May 9, 1961 L. E. PHILIPPS 2,983,902

CRYSTAL VIBRATED REED AND RECEIVER

Filed March 30, 1956

2 Sheets-Sheet 1

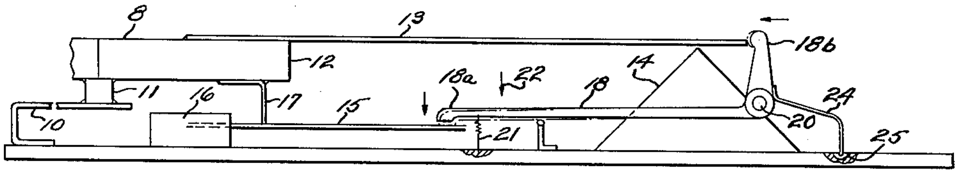

FIG. 1

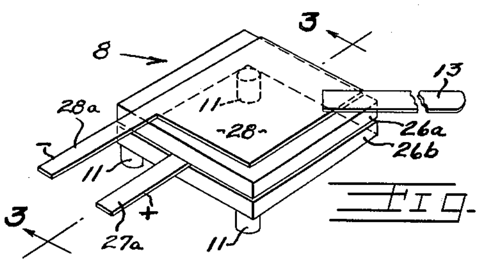

FIG. 2

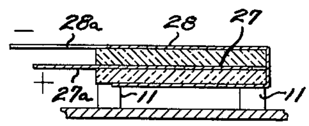

FIG. 3

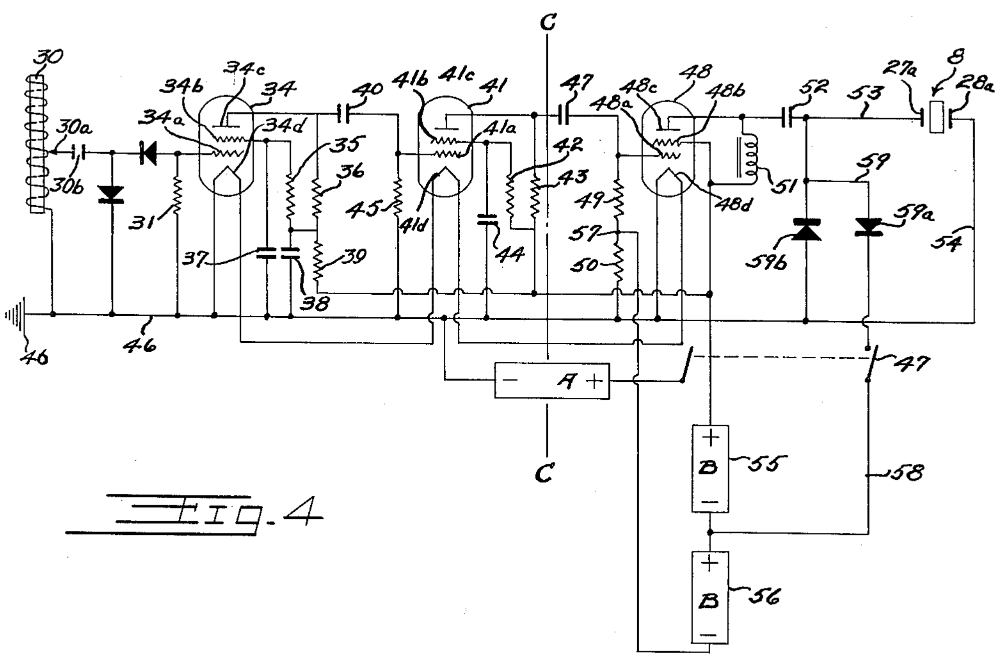

FIG. 4

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CRYSTAL VIBRATED REED AND RECEIVER

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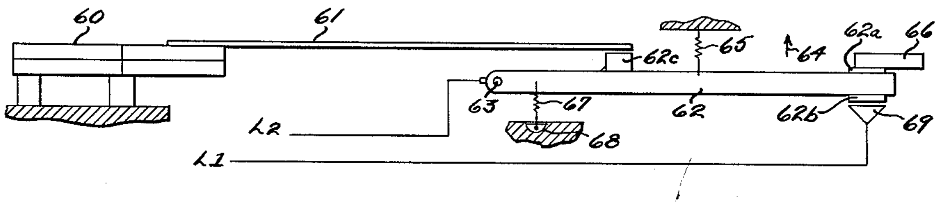

FIG. 5

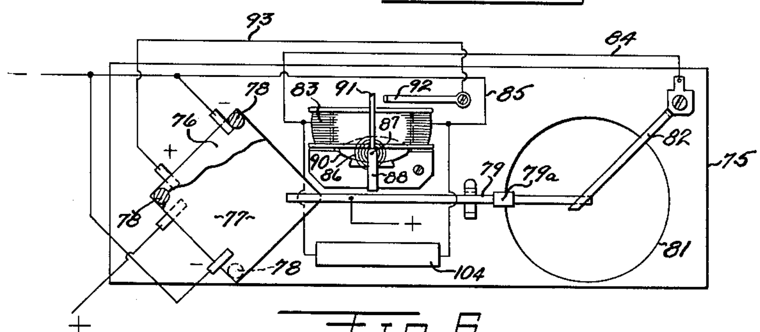

FIG. 6

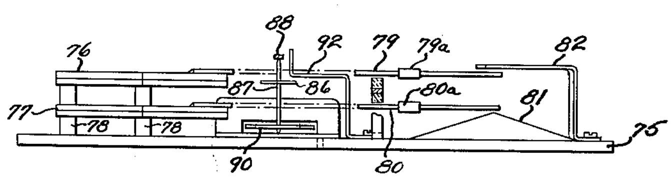

FIG. 7

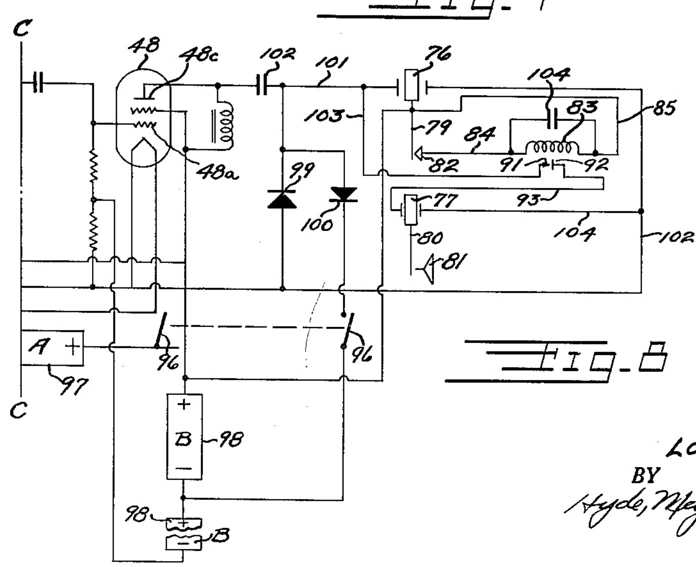

FIG. 8

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CRYSTAL VIBRATED REED AND RECEIVER

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Filed Mar. 30, 1956, Ser. No. 575,021

8 Claims. (Cl. 340—156)

This invention relates to reeds vibrated by laminated piezoelectric crystals, one use of which is in individual portable receivers in an improved personal signalling system, and another use as switching means in a relay circuit.

An object of the present invention is to provide a laminated piezoelectric crystal with a tuned reed rigidly attached thereto, said crystal causing said reed to vibrate upon receipt of a predetermined frequency signal which is selectively resonant to said reed.

Another object of the present invention is to provide an individual receiver unit employing a tuned reed which is driven by a laminated piezoelectric crystal and strikes directly upon a sounding cone to produce an audible signal upon receipt by said crystal of an audio-frequency signal selectively resonant to said reed.

Another object of this invention is to provide individual portable receiver units, each of which has two or more reeds tuned to different frequencies wherein vibration of said reeds is caused by vibration of a laminated piezoelectric crystal which receives and vibrates in response to audio-frequency signals and causes the reed to actuate signal means, as by striking a sounding cone to produce an audible signal.

Another object of the present invention is to provide an individual receiver using a laminated piezoelectric crystal having a power requirement of only about 16 micro-watts for driving a tuned reed which strikes a sounding cone to produce an audible signal.

Another object of the present invention is to provide individual receivers, each of which has two or more reeds tuned to different audio-frequencies for action in series, wherein the second of said reeds cannot vibrate until the first has been caused to vibrate and thereby disengage holding means which prevented said second reed from vibrating.

Another object of this invention is to provide novel crystal pick-up means responsive to waves of audio-frequency and adapted to vibrate reeds or other devices corresponding in frequency to the frequency of said signals and thereby to cause other operations to occur.

Another object of the present invention is to provide a novel piezoelectric crystal vibrated reed and communication receiver characterized by its structural simplicity, the ease of assembly of its parts, its strong and sturdy nature and its low manufacturing cost. Other features of this invention reside in the arrangement and design of the parts for carrying out their appropriate functions.

Other objects and advantages of this invention will be apparent from the accompanying drawings and the following description, and the essential features will be set forth in the appended claims.

In the drawings:

Fig. 1 is a side elevational view of a piezoelectric crystal vibrated reed device having a plurality of reeds and designed for sequential operation of the reeds.

Fig. 2 is a perspective view of the piezoelectric crystal constructed in accordance with the present invention and shown associated with a tuned reed adapted to strike a sounding cone during vibration.

Fig. 3 is a vertical sectional view taken along the plane of line 3—3 of Fig. 2.

Fig. 4 is a schematic diagram of a circuit employed in the receiver of the present invention.

Fig. 5 is a side elevational view of a piezoelectric crystal vibrated reed employed as a relay switch for making and breaking contacts in a circuit.

Fig. 6 is a top plan view of a modified form of a crystal vibrated reed signal receiving device.

Fig. 7 is a side elevational view of the device of Fig. 6 with parts broken away to more clearly show the construction.

Fig. 8 is a schematic diagram of the decoder portion of the circuit employed in the device shown in Figs. 6 and 7.

The present invention has many uses but is here shown in Figs. 1 to 4 as intended for use in a communication system which consists of a central broadcasting unit comprising an audio-frequency generator or transmitter and a plurality of small receivers of the present invention which may be easily carried in the pocket of persons on call. The transmitter sends out a single frequency signal or preferably two or more audio-frequency signals in sequence on a carrier wave. Each receiver is equipped with a flexible laminated piezoelectric crystal which vibrates in response to receipt of a wide range of audio-frequency signals. The piezoelectric crystal is associated with suitable tuned reeds which are each resonant at a selected audio-frequency, and, where two or more reeds are used, they may be so interlocked as to vibrate in one sequence only and thereby produce an audible signal readily noticed by the person carrying the particular receiver.

In Fig. 1, a laminated piezoelectric crystal **8** constructed according to Fig. 2, which will be described later, is utilized in a two-reed receiver. The crystal **8** is generally constructed with four sides, three corners of which are rigidly mounted on a base plate **9** by means of securing legs **11** (as best seen in Fig. 2) and bracket **10**, leaving the fourth corner **12** free to vibrate. A tuned reed **13** is rigidly connected to the free corner **12** and projects outwardly over a sounding cone **14**. A small air gap or space is provided between the apex of the cone and reed **13**. A second tuned reed **15** is firmly held in a block **16** supported on the base plate **9**. The reed **15** is positioned below the piezoelectric crystal **8** and extends outwardly substantially parallel to and in alignment vertically beneath the reed **13**. A rigid arm **17** is secured to the bottom surface of the free corner **12** of crystal **8** and projects downwardly to engage the reed **15**. An L-shaped lever **18** is pivotally mounted on a fixed pivot **20** and has one end **18***a* normally spring biased into close proximity to reed **15** by means of a hair spring **21** which normally acts in the direction of the arrow **22**. The other end **18***b* of lever **18** is normally lightly urged by the spring to its dot-dash position wherein it touches the free end of reed **13**. A very slight touch of the end **18***a* of lever **18** upon reed **13** will prevent the reed from vibrating. A suitable dampening device is provided for the lever **18** and includes a stiff wire **24** which extends into a recess **25** at one end while its other end is rigidly secured to an upstanding leg portion of the L-shaped lever **18**. The recess **25** is filled with silicone or a like viscous fluid which acts as a dash-pot and is effective in causing the lever **18** to be moved very slowly since the lever and its connecting parts are all constructed of extremely small light-weight parts.

The device of Fig. 1 is designed for use in a receiver responsive to two audio-frequency signals transmitted in sequence. It will be understood that each of the reeds **13** and **15** is selectively resonant to a respective one of said audio-frequency signals. A first signal of the resonant frequency of reed **15** is received by the piezoelectric crystal **8** and causes the crystal to vibrate. The vibrations of the crystal **8** are transmitted to the reed **15** by arm **17**. The reed **15**, being selectively resonant to this particular signal, begins to vibrate and causes the end **18**a of lever **18** to move upwardly into the full line position where the other end **18**b of the lever clears the end of reed **13**. It requires a second or two for the reed **15** to work the lever into this position. When the piezoelectric crystal no longer receives the first audio-frequency signal, it ceases to vibrate and in turn causes reed **15** to stop vibrating. The dash-pot effect of wire **24** in the dash-pot recess **25** causes the lever **18** to take about three seconds or longer to return to the dot-dash position. Meanwhile, if during the period while the lever **18** is disengaged from reed **13**, a second audio-frequency signal is received by the piezoelectric crystal **8** and having the resonant frequency of reed **13**, then reed **13** will be caused to vibrate. During vibration, the end of reed **13** directly strikes or engages the sounding cone **14** and gives a characteristic tone or humanly recognizable signal. The power requirement here is only about 16 microwatts, which is much less than for magnetic devices of similar character. It is to be understood that I do not wish to limit myself to any particular number of reeds, since any feasible number may be employed, each interlocked with the next in series so that a predetermined sequence of signals is required to operate them all. The prime advantage gained by increasing the number of vibrating reeds is found in an increased number of combinations of different signals that may be sent out from the transmitting equipment, thereby permitting an increase in the number of persons subject to individual call.

In Fig. 2, I have shown the detailed construction of a type of piezoelectric crystal suitable for use in the device shown in Fig. 1. The crystal is in two laminations or layers **26**a and **26**b, which when cemented together and a voltage applied thereto, causes the plates to deform in opposite directions, producing a twisting or bending action similar to that of bi-metallic thermostat strips. The laminated sections are made of Rochelle salt (sodium potassium tartrate). The Rochelle salt laminations may be cut so that their crystals extend at an angle to one another in a known manner so that when three corners of a four-cornered crystal are held solid by legs **11**, the fourth corner tends to move up and down in tune with the audio-frequency signal applied to the crystal. This crystal is sold under the name "Twister Bimorph" by Brush Electronics Company. I may also use a "Bender Bimorph" crystal made by the same company, merely by changing the mounting so as to utilize its bending action. A sheet of foil is applied between the upper face of the bottom crystal layer **26**b and the lower face of the top crystal layer **26**a when the laminated sections of the crystal are assembled, to form a central layer of foil **27**. A tab **27**a leads out from this central sheet of foil to form an electrical contact. After the laminated crystal layers are cemented together, as viewed in Fig. 2, a second sheet of foil **28** is attached to the upper surface of the top crystal layer **26**a and then folded around one end of the crystal and extended across the lower face of the bottom crystal layer **26**b. This outermost layer of foil is also provided with a tab **28**a, one of the tabs usually being connected to an electrical conductor while the other is connected to a ground to complete a circuit, as hereinafter described in Fig. 4. A tuned reed **13** is rigidly connected to the fourth or free corner of the crystal and is caused to vibrate upon the crystal receiving an audio-frequency signal having the resonant frequency of the reed. The piezoelectric crystal assembly is in essence a mechanical transformer which multiplies the effective motion of the individual plates as much as ten to one hundred times for a given voltage. Likewise, it multiplies voltage-producing stresses,

for a given twisting or bending motion. At certain frequencies, depending on physical dimensions, the piezoelectric elements act as sharply tuned electrical circuits. When properly constructed, the crystals respond perfectly to resonant frequencies independent of temperature. Conventional tuned circuits employing inductors and capacitors of practical size cannot compete with the crystals for sharpness of tuning and stability.

Referring now to Fig. 4, I have shown a typical control circuit for use with my novel crystal vibrated reed receiver. The control circuit includes three main portions, namely, a receiver, a voltage limiter and a decoder. The antenna **30** is constructed of a central core having a plurality of windings or coils encircling it. This novel antenna may be electrically lengthened by increasing the total number of coils on the center core. The antenna **30** receives the combination of radio carrier waves and audio-frequency signals carried by said wave and transmits them to grid **34**a of amplifier tube **34** where the radio frequency is demodulated and the audio-frequency, so derived, is then amplified. The antenna is tuned by means of a variable lead **30**a connecting to a capacitor **30**b capacitor to thus resonate at the desired radio frequency. Screen grid **34**b is maintained at the correct voltage by means of resistor **35** which is connected in parallel with capacitor **37**, the value of which is such as to pass any signal that has a frequency lower than the lowest frequency which is to be amplified.

Capacitor **38** with resistor **39** form a filter network. Resistor **36** connected to plate **34**c will produce a voltage drop varying as the audio-frequency varies. This varying signal is coupled through capacitor **40** to grid **41**a of amplifier tube **41** where it is further amplified. Resistor **45** connected from grid **41**a to ground **46** provides bias for the tube. Screen grid **41**b is maintained at the correct voltage by resistor **42** and is by-passed to ground by capacitor **44**. Resistor **43** is connected to plate **41**c and will produce a voltage drop varying as the audio-frequency varies. This varying signal is coupled through capacitor **47** to grid **48**a of power tube **48** where it is further amplified. Resistors **49** and **50** connected from grid **48**a to ground **46** provide bias for the tube by means of the current flowing from the batteries **55** and **56** through resistor **50** to the negative pole of said batteries. Screen grid **48**b is connected directly to the batteries **55** and **56**. An audio-frequency choke **51** is connected to plate **48**c of power tube **48** and the voltage drop across this impedance will vary at the rate of the audio-frequency being amplified. Capacitor **52** couples the audio signal from choke **51** to crystal reed unit **8** through foil tabs **27**a and **28**a. The filaments **34**d and **41**d of tubes **34** and **41** respectively are connected in series between the A battery and ground **46**. This arrangement causes grid **41**a of tube **41** to become negative with respect to the filament **41**d by the amount of the voltage drop across filament **34**d. Filament **48**d is connected between the A battery and ground **46** in the usual manner. One of said tabs **27**a is connected by line **53** through condenser **52** to the midpoint between choke **51** and plate **48**c, while the other tab **28**a is connected to the ground **46** by line **54**. Two B batteries **55** and **56** of 15 volts each, are connected in series between choke **51** and the midpoint between resistors **49** and **50** at **57**. A tap line **58** is connected from line **53** through a switch **47** with a germanium diode **59**a. A second diode **59**b is connected between line **53** and ground **46**. The diodes are connected by line **59**. Batteries **55**, **56** and germanium diodes **59**a and **59**b form a voltage limiter. Since the alternating current wave has equal peaks above and below zero voltage, one of the diodes **59**a will be active in clipping off a peak portion of the sine wave and the other diode **59**b will not conduct the wave until it overcomes the back voltage from the connection **58**. This arrangement permits the voltage to rise at a rapid rate to 7½ volts where it is limited quickly at approximately

8 volts. If the receiver were located directly next to the antenna sending out the signal, through the use of the present voltage limiter the receiver would not be subjected to perhaps 30 volts but only to a maximum of 8 volts. With this arrangement, a crystal tuned to the next higher or lower frequency can be set to vibrate very slightly at 9 volts and when the voltage limiter comes into action, it will never receive more than 8 volts and, therefore, will not vibrate when it is undesirable. With this device, a signal of proper audio-resonance-frequency will cause the crystal **8** and reed **13** or **15**, constructed in accordance with the device shown in Fig. 2, to vibrate causing the end of the reed to engage a signal cone **14** and thereby produce a humanly recognizable signal. It is obvious that with lever **18** omitted, the reed **13** vibrating at resonance will strike cone **14** when the parts are properly spaced, thus forming a single-reed device.

The use of the voltage limiter, as shown in Fig. 4, with the device of Figs. 1 and 2 has several important advantages, namely, (1) the reed can be made to give a proper response whether it is close to the antenna sending out the signal or a long way off; (2) it is possible to limit the response of a crystal to a signal of a certain peak voltage; and (3) it is possible to set various receivers at more closely spaced intervals.

Refer now to Fig. 5, wherein I have shown how the present invention may be utilized as a relay for general purposes. A piezoelectric crystal **60** constructed as shown in Fig. 2, is provided with a rigidly attached reed **61** to be vibrated by the free corner of the crystal in a manner similar to that previously described herein. A lever **62** pivotally mounted at **63**, extends substantially parallel to but spaced from the reed **61**. The lever **62** is biased in the direction of the arrow **64** by means of a light hair of spring **65** so that contact **62*a*** on the lever is normally held against a stop or contact **66**. A damping device is provided for the lever **62** and is here shown as a stiff wire **67** which extends into a recess **68** which is filled with silicone or the like. The dash pot effect provided by the wire **67** in recess **68** is sufficient to cause the lever **62** to be moved very slowly. Another way of providing a damping effect would be to provide the pivot **63** with silicone or other sticky compounds which would act to retard the lever **62** as it pivoted at **63**. The reed **61** is selectively resonant to a particular audio-frequency signal and upon receipt of such a signal by a crystal **60** in a circuit similar to Fig. 4, the reed is caused to vibrate. As the reed vibrates, it strikes a raised seat **62*c*** on lever **62** and in a second or two drives the lever **62** downwardly where a second contact **62*b*** on the lever engages a contact **69** provided in a relay circuit **L1, L2** thereby energizing another circuit and causing a second desired operation to occur. As the lever **62** is driven downwardly by vibrating reed **61**, the stiff wire **67** in recess **68** creates a dash-pot effect thereby holding the lever **62** for a selected period of time before returning to its initial position. During this period of time contact **62*b*** on lever will be in engagement with the contact **69** of the relay circuit. Thus, through the provision of a crystal vibrated reed I have provided an extremely low powered, high impedance audio-frequency selective switch.

Referring now to Figs. 6 and 7 wherein I have shown a preferred embodiment of a two-reed receiver. The receiver unit is mounted in a small case of such size as to be capable of being carried around in the coat pocket of the user. Here the piezoelectric crystal receiver is constructed of two separate crystals **76** and **77** each constructed as described in connection with Fig. 2. The crystals are placed one above the other and are so arranged as to be completely independent of each other in their action. Each of the crystals **76** and **77** is constructed with four sides, three corners of which are rigidly mounted to the base **75** of the container by means of securing legs **78**, leaving a fourth corner free to vibrate. Each of the crystals **76** and **77** is provided with a tuned reed **79** and **80** respectively, each of which is rigidly connected to the free corner of its respective crystal and projects outwardly, as seen in Figs. 6 and 7. The lower tuned reed **80** projects over a sounding cone **81** in such a manner as to provide a small air gap or space between the apex of the cone and the end of the reed. The upper tuned reed **79** extends outwardly substantially parallel to and in spaced alignment with reed **80**. An electric contact member **82** is secured to the base **75** of the container and extends upwardly and outwardly to a position wherein its free end is spaced but a small distance from the end of the upper reed **79**. An electrically wound coil **83** (Figs. 6 and 8) is positioned adjacent one edge of the container. The coil is connected to the electrical contact member **82** by means of line **84**. Line **85** connects the coil with the negative poles of both piezoelectric crystal **76** and **77**. Associated with the coil is a pivotally mounted shaft **87** which is vertically supported between the arms of a U-shape bracket member **88** which is secured to the base of the container. A transverse oscillating steel member **90** is rigidly secured to the lower end of the shaft **87** in the magnetic field of coil **83** and is caused to rotate in a clockwise direction as viewed in Fig. 6 upon energization of the coil **83** the latter being effected by any suitable current source connected to the terminals provided therefor as indicated in Fig. 6 by the conventional plus (+) and minus (−) symbols, as is well known in the art. Rigidly secured to the upper end of the shaft **87** is an outstanding contact finger **91** which rotates in a clockwise direction along with the shafts **87** and member **90** upon energization of coil **83**. A hair spring **86** connected between shaft **87** and a fixed point on the base causes the shaft **87** and its associated members to return to an inoperative neutral position, as shown in Fig. 6, upon deenergization of the coil **83**. An upstanding contact member **92** is secured at one end to the base **75** of the container and has its free end positioned a small spaced distance from the end of finger **91** when said finger is in a neutral position, as seen in Fig. 6. The lower end of the contact member **92** is electrically connected to the lower piezoelectric crystal **77** by means of line **93**.

The operation of the device should now be apparent. The present embodiment, as that of Fig. 1, is designed for use as a receiver responsive to two audio-frequency signals transmitted in sequence. Each of the reeds **79** and **80** is selectively resonant to a respective one of said audio-frequency signals. By providing each of the reeds with an adjustable weight **79*a*** and **80*a*** respectively the frequency at which the reeds becomes resonant may be altered. In effect, this is a method of lengthening or shortening the reeds.

A first signal having a resonant frequency of the upper reed **79** is received by the upper piezoelectric crystal **76** and causes the crystal to vibrate, which in turn transmits its motion to its associated reed **79**. Since the reed is selectively resonant to this particular frequency, it begins to vibrate and its outermost end contacts the contact member **82**. Immediately upon contacting the member **82**, a circuit is established between the reed **79** and coil **83**, and the coil becomes energized, and capacitor **104** connected across the coil is energized to hold the charge briefly. Upon energization of coil **83**, the oscillating member **90** is caused to pivot in a clockwise direction, toward the coil **83**, as viewed in Fig. 6, which has the effect of rotating the contact finger **91** through shaft **87** in a clockwise direction, wherein it will contact member **92**. A circuit is thereby completed through line **93** with the lower piezoelectric crystal **77**. If, during the period that the coil **83** is energized, which may be a few seconds, a second audio-frequency signal having the resonant frequency of reed **80** is received by the lower piezoelectric crystal **77**, then reed **80** will be caused to vibrate. During its vibration, the end of reed **80** directly strikes or engages the sounding cone **81** and gives a characteristic tone or humanly recognizable signal. The advantage gained by increasing the number of vibrating reeds, as formerly explained, is found in an increased number of combinations of different signals that may be sent out from the transmitting equipment, thereby permitting an increase in the number of persons subject to individual call.

Referring now to Fig. 8, I show a portion of the control circuit for use with the novel embodiment of the receiver shown in Figs. 6 and 7. The portion of the circuit shown in Fig. 6 relates to the decoder or that portion of the circuit, as seen in Fig. 4, which lies to the right of line C—C. The other portions of the circuit, namely, the receiver and voltage limiter are identical to those shown to the left of line C—C in Fig. 4. An A battery **97** provides power for the power tube **48** by means of a double-acting switch **96**. A pair of B batteries **98** and **98** provide current for the germanium diodes **99** and **100**. Power tube **48** and the germanium diodes are identical in their operation to those shown in Fig. 4. The plate **48*c*** of the power tube **48** is connected by means of line **101** through capacitor **102** to the piezoelectric crystal **76** by means of suitable tabs. Upon receipt of an audio-frequency signal through line **101** which is connected to the piezoelectrical crystal **76**, the reed **79** vibrates and makes connection through contact **82** and line **84** with the coil **83** and capacitor **104**. Upon energization of the coil **83** the hair spring controlled contact **91** closes a circuit through line **93** with the lower piezoelectric crystal **77**. If during the period that the coil **83** is energized and current flows through lines **101** and **103** from power tube **48** to the piezoelectrical crystal **77**, a second audio-frequency signal having the resonant frequency of reed **80** is received through lines **102** and **105** by the piezoelectrical crystal **77**, then the reed **80** is caused to vibrate and directly strikes the sounding cone **81**, to produce a characteristic tone or humanly recognizable signal.

In view of the foregoing description, taken in conjunction with the accompanying drawings, it is believed that a clear understanding of the construction, operation and advantages of the device will be quite apparent to those skilled in this art.

It is to be understood, however, that even though there is herein shown and described a preferred embodiment of the invention, the same is susceptible of certain changes fully comprehended by the spirit of the invention.

Having thus described my invention and illustrated its use, what I claim as new and desire to secure by Letters Patent is:

1. A personal signal receiver comprising a base, a crystal mounted on said base, a second crystal mounted on said base in spaced relation to said first crystal, a reed connected to said first named crystal selectively resonant and responsive to a first particular audio-frequency signal applied to said first named crystal to cyclically oscillate within a predetermined amplitude of movement, a second reed connected to said second crystal selectively resonant and responsive to a second particular audio-frequency signal applied to said second crystal to cyclically oscillate within a predetermined amplitude of movement, contact means positioned within said amplitude of movement for said first named reed, a shaft rotatably mounted on said base, a current source, electromagnetic means supported on said shaft and in circuit with said contact means and said current source, said first reed responsive to said first named particular audio-frequency signal to actuate said contact means and cause the energization of said electromagnetic means, contact means in circuit with said second crystal and actuatable in response to the energization of said electromagnetic means to cause the excitation of said second crystal, said second crystal while excited being responsive to said second particular audio-frequency signal to cause the vibration of said second reed, and sound reproducing means spaced from said second reed within its amplitude of movement and actuatable in response to the vibration of the same to produce a humanly recognizable signal.

2. A personal signal receiver comprising a base, first and second crystals mounted on said base, a reed connected to each of said crystals and selectively resonant and responsive to a first and second particular audio-frequency signal respectively applied to said crystals to cyclically oscillate within a predetermined amplitude of movement, contact means positioned within said amplitude of movement for the reed connected to said first crystal, a shaft rotatably mounted on said base, a current source, electromagnetic means supported on said shaft and including a coil in circuit with said contact means and said current source, said reed connected to said first crystal responsive to said first particular audio-frequency signal to actuate said contact means and cause the energization of said coil, contact means in circuit with said second crystal and actuatable in response to the energization of said coil to cause the excitation of said second crystal, said second crystal while excited being responsive to said second particular audio-frequency signal to cause the oscillation of the reed connected thereto, and sound reproducing means positioned within the amplitude of movement for said last named reed and actuatable by the oscillations thereof to produce a humanly recognizable signal.

3. A personal signal receiver comprising first and second crystals, a reed connected to each of said crystals selectively resonant and responsive to a first and second particular audio-frequency signal respectively applied to said crystals to cyclically oscillate within a predetermined amplitude of movement, contact means positioned within said amplitude of movement for the reed connected to said first crystal, a current source, electromagnetic means in circuit with said contact means and said current source, said reed connected with said first crystal responsive to said first particular audio-frequency signal to actuate said contact means and cause the energization of said electromagnetic means, contact means in circuit with said second crystal and actuatable in response to the energization of said electromagnetic means to cause the excitation of said second crystal, said second crystal while excited being responsive to said second particular audio-frequency signal to cause the oscillation of the reed connected thereto, and sound reproducing means positioned within the amplitude of movement for said last named reed and actuatable thereby to produce a humanly recognizable signal.

4. A personal signal receiver comprising a base, a first crystal mounted on said base, a second crystal spaced vertically below said first crystal and attached to said base, a reed connected to each of said crystals extending over said base in parallel spaced relation being selectively resonant and responsive to a first and second particular audio-frequency signal respectively applied to said crystals to cyclically oscillate within a predetermined amplitude of movement, contact means positioned within said amplitude of movement for the reed connected to said first crystal, a shaft rotatably mounted on said base, a current source, electromagnetic means supported on said shaft and including a coil in circuit with said contact means and said current source, said reed connected to said first crystal responsive to said first particular audio-frequency signal to actuate said contact means and cause the energization of said coil, contact means in circuit with said second crystal and actuatable in response to the energization of said coil to cause the excitation of said second crystal, said second crystal while excited being responsive to said second particular audio-frequency signal to cause the oscillation of the reed connected thereto, and sound reproducing means disposed on said base below the reed connected to said second crystal and positioned within its amplitude of movement and actuatable thereby to produce a humanly recognizable signal.

5. A personal signal receiver comprising a base, first

and second crystals mounted on said base, a metallic reed connected to each of said crystals and selectively resonant and responsive to a first and second particular audio-frequency signal respectively applied to said crystals to cyclically oscillate within a predetermined amplitude of movement, contact means mounted on said base and positioned within said amplitude of movement for the reed connected to said first crystal, a shaft rotatably mounted on said base, a current source, electromagnetic means supported on said shaft and including a coil in circuit with said contact means and said current source, said reed connected to said first crystal responsive to said first particular audio-frequency signal to variably connect with asid contact means and cause the energization of said coil, switch means in electrical circuit with said second crystal and responsive to the energization of said coil to effect the excitation of said second crystal, said second crystal while excited being responsive to said second particular audio-frequency signal to cause the oscillation of the reed connected thereto, and sound reproducing means mounted on said base normally spaced below said latter reed and positioned within its amplitude of movement and actuatable thereby to produce a humanly recognizable signal.

6. A pair of spaced reeds responsive to different audio-frequency signals, the first of said reeds being secured to a first crystal, a second crystal and means connecting the other of said reeds to said second crystal, circuit means connected to said first reed, means connected to said first crystal for applying a predetermined one of said audio frequency signals to said first crystal and cause the vibration of said first reed, vibration of said first reed causing the enabling of said circuit means, and means responsive to the enabling of said circuit means for applying another of said audio frequency signals to said second crystal and thereby cause the vibration of said second reed, and sound resonator means positioned adjacent to said second reed whereby the vibration of said second reed produces an audible signal.

7. A pair of spaced reeds each being responsive to a different audio-frequency signal, the first of said reeds being secured to a first crystal, a second crystal and means connecting the other of said reeds to said second crystal, first circuit means connected to said first reed, a coil in said first circuit means, means connected to said first crystal for applying a predetermined one of said audio-frequency signals to said first crystal to thus cause the vibration of said first reed, second circuit means connected to said second crystal, switch means in said second circuit means, vibration of said first reed causing the energization of said coil in said first circuit means for a predetermined time interval, said switch means being responsive to the energization of said coil to thus cause the enabling of said second circuit means, means responsive to the enabling of said second circuit means for applying another of said audio-frequency signals to said second crystal and thereby cause the vibration of said second reed, and means responsive to the vibration of said second reed for causing a humanly recognizable signal.

8. A plurality of reeds each tuned to a different audio-frequency signal, a first of said reeds secured to a piezoelectric crystal, a second crystal and means connecting another of said reeds to said second crystal, first circuit means connected to said first reed, energizing means in said first circuit means, means connected to said first crystal for applying a predetermined one of said audio-frequency signals to said first crystal to thus cause the vibration of said first reed, second circuit means connected to said second crystal, switch means in said second circuit means, vibration of said first reed causing the actuation of said energizing means, means in said first circuit means for maintaining the actuation of said energizing means for a predetermined time interval, said switch means being responsive to the actuation of said energizing means to thus cause the enabling of said second circuit means, means responsive to the enabling of said second circuit means for applying another of said audio-frequency signals to said second crystal and thereby cause the vibration of said second reed, and means responsive to the vibration of said second reed for causing a humanly recognizable signal.

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