

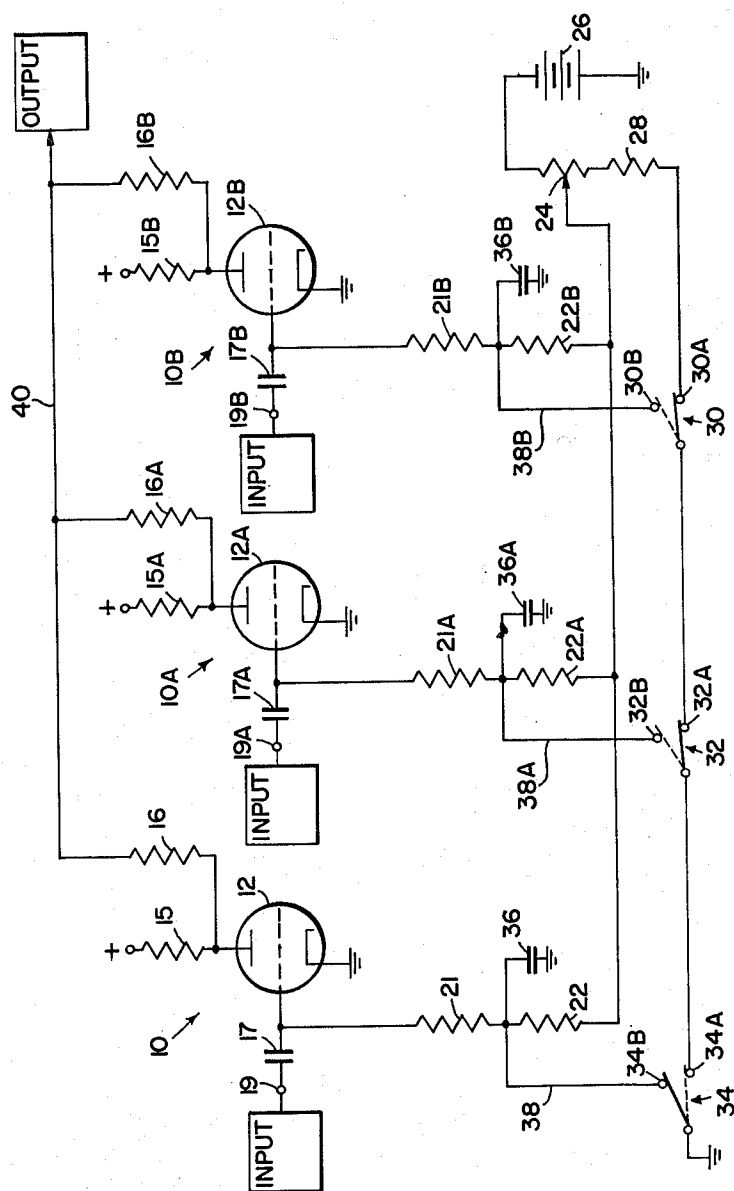
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PERCUSSION CIRCUIT FOR ELECTRONIC ORGANS

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ATTORNEYS

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PERCUSSION CIRCUIT FOR ELECTRONIC
ORGANS

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This invention pertains generally to electronic organs
and particularly to control circuits for percussive ampli-
fiers used in such instruments.

A percussive amplifier, as the term is presently used in
the electronic organ art, is a special type of amplifier
utilizing an electron discharge tube, the amplification of
the tube being variable to simulate electrically the fast
attack and slow decay of notes produced by various musical
instruments. In quality organs, it is customary to
provide a separate percussive amplifier for each note of
the musical scale, so that selected notes may be amplified
percussively in accordance with the musical score being
played.

A type of percussive amplifier which may, for present
purposes, be taken as a typical example of the circuitry
heretofore known is shown in the patent to George H.
Hadden and the inventor hereof entitled Electronic Organ,
U.S. Patent No. 3,006,229, issued on October 31,
1961. In the cited application, a plurality of similar ampli-
fiers is shown, each having a triode normally biased be-
yond cutoff. A keying circuit is provided whereby the bias-
ing voltage on any selected one of the triodes may be inde-
pendently changed to have the output of the selected tri-
ode simulate the fast attack and slow decay of a musical
note. A separate capacitor in each biasing circuit is con-
trolled by the keying circuit to accomplish such an end.
Briefly, the keying circuit is so arranged that the appro-
priate capacitor is quickly discharged to "turn on" a tri-
ode and slowly charged to "turn off" the triode, the in-
stantaneous voltage on the capacitor being proportional
to the biasing voltage on the triode.

Circuits shown in the prior art (as the circuit just dis-
cussed) have proven quite satisfactory when controlled by
manual keyboards. However, when it is desired to use
a pedal keyboard to control percussive amplification, it
must be recognized that the relatively unskilled organist
often and mistakenly will actuate more than one key
simultaneously and at the low frequencies of the pedal
keyboard an unpleasant sound results. Even a relatively
skilled organist who is careful to play only one note at a
time may, if a second note is required to be percussively
amplified, play such a second note before the first has
fully died out, likewise producing an unpleasant sound.
Attempted solutions for this problem have involved either
the use of a complicated mechanical latching system to
disconnect the signal from all circuits except the last
played, or circuitry for percussive amplifiers controlled
by a pedal keyboard in which the sustain period of any
note is very short. The former expedient is expensive and
susceptible to difficulty in use, while the latter expedient
minimizes unpleasant effects but loses most of the desired
percussive effect.

Therefore, it is a primary object of this invention to
provide a circuit for use in conjunction with the pedal
keyboard of an electronic organ to obtain a percussive
effect of a single note being played at any time without
running any risk of there being other notes decaying dur-
ing the identical time.

It is another object of the invention to provide a con-
trol circuit for a plurality of percussive amplifiers by
which amplification by the amplifier amplifying the lowest
note is automatically preferred.

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Still another object of the invention is to provide a con-
trol circuit for a plurality of percussive amplifiers by
means of which the keying circuit of a given amplifier
may be overridden at any time when it is desired to am-
plify a different note.

In the accomplishment of these and other objects of
my invention, I have provided a plurality of percussive
amplifiers, each having a triode as its active element. To
control the triodes, I also provide means normally bias-
ing each of the triodes beyond cutoff and a similar plural-
ity of switches, the switches being arranged selectively to
change the bias on each triode to put each in condition
for amplifying a signal, and to make it almost impossible
for any other triode simultaneously to be put in condi-
tion for amplifying. In addition, actuation of any one of
the switches also shortens the sustain of any amplifier
except the one associated with the actuated switch so that
different notes may be amplified in close succession with-
out the sustain of a previously played note blending with
the note being played to produce an unpleasant result.

Further objects and features of my invention will best
be understood and appreciated from a detailed descrip-
tion of a preferred embodiment thereof selected for pur-
poses of illustration and shown in the accompanying
drawing in which:

The single FIGURE is a schematic diagram of a per-
cussive amplifier circuit contemplated by my invention
showing percussive amplifiers in an electronic organ.

Before considering the drawing in detail it should be
noted that I have elected to show only three percussive
amplifiers, it being understood that a much greater num-
ber of similar percussive amplifiers would be incorporated
in an electronic organ for use in performing musical selec-
tions. It should also be noted that I have elected to show
the circuit in a schematic form since standard elements
for the amplifiers which are well known in the art are
used. The single figure shows three percussive ampli-
fiers 10, 10A, 10B. Since these amplifiers are basically
similar, only amplifier 10 will be described in detail.
Amplifier 10 consists of an electron tube 12 (as one-half
of a 12AX7 type tube) having its cathode electrode
grounded, or connected to a reference point, and its anode
electrode connected through a resistor 15 to a source of
positive potential, say 300 volts D.C. The anode elec-
trode is also connected through a resistor 16 to an output
bus 40 as shown. The signal to be amplified is im-
pressed on the grid electrode of the electron tube 12
through a coupling capacitor 17 and a terminal 19. A
biasing voltage is also applied to the control grid electrode
of the electron tube 12 through a resistor 21, serially con-
nected through a resistor 22 to the movable arm of a
potentiometer 24. One fixed terminal of the potentiom-
eter 24 is connected to the negative side of a biasing volt-
age source 26. The second side of the biasing source 26
is connected to ground, or to a common reference point as
shown in the lower right hand side of the single figure.
The second fixed terminal of the potentiometer 24 is con-
nected serially through a limiting resistor 28 and a num-
ber of keying switches 30, 32, 34 to ground, or to the
common reference point as shown at the bottom left hand
side of the single figure. In passing it should be noted
that the reference point just mentioned may be the cath-
ode electrodes of the tubes in the various amplifiers 10,
10A, 10B. However, whether the reference point is the
cathode electrode of the tube or the chassis on which the
tube is mounted, it will be seen that a negative potential
is impressed between the cathode electrode and the con-
trol grid electrode of the electron tube 12. By adjust-
ment of the movable contact of the potentiometer 24, the
exact potential between the control grid electrode and the
cathode electrode may be varied when all the switches

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30, 32, 34 are in their "A" position. This potential is kept greater than the cutoff voltage of the electron tubes, so that none of the tubes may conduct, regardless of the amplitude of the input signal impressed on terminal 19. A capacitor 36 is connected between the common reference point and the junction of resistors 21, 22. Also connected to the junction of resistors 21, 22 in amplifier 10 is a lead 38 connecting the junction of the resistors 21, 22 with one terminal of the switch 34, as shown. When the switch 34 is moved so that a connection is made between the junctions of the resistors 21, 22 and the common reference point, it may be seen that the charge on the capacitor 36 passes through lead 38 to the common reference point and capacitor 36 is almost instantaneously discharged. Such a discharge in turn causes the voltage at the bottom of resistor 21 to rise almost instantaneously above the cutoff bias voltage of electron tube 10 to allow amplification of a signal impressed on terminal 19, whereby the fast attack of a note is simulated. When the switch 34 is moved back to its original position, capacitor 36 starts to charge exponentially toward the voltage of the movable contact of the potentiometer 24. The time constant for this charging is, in a practical circuit, determined largely by the value of the resistor 22 and capacitor 36. Therefore, the time taken for the capacitor 36 to reach the potential of the movable contact of the potentiometer 26 may be considered to be invariable. However, the time taken for the voltage at the junction of resistors 21, 22 to reach the cutoff voltage of the electron tube 12 is variable depending upon the voltage at the movable contact of the potentiometer 26. Consequently, the time electron tube 12 conducts after switch 34 is moved back into its original position may be varied by setting the movable arm of potentiometer 26 as desired, whereby the slow decay of notes produced by various musical instruments may be simulated.

The interlocking features of switches 30, 32, and 34 may now clearly be seen. If it be assumed first that all the switches are in their "A" position; that is, switch 30 is in position 30A, switch 32 is in position 32A and switch 34 is in position 34A, then all the amplifiers are biased beyond cutoff and it is impossible for any of them to pass a signal. If switch 34 is placed in position 34B, then amplifier 10 will pass a signal as has been described. If then switch 32 is placed in position 32B, it will be observed that the circuit from the junction of the resistors 21A, 22A, in amplifier 10A to the reference point is not completed because switch 34 is in position 34B. Therefore, under those conditions operation of switch 32 has absolutely no effect on amplifier 10A, that amplifier remaining in a nonconductive state. If, on the other hand, switch 34 is returned to position 34A, and switch 32 is moved to position 32B, then the capacitor 36A in amplifier 10A will be connected directly to ground, or the common reference point and will discharge, thus placing amplifier 10A in a conductive state.

It should be noted here that, if any one of the switches 30, 32, or 34 is in its "B" position or is open, then the voltage at the movable arm of the potentiometer 24 is essentially the same as the full voltage of the biasing source 26 (since the value of resistors 22, 22A, and 22B is very large their effect in the reduction of the voltage is so slight that it may be disregarded). This is of particular interest when one amplifier, say 10A, is being operated and it is desired to change quickly to operation of another amplifier, say amplifier 10, and in doing so quickly to terminate the amplification of amplifier 10A without permitting it to continue throughout its normal decay time. Thus, assume switch 32 to be in its "B" position so that amplifier 10A is operating. Switch 32 may then be returned to its "A" position and switch 34 moved to its "B" position almost simultaneously or even in the reverse order. Since one of the switches is in its "B" position, capacitor 36A starts effectively to charge toward the full voltage of the biasing source 26, regardless of the

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setting of the movable contact of potentiometer 24. This means then that the time taken for the bias voltage on electron tube 12A to reach cutoff is independent, in this case, of the setting of the movable contact of potentiometer 26 and is, in fact, reduced to a minimum.

It may be thought that the circuit just described has basic shortcomings which would make it impractical for use in an electronic organ. For example, it would appear that the movement of any switch from its "B" position back to its "A" position to initiate percussive amplification would also be operative to cut off the electron tube controlled by the switch for the reasons given in the preceding paragraph. However, it has been found that the voltage on the associated capacitor cannot, in normal operation, change appreciably during the short period of time required to move any switch from its "B" position to its "A" position. Therefore, this apparent shortcoming is of little concern. A different apparent shortcoming is the fact that it appears possible, under certain conditions, to initiate the sustain period of two notes almost simultaneously. Thus, two switches may be moved simultaneously to their "B" positions and then returned in rapid succession to their "A" positions, so that the bias voltages on the electron tubes controlled by the so-actuated switches are above cutoff. However, in order that such a condition exist, it is necessary to return the switches to their "A" positions in a particular order. For example, if switches 32 and 34 are the two switches being moved, switch 34 must be returned to its "A" position before switch 32. Obviously then, since two particular operations, neither of which alone would ordinarily occur are required to have the bias voltage on two electron tubes simultaneously above cutoff, the probability of the two occurring in the required order is very small. Furthermore, even if the two electron tubes are by chance, operated as just described, the audible effect of such operation is of relatively short duration. Therefore, even this second apparent shortcoming is of but little concern in a practical circuit.

In view of the many modifications and variations to my invention which may be made without departing from my inventive concepts, the invention should not be limited to the circuit specifically described, but rather should be limited only by the spirit and scope of the appended claims.

I claim:

1. In an electronic organ an output circuit, a plurality of percussive amplifiers comprising a similar plurality of electron discharge tubes for amplifying the percussive notes of said organ, means for separately applying a signal to be amplified to each one of said plurality of electron tubes, means for coupling the output of each one of said electron tubes to said output circuit, biasing means for biasing normally to cutoff each one of said plurality of electron tubes, switching means coupled to said tubes and said biasing means operable to remove cutoff bias on any of said tubes corresponding to a note played, said switching means operable on release of any played note for gradually restoring cutoff bias to the tube corresponding to said played note, and circuit means coupled to said switching means operable for any note played to decrease the time required to restore cutoff bias to any tube corresponding to another note.

2. In an electronic organ, a plurality of percussive amplifiers as in claim 1 wherein said biasing means consists of a source of biasing voltage having a first terminal and a second terminal side, a common resistor connecting said first terminal through separate isolating resistors to each one of said electron tubes to cut off each one of said electron tubes, a similar plurality of switching means serially connected to join said common resistor to said terminal, a similar plurality of capacitors, individual ones of said plurality of capacitors being connected on one side to a point on said isolating resistors, the second side of each one of said plurality of capacitors being

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connected to said second terminal, and means connecting said one side of said plurality of capacitors to a respective one of said plurality of switching means to connect said one side to said second terminal when the respective switch is actuated while simultaneously interrupting the circuit connecting said common resistor to said second terminal.

3. In an electronic organ a plurality of percussive amplifiers as in claim 2 wherein said common resistor is a potentiometer and said isolating resistors are connected to an adjustable point on said potentiometer.

4. A biasing and control circuit for electron tubes in a plurality of percussive amplifiers which is adapted normally to maintain each one of said plurality of amplifiers in a cutoff condition and to allow a single selected one of said plurality of percussive amplifiers to pass an electric signal simulating the fast attack and slow decay of a note produced by a musical instrument comprising, a source of biasing voltage having a first and a second terminal, a plurality of first and second resistors, a potentiometer connected at one end to said first terminal, means serially and separately connecting said plurality and first and said second resistors between a point on said potentiometer and a first electrode of each one of said electron tubes, means connecting a second electrode of each one of said electron tubes to said second terminal, a similar plurality of single pole-double throw switches, means serially connecting said similar plurality of single pole-double throw switches between said second terminal and the other end of said potentiometer whereby when each one of said similar plurality of switches are in similar positions a first lower biasing voltage from said source of biasing voltage is impressed on corresponding electrodes of said electron tubes to maintain each of said electron tubes in a cutoff condition, a similar plurality of similar capacitors, means connecting a different one of said similar plurality of similar capacitors between the junction of a different one of said plurality of first and second resistors and said second terminal, and means separately connecting each one of the junctions to a single second contact in said single pole-double throw switches whereby the biasing voltage on a single selected one of said electron tubes may be changed by operation of a selected one of said single pole-double throw switches to place said single selected one of said electron tubes in a conductive state and return of said single pole-double throw switch to its original position causes said selected one of said electron tubes to return to its non-conductive state in accordance with the rate of charging of its associated capacitor toward said first lower biasing voltage.

5. A biasing and control circuit as in claim 4 wherein said point on said potentiometer is adjustable.

6. A keying circuit to interlock a plurality of percussive amplifiers, each one of said amplifiers having an electron

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discharge tube, comprising biasing means for each said electron discharge tube normally to hold each beyond cutoff, and switching means cooperating with said biasing means selectively to change the bias voltage on a single one of the electron discharge tubes to allow said single one to pass a signal and simultaneously to hasten the return of cutoff bias to any other said electron tube previously operated.

7. A keying circuit as in claim 6 wherein said switching means comprises a similar plurality of switches, each of said switches having a first and a second position, and said biasing means comprises a source of bias voltage having the first terminal of a potentiometer connected to one side thereof, a first electrode of each one of said electron discharge tubes being connected to the movable tap of said potentiometer through separate isolating resistors, the second side of said potentiometer being connected serially through said first position of said switches to the second side of said source of bias voltage to complete a first electrical circuit whereby each one of the first electrodes are held at the potential of said movable tap to cutoff said electron discharge tubes, the second position of each one of said switches being connected to separate ones of said first electrodes whereby movement of any selected one of said switches to its second position breaks said first electrical circuit and completes a second electrical circuit wherein the voltage on the first electrode of the electron discharge tube associated with such selected one of said switches approaches the voltage at said second side of said source of bias voltage and the voltage at the first electrode of each one of the remaining electron discharge tubes approaches the voltage at said first side of said source of bias voltage.

8. A percussion circuit for predetermined notes of an electronic organ comprising, a separate amplifier for each of said notes, means for normally biasing each said amplifier to cutoff, keying means connected to the biasing means and operable individually for selectively removing the bias of said amplifiers to play one said note at a time, delay means for each of said amplifiers operative gradually to restore the cutoff bias after a note is played and following the release of said keying means, and means connected to each said amplifier biasing means responsive to the selection of another note by said keying means for more rapidly restoring said cutoff bias.

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