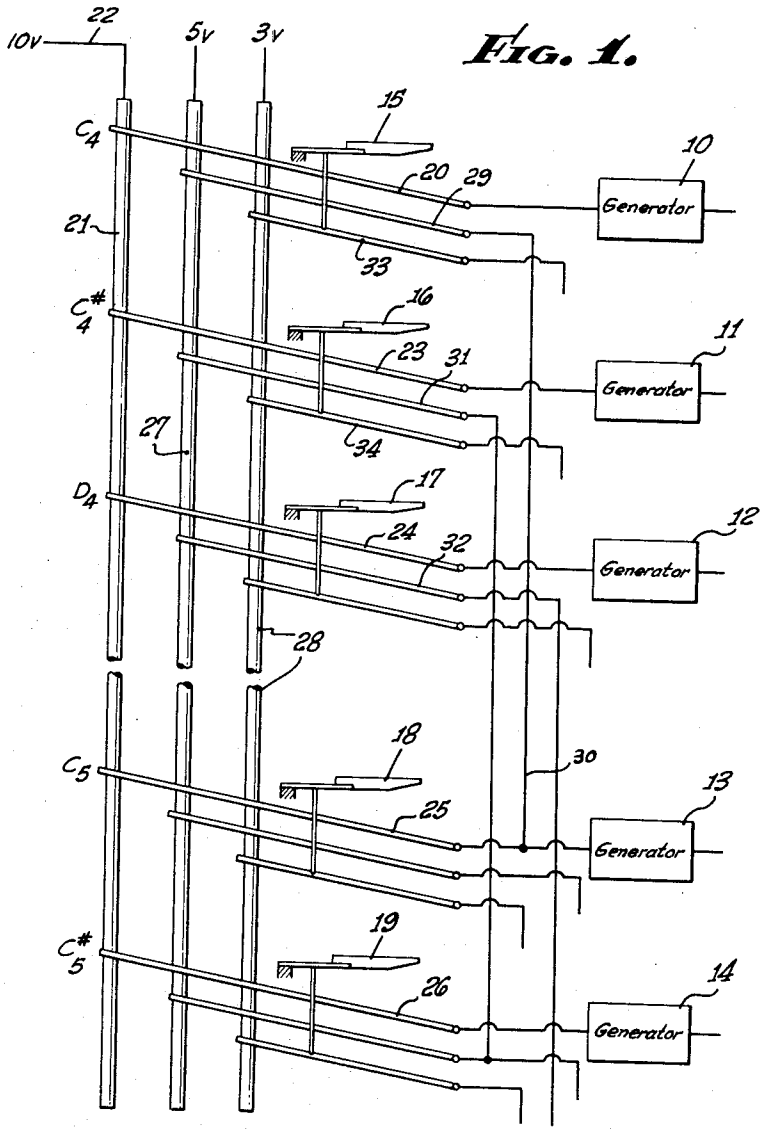
Aug. 23, 1960 D. J. LESLIE 2,949,803

CROSS-WIRED ORGAN SYSTEM AND RECTIFIER THEREFOR

Filed Feb. 25, 1957

FIG. 1.



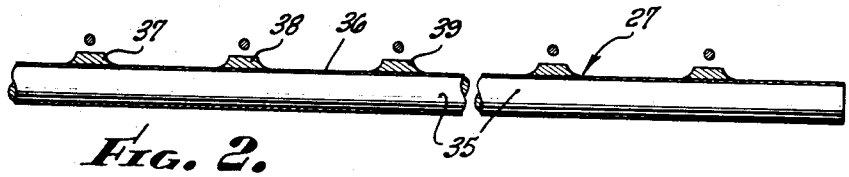


FIG. 2.

INVENTOR.
DONALD J. LESLIE,
BY
Flam and Flam
ATTORNEYS.

United States Patent Office 2,949,803 Patented Aug. 23, 1960

2,949,803

CROSS-WIRED ORGAN SYSTEM AND RECTIFIER THEREFOR

Donald J. Leslie, 313 S. Fair Oaks Ave., Pasadena 1, Calif.

Filed Feb. 25, 1957, Ser. No. 642,025

6 Claims. (Cl. 84—1.11)

This invention relates to an electric organ, and particularly to keying systems for purposes of obtaining various overtones, harmonics and the like.

Electric organs contain a great quantity of equipment, there being a substantial multiplication of similar equipment by virtue of the fact that there are numerous notes in the desired musical range. In addition, a plurality of manuals again multiplies the equipment required. The cost of electric organs is, accordingly, quite high. The demand for electric organs would increase very substantially if the price could be materially reduced.

One object of this invention is to provide an electric organ having quality features in a simple and inexpensive manner.

In order to obtain controlled harmonics, overtones, subtones and the like, which are so necessary to create the desired musical effects, a plurality of generators is often provided for each key or note. It has been proposed that fundamental tone generators alone be provided and that the keys be appropriately cross-wired to operate generators falling close to the desired harmonic or overtone relationship. This, of course, seems to obviate a great deal of equipment. The only compromise seems to be a slight difference in frequency between some true harmonics and the frequency of the fundamental which approximates the harmonics, overtones or the like. However, the relative amplitudes of the harmonics, overtones and the like cannot in a simple manner be controlled. If the output of the generators depends upon voltage applied, for example, the problem is how to transmit different voltage in the cross-wire circuits. This can be done by using a plurality of bus bars and a plurality of contact arms for each key respectively engageable with corresponding bus bars. Each bus bar corresponds to a particular fundamental or harmonic. Thus, the first, second and third bars may correspond to fundamental, second and third harmonics. Of course, more numerous bus bars are provided in practice to achieve the numerous desired frequency component.

In this arrangement, the second contact arm for the C_4 key, for example, is cross-wired to the generator for C_5. Similarly, the second contact arms for $C_4\sharp$, D_4, etc. are cross-wired to the generators for $C_5\sharp$ and D_5. Different voltages, preferably controlled in value, are applied to each of the bus bars.

The difficulty with this arrangement may become clear on analysis. There are several connections made at each generator terminal, including various cross-wiring circuits as well as the main contact arm for that generator. Since these connections are from different bus bars, short circuit conditions exist unless the voltages at all of the bus bars are equal. But equal voltages are undesired since in this case impulses would be produced in which all frequency components are equal in amplitude.

In order to provide different bus bar voltages for controlling relative harmonic content and to overcome short circuit problems, a unidirectional conductor such as a rectifier can be inserted in every cross-wiring circuit. This solution is impractical since this means hundreds of rectifiers, because there may be hundreds of cross-wired connections in a single instrument. However, this has been done since providing numerous rectifiers may be more desirable than providing numerous generators. Clearly

a better type of amplitude control of harmonics in a cross-wired keying system is preferable.

A second solution seems possible. By inserting a rectifier in the supply lead to the bus bars, short circuit conditions can be avoided by the use of just a few rectifiers. However, this produces spurious results. In this instance, if, for example, keys for C_4 and C_5 are both depressed, the second harmonic bus bar will be supplied with full voltage, and other keys simultaneously operated will have second harmonic in full, unattenuated amplitude even though the corresponding key in octave relationship is not operated.

It does not appear obvious that a solution exists.

The primary object of this invention is to provide a practical solution to this problem in which only a slight amount of extra equipment is required and in which spurious operations are nevertheless avoided. To accomplish this purpose, the bus bars themselves incorporate novel rectifying means.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of one embodiment of the invention. For this purpose, there is shown a form in the drawings accompanying and forming part of the present specification. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a diagrammatic view illustrating a system incorporating the present invention; and

Fig. 2 is an enlarged fragmentary longitudinal sectional view of one of the bus bars.

In Fig. 1 a series of electrical devices or tone generators **10**, **11**, **12** . . . **13**, **14** create electrical impulses corresponding to musical tones.

By way of example, the generator **10** generates impulses corresponding to middle C, designated conventionally as C_4. The generators **11** and **12** correspond to $C_4\sharp$ and D_4; and the generators **13** and **14** correspond to C_5 and $C_5\sharp$. The generators **10** through **14** are, of course, representative of a complete set of generators in an electric organ.

The generators may comprise vibrating reeds, electronic oscillators or other suitable devices. The necessary characteristic, so far as the present invention is concerned, is that the amplitude of output by the generators may be determined by the amplitude of a supply voltage or the like.

Keys **15**, **16**, **17**, **18** and **19**, arranged in usual keyboard fashion, operate appropriate control or energization circuits for the generators. Associated with the key **15**, for example, is a contact arm **20** which engages a bus bar **21** upon depression of the key **15**. The bus bar **21** is connected to a source of supply voltage through a lead **22**. Upon depression of the key **15**, the contact arm **20** transmits voltage to the corrseponding generator **10** and an appropriate signal is created. Contact arms **23**, **24**, **25**, **26**, respectively associated with the keys **16**, **17**, **18**, **19**, similarly cooperate with the bus bar **21** to energize or control their respective generators **11**, **12**, **13** and **14**.

In order to provide overtones, subtones, harmonics and the like, additional contact arms, cooperable with additional bus bars **27** and **28**, are provided. For example, the first harmonic of C_4, namely, C_5, can be added to the output whenever the C_4 key **15** is depressed. This is accomplished by a second contact arm **29** operated by the key **15**. A lead **30** connects this second arm **29** to the generator **13**.

The second contact arm **29** engages the bus bar **27** to which is supplied an appropriate, controlled voltage different from that at the bus bar **21**. In the present example, the bus bar **27** is at five volts, and the bus bar **21** is at ten volts.

If the bus bar **27** is operative, depression of the key **15** will cause energization or control of the generators **10** and **13**. The voltage applied from the bus bar **27** to the C_5 generator **13** differs from that applied to the C_4 generator **10**. Accordingly, the ratio of second harmonic to fundamental is controlled by appropriate choice of the voltage of the first and second bus bars.

Second contact arms **31**, **32**, respectively associated with the keys **16** and **17** for $C_4\sharp$ and D_4, similarly cooperate with the second bus bar **27** and are correspondingly cross-wired to generators $C_5\sharp$ and $D_5\sharp$. By inserting a switch ahead of the second bus bar **27** or by physically moving the bus bar **27** away from operative position with respect to the second contact arms **29**, **31**, **32**, etc., the presence or entire absence of second harmonics due to cross-wiring can be controlled by the musician. Furthermore, the voltage applied to the second bus bar **27** can also be varied by a potential arrangement or the like. By such means, the desired intensity of the second harmonic relative to the fundamental may be controlled.

The third contact arms **33**, **34** cooperate with the bus bar **28**, and these third arms may be cross-wired to generators for notes bearing appropriate overtone or subtone relationship with respect to the notes produced by the main contacts of the respective switch sets.

As many bus bars may be provided as are desirable or necessary. As many as eight or ten may be provided in order to control numerous harmonics, overtones and the like.

Should the keys **15** and **18** for C_4 and C_5 be simultaneously depressed, the second harmonic of C_4 will disappear as such, since the generator **13** will be supplied with full voltage through the bus bar **21**. Similarly, simultaneous depression of any two keys in which a cross-wiring relationship exists will cause the cross-wired circuit to be subordinated. This does not detract from esthetic effects.

If any cross-wired keys are simultaneously depressed, a possibility of short-circuiting exists. Thus, for example, if keys **15** and **18** for C_4 and C_5 are simultaneously depressed, the bus bar **21** connected to the ten-volt source connects through the main contact arm **25**, the cross-wiring **30**, the second contact arm **29** of the key **15**, through the bus bar **27** to the five-volt source.

To prevent this short-circuiting relationship, each bus bar incorporates a unidirectional conductor or rectifier structure. This is shown in detail in Fig. 2.

The bus bar **27**, for example, incorporates a conductive base rod **35**. The base rod **35** is coated with material **36** having unidirectional or rectification properties such as selenium, germanium, silicon or the like. Contact islands **37**, **38**, **39** are supported upon the layer **36** and are provided for cooperation with the second contact arms **29**, **31**, **32**.

Of course, as many contact islands are provided as there are keys cooperating with the bus bar **27**. Instead of a complete coating, the rectifying layer can be provided as a strip only along one side of the base rod. If convenient or desirable from a manufacturing standpoint, a series of short strips or rings can be provided instead of a continuous strip or coating. The short-circuit condition can no longer arise. In the example given above, the layer **36** blocks the higher voltage at the contact island **37** and prevents reverse current flow through the bus bar **27**.

The first or main bus bar **21** may also be provided with a rectifier structure since in some cases, as in oboe tones for example, the second harmonic exceeds the fundamental in amplitude.

The thickness of the layer and/or the material comprising the layer **36** may be varied in accordance with the voltages required in the particular system. In a system utilizing transistor oscillators, the voltages applied to the generators normally do not exceed fifteen volts. Accordingly, a thin selenium layer may be provided to achieve effective operation. Should higher voltages be present, such as in connection with polarizing voltages for vibrating reeds, the layer may be made of germanium or other more effective rectifying material.

The bus bar can be readily provided with the rectifying layer **36**. By incorporating the rectifier structure in the bus bar, it is unnecessary to provide separate rectifiers for each of the cross-wired circuits. The layer prevents application of an undesired high voltage to the base rod **35**, and spurious results are avoided.

The inventor claims:

1. For use in a cross-wired electric organ: an elongate conductive bus bar; a layer of material having rectification properties and extending along the length of the bar; and a plurality of electrically separate contact means secured to the layer at spaced positions along the bar.

2. For use in a cross-wired electric organ: an elongate conductive bus bar; material having rectification properties and located along the length of the bar; and a plurality of electrically separate contacts selectively movable to be placed in electrical contact with the material at spaced positions along the bar.

3. In an electric organ system of the class including: a plurality of bus bars; a plurality of keys, each having a series of contact means engageable with the respective bus bars; a plurality of impulse producing means operable upon engagement of the contact means with said bars; means for cross-wiring the contact means for adding harmonics or the like to impulses upon depression of the keys; means for applying voltages in controlled amounts to the bus bars; the combination therewith of: means located along each bus bar and interposed between the bus bar and the corresponding contact means for preventing short-circuiting conditions upon the simultaneous operation of cross-wired contact means.

4. For use in an electric organ or the like: an elongate conductive member; a plurality of independently operable electrically separate contact means selectively engageable with the member; and rectifier means interposed between each of the contact means and the member.

5. For use in an electric organ or the like: an elongate conductive member; a plurality of independently operable electrically separate contact means selectively engageable with the member; and rectifier means carried by the member and interposed between each of the contact means and the member.

6. In an electrical switching system utilizing a plurality of bus bars adapted to be connected to sources of electrical energy, said system having a plurality of circuit controllers, and a plurality of electrical devices adapted to be connected to selected bus bars by the aid of said circuit controllers, at least some of the circuit controllers cooperable with different bus bars being connected to a common device, the combination therewith of rectifier material carried by the bus bars and interposed between the circuit controllers and the bus bars for preventing cross-wiring short circuits between the bus bars by way of the circuit controllers.

References Cited in the file of this patent

UNITED STATES PATENTS

2,504,906	Tremblay	Apr. 18, 1950
2,528,086	Schenck	Oct. 31, 1950
2,562,471	Martenot	July 31, 1951
2,579,358	Bourn	Dec. 18, 1951
2,767,264	Scott	Oct. 16, 1956
2,832,898	Camp	Apr. 29, 1958
2,852,973	Corbett	Sept. 23, 1958