

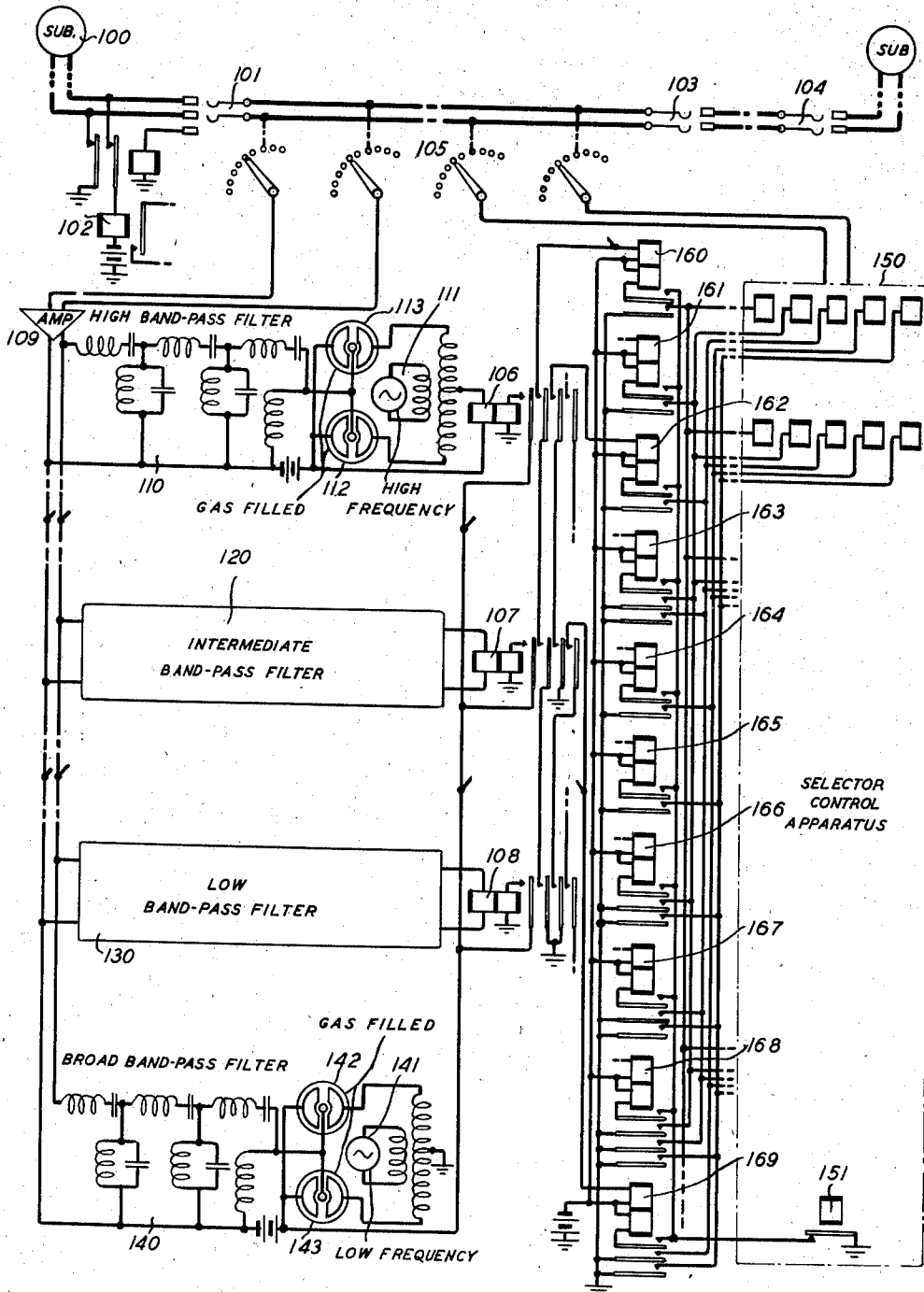
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AUTOMATIC TELEPHONE SYSTEM

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AUTOMATIC TELEPHONE SYSTEM

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The present invention relates to automatic telephony and more particularly 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.

A particular feature of my invention is the use of a plurality of band-pass filters automatically connected to a calling line at the time a call is initiated and tuned to respond to the various components of the "electrical alphabet" whereby the responses can be utilized to operate relays or other suitable recording devices which can selectively control the movement of switching devices to connect with the terminals of a wanted line.

The phenomena of sound, and particularly of the sound waves produced by the vocal cords and transmitted through the vocal passages, has been the subject of many thoroughgoing scientific investigations which have established the fact that speech sound waves initiated by the vocal cords have certain resonant characteristics impressed upon them which causes them to be distinguished from one another as words or parts of words. According to Dr. H. Fletcher's text "Speech and Hearing" the spoken sounds of the English language can be classified into 39 speech sounds readily distinguished by the average person as follows:

1. Pure vowels—11

Long ū (tool), ō (tone), ō (talk), a (far), ā (tape), ē (team).

Short u (took), o (ton), á (tap), e (ten), i (tip).

2. Diphthongs—4

i, ou, oi, ew.

3. Transitionals—3

u, y, h.

4. Semi-vowels—5

l, r, m, n, ng.

5. Fricative consonants—8

Voiced	Unvoiced	Formation of air outlet
V.....	F.....	Lip to teeth.
Z.....	S.....	Teeth to teeth.
TH (then).....	TH (thin).....	Tongue to teeth.
ZH (azure).....	SH.....	Tongue to hard palate.

6. Stop consonants—8

Voiced	Unvoiced	Formation of the stop
B.....	P.....	Lip against lip.
D.....	T.....	Tongue against teeth.
J.....	CH.....	Tongue against hard palate.
G.....	K.....	Tongue against soft palate.

Since words are composed of the fundamental sounds as above indicated, a study of the physical characteristics of these sounds makes it possible to recognize different words by their sound frequency spectra. Thus, the vowels range in frequency from 325 for the short u to 2100 for the long i, which is to say, that each vowel is characterized by a fixed region or regions of resonance in which there is a distinctive energy frequency characteristic of the vowel or vowels.

This fact has been made use of in the analysis of sound by causing the sound energy to be changed into an undulating electric current which varies exactly in accordance with the sound impressed. This electric current is then passed through a plurality of selective filter networks, each responsive only to a narrow band of frequencies. At those frequencies of tuning which coincide with the component frequencies of the sound wave, the response of the electric devices connected to each of the filters will be a maximum.

It is this fundamental relation between sound energy and equivalent electrical energy which forms the basis of the present invention. Ordinarily, in automatic telephony, selective switches are operated in response to groups of impulses produced by a dial at the subscriber's substation. These impulses either actuate the switches directly, in which case the switches take a number of steps equal to the number of impulses, or they actuate registering devices to record the wanted number, in which case the devices selectively control the operation of a number of switches to reach the desired line. In my invention, the dial at the telephone station is 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 way as 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 operation of band-pass filters each of which is tuned to maximum resonance for a particular

frequency that characterizes a vowel or consonant in the electrical alphabet. These 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, all in accordance with well-known automatic telephone practices.

Referring to the drawing, which discloses in diagrammatic form so much of the apparatus and cooperating circuits as are necessary to understand the invention, 100 represents a subscriber's line extending to the terminals of a line-finder 101, the brushes of which are caused to move into position to connect with said line by circuits which are controlled through the contacts of the line relay 102 which operates at the time that subscriber 100 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 103 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 104 are connected.

The line-finder, through a suitable selection switch like 105 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 a number of band-pass filters 110—140 connected in parallel through an amplifier 109. Each of the filters 110—130 comprises a network which is responsive to a particular resonant frequency of the electrical alphabet, and is adapted to work into one or more gas-filled tubes operating on the potential available at the resonant frequency. The tubes associated with each filter in turn control the operation of a relay the contacts of which can be cross-connected with well-known switching control devices to control the movement of switches in accordance with circuits completed through the contacts of this relay and the relays of the other band-pass filters.

With the arrangement of the above apparatus, the principle of the operation of what may be called the dialless automatic telephone system becomes apparent. The method of sound analysis depends upon the use of a multiple receiving circuit consisting of tuned band-filters acted upon simultaneously by the incoming sound controlled waves. Each filter is so adjusted that the bands of certain frequencies can pass while other frequencies are completely suppressed. The frequencies that do pass will act on the control electrodes of the associated gas-filled tubes, causing them to become conducting when the potential applied thereto exceeds a critical value. The current flow through the gas-filled tubes will then cause an associated relay to function inasmuch as the circuit of the relay is in series with the tubes.

This electrical circuit arrangement can be used in differentiating speech sounds according to their physical characteristics, and use thereof made to control the movement of a switching selector. Thus, after the subscriber at station 100 has initiated a call, and the band-pass filter networks 110—140 have been connected to his line in the well-known manner, the subscriber speaks the words of the wanted exchange and number into the telephone transmitter. The electric current modulated by the speech will pass to the input side of the amplifier 109 and will then be raised to a predetermined value.

The amplified electrical "sound" waves are then transmitted to the band-filter networks, each of which will pass that frequency component of the current for which it is resonant, firing the associated gas-filled tubes, which, in turn, will operate the associated relays such as, for instance, relay 106.

Now since the control relay associated with each filter operates in response to a component of a spoken word it follows that a number of these relays will operate on the pronouncement of the whole word into the telephone transmitter, that is, such relays will operate as correspond to the electrical alphabet of the word spoken. A gas-filled tube has the characteristic that once it has been rendered conducting in response to the application of a breakdown potential of the proper value to its control electrode it will continue in that condition even after the removal of the potential unless the potential difference between its cathode and anode is lowered or reduced to zero. Provision is therefore made for extinguishing the tubes associated with each filter circuit a short interval after the tubes have fired and operated the associated control relay by the inductive connection of a high frequency source of alternating current to the cathode-anode circuits of the tubes. For example, the source 111 is thus inductively connected to the cathode-anode circuits of tubes 112 and 113 associated with the filter circuit 110. To prevent the operated control relays such as 106, from releasing at once, each relay is provided with a locking circuit which is closed in the operation thereof and completed through the tubes 142 and 143 associated with the broad band-pass filter 140 which also fire in response to any speech frequency transmitted. The latter tubes are extinguished by the low frequency source of alternating current 141 after an interval sufficient to insure that the control circuits jointly established through the operation of the control relays have been completed whereupon the operated control relays are released.

By the suitable wiring of the contacts controlled by these relays a corresponding one of the ten digit relays 160 to 169 is operated and locked to ground at the back contact of relay 151 in the selector control apparatus. For example, assuming the word aught is spoken, this word having such components as to be selectively passed by all three filters 110, 120, and 130, the 0 digit relay 160 would be operated for registering the digit 0 in the control apparatus 150. Relays 160 to 169 by grounding one to three of a set of five conductors extending to the control apparatus may selectively operate the relays of a register thereof in the manner disclosed in Patent No. 1,862,549, granted June 14, 1932, to R. Raymond and W. J. Scully.

In the interval between the spoken digit words, whether letters or numbers, the filter controlled relays release and the completion of a digit registration in the control apparatus operates relay 151 to release the digit relays 160 to 169 to prepare for the reception of the next digit. When the registration is complete, the control apparatus 150 will control the operation of the selective switches such as selector 103 in the usual manner. When the called line has been selected, a talking connection is established and the switch 105 released to restore the filters and control apparatus for use with other calls.

In a small system such as a private branch exchange, or in a system of the step-by-step type

the digit relays might control the selector switches directly.

Different words will, of course, cause different filters to respond and operate their associated control relays, each word thereby causing the establishment of a control circuit individual thereto over the contacts of the operated control relays. Since each word can be made to form a completed circuit by the proper cross-connections to the contacts of the control relays, words that may be uttered and not accounted for will not form a complete circuit. In this way, only words (or numbers) that are known to represent the pronouncement of the various office designations and numbers of lines terminating therein will cause the control relays to operate in the proper combinations to complete the control circuits that will cause the operation at the selector control apparatus to selectively control the various selectors in reaching the desired line.

What is claimed is:

1. The method of establishing a connection between two telephone stations which consists in producing an undulating electric current corresponding to sound undulations produced at one of said stations, separating said current into component currents of fundamental frequencies, prolonging the effect of said component currents to establish a record in accordance therewith and controlling the selection of said other station by said record.

2. In a telephone system, a calling station and a called station, means for generating an undulating current corresponding to sound undulations produced at said calling station, means associable with said calling station and responsive to said undulating current for separating said current into component currents of fundamental frequencies, and means responsive to said component currents for controlling the automatic selection of said called station.

3. In a telephone system, a calling station and a called station, a plurality of band-pass filters, each of said filters being resonant to a fundamental frequency of a spoken sound, switching apparatus adapted to connect said calling station with said called station, means responsive to the initiation of a call from said calling station for connecting said filters to said station, means responsive to the operation of said filters when the identity of said called station is pronounced at said calling station for selectively controlling said switching apparatus to connect said called station with said calling station, and a broad band filter resonant to all of said fundamental frequencies for prolonging the operation of said latter responsive means.

4. In an automatic telephone system, a calling line, a called line, switching selectors for extending said calling line to said called line, and a control apparatus for directing the selective movements of said selectors comprising a plurality of band-pass filters each responsive to a fundamental frequency of the speech frequency range, a plurality of recording means corresponding to the numerical elements of a telephone designation, means responsive to the operation of combinations of said filters for operating said recording means to selectively control said selectors to connect with said called line, and means responsive to all of said fundamental frequencies to prolong the effect of the operation of said combinations of filters to insure the operation of said recording means.

5. In a telephone system, a calling station and

a called station, a plurality of band-pass filters, each of said filters being resonant to a fundamental frequency of a spoken sound, switching apparatus adapted to connect said calling station with said called station, means responsive to the initiation of a call from said calling station for connecting said filters to said calling station, means operated by each of a plurality of said filters in responding to a complete spoken digit of a called line designation, means responsive to the conjoint operation of said filter operated means to selectively control said switching apparatus to connect said called station with said calling station, a broad band filter resonant to all of said fundamental frequencies, and means controlled by said broad band filter for locking said filter operated means for an interval sufficient to insure the correct operation of said latter responsive means.

6. In a telephone system, a calling station and a called station, a plurality of band-pass filters, each of said filters being resonant to a fundamental frequency of a spoken sound, switching apparatus adapted to connect said calling station with said called station, means responsive to the initiation of a call from said calling station for connecting said filters to said calling station, means progressively operated by each of a plurality of said filters in responding to the complete undulating electric current produced by a complete spoken digit of a called line designation, means responsive to the conjoint operation of said filter operated means to establish a numerical record for selectively controlling said switching apparatus to connect said called station with said calling station, a broad band filter resonant to all of said fundamental frequencies, and means controlled by said broad band filter for locking said filter operated means as they operate and holding them locked for an interval sufficient to insure that said numerical record represents all of said filter operated means.

7. The method of establishing a connection between two telephone stations which consists in producing a series of complex undulating electric currents corresponding to words spoken at one of said stations, separating the current produced by each spoken word into component currents of fundamental frequencies, making a record of each fundamental frequency detected in each spoken word and combining the records made in response to each spoken word to make a registration for controlling the selection of said other station.

8. The method of establishing a connection between two telephone stations which consists in producing a series of complex undulating electric currents at one of said stations corresponding to the spoken elements of a station designation, separating the current produced by each spoken element into component currents of fundamental frequencies, making a record of each fundamental frequency detected in each complex current and combining the records made from each complex current to make a registration indicative of the corresponding element of the station designation for controlling the selection of said other station.

9. In a telephone system, a calling station and a called station, a plurality of band-pass filters, each of said filters being resonant to a fundamental frequency of a spoken word, switching apparatus adapted to connect said calling station with said called station, a gas-filled tube in the output of each filter, relays operable by the

response of said gas-filled tubes, circuits selectively established by the operation of said relays, and registering means operable over said circuits when said filters respond to spoken words characteristic of the digits of telephone designations to control said switching apparatus. 5

10. The method of establishing a connection between two telephone stations which consists in speaking into the transmitter at one of said stations the elements of the directory number of a desired station thereby generating complex un-

dulating electric currents corresponding to said spoken elements, electrically amplifying and detecting the electric currents corresponding to each spoken element, making a registration of each spoken element in response to the detection of the corresponding currents thereof, and controlling the operation of switching mechanism by said registrations to establish a connection from the calling station to the station whose directory number has been spoken. 10

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