Sept. 22, 1970 B. J. PLUNKETT ET AL 3,530,224

FOOT CONTROLLED CONTINUOUSLY VARIABLE PREFERENCE CIRCUIT FOR MUSICAL INSTRUMENTS

Filed Feb. 24, 1967 2 Sheets-Sheet 1

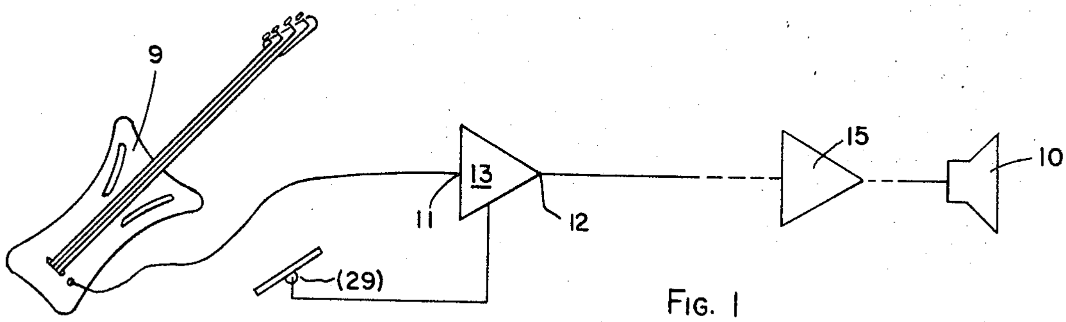

FIG. 1

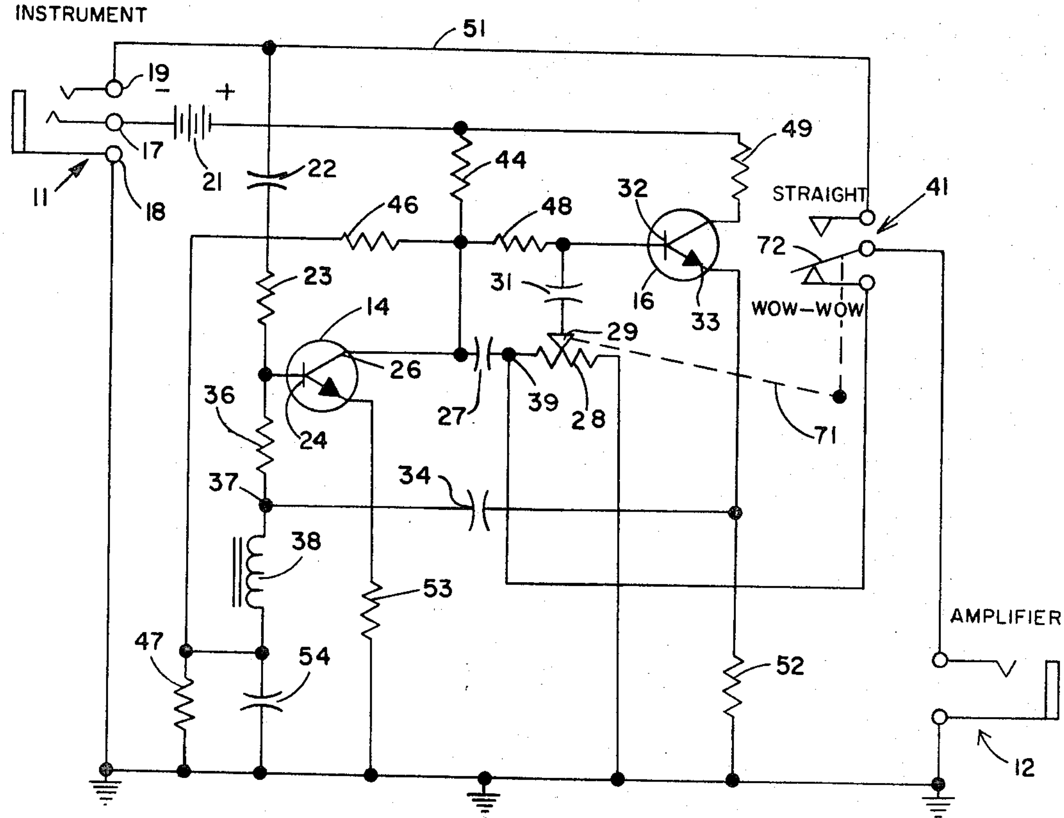

FIG. 2

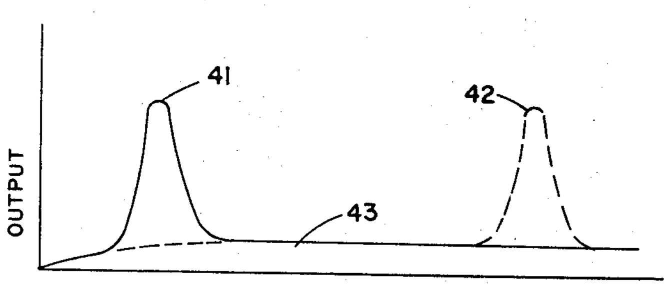

FIG. 3

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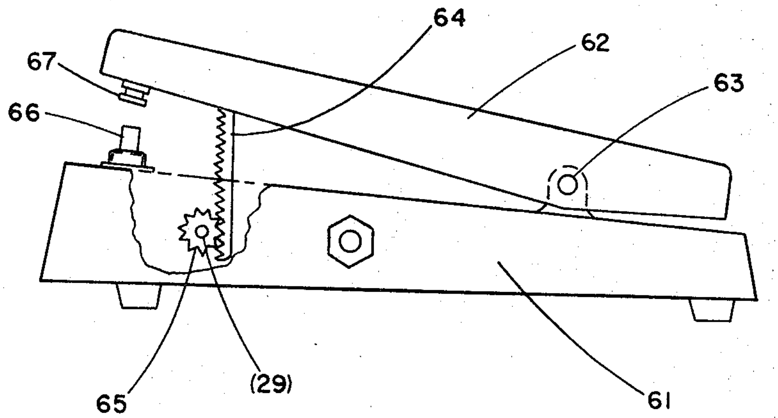

Fig. 4

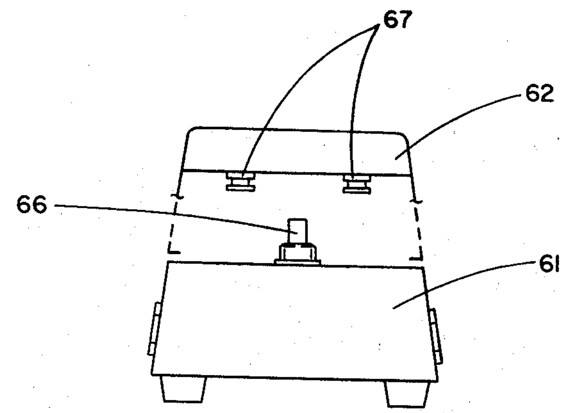

Fig. 5

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FOOT CONTROLLED CONTINUOUSLY VARIABLE PREFERENCE CIRCUIT FOR MUSICAL INSTRUMENTS

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Int. Cl. G10h *1/02*
U.S. Cl. 84—1.11 7 Claims

ABSTRACT OF THE DISCLOSURE

In a musical instrument a resonant circuit is connected in the circuit between the tone generators and the loudspeaker. The tone generators deliver tone signals rich in harmonics covering a wide frequency spectrum. Within this spectrum a given frequency (or a narrow band of frequencies) is given preference in the delivery path of the tones from the tone generators to the loudspeaker. The position on the frequency scale of this preferred frequency or resonant peak is continuously variable, from low frequency to high frequency over the wide frequency spectrum. This variability is under the ready control of the instrument player, as for example by being connected to a foot pedal. Thus, during playing of the instrument, the player can continuously move the resonant peak back and forth across the frequency spectrum and create a rhythmic musical sound. The musical effect may be described as a wow-wow and is closely akin to that produced by the warbling of a trumpet mute across the bell of a trumpet.

BACKGROUND OF THE INVENTION

Electronic musical instruments are becoming more and more popular among musical groups. In some cases, for example, in an electronic organ, the tone itself is generated electronically and treated in its electric signal state in numerous ways, finally emerging, for the first time as a vibration or acoustic signal, from the loudspeaker of the system. In other musical instruments the tone is generated mechanically, as for example by vibrating a guitar string or blowing into a wind instrument. The mechanical or acoustic vibration is then picked up and translated into an electric signal. The electric signal is then acted upon in a variety of ways by numerous electronic circuits, and then emerges once more to acoustic form in the loudspeaker of the system.

In years past, for example in dance bands, certain trumpet players have produced a unique effect which may be described as a wow-wow. This is done by holding a mute over the bell of the trumpet and moving the mute so as to in effect rhythmically open and close the bell passage. When done skillfully the effect can almost simulate the human voice. A rudimentary practice of the effect, as noted hereinbefore, produces a sound closely akin to a person's singing wow-wow-wow. Heretofore, this effect has been largely confined to horns, such as trumpets, and has required skillful manipulation of a mute over the bell of the horn by sophisticated horn players.

SUMMARY

The present invention consists of an electronic circuit

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by means of which the artist or player of any electronic musical instrument has at his control a lever, such as a foot pedal, through which he can closely simulate the wow-wow sound previously limited to the trumpet, as noted hereinbefore. The invention may be applied to any musical instrument in which electric tone signals are produced, whether such signals are initially produced electronically or whether they are produced acoustically, and then translated into electric tone signals by means of pickup devices. It is particularly adaptable to hand-held instruments, such as wind instruments, guitars and other string instruments and the like. The present invention consists of a resonant circuit which favors or discriminates in favor of a particular frequency, or narrow band of frequencies, in the translation path between the tone generators and the loudspeaker. By continuously moving this favored frequency back and forth across the frequency spectrum rhythmically, as with a foot pedal, the player can simulate the wow-wow sounds previously done acoustically by sophisticated trumpet players.

In a preferred form of the invention the frequency tuning is accomplished by means of an amplifier circuit having negative feedback and so connected that the apparent input reactance of the total amplifier circuit may be varied in accordance with the gain of the amplifier. This reactance, for example a capacitive reactance, is coupled with a complementary reactance, e.g., an inductor, to form a variable frequency resonant circuit, the frequency position of which depends on the gain of the amplifier at that particular moment. The amplifier is so designed that the gain may be controlled by a controllable member, such as a potentiometer, which is readily placed under the manual or pedal control of the instrument player or performer.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing, FIG. 1 is a block diagram of the musical circuit. FIG. 2 is a circuit diagram illustrating the variable frequency circuit of the present invention. FIG. 3 is a graph illustrating the effect of the variable frequency circuit on the output of the musical system. FIG. 4 is a side view of a pedal designed to inject the wow-wow effect into the circuit. FIG. 5 is an end view of the pedal.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 there is shown an amplifier **13** having an input **11** and an output **12**. To the input **11** there is designed to be applied an electric tone signal and especially an electric tone signal rich in harmonics. This signal may be generated electronically, e.g., in an electronic organ, or may be generated acoustically, e.g., by vibrating the strings of a guitar **9**, or in the mouthpiece of a wind instrument, and then translated into an electric signal by any form of known pick-up device.

The output **12** is adapted to be connected ultimately to some form of speaker means or electro-acoustic transducer **10**. Interposed between the output **12** and speaker may if desired be any form of amplifier, formant circuit, tone control circuit, or other musical instrument circuitry, exemplified generally at **15**.

Referring to FIG. 2 the amplifier **13** interposed between the input **11** and the output **12** consists of two stages, the first stage including the transistor **14**, and the second stage, the transistor **16**.

The input **11** consists of a jack having a B— terminal **17**, a ground terminal **18**, and a hot or signal terminal **19**. When the plug from the tone signal generator **9** is plugged into the jack **11**, signal voltage is applied between the terminals **17** and **19**, and simultaneously the terminal **17** is connected with terminal **18**. The plug thus serves the double function of injecting signal into the system and also energizing the circuit by connecting the negative side of the energizing battery **21** to ground **18**.

Tone signals are applied from the input terminal **19**, through a coupling capacitor **22** and resistor **23**, to the base **24** of the transistor **14**. Amplified output is taken from the collector **26** through the coupling capacitor **27** and applied to a variable resistance means in the form of a potentiometer **28**. The slider **29** of the potentiometer **28** is connected through a coupling capacitor **31** to the base **32** of the second stage transistor **16**. The transistor **16** is connected as a low output-impedance amplifier of approximately unity gain, i.e., as an emitter follower.

Output from the second stage **16** is taken from the emitter **33** through a feedback impedance, in the form of a feedback capacitor **34**, to the input to the amplifier, i.e., to the base **24**, through a resistor **36**.

The first stage **14** amplifies and inverts the applied tone signal. Because of the amplification of the signal applied across the feedback capacitor **34**, the apparent reactance, seen by the input signal looking into the capacitor **34**, is much lower than the actual reactance. The input impedance into the transistor **14** on the other hand is relatively high. Thus, so far as current flow is concerned, as a practical matter, the signal looks primarily into the reactance **34**, the apparent magnitude of which, as noted, depends on the gain of the signal in passing through the amplifier. This gain is determined by the position of the slider **29** of the potentiometer **28**. When the slider is farthest to the right in FIG. 2, the gain is minimum; the current flow through the feedback capacitor **34** is minimum; and, hence, the apparent reactance is maximum, i.e., the apparent capacitance approaches the true capacitance, viz, a relatively small value. When the slider **29** is in its left-hand position in FIG. 1, the gain is maximum; the current through the capacitor **34** is maximum; the apparent reactance **34** is minimum; and, hence, the apparent capacitance of **34** is a maximum.

There is thus presented to the input signal appearing at the junction point **37**, a relatively pure capacitive reactance, the magnitude of which is dependent upon the gain in the amplifier, i.e., upon the position of the slider **29**. There then remains only the matter of connecting a complementary reactance, in this case an inductor **38**, in circuit with the capacitor **34**, to produce a resonant circuit, the tuning of which may be adjusted by tuning the apparent magnitude of the capacitor **34**.

The output from the amplifier is taken from the junction point **39**, between the capacitor **27** and potentiometer **28**, and applied through a double-throw switch **41** to the output jack **12**.

The operating characteristics of FIG. 2 will be readily understood by reference to FIG. 3, wherein the ordinate represents output signal appearing at the output jack **12** and the abscissa represents frequency of the tone components in the harmonic-rich tone applied to the input **11**. When the slider **29** is moved to the left the net gain in the amplifier is high and the apparent capacitance of **34** is likewise high, so that the resonance frequency of the LC circuit **34/38** is relatively low. Hence the circuit in this condition gives decided preference to the low frequency, exemplified at peak **41** in FIG. 3. Conversely when the slider **29** is moved to the right, the amplifier gain is low, the apparent capacitance of **34** is likewise low, and the circuit peaks at **42**. The peak can be positioned anywhere in between simply by positioning the slider **29** between its extreme positions.

The aggregate Q of the circuit is quite high, thereby giving decided preference to the selected frequency (or

narrow frequency band). This is seen in FIG. 3, where the peak output at **41** is many times, e.g. 10 times, the output at the other frequencies, represented by the relatively flat line at **43**. The innate Q of the circuit, in fact, is so high that it was found desirable to insert the resistor **36** in order to admit some of the non-favored (off-peak) frequencies into the amplifier, so that they could pass to the output. Without the resistor **36**, virtually the only frequency appearing at the base **24** would be the selected frequency, because of the high Q of the circuit. The presence of resistor **36** allows all frequencies to be developed to a certain extent thereacross, and hence to be passed to the amplifier.

The function of the other components in FIG. 2 will now be described. Resistor **44** constitutes the DC load for the collector **26** of the transistor **14**. Resistors **46** and **47** form a voltage divider for determining the bias applied to the base **24** through the inductor **38** and resistor **36**.

The bias for the second stage, transistor **16**, is obtained from the collector **26** of the first stage **14**, through the resistor **48**. The emitter follower **16** has some slight tendency to oscillate. The inclusion of resistor **49** in its collector circuit supresses any parasitic oscillations.

Resistor **52** is a DC return resistor for the emitter follower **16**. Resistor **53** is a DC return for the emitter of transistor **14**. Capacitor **54** constitutes an AC return path for the tuned circuit **38/34**, and also serves as a bypass for AC around the bias network resistor **47**.

It will be noted that the output, being taken from the point **39**, is unaffected by the position of the potentiometer slider **29**. Therefore the position of the slider **29** does not change the overall amplification of the circuit, at the output **12**. Its only effect is to move the resonant frequency peak back and forth along the frequency scale, shown in FIG. 3.

When the wow-wow effect is not desired, the double throw switch **41** is thrown to the upper position, which bypasses the amplifier and sends the signal directly from the input terminal **19** to the output jack **12**. It will be noted that even in this position of switch **41**, the input to the amplifier is still attached to the circuit, through the permanently attached coupling capacitor **22**. This produces a slight hump at the frequency to which the amplifier is set, but the effect is so slight as not to be audible to the ear. That is, at the peak frequency the amplifier presents to the bypass conductor **51** an impedance which is approximately the sum of resistor **23** (68 kilohms) plus the parallel impedance of the resonant circuit **38/34**, which is about 15 kilohms. This totals approximately 83 kilohms. At off peak frequencies, the impedance is essentially the 68 kilohms of resistance **23**, plus the resistance of resistor **36**, about 1.5 kilohms. This difference in loading placed on the bypass circuit **51**, as noted, does produce a slight hump at the resonant frequency, but it is not enough to be discernible by the ear.

As noted hereinbefore, the slider **29** is attached to some form of lever or operating member which is readily controllable by the instrument player. In the case where the tone generator which produces and delivers the basic musical tone to the input **11**, is an instrument such as a guitar **9** held by both hands of the player, this operating lever may conveniently take the form of a foot pedal, which is rocked back and forth to produce the wow-wow sound discussed hereinbefore. Alternatively, the lever may be a rocker arm attached to the face of the guitar, for example, a bridge member which may span the guitar strings and be rocked back and forth, somewhat in the way that a mute control is moved to apply a muting pad to the strings of the guitar.

In place of the potentiometer **28** having the movable slider **29**, there may be light dependent resistor (LDR) which constitutes one segment of a voltage divider. The output to the second stage **16** is taken from the junction point between a fixed resistor and the LDR. In this case the voltage division is continually dependent upon the magnitude of the LDR, and, hence, upon the amount of light falling on it. By giving the instrument player or performer control over the amount of light falling on the LDR, he can be given control of the gain of the amplifier and, hence, control of the position of the frequency peak 41 (FIG. 3).

A satisfactory circuit has been constructed as shown in FIG. 2 having the following parameters.

Transistor 14—2N3900A
Transistor 16—2N2924
Resistor 23—68 kilohms
Resistor 36—1.5 kilohms
Resistor 47—100 kilohms
Resistor 46—470 kilohms
Resistor 53—470 ohms
Resistor 44—22 kilohms
Resistor 48—470 kilohms
Potentiometer 28—100 kilohms
Resistor 49—1 kilohm
Resistor 52—10 kilohms
Capacitor 22—0.01 microfarad
Capacitor 54—4 microfarads
Capacitor 27—0.22 microfarad
Capacitor 34—0.01 microfarad
Capacitor 31—0.22 microfarad
Inductor 38—500 millihenrys
Battery 21—9 volts

Another feature of the invention is the construction of the foot pedal which operates the slider 29 of the potentiometer 28. This foot pedal is so constructed as to conveniently gang the slider 29 and the double-pole switch 41, in such a manner that the instrument player may conveniently operate both the slider 29 and the double-throw switch 41 by appropriate manipulation of a single pedal.

This configuration is shown in FIG. 4, wherein 61 represents a base to which a foot pedal 62 is hinged at 63. The pedal 62 is so mounted that by downward movement of the toe the pedal may be rocked down toward the base 61, while by pressing back with the heel against the rear of the pedal 62, the toe end of the pedal may be raised from the base 61. By means of a rack 64 and pinion 65, the rocking of the pedal 62 is coupled to a shaft, shown figuratively at 29 in FIG. 4, which in turn actuates the slider 29 back and forth across the potentiometer resistance 28.

The double-throw switch 41 is mounted on top of the base 61, just under the toe of the pedal 62. Switch 41 is a conventional type of switch, characterized by an operating member or element, in this case a reciprocable plunger 66, which is biased upwardly and which returns to its starting or upward position after each actuation. The plunger 66 thus always moves through a given cycle of movement, up and down, with each actuation. Each cycle of movement, i.e., pushing down and releasing on the plunger 66, causes the double-throw switch 41 to move from either position to the other. Thus, assuming the arm 72 of switch 41 is in the lower or wow-wow position (FIG. 2) and the underside of the pedal 62 is brought against the plunger 66 and pressed down, the arm 72 will be thrown to the upper or by-pass position. The pedal 62 is then returned to a "normal" position, out of contact with the switch plunger 66. The next identical operation of the foot switch 62 on the plunger 66 will cause the plunger to go through exactly the same reciprocating cycle, but this time the arm 72 of switch 41 will be thrown back to the lower or wow-wow position.

The lower (counterclockwise, FIG. 4) position of the pedal 62 is, of course, at one extreme of the slider 29 in its passage across the resistor 28. For example, this may be the right-hand end of resistor 28 in FIG. 2, i.e., where the circuit represented by 38/34 is tuned to its highest frequency.

Thus, to switch the wow-wow circuit in or out, the instrument player need only move the pedal 62 to its extreme downward position. The terminal operation serves to actuate the plunger 66 and thus switch the double-throw switch 41 to its other position. In this way the wow-wow circuit may be conveniently placed in or out of the instrument circuit without requiring any special operation by the player, since his foot is already on the pedal 62 ready to operate the wow-wow effect (potentiometer 28/29) whenever the arm 72 of switch 41 is in its down position (FIG. 2).

In practice it is preferred to construct the potentiometer 28 so that at the switch operating end, there is no variation in resistance. Thus, during that portion of the movement of pedal 62, where the switch 41 is being operated, no change in the resonant frequency of the circuit occurs.

In order that the switch 41 be not accidentally operated there are provided a pair of rubber bumpers 67 projecting downward from the underside of the pedal 62 on each side of the switch 41. These bumpers engage the base 61 about the time the pedal 62 comes into contact with the switch operating plunger 66. Thus, the instrument player must increase the force on the pedal 62 greatly in order to overcome the resistance of the bumpers 67, thereby compressing them and forcing the pedal down against the plunger 66 far enough to actuate the switch 41. Upon release of this extra pressure, the rubber bumpers aid in returning the pedal 62 to a position clear of the actuating plunger 66.

The slider 29 and switch 41 are thus to a certain extent ganged together by the foot pedal 62. This ganging is represented schematically by the dotted line 71 in FIG. 2.

While the present invention has been shown and described herein in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of the invention which is, therefore, not to be limited to the details disclosed herein, but is to be afforded the full scope of the claims.

What is claimed is:

1. A circuit means adapted to be inserted between a musical instrument and a speaker means, said instrument including tone generating means for delivering electric tone signals corresponding to musical sounds, and said speaker means serving to transduce said tone signals into musical tones; said circuit means being adapted to have applied thereto from said instrument, electric tone signals in a predetermined frequency range lying within the range of said electric tone signals delivered by said tone generating means for passing said electric tone signals delivered by said tone generating means for passing said electric tone signals from said tone generating means to said speaker, and said circuit means including:

network means for favoring the delivery of certain signal frequencies in a narrow frequency band within said predetermined frequency range from said tone generating means to said speaker means, and

foot-operated control means physically separated from said instrument and readily controllable by the foot of the instrument player for continuously varying said narrow frequency band back and forth over said predetermined frequency range.

2. The combination defined in claim 1, in which said network means comprises a resonant network having a high Q relative to said circuit means to exhibit a sharp peak amplitude/frequency response characteristic superimposed on the aforesaid substantially uniform response characteristic, and extending to an amplitude representing a substantial multiple of the corresponding amplitude of said uniform response characteristic, the position of said narrow frequency band in said frequency range being established by the resonant frequency of said resonant network, and said foot-operated control means serving to vary said resonant frequency so as to move said narrow frequency band back and forth over said predetermined frequency range.

3. The circuit means defined in claim 2, wherein said foot-operated control means comprises a potentiometer, the position of which determines the apparent magnitude

of a resonant frequency-determining reactance element forming a portion of said resonant network.

4. The circuit means defined in claim 2, wherein said resonant network comprises: a variable gain amplifier having feedback means for creating an apparent resonant frequency-determining reactive input impedance to said amplifier, the magnitude of which depends upon the gain of the amplifier, and wherein said foot-operated control means comprises means for varying the gain of said amplifier.

5. The circuit means defined in claim 4, in which said amplifier comprises: a first stage of amplification, variable resistance means in the output of said first stage, a second stage of amplification having its input taken from said variable resistance means, a feedback impedance connected from the output of said second stage to the input of said first stage, whereby variation of said variable resistance means varies the resonant frequency-determining apparent reactive input impedance of the amplifier.

6. The circuit means defined in claim 5, in which said variable resistance means comprises a potentiometer.

7. The circuit means defined in claim 5, in which said second stage of amplification is a low impedance amplifier of approximately unity gain.

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WARREN E. RAY, Primary Examiner

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