Nov. 23, 1954 F. M. SCHMIDT 2,695,386

ORGAN SWELL CONTROL

Filed June 1, 1949 2 Sheets-Sheet 1

Fig. 1.

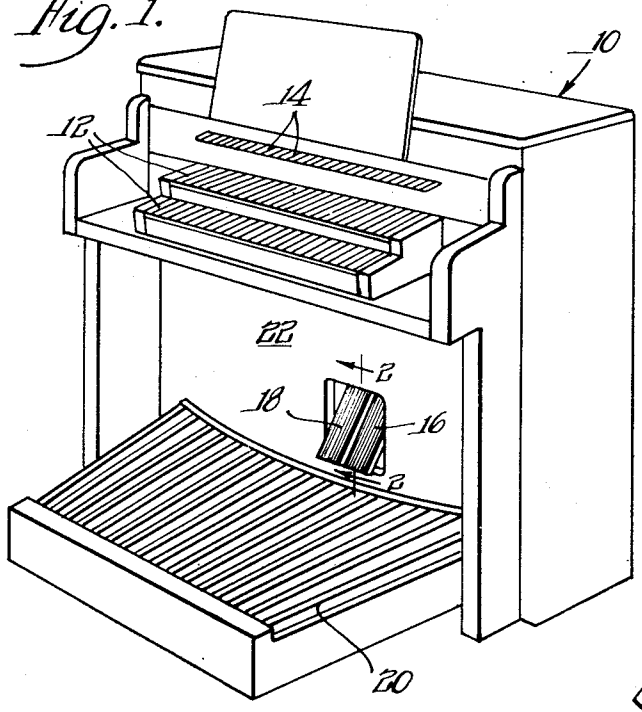
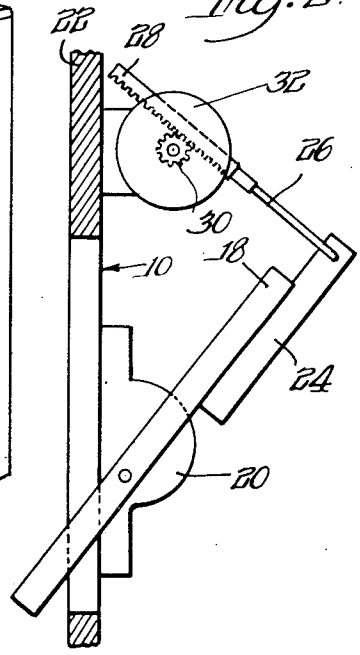


Fig. 2.



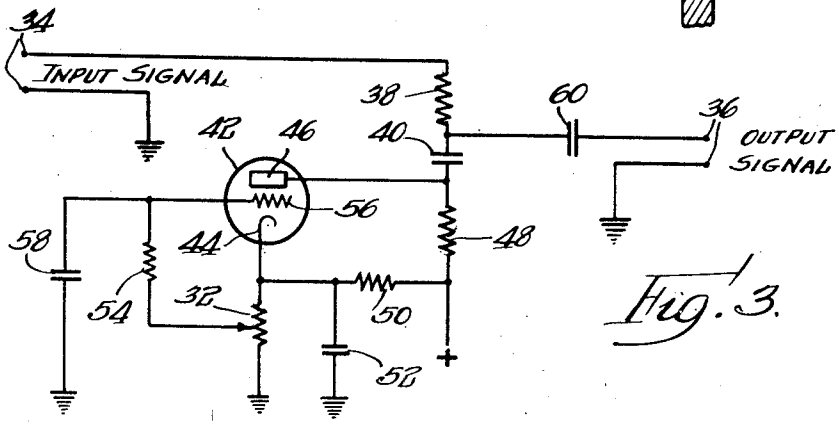
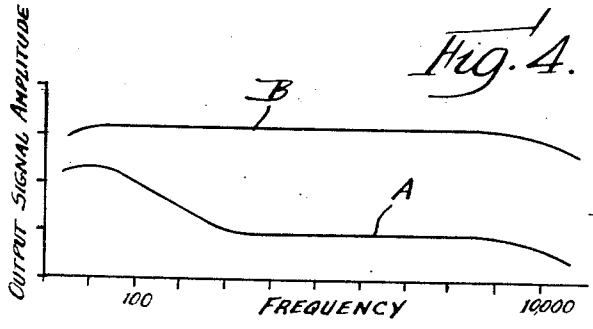


Fig. 3.

Fig. 4.



INVENTOR.
Francis M. Schmidt
BY
Moore, Olsen & Tredo
Attys.

Nov. 23, 1954 F. M. SCHMIDT 2,695,386

ORGAN SWELL CONTROL

Filed June 1, 1949 2 Sheets-Sheet 2

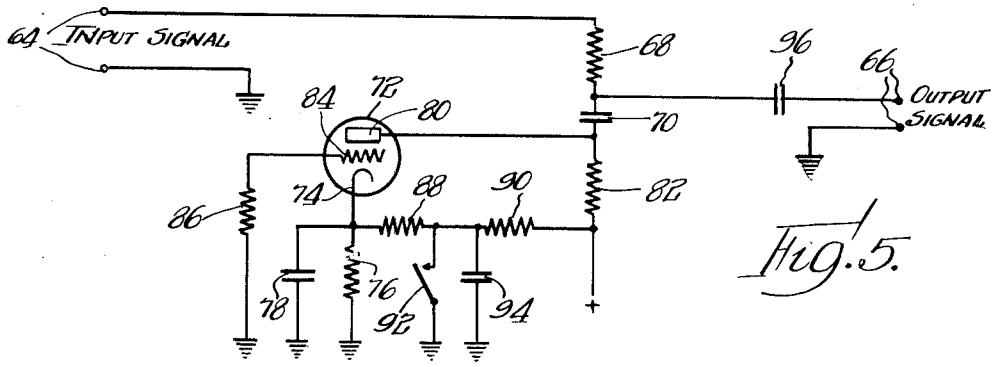


Fig. 5.

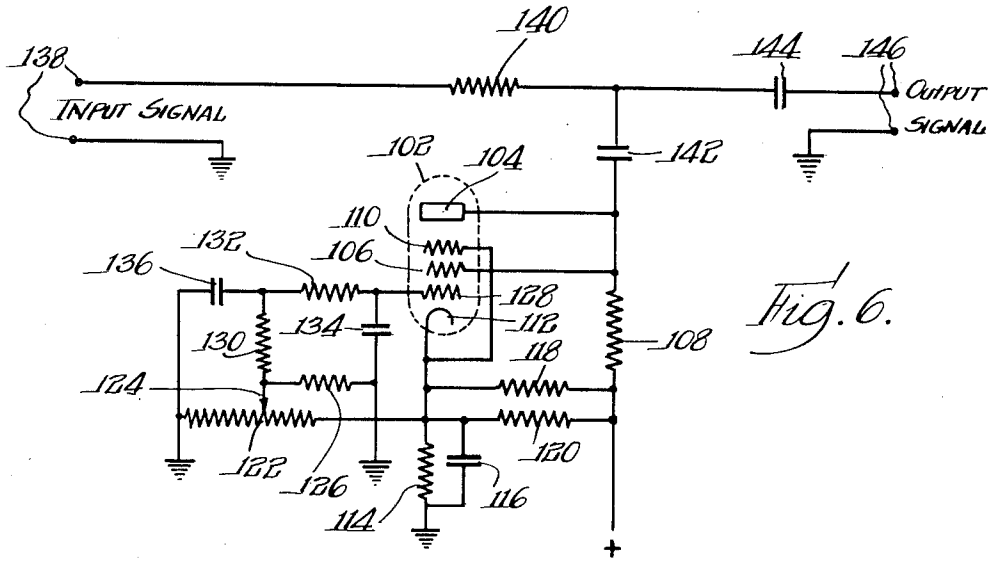


Fig. 6.

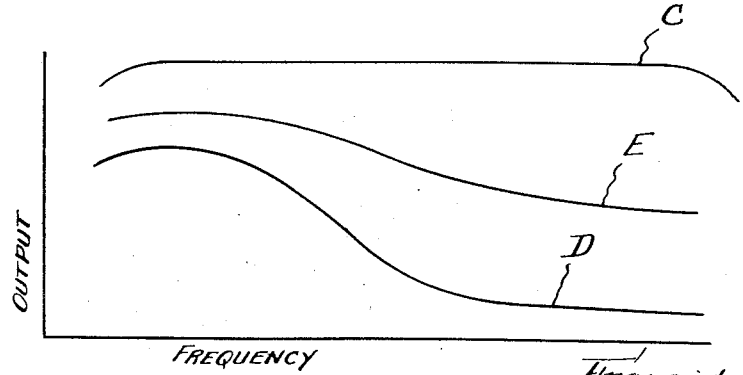


Fig. 7.

INVENTOR.
Francis M. Schmidt
BY
Moore, Olson & Theeler
attys.

United States Patent Office 2,695,386 Patented Nov. 23, 1954

2,695,386

ORGAN SWELL CONTROL

Francis M. Schmidt, North Tonawanda, N. Y., assignor to The Rudolph Wurlitzer Company, North Tonawanda, N. Y., a corporation of Ohio

Application June 1, 1949, Serial No. 96,544

3 Claims. (Cl. 333—28)

This invention relates to electric organs and particularly to means for controlling the volume or intensity level of sounds produced by such instruments.

In an organ of the type contemplated herein it is customary to provide a volume control rheostat or potentiometer which is operated by the so-called swell pedal of the organ. Prior circuit arrangements utilizing such volume controls have not proved entirely satisfactory because of several factors. Such devices generally are unable, through their own inherent action, to compensate for undesired tonal effects that tend to accompany changes in level. Also, they are prone to be noisy if the resistor contacts are not properly spaced or if the parts become worn and loose.

An object of the present invention is to provide an improved swell or volume control which effects tone shaping in accordance with frequency, particularly in the lower-frequency portion of the instrument, simultaneously with level changes.

An ancillary object of the present invention is to provide an auxiliary volume control having a plurality of fixed settings which effects tone shaping in accordance with frequency, the intensity controlled depending in large measure on the frequency of the tone being controlled.

A further object is to provide an electronic swell control comprising an attenuating network wherein a portion of the network is shunted by a variable impedance including an electron tube the grid bias of which is varied by a volume control element such as a potentiometer, the network being so constituted as to progressively increase the relative strength of the lower tones as the level is reduced, and conversely.

A still further object is to provide an improved swell control having means to eliminate noise which otherwise might result from imperfections in the control potentiometer.

A still further object is to provide an electronic swell control including a timing circuit which prevents abrupt changes in volume as the control setting is varied.

Other objects, features and advantages will become apparent from a study of the following description taken in connection with the accompanying drawing wherein:

Fig. 1 is a perspective view of a typical organ adapted to utilize the principles of the invention;

Fig. 2 is a partial vertical section on the line 2—2 in Fig. 1 showing the mechanical arrangement of certain parts;

Fig. 3 is a schematic diagram of a circuit embodying the invention;

Fig. 4 is a diagram depicting the frequency response characteristics of the circuit at different levels;

Fig. 5 is a schematic diagram of a circuit, embodying a different form of the invention;

Fig. 6 is a schematic diagram of a circuit, embodying yet another form of the invention; and

Fig. 7 is a diagram depicting the frequency response characteristics at different levels of the circuit shown in Fig. 6.

The organ illustrated in Fig. 1 is housed in a console 10 and includes two manual keyboards 12, a row of stop tablets 14, a crescendo pedal 16, a swell pedal 18 and a pedal clavier 20. The swell pedal 18, as shown in Fig. 2, is pivotally mounted in a bracket 20 secured to a vertical panel 22 in the lower part of the console 10. An extension 24 on the pedal 18 is connected by a link 26 to a rack 28 which is meshed with a pinion

30 on the shaft of a volume control potentiometer 32. The potentiometer 32 is mounted at a convenient location on the supporting panel 22 and may be of a conventional type customarily used in electric organs.

Referring now to Fig. 3, the volume control potentiometer 32 is shown connected in circuit with an attenuating network having input terminals 34 and output terminals 36. This attenuating network may be interposed at any convenient point in the electrical system of the instrument, for example, intermediate two successive amplifier stages. The network essentially comprises a series circuit including a resistor 38, a capacitor 40 and the plate-cathode impedance of a triode 42. The cathode 44 of the tube 42 is connected to ground through the resistance element of the potentiometer 32. The plate 46 of tube 42 is connected to the junction of the capacitor 40 and a resistor 48, through which last-named element the operating potential is applied to the plate 46 from a suitable direct-current plate voltage source.

Cathode bias is supplied to the tube 42 through a voltage divider comprising the series combination of a resistor 50 and the resistance element of the potentiometer 32, the resistor 50 being connected at one end to the plate voltage source and at its other end to the cathode 44. A capacitor 52 by-passes the potentiometer 32 for alternating-current signals. Grid bias for the tube 42 is furnished by the potentiometer 32, the movable contact of which is connected through a resistor 54 to the control grid 56 of tube 42. A capacitor 58 is connected between the grid 56 and ground for a purpose which will be explained presently.

The input signal terminals 34 are connected respectively to ground and to one terminal of the resistor 38. One of the output terminals 36 is grounded while the other is connected through a coupling capacitor 60 to the junction between the resistor 38 and the capacitor 40. The amount of attenuation of the input signal depends upon the setting of the potentiometer 32, which is controlled by the swell pedal 18 of the organ. For instance, if the swell pedal 18 is depressed to increase the output level, the potentiometer 32 is operated in such manner as to increase the negative bias on the grid 56. This produces a corresponding increase in plate impedance of the tube 42 whereby a larger portion of the input signal voltage is caused to appear at the output terminals 36. A converse action takes place when the swell pedal 18 is operated to return toward its upper position.

The capacitor 40 with its cooperative circuit elements constitutes a reactance means for "shaping" the frequency response characteristic of the attenuating network in different ways depending upon the output level. For example, referring to Fig. 4, a low-level response of the circuit is indicated by the curve A. The plate impedance of the tube 42 being low for a low output signal intensity, the reactance of the capacitor 40 has a relatively great effect at the lower tone frequencies, causing the response curve A to have a pronounced upward swing in the lower frequency portion of the audible spectrum. At higher signal frequencies the decreased reactance of the capacitor 40 has less effect, as indicated by curve A. For high output levels, on the other hand, the plate impedance of the tube 42 (which is practically a pure resistance of very nearly constant value with respect to frequency throughout practically the entire audible range) is relatively large and dominates the effect of the capacitor 40. This produces a substantially flat response characteristic at high level as indicated by the curve B, Fig. 4.

The above described arrangement has the advantage that it provides low-level compensation whereby the low tones are given greater emphasis. Thus, a more pleasing effect is produced upon the listener at low levels than would otherwise be the case. Music played softly by the instrument therefore does not suffer from the undesirable phenomenon of low-frequency attenuation which normally characterizes the response of the human auditory system to low-intensity sounds.

Undesirable effects sometimes are produced by organ volume controls in which the resistor contacts are improperly spaced or the parts have become loose and worn

through use. Such volume controls are said to be "noisy." In order to insure a smooth variation of plate impedance with respect to the setting of the potentiometer **32** and consequent freedom from noise, despite imperfections in the potentiometer, I provide a timing circuit including the capacitor **58**, resistor **54** and potentiometer **32**. The rate at which the control grid bias of tube **42** changes for each new setting of the potentiometer **32** is determined by the values of the capacitor **58** and resistor **54**. Thus, irregular variations of plate impedance with respect to time are avoided, improving the quality of the output.

Although in many applications it is desirable to have the volume control tone compensated at all times as just described, there are many times when it is not desirable to have the volume control continually tone compensated. For this purpose the form of the invention shown in Fig. 5 is used.

The attenuating network shown in Fig. 5 is substantially similar to that shown in Fig. 3 and previously described except that it does not provide for a continuous range of volume control. The continuous range of volume control is provided in another amplifying stage and in the stage shown in Fig. 5 the tone compensation is provided as is desired by the musician. Still referring to Fig. 5, the tone compensating network has input terminals **64** and output terminals **66**. This compensating network, which is essentially a frequency discriminating attenuator, comprises a resistor **68** in series with a capacitor **70** and the plate-cathode impedance of a triode **72**. The cathode **74** of the tube **72** is connected to ground through a resistor which is paralleled in the usual case by a capacitor **78**. The plate **80** of the tube **72** is connected to the junction of the capacitor **70** and a resistor **82**, the operating potential being applied to the plate **80** through this last named resistor from a suitable direct current plate voltage source.

The grid **84** of the tube **72** is grounded through a resistor **86** and the tube is provided with cathode bias by means of a voltage divider included in the cathode resistor **76** and two resistors **88** and **90** connected to the cathode in series with the direct current plate voltage source. The tube is normally biased beyond cut-off. A switch **92** which may be controlled by one of the stop tablets **14** is connected between the junction of the resistors **88** and **90** and ground and is paralleled by a capacitor **94**.

The input signal terminals **64** are connected respectively to ground and to one terminal of the resistor **68**. One of the output terminals **66** is grounded while the other is connected with an accompanying capacitor **96** to the junction between the resistor **68** and the capacitor **70**. When the switch **92** is open and the tube **72** is biased beyond cut-off, its plate-cathode impedance is very nearly a pure resistance of very high value. Under this condition the shunting effect of the tone compensating network is negligible and the input signal is transmitted through the resistor **68** and the coupling capacitor **96** to the output terminals **66** at very nearly the same magnitude as appears at the input terminal **64**. When the switch **92** is closed, however, the tube is no longer biased beyond cut-off and its plate-cathode impedance is relatively small. The shunting impedance of the tone compensating network is then rather low and attenuation of the signal is considerable except at the low frequencies where the reactance of the capacitor **70** is sufficient to increase the shunting impedance significantly. With the switch **92** closed, the shunting effect of the tone compensating network will be such as to produce an output signal substantially the same as that of curve A in Fig. 4.

A form of the invention producing results somewhat similar to those produced by the network shown in Fig. 3 but producing somewhat different results in the output is shown in Fig. 6. A pentode amplifier tube **102** which may aptly be termed a swell control tube has its plate **104** and screen grid **106** electrically connected so that the tube will operate as a variable mu triode. Plate and screen grid potentials are supplied in a conventional manner through a plate load resistor **108** from a suitable source of D.-C. plate potential. The suppressor grid **110** of the tube **102** is electrically connected to the cathode **112** and both the suppressor grid and cathode are connected to ground through a cathode resistor **114** paralleled by a capacitor **116**. The cathode and suppressor grid are also connected to the source of D.-C. plate potential by means of two parallel resistors **118** and **120** which together with the cathode resistor **114** form a voltage divider network biasing the cathode at the proper operating potential.

A potentiometer **122** which in this embodiment is located in place of the potentiometer **32** shown in Fig. 2 has its extremities connected to the cathode **112** and ground. The movable tap **124** on the potentiometer is grounded through a resistor **126** and is also connected to the control grid **128** of the tube **102** through two series resistors **130** and **132**. The control grid **128** is maintained at alternating current ground potential by means of a capacitor **134** connected between the grid and ground. Another capacitor **136** is connected between the junction of the resistors **130** and **132** and the grounded end of the potentiometer **122**. The resistors **126**, **130** and **132** and capacitors **134** and **136** serve as an RC filter network to eliminate transient disturbances which may arise from operation of the potentiometer.

The other connections of the compensated volume control are substantially the same as those shown in Fig. 3. Input terminals **138** are connected respectively to ground and to a resistor **140** which is in turn connected through a capacitor **142** to the plate **104** of the pentode tube **102**. The junction of the resistor **140** and capacitor **142** is connected through a coupling capacitor **144** to one of the output terminals **146**, the other of these output terminals being connected to ground. When the tap **124** of the potentiometer **122** is at its extreme left end the tube **102** is biased beyond cut off and its plate impedance is very high so that substantially no attenuation takes place and an output curve C is produced. When the tap is at the other end of the potentiometer, the plate impedance of the tube **102** is very low due to the fact that the control grid is at substantially the same potential as the cathode and the output signal may be plotted as a curve D. At the low frequencies the reactance of the capacitor **142** is considerable and the attenuation of the low frequencies is much less than that of the highest, thus accounting for the hump at the low frequency end of the curve. The output signal may be plotted as a curve E lying intermediate the curves C and D when the tap **124** is intermediate the ends of the potentiometer **122**. It may be seen that although the results of the circuit shown in Fig. 6 are akin to the results obtained by use of the circuit shown in Fig. 4 the curves of output against frequency are somewhat different and may be preferable for some musicians or for certain installations.

Various changes may be made in the specific embodiment set forth for purposes of illustration without departing from the spirit of the invention, and it is intended that such modifications as may readily occur to persons skilled in the art shall be included in the scope of the following claims.

The invention is hereby claimed as follows:

1. In a swell control for an electric organ, a volume control pedal, an attenuating network including series-connected resistance and capacitance elements, a vacuum tube including a plate, a cathode, and a control grid so arranged that its plate resistance is included in said network, a voltage divider connected across the potential supply for said plate, said voltage divider including a potentiometer, means connecting said potentiometer to said volume control pedal for operation thereof, said cathode being connected to a fixed point on said voltage divider, a variable tap on said potentiometer connected through a resistor to said control grid to provide a grid return for said tube including a variable potion of said potentiometer whereby the plate to cathode impedance of said tube and the amount of signal attenuation is determined by the setting of said potentiometer, and a capacitor connected in parallel with said resistor and a variable portion of said potentiometer said capacitance element having a relatively greater shaping effect upon the frequency response characteristic of the swell control at low levels than at higher levels.

2. In combination with an apparatus as set forth in claim 1, an additional timing capacitor connected to the grid return of said vacuum tube for modifying the response of said tube to changes in the potentiometer setting thereby to reduce noise caused by imperfections in the potentiometer.

3. In a swell control for an electric organ having a volume control pedal and input and output circuits; a volume control and tone shaping circuit connected across the output circuit of the organ and comprising a capacitor

in series with the plate to cathode impedance of a grid controlled electronic tube, a source of positive potential connected to the plate of said tube, a voltage divider across said source, the cathode of said tube being connected to a fixed point on said voltage divider, a fixed resistor connected directly between the plate of said tube and said source, said voltage divider including a potentiometer in the cathode circuit of said tube and connected between said source and ground, a variable tap on said potentiometer connected to the control grid of said tube, and means connecting said tap to said voltage control pedal for controlling the volume and effecting greater attenuation of higher frequencies at low volume.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,993,860	Roberts	Mar. 12, 1935
2,093,223	Yamashita	Sept. 14, 1937
2,263,683	Rockwell	Nov. 25, 1941
2,270,789	Smith	Jan. 20, 1942
2,358,325	Fyler	Sept. 19, 1944
2,488,410	Keizer	Nov. 15, 1949