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Pavia

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[54] **ENHANCEMENT EQUIPMENT FOR CONNECTION TO ELECTRONIC MUSICAL INSTRUMENTS**

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[21] Appl. No.: **295,361**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 145,856, May 21, 1971, abandoned.

[52] **U.S. Cl.** **84/1.24,** 84/1.06, 84/1.18, 84/DIG. 19, 84/DIG. 26

[51] **Int. Cl.** **G10h 1/02**

[58] **Field of Search** ..... 84/1.01, 1.18, 1.24, 1.25, 84/1.26, DIG. 26, DIG. 19; 179/1 M, 1 C, 1 D, 1 J

[56] **References Cited**

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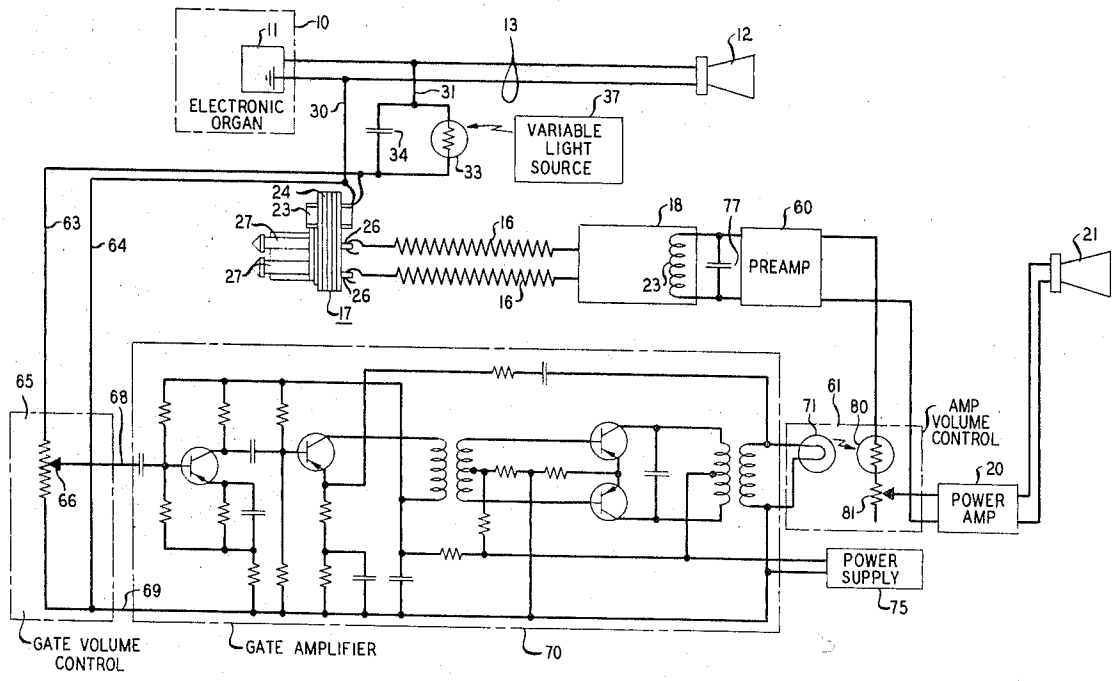
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Assistant Examiner—U. Weldon

[57] **ABSTRACT**

Spatial enhancement equipment for connection to existing organs or other electronic musical instruments comprises an artificial reverberation unit having coiled springs and an input transducer including a driving coil. The connection of the driving coil to the output amplifier of the organ includes a series connection of a photoresistor having a capacitor shunted across it. A variable light source applies pulses of light to the photoresistor alternately to cause it to conduct and not conduct. When the photoresistor is not conducting the electrical signals from the organ are applied to the driving coil through the shunt capacitor, introducing a phase shift into the signal. The variable light source is disclosed as a rotating disc having different patterns of opacity on it. A gating arrangement connected in parallel with the reverberation unit prevents noise from activating the power amplifier of the enhancement equipment in the absence of musical input. The gating arrangement includes a gating amplifier driving a filamentary bulb optically coupled to a photoresistor connected between the preamplifier and power amplifier of the enhancement equipment.

10 Claims, 4 Drawing Figures



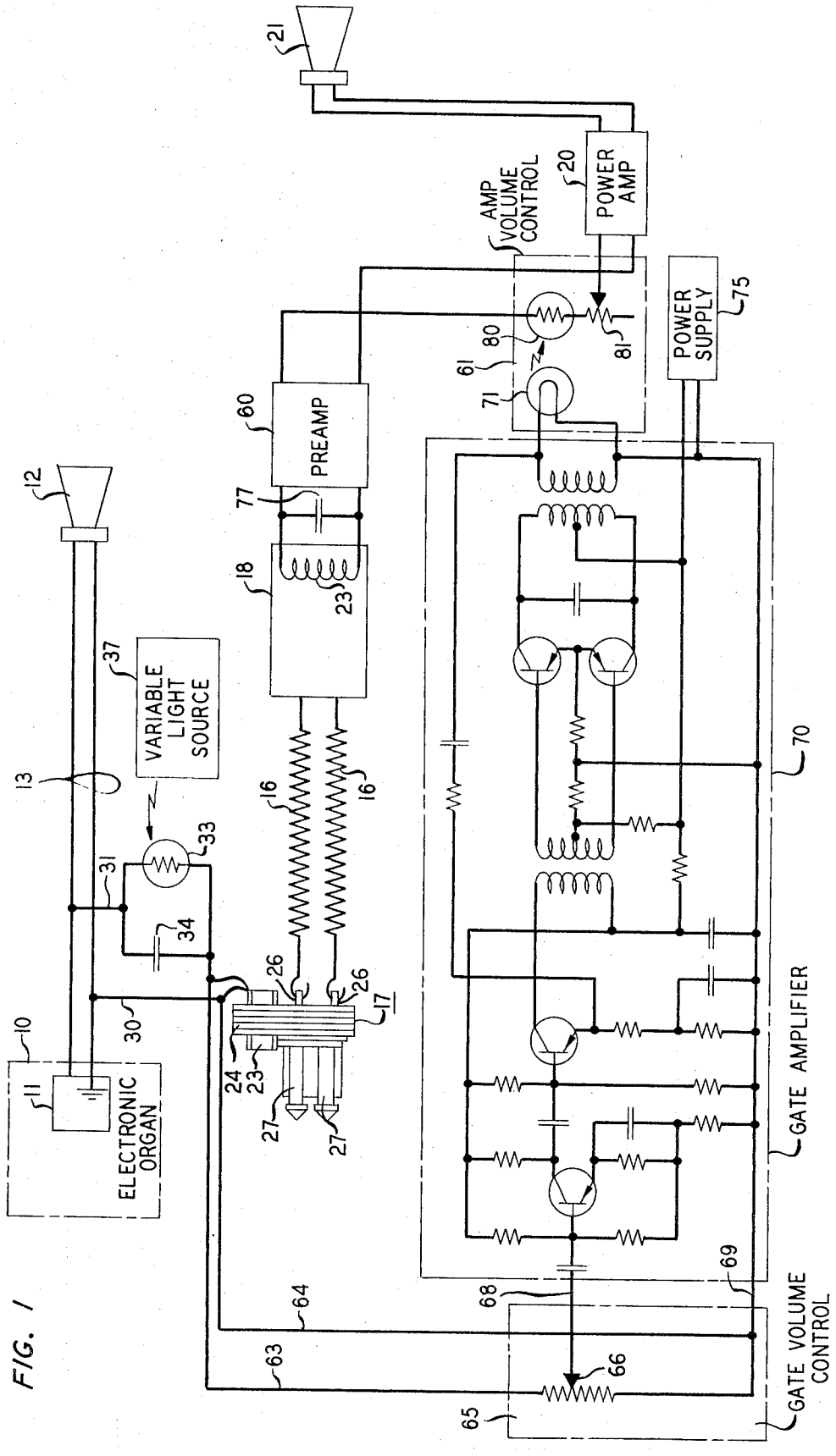

21
AMP VOLUME CONTROL
20
POWER AMP
POWER SUPPLY
75
61
80
81
71
60
PREAMP
77
18
23
12
37
VARIABLE LIGHT SOURCE
13
16
16
33
31
34
26
26
17
10
30
24
23
27
27
11
ELECTRONIC ORGAN
70
GATE AMPLIFIER
69
68
64
63
66
65
GATE VOLUME CONTROL

FIG. 1

FIG. 2

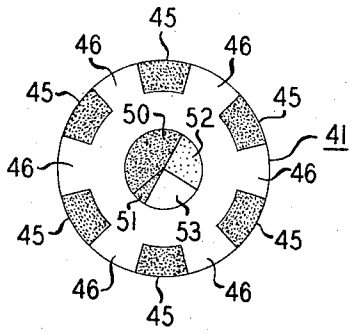


FIG. 3

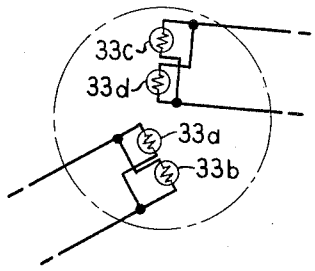
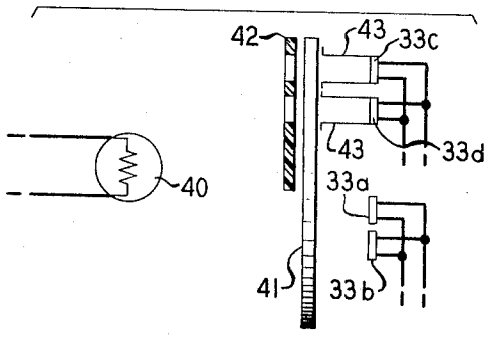


FIG. 4



ENHANCEMENT EQUIPMENT FOR CONNECTION TO ELECTRONIC MUSICAL INSTRUMENTS

RELATED APPLICATION

This application is a continuation-in-part of my copending U.S. Pat. application Ser. No. 145,856, filed May 21, 1971, now abandoned.

BACKGROUND OF THE INVENTION

Electronic organs have become very popular in recent years as musical instruments. Electronic organs can produce many sounds with the versatility one associates with pipe organs, including simulating numerous types of instruments or combinations of instruments. Additionally electronic organs are much less expensive then the older and traditional pipe organs.

Unfortunately, most electronic organs have produced their own unique sounds which are distinct from those provided by pipe organs. Specifically, the electronic organ has generally not succeeded in reproducing the grandeur and spatial sounds of the pipe organ. Particular areas where electronic organs have not completely reproduced the sound of pipe organs concern the spatial quality, chorusing, quality of the voicing and reverberation. Reverberation occurs because pipe organs have usually been played in large rooms which are acoustically reverberant. Electronic organs, which are frequently placed in a person's home, are less likely to be located in rooms having this particular acoustic environment.

Various techniques and equipments have been proposed to improve the sound characteristics of electronic organs. To improve the random sound character resulting from slight differences in the pipes, a random tone generator may be employed, as described in my U.S. Pat. No. 3,405,223, Oct. 8, 1968. To provide a degree of reverberation a reverberation unit as disclosed in Hammond U.S. Pat. No. 2,230,836, Feb. 4, 1941, and further in my U.S. Pat. No. 3,564,106, Feb. 16, 1971, may be utilized.

The difficulty with these prior arrangements is that they must be placed in the organ initially when it is built or require substantial rewiring of an organ if they are to be added to an existing electronic organ.

It is therefore an object of my invention to provide a reverberation device which adds tone color, smooths out the sound, adds the spatial sound effect one expects from reverberation with pipe organs, may be connected to existing organs without rewiring of the organ, is insensitive to noise, and does not have an overly long reverberation signal length.

SUMMARY OF THE INVENTION

In one specific illustrative embodiment of my invention the enhancement device may be connected in parallel to the output speakers of the organ. My spatial enhancement device includes its own speaker or speakers and an artificial reverberation unit of the type, known in the art, wherein mechanical waves are transmitted along springs, the waves being launched by an input transducer including a driving coil and being picked up and translated again to electrical energy by an output transducer; such reverberation units are described, inter alia, in A. C. Young U. S. Pat. No. 3,106,610, Oct. 8, 1963, and my prior U.S. Pat. No. 3,564,106, Feb. 16, 1971.

In accordance with an aspect of my invention the driving coil of the input transducer is thus connected in parallel with the speaker of the electronic organ. Connected in series in one of the input leads to the driving coil is a photosensitive resistor having a capacitor connected in parallel therewith. A variable light source applies light to the photoresistor, the photoresistor having a relatively low resistance when light is applied to it and a relatively high resistance when the photoresistor is not illuminated.

Since the external reverberation device of my invention is in parallel with the output leads between the output amplifier of the electronic organ and the speaker of the organ, only a small portion of the output signals from the organ will be applied to my device. However, this small portion is amplified to be a significant part of the total sound. The sound reinforcement through the speakers of my device thus adds to the sound from the main speakers of the organ. This addition gives the sound greater depth, greater spatial characteristics, increased reverberation, and an element of air motion.

This is particularly obtained because of my unique arrangement of an on-off switch shunted by a capacitor in the input lead to the drive coil of the reverberation unit. I have found that the capacitor together with the inductance of the driving coil of the input transducer comprise a tuned circuit. The result of this is to introduce a phase shift in the electrical signal applied to the reverberation unit through the capacitor.

Accordingly, in operation, when light is impinging on the photoresistor, the signal from the output amplifier of the electronic organ is applied directly through the conducting photoresistor to the reverberation unit input driving coil. When the light is not impinging the photoresistor, the resultant high impedance prevents the electrical signal from following this path. Instead the signal now passes through the capacitor connected in parallel with the photoresistor. The result is that the level of the input signal to the reverberation unit is lower but more significantly, as discussed above, it undergoes a phase shift. It is this phase shift particularly that provides the spatial effect desired.

Because the enhancement device in accordance with my invention would be activated by noise levels of the organ when it is not being played as well as by internal noise within the enhancement device itself, I provide, in accordance with another aspect of my invention, an automatic gating circuit to gate signals through my enhancement device only when the organ is actually being played. Specifically the phase shifted signal is also applied to a gating control arrangement in parallel with the reverberation device. The gating control arrangement includes a gate volume control circuit, allowing the gating point to be individually set for each organ, a gate amplifier whose output causes illumination of a filamentary lamp, and an amplifier volume control circuit. The output of the reverberation unit is applied to a preamplifier having serially connected in its output a photoresistor optically coupled to the filamentary lamp of the gate control arrangement. When the photoresistor is in its high impedance state the preamplifier can not drive the final power amplifier of my enhancement device.

By adjusting the gate volume control circuit, the player arranges the enhancement device in accordance with my invention so that no output occurs from the

enhancement device for maximum noise output from the organ in the absence of music. Under these conditions the input to the gate amplifier is insufficient to turn the output lamp on. However, as soon as music is played, the lamp is turned on and the enhancement device of my invention is activated.

However, when the music stops, there is a decay time during which the lamp remains first bright enough and then warm enough to maintain the conductive coupling between the preamplifier and the power amplifier due to the infrared sensitivity of the photoresistor. This decay closely approximates the decay time of an organ pipe. Because the power to the lamp is removed as soon as the musical signal ceases, the enhancement signal through the reverberation unit is not unduly long, but itself will cease after this short delay for the lamp filament to cool down.

Advantageously, in accordance with my invention the musical effect is enhanced not only because of the phase and amplitude shift due to the capacitor and photoresistor in the input loop of the reverberation unit but also due to a capacitor connected across the coil of the output transducer, providing a resonant effect, and due to the preamplifier clipping the output signals from the output transducer, all of these effects cooperating for the desired musical sound.

In one specific illustrative embodiment I employ as the variable light source a lamp and a rotating disc on which are positioned different patterns of opacity and translucency, depending on the sound effect desired. Further by employing a disc the sound effect of the organ can readily be changed by a simple substitution of one disc for another. Specifically, the disc may have a number of alternate areas of opacity and translucency, the areas being of equal sizes; in one specific embodiment twelve such alternate areas are provided. In this specific embodiment with a disc rotation at a speed of 45 revolutions per minute, nine light pulses every two seconds are provided impinging on the photoresistor.

Alternatively, the disc may have areas of different degrees of opacity, shaded from translucent to fully opaque. This provides, at a speed of 45 revolutions per minute, one light pulse per one and one-third seconds. But whereas in the prior disc arrangement the pulses are sharp edged, being substantially square waves, in this arrangement the pulse has a gradual amplitude increase, causing a substantially sinusoidal wave form; the disc may be shaded from opaque to translucent both for its leading and trailing edges, or it can drop from opaque to translucent sharply, in which case the trailing edge is also sharp.

Multiple patterns may be present on the same disc, cooperating with different photoresistors, in which case a switch may be advantageously provided to allow selection of the particular photoresistor, and thus the particular light pattern, employed with the phase shift network and the reverberation unit.

To provide improved sound characteristics in one embodiment I utilize two photoresistors in parallel, thereby further lowering the resistance when the light impinges. But further, for a gentle effect I position the photoresistors at an angle to a radius from the center of the rotating disc. In this way the light does not equally impinge on the photoresistors but instead initially impinges only one, then both, and then only the other.

If sharp light pulses on the photoresistors are desired I utilize both a screen or mask between the rotating disc and the light source and also collars or shields on the photoresistors and I align the photoresistors with the radius from the center of the disc. This prevents stray light from exciting the photoresistors and increases the sharpness of the pulse. The screen has an aperture in it shaped to match the photoresistors positioned behind the disc. If a smoother transition is desired for the gentle effect discussed above, I omit the collars and the screen and allow some stray light to lower the resistance of the photoresistors before they are directly impinged by the light.

In operation, when the light is impinging the photoresistors, the signal from the output amplifier of the electronic organ is applied directly through the photoresistors to the reverberation unit input transducer driving coil. When the light is not impinging the photoresistors, the resultant high impedance prevents the electric signal from following this path. Instead the signal now passes through the capacitor connected in parallel with the photoresistors. I have found that the capacitor changes the input to the coil dependent on the frequency of the signal, thereby introducing a degree of frequency selectivity in the phase shift network.

If different widths of opaque and translucent bands are employed, then the ratio of normal signal to lessened signal is changed. The phase shift effect in accordance with my invention is still present but the durations of the direct and phase shifted input signals are changed consistent with the change in pattern on the disc.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic representation of one illustrative embodiment of my invention as connected to an electronic organ;

FIG. 2 is a plan view of the rotating disc employable in the variable light source of the embodiment of FIG. 1;

FIG. 3 is a diagram illustrating the physical positioning of the photoresistors behind the rotating disc in one embodiment of my invention; and

FIG. 4 is a side view of the variable light source and photoresistors in the embodiment of FIG. 1.

DETAILED DESCRIPTION

Turning now to the drawing, there is depicted in FIG. 1 one specific illustrative embodiment of my invention as connected to an electronic organ **10**. It is to be understood of course that a spatial enhancement device in accordance with my invention can be utilized with many different types of electric or electronic musical instruments but I have found that my invention is particularly useful in enhancing the spatial sound characteristics of electronic organs.

As is known in the art an electronic organ includes an output amplifier **11** connected to the output speaker **12** by output leads **13**. My invention is advantageously bridged across the leads **13** so that a portion of the energy from the output amplifier **11** is diverted away from the speaker **12** and into the spatial enhancement device of my invention.

My spatial enhancement device includes an artificial reverberation unit of a type known in the art; in this specific embodiment I employ a unit of the general type shown in Hammond U.S. Pat. No. 2,230,836, Feb.

4, 1941, wherein coiled springs **16** are caused to vibrate in response to the electrical signals representing the musical tones. An input electromechanical transducer **17** serves as an input driver to launch the mechanical signals onto the springs in response to the applied electrical signals. An output electromechanical transducer **18** serves as the output pickup device for receiving the mechanical vibrations from the springs and converting them again to electrical signals for application, through a preamplifier **60**, amplifier volume control **61**, and power amplifier **20**, to the separate output speaker **21** of the device; the preamplifier **60** advantageously clips the output signals from the output transducer **18**.

The transducers, which may be of any of several types known in the art, include a coil **23** wound on a core, not shown, so as to define a magnetic circuit including the annular laminations **24**; while only the input transducer **17** has been depicted in detail, as my invention is particularly concerned with the application of the input signals to that transducer, the output transducer **18** is similar, as is known. Positioned within the magnetic circuits thus defined are highly compliant wires, such as of beryllium copper, whose ends **26** are bent in the form of a hook. Each of these wires extends into and is supported by a tubular housing **27**; further as is known in the art, a small diameter annular permanent magnet, not shown, surrounds the end **26** of each of the wires and is positioned within the magnetic circuits of the laminations **24**.

Extending between the hooks **26** of the input and output transducers **17** and **18** are the spring elements **16** which may advantageously be of slightly different lengths or number of turns so as to have slightly different transmission characteristics.

When the output signals from the organ amplifier **11** are applied to the organ speaker **12**, advantageously a portion of the output signal is applied over leads **30** and **31**. Because the spatial enhancement device in accordance with my invention contains its own amplifier **20** I can balance the sound outputs from the speakers **12** and **21** to get any desired ratio of straight sound to enhanced sound; the exact proportion will depend somewhat on the effects desired. I have found it satisfactory in some instances to have the sound actually evenly divided between the two speakers.

It should also be pointed out that while I have depicted only a single output amplifier **11** for the organ, in actuality there may be a number of separate output channels in the organ. For home instruments it may be advantageous to apply all of these organ outputs to a mixer circuit and apply the output of the mixer to my spatial enhancement device. Alternatively for a church organ it may be desirable to provide a separate spatial enhancement device in accordance with my invention for each organ channel.

In accordance with an aspect of my invention the input coil **23** of the driving transducer **17** is connected to the leads **13** by an arrangement which affects the input signal. Specifically in lead **31** are connected a switch device **33** having a capacitor **34** connected across it. The switch device **33** is arranged to be alternately conductive and non-conductive. In this specific illustrative embodiment the switch device **33** comprises a pair of parallel connected photoresistors, as of cadmium sulfide cells. These cells have an impedance of the order of 5 megohms when light is not impinging on them and of the order of 50–75 ohms when conductive. Since I utilize two in parallel the resistance introduced when they are conductive is only of the order of 25 ohms.

In this specific illustrative embodiment I employ a variable light source **37**, described further below, to turn the switching elements **33** on and off. It is to be understood however that various other switching devices might be employed. I have found the light actuated elements to be particularly advantageous as they do not introduce any electrical noise or clicks into the signal, which noise is increased due to the effects both of the reverberation unit and the final amplification. Accordingly, my preferred embodiment incorporates the light actuated switching elements as disclosed.

Leaving aside the mechanism of the variable light source and my gating control circuitry, for the moment, let me describe the basic operation of my invention. When the switch **33** is conductive due to light from source **37**, the switch element provides a low impedance path for the signal from the amplifier **11** to the drive coil **23** of the input transducer **17**. However, when the switch **33** is in its high impedance state, that is, when no light is being emitted by the light source **37**, the input signal is not blocked from the drive coil **23**. Instead the input signal is diverted from the switch **33** and flows through the parallel capacitor **34**. The signal passing through the capacitor I have found to be diminished in amplitude but more significantly to have its frequency characteristic altered; more specifically I believe the signal undergoes a phase shift, dependent upon the frequency components of the output signal from the organ, the magnitude of the capacitor, and the inductance of the coil **23**. In one specific illustrative embodiment I have employed a .22 microfarad capacitor for capacitor **34**.

By pulsing the switching element **33** I can accordingly obtain a celesta effect in the total sound, with the sound from speaker **21** alternately reinforcing and cancelling the sound from speaker **12**. Further by the placement of the speakers relative to the listener and by choice of the driving of the switch **33** I can attain various other effects. The overall effect, particularly for an organ, is that the enhancement device in accordance with my invention adds a spatial and a chorusing quality to the sound, improves the voicing effect and provides an impression of space such as one expects from an organ in a large acoustically reverberant room. In fact organs whose own sound outputs are relatively flat and very electrical sounding can readily be made to sound spatial and more like a true pipe organ.

A reverberation unit such as employed herein is very sensitive to various types of noise, including motor noise, room noise, amplifier noise, and noise present in the organ as well as in the enhancement device. When a signal is being applied to the reverberation unit this noise is generally masked and is not heard. However, when no input signal is applied this noise is still present and may be transmitted along the reverberation unit, amplified, and reproduced by the speaker **21**. In accordance with another aspect of my invention, a gating arrangement is employed to prevent the occurrence of any noise output signal under these conditions.

Specifically, in this specific illustrative embodiment as depicted in FIG. **1**, the input signal from the phase shift circuitry of capacitor **34** and switch **33** is applied

not only to the input coil **23** of the transducer **17**, thereby to define the resonant circuit, but also over leads **63,64** to a gate volume control circuit **65** comprising a potentiometer **66**. The purpose of the gate volume control circuit will become apparent from the further description below.

The gate control signal is then applied over leads **68,69** to a gate amplifier circuit **70**, the output of which activates a small filamentary bulb **71**, located in the amplifier volume control circuit **61**. The gate circuit amplifier may advantageously have a small power output, as of the order of one watt, and should have a logarithmic output characteristic rather than a linear characteristic. In this way the amplifier reaches its maximum output power and then flattens out so that the small bulb **71** does not burn out. A power supply **75** powers the gate amplifier **70**, as is known in the art.

The output transducer **18** of the reverberation unit applies the modified signal to a preamplifier **60**, which may be of any of many known designs but which clips the signals applied to it. I have found it desirable that a capacitor **77** be across the coil **23** of the output transducer so that a resonant peak occurs in the signal to the preamplifier **60**. In accordance with an aspect of my invention, the output of the preamplifier **60** is connected to the power amplifier **20** through an amplifier volume control circuit **61** including a potentiometer **81**, a light sensitive or photoresistor **80**, and the output filamentary bulb **71** connected to gate amplifier **70**. The output of the amplifier volume control circuit **61** is connected through the power amplifier **20** to the speaker **21**.

The gate volume control circuit **65**, gate amplifier **70**, and amplifier volume control circuit **61** thus define, in accordance with this aspect of my invention, a self-activating optical gating circuit, whereby the enhancement equipment of my invention is virtually silent when the organ is not playing, the equipment being in a waiting condition with the volume automatically turned off. However, when the musician plays the instrument, the enhancement equipment immediately comes into action; which the musician stops playing, the enhancement equipment will gradually turn itself off, this taking approximately a half second on average volume to one full second on louder volume levels. This delay in turn off occurs because the filamentary lamp **71** continues to radiate, particularly infrared, after there is no output from the gate amplifier **70**. I have found that the decay caused by the cooling down of the lamp filament to be substantially identical to the decay in signal in a pipe organ, thereby further enhancing the sound effects of the electronic organ.

Since each organ to which my invention may be connected presents its own noise level, the gate volume control circuit allows the automatic gating arrangement to be regulated for each instrument so that the enhancement equipment does not transmit any noise signals when the organ is not being played. In operation, the player of the organ initially depresses the volume pedal of the organ fully so that it generates the maximum amount of residual noise that the organ is capable of producing. The player then adjusts the potentiometer **66** of the gate circuit **65** to its off position so that no signal at all will be applied to the input of the gate amplifier **70**. The player then slowly turns the potentiometer control until the enhancement equipment is just activated and noise output appears at speaker **21**. The player then backs off on the potentiometer control until the noise just ceases coming from the speaker **21**. At this point, the automatic gate control is fully adjusted for the particular organ to which my invention is connected.

I have found that when the organist is playing soft tonalities, the enhancement equipment in accordance with my invention will produce an air noise quality which enhances the tonalities of the soft wind stops; this air noise effect is due to noise effects within the preamplifier **60** and the power amplifier **20** of the enhancement equipment itself. On higher volume levels, this windy quality tends to be absorbed, and is not noticeable to any large extent, but is still always present, adding its own unique characteristics. However, in all cases, because of the automatic gating provided by my invention, and specifically by the arrangement including the filamentary bulb **71** in the amplifier volume control circuit, noise is not present when the organ is not being played and a pipe organ decay characteristic is attained.

The potentiometer **81** in the volume control circuit **72** allows the player to adjust the volume output of the enhancement equipment in accordance with my invention in accordance with the particular organ and room in which he is playing, since the degree of volume desired is generally a matter of personal taste of the player.

In the specific illustrative embodiment of my invention depicted I utilize a rotating disc to create a variable light source **37**. Various other variable light sources may be employed, such as logic or digital circuitry which turns on and off a light in various timed patterns. I have found a rotating disc however to offer certain advantages, including ease of changing from one pattern of light pulses to another and accurate control of the time of switching. Specifically, as depicted in FIG. **4**, the variable light source includes a bulb **40**, a rotating disc **41** driven by a motor, not shown, a mask or screen **42**, and the photoresistors **33** at the bottom of shields or collars **43**, as depicted for one pair of photoresistors, or without such shields or collars, as depicted for another pair of photoresistors. The reason for this difference will be discussed below.

The disc **41** is itself of a translucent material and, as seen in FIG. **2**, can have various patterns of translucent and opaque areas. Specifically, the particular disc depicted in FIG. **2** has an outer ring of alternate areas **45** and **46** which are of equal size and are, respectively, opaque and translucent. If the disc is driven at a rate of 45 revolutions per minute there are therefore developed light pulses of equal duration at a rate of nine pulses every 2 seconds for the 12 area pattern depicted. Alternatively, if seven alternate pairs of areas **45** and **46** are employed, light pulses occur at a rate of 5 and ¼ pulses per second. To prevent stray light from impinging on the photoresistors **33***c* and **33***d* before the translucent pattern **46** is directly above the photoresistor, I provide the mask or screen **42** between the disc **41** and bulb **40** and I also provide the collars **43** in order to obtain sharp signals.

Alternately, a different sound effect may be obtained if the light pulses are not sharp edged but provide smoother transitions. In this instance the inner ring of disc **41**, FIG. **2**, may be employed. As there depicted, the opaque area **50** is about 40 percent of the total

area. Opposite that is a translucent area **53** of about 25 percent of the area. Between the two is a short transition area **51** of about 10 percent of the area and a longer area **52** of about 25 percent of the area. In this instance, as seen in FIG. **4**, no collars are provided on the photoresistors **33***a* and **33***b* and no mask **42** is utilized as some light leakage onto the photoresistors is desired.

I have found that the outer ring may advantageously be used when a large theatre effect is desired. Normally in electronic organs vibrato is provided at a rate of about seven or eight pulses per second. Sound therefore comes out of the organ speaker **12** and also out of the speaker **21** with this vibrato imposed on it. The enhancement device of my invention, if 14 equal areas are utilized for the disc pattern, causes the sound to be shifted by the 5 and ¼ pulses per second phase shift. In the air an acoustic coupling occurs so there is a doubling effect, that is, the organ sound through the speaker **21** is effected directly and then the sound from the speaker **12** is effected in air by the sound from the speaker **21**. For this it is desirable both to have the faster pulse rate and the sharper pulses.

On the other hand when softer and subtler sounds are desired, the inner pattern on disc **41** may be utilized with gentler pulses at the slow speed. Electronic organs have various imperfections, particularly resulting in beat frequencies in the output. A gentler phase shift serves to smooth over these beats. In this instance, the signal through the speaker **12** has its imperfections masked by the slow phase shift effect from the speaker **21**.

Advantageously a manual switch can be provided to insert either pair of photoresistors of FIG. **4** into the circuit of FIG. **1**. It is apparent that additional patterns can be provided on the disc **41**, each pattern cooperating with a different pair of photoresistors and each being selectively chosen by the user of the instrument.

I have found that a multitude of different spatial effects may be attained by varying the patterns on the disc and by changing the speed of rotation of the disc. One advantage of the disc as a control for the light source is in fact this degree of flexibility, if not to the user at least to the manufacturer who can readily tailor the sound effect of the enhancement device in accordance with my invention to the particular use to which it is to be put and to the particular musical instrument and room in which it is to be located.

In accordance with another aspect of my invention, the mounting of the photoresistors may also be utilized to determine the character of the light signal impinging on the photoresistors. Thus as seen in FIG. **3**, the photoresistors **33***a* and **33***b* are mounted for a gradual effect of the light whereas photoresistors **33***c* and **33***d* are mounted for sharp edged signals. Thus if one considers a radius of the disc as passing between the photoresistors **33***a* and **33***b*, these photoresistors are at an acute angle to that radius. This further assures the gradual effect of the light on these photoresistors; it is to be remembered that, as seen in FIG. **4**, no collars **43** or mask **42** is utilized with these photoresistors. Advantageously, the light first impinges on one of these photoresistors, then both of them, and finally the other photoresistor alone. In contradistinction, photoresistors **33***c* and **33***d* are aligned with a radius of the disc so that the light impinges each equally. This further assures the sharp edged signals desired with these photoresistors.

While I have depicted one specific embodiment of my invention, it is to be understood that various modifications may be made without departing from the spirit and scope of my invention. Thus, as indicated, other switching devices may be employed for connection in the lead **31**, provided they introduce no noise into the electrical signals, and other control mechanisms can be employed for controlling the switching devices. Similarly, the degree of the change in frequency characteristic due to the capacitor **34**, the relative amounts of the signals, the frequency and phase shift of operation of the switching device and the amount of reverberation introduced, as by the springs **16**, can all be varied at the will of the designer and player of the instrument for the maximum sound effect he desires.

Specifically, the variable light source **37** may include a light bulb controlled by a relaxation oscillator, the light being turned on and off at the rate of the oscillator. In such an embodiment, different light bulbs and oscillators would be employed for the different photoresistors.

What I claim is:

1. A musical enhancement device for connection to electronic musical equipment having an output amplifier connected by a pair of leads to a speaker, said device comprising

a reverberation unit including means for transmitting a mechanical signal, an input transducer including a coil for launching said mechanical signal in response to an electrical signal, and an output transducer,

an amplifier arrangement connected to said output transducer,

a separate speaker connected to said amplifier arrangement,

an input loop for connection across the pair of leads from the output amplifier of the equipment, said input loop comprising a capacitor in series with said coil,

a switch device connected in parallel with said capacitor,

means for controlling said switch device, whereby said capacitor and coil being directly connected together in said input loop alter the characteristics of the signal applied to said mechanical signal transmitting means so that the sound from said separate speaker undergoes both amplitude and phase modulation,

a gating control arrangement connected to said coil of said input transducer by an adjustable gate volume control device so as to be responsive to signals from the output amplifier of the equipment for controlling said amplifier arrangement, said gating control arrangement including

a gate amplifier connected to said gate volume control device, and

a lamp connected to the output of said gate amplifier,

said amplifier arrangement including an amplifier volume control arrangement including a photosensitive element responsive to said lamp.

2. A musical enhancement device in accordance with claim **1** wherein said adjustable gate volume control device includes an adjustable resistor connected across

coil of said input transducer and said gate amplifier comprises an amplifier having a logarithmic output characteristic.

3. A musical enhancement device in accordance with claim 1 wherein said amplifier arrangement includes a preamplifier and a power amplifier, said volume control arrangement is connected between said preamplifier and said power amplifier, and said lamp is a filamentary lamp.

4. A musical enhancement device in accordance with claim 3 wherein said output transducer includes a coil and a capacitor connected across said coil, said coil being connected to said preamplifier.

5. A musical enhancement device in accordance with claim 1 wherein said switch device includes a photosensitive element and said controlling means includes means for applying pulses of light to said photosensitive element.

6. A musical enhancement device in accordance with claim 5 wherein said photosensitive element is a photoresistor and said light pulse applying means includes a disc having areas of different light transmitting characteristics.

7. A device for connection to an electronic organ comprising

means for transmitting a mechanical signal,

an input transducer including a coil for launching said mechanical signals in response to electrical signals,

means for connecting said input transducer to the organ, said connecting means including a switch device connected between the organ and said input transducer, means for controlling said switch device, and a capacitor connected in parallel with said switch device between the organ and said input transducer for providing a phase shift and amplitude shift of the electrical signals when said switch device is not conductive,

an output transducer for generating output electrical signals in response to said mechanical signals,

an output arrangement connected to said output transducer and including an output amplifier and an amplifier volume control circuit, and

a control arrangement for blocking output signals from said output transducer to said output amplifier in the absence of a musical signal from the organ, said control arrangement including means for controlling said amplifier volume control circuit, means for energizing said last mentioned means, and adjustable means for connecting said energizing means to said means for connecting said input transducer to the organ

8. A device in accordance with claim 7 wherein said switch device comprises a photosensitive element connected to said coil, and said controlling means includes means for applying light pulses to said photosensitive element.

9. A device in accordance with claim 7 wherein said amplifier volume control circuit includes a photosensitive element, and said energizing means includes a gate amplifier, a filamentary bulb connected to the output of said gate amplifier as to be powered thereby, the light from said bulb being coupled to said volume control circuit photosensitive element.

10. A device in accordance with claim 9 wherein said output arrangement includes a preamplifier, said amplifier volume control circuit being connected between the output of said preamplifier and the input of said output amplifier, and said preamplifier clips said output electrical signals from said output transducer, and further comprising a capacitor connected across said output transducer.

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