Jan. 29, 1963 R. W. BRANDT ETAL 3,075,423

SWELL CONTROL

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FIG. 1

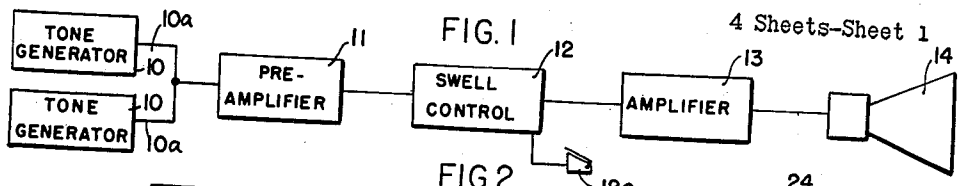


FIG. 2

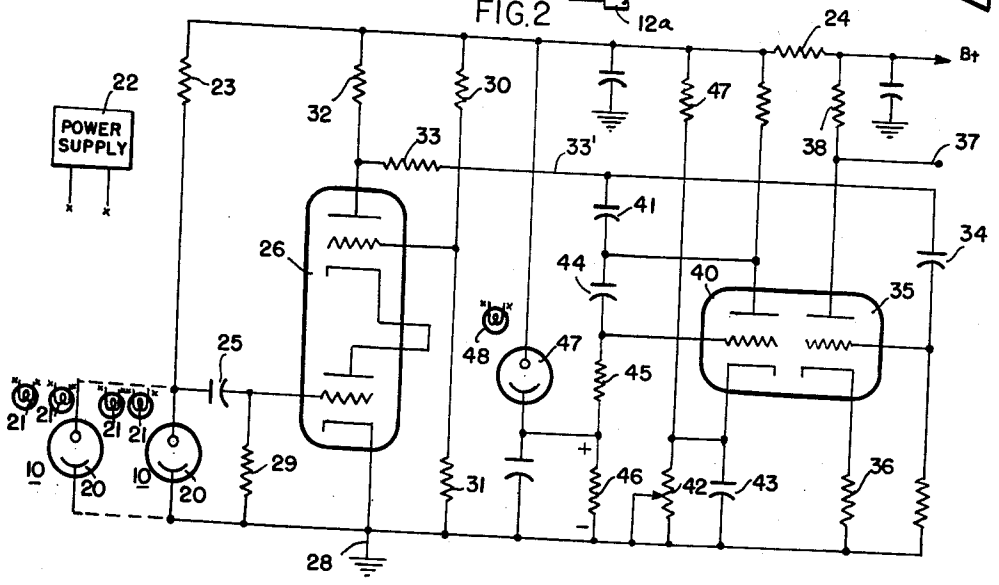
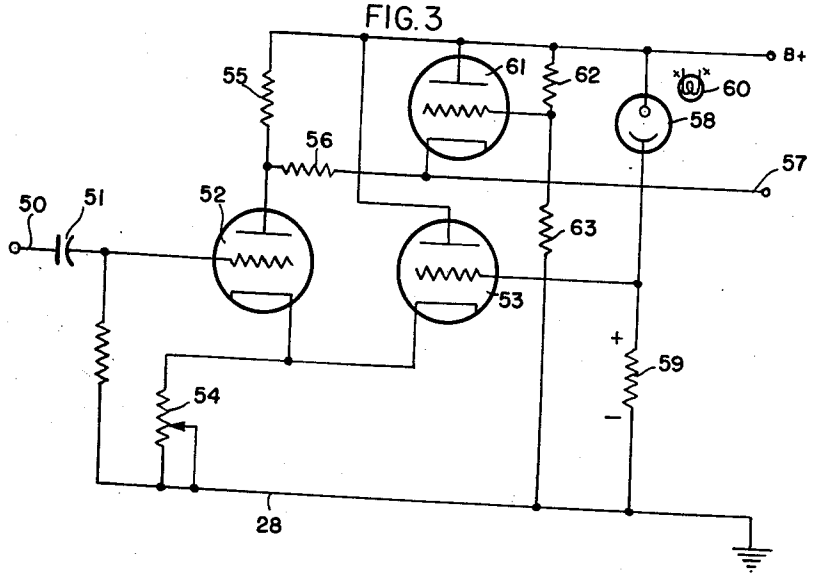


FIG. 3



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FIG. 4

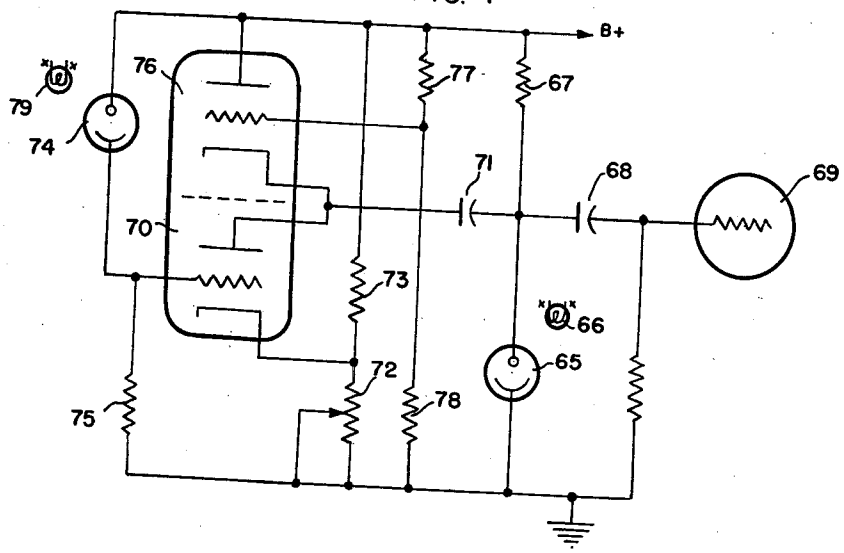
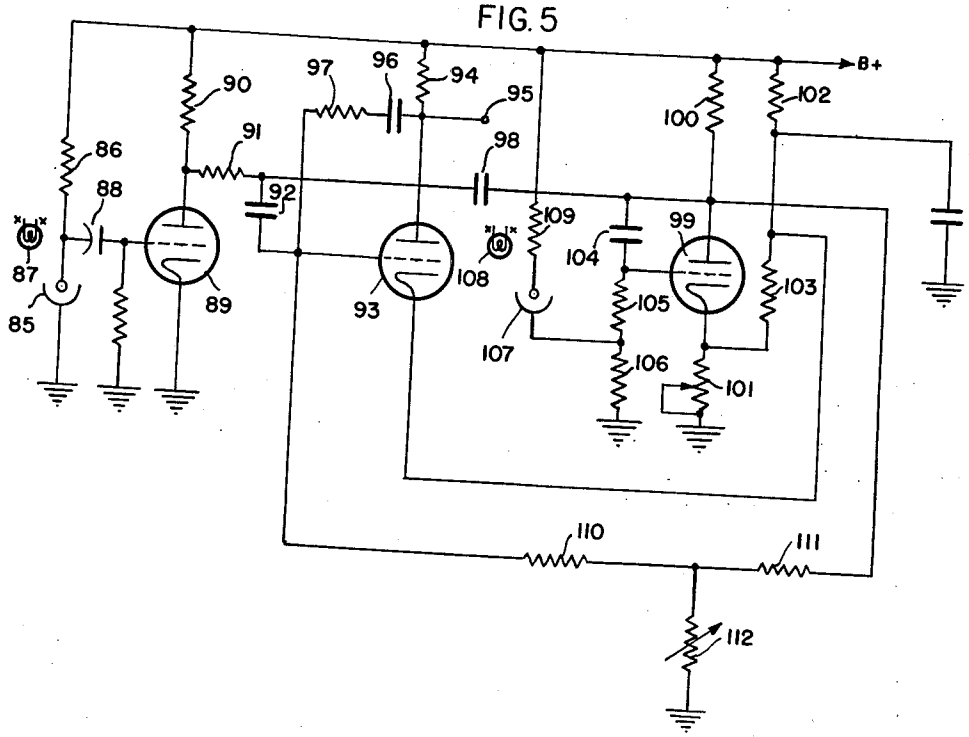


FIG. 5



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FIG. 6

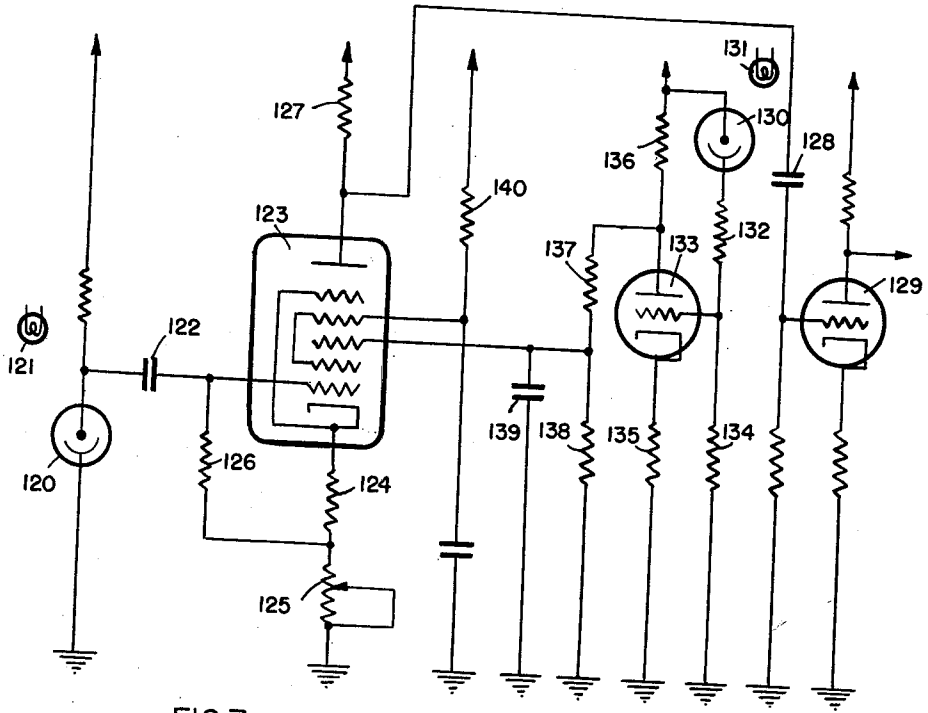


FIG. 7

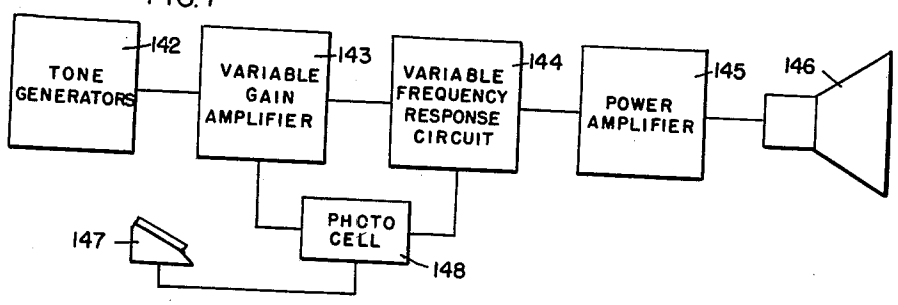
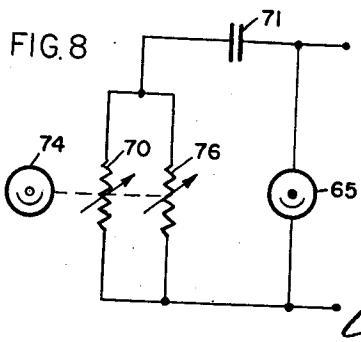


FIG. 8



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FIG. 9

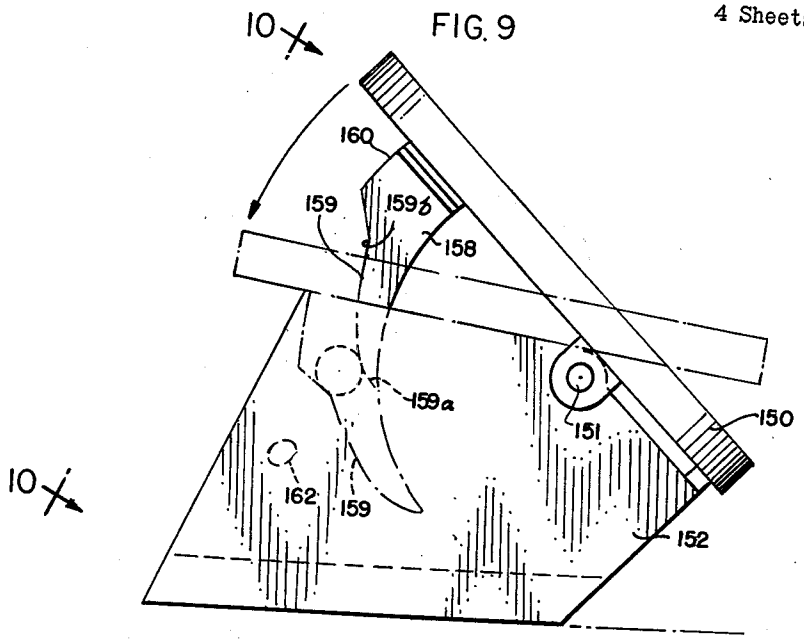
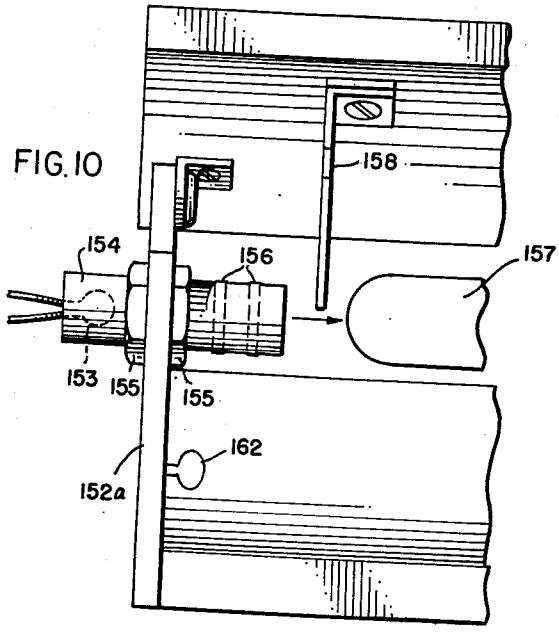


FIG. 10



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3,075,423

SWELL CONTROL

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Filed Aug. 6, 1958, Ser. No. 753,491
4 Claims. (Cl. 84—1.27)

This invention relates to a swell control for an electronic musical instrument, as an electronic organ.

In an electronic organ it is desirable that the swell control operate, as nearly as practicable, in the same manner as in a pipe organ. That is, the physical mounting and arrangement of the swell control should correspond with that used in a pipe organ, and a given deflection or movement of the swell control of the electronic musical instrument should provide a volume change comparable with the change of volume in a pipe organ for the same deflection of the swell control. It is, of course, also desirable that the operation of the swell control be made as noise-free as possible, from an electrical standpoint. For this and other reasons, as will appear it is preferred that a direct connection of the swell control to the electrical circuit not be used. The most common example of a direct connection which might be utilized in this situation is a variable resistor mechanically connected with the swell control pivot. This has the dual objection that it is difficult to reproduce the desired swell control characteristic in a variable resistance element, and that noise is introduced by the frictional connection between the slider of the potentiometer and the resistor element.

A principal object of this invention is to provide a swell control in which the variable element has no direct electrical or mechanical connection with the signal channel; rather, in a preferred embodiment of the invention, a light sensitive element, as a photoelectric cell is used, together with a movable mask associated with the swell control to vary the amount of light impinging on the photoelectric cell, and in turn a characteristic of the signal channel, to control the amplitude of the signal transmitted therethrough. For example, the photoelectric cell may be used to control the impedance or gain, or both, of the signal channel.

One feature of the invention is the provision in an electronic musical instrument of a signal handling system, comprising a source of signals representing musical tones, a signal handling channel connected with said source, a manually operable swell control member, and means responsive to the swell control member for varying a characteristic of the channel to control the amplitude of the signal, such means being electrically and mechanically independent of the swell corntol member. Another feature is that the swell control responsive means include a light source and a light sensitive element, and that the swell control member has a mask mounted thereon, whereby movement of the swell control member varies the quantity of light impinging on the light sensitive element.

A further feature is the provision in an electronic musical instrument of a source of signals representing musical tones and including a light source or lamp connected with the source of electrical energy and a light sensitive circuit element for producing an electrical signal representing a musical tone, the amplitude of the signal being a function of the intensity of the light from the source on the element, together with a signal handling channel having a variable characteristic which is controlled by means including a second light source, also connected with the source of electrical energy, and a second light sensitive element, for varying the amplitude of the tone representing signal passed through said channel inversely as a function of the quantity of light from the second source

impinging on the second light sensitive element, to compensate the amplitude of the tone representing signal for variations in the source of electrical energy to which the light sources are connected.

Still another feature is the provision of such a musical instrument including a variable impedance element shunted across the signal handling channel, together with means responsive to the swell control member for varying the impedance of the channel, and thus the amplitude of the signal transmitted therethrough. Yet a further feature is that the variable impedance element is an amplifying element having a control electrode and shunted across the signal channel, with means including a photoelectric cell responsive to actuation of the manual swell control member connected with said control electrode for varying the impedance of the amplifying element.

Another feature is the provision of such a musical instrument together with a control circuit that includes means for clamping the direct current level of the signal handling channel, and means for varying a characteristic of the channel to control the amplitude of the signal passing therethrough. For example, the direct current level of the channel may be stabilized by connecting thereto a three element device having a controlled element connected to the channel and a control element connected to a source of fixed voltage.

Still a further feature is the provision of such a musical instrument in which both the impedance and the gain of the signal handling channel are varied by actuation of the manual swell control member.

Yet another feature is the provision of such a musical instrument in which the frequency response of the signal handling channel is varied by actuation of the manual swell control member. Thus, the tonal quality of the signal may properly be adjusted for various swell conditions, as by accentuating the lower or bass tones as the swell or volume is increased.

Further features and advantages will readily be apparent from the following specification and from the drawings, in which:

FIGURE 1 is a block diagram of an electronic musical instrument;

FIGURE 2 is a schematic diagram of a swell control circuit embodying the invention;

FIGURE 3 is a schematic diagram of a modified swell control circuit embodying the invention;

FIGURE 4 is a schematic diagram of a further modification of a swell control circuit embodying the invention;

FIGURE 5 is a schematic diagram of a further modification of a swell control circuit embodying the invention;

FIGURE 6 is a schematic diagram of still another modification of a swell control circuit embodying the invention;

FIGURE 7 is a block diagram of yet another modification of a swell control embodying the invention;

FIGURE 8 is an equivalent circuit of the swell control of FIGURE 4;

FIGURE 9 is a side elevation of a swell control mechanism embodying the invention; and

FIGURE 10 is a fragmentary end view taken generally along line 10—10 of FIGURE 9.

The invention will be described in connection with a swell control for an electronic organ, and in particular an electronic organ having a tone generating system utilizing light sources and photoelectric cell pickups. It will be understood, however, that there are certain novel aspects of the invention which are usable in other types of musical instruments and electronic devices.

Turning now to the drawings, FIGURE 1 is a simplified block diagram of an electronic organ. A plurality of tone generators 10 have their outputs 10*a* connected

in parallel and to a preamplifier 11. The output of the preamplifier is coupled to a swell control 12 actuated by a manual control device, as pedal 12*a*, to control the amplitude of the tone representing signals. The output of the swell control is connected to amplifier 13 which drives speaker 14. The present invention is concerned primarily with the swell control circuitry and mechanism 12 and 12*a*, and their relationship to the signal handling channel of the device.

In the course of the following description, various specific swell control circuits will be described and tube types and component values indicated for various elements. It is to be understood that these specific embodiments are disclosed in detail in order to provide a complete operative disclosure of the invention, and they are not to be considered as critical or essential to the operation of the invention. Many changes and modifications will be readily apparent to those skilled in the art.

Turning now to FIGURE 2 of the drawings, it is seen that the tone generators 10 each include a photocell 20, as an RCA type 7043, which are actuated by the light from lamps 21. The light from lamps 21 is mechanically controlled in a suitable manner to produce in the output of the light sensitive cells 20 electrical signals corresponding with desired musical tones. The showing in FIGURE 2 is merely to give an understanding of the nature of the tone generation system, and is not intended to illustrate a complete tone generator. In a physical embodiment of the system, there are 12 photocells with their associated mechanisms, each of which may include a large number of lamps. The lamps 21 are energized from a suitable power supply 22, to which they are all connected in parallel. The photocells 20 are provided with an operating bias through resistor 23, 1 megohm, connected through the coupling resistor 24, 4700 ohms, with a suitable B+ potential, as 250 volts. The musical tone representing signals from the tone generators 10 are coupled through capacitor 25, 0.05 μf. (microfarads), to the control grid of the first triode section of a cascade connected amplifier 26, 12AT7. The cathode of the first triode section is connected directly to ground 28, and the control grid is returned to ground through resistor 29, 270,000 ohms. The amplified signal from the first section of the tube is fed directly to the cathode of the second section, the control grid of which is connected to a voltage divider made up of resistors 30, 220,000 ohms, and 31, 27,000 ohms. The plate is connected to the B+ source through load resistor 32, 330,000 ohms. The amplified signal from the second stage of the cascade amplifier is coupled through a series resistor 33, 330,000 ohms, over a signal handling channel comprising lead 33′ and blocking capacitor 34, 0.01 μf., to the control grid of another triode amplifier stage 35, one-half of a 12AT7. The cathode of amplifier 35 is returned to ground through an unbypassed cathode resistor 36, 1500 ohms, and the amplified output appears at preamplifier output terminal 37, across load resistor 38, 68,000 ohms.

Shunted across the signal channel 33′, between resistor 33 and blocking capacitor 34, is a variable impedance network which is utilized to control the impedance of the signal channel, and thus the amplitude of the tone representing signals transmitted therethrough, providing a "swell" or volume control for the system. The variable impedance element shown here comprises a triode 40, one-half of a 12AT7, the internal impedance of which is shunted across the signal channel through capacitor 41, 0.1 μf., connected to the anode, and a parallel combination of variable resistor 42, 10,000 ohms, and capacitor 43, 4 μf., connected between the cathode and ground. Adjustable cathode resistor 42 is part of a voltage divider including resistor 47, 150,000 ohms, and is used to vary the impedance of tube 40, and thus the volume of the system output, under conditions of minimum swell. Connected in parallel with the variable tube impedance is capacitor 44, 0.004 μf., connected between the anode and control grid of tube 40, connected in series with resistors 45, 1 megohm and 46, 330,000 ohms. The swell control itself is effected through the medium of photoelectric cell 47, RCA 7043, which is actuated by light from lamp 48, also connected to power supply 22.

A specific physical embodiment of the swell control 12*a* will be considered below. It is sufficient for consideration of the operation of the circuit to say that the quantity of light from lamp 48 impinging on the photosensitive surface of cell 47 is varied by actuation of the swell control pedal. With no swell, the swell pedal in raised position, the full light from photocell 48 strikes the photocell causing it to conduct heavily establishing a potential across resistor 46 as indicated in FIGURE 2, and applying a positive potential to the control grid of variable impedance tube 40. This causes the tube to conduct relatively heavily so that it presents a low impedance to the signal channel, reducing the level of the signal transmitted therethrough. As the swell pedal is depressed, to increase the volume of the music, the quantity of light striking the photocell 47 is diminished. With full swell, photoelectric cell 47 is dark, the voltage across resistor 46 drops substantially to zero and the current through control tube 40 is reduced, raising its internal impedance and reducing the shunting effect to increase the amplitude of the signal transmitted through the signal channel.

The reactive network including capacitors 41 and 44, together with resistors 45 and 46, serves a dual function, in addition to coupling the variable impedance tube to the signal channel. Transient effects in the swell control circuit, which result from a change in the D.C. (direct current) level of the channel during operation of the manual swell control, are reduced by the feedback capacitor 44 connected between the anode and control grid of the variable impedance tube. The time constant of this circuit, which includes grid resistors 45 and 46, is selected to be greater than the lowest audio signals handled by the system (16 cycles per second) and smaller than the period of operation normally encountered in the swell control. The value of capacitor 41 is selected so that the swell control circuit has a somewhat higher reactance at the lower audio frequencies than at the high frequencies, reducing the swell effect on the lower or bass frequencies of the tone representing signal.

The swell control system of FIGURE 2 has an additional operational feature. It will be recalled that the amplitude of the tone representing signals generated in tone generators 10 is directly related to the quantity of light impinging on the photosensitive surfaces of photocells 20 from the lamps 21. The light generated by lamps 21 is, in turn, dependent on the voltage of power supply 22. Even with a well regulated power supply, there is a tendency for the voltage to vary somewhat, both with the number of lamps lit, and with variations in line voltage from which the supply is energized. This, in turn, causes a variation in the amplitude of the generated tone representing signals. Lamp 48, associated with the swell control system, is likewise energized from power supply 22, so that the voltage applied to it varies with any variation in voltage to the tone generator lamps 21. However, the light output from swell control lamp 48 has an inverse effect on the amplitude of the tone representing signals. As the light output decreases, the impedance shunting the signal channel 33′ increases, resulting in an increase in the level of the signal amplitude. Conversely, if the voltage rises, the amplitude of the generated signal rises and the variable impedance shunting the channel is decreased, to compensate therefor. Thus, the output of the system is relatively constant with lamp voltage variation.

FIGURE 3 illustrates a modified swell control circuit having an input terminal 50 which may be connected with

the output of the tone generator, or of a preamplifier, as a cascade preamplifier 26 of FIGURE 2. The tone representing signals applied to input terminal 50 are coupled through blocking capacitor 51 to the control grid of a variable gain amplifier 52, one-half of a 12AX7. The cathode of the amplifier 52 is connected with the cathode of control tube 53, one-half of a 12AT7, and the common circuit is returned to ground 28 through a variable unbypassed resistor 54, 1800 ohms. The output from the amplifier is derived across plate load resistor 55, 100,000 ohms, connected with B supply of 250 volts, and is coupled through series resistor 56 with an output terminal 57. The swell control photocell 58 is connected through resistor 59, 1 megohm, between B+ and ground, with the control grid circuit of control tube 53 connected across the resistor. Consideirng first the situation with no light shining on swell control photocell 58, there is no current flow through resistor 59 and the control grid of tube 53 is substantially ground potential. The current flow through control tube 53 is determined by the cathode resistor 54. The current flow through resistor 54 in turn establishes an operating point for amplifier 52. When light from lamp 60 causes a photocell 58 to conduct, a positive potential is established at the control grid of tube 53, increasing the current flow therethrough and through cathode resistor 54. This in turn increases the bias on amplifier 52, reducing the gain thereof, in accordance with the variations in light on photocell 58.

Connected between the signal channel (output terminal 57 and B+ is triode 61, one-half of a 12AT7, the cathode being connected to the signal channel and the anode to the B+ supply. The control grid of tube 61 is connected to a voltage divider including resistors 62 and 63, 100,000 ohms each, establishing the control grid at substantially 125 volts with respect to ground 28. The purpose of tube 61 is to establish fixed D.C. level for the signal channel, preventing the transient condition discussed in connection with FIGURE 2 during operation of the swell control. Resistor 54, in the cathode circuit of amplifier 52, is adjusted to establish the D.C. level of the channel so that the cathode of tube 61 is negative with respect to the control grid. In this condition, the plate current through amplifier 52 divides with one portion flowing through resistor 55 and another portion through resistor 56 and clamping tube 61. As the gain of tube 52 changes, as a result of manipulation of the swell control, the plate current of the tube also changes. Clamping tube 61 resists any attempt of the voltage level of the signal channel to change and draws more or less current as necessary to keep the cathode within a volt or two of the grid voltage, stabilizing the signal channel.

FIGURE 4 shows a modification of the swell control circuit of FIGURE 3, providing a stabilized direct current level for the signal channel, with the amplitude of the tone representing signals controlled by a variable impedance element shunted across the channel. The tone representing signals are generated in photocell 65, actuated by lamp 66. The photocell is connected through resistor 67, 1 megohm, with the B+ supply. The output of the tone generator is coupled through capacitor 68 to the control grid of preamplifier 69.

Shunted across the signal channel is one-half 70 of a dual triode, 12AX7. The anode of triode 70 is connected through capacitor 71 with the signal channel and the cathode is returned through variable resistor 72, 10,000 ohms, to ground. Resistor 72 forms a part of a voltage divider network including a resistor 73, 220,000 ohms connected between B+ and ground applying a small fixed voltage to the cathode of tube 70. Connected with the control grid of tube 70 is a swell control circuit including photocell 74 and resistor 75, 1 megohm.

The direct current level of the signal channel is stabilized by the second section 76 of the dual triode, the cathode of which is connected directly to the anode of section 70 and the anode directly to the B+ supply. The control grid is connected to a fixed voltage provided by voltage divider made up of resistors 77 and 78, both 100,000 ohms, fixing the control grid voltage at about 125 volts.

Essentially, the plate resistance of tube 70 and the cathode resistance of tube 76 are connected in parallel, through capacitor 71, across the signal channel, as shown in the equivalent circuit, illustrated in FIGURE 8. With no light from lamp 79 striking swell control photocell 74, the photocell does not conduct and the control grid of tube 70 is substantially at ground potential. In this condition, cathode resistor 72 is adjusted to maintain tube 70 cutoff. As no current flows through tube 70, there is no current flow through tube 76 and a high impedance is presented to the signal channel, the full swell condition. With maximum light on the photocell 74, it conducts heavily, applying a substantial positive bias to the control grid of tube 70 causing it in turn to conduct heavily, the plate current of tube 70 also flowing through tube 76. In this condition, both the plate resistance of tube 70 and cathode resistance of tube 76 are reduced materially over the cutoff condition, loading the signal channel and reducing the amplitude of the tone representing signals. This corresponds with a condition of minimum swell.

Tube 76 performs the additional function of stabilizing the direct current level of the signal channel. As the control grid potential of tube 76 is held constant, the cathode voltage automatically adjusts to the grid voltage, depending upon the condition of the tube. With no conduction, i.e. cutoff, the cathode assumes voltage about two volts positive of the grid. With maximum current flow, the cathode holds substantially at the grid voltage. Thus, regardless of the variation in impedance of the circuit presented to the signal handling channel, the direct current level thereof changes less than two percent eliminating any objectionable transient condition. The impedance variation possible with the circuit described above permits a variation in signal level of 40 db from a generated signal of 0.5 volt.

At low frequencies the effect of the swell control may be limited by the value of the capacitor 71 if its reactance is sufficiently large to be comparable with the channel loading impedance of tubes 70 and 76, when they are conducting heavily.

FIGURE 5 illustrates an embodiment of the invention in which both the gain of the signal channel and an impedance shunting the channel are varied in accordance with manipulation of the swell control. Tone generator photocell 85 is connected through resistor 86, 1 megohm with B+, and is actuated by light from lamp 87. The tone representing signals from the signal generator are coupled through capacitor 88 to the control grid of preamplifier 89, one-half of a 12AX7. The output of preamplifier 89 is developed across plate load resistor 90 and coupled through series resistor 91, 680,000 ohms and capacitor 92, 0.01 μf., to the control grid of variable gain amplifier 93. The output of amplifier 93, developed across plate load resistor 94, 100,000 ohms, appears at terminal 95. The linearity of amplifier 93 is improved by a feedback network including capacitor 96 and resistor 97 connected in series between the plate and control grid. Connected in shunt with the signal channel through capacitor 98, 0.03 μf., is a variable impedance element including triode 99, one-half of a 12AT7.

The variable impedance stage is generally the same as that disclosed in FIGURE 2 and will be discussed only briefly here. The anode circuit of variable impedance tube 99 is connected to the B supply through resistor 100, 330,000 ohms, while the cathode is returned to a variable resistor 101, 10,000 ohms, connected in a voltage divider network with resistors 102, 150,000 ohms and 103, 8200 ohms, establishing a positive voltage on the cathode. Feedback capacitor 104, 0.004 μf., is connected between the plate and control grid, which is returned

to ground through resistors 105, 1 megohm and 106, 470,000 ohms. The swell control photocell 107, which is responsive to light from lamp 108, is connected through dropping resistor 109 and resistor 106 between B+ and ground. As in FIGURE 2, with minimum swell, maximum light from lamp 108 shines on photocell 107, applying a positive voltage to the control grid of tube 99 causing it to conduct heavily and to present a relatively low impedance to the signal channel. With full swell, tube 99 is cutoff, presenting a high impedance to the signal channel.

The control grid of variable gain amplifier 93 is returned through series resistors 110, 1 megohm, and 111, 1.2 megohms, to the anode of variable impedance tube 99. The juncture of resistors 110 and 111 is connected to ground through variable resistor 112, 150,000 ohms, forming a voltage divider including load resistor 100. The cathode of amplifier 93, in order to provide the proper operating potential for the stage relative to the control grid potential, is connected to the juncture of resistors 102 and 103 in the cathode voltage divider circuit of tube 99. When variable impedance tube 99 is cutoff, in full swell condition, the voltage on the control grid of amplifier 93 is determined by resistors 100, 111 and the setting of variable resistor 112. As control tube 99 begins to conduct, the voltage at the anode drops, reducing the positive voltage applied to the grid of amplier 93 and reducing the gain. This renders the control grid of amplifier 93 more negative with respect to the cathode, reducing the gain. Thus, as the swell control is operated, not only is the channel shunting impedance of tube 99 varied, but the gain of amplifier 93 is also varied, providing a dual control over the amplitude of the tone representing signals.

FIGURE 6 illustrates another swell control circuit utilizing a variation in gain of an amplifier in the signal channel. The tone representing signals generated by photocell 120, actuated by light from lamp 121, are coupled through capacitor 122 to the first grid of a heptode or pentagrid tube 123, a 6CS6. The cathode of tube 123 is returned to ground through resistor 124, 1000 ohms, and variable resistor 125, 2000 ohms. The control grid is returned to the juncture of resistors 124 and 125 through resistor 126, 180,000 ohms. The amplified output from tube 123 is derived across plate load resistor 127, 470,000 ohms and is coupled through capacitor 128 to the control grid of a further amplifier stage 129. The swell control photocell 130 is actuated by a light from lamp 131 and is connected through resistor 132 with the control grid circuit of phase inverter 133, one-half of a 12AU7. The control grid of the phase inverter is returned to ground through resistor 134, 180,000 ohms, while the cathode is connected to ground through resistor 135, 2700 ohms. The plate is connected with the B+ supply through load resistor 136, 100,000 ohms. The amplified and inverted signal from photocell 130 appears across a voltage divider network made up of resistor 137, 290,000 ohms and 138, 39,000 ohms, connected from the plate of tube 133 to ground. The voltage appearing across resistor 138, which is shunted by capacitor 139, 0.25 μf., is connected to the third grid of pentagrid tube 123. The second and fourth grids of the pentagrid tube are connected together and through resistor 140, 120,000 ohms, to B+.

With minimum swell conditions, i.e. full light on photocell 130, the photocell conducts heavily applying a positive voltage to the control grid of phase inverter 133. The plate current of tube 133 flowing through resistor 136 drops the voltage appearing at the plate to a relatively low value, and a portion of this voltage is applied to the third grid of the controlled amplifier 123 establishing a relatively low level of gain. As the light from lamp 131 impinging on photocell 130 is reduced by manipulation of the swell control pedal, the current flow through resistor 134 is reduced and the positive potential applied to the control grid of phase inverter 133 drops reducing the tube current. This in turn causes an increase in the anode potential which is reflected by an increased potential on the third grid of amplifier 123, increasing the gain thereof. The phase inverter arrangement of FIGURE 6 is necessary in order to provide the voltage compensation action described in connection with FIGURE 2, so that variations in the potential of the lamp source have opposite effects in the tone generator and the amplifier sections, keeping the signal level constant.

FIGURE 7 illustrates in block form a further modification of the invention in which the signals from tone generator 142 are coupled through a signal handling channel including a variable gain amplifier 143 (with a flat frequency response characteristic in the range of the tone generator) and a variable frequency response circuit 144 to power amplifier 145, and thence to speaker 146. The manual swell control 147 controls the conduction through a photocell control tube 148, as described above. The photocell in turn serves the dual function of controlling the gain of variable gain amplifier 143 and the frequency response of variable frequency response circuit 144, both in the signal handling channel. Thus, as the position of the manual swell control 147 is varied, not only is the amplitude of the signal transmitted through the channel controlled, but the frequency response of the channel is adjusted so that the resulting tones produced by the instrument have a desired relation for the particular intensity level. For example, in most instances it is desirable that the lower or bass notes be accentuated or emphasized at higher volume levels to compensate for the frequency response characteristics of other portions of the system, including the loud speaker 146, and the human ear.

In FIGURES 9 and 10, a physical embodiment of the swell control pedal, and the associated light source and photocell are illustrated. Swell pedal 150 is pivotally mounted at 151 on a light-tight housing 152. As best seen in FIGURE 10, the light source includes a lamp 153 mounted in the outer end of a tube 154 extending through a wall 152*a* of the housing, and secured thereto by nuts 155. A pair of collimating lenses 156 in the inner end of tube 154 direct the light from lamp 153 toward photocell 157. Mounted on the undersurface of pedal 150 is a mask 158 which extends downwardly between the light source and the photocell when the pedal is depressed. When the pedal is in full raised position (minimum swell) maximum light from the source strikes the photocell. When the pedal is fully depressed (as shown in broken lines in FIGURE 9), the condition of maximum swell, the light source is completely masked so that no light from it strikes the photocell.

It will be apparent from consideration of FIGURE 9 that the light from the source is progressively masked by surface 159 of mask 158, as the pedal is depressed. The curvature of this surface is developed to control the system in such a manner that db variation in the signal is a direct function of the angle through which the pedal is depressed. To achieve this effect, the curve is generated by what is effectively a constantly varying radius taken about a point inside pivot 151. In the embodiment illustrated, the pivot is about 8½" from the upper forward edge 160 of the mask. Edge 159 is formed about a point lying inside the pivot, with a radius varying from four and three quarters inches at the lower end, 159*a*, to almost five and one-half inches at the upper end, 159*b*.

A second lamp 162 may be located in the housing 152 in such a position that it is not intercepted by mask 158. This provides a continual excitation for the photocell permitting the voltage compensating effect described above during full swell operation. If desired, this may be effected by the incorporation of an entirely separate light source and photocell control system.

While we have shown and described certain embodiments of our invention, it is to be understood that it is capable of many modifications. Changes therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

We claim:

1. In an electronic musical instrument, a signal handling system, comprising: a source of signals representing musical tones; a signal handling channel connected with said source; a pivotally mounted, manually operable swell control member; a circuit element connected to said channel and having a variable characteristic, for varying the amplitude of a signal transmitted through said channel; a light sensitive element connected with said circuit element for varying said characteristic thereof; a light source for actuating said light sensitive element; and a mask mounted on said swell control member and spaced from said pivot, the mask being interposed between said light source and light sensitive element and having a curved edge of constantly varying radius for defining the area of light from said source impinging on said light sensitive element whereby the signal amplitude is varied as a direct function of the angle of said swell control member, the varying radius of said edge extending from a common point and being less than the spacing of said edge from said pivot.

2. In an electronic musical instrument: a source of signals representing musical tones and including at least one light source connected to a source of electrical energy and a light sensitive circuit element, for generating an electrical signal representing a musical tone, the amplitude of said signal being a direct function of the quantity of light from said source impinging on said element; a signal handling channel connected with said signal source; and compensating means connected with said signal channel and including a second light source connected with said source of electrical energy, and a second light sensitive circuit element connected with said channel, said compensating means varying a characteristic of said channel with variations of the quantity of light from said second light source impinging on said second light sensitive element to vary the signal amplitude in said channel accordingly, the amplitude of the signal passing through said channel also varying as an inverse function of the quantity of light from said second light source impinging on said second light sensitive element, to compensate for variations in the amplitude of generated signals due to variations in said source of electrical energy.

3. In an electronic musical instrument: a source of signals representing musical tones, and including a plurality of tone generators each having a plurality of selectively operable light sources and a light sensitive element for generating electrical signals representing musical tones, the amplitude of said signal being a direct function of the quantity of light from said sources impinging on said elements, all of said light sources being connected in parallel with a single source of electrical energy; a signal handling channel connected with said signal source; and compensating means connected with said signal channel and including a second light source connected with said source of electrical energy, and a second light sensitive circuit element connected with said signal channel, said compensating means varying a characteristic of said channel with variations of a quantity of light from said second light source impinging on said second light sensitive element to vary the signal amplitude in said channel accordingly, the amplitude of the signal passing through said channel also varying as an inverse function of the quantity of light from said second light source impinging on said second light sensitive element, to compensate for variations in the amplitude of the generated signal due to variations in said source of electrical energy.

4. In an electronic musical instrument, a signal handling system, comprising: a source of signals representing musical tones; a signal handling channel connected with said source; a manually operable swell control member; an amplifying element having at least an anode, a cathode and a control element, and having a variable impedance; a capacitive network connecting the anode-cathode circuit of said amplifying element acrosss said channel, and providing capacitive feedback from the anode to the control grid circuit thereof; and a circuit including a photoelectric cell responsive to said manually operable swell control member, connected with the control electrode of said element for varying the impedance thereof to control the amplitude of signals transmitted through said channel.

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