Jan. 14, 1969 R. D. BARRY 3,422,208

ELECTRONIC LATCHING PEDAL

Filed Aug. 30, 1965 Sheet 1 of 3

Fig. 1.

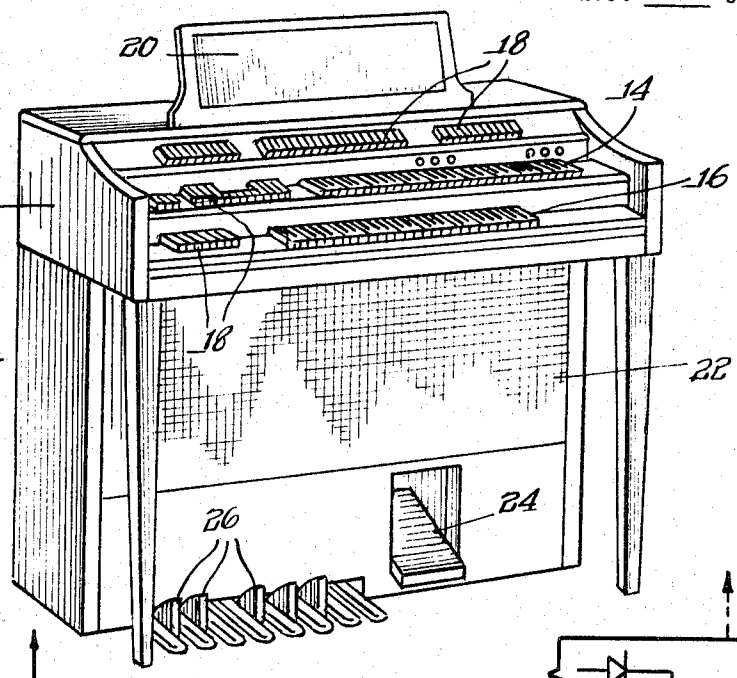
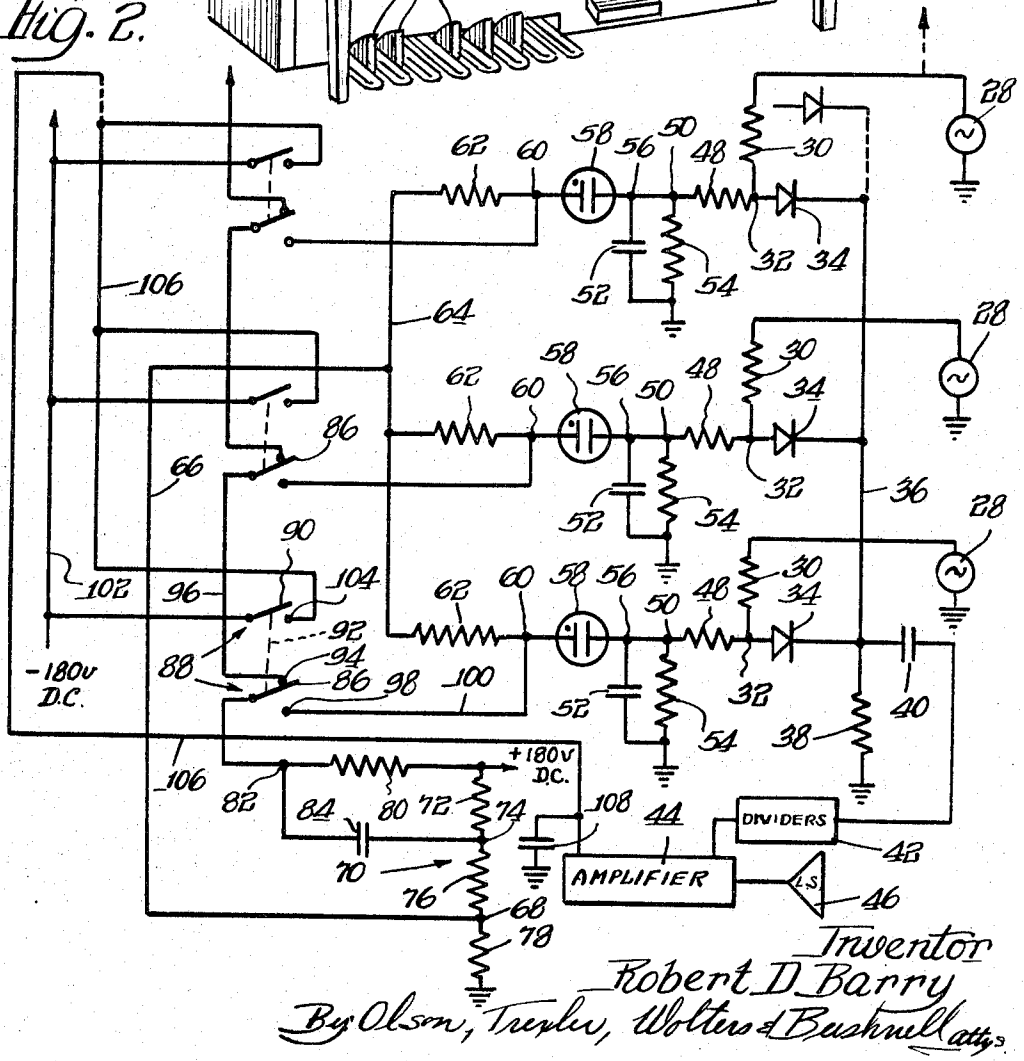


Fig. 2.



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Filed Aug. 30, 1965 Sheet 2 of 3

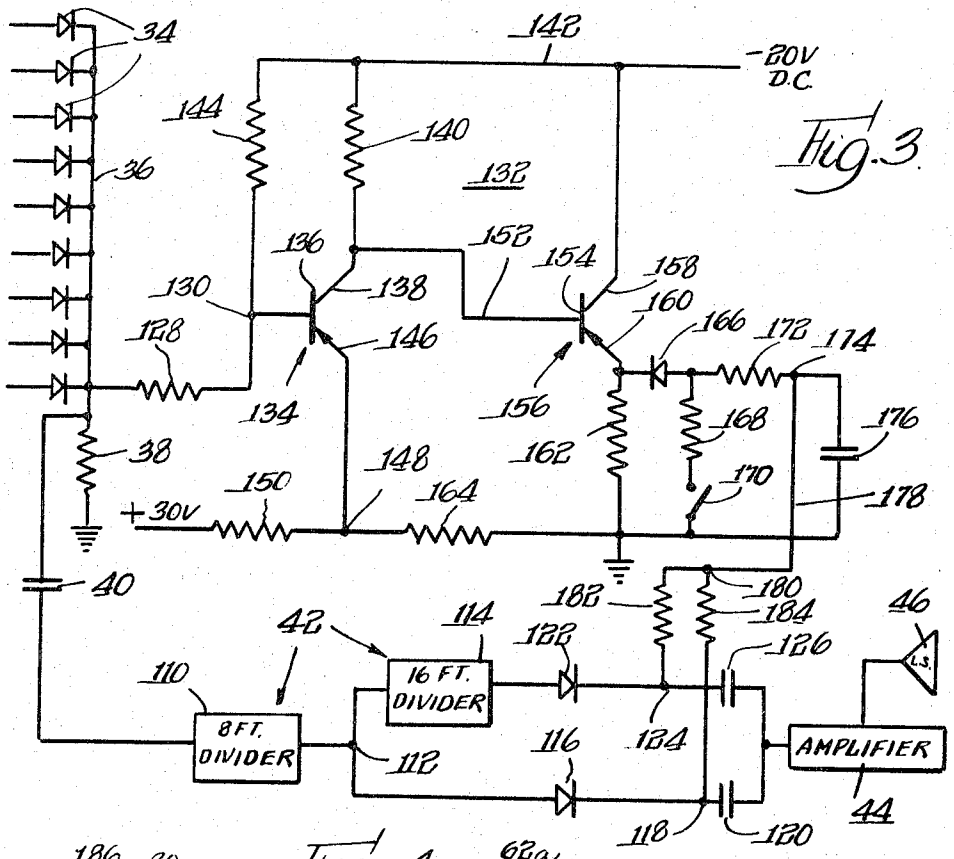

Fig. 3.

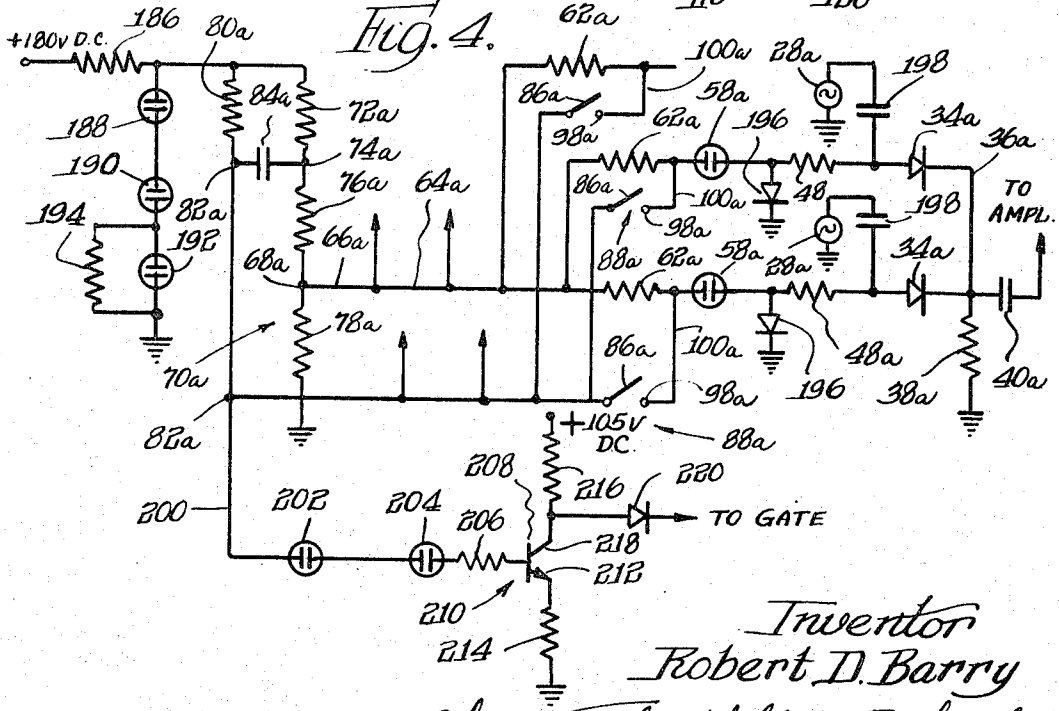

Fig. 4.

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ELECTRONIC LATCHING PEDAL

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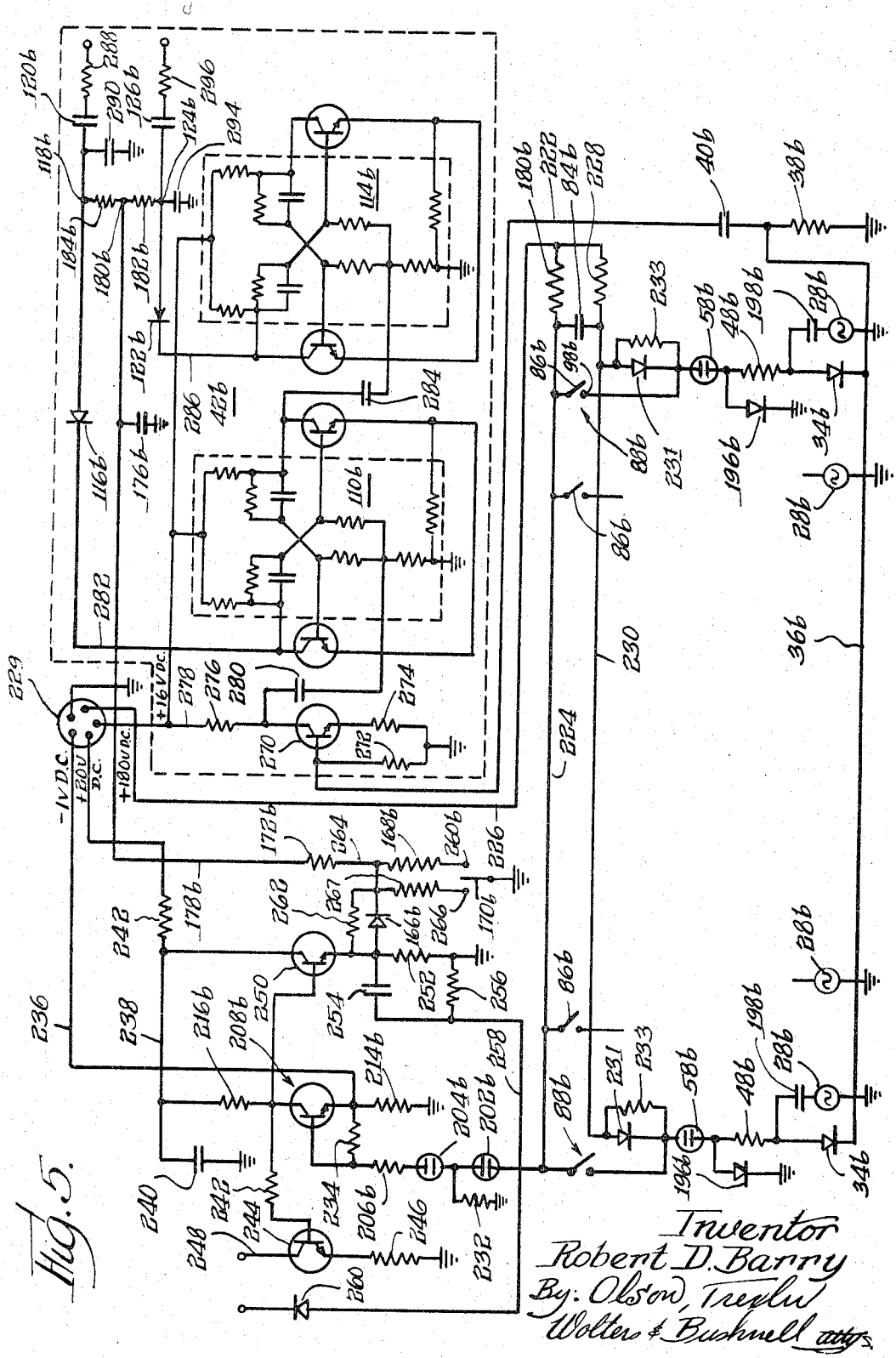

Fig. 5.

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3,422,208

ELECTRONIC LATCHING PEDAL

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Filed Aug. 30, 1965, Ser. No. 483,632
U.S. Cl. 84—1.01 18 Claims
Int. Cl. G10h 1/00; G10h 1/02; G10f 1/00

ABSTRACT OF THE DISCLOSURE

A monophonic organ pedal switching circuit wherein each note is switched through a diode which is normally off. A plurality of neon bulbs, one for each note, is included. When any pedal switch is closed by depression of the pedal, positive voltage is applied to the corresponding neon bulb, causing it to fire, and biasing the corresponding diode for conduction. Simultaneously, a negative pulse is applied to all other neon bulbs to insure that any bulb which remains in firing condition is cut off. Upon release of a pedal and opening of the corresponding switch, a lesser voltage remains applied to all of the neon bulbs which is sufficient to maintain in firing condition the one bulb that has most recently been fired, but which is not sufficient to fire or ignite any other neon bulb, whereby the last note played can be sustained.

This invention relates to the art of electronic musical instruments, and more specifically to an electronic latching pedal or circuit for playing pedal tones as in an electronic organ with sustain, and with cancellation of a sustaining note when a subsequent note is played.

As is known, it is desired to have the pedal tones on an electronic organ sustain, i.e., a note should not decay abruptly as soon as the corresponding pedal is released. On the other hand, it generally is not desirable to have one note to continue to sustain when a subsequent note is played. Various electro-mechanical switching expedients have been utilized heretofore to provide for sustain and cancellation thereof. Electro-mechanical devices inherently present certain types of service problems, and also inherently are a source of noise.

Accordingly, it is an object of this invention to provide a completely electronic system for accomplishing the same purposes.

In particular, it is an object of this invention to provide an electronic switching circuit utilizing electronic switches for playing the pedal notes of an electronc organ, for sustaining a note that has been played, and for canceling a previously sustaining note when another note is played.

Yet another object of the present invention is to provide a switching system as heretofore set forth using a single gate and sustain capacitor for each pedal footage stop.

Specifically, it is an object of this invention to utilize neon bulbs for switching potentials to control the conduction of switching diodes in an electronic organ pedal switching circuit.

A further specific object of the present invention is to provide a common voltage supply means operative with a plurality of voltage switching neon bulbs so arranged that one neon bulb is extinguished as a subsequent one fires.

Other and further objects and advantages of the present invention will be apparent from the following description when taken in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view of an electronic organ constructed in accordance with the principles of the present invention;

FIG. 2 is a schematic wiring diagram of a basic circuit exemplifying the pedal switches and accompanying electronic switches for effecting playing of selected pedal notes;

FIG. 3 is a schematic wiring diagram of an electronic organ pedal note divider circuit and gating circuit for effecting sustain;

FIG. 4 is a similar circuit useful with a different type of waveform input; and

FIG. 5 is a schematic wiring diagram of a portion of a commercial electronic organ as built in accordance with the principles of the present invention.

Referring now in greater particularity to the drawings, and first to FIG. 1, there will be seen an electronic organ **10** comprising a case **12** having a pair of manuals or keyboards **14** and **16**, generally in accordance with conventional practice. Various stop tablets **18** are provided for effecting switching functions, most of which are not directly involved in the present invention. The organ case is provided with a music rack **20**, with a grill **22** behind which loud-speakers are mounted, and with a swell pedal **24** for controlling the overall volume. In addition, the organ is provided with a pedal clavier comprising a plurality of pedals **26** for playing the pedal notes of the organ.

Turning now to FIG. 2, along the right side thereof will be seen a plurality of tone generators **28**. The tone generators **28** may be of any suitable or known type, or for purposes of the present invention preferably provide a square wave output. The number of generators is equal to the number of pedal notes, i.e., an octave plus one of semi-tones or a total of 13. Only three are shown, and additional parts are suggested by dashed lines, the circuits being duplicated and unnecessary of specific disclosure. Each generator is connected to a resistor **30**, and this resistor leads to a junction **32**. The junction is connected through a diode **34** poled for conduction of positive current from left to right to a collector bus **36** grounded through a shunt resistor **39**, and connected through a series coupling capacitor **40** to dividers **42**, and hence to an amplifier **44** and loudspeaker **46**. As is common in electronic organ practice, the generators **28** actually generate notes higher than the desired pedal tones, and these are divided once in frequency for the eight foot stop, and twice for the sixteen foot stop.

Normally the diodes **34** do not conduct signals from the generators to the collector bus **36**. Switching circuits are provided for individually biasing the diodes **34** for conduction, and these circuits will now be set forth.

To each junction there is connected a series resistor **48**, and this in turn is connected to a junction **50**. A capacitor **52** of rather large size is connected in parallel with a resistor **54**, having at the top end a junction **56** connected directly to the junction **50**; the resistor-capacitor parallel combination being grounded as shown. The junction **56** is connected to a neon bulb **58**, and each neon bulb is connected to a junction **60**. Each of the junctions **60** is connected through a resistor **62** to a common bus **64**.

The bus **64** is connected by a line **66** to a junction **68** on a voltage divider **70** comprising a resistor **72** connected at a junction **74** to a resistor **76**, the latter being connected at the junction **68** to a grounded resistor **78**. The top end of the resistor **72** is connected to a positive 180 volts direct current source, as indicated, and is also connected to a resistor **80**. The resistor **80** is connected to a junction **82**, and this resistor is connected to a capacitor **84** leading to the junction **74**. The junction **82** is connected to a movable contact **86** of a switch **88**.

The switch **88** comprises a pedal switch operated by one of the pedals **26**, and has an additional movable contact **90** ganged as indicated at **92** with the contact **86**. The contact **86** normally engages a fixed contact **94**, and each fixed contact **94** is connected by means of a wire to the next adjacent (above) movable switch contact **86**. The movable contact **86** is arranged to leave the fixed contact **94** and to move into engagement with a fixed contact **98** when a pedal corresponding thereto is depressed. Each fixed contact **98** is connected by a wire **100** with the corresponding junction **60**.

Each movable switch contact **90** is connected to a supply line or bus **102** maintained at —180 volts D.C. Each contact **90** normally is not in engagement with a fixed contact, but upon depression of a corresponding pedal **26** a contact **90** moves into engagement with a corresponding fixed contact **104**. All of the fixed contacts **104** are connected to a collector bus **106** which leads to the amplifier **44** and which has a shunting sustain capacitor **108**.

When the organ is first turned on, none of the neons **58** is ignited. Closure of one of the key switches **88**, and specifically engagement of a movable contact **86** with a fixed contact **98**, for example the bottom one in FIG. 2, will raise the potential of the neon **58** in series with the switch and cause ignition thereof. Junction **82**, which previously has been substantially at the supply source voltage of +180 volts will drop in voltage to approximately 90 volts. Surge current through the capacitor **84** momentarily drops junction **74** to approximately 90 volts, and this in turn drops the voltage at junction **68**.

Current drawn through the neon bulb **58** to the resistor **54** causes a voltage drop across the resistor **54**, and this in turn forward biases the corresponding diode **34**. The signal supplied by the corresponding generator **28** thus is carried through the now conducting diode **34**, and through capacitor **40** to the dividers **42** and on to the amplifier **44**.

At the same time, movable contact **90** was moved into engagement with fixed contact **104**, thus supplying —180 volts D.C. from the supply line **102** to the collector **106** and on to the amplifier **44**, turning on a gate in the amplifier to conduct the signal from the dividers **42**. If the lower switch **88** is now released, potential is held on the line **106** for a predetermined time by the capacitor **108**, whereby to provide sustain.

If another of the switches **88**, for example, the second from the bottom, is now operated by its corresponding pedal while the sustained note is still sounding, the corresponding neon bulb **58** (second from the bottom in the present example) is ignited. Surge current through the capacitor **84** drops junction **82** to about 90 volts, thus dropping junction **68** below the potential necessary to maintain the lowermost neon bulb **58** firing. Thus, one neon is extinguished as another ignites. The junction point **68** again rises to its approximate 100 volts D.C. potential, which is sufficient to maintain ignition of the last ignited neon bulb, even though the newly closed switch be allowed to open by release of the corresponding foot pedal.

It will be observed that potential is supplied to the movable switch contacts **86** in series from the positive 180 volt source, and if any two switches are operated at the same time, only the lowermost will have any effect on its corresponding neon bulb, since the series chain will be broken before reaching the upper of the two switches. Thus, the present switching system also comprises a preference network, which may be considered to be a low note perference with the lowest switch and associate parts corresponding to the lowest pedal note, etc.

In the invention as heretofore shown and described, sequencing of the switch contacts and **86** and **90** is important. The switch contact **86** must make contact with its adjacent fixed contact **98** at least as soon as, and preferably slightly before the movable switch contact **90** engages its fixed contact **104** to insure that a new note will be playing before its readout is initiated. In order to eliminate the second movable switch contact, and to insure proper sequence, a variation in the output circuit is employed, as shown in FIG. 3. The switching circuit of FIG. 2 may be employed in connection with FIG. 3 without change, except for elimination of the —180 volt D.C. supply line, the second movable switch contact **90**, and the connecting line **106** leading to the amplifier. Thus, the diodes **34** (of which only nine are illustrated), the collector **36**, the resistor **38** and capacitor **40** are as heretofore shown and described. The capacitor **40** is connected to the dividers **42**, specifically illustrated as an eight foot divider **110** connected to a junction **112**, the junction **112** being connected to a sixteen foot divider **114**. The junction **112** is connected to a diode **116** poled to conduct positive current from left to right. The diode **116** is connected to a junction **118**, and from there through a capacitor **120** to the amplifier **44** and loudspeaker **46**.

The 16 foot divider **114** is connected to a similarly poled diode **122**, the latter being connected to a junction **124**, and from the junction to a capacitor **126**. The capacitor is connected to the amplifier **44**.

From the collector bus **36**, connection is made through a resistor **128** to an input junction **130** through a two-stage transistor switching circuit **132** comprising a first transistor **134** having the base **136** thereof connected direct to the junction **130**. The transistor **134** is of the p-n-p type, and the collector **138** thereof is connected through a resistor **140** to a supply line **142** of —20 volts D.C. The base also is connected through a resistor **144** to the supply line **142**. The emitter **146** is connected to a junction **148** leading through a resistor **150** to a source of positive potential indicated at +30 volts.

The collector **138** also is connected directly at **152** to the base **154** of another p-n-p transistor **156**, the collector **158** of which is directly connected to the negative supply line **142**. The emitter **160** is grounded through a resistor **162**. The junction **148** also is grounded through a resistor **164**.

The emitter **160** also is connected to a diode **166**, poled to conduct positive current toward the emitter from right to left as shown in the drawing. The opposite side of the diode **166** is connected to a resistor **168** leading to a sustain switch **170**, grounded on the other side, and the diode is also connected to a resistor **172** leading to a junction **174**. The junction **174** is grounded through a capacitor **176**, and further is connected to a junction **180** which leads through respective resistors **182** and **184** to the junctions **124** and **118**.

Normally the transistor **134** conducts quite heavily, and this in turn biases the transistor **156** off. Whenever one of the key switches (previously described movable contact **86**, etc.) is operated, the voltage on the collector line **36** rises from a normal quiescent potential of approximately one volt to about four or five volts, thus cutting off transistor **134**. The collector voltage of transistor **134** thus approaches the supply voltage of —20 volts, and this in turn turns on transistor **156**, allowing nearly 20 volts negative to appear on the collector **160** of this transistor. This charges capacitor **176** through diode **166** and resistor **172**. The negative potential on capacitor **176** is applied to resistors **182** and **184** to turn on the diodes **122** and **116**, and thus to conduct the eight and sixteen foot dividers respectively to the amplifier **44**. When a pedal is released, the capacitor **176** discharges only very slowly, thereby causing the note to sustain. If it is desired not to have any substantial sustain, then the switch **170** is closed. The capacitor **176** thereupon discharges through the resistor **168** quite rapidly in series with the resistor **172**.

The circuits as noted heretofore are intended for use primarily with tone generators providing a square wave

output. This is a desirable output in that it is rich in harmonics. However, there may be times in which it is desired to operate with a sine wave generator, and a suitable circuit is shown in FIG. 4. Many of the parts in the circuit are similar to those heretofore shown and described in connection with FIG. 2, and similar numerals therefore are utilized to identify similar parts with the addition of the suffix *a*. Thus, the voltage divider **70***a* is generally the same as heretofore shown and described. However, voltage regulation is supplied by means of an input resistor **186** connected from the positive 180 volt D.C. supply to the top of the voltage divider, the junction between the top of the voltage divider and the input resistor being grounded through a shunt combination of three series-connected neon bulbs **188**, **190** and **192**, the latter being paralleled by a resistor **194**.

The tap or junction **68***a* on the voltage divider is again connected by a line **66***a* and a further line **64***a* and resistors **62***a* to the neons **58***a* for holding a fired neon in the firing or ignited condition.

Keying potential to fire a neon, the neons normally being off at the start of playing, is supplied from the junction **82***a* to the movable contacts **86***a* of the various key switches **88***a*, only three thereof being shown. The fixed contacts **98***a* of the key switches, in this case single pole, single throw switches, are connected by wires **100***a* to the neons **58***a*.

At the output side of the neons there is a significant distinction. The neons are again connected to series resistors **48***a*, but are shunted to ground by diodes **196**, each being poled to conduct positive current to ground. The generators **28***a* are coupled by means of capacitors **198** to the junctions between the resistors **98***a* and the output diodes **34***a*.

In addition to the foregoing, a wire **200** leads from the junction **82***a* (labeled at two different points in FIG. 4 for convenience) to a pair of series connected neons **202** and **204** leading to a resistor **206**. The resistor **206** is connected to the base **208** of an n-p-n transistor **210**, the emitter **212** of which is grounded through a resistor **214**. Positive potential of +105 volts D.C. is connected through a resistor **216** to the collector **218** of the transistor, and the output is taken from the collector **218** through a diode **220** poled to conduct positive current from left to right and leading on to the gate in the output amplifier.

Normally, the keying circuit transistor **210** is biased through the neon bulbs **202** and **204** into heavy conduction during standby periods. The collector **218** therefore is at a very low voltage, and little or no voltage is transmitted through the diode **220**. However, when a key switch **88***a* is closed, the potential at junction **82***a* drops to 70 to 80 volts. This is too low a potential to maintain the series connected neon bulbs **202** and **204** in firing condition and these two bulbs therefore extinguish. The bias then changes such that the transistor **210** stops conducting, whereby substantially +105 volts is applied to the diode **220**, and this supplies the necessary positive potential to the gate in the amplifier to cause a tone to be transmitted.

As to the keying circuit, when no key switch **88***a* is closed, each capacitor **198** charges to the peak negative A.C. signal potential, since there is no D.C. return path or load on the rectifier circuit comprising the capacitor **198** and **34***a*. Thus, no output A.C. signal voltage is available to the amplifier.

Upon closing of a key switch, for example, the bottom most of the switches **88***a*, potential is applied from the point **82***a* to the adjacent neon **58***a*. This causes the neon **58***a* to fire, and also causes the diode **196** to conduct. This provides a D.C. return path for the rectifier circuit comprising the capacitor **198** and diode **34***a*, whereby positive pulses are passed by the capacitor **40***a* to the amplifier, or strictly speaking, to the divider circuits, then on to the amplifier.

When the pedal is released so that the switch **88***a* opens, the bulb **58***a* remains conducting by virtue of connection of the wires **66***a* to the junction **68***a* at about +100 volts. However, subsequent closure of another key switch drops the potential at **82***a*, providing a negative pulse across the capacitor **84***a* which drops the potential applied to the previously fired neon bulb **58***a* to cause it to extinguish. This removes the D.C. return path from the rectifier circuit of the previously played note, and the previously played note is cut off.

A practical circuit embodying the principles of the present invention as actually utilized in a commercial electronic organ is shown in FIG. 5. Certain of the parts that are shown therein are similar to those heretofore shown and described, and are identified by similar numerals with the addition of the suffix *b*. Thus, tone generators **28***b* are shown, coupled through capacitors **198***b* to a junction between resistors **48***b* and diodes **34***b*, normally biased off. The diodes are connected to a common collector line **36***b* to the junction between a shunting resistor **38***b* and a capacitor **40***b* leading to the dividers **42***b* through means including a wire **222**.

Each resistor **48***b* is connected at the top end to a shunting diode **196***b*, normally biased off, and to a neon bulb **58***b*. The neon bulb at the top end is connected to the fixed contact **98***b* of a pedal switch **88***b*, the movable contact **86***b* of which is connected to a positive bus **224**. This bus is connected through a resistor **180***b* to a supply line **226** receiving a positive 180 volts D.C. at a plug connector **229**. The supply line **226** also is connected through a resistor **228** to a bias line **230**, and a capacitor **84***b* is connected between the lines **224** and **230**.

It will be understood from what has gone before that the full complement of key switches **88***b* and associated parts is provided, there being a total of 13 switches and associated individual circuits for the organ under consideration which has 13 pedal notes, one octave of semitones plus one.

A holding circuit for the respective neons **58***b* is provided by means of a diode **231** and a paralleling resistor **233** connected from the line **230** to each neon **58***b*.

Connection is made from the line **224** to series connected neon bulbs **202***b* and **204***b*, a high value biasing resistor **232** being connected to ground from between the two neon bulbs. The neon bulb **204***b* is connected through a resistor **206***b* to the base of transistor **210***b*. Connection also is made from the resistor **206***b* through another resistor **234** to the emitter of the transistor **208***b*, the latter being grounded through a resistor **214***b*. The emitter also receives a −1 volt D.C. bias through line **236** leading to the plug **229**.

The collector is connected through resistor **216***b* to positive supply line **238** shunted to ground by capacitor **240**, and connected through resistor **242** to a source of +20 volts D.C. supplied through the plug **229**.

A further connection is made from the collector of the transistor **208***b* through a resistor **242** to the base of an n-p-n transistor **244** having the emitter thereof grounded through a resistor **246**. The collector is connected through a wire **248** to a cymbal switch of a rhythm accompaniment unit forming no particular part of the present invention, but fully shown and described in the accompanying application of Harold O. Schwartz and Peter E. Maher, "(Transistorized) Electronic Percussion Unit with Organ," Ser. No. 448,362, filed Apr. 15, 1965.

Connection further is made from the collector of the transistor **208***b* to the base of the transistor **250**. Like the remaining transistors in the circuit of FIG. 5, this is n-p-n transistor. The collector is connected direct to the line **238**, while the emitter is grounded through resistor **252**. Connection is made from the emitter through a capacitor **254** and a shunting resistor **256** to a wire **258** leading to a diode **260** which goes to a drum switch for the rhythm accompaniment device previously referred to in the Schwartz et al. application.

Connection further is made from the emitter of the

transistor **250** through diode **168***b*, paralleled by a resistor **262** to a line **264** leading through resistor **172***b* to gating line **178***b*.

A two pole double throw sustain switch **170***b* has a movable contact thereof grounded, and is engageable with a fixed contact **266** which is connected to the line **264** through a relatively low value resistor **267** or with a fixed contact **268** which is connected through a relatively high value resistor **168***b* with the wire **264**. The movable contact also can be left in a center position away from both fixed contacts.

With the switch **170***b* in the center or open position as shown sustain is on at a maximum. With the contact closed against the fixed contact **266**, there is little sustain, and with the movable switch contact closed against the fixed contact **260***b*, there is a short sustain.

The sustain line or gating line **178***b* leads across a shunting sustain capacitor **176***b* to the junction **180***b* between resistors **182***b* and **184***b*.

The output line **222** from the pedal switches leads to the base of a transistor **270**, the base being connected to ground through a resistor **272**. The emitter also is grounded through a resistor **274**, while the collector is conected through a resistor **276** to a +16 volt D.C. bus **278** receiving its potential supply from a remote source by way of the plug **229**. The collector of the transistor **270** is coupled through a capacitor **280** to an eight foot divider **110***b*. This divider comprises a pair of transistors and suitable interconnecting resistors and capacitors to form an Eccles-Jordan circuit having an output on line **282** one-half the input frequency. The divider **110***b* is coupled by a capacitor **384** to the 16-foot divider **114***b*, also comprising a transistorized Eccles-Jordan circuit having an output line **286** providing oscillations at one-half the frequency of the first divider **110***b*.

Operation of the amplifying transistor **270** is such that the input signal is amplified to the point of clipping, and thereby to limit to a consistent peak. The output of the two Eccles-Jordan divider circuits common namely **110***b* and **114***b*, is in each case a square wave. The circuits are sufficiently well-known that no particular detailed description is believed warranted.

The eight-foot divider output line **282** is connected to a diode **116***b* poled, as shown, to conduct a positive current from right to left, and the right side of the diode is connected to the junction **118***b* with the resistor **184***b*, and on through coupling capacitor **120***b* and series resistor **288** to the amplifier, including the filter circuits. A capacitor **290** shunts the junction **118***b* to ground.

Similarly, the output line **286** of the sixteen foot divider **114***b* is connected to a diode **122***b* leading to the junction **124***b* with the resistor **182**. This junction is shunted to ground by a resistor **294**, and is connected through coupling capacitor **126***b* and series resistor **296** on to the amplifier, including the filter circuits.

Operation of these circuits is similar to that of the circuits heretofore shown and described. Considering first one of the key switches **88***b* and associated parts, when the organ is first turned on the potential on the line **230** acts through one of the diodes **231** to turn on a neon bulb **58***b*. This is at random, and it is the neon bulb **58***b* with the lowest firing potential that normally comes on. Current through the resistor **228** drops the potential on line **230** sufficiently low that no other neons **58***b* are ignited after the first one. There is no output since the signal is blocked at diodes **116***b* and **122***b*.

It will be appreciated that the leakage across any pedal switch **88***b* could be on the order of magnitude of 5–10 megohms whereby a corresponding neon bulb **58***b* might accidentally be fired. This is prevented by resistor **233** which acts as a voltage divider with the switch leakage resistance. A diode **231** allows a holding voltage of about 65–70 volts to be applied to the previously ignited neon bulb **58***b* to maintain it ignited, while still providing isolation from line **230** to line **224**. As in the embodiment of FIG. 4, when a neon bulb **58***b* is not conducting, there is no return path for the rectifier comprising capacitor **198***b* and diode **98***a*. Hence, the capacitor **198***b* simply charges up, and no signal is carried. However, when a switch **88***b* is closed, approximately 150 volts positive potential is applied from the line **224** to the corresponding neon **58***b* thereby to fire it and to render the diode **196***b* conductive. A return path is provided and the diode **34***b* conducts to provide output signals on the line **36***b*, and subsequently on the line **222**.

When any subsequent key switch **82***b* is closed, the potential on the line **224** drops, applying a pulse through capacitor **84***b* and extinguishing previously ignited neon **58***b*.

The neons **202***b* and **204***b* come on when the organist turns on and biases the transistor **208***b* for heavy conduction, and this holds transistor **250** off. When a key switch is closed, the current drawn through the resistor **80***b* causes the potential on the line **224** to drop to a point where the two neons **202***b*, **204***b* cannot remain ignited in series. Upon this occurring, the transistor **208***b* turns off, and the transistor **250** turns on. Output potential through the diode **166***b* thereby is applied through the line **178***b* to turn on the diodes **116***b* and **122***b* and thereby to allow the divided signal from the eight and six foot dividers **110***b* and **114***b* to go through the output circuits to the amplifier.

Although those skilled in the art will have no difficulty in choosing proper circuit values, the following are set forth by way of example:

C40—.01 mfd.	R140—12K ohms
C40*b*—.02 mfd.	R144—390K ohms
C52—2 mfd.	R150—8.2K ohms
C84—.1 mfd.	R162—680 ohms
C84*a*—.015 mfd.	R164—470 ohms
C84*b*—.01 mfd.	R168—4.7K ohms
C108—5 mfd.	R172—1470 ohms
C120—.01 mfd.	R172*b*—1K ohms
C120*b*—.047 mfd.	R180—100K ohms
C126—.01 mfd.	R180*b*—270K ohms
C126*b*—.047 mfd.	R182—100K ohms
C176—5 mfd.	R182*b*—56K ohms
C198—.0047 mfd.	R184—100K ohms
C240—100 mfd.	R184*b*—56K ohms
C254—2 mfd.	R186—27K ohms
C280—.0056 mfd.	R194—470K ohms
C290—.015 mfd.	R206—390K ohms
C294—.047 mfd.	R206*b*—1 mohms
R30—100K ohms	R214—470 ohms
R38—22K ohms	R216—22K ohms
R38*b*—100K ohms	R228—270K ohms
R48*b*—10K ohms	R232—10 mohms
R48*b*—22K ohms	R233—1.5 mohms
R54—10K ohms	R234—47K ohms
R62—47K ohms	R242—100K ohms
R72—22K ohms	R246—68 ohms
R72*a*—33K ohms	R252—15K ohms
R76—68K ohms	R256—4.7K ohms
R76*a*—56K ohms	R262—220K ohms
R78—130K ohms	R272—10K ohms
R78*a*—120K ohms	R274—100 ohms
R80—150K ohms	R276—10K ohms
R80*a*—33K ohms	R288—27K ohms
R128—39K ohms	R296—27K ohms

The invention is claimed as follows:

1. A switching circuit for an electronic musical instrument comprising a plurality of signal input means, signal output means, voltage supply means providing a first voltage sufficient to fire a gas tube and a second voltage sufficient to maintain a gas tube in firing condition but not sufficient to start firing thereof, a plurality of like means respectively interconnetcing said plurality of signal input means and said signal output means, each of said connecting means including a normally non-conduct-

ing electronic switch in series between a signal input means and said signal output means and a normally non-conducting gas tube connected to a respective electronic switch, means including a plurality of key switch means interconnecting said voltage supply means first voltage and said gas tubes for selectively firing said gas tubes, a gas tube when firing rendering a corresponding electronic switch conductive to convey a singal from a respective signal input means to said signal output means, means interconnecting said voltage supply means second voltage with said gas tubes to maintain a firing tube in firing condition, and means interconnecting said key switch means and said voltage supply source second voltage to lower said second voltage upon operation of a subsequent key switch to extinguish a previously fired gas tube.

2. A switching circuit for an electronic musical instrument comprising a plurality of signal input means, signal output means, voltage supply means providing a first voltage sufficient to fire a gas tube and a second voltage sufficient to maintain a gas tube in firing condition but not sufficient to start firing thereof, a plurality of like means respectively interconnecting said plurality of signal input means and said signal output means, each of said connecting means including a normally non-conducting diode in series between a signal input means and said signal output means and a normally non-conducting gas tube connected to a respective diode, means including a plurality of key switch means interconnecting said voltage supply means first voltage and said gas tubes for selectively firing said gas tubes, a gas tube when firing rendering a corresponding diode conductive to convey a signal from a respective signal input means to said signal output means, means interconnecting said voltage supply means second voltage with said gas tubes to maintain a firing tube in firing condition, and means interconnecting said key switch means and said voltage supply source second voltage to lower said second voltage upon operation of a subsequent key switch to extinguish a previously fired gas tube.

3. A switching circuit as set forth in claim 2 wherein said voltage supply means comprises a potential source and a voltage divider, said first and second voltages being taken at different points on said divider.

4. A switching circuit as set forth in claim 3 wherein the means for lowering said second voltage is effective only momentarily to lower said second voltage.

5. A switching circuit for an electronic musical instrument comprising a plurality of signal input means, signal output means, voltage supply means providing a first voltage sufficient to fire a gas tube and a second voltage sufficient to maintain a gas tube in firing condition but not sufficient to start firing thereof, a plurality of like means respectively interconnecting said plurality of signal input means and said signal output means, each of said connecting means including a normally non-conducting diode in series between a signal input means and said signal output means and a normally non-conducting gas tube connected to a respective diode, means including a plurality of key switch means interconnecting said voltage supply means first voltage and said gas tubes for selectively firing said gas tubes, a gas tube when firing rendering a corresponding diode conductive to convey a signal from a respective signal input means to said signal output means, means interconnecting said voltage supply means second voltage with said gas tubes to maintain a firing tube in firing condition, means interconnecting said key switch means and said voltage supply source second voltage to lower said second voltage upon operation of a subsequent key switch to extinguish a previously fired gas tube, said signal output means including normally closed electronic gate means, and means interconnecting said key switch means and said normally closed electronic gate means for opening said gate means upon closure of a key switch means.

6. A switching circuit as set forth in claim 5 wherein the means interconnecting the gate means and the key switch means comprises an additional set of contacts on each key switch means.

7. A switching circuit as set forth in claim 5 wherein the means interconnecting the gate means and the key switch means comprises gas tube means normally conducting to bias said gate means off, and means interconnecting said key switch means and said gas tube means for extinguishing said gas tube means upon closure of any of said key switch means.

8. A switching circuit for an electronic musical instrument comprising a plurality of signal input means, signal output means, voltage supply means comprising a voltage supply means having a first voltage output sufficient to fire a gas tube and a second voltage output sufficient to maintain a gas tube in firing condition but not sufficient to start firing thereof, a plurality of like means respectively interconnecting said plurality of signal input means and said signal output means, each of said connecting means including a normally non-conducting electronic switch in series between a signal input means and said signal output means and a normally non-conducting gas tube connected to a respective electronic switch, means including a common resistor and a plurality of key switch means interconnecting said voltage supply means first voltage output and said gas tubes for selectively firing said gas tubes upon closure of a respective key switch means, a gas tube when firing rendering a corresponding electronic switch conductive to convey a signal from a signal input means to said signal output means, means interconnecting said voltage supply means second voltage output with said gas tubes to maintain a firing tube in firing condition, and a capacitor connected from said common resistor to said second voltage output on said voltage supply means for momentarily dropping said second voltage upon operation of a subsequent key switch to extinguish a previously fired gas tube.

9. A switching circuit for an electronic musical instrument comprising a plurality of signal input means, signal output means, voltage supply means comprising a voltage divider having a first voltage output sufficient to fire a gas tube and a second voltage output sufficient to maintain a gas tube in firing condition but not sufficient to start firing thereof, a plurality of like means respectively interconnecting said plurality of signal input means and said signal output means, each of said connecting means including a normally non-conducting electronic switch in series between a singal input means and said signal output means and a normally non-conducting gas tube connected to a respective electronic switch, means including a common resistor and a plurality of key switch means interconnecting said voltage divider first voltage output and said gas tubes for selectively firing said gas tubes upon closure of a respective key switch means, a gas tube when firing rendering a corresponding electronic switch conductive to convey a signal from a signal input means to said signal output means, means interconnecting said voltage divider second voltage output with said gas tubes to maintain a firing tube in firing condition, and a capacitor connected from said common resistor to said second voltage output on said voltage divider for momentarily dropping said second voltage upon operation of a subsequent key switch to extinguish a previously fired gas tube.

10. A switching circuit as set forth in claim 9 wherein said signal output means comprises a normally closed electronic gate, and means interconnecting said gate and said key switch means for opening said gate upon closure of any of said key switch means.

11. A switching circuit as set forth in claim 10 wherein the means interconnecting said gate and said key switch means includes a second set of contacts on each of said key switch means.

12. A switching circuit as set forth in claim 9 wherein the means interconnecting said electronic gate and said

key switch means comprises gas tube means biased through said common resistor to firing condition and biasing said gate off, the voltage supplied through said first resistor to said gas tube means dropping upon closure of any key switch means to extinguish said gas tube means for biasing said electronic gate on.

13. A switching circuit for an electronic musical instrument comprising a plurality of signal input means, signal output means, a plurality of like means respectively interconnecting said plurality of said signal input means and said signal output means, each of said interconnecting means including a normally non-conducting electronic switch in series between a signal input means and said signal output means and a normally non-conducting gas tube connected to a respective electronic switch, a plurality of key switch means each comprising a first set of means, means including said first set of contacts connecting said voltage supply means and said gas tubes respectively for selectively firing said gas tubes, a gas tube when firing rendering a corresponding electronic switch conductive to convey a signal from a signal input means to said signal output means, means interconnecting said voltage supply means and said gas tubes for supplying to said gas tubes a voltage sufficient to maintain firing but not sufficient to start firing thereof, means interconnecting said voltage supply means and said last mentioned connecting means for lowering the potential supplied to said gas tubes to extinguish any previously fired tube upon closure of a corresponding set of first contacts, said signal output means including a normally closed electronic gate, an additional voltage source, and means including said second contacts interconnecting said additional voltage source and said electronic gate for opening said gate upon closure of any of said second contacts.

14. A switching circuit for an electronic musical instrument comprising a plurality of signal input means, signal output means, means including a plurality of key switch means interconnecting said signal input means and said signal output means and selectively operable to connect a respective signal input means to said signal output means, said signal output means including normally closed electronic gate means, voltage supply means, means for controlling the operation of said electronic gate means and interconnected therewith and comprising gas tube means, means interconnecting said voltage supply and said gas tube means for normally maintaining said gas tube means in a first condition of conduction or non-conduction, means interconnecting said voltage supply, said key switch means and said gas tube means and operative upon closure of a key switch means to reverse the condition of conduction or non-conduction of said gas tube means and thus to bias said electronic gate open, and a normally conducting transistor interconnecting said gas tube means and said electronic gate to bias said gate closed, said transistor being cut off and biasing said gate open when the condition of conduction of said gas tube means reverses.

15. A switching circuit as set forth in claim 14 and further including a diode interconnecting said transistor and said electronic gate, said diode being normally cut off by conduction of said transistor and being biased for conduction upon stopping of conduction of said transistor and thereupon biasing said electronic gate for conduction.

16. A switching circuit for an electronic musical instrument comprising a plurality of signal input means, signal output means, a plurality of like means respectively interconnecting said plurality of signal input means and said signal output means, each of said interconnecting means including a rectifier circuit normally having a return path including a normally non-conducting electrically controlled circuit element and hence effective to block signal transmission from said signal input means to said signal output means, and means including a plurality of key switch means respectively connected to said rectifier means and to said circuit element and a potential means to render said circuit element conductive upon operation of said key switch means and thereby providing a return path for said rectifier means to render said rectifier means effective to transmit a signal from a respective signal input means to said signal output means.

17. A switching circuit as set forth in claim 16 wherein each rectifier means comprises a capacitor connected to the respective signal input means and a series connected diode, and wherein the means for providing a return path further includes a shunt diode connected from a position between said capacitor and said series connected diode to ground and normally non-conducting, said shunt diode being rendered conductive upon operation of a corresponding key switch to provide a return path.

18. A switching circuit for an electronic musical instrument comprising a plurality of signal input means, signal output means, voltage supply means providing a first voltage sufficient to fire a gas tube and a second voltage sufficient to maintain a gas tube in firing condition but not sufficient to start firing thereof, a plurality of like means respectively interconnecting said plurality of signal input means and said signal output means, each of said connecting means including a normally non-conducting diode in series between a signal input means and said signal output means and a normally non-conducting gas tube connected to a respective diode, means including a plurality of key switch means interconnecting said voltage supply means first voltage and said gas tubes for selectively firing said gas tubes, a gas tube when firing rendering a corresponding diode conductive to convey a signal from a respective signal input means to said signal output means, means interconnecting said voltage supply means second voltage with said gas tubes to maintain a firing tube in firing condition, means interconnecting said key switch means and said voltage supply source second voltage to lower said second voltage upon operation of a subsequent key switch to extinguish a previously fired gas tube, said series input means including a capacitor connected in series with said diode, and a second diode connected from the previously mentioned diode and adjacent gas tube to ground, said second diode being normally nonconductive and rendered conductive upon firing of a corresponding gas tube to provide a D.C. return circuit for the rectifier comprising said capacitor and said first mentioned diode.

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84—1.03, 1.26

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,422,208 January 14, 1969

Robert D. Barry

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 41, "39" should read -- 38 --. Column 11, lines 16 and 17, after "set" insert -- contacts and a second set of contacts, voltage supply --; line 59, claim reference numeral "15" should read -- 14 --.

Signed and sealed this 17th day of March 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents