complex electrical wave of a wide frequency band, means for dividing said wave into a plurality of subbands of frequency, means for deriving from each subband a low frequency wave of a fundamental frequency of less than 10 cycles per second whose amplitude defines the power level in the subband, a plurality of movable code bars each controlled in position in accordance with the amplitude of a separate one of said low frequency waves whereby said bars assume positions successively defining the various phonetic sounds represented by said wave, a plurality of movable elements each representing a separate one of said phonetic sounds, means for successively actuating those elements representing sounds defined by the various positions assumed by said code bars, a plurality of movable members each representing a separate one of said spoken words, and means responsive to the successive actuation of said elements for the various sounds of a certain word for actuating said member representing said certain word.

13. Voice operated mechanism comprising means for producing a complex electrical wave representing a plurality of groups of phonetic sounds, a plurality of movable elements each representing a separate one of said sounds, means for selecting a number of substantially independent characteristics of that portion of said wave representing a separate phonetic sound and for utilizing said characteristics in selectively actuating that one of said elements corresponding to that particular sound, a plurality of movable members each representing a different group of phonetic sounds, means responsive to the selection of a group of said elements representing the different sounds defined by one of said members for actuating said one member, a plurality of electrical means each defining a different series of groups of said sounds, and means responsive to the selection of said members representing the different groups collectively defined by one of said electrical means for actuating said one electrical means.

14. Voice operated mechanism comprising means for producing a complex electrical wave representing a series of successively spoken words each word comprising a plurality of significant phonetic sounds, a plurality of movable elements each representing a different one of the phonetic sounds present in said spoken words, means for selecting a number of substantially independent characteristics of that portion of said wave representing a phonetic sound and for utilizing said characteristics for selectively actuating that one of said elements defining each phonetic sound, a plurality of movable members each representing a different one of the spoken words, means

responsive to the successive actuation of those elements representing the significant sounds of a given word for actuating that member representing said word, a plurality of devices each representing a different combination of spoken words and means responsive to the actuation of the members representing all of the words of a certain combination of words for selecting that device defining the said word combination.

15. Voice operated mechanism comprising means for producing a complex electrical wave representing a series of successively spoken words each word comprising a plurality of significant phonetic sounds, a plurality of movable elements each representing a different one of the phonetic sounds present in said spoken words, means for selecting a number of substantially independent characteristics of that portion of said wave representing a phonetic sound and for utilizing said characteristics for selectively actuating that one of said elements defining each phonetic sound, a plurality of movable members each representing a different one of the spoken words, means responsive to the successive actuation of those elements representing the significant phonetic sounds of a given word for actuating that one of said members representing said given word provided the actuated elements are actuated in the order in which the phonetic sounds defined thereby are present in said given word, a plurality of devices each representing a different combination of words spoken in a definite sequence, and means responsive to the successive actuation of those members representing the different words of a combination of words for selecting that device representing said word combination provided the actuated members are actuated in the order in which the words defined thereby are present in said word combination.

16. In a telephone system, a calling station and a called station, switching apparatus adapted to connect said calling station with said called station, and means associable with said calling station and responsive to the complex electrical wave produced by the pronouncement at said calling station of the group of words defining the called station for selectively controlling said switching apparatus to connect said called station to said calling station, said means comprising a plurality of movable elements each representing a different one of the significant phonetic sounds present in said wave, means for selecting a number of substantially independent characteristics of that portion of said wave representing each phonetic sound present in said wave and for utilizing said characteristics in selectively actuating that one of said elements corresponding to each phonetic sound, means for temporarily holding each selected element in its actuated condition until the actuation of all elements defining the significant phonetic sounds of each word of said group, a plurality of movable members each representing a different word of said group, means responsive to the actuation of those elements defining the significant phonetic sounds of each word of said group for actuating that member defining each of said words, and means responsive to the actuation of each member for releasing the actuated elements to prepare said elements for use in defining the next word of said group, said switching apparatus being selectively controlled by the actuation of said members which collectively define the designation of the called line.

17. Voice operated mechanism comprising means for producing a complex electrical wave representing a group of spoken words, means for selecting a number of substantially independent characteristics of said wave, a plurality of movable code bars each controlled in position by the syllabic variation of one of said characteristics whereby for each portion of said wave representing a separate phonetic sound said code bars assume positions collectively defining said sound, a plurality of groups of movable elements, means for selectively actuating the elements of a first group to define the first phonetic sound represented by the actuated bars and for selectively actuating other groups of said elements to define other phonetic sounds represented by the actuated bars, mechanisms each defining a separate one of said spoken words and means responsive to the actuation of said groups in defining all the significant phonetic sounds of one of said words for selecting said mechanism defining that word.

18. Voice operated mechanism comprising means for producing a complex electrical wave representing a group of spoken words, means for selecting a number of substantially independent characteristics of said wave, a plurality of movable code bars each controlled in position by the syllabic variation of one of said characteristics whereby for each portion of said wave representing a separate phonetic sound said code bars assume positions collectively defining said sound, means for temporarily storing indications of the various phonetic sounds represented by said bars as said bars are successively actuated to define the significant phonetic sounds of said words, a plurality of movable members each defining a different one of said words, means for actuating each of said members when the significant phonetic sounds of the word defined by each member are registered in said storing means, means responsive to the actuation of each member for releasing said storing means to permit the registration in said storing means of the significant phonetic sounds of another word, mechanism defining a group of spoken words and means responsive to the actuation of those members defining all the words of said group for selecting said mechanism.

19. Voice operated mechanism comprising means for producing a complex electrical wave representing a series of spoken words, means for amplifying said wave to cause said wave to have a substantially constant energy level for successively spoken words to compensate for any variations in the loudness of the talker, means for selecting a set of substantially independent parameters corresponding in number to the number of the important independently movable parts of the vocal system involved in speech production, means for assigning to each of said parameters a value independently controlled by the syllabic rate of change of an essential characteristic of said amplified wave, storing means, means controlled by the values of said parameters for producing significant registrations in said storing means of the successive phonetic sounds of the words represented by said wave, a plurality of movable members each defining a different word, means controlled by the registration in the proper sequence in said storing means of the essential phonetic sounds of a given word for actuating said member individual to said given word, mechanism defined by a group of said spoken words and means controlled by the

actuating of those members defining all words of said group for selecting said mechanism.

20. Voice operated mechanism comprising means for producing complex electrical waves of a wide frequency band representing a series of spoken words, means for dividing said waves into a plurality of subbands of frequency, a plurality of movable elements one for each subband, means for biasing said elements to a neutral position, means for moving each of said elements to any one of a plurality of advanced positions in accordance with the average energy level in one of said subbands for each phonetic sound represented by said waves whereby the relative advanced positions of said elements collectively define the successive phonetic sounds of said waves, a plurality of movable members each defining a different one of said phonetic sounds, means controlled by said elements for actuating those members representing the phonetic sounds successively defined by the relative positions of said elements, a plurality of groups of relays, means controlled by the first actuated member for selectively operating the relays of a first group to define the phonetic sound represented by the first actuated member and controlled by other actuated members for selectively operating the relays of other groups whereby said groups collectively define a plurality of phonetic sounds, a plurality of mechanisms each defining a different word, and means controlled by said groups of selectively operated relays for selecting that mechanism defined by the various phonetic sounds represented by said relay groups.

21. Voice operated mechanism comprising means for producing a complex electrical wave representing spoken words, a series of multiwinding relays each representing a different one of said words, each relay having a separate winding for each significant phonetic sound of the word represented thereby, each relay being marginal and operating only when all of its windings are energized, means for analyzing said wave to determine the different phonetic sounds defined thereby, means controlled by said analyzing means for closing an energizing circuit for all relay windings defining each analyzed sound and mechanism selectively controlled by the operation of said relays.

22. Voice operated mechanism comprising means for producing an electrical wave representing a number of spoken words, a plurality of code bars each biased to a normal position, means for analyzing said wave to actuate said bars to positions defining the successive phonetic sounds present in said wave, a plurality of pull bars associated with said code bars and each defining a different phonetic sound, means for causing the selection of one of said pull bars each time said code bars occupy relative positions defining one of said sounds, a second set of code bars each biased to a normal position, means for actuating one group of said second code bars to positions defining the first selected pull bar and for actuating other groups of said second set to positions defining other selected pull bars, a second set of pull bars associated with said second set of code bars and each defining a different word, and means for causing said second set of pull bars to test said second set of code bars and for selectively actuating any one of said second set of pull bars which represents a word defined by the phonetic sounds

registered on the different groups of said second set of code bars.

23. Voice operated mechanism comprising a transmitter for transforming spoken words into electrical waves representing said words, means for amplifying said waves to have a substantially constant energy level for successively spoken words to compensate for any variations in the loudness of the talker, a plurality of code bars each biased to a normal position, means for analyzing said amplified waves to actuate said bars to positions defining the successive phonetic sounds present in said waves, a plurality of pull bars associated with said code bars and each defining a different phonetic sound, means for causing the selection of one of said pull bars each time said code bars occupy relative positions defining one of said sounds, a second set of code bars each biased to a normal position, means for actuating one group of said second code bars to positions defining the first selected pull bar and for actuating other groups of said second set to positions defining other selected pull bars, a second set of pull bars associated with said second set of code bars and each defining a different word, means for causing said second set of pull bars to test said second set of code bars and for selectively actuating any one of said second set of pull bars which represents a word defined by the phonetic sounds registered on the different groups of said second set of code bars, and means responsive to the selection of a pull bar of said second set for restoring all code bars of said second set to their normal positions.

24. In combination, a complex electrical wave representing the phonetic sounds of a series of spoken words, means for analyzing said wave to determine the phonetic sounds represented thereby, a plurality of movable elements each defining a different phonetic sound, means controlled by said analyzing means for selectively actuating that element representing each phonetic sound represented by said waves whereby the order in which said elements are selected is the same as the order in which the phonetic sounds represented thereby are present in said wave, a plurality of groups of movable members with said groups being adapted to be operated in a predetermined order, means for selectively actuating the first group of said members to positions defining the first selected element, for actuating the second group of said members to positions defining the second selected element and for actuating the third group of members to positions defining the third selected element, a plurality of mechanisms each defining a word of a plurality of significant phonetic sounds occurring in a definite order, one of said mechanisms defining a word whose first phonetic sound is registered on said first group, whose second phonetic sound is registered on said second group, and whose third phonetic sound is registered on said third group, and means responsive to the registration in said three groups of said three phonetic sounds for selectively actuating said one mechanism.

25. Voice operated mechanism comprising means for dividing electrical speech waves into a plurality of frequency subbands, means for rectifying each subband to produce a low frequency wave whose amplitude defines the power level in its subband whereby said low frequency waves collectively define the various phonetic sounds represented in the speech waves, means controlled by said low frequency waves for suc-

cessively indicating the phonetic sounds defined by said low frequency waves, a group of electrical contacts, and means controlled by said indicating means for operating a different combination of said contacts for each analyzed phonetic sound whereby the collective condition of said contacts after each such operation represents the analyzed phonetic sound.

26. Voice operated mechanism comprising means for producing a complex electrical wave representing a series of phonetic sounds, a plurality of movable elements each representing a separate one of said sounds, means for selecting a number of substantially independent characteristics of that portion of said wave representing a separate phonetic sound and for utilizing said characteristics for selectively actuating that one of said elements corresponding to that particular sound, a group of electrical contacts, and means responsive to the actuation of each of said elements for operating said contacts in a manner individual to the actuated element.

27. Voice operated mechanism comprising means for producing a complex electrical wave representing a series of phonetic sounds, a plurality of movable elements each representing a separate one of said sounds, means for selecting a number of independent characteristics of that portion of said wave representing a separate phonetic sound and for utilizing said characteristics in selectively actuating that one of said elements corresponding to that particular sound, a plurality of movable members each representing a different series of phonetic sounds, and means responsive to the selection of a group of said elements representing the separate sounds collectively defined by one of said members for actuating said one member.

28. Voice operated mechanism comprising means for providing an electrical wave representing a series of phonetic sounds, means for analyzing said wave into a plurality of frequency subbands, means for obtaining from each subband an electrical current whose amplitude is a measure of the power in the respective subband, movable elements, means actuated by said respective electrical currents to operate each of said movable elements an amount proportional to the power in one of said electrical currents, movable members each representative of a given phonetic sound, means to actuate one of said members when a group of said elements corresponding to the given phonetic sound have been moved to positions indicative of the corresponding phonetic sound defined by the actuated member, other movable members each representative of a different series of phonetic sounds, and means to move one of said other movable members when a group of said first members corresponding to said series of phonetic sounds have been moved to positions indicative of said series of phonetic sounds.

29. Voice operated mechanism comprising means for transforming sound waves corresponding to speech into electrical waves, means for separating said electrical waves into a plurality of frequency subbands, means for obtaining from each subband an electrical current whose amplitude is a measure of the power in the respective subband, movable elements each representative of a phonetic sound, means to move one of said elements when the distribution of the power in said electrical currents corresponds to the respective phonetic sound represented by said element, a plurality of movable members each rep-

resentative of a different series of phonetic sounds, and means to move each of said members when the elements corresponding to the respective series of phonetic sounds have been operated.

30. Voice operated mechanism comprising means for providing an electrical wave representing a series of phonetic sounds occurring in a definite sequence, a plurality of movable elements each representing a separate phonetic sound, means controlled by said wave for sequentially actuating those movable elements representing the separate sounds of said series, a plurality of movable members each representing a separate series of a definite sequence of phonetic sounds, and means responsive to the successive actuation of said movable elements in a definite sequence for actuating that member representing said series of sounds in said definite sequence.

31. Voice operated mechanism comprising means for providing an electrical wave representing a series of phonetic sounds occurring in a definite sequence, means for analyzing said wave into a plurality of frequency subbands, means for obtaining from each subband an electrical current whose amplitude is a measure of the power in the respective subband, movable elements, means actuated by said respective electrical currents to operate each of said movable elements an amount proportional to the power in one of said electrical currents, movable members each representative of a given phonetic sound, means to move each of said members when said movable elements have been moved to positions collectively indicative of the corresponding phonetic sound, other movable members each representative of a definite sequence of phonetic sounds, and means to actuate one of said other movable members only when said first movable members have been actuated in the order in which the phonetic sounds are defined by said one other member.

32. Voice operated mechanism comprising means for transforming sound waves corresponding to speech into electrical waves, means for separating said electrical waves into a plurality of frequency subbands, means for obtaining from each subband an electrical current whose amplitude is a measure of the power in the respective subband, movable elements each representative of a phonetic sound, means to move one of said elements when the distribution of power in said electrical currents corresponds to the respective phonetic sound represented by said element, a plurality of movable members each representative of a different series of phonetic sounds in a definite sequence, and means to move each of said members when the elements corresponding to the respective series of phonetic sounds have been operated in the definite sequence.

33. Voice operated mechanism comprising means for providing an electrical wave representing a series of phonetic sounds, a plurality of movable elements each representing a phonetic sound, means controlled by said wave for actuating the elements corresponding to the sounds contained in said series, holding means to maintain said movable elements in their respective operated positions, a plurality of movable members each representing a separate series of phonetic sounds, means to actuate one of said movable members corresponding to a definite series of phonetic sounds when those movable elements corresponding to the phonetic sounds in said series have all been operated and held in their

operated positions, and means responsive to the actuation of said movable member to release said movable elements from their operated positions.

34. Voice operated mechanism comprising means for providing an electrical wave representing a series of phonetic sounds occurring in a definite sequence, a plurality of movable elements each representing a separate phonetic sound, means controlled by said wave for sequentially actuating those movable elements representing the separate sounds of said series, holding means to maintain said movable elements in their respective operated positions, a plurality of movable members each representing a separate series of a definite sequence of phonetic sounds, means to actuate one of said movable members corresponding to a separate series of a definite sequence of phonetic sounds when those movable elements corresponding to the phonetic sounds in said series have been operated in a sequence corresponding to the sequence of said phonetic sounds and held in their operated positions, and means responsive to the actuation of said movable member to release said movable elements from their operated positions.

35. Voice operated mechanism comprising

means for providing an electrical wave representing a series of phonetic sounds occurring in a definite sequence, means for analyzing said wave into a plurality of frequency subbands, means for obtaining from each subband an electrical current whose amplitude is a measure of the power in the respective subbands, a plurality of movable elements, one for each frequency subband, means actuated by said respective electrical currents to operate said movable elements amounts proportional to the power in said respective electrical currents, a plurality of movable members each representative of a phonetic sound, means to move said members in accordance with the movement of said movable elements, means to hold said movable members in their operated position, other movable members each representative of a definite sequence of a series of phonetic sounds, means to operate said other movable members upon the operation of a series of said first members in a definite sequence, and means to release said first members from their operated positions upon the operation of the corresponding one of said second members.

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