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SYSTEM FOR STORING COCHLEAR PROFILES

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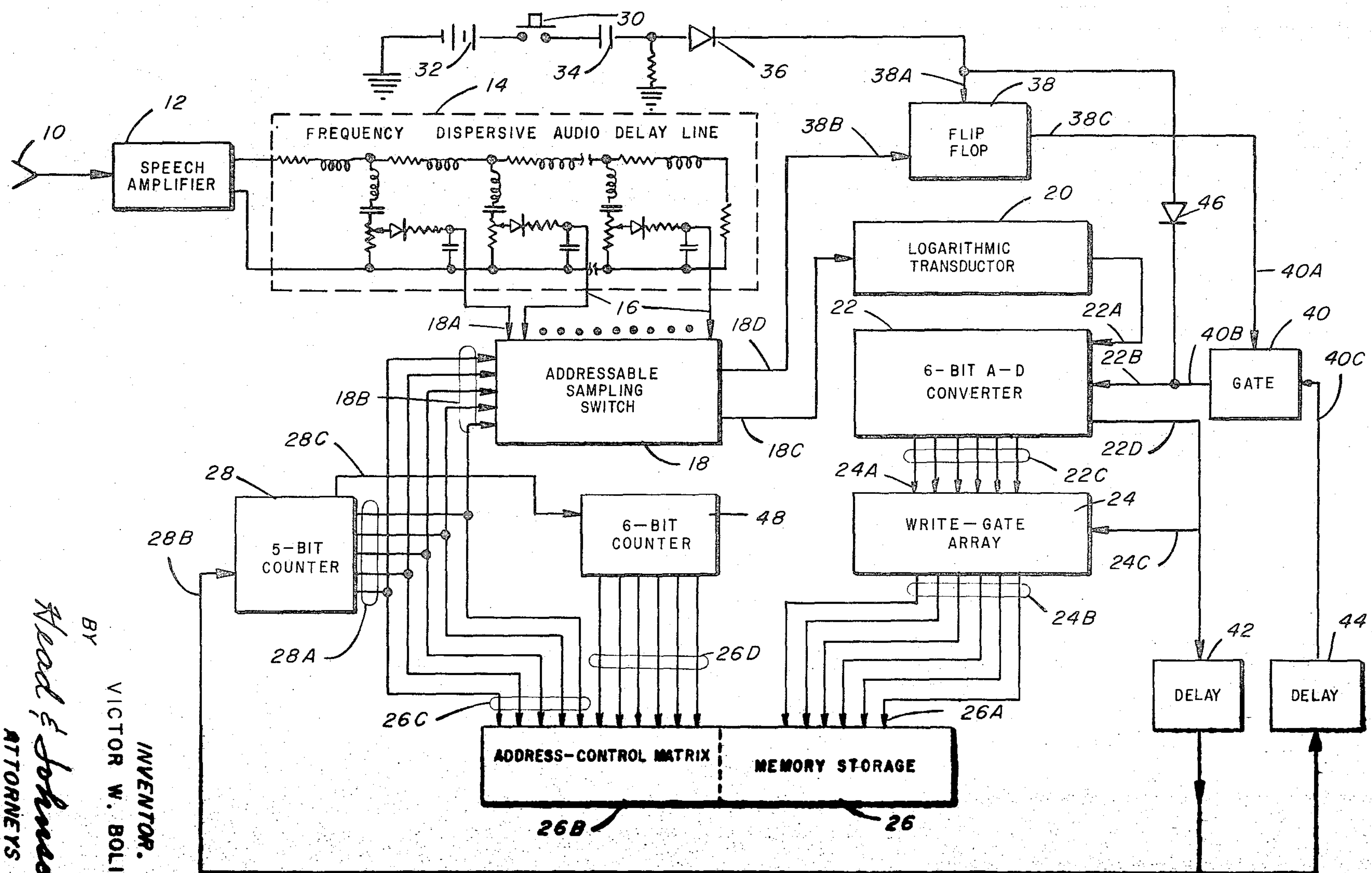

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SYSTEM FOR STORING COCHLEAR PROFILES

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ABSTRACT OF THE DISCLOSURE

This invention relates to a system for storing cochlear profiles. More particularly, the invention relates to a system for storing cochlear profiles of phonemes including a frequency dispersing circuit receiving at its input the full spectrum of frequencies making up a phoneme and providing multiple individual outputs of separate narrow frequency bands, each of the bands representing an analog signal of a discrete portion of the phoneme full spectrum and which multiple analog signals define a composite cochlear profile of the phoneme, a sampling step switch providing sequentially an output signal of each of the analog signals of the frequency dispersing circuit, an analog-to-digital converter receiving the sequential analog signal outputs of the sampling switch and converting each signal sequentially into a digital signal, a memory storage means connected to receive and store the digital signals, and means of automatically sequentially advancing in synchronization the sampling switch and the memory storage means until each of the discrete portions of the phoneme full spectrum is stored in digital form.

CROSS-REFERENCES

This disclosure is not related to any pending United States or foreign patent application.

BACKGROUND AND SUMMARY OF THE INVENTION

It has been recognized that the ultimate application of computer technology will include means of direct vocal communication of human operators with the computer devices. Only in this way can immediate and direct communication from the human mind to the memory storage and recall devices of computer apparatus be established in a way not requiring requests and commands to be translated into code form. In addition, there are many practical reasons why it is important to be able to recognize orally transmitted intelligence.

A first step in a means of oral communication with computer and memory storage devices includes the storing of the various portions of speech of any given language in an arrangement so that such stored speech portions may be subsequently scanned for use in implementing automatic speech recognition techniques. Speech sounds may be generally classified as voiced and unvoiced. Of the voiced sounds in the English language the vowels form the larger part. These are sounds like a, e, i, o, u, and sometimes y. In addition there are vowel-like consonants including m, n, g, w, and l, which are all characterized by a musical type sound. Other sources of oral word components are those which may be considered unvoiced sounds, that is, those which are generated without use of the vocal cords. The consonants t, p, f, s, and k are examples of unvoiced sounds in which the vocal cords are not used. Such sounds are generated by the interruption of the speaker's breath outflow by action of the lips, tongue, and soft palate in such a way as to cause momentary buildup of air pressure, with the sudden release of the breath pressure causing characteristic sounds

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of the particular consonants. Other consonants are provided by partially restricting the free flow of air from the mouth producing the hissing sounds characteristic of the letters s, ch, f, h, th, soft c, v, and z. Such are called sibilants. Other consonants, such as b, d, and g, are formed by the generation of a subdued buzz combined with the interruption of the breath flow by the action of the lips, tongue, and soft palate. In addition, there are voiced sibilants such as the change of an s sound to a z sound when the vocal cords are brought into place.

Language is made up of words, and words are made up of a combination of small sound increments, such increments being termed a "phoneme." There is some area of disagreement as to the total number of phonemes utilized in any given language. For instance, in the English language the number of phonemes is said by some to be as few as twenty-five. Others say that as many as forty different phonemes are required to formulate the words of the full range of the commonly spoken English language. In any event it is recognized that a relatively few sounds (25 to 40) are all that is required to form words and that the combination of these sounds into words and the words into sentences results in the tools by which all human intelligence is vocally transmitted and received. Generally speaking the ear of a human being functions in conjunction with the logic system of the brain to recognize each phoneme of sound and thereafter to recognize the combination of phonemes which make up words. Subsequently a higher order of intelligent activity recognizes combinations of words as expressions of thought. Thus it can be seen that oral communication begins with a number of phonemes in the range of approximately 25 to 40. Any computer arrangements for utilizing the spoken language must therefore begin with means of storing for subsequent scanning and recognizing the phonemes which make up human speech.

It has also been learned that the ear apparently functions to recognize phonemes by an arrangement in which the cochlea distinguishes the separate but sometimes overlapping frequency bands making up each phoneme of sound.

In response to this knowledge others have provided simulators for mechanical action of the human ear which provides electrical signal outputs of space-time activity patterns corresponding to those communicated from the inner ear through the acoustic nerve to the brain as a result of sound stimulation. Generally speaking, such devices may be termed an "analog ear" or a "frequency dispersive audio delay line," or a "frequency dispersive circuit." By any of the names to which they are referred such circuit arrangements are primarily spectrum analyzers, that is, each circuit receives an audio reproduction of the full frequency range of a phoneme, such as from a microphone and audio amplifier, and provides, at a series of output terminals, narrow bands of discrete portions of the composite frequency spectrum. Such bands may be overlapping or non-overlapping, however, in the preferred arrangement the bands are overlapping. The total of the composite signal output from the frequency dispersing circuit defines an envelope which is characteristic of the phoneme received. By storing the envelopes of the various phonemes in digital form in a memory storage device, the device may be subsequently scanned for comparison of envelopes to identify phonemes. This invention relates to a system for storing the envelopes of discrete signal outputs from a frequency dispersive circuit, which may be termed a cochlear profile, in a memory storage means.

It is therefore an object of this invention to provide a system for storing cochlear profiles of sound phonemes.

More particularly, an object of this invention is to provide a system for establishing cochlear profiles of phonemes and to code such profiles in digital form into a memory device.

Still more particularly, an object of this invention is to provide a system wherein a phoneme may be introduced into a sound receiving means and, by a single switch actuation, a series of discrete analog signals forming a composite envelope characteristic of the phoneme is sequentially converted from analog-to-digital form and stored into a memory device, the memory device and means of sequentially selecting discrete portions of the composite signal being automatically advanced in synchronization.

These as well as many other objects of this invention will be understood by referring to the description and claims taken in conjunction with the drawings.

DESCRIPTION OF THE VIEW

The drawing is a circuit diagram of a system for storing cochlear profiles illustrating an embodiment of the invention.

As previously stated the invention relates to a system for storing cochlear profiles of phonemes. When a profile of a phoneme is to be stored a sound, such as from a speaker, is directed into a microphone **10**. As an example, if it is desired to store in digital form a profile of the phoneme "ah" this sound is expressed into the microphone **10**. The sound is amplified in amplifier **12** and fed into a frequency dispersive audio delay line **14** which may also be described as a frequency dispersive circuit. The frequency dispersive audio delay line **14** provides a plurality of separate outputs **16** each responsive to pass a separate narrow frequency band. The sum of the frequency bands passed through outputs **16** provides a composite envelope of substantially the full spectrum of the phoneme to be stored. While the number of frequency bands delivered out of the frequency dispersive audio delay line **14** may vary, a typical arrangement for practicing the invention includes thirty-two output points **16** each of which pass only those frequency components in a selected narrow band, the width of the band being typically about ten to twenty percent of the center frequency of the band. The frequency dispersive audio delay line **14** includes a series of rectifiers and RC smoothing filters which provide a corresponding series of measures of the intensities of the various frequency components of the speech signal. The frequency-selective characteristics of the audio delay line may be achieved by means of a sequence of low-Q series-RLC-shunts interleaved with a corresponding sequence of low-Q series-RL-segments with the inductances of both the series and shunt inductors having numerical values proportional to the antilogarithm of their normalized distances from the receiving end of the line, and with the resonant frequency of each series-RLC-shunt being made inversely proportional to the antilogarithm of its normalized distance from the receiving end of the line. The two dimensional patterns which would be seen from a plot of a tapped-voltage amplitude versus the tap-number can be designated as a "cochlear profile" in analog with the profile of vibration-amplitudes existing on the basilar membrane of the inner ear in response to a composite sound wave impinging on the eardrum. The thirty-two outputs, only three of which are shown to conserve space on the drawing, are fed into the input of an addressable sampling switch **18**. In the illustrated embodiment the addressable sampling switch **18** has thirty-two analog signal inputs **18**A connected to the thirty-two outputs **16** of the frequency dispersive audio delay line. In addition, the addressable sampling switch **18** has a multi-bit address input **18**B by which the switch is sequentially addressed to each of said inputs **18**A. In the illustrated arrangement the address input is made a five-bit binary signal, to provide any one of thirty-two different addresses. The sampling switch **18** further has an analog signal output **18**C to which each of the frequency dispersive audio delay line outputs **16** is sequentially connected. The sampling switch in addition includes a terminator signal output **18**D at which a signal in the form of a single digital pulse appears when the sampling switch has completed a sweep of each of the frequency inputs **18**A.

The analog signal output **18**C of the sampling switch **18** is connected through a logarithmic transductor **20** to an analog-to-digital converter **22**. Since the logarithmic transductor **20** is optional it can be said that the sampling switch analog signal output **18**C is connected to analog signal input **22**A of an analog-to-digital converter **22**. The analog-to-digital converter **22** further includes an initiator signal input **22**B in the form of a single digital pulse, and a multichannel binary signal output collectively identified as **22**C. In the illustrated embodiment the analog-to-digital converter **22** is a six-bit converter so there are six output circuits **22**C as illustrated. In addition the analog-to-digital converter **22** includes a terminator signal output **22**D at which a signal in the form of a single digital pulse appears each time the analog-to-digital converter has completed the conversion started by the initiator pulse applied to terminal **22**B.

The multichannel binary signal output **22**C from analog-to-digital converter **22** is fed to the multichannel binary signal input **24**A of a write-gate array **24**. The write-gate array **24** further includes a multichannel binary signal output collectively identified as **24**B and a write-command input **24**C. The write-command input **24**C is connected to the terminator signal output **22**D of analog-to-digital converter **22**. The cochlear profile is stored in a memory storage means **26** which may be in the form such as a memory drum. The memory storage means **26** includes a multichannel signal input **26**A which is connected to the write-gate array output **24**B. The memory storage means **26** includes an address control matrix portion **26**B having a multibit address input collectively identified as **26**B. In the illustrated arrangement the address control matrix of the memory storage means has a five-bit address signal input **26**C plus a six-bit address-advance signal input **26**D totaling an eleven-bit address control matrix.

A multibit counter **28** is provided having a multichannel output collectively identified as **28**A which is connected both to the memory storage means address signal input **26**C and to the multibit address input **18**B of the addressable sampling switch **18**. In addition the multibit counter **28** includes a count stepping signal input **28**B. In the illustrated arrangement the counter **28** is a five-bit counter corresponding to the five-bit input **18**B of the addressable sampling switch **18** and the five-bit input **26**C address control matrix of memory storage means **26**. Multibit counter **28** also furnishes a terminator signal output **28**C in the form of a single digital pulse which appears each time counter **28** has been stepped through a full sweep of its maximum available steps.

A second multibit counter **48** is provided having a multichannel output which furnishes the address-advance signal **26**D of memory storage means **26** and also having a stepping signal input **28**C received from the terminator output of multibit counter **28**. In the illustrated arrangement counter **48** is a six-bit counter. The total eleven-bit input to address control matrix **26**B thus allows the storage in memory storage means **26** of a total of $2^6=64$ cochlear profiles each consisting of a sequence of $2^5=32$ numerically represented data samples obtained from the frequency dispersive audio delay line **14**.

Storage of a cochlear profile is initiated when storing signal switch **30** is depressed. By means of a battery **32** a voltage pulse is transmitted through capacitor **34** and diodes **36** and **46** to the initiator signal input **22**B of the analog-to-digital converter **22**. In addition, a flip-flop circuit is provided having a set signal input **38**A, a reset signal input **38**B, and a control signal output **38**C. The storing signal passing through diode **36** is applied to the set signal input **38**A of the flip-flop circuit **38**. One output signal **38**C of flip-flop circuit **38** is fed as a control signal **40**A to gate circuit **40**, the digital pulse input **40**C of which is transmitted as a digital pulse output control signal **40**B only during the time interval beginning when flip-flop **38** is set by input signal **38A** and ending when flip-flop **38** is reset by input signal **38B**. The output pulse signal **40B** from gate **40** is connected to the initiator signal input **22B** of analog-to-digital converter **22**. Diode **46** prevents signal **40B** from affecting flip-flop **38**. The terminator signal output **22D** of the analog-to-digital converter **22** not only furnishes the write-command signal **24C** but also is connected by way of a first delay circuit **42** and a second delay circuit **44** (the function of which will be described subsequently) to the signal input **40C** of gate **40**. The output pulse signal of the first delay circuit **42** also furnishes the input signal **28B** to multibit counter **28**.

OPERATION

When it is desired to store a cochlear profile of a specific sound, such as a phoneme of speech, the sound, such as an "ah" sound, is directed into the microphone **10**. The sound is amplified in speech amplifier **12** and is fed to the frequency dispersive audio delay line **14**. There the sound is separated into separate analog signal outputs, each representing an analog signal of a discrete portion of the phoneme full spectrum. The multiple analog signals appearing at the output **16** of the frequency dispersive audio delay line **14** together define a composite cochlear profile of the phoneme. Each of these analog signals is fed to sampling switch **18**. Assuming counters **28** and **48** are first initialized to their all-zero conditions, the analog signal of the first of the analog outputs of the audio dispersive line is fed by way of logarithmic transductor **20** to the analog input **22A** of analog-to-digital converter **22**. While the phoneme is directed into microphone **10** its cochlear profile can be stored by depressing switch **30**. This not only sends a signal by way of diode **46** to the initiator signal input of analog-to-digital converter **22**, but also enables gate **40** to transmit by reason of flip-flop **38** being simultaneously set. By reason of such initiator signal input the analog signal representing the first of the thirty-two outputs of frequency dispersive audio delay line **14** is converted from an analog to a digital signal. Such digital signal appears across multibit output **22C** of the analog-to-digital converter and at the input of the write-gate array **24**. Upon completion of the conversion a termination signal appears at analog-to-digit converter termination signal output **22D** which is fed to the write signal input **24C** of the write-gate array. This signal causes a transfer of the multibit digital signal into the particular location in memory storage **26** determined by the initialized all-zero conditions of counters **28** and **48**. Thus, a digital signal is stored in memory storage means **26** representing the analog signal appearing at the first of the thirty-two outputs of the frequency dispersing audio delay line. Shortly thereafter the termination signal at **22D** is fed through delay **42** to the count stepping signal input **28B** of counter **28**. This advances the counter by one step which not only advances the sampling switch **18** so that the analog signal from the second output of the frequency dispersive audio delay line **14** is fed to the analog signal output **18C** but also advances the address of memory storage means **26** to the next location. First delay **42** is provided to insure that the digital signal from analog-to-digital converter **22** and write-gate array **24** appearing at digital signal inputs **26A** is stored in the memory storage means **26** before the memory storage means is advanced to its next address by means of counter **28**. In addition, the signal passing through delay circuit **42** passes through a second delay circuit **44** and to the signal input **40C** of gate circuit **40**. As long as the flip-flop circuit **28** is in the set position gate circuit **40** is biased to conduct so that such input signal **40C** is passed through a gate output signal **40B** to the initiation signal input **22B** of the analog-to-digital converter **22**. This then converts the analog signal from the second tap of the frequency dispersive audio delay line **14** and upon conversion and appearance of the terminator signal at **22D** the write-gate array **24** is signaled to transmit the digital signal to storage means **26**. The function of second delay **44** is to insure that the sampling switch **18** and the address control matrix **26B** have each advanced to their next positions following the signal at the output of first delay **42** before the signal **40C** passes through gate **40** for the next conversion.

This sequence continues, automatically stepping the sampling switch **18** through thirty-two separate positions at each of which positions the analog signal appearing at a different tap of the frequency dispersive audio delay line is converted into a digital signal and stored. Upon termination of the thirty-second storage a reset signal appears at signal output **18D** of sampling switch **18**. This signal resets flip-flop circuit **38** so that the signal appearing at **38C** and **40A** turns gate circuit **40** to the off condition, in which condition no additional signal inputs at **40C** can pass therethrough to initiate further conversions by converter **22**. Thus, a sweep of the full thirty-two taps of the frequency dispersive audio delay line is automatically completed upon the pressing at one time of the storage signal switch **30**. At the same time five-bit counter provides a count termination signal at output **28C** to step six-bit counter **48** which in turn advances the address of the control matrix for storing the next cochlear profile.

When it is desired to store the next cochlear profile such as the "ē" phoneme the sound is directed into microphone **10** and storage signal switch **30** is pushed. The automatic sequence is then repeated in which thirty-two analog signals are converted into digital form and stored in the next sequence of thirty-two locations in memory storage **26**.

The cochlear profile described by the amplitude of the thirty-two output voltages of the frequency dispersive audio delay line has a pattern shape which responds only slowly to changes in speech sounds, provided that the time constants of the RC filters supplied by the associated rectifiers are suitably long. The switching delays of the various components of the system are of such brevity that the total time interval in which the flip-flop **38** maintains the gate **40** in the "enabled" condition is less than 100 milliseconds so that the cochlear profile remains essentially stationary during the time required to read and store the thirty-two corresponding voltage amplitudes.

The logarithmic transductor **20** is optional in the circuit, the purpose being to convert the analog signal output of each of the taps of the frequency dispersive audio delay lines into a voltage proportional to the logarithm of each such signals so that the storage signal more nearly corresponds with the aural receptiveness of the human ear. It can be seen that the system functions the same whether or not the logarithmic transductor **20** is utilized.

The delay circuits **42** and **44** may each be in the form of a monostable multivibrator followed by simple RC differentiator circuit and diode to produce the appropriately delayed pulse.

The airborne sound directed to microphone **10** may include, in addition to aural phonemes, musical tones, underwater sounds, noises of burning fires, sound of approaching aircraft, or sounds from any other source. Once the various cochlear profiles are loaded into the data memory, they can be recalled whenever needed as reference signals for more detailed analysis. In addition, such storage profiles may be utilized in computer devices for automatic pattern recognition operation, for sound operated control systems, and multitude of other uses requiring rapid access to a set of cochlear profiles.

In the invention certain numerical relationships are shown such as counter **28** is illustrated as being a five-bit counter, analog-to-digital converter is illustrated as being a six-bit converter, and so forth. This is by way of exemplification only and the invention is not limited to such illustrated numerical embodiments.

It is understood that the invention has been described with a certain degree of particularity and that many changes may be made in the details of construction and the arrangement of components without departing from the spirit and scope of this disclosure. It is understood that the invention is not to be limited by the abstract herein, nor the circuit arrangement which is shown to exemplify one embodiment of the invention, but the invention is to be limited only by the scope of the attached claims, including the full range of equivalency to which each element thereof is entitled.

What is claimed:

1. A system for storing cochlear profiles of phonemes comprising:

a frequency dispersive circuit receiving at its input the full spectrum of frequencies making up a phoneme and providing multiple individual outputs of separate frequency bands, each of which bands is represented by a rectifier-derived signal voltage analog of the intensity of a discrete portion of said phoneme full spectrum and which multiple analog signals define a composite cochlear profile of the phoneme;

a sampling step switch providing sequentially an output signal of each of said analog signals from said frequency dispersive circuit;

an analog-to-digital converter receiving the sequential analog signal outputs of said sampling switch and converting each such signals sequentially into a digital signal;

a memory storage means connected to receive and store said digital signals from said analog-to-digital converter; and

means of automatically sequentially advancing in synchronization said sampling switch and said memory storage means until each said discrete portion of said phoneme full spectrum is stored in digital form.

2. A system for storing cochlear profiles of phonemes according to claim 1 wherein said means of automatically advancing said sampling switch and said storage means includes:

a multibit counter having a counter step signal input and a multibit addressing signal output connected to said sampling switch and said memory storage means whereby said sampling switch and said memory storage means are advanced in response to said multibit addressing signal which in turn is controlled in response to said counter step signal input, and wherein said analog-to-digital converter includes a termination signal output connected to said multibit counter step signal input whereby upon completion of each conversion by said analog-to-digital converter a stepping signal is provided to said multibit counter.

3. A system for storing cochlear profiles of phonemes according to claim 1 in which said analog-to-digital converter includes an initiator signal input and including:

a gate means having a signal output connected to said initiator signal input of said analog-to-digital converter and having a signal input connected to said terminator signal output of said analog-to-digital converter, and further having a control input and including means of providing an enabling control signal to said gate during said automatically sequentially advancing of said sampling switch and said memory storage means as said discrete portions of said phoneme full spectrum is stored and of providing a disabling control signal to said gate to terminate said automatically sequentially advancing of said sampling switch and said memory storage means upon the completion of the storage of all of the said discrete portions of the full spectrum of a phoneme.

4. A new system for storing cochlear profiles of phonemes according to claim 3 wherein said sampling switch provides reset signal output when said sampling switch has been sequentially stepped through the number of steps equal to said individual outputs of said frequency dispersive circuit and wherein said means of providing said enabling control signal and said disabling control sign to said gate include:

a flip-flop circuit having a set signal input, a reset signal input connected to said reset signal output of said sampling switch, and a control signal output connected to said gate means control input, said flip-flop circuit providing an enabling signal to said gate means when a set signal is received and providing a disabling signal to said gate means when a reset signal is received from said sampling switch; and including

a storing switch means providing, upon actuation, a storing signal to said flop-flop circuit set signal input.

5. A system for storing cochlear profiles according to claim 4 including:

a delay means in said terminator signal output of said analog-to-digital converter whereby said terminator signal to said multibit counter which in turn steps said sampling switch and addresses said memory storage means is delayed to insure that the digital signal to said memory storage means is first stored before said counter is stepped.

6. A system of storing cochlear profiles according to claim 4 including:

a delay means in said gate circuit initiator signal input whereby the receipt of an initiator signal input to said analog-to-digital converter is delayed after the storing of each converted analog signal before the storing of the subsequent signal to permit sufficient time for said multi-bit counter to step said sampling switch and to address said memory storage control matrix.

7. A system of storing cochlear profiles according to claim 4 including:

a first delay means in said terminator signal output of said analog-to-digital converter whereby said terminator signal to said multibit counter which in turn steps said sampling switch and addresses said memory storage means is delayed to insure that the digital signal to said memory storage means is first stored before said counter is stepped; and

a second delay means in said gate circuit signal input whereby the receipt of an initiator signal input to said analog-to-digital converter is delayed after the storing of each converted analog signal before the storing of the subsequent signal to permit sufficient time for said multi-bit counter to step said sampling switch and to address said memory storage control matrix.

8. A system of storing cochlear profiles of phonemes of sound comprising:

a microphone providing means for receiving phonemes of sound;

an amplifier having an input and an output, the input being connected to said microphone;

a frequency dispersive circuit having an input connected to the output of said amplifier, and having a plurality of separate outputs each responsive to the intensity of a component of the output of said amplifier as passed in a separate frequency band, each represented as an analog signal, the sum of the analog signals covering substantially the full spectrum of each of the phonemes to be stored;

an addressable sampling switch having a plurality of analog signal inputs each connected to one of said outputs of said frequency dispersive circuit, and having a multibit address input by which the switch is sequently stepped through each of said inputs, the sampling switch further having an analog signal output to which each of said outputs of said frequency dispersive circuit is sequentially connected, and the sampling switch further having a reset signal output at which a signal appears when the switch has completed a stepped sweep of each of said analog signal inputs;

an analog-to-digital converter having an analog input, an initiator signal input, a terminator signal output, and a multichannel digital signal output, the analog input being connected to said analog signal output of said sampling switch;

a write-gate array having a multichannel digital signal input connected to said multichannel digital signal output of said analog-to-digital converter, and having a multichannel digital signal output and a write signal input;

a memory storage means having a multichannel digital signal connected to said multichannel digital signal output of said write-gate array, and including an address control matrix portion having a multibit address input and an address advance signal input;

a multibit counter having a multichannel output connected to said multibit address input of said memory storage address control matrix and to said multibit address input of said addressable sampling switch, the counter having a count termination signal output connected to said address advance signal input of said memory storage address control matrix, and having a count stepping signal input;

a storing signal switch providing, when actuated, a storing signal pulse, said storing signal switch connected to said initiator signal input of said analog-to-digital converter;

a flip-flop circuit having a set signal input connected to said storing signal switch, a reset signal input connected to said reset signal output of said sampling switch, and a control signal output; and

a gate circuit having a signal output connected to said initiator signal input of said analog-to-digital converter, and having a signal input connected to said terminator signal output of said analog-to-digital converter and further having a gate control input connected to said control output of said flip-flop circuit, said flip-flop circuit providing an enabling control signal to said gate circuit upon receipt of a storing signal and maintaining said enabling control signal until a reset signal is applied to said flip-flop reset signal input from said sampling switch upon the completion of the stepped sweep of each of said analog signal inputs, said count stepping signal input of said multibit counter being connected to said terminator signal outptu of said analog-to-digital converter whereby upon the completion of a conversion said counter delivers a next address signal to said memory storage address control matrix to automatically advance said memory storage to receive and store, in digital form, each of said separate analog signals at said plurality of outputs of said frequency dispersive circuit upon the initial actuation of said storing signal switch.

9. A system for storing cochlear profiles according to claim **8** including:

a delay means in said terminator signal output of said analog-to-digital converter whereby said terminator signal which is communicated to said multibit counter which in turn advances the address of said sampling switch and advances the address of said memory storage means is delayed to insure that said signal to said write-gate array has first stored the digital conversion of the previous analog signal.

10. A system of storing cochlear profiles according to claim **8** including:

a delay means in said gate circuit initiator signal input whereby the receipt of an initiator signal input to said analog-to-digital converter is delayed after the storing of each converted analog signal to permit sufficient time for said multibit counter to step said sampling switch and to address said memory storage control matrix.

11. A system of storing cochlear profiles according to claim **8** including:

a first delay means in said terminator signal output of said analog-to-digital converter whereby said terminator signal to said multi-bit counter which in turn steps said sampling switch and addresses said memory storage means is delayed to insure that the signal to said write-gate array has first stored the digital signal of the previous analog signal; and

a second delay means in said gate circuit initiator signal input whereby the receipt of an initiator signal input to said analog-to-digital converter is delayed after the storing of each converted analog signal to permit sufficient time for said multibit counter to step said sampling switch and to address said memory storage control matrix.

12. A system for storing cochlear profiles according to claim **8** including a logarithmic transductor circuit between said sampling switch analog signal output and said analog-to-digital converter analog signal input whereby the analog signal of each output position of said frequency dispersive circuit is logarithmically scaled prior to conversion and storage.

References Cited

UNITED STATES PATENTS

3,294,909	12/1966	Caldwell et al.	179—1
3,469,034	9/1969	Stewart	179—1

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