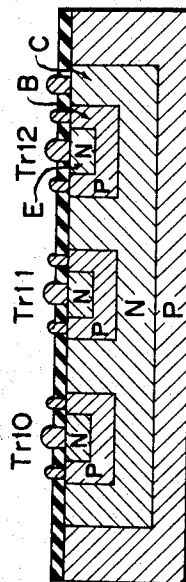


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**INTEGRATED CIRCUIT SWITCHING DEVICE
FOR ELECTRONIC MUSICAL INSTRUMENTS**
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4 Claims

ABSTRACT OF THE DISCLOSURE

The switching device supplies signals of different footages produced by tone generators simultaneously to a tone coloring circuit in an electronic musical instrument. The switching device preferably is fabricated as an integrated circuit and includes transistors connected in an emitter follower, whose bases each receives each said signal and whose emitters have a common capacitor. The capacitor is connected in parallel with switching means responsive to the operation of keys. Each of said emitters is connected to an input terminal of the tone coloring circuit.

BACKGROUND OF THE INVENTION

This invention relates to a switching device used in an electronic musical instrument, which is capable of simultaneously switching a plurality of signals of different footages by the switching action of a single switch.

In an electronic musical instrument, a plurality of signals having different footages are generally selectively extracted or composed in response to the operation of a single stopper key to be suitably transmitted to a tone coloring circuit for tone coloring, whereby a tone signal corresponding to the operated key is obtained. The keys are associated with a plurality of switches which correspond to signals of different footages to switch a supply of the respective signals into the tone coloring circuit. By operating the keyboard, said plurality of switches are controlled to be simultaneously switched. Switch control of the switches must be precisely carried out to obtain stable note signals. It is also desired that the switch assembly be fabricated to be as small and simple as possible.

SUMMARY OF THE INVENTION

The invention contemplates not only satisfying the requirements in a switching device of the tone generator circuit, but also simultaneously controlling a plurality of signals of different footages by a single switch common to all keys which are operated to produce a single sound one at a time as in the keys of a pedal keyboard.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows a circuit diagram showing a switching circuit of the present invention connected with a frequency dividing circuit of a tone generator used in an electronic musical instrument, and

FIG. 2 is a cross section of a semiconductor substrate integrating three transistors and embodying the switching device of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The circuit diagram shown in the FIG. 1 shows a switching circuit 12 which corresponds to a pedal keyboard and a tone generator circuit which comprises a pulse shaping circuit 10 and a dividing circuit 11. The pulse shaping-circuit 10 shapes a signal transmitted from an oscillator circuit (not shown) of the tone generator into a predetermined pulse signal, as is generally employed in the art.

An output from the circuit 10 is supplied to the frequency submultiplication circuit 11 comprising a cascade connection of three bistable multivibrators 13, 14 and 15. Namely, the input terminal of the first bistable multivibrator 13 formed of transistors Tr_4 and Tr_5 is connected to the collector of a transistor Tr_3 of the pulse shaping circuit 10, and its output terminal is connected to the input terminal of the second multivibrator 14 whose output terminal is in turn connected to the input terminal of the third multivibrator 15. As a result, the frequencies of the output signals from the first multivibrator, the second multivibrator and the third multivibrator are $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{8}$ of the frequency of the signal from the pulse shaping circuit 10, respectively. Various methods well known in the art may be employed as a dividing circuit, other than the one using bistable multivibrators as described above.

The output terminals of said multivibrators 13, 14 and 15 are connected respectively to the base terminals of NPN-type transistors Tr_{10} , Tr_{11} and Tr_{12} via diodes D_1 , D_2 and D_3 connected in the forward direction. In this case, a 4-foot signal, and an 8-foot signal and a 16-foot signal from the dividing circuit are respectively supplied to the transistors Tr_{10} , Tr_{11} and Tr_{12} . The collectors of said transistors are commonly connected and are in turn connected to a line of a positive DC voltage, while the emitters thereof are connected respectively through resistors R_1 , R_2 and R_3 , and connected through a common capacitor C to a ground line, so that the transistors are connected in an emitter follower. Although the transistors Tr_{10} , Tr_{11} and Tr_{12} are of NPN-type, PNP-type transistors may be used by reversing the polarity of the power supply. Each of the emitters of the transistors Tr_{10} , Tr_{11} and Tr_{12} is connected to input terminal of a tone coloring circuit (not shown) in a predetermined relationship therewith as is apparent to those skilled in the art. A switch S is connected in parallel with said capacitor C via a resistor R. Said switch S operates its switching action common to all pedal keys, not shown, of an electronic musical instrument. In other words, the switch is in its on positive DC line through a resistor R_4 and a variable resistor R_5 , so that when the switch S is in the off position the capacitor C is charged to the positive DC potential or a collector potential. Said variable resistor R_5 is provided to control the sustaining operation, but may be omitted.

An example of the switching device according to this invention composed of a semiconductor integrated circuit is as follows. As shown in FIG. 2, an N-type collector region C common to three transistors Tr_{10} , Tr_{11} and Tr_{12} is formed in a P-type silicon substrate, and three base regions B each consisting of three P-type layers are formed in said collector region. Further an emitter region E consisting of an N-type layer is formed in each of said base regions. The above-mentioned formation of regions is executed by a usual diffusion process.

The semiconductor device as described above makes it possible to compactly integrate a plurality of transistors, since one collector has only to be used commonly to said transistors and hence no isolation between each of collectors thereof is required as in the usual case. First, transistor elements Tr_{10} , Tr_{11} and Tr_{12} are formed, with a usual diffusion process, by forming P-type base layers and N-type emitter layers, each collector connected in an N-type silicon substrate defining a common collector layer. Diodes D_1 , D_2 and D_3 , and resistance elements R_1 , R_2 and R_3 are formed in said substrate and interconnected from one another by a well known process.

The switching circuit in the form of an integrated circuit makes it possible to easily form transistor elements and diodes of equal property, so that the device can be arranged in high precision.

In the switching circuit of the construction described above, when a foot-operated key is out of operation i.e.

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the switch S is open, the capacitor C is charged up to the collector potential through the resistors R₄ and R₅, and as a result the base-emitter junction of each of the transistors Tr₁₀ to Tr₁₂ tends to be impressed by a reverse bias, so that the transistors Tr₁₀ to Tr₁₂ all maintain the value of the output signal at zero. The transistors Tr₁₀ to Tr₁₂ are, however, protected by diodes D₁ to D₃ inserted into the base circuit. These diodes will not be necessary if the intensity of the reverse bias breakdown voltage between the base and emitter of transistors used is sufficiently large.

When the key is operated, the switch S is closed to discharge the capacitor C. This discharge causes the emitter potential of each of the transistors Tr₁₀ to Tr₁₂ to be lowered and each of the transistors Tr₁₀ to Tr₁₂ is set in an operative state. Under this state, the signal from the multivibrator 13, for example, is fed to the base of the first transistor Tr₁₀ and derived from the emitter of said first transistor Tr₁₀ to be supplied to the input terminal of the tone coloring circuit.

According to this invention, the arrangement of switching means is very simple as a switching circuit, so that it is not only possible to simplify the construction of a keyboard, but also possible to cause the switching circuit to have high input impedance, thereby keeping a loss of signal in minimum, with the result that predetermined tone signals responsive to the operation of the keyboard can be effectively produced so that the electronic musical instrument can be operated stably. A single common capacitor is sufficient for properly operating a plurality of signal switching sections used in combination, so that the arrangement of the circuit is greatly simplified and may be integrated to permit the circuit to be more miniaturized.

What is claimed is:

1. A switching device of a tone generator circuit for an electronic musical instrument comprising a plurality of transistors, the bases of said transistors being supplied with tone signals of different footages, means for connecting the collectors of said transistors, a plurality of

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resistors connected respectively at one end to the emitters of said transistors, means for connecting the other ends of said resistors, resistor means connected between said collector connecting means and said emitter connecting means, a capacitor connected at one end to said emitter connecting means, switch means connected at its rear end to the other end of said capacitor and connected at its forward end to said emitter connecting means, and output terminals taken out respectively from the emitters of said transistors, wherein said signals are simultaneously derived from the output terminals connected with the emitters of said transistors by closing said switch means when a predetermined potential difference is supplied between said collector connecting means and the rear end of said switch means and when the base of each said transistor is fed the input signal.

2. A switching device as claimed in claim 1 in which a diode in the forward direction is connected with the base of each of said transistors, said input signal being introduced through said diode.

3. A switching device as claimed in claim 1 in which said resistor means connected between said collector connecting means and said emitter connecting means comprises a variable resistor.

4. A switching device as claimed in claim 2 in which said plurality of transistors, said diodes connected with the bases of said transistors, comprise an integrated circuit formed of a P-type silicon substrate in which said plurality of transistors, said substrate having an N-type layer defining a collector region common to said transistors.

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