

Crimmins et al.

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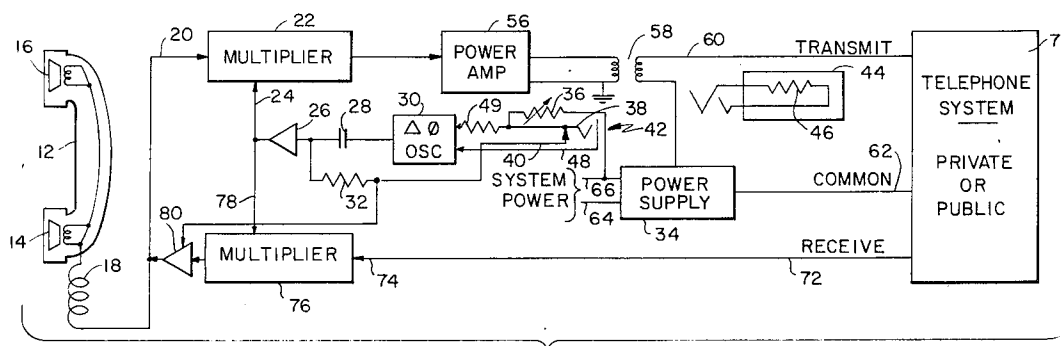
- [58] **Field of Search** 179/1.5 SR, 81 B,
179/170 J; 331/177, 179

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An electrical signal scrambling system operative to convert intelligible voice signals to one of a plurality of states of uniquely coded unintelligible signals prior to transmission through a communication network and operative to reconvert received unintelligible signals into normally intelligible signals. The scrambling system is adapted for mounting directly within the handset of a normal telephone terminal, with selection of an unintelligible state provided by a set of plugs. Operating power for the scrambling system is provided in a novel manner from the communication network.

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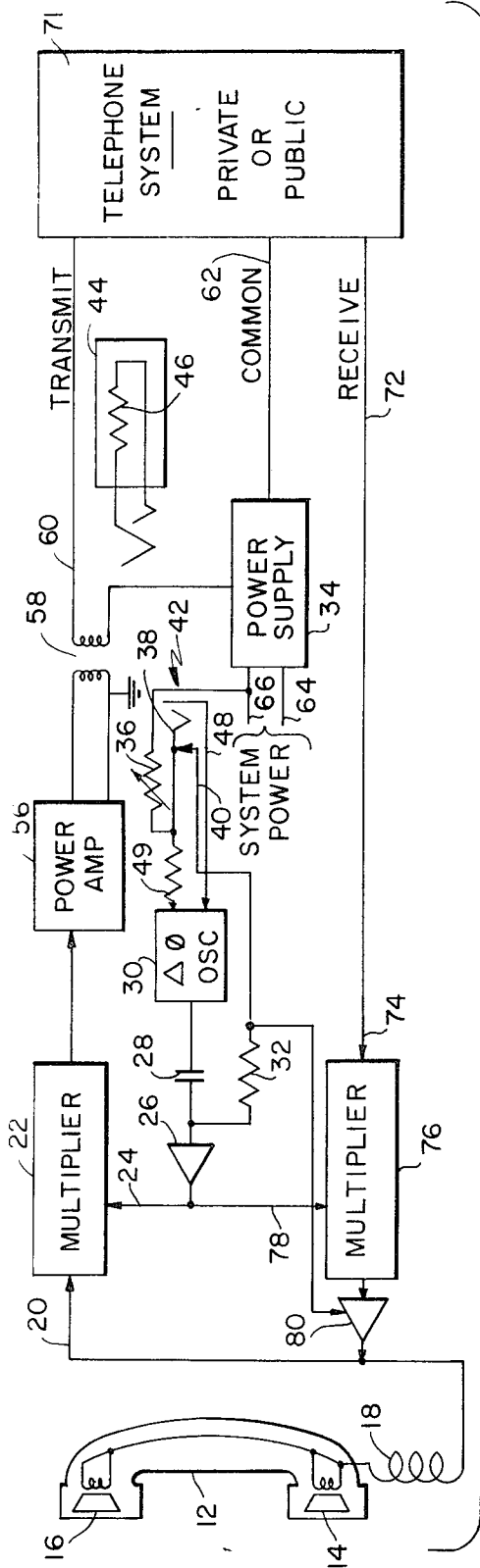


FIG. 1

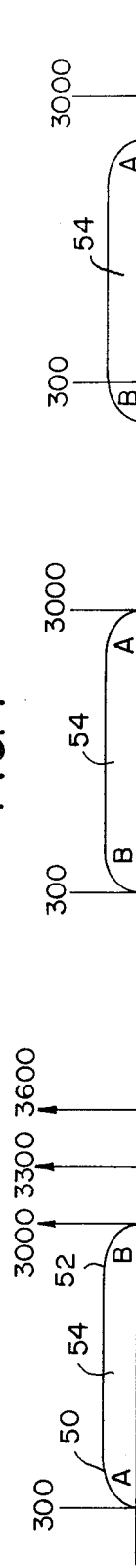


FIG. 2a

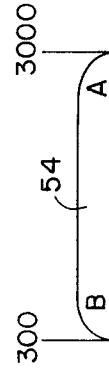


FIG. 2b

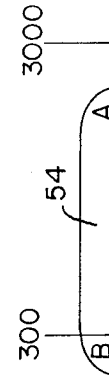


FIG. 2c

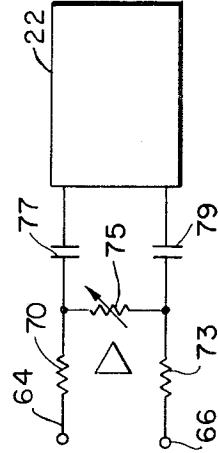


FIG. 3

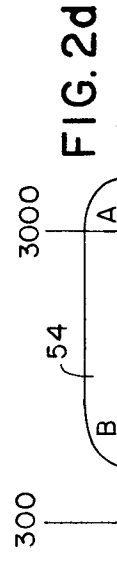


FIG. 2d

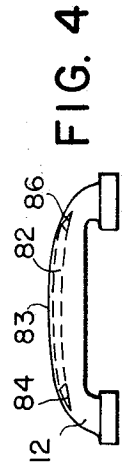


FIG. 4

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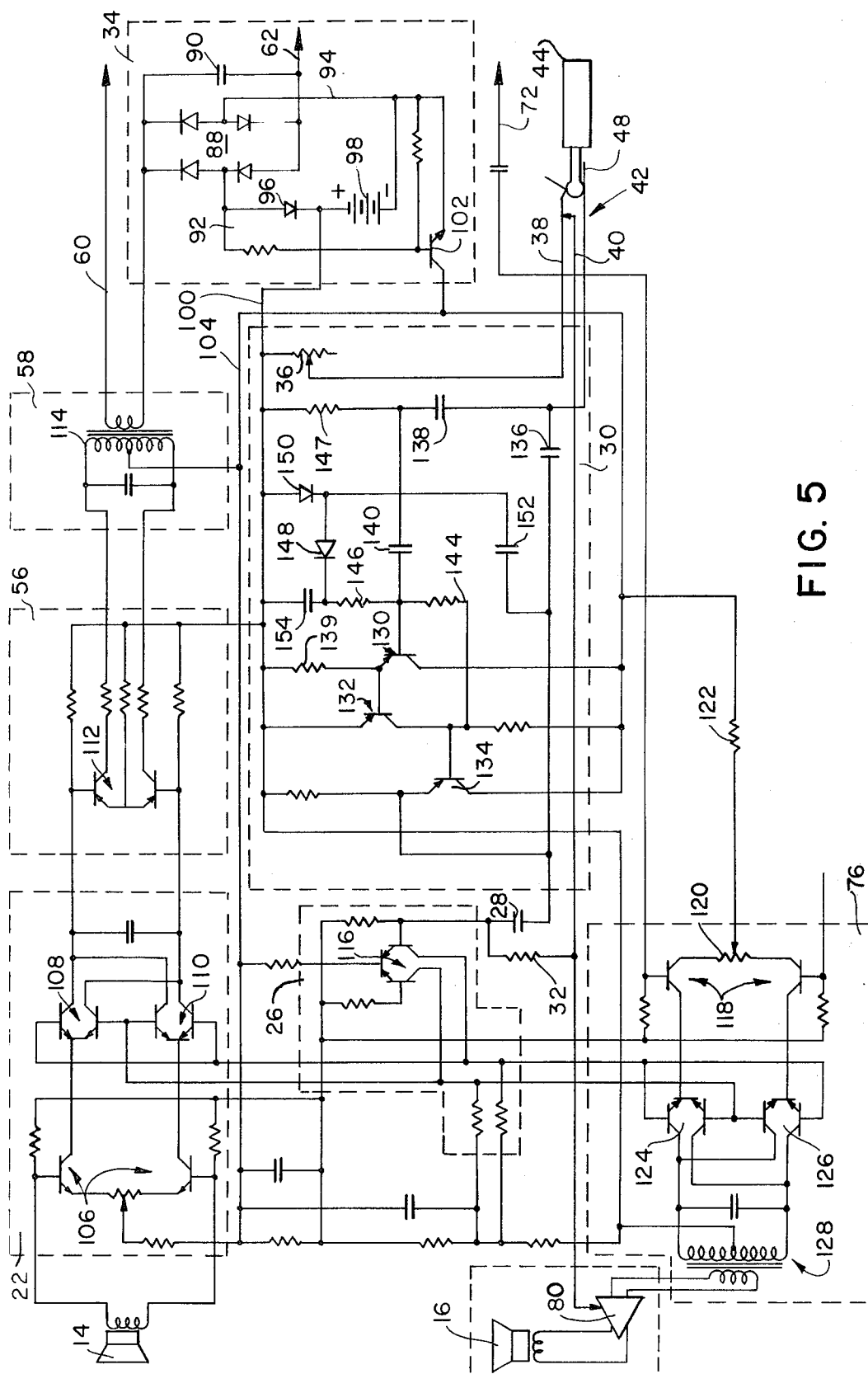


FIG. 5

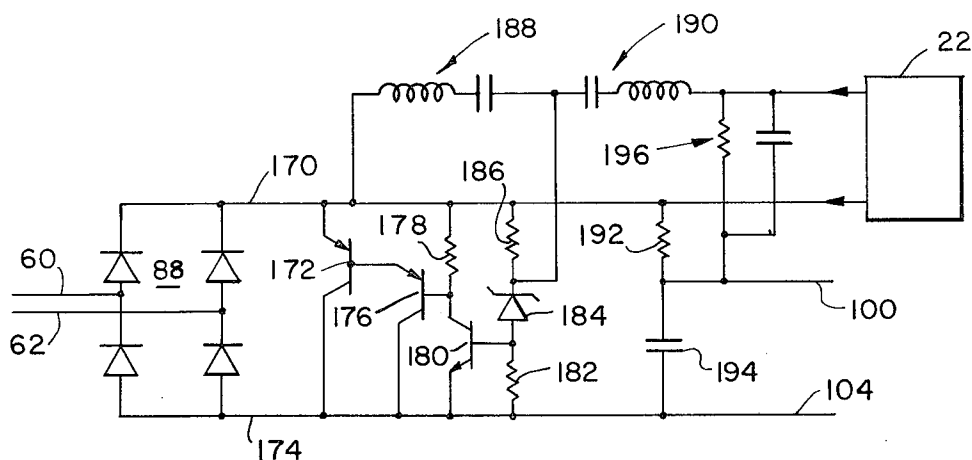


FIG. 6

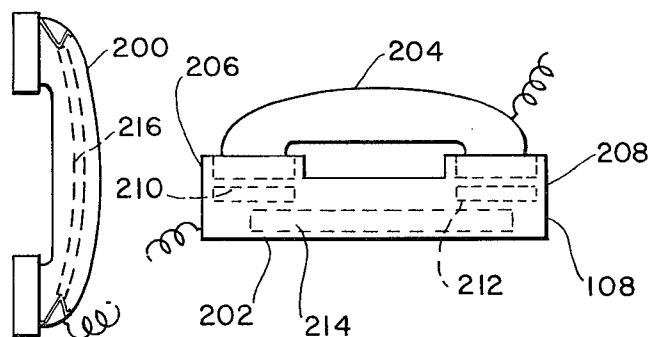


FIG. 7

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SECURITY PHONE**FIELD OF THE INVENTION**

This invention relates to signal coding systems and in particular to systems for providing a plurality of uniquely coded unintelligible scrambling and unscrambling operations for audio frequency communications.

BACKGROUND OF THE INVENTION

Undetected eavesdropping on telephone conversations by secretaries, switchboard operators, and others is of great concern to organizations having more than one listening post for each telephone line. While total security against the most persistent eavesdropper is, from a practical standpoint, impossible in a telephone system, many telephone conversations between businessmen and professionals do not require this complete security but do require freedom from the occasional, intentional, or even unintentional, eavesdropping by other organization members and outsiders.

To prevent any type of eavesdropping on multiple access telephone lines it is necessary to alter the transmitted electrical signals so as to make them unintelligible before transmission from the originating part and to restore the intelligibility of the information after reception by the intended party. Various forms of frequency conversion techniques to accomplish this scrambling function are well known and have been applied to code telephone transmissions. Until the present invention, however, no prior art system provided a simple, self-contained unit adapted for integral use with telephone handsets of the originating and receiving parties to prevent unauthorized listening on other handsets. Prior art systems suffered from complexity aimed at achieving a greater security than necessary in order to defeat casual eavesdropping while not totally removing the possibility of listening by the persistent snoop. The sophisticated scrambling systems, moreover, reduced the flexibility of the telephone system in attempting to achieve more complete security than is usually necessary. Previously, if several telephone terminals were to be able to communicate over scrambled lines it became complex and costly to provide several scrambling levels so as to exclude some scrambled terminals from the ability to listen to other scrambled terminals while providing at least some level of scrambling security for all combinations of communications among the several equipped terminals. Prior systems were also based upon providing scrambling levels on the basis of the terminal employed and not on the basis of the user's security needs, regardless of the terminal employed.

BRIEF SUMMARY OF THE INVENTION

In an exemplary, preferred embodiment of the present invention, a system is shown for selectively scrambling communications between terminals of a network and providing for selection of one of a plurality of unintelligible states for the electrical signals transmitted through the network. The scrambling system is integral to each terminal which is to be equipped with scrambling and unscrambling capabilities so that there is no fear of being overheard by telephone terminals not requiring coding capability and consequently not equipped with scrambling electronics. A number of terminals on the same line may be equipped with scrambling electronics without dilution of the security of the system by providing for the scrambling and descram-

bling functions to be performed only in response to the insertion into the equipped terminal of one of a plurality of different, personally retained keys or plugs; each of the different keys providing a unique scrambling and unscrambling characteristic to the electrical signals transmitted through the network. By distributing keys only to authorized personnel and by limiting the types of different keys distributed to different classes of personnel, various levels of security may be maintained within the individual organization with each scrambling equipped terminal available for any level of security determined by the users keys. Unequipped terminals are made highly secure against all unauthorized listening on scrambled communications by having no scrambling equipment at all usable with any key.

When used with the telephone system, operating power for the scrambling system of each terminal is provided by diverting the limited DC current available from two lines of the telephone system from use to power the mouthpiece to use for system power in isolation from the information bearing signals impressed across the same two lines.

A portable scrambling system may also be provided to accommodate executives away from the office. The infrequent use of these portable units allows them to be locked against unauthorized use, which in conjunction with the system of plug-in, scrambling characteristic selection keys prevents dilution of the security of the entire scrambling system.

BRIEF DESCRIPTION OF THE DRAWINGS

The telephone scrambling system according to the invention will be more fully understood by reference to the following detailed description of the preferred embodiment presented for purposes of illustration and not limitation and read in conjunction with the drawings of which:

FIG. 1 is a block diagram and partial schematic of electronics for accomplishing scrambling functions of the invention;

FIGS. 2A-2D are frequency domain graphs useful in interpreting the functions of the scrambling system of the invention;

FIG. 3 is a partial schematic and partial block diagram of alternative system microphone input means;

FIG. 4 is a pictorial view of a telephone handset having therein a scrambling system;

FIG. 5 is a schematic and partial block diagram of circuitry for performing the scrambling function according to the invention;

FIG. 6 is a partial schematic and partial block diagram of alternative means for combining a signal with network lines and for obtaining system power therefrom; and

FIG. 7 is a pictorial and partial sectional view of portable equipment for accomplishing the scrambling function according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, an exemplary preferred embodiment is shown in block and partial schematic diagram of circuitry for accomplishing the scrambling function of the invention. A normal telephone or network handset 12 has electromagnetic mouth and earpieces 14 and 16 respectively with electrical connections to a cable 18. The two wires in cable 18 carrying electrical signals

from the mouthpiece 14 are applied to a multiplicand input 20 of a multiplier 22 preferably operating as a chopper or double pole double throw switch as indicated below. A multiplier input 24 thereof receives a square wave through a clipping amplifier 26 and a capacitor 28 which are in turn fed the sine wave output of a phase shift oscillator 30. A resistor 32 feeds a constant amplitude electrical signal from a system power supply 34 through a variable resistor 36 and the switch contacts 38 and 40 of a socket 42. Contacts 38 and 40 are normally closed but open when a plug 44 is inserted into the socket 42.

The phase shift oscillator 30 is inhibited from oscillating when the contacts 38 and 40 are together and no plug 44 is inserted into the socket 42. When a plug 44 is inserted into the socket 42, the contacts 38 and 40 are opened and a resistor 46, in plug 44, is connected via socket contacts 38 and 48 and a resistor 49 across control terminals of oscillator 30. With the plug inserted, a substantially sinusoidal oscillation is fed to the capacitor 28 and by clipping of amplifier 26 a square wave is ultimately conducted to the multiplier input 24 of the multiplier 22. The frequency of oscillation is determined by the value of the resistor 46. The value of the resistor 46 may be any of a plurality of predetermined values allowing the output frequency of the phase shift oscillator 30 to be established at a corresponding plurality of frequencies.

The output of the multiplier 22 may be more fully understood by referring to the frequency response charts of FIGS. 2A-2D. FIG. 2A shows a normal range, 54, of network audio signals applied to the multiplicand input 20 of multiplier 22. This normal range 54 has a low frequency portion A and a high frequency portion B shown respectively as 50 and 52.

With the output of amplifier 26 fed to multiplier 22, and if the frequency of the phase shift oscillator 30 is, for example, 3,300 Hz, the output of the multiplier 22 will be as shown in FIG. 2B with the frequency range 54 inverted and falling between the frequencies of 300 Hz and 3,000 Hz. If the frequency of the oscillator 30 is, for example, 3,000 Hz, the output of the multiplier 22 will be as shown in FIG. 2C with the frequency range 54 not only inverted but occurring 300 Hz lower in frequency than shown in FIG. 2B. Similarly, if the frequency of the oscillator 30 is 3,600 Hz, FIG. 2D shows that the output of multiplier 22 is the inversion of the frequency range 54 and with a shift higher in frequency by 300 Hz than shown in FIG. 2B.

In practice it is found convenient to adapt the resistances 46 of the plugs 44 so as to provide approximately 300 Hz separation between each frequency produced by the oscillator 30 over a range of frequencies between 2,500 Hz and 4,200 Hz. A 300 Hz shift in voice frequencies carried as a normal telephone signal is sufficient to produce unintelligibly to untrained ears.

The phase shift oscillator 30 is designed so as to produce a substantially sinusoidal output by using a phase shift technique to establish the positive feedback necessary for oscillation and by limiting the gain of the closed loop path so that substantially single frequency oscillation occurs. Signal shaping is achieved by amplifier 26 to provide a square wave for application to the multiplier 22. Use of a well shaped square wave insures the harmonics of significant amplitude in the modulated output of multiplier 22 are at such a high fre-

quency as to be substantially eliminated by filtering of the network system.

Returning to FIG. 1, the output of the multiplier 22 is applied to a power amplifier 56 and its output coupled through a transformer 58 into the voice transmitting line 60 of a three line telephone system.

The power supply 34 is coupled between the winding of the transformer 58 in the transmit line and a common line 62 of the telephone system. Because the mouthpiece transponder 14 in the headset 12 is commonly a variable resistance or carbon button device, a DC potential of approximately 40 volts with just enough current to power the mouthpiece appears between the transmit and common line of the telephone system. The power supply 34 separates this DC potential from the AC signal and diverts the DC current from the mouthpiece to provide power for the electronic system of FIG. 1 through output lines 64 and 66. Amplification is provided for the mouthpiece signal to compensate for the reduced output therefrom. An AC short circuit is provided within the power supply 34 between the common line 62 and the transformer 58 so as not to attenuate the voice signal coupled into the telephone network by the transformer 58. Use of the telephone system power avoids the problem of a separate line cord or reliance entirely on batteries.

As shown in FIG. 1 the mouthpiece 14 is a dynamic microphone, requiring no operating current but providing a relatively low level signal which, as indicated above, must be amplified before being applied to the telephone network. All current supplied by the telephone network can accordingly be utilized for system operation. Some users may prefer the inclusion of a standard variable resistance microphone because of its sound characteristics. In this case the circuitry of FIG. 3 is used to provide a small operating current for the resistive microphone without significant reduction in the current available from the telephone network for powering the rest of the system.

In FIG. 3 the power supply output on line 64 and 66 is conducted through respective resistors 70 and 73 to a variable resistance microphone 75. The signal across microphone 75 is conducted through DC blocking apparatus 77 and 79 and applied as an input to the multiplier 22.

Returning to FIG. 1, the signal to be transmitted is conducted by the common and transmit lines 60 and 62 respectively into a telephone system 71 which includes the base of the normal telephone user terminal as well as the switching network of a private or public telephone system. Electrical signals are received from the telephone system 71 between the common line 62 and a receive line 72. The received signal is applied to a multiplicand input 74 of a multiplier 76. A multiplier input 78 thereof receives the output of the amplifier 26 from the oscillator 30. The output of the multiplier 76 is applied to a variable gain amplifier 80 and thence through the telephone cable 18 to the earpiece 16 of the handset 12. The gain of amplifier 80 is controlled by a signal from contact 40 to provide approximately 10 db gain when a plug 44 is inserted into socket 42 and unity gain otherwise. The gain compensates for attenuation by the multipliers 22 and 76 when they are fed a square wave signal rather than a constant potential.

If the signal which is received between the lines 62 and 72 has been multiplied prior to transmission by a distance terminal by the same frequency to which the

oscillator 30 is set, the further multiplication by that same frequency in the multiplier 76 restores the received signal to substantially its original frequency range and distribution.

Because the initial multiplication or modulation at the transmitting terminal shifts the signal so that part of it is outside of the 300 Hz to 3,000 Hz telephone line bandwidth some portion of that outside frequency range is lost in transmission through the telephone system 71. Though it may be noticeable, it will not interfere with the intelligibility of the received signal.

In actual practice and as shown in FIG. 4, the electronic system of FIG. 1 is mounted on a flexible circuit board 82 adapted for installation through openings for either the mouth or earpiece portions 14 and 16 of the handset 12 to lie within the handle portion 83 and be secured in place by end clips 84 and 86. In that case, the cable 18 carries instead of the signals directly from the mouth and earpieces 14 and 16 the signals over the common, transmit, and receive lines 60, 62 and 72 respectively.

With reference to FIG. 5 there is shown a complete circuit diagram exemplary of specific components for accomplishing the functions of the invention indicated with the block diagram of FIG. 1. The power supply 34 is shown as further composed of a full wave rectifier bridge 88 connected across the inputs to the power supply 34 from line 60 and the transformer and further having thereacross an AC short circuiting capacitor 90. The full wave rectifier 88 is provided to produce a predetermined output polarity across lines 92 and 94 because the polarity of the DC potential between the common and transmit lines 60 and 62 is not constant. The output of the full wave rectifier bridge 88 at lines 92 and 94 is applied through a diode 96 to a battery 98 for charging thereof. Battery 98 provides primarily voltage regulation for the output of the power supply. The junction between the diode 96 and the battery 98 feeds a positive potential power supply line 100. The opposite side of the battery 98 is connected through a voltage divider biased NPN transistor 102 to a common power supply line 104.

Power for the circuitry is provided by the potential between the lines 100 and 104, this power being supplied from the telephone line in the case where it exceeds the potential of the battery 98 and from the battery 98 in the case where loading of the telephone lines has reduced its potential below that of the battery 98.

The multiplier 22 receives the electrical signal from the mouthpiece 14 at the bases of a differential transistor pair 106. The collector outputs of the differential pair 106 are fed respectively to joined emitters of further differential pairs 108 and 110. The first and second collectors respectively of each differential pair 108 and 110 are fed to first and second bases of a power amplifier differential pair 112, biased from the line 100. The collector outputs of the differential pair 112 are fed to opposite ends of a primary winding of a transformer 114. A center tap thereof is connected to the line 104. The secondary of transformer 114 is serially connected between the line 60 and power supply 34 in order to couple multiplied, amplified signals from the mouthpiece 14 into the telephone network.

Multiplier inputs to the multiplier 22 are provided from the collectors of a differential pair 116 which comprises the amplifier 26 and are applied to the bases of the differential pairs 108 and 110 with each collector

of the pair 116 connected to one base of each pair 108 and 110.

The multiplier 76, similar to the multiplier 22, comprises a differential pair 118 having the receive line 72 capacitively coupled to one base thereof. The differential pair 118 has its emitters tied through a potentiometer 120, the center tap of which is fed through a resistor 122 from the line 104. The collectors of the differential pair 118 are fed to joined emitters of respective differential pairs 124 and 126. The bases of the differential pairs 124 and 126 are fed from the differential pair 116 of the amplifier 26 similarly to the pair 108 and 110 in the multiplier 22. One collector from each pair 124 and 126 feeds opposite ends of a center tapped primary of a transformer 128 which couples to a secondary feeding the amplifier 80, and in turn the earpiece 16. In actual design, the amplifier 80 is attached directly onto the terminals of the earpiece 16.

The phase shift oscillator 30 comprises three NPN transistors: a first transistor 130 having its emitter coupled into the base of a second transistor 132 which in turn has its collector coupled into the base of a transistor 134. The emitter of the transistor 134 leads to capacitor 28 and also to phase shift, serially connected capacitors 136, 138 and 140 into the base of the transistor 130. The contact 48 at the socket 42 is connected to the junction between the capacitors 136 and 138 and provides conduction through the plug resistance 46 and the variable resistance 36 to the line 100 whenever a plug 44 is inserted into the socket 42. A resistor 142 leads from the junction of the capacitors 138 and 140 to the line 100 to provide further phase shift characteristics. A high value resistor 144 biases the base of the transistor 130 from the collector of the transistor 132 in conjunction with a resistor 146 leading to the base of the transistor 130 through a series of diodes 148 and 150 from the line 100. The junction between the diodes 148 and 150 is connected through a capacitor 152 to the emitter of the transistor 134. A capacitor 154 is connected across the diodes 148 and 150.

It can be seen that by the provision of different values for the resistor 46 in the plug 44 when inserted in the socket 42 the frequency of oscillation of the phase shift oscillator 30 may be adjusted, by altering the phase shift characteristics of the feedback path from the transistor 134 to the transistor 130. Whenever the plug 44 is not inserted in the socket 42 the phasing in the feedback path in conjunction with the gain and frequency response of the transistors 130 and 132 and 134 is such as to inhibit oscillations. Also, the contacts 38 and 40 are joined so as to impress a constant amplitude electrical signal through the variable resistance 36 and resistor 32 onto the input of the amplifier 26 to one base of the differential pair 116, and onto the bases of the differential pairs 108, 110, 124 and 126 causing them to operate as constant gain amplifiers. Without the insertion of a plug 44, then, the normal voice signals are coupled without scrambling between the telephone system 71 and the mouth and earpieces, 14 and 16.

As an alternative to the power amplifier 56, transformer 58, and power supply 34 shown in FIG. 5, a combination power supply and power amplifier is indicated in FIG. 6 with the advantage of less components and a solid state system for providing regulated voltage for operating the remainder of the electronics. In the circuitry of FIG. 6 the network lines 60 and 62 are conducted through a rectifier bridge 88 as indicated above.

The positive potential from the diode bridge 88 is conducted on a line 170 to the emitter of a PNP transistor 172 with the collector thereof connected over a line 174 to the negative potential from the bridge 88. The base of transistor 172 is connected to the emitter of a PNP transistor 176, the collector thereof being connected to the line 174. The base of transistor 176 is connected through a resistor 178 to line 170 and to the collector of an NPN transistor 180. The emitter of the transistor 180 is connected to the line 174 and the base thereof connected through a resistor 182 also to the line 174. The base of transistor 180 is further connected through a Zener, regulating diode 184 and through a resistor 186 to the line 170 with the Zener 184 oriented to provide reverse bias breakdown regulations. A first LC pair 188 is connected between the line 170 and the junction between the resistor 186 and diode 184. A second LC pair 190 is connected between the junction of resistor 186 and diode 184 and one output of the multiplier 22 of FIG. 5. From line 170 a resistor 192 conducts to a capacitor 194 and thence to the line 174. From the junction between resistor 192 and capacitor 194 a parallel RC pair 196 leads to the same output of the multiplier 22 that is connected to the LC pair 190. The other output of the multiplier 22 is connected to the line 170. System operating power is provided to the lines 100 and 104 by a connection between line 100 and the junction between resistor 192 and 194 and by a connection between line 104 and line 174.

In operation the transistors 172, 176 and 180 provide amplification of a regulation signal provided by the resistors 182 and 186 and diode 184. The amplification causes transistor 172 to shunt current from the diode bridge 88 to maintain the potential between the lines 170 and 174 at a predetermined voltage. Regulation is necessary because, substantial variation exists in the distance between each telephone set and the source of DC potential with the resulting intervening resistance greatly varying the amount of total current which can be taken from the DC potential across the lines 60 and 62. The shunt current regulation effect produced by the transistor 172 effectively absorbs extra current to maintain the voltage and current available at the supply lines 100 and 104 substantially constant.

The output of the multiplier 22 is coupled into the amplification provided by the transistors 172, 176 and 180 through the filters composed of the component pairs 188, 190 and 196. The output of the multiplier 22 is boosted to a level sufficient to cause an appropriate variation in the current shunted through the transistor 172 so that sufficient amplitude is provided for the modulated voice signal transmitted on lines 60 and 62.

In the case of the power supplies shown in FIG. 5 or FIG. 6, they further operate, because of the limited network current available, to cut-off power to the system or produce a noticeable signal change whenever a local network extension is activated on the same line. Either change allows the user to prevent unauthorized listening, even to scrambled signals, by terminating use.

Referring now to FIG. 7 there is shown a pictorial and diagrammatic view of a portable scrambling system according to the invention. A portable system comprises a handset 200 and a handset cradle 202. A handset 204 from a normal telephone terminal is placed in the cradle with the ear and mouthpieces facing into respective receptacles 206 and 208. Acoustic or electromagnetic couplers 210 and 212, respectively couple

into and couple from the ear and mouthpieces in receptacles 206 and 208.

In the portable system, acoustic signals into and out of the handset are scrambled and unscrambled by the circuitry of FIG. 5. Scrambled signals are transmitted and receiver over the telephone system by coupling with the handset 204 through the couplers 210 and 212. The couplers 210 and 212 are connected into the circuitry of FIG. 4 at points normally connected to lines 72 and 60 respectively. The circuitry of FIG. 5, which may be placed either within the cradle at 214 or within the handset at 216 as indicated above, has in place of the power supply 34, a simple replaceable battery for providing system power to the portable scrambling system of FIG. 7.

Among the features of this invention as described above is the provision of a set of plugs or keys 44 having different resistances to provide different scrambling characteristics when inserted into the socket 42. The correct plug is an essential element to allow reception of scrambled telephone signals, and, because of the portability of the plugs, selected organization personnel can be readily provided with one or more echelons of telephone security by distributing specific plugs to them. Such personnel then have with them at all times the capability for scrambled telephone communication according to their assigned specific plugs. They need only locate a terminal equipped with standard scrambling electronics or carry a portable unit with them.

A further advantage of this scrambling system is that acoustic messages are transmitted in scrambled form over the entire communications network. The messages are scrambled before leaving the senders handset and are not unscrambled until they are in the handset of the receiver. This eliminates any transmission of signals before or after scrambling where they might be intercepted by unauthorized listeners.

Having above described illustrative preferred embodiments for accomplishing the scrambling function according to the invention, it will be clear to those skilled in the art that certain modifications and alterations can be made to the preferred circuitry without departing from the spirit of the invention. It is accordingly intended to define the scope of the invention only as indicated in the following claims.

What is claimed is:

1. Apparatus operable with a communication network to provide scrambled communications comprising:

means for receiving electrical signals representative of information to be conveyed by lines of said network;

said network having a DC electrical signal;

means for generating periodic electrical signals at a plurality of frequencies having a predetermined relationship to the range of frequencies of said received electrical signals;

said generating means having a first state and a plurality of second states;

means for selecting one state for said generating means from among said first state and said plurality of second states;

said first state of said generating means providing as an output of said generating means a constant amplitude electrical signal;

each of said plurality of said second states providing as the output of said generating means a different frequency of said plurality of frequencies; means, externally provided, for selecting one or more of said second states; means for modulating said received electrical signals with the signals generated by said generating means; means for combining said modulated signal with the DC signal of said network; and means for extracting said DC signal of said network in substantial isolation from said modulated signal as combined therewith to provide electrical power for operating said apparatus from said extracted DC signal substantially without variation from said modulated signal.

2. The apparatus of claim 1 further comprising: means for receiving varying amplitude electrical signals from said network; and means for demodulating said signals as received from said network with the output of said generating means.

3. A scrambled communication system having a plurality of apparatus according to claim 2 as user terminals of said network.

4. The apparatus of claim 2 wherein the DC potential of said network is limited in available current and said apparatus further comprises means for developing said electrical signals representative of information from acoustic waves and using significantly less than said available limit of current.

5. The apparatus of claim 4 further comprising means for converting said demodulated signals into acoustic waves.

6. The apparatus of claim 2 further comprising: a flexible circuit board providing mounting for said apparatus and adapted for insertion into an ordinary telephone handset and for placement within the handle region of said handset; and means for retaining said circuit board within said handset substantially within said handle portion thereof.

7. The apparatus of claim 6 wherein: said means for receiving electrical signals representative of information receives the electrical signals from the mouthpiece of said handset; and means are provided for selectively amplifying said demodulated electrical signals to provide amplification thereof during the second states of said generating means and to apply the amplified signals to the earpiece of said handset.

8. The apparatus of claim 1 wherein: said generating means further comprises an oscillator; and said means for selecting one from among said first state and plurality of second states includes a socket adapted to provide the first state for said generating means when no plug is inserted in said socket and a plurality of plugs, each with a different electrical characteristic;

each said plug, upon insertion into said socket, being adapted to provide a particular one of said plurality of said second states for said oscillator whereby the frequency of oscillation of said oscillator is determined by the particular plug inserted in said socket.

9. The apparatus of claim 1 wherein said means for extracting said DC signal is operative to prevent undetected interception of said modulated signal by an extension of said communication network having available thereat the same set of lines.

10. Apparatus operable with a communication network to provide scrambled communications, said apparatus comprising:

means for receiving electrical signals representative of information to be conveyed by a set of network lines;

said set of network lines having a common line and a voice transmission line;

means for generating periodic electrical signals at a plurality of externally selected frequencies having a predetermined relationship to the range of frequencies of said received electrical signals;

means for selecting one of said plurality of externally selected frequencies for said generating means;

said selecting means having a plurality of separate frequency determining elements separable from said generating means and separable from each other;

means for associating at least one of said frequency determining elements with said generating means to cause the generation of said signals thereby at a corresponding frequency;

means for modulating said received information representing electrical signals by the signals generated by said generating means;

means operative when none of said frequency determining elements are associated with said generating means for inhibiting frequency characteristic alteration of said received electrical signals by said modulating means; and

means for applying said received electrical signals as selectively modulated to said common and said voice transmission lines of said communication network.

11. The apparatus of claim 10 further including: means for receiving electrical signals between said common line and a voice reception line of said communication network;

means for demodulating said signals received from said communication network by the signals generated by said generating means; and

means for inhibiting said demodulating means from substantially altering the frequency characteristics of said received network signals whenever none of said frequency determining elements are associated with said generating means.

12. The apparatus of claim 11 further including: a variable gain amplifying device having first and second states;

said first state of said amplifying device providing an amplification greater than the second state of said amplifying device by an amount corresponding to attenuation in said received information representing electrical signals and said received network signals produced respectively by said modulating and demodulating means; and

means for providing the first state of said amplifying device whenever one of said frequency determining elements is associated with said generating means and for providing the second state of said amplifying device whenever none of said frequency

determining elements is associated with said generating means.

13. The apparatus of claim 1 wherein:

said means for applying said modulated signal to said network further includes means for coupling said modulated signal into a telephone type handset of a user station of said network; and

said means for receiving signals from said network further includes means for coupling the signals to be received from in said network through said handset to said apparatus;

said apparatus being a portable unit not requiring direct mechanical connection to said handset to achieve said coupling function.

14. Apparatus operable to provide scrambled communications for a communication network having a set of input and output lines that comprise a common line, a voice reception line, and a voice transmission line with a DC electrical potential between said transmission and common lines to provide a limited excitation current for an input microphone, said apparatus comprising:

an input microphone providing conversion of acoustic waves to electrical signals and using substantially less current than the excitation current provided by said common and transmission lines;

a phase shift oscillator providing a substantially sinusoidal output at one of a plurality of frequencies within a range of frequencies;

a plurality of externally controlled elements selectively associable with said phase shift oscillator to determine the frequency of oscillation thereof;

the output of said phase shift oscillator being a constant signal whenever none of said plurality of elements is associated with said oscillator;

means for producing a well shaped square wave in response to the substantially sinusoidal output of said phase shift oscillator;

first means for multiplying said microphone electrical signals by said square wave;

means for applying an amplified representation of said multiplied signal to said common and said transmission lines;

means for receiving signals carried by said common and said reception lines;

second means for multiplying said received signals by said square wave;

means for selectively amplifying said multiplied received signals operative to provide a first level of amplification whenever one of said frequency determining elements is associated with said phase shift oscillator and operative to provide a second amplification whenever none of said frequency determining elements are associated with said phase shift oscillator;

the difference in amplification between said first and second amplifications providing compensation for the attenuation of said first and second multiplying means when operating to provide modulation of said respective microphone and received signals; and

means for separating the DC potential between said common and transmission lines in isolation from the signal applied thereto for transmission and operative to provide operating current for said apparatus from the limited current provided by said DC signal.

15. The apparatus of claim 14 wherein said power separating means includes means for regulating the signal applied to power said apparatus.

16. The apparatus of claim 15 wherein said means for separating said power further includes;

a diode bridge providing a predetermined polarity output in response to said DC signal being of either polarity; and

an amplifier providing varying degrees of current shunting between the outputs of said diode bridge in response to a relationship between the potential from said diode bridge and a predetermined potential to regulate the signal between the outputs of said diode bridge;

said applying means including said amplifier and means for applying said multiplied signal from said first multiplier to said amplifier to cause variations in the current shunted by said amplifier in response to said multiplied signal from said first multiplier.

17. Apparatus operable with a communication network to provide scrambled communications comprising:

means for receiving electrical signals representative of information to be conveyed by lines of said network;

said network having a DC electrical signal;

means for generating periodic electrical signals at a plurality of frequencies having a predetermined relationship to the range of frequencies of said received electrical signals;

said generating means having a first state and a plurality of second states;

means for selecting one state for said generating means from among said first state and said plurality of second states;

said first state of said generating means providing as an output of said generating means a constant amplitude electrical signal;

each of said plurality of said second states providing as the output of said generating means a different frequency of said plurality of frequencies;

means for modulating said received electrical signals with the signals generated by said generating means;

means for extracting said DC signal of said network in substantial isolation from said modulated signal as combined therewith to provide electrical power for operating said apparatus from said extracted DC signal substantially without variation in response to said modulated signal;

means for establishing a reference signal; and

means responsive to said reference signal and said modulated signal for regulating said extracted signal and for applying said modulated signal to said network.

18. The apparatus of claim 17 wherein said applying and regulating means further include current shunt.

19. Apparatus operable with a communication network to provide scrambled communications comprising:

means for receiving frequency inverted electrical signals from said network representative of information conveyed by said network in a scrambled form;

said network having a DC electrical signal;

means responsive to the network DC electrical signal for providing operating power therefrom for said apparatus;

means for efficiently utilizing said operating power to generate a periodic electrical signal having a predetermined frequency relationship to the range of frequencies of said received frequency inverted electrical signal;

first means responsive to said generated electrical signal and the received, inverted electrical signal for efficiently utilizing said operating power to provide frequency inverting of said received inverted electrical signal to define a non-inverted output signal of readily intelligible information;

means for producing an electrical signal representative of information to be conveyed by said network;

second means responsive to said produced and generated electrical signals for efficiently utilizing said operating power to provide frequency inversion of the produced electrical signal to define a further frequency inverted electrical signal; and

means for applying said further frequency inverted electrical signal to said network for communication of the information contained therein in a scrambled form;

said operating power providing means including means for providing said operating power in isolation and substantially without variation from said electrical signal representative of information to be conveyed.

20. Apparatus operable with a communication network to provide scrambled communications comprising:

means for receiving frequency inverted electrical signals from said network representative of information conveyed by said network in a scrambled form;

said network having a DC electrical signal;

means responsive to the network DC electrical signal for providing operating power therefrom for said apparatus;

means for efficiently utilizing said operating power to generate a periodic electrical signal having a predetermined frequency relationship to the range of frequencies of said received frequency inverted electrical signal;

first means responsive to said generated electrical signal and the received, inverted electrical signal for efficiently utilizing said operating power to provide frequency inverting of said received inverted electrical signal to define a non-inverted output signal of readily intelligible information;

means for producing an electrical signal representative of information to be conveyed by said network;

second means responsive to said produced and generated electrical signals for efficiently utilizing said operating power to provide frequency inversion of the produced electrical signal to define a further frequency inverted electrical signal; and

means for applying said further frequency inverted electrical signal to said network for communication of the information contained therein in a scrambled form;

said means for providing operating power further including means for regulating said operating power; and

said further inverted signal applying means including means for controlling said regulating means to provide the application of said further inverted signal to said network.

21. The apparatus of claim 19 wherein:

the first and second means for efficiently providing frequency inversion include first and second solid state multipliers; and

means for driving said first and second multipliers with a square wave in response to said generated periodic electrical signal.

22. The apparatus of claim 21 wherein said generating means includes a phase shift oscillator.

23. The apparatus of claim 19 wherein said operating power providing means further includes means for compensating for variations in said network DC electrical signal with network characteristics.

24. Apparatus operable to provide scrambled communications for a communication network having a set of input and output lines that comprise a common line, a voice reception line, and a voice transmission line with a DC electrical potential between said transmission and common lines to provide a limited excitation current for an input microphone, said apparatus comprising:

an input microphone providing conversion of acoustic wave to electrical signals and using substantially less current than the excitation current provided by said common and transmission lines;

a phase shift oscillator providing a substantially sinusoidal output at one of a plurality of frequencies within a range of frequencies;

a plurality of elements selectively associable with said phase shift oscillator to determine the frequency of oscillation thereof;

the output of said phase shift oscillator being a constant signal whenever none of said plurality of elements is associated with said oscillator;

means for producing a well shaped square wave in response to the substantially sinusoidal output of said phase shift oscillator;

first means for multiplying said microphone electrical signals by said square wave;

means for applying an amplified representation of said multiplied signal to said common and said transmission lines;

means for receiving signals carried by said common and said reception lines;

second means for multiplying said received signals by said square wave;

means for selectively amplifying said multiplied received signals operative to provide a first level of amplification whenever one of said frequency determining elements is associated with said phase shift oscillator and operative to provide a second amplification whenever none of said frequency determining elements are associated with said phase shift oscillator;

the difference in amplification between said first and second amplifications providing compensation for the attenuation of said first and second multiplying means when operating to provide modulation of said respective microphone and received signals;

means for separating the DC potential between said common and transmission lines in isolation from the signal applied thereto for transmission and operative to provide regulated operating current for

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said apparatus from the limited current provided by said DC signal, said separating means including: a diode bridge providing a predetermined polarity output in response to said DC signal being of either polarity; and an amplifier providing varying degrees of current shunting between the outputs of said diode bridge in response to a relationship between the potential from said diode bridge and a predetermined poten-

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tial to regulate the signal between the outputs of said diode bridge; said applying means including said amplifier and means for applying said multiplied signal from said first multiplier to said amplifier to cause variations in the current shunted by said amplifier in response to said multiplied signal from said first multiplier.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,775,562 Dated November 27, 1973

Inventor(s) James W. Crimmins and Peter W. Hartman

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 24, "part" should read --party--.

Column 6, line 35, "is" should read --in--.

Column 8, line 21, "elment" should read --element--.

Column 9, line 24, "as user" should read --at user--.

Column 11, line 3, "The apparatus of claim 1" should read --The apparatus of claim 11--.

Signed and sealed this 6th day of August 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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