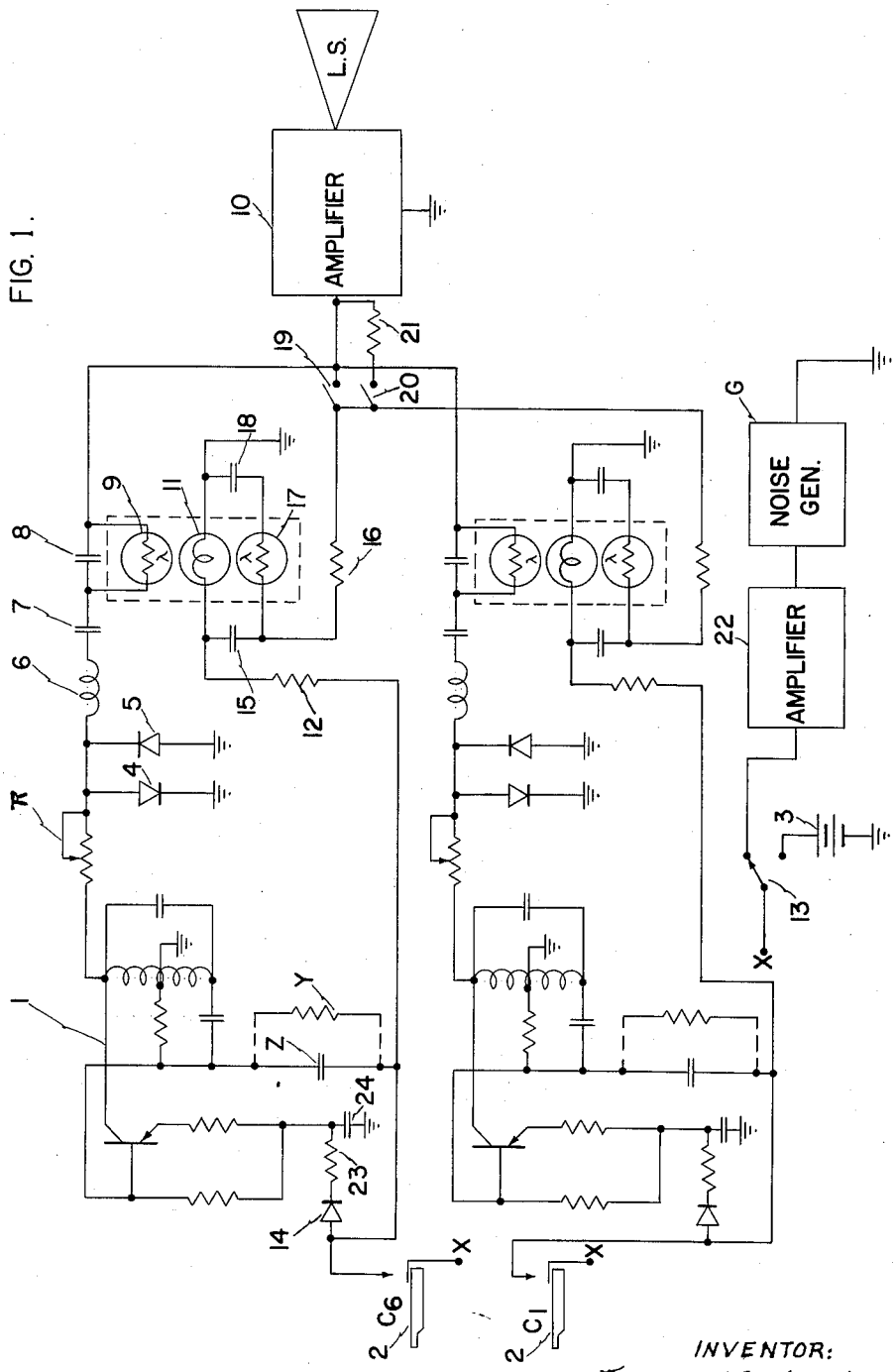
June 27, 1961 J. MARKOWITZ 2,989,887

ELECTRONIC ORGAN AND THE LIKE HAVING TRANSIENT TONAL CHARACTERISTIC PRODUCING MEANS

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FIG. 1.



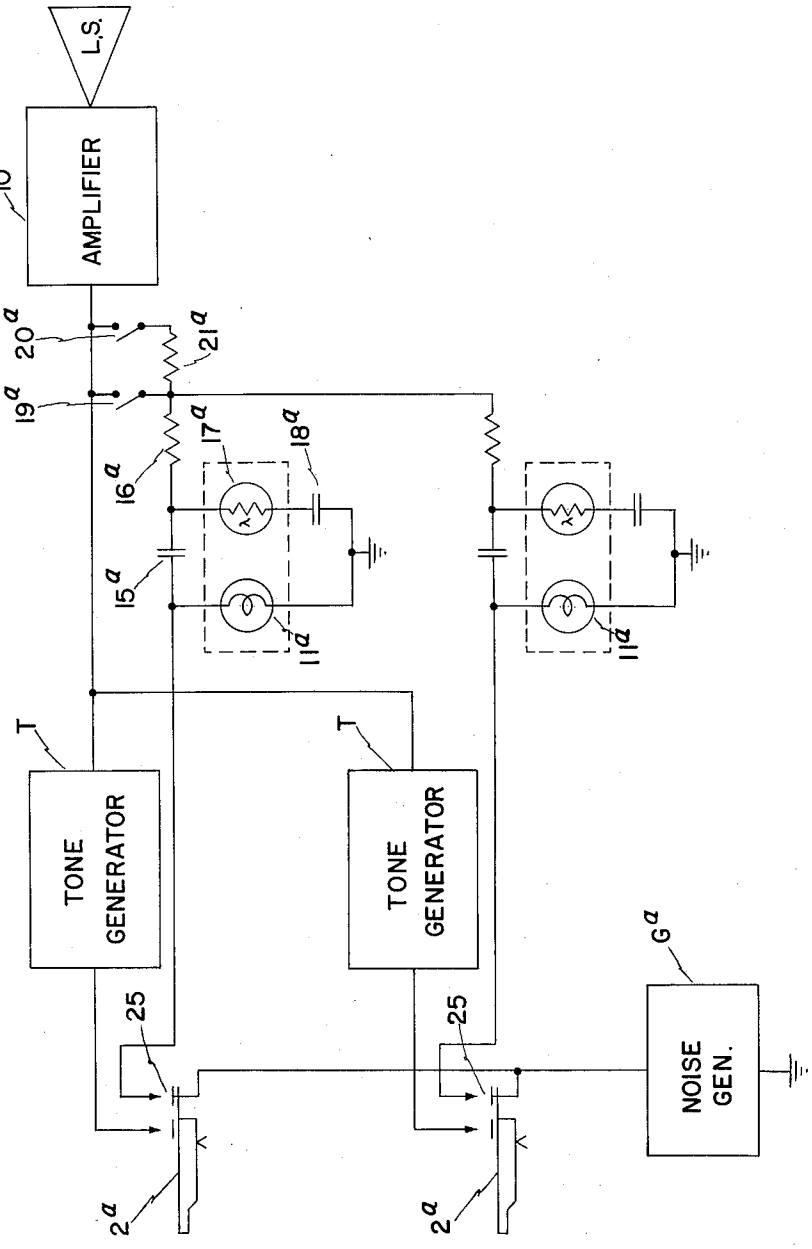
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FIG. 2.



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ELECTRONIC ORGAN AND THE LIKE HAVING TRANSIENT TONAL CHARACTERISTIC PRODUCING MEANS

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8 Claims. (Cl. 84—1.24)

This invention relates to electronic musical instruments, such as electronic organs and the like.

It is an established fact that, up to this time, the electronic organ has not been fully accepted by prominent, classical organists for a variety of reasons, some of which seem to stem from the difference in the psycho-acoustical effect upon many listeners when comparing a pipe and ordinary electric or electronic organ.

The organist may note the following comparative differences in electronic organ as against a pipe organ:

(1) Absence of chiff or speech transients.

(2) Absence of wind noise.

(3) Absence of steady state random pitch and intensity variations.

One object of my invention is to provide a novel electronic musical instrument, such as an electronic organ, in which the above elements are present to an extent easily discernible by the average listener.

Another object is to provide such an instrument which has an electronic "air noise" device that can be selectively controlled by the organist.

A further object is to provide an instrument, the individual notes of which may have speech and steady state characteristics which are indistinguishable from those of pipe organs.

A further object is to provide an electronic organ or the like, the notes of which include in their speech a transient comprising:

(1) A given upper harmonic or band of harmonics which is audible only at very beginning of the speech of any given note.

(2) What may be referred to as an excess of "wind noise" at the beginning of the speech of each note, and to provide means whereby this wind noise will settle down to a normal level during the steady state speech of any individual note.

(3) Random variations in the steady state intensity and frequency of individual notes.

A further object of the invention is to provide an electronic organ, the individual notes of which have transient speech characteristics, said transients being controlled by the action of light responsive resistors.

A further object of the invention is to provide a light controlled electronic transient producing device which can be directly embodied in any electronic organ so as to initially form a part thereof, or combined with such an organ as a separate unit.

With these and other objects in view, which will become more readily apparent from the following detailed description of the various practical and illustrative electronic organ improvements shown in the accompanying drawings, my invention comprises the novel electronic organ, devices, elements, features of construction and arrangement of parts in co-operative relationship, as more particularly indicated and defined by the hereto appended claims.

In the accompanying drawings:

FIG. 1 is a wiring diagram that shows one form of transient device incorporated in a certain type of electronic organ in accordance with my invention.

FIG. 2 is a wiring diagram which shows the said transient device as combinable with any type of electric or electronic organ.

For purposes of exemplification, or illustration, my invention is herein disclosed as embodied in, or applied to, a standard, or conventional type electronic organ. However, it is to be noted that only those parts of such an organ have been shown in the drawings as are deemed necessary to facilitate a clear understanding of the construction and operation of my invention, the performance of its intended purpose and the manner in which it achieves certain unique and desirable results and advantages. From this disclosure it will be readily apparent to those skilled in this art how my invention can be utilized, in the same or in similar manner, with electronic musical instruments in general.

It will facilitate an understanding of my invention to first briefly consider some of the more important aspects and phases thereof so that these may be kept in mind when subsequently reading the detailed description of the practical and illustrative embodiments of my improvements shown in the drawings.

Accordingly it is noted that, in general, the invention includes the following:

(1) An electronic organ control system or the like, that is, one having conventional keys, contacts, etc.

(2) A series of electron oscillators which for convenience may be of the transistor or Solid State type, however, the principles involved are also applicable to electron tube and other type oscillator systems.

(3) Means for selectively employing either an ordinary direct current potential for operating the aforementioned oscillators or instead, an electrical noise generator which provides a random varying operating potential to the oscillators and in addition provides the electrical equivalent of air noise to the audio system.

(4) A series of wave shaping circuits, one for each oscillator.

(5) A connection from each key contact of each note to a small electric bulb which is mounted in an enclosure, along with two light responsive resistors. One of the light responsive resistors being arranged so as to short-circuit a portion of the wave shaping circuit within a pre-determined time after the key is depressed, and the other light responsive resistor being arranged so that a connection from the key contact to the audio system is partially short-circuited within a pre-determined time after the key is depressed.

(6) An amplifier and loudspeaker system for said electronic organ.

Referring now to the drawings, FIG. 1 schematically illustrates and exemplifies an electronic organ system which incorporates a unique arrangement for the production of transient and steady state sound effects by electronic means in imitation or simulation of the sounds produced when the stops are operated in classic type pipe organs. For purpose of exemplification, FIG. 1 discloses only the components (schematically) which would be associated with two notes, since this will serve to illustrate the principles involved, which are the same as when a complete set of oscillators are present and encompass the entire musical range of frequencies normally found in an organ.

A typical oscillator utilizing a transistor as the amplifying device and employing a Hartley circuit configuration **1** is energized when the organist presses the associated key **2** at the organ console, completing the circuit between the oscillator and the power source which may be a direct current source such as a battery **3** or a noise generator G. The variable resistance R, establishes a potential level that will result in proper harmonic generation by the diodes, **4**, **5**. Values of inductance **6**, and capacitance **7** and **8** are selected to produce a series reso-

nance at a desired harmonic of the oscillator frequency. The capacitors are also of such values that if capacitor **8** is effectively shorted by the light dependent resistor **9**, the resultant increase in effective capacity of the resonant circuit **6**, **7** will produce a resonance at a lower order harmonic of the oscillator fundamental frequency.

Therefore, when the oscillator is energized by depressing its associated key, the resulting signal which is applied to the audio amplifier will have a prominent harmonic whose order is established by the resonant frequency of **6**, **7**, and **8**. Simultaneously current starts flowing in the lamp **11** which in turn causes the resistance of the light sensitive resistor **9** to decrease and effectively short out capacitor **8**. At this point, the lower order harmonic which is established by the resonant frequency of **6** and **7** will be prominent and will continue while the key is depressed. The preceding sequence of a transient harmonic followed by a steady state tone of lower harmonic order simulates an effect produced in certain classic organ pipes and known as "Chiff". The resistance **12** establishes the desired operating point of the lamp that provides the desired amount of delay before the steady state condition is reached. It should be understood that the use of this particular type of harmonic generator circuit is related to the production of a particular type of pipe organ tonality, namely a chiffy stopped flute.

Generally speaking the presence of transients are of especial importance in the simulation of flue tonalities, that is, flutes, diapasons and strings. The remaining family of organ tone, the reeds, is usually more "solid" and in fact it may be that the type of transients herein described would be of no value with such tones. An ideal electronic organ would, therefore, combine tone generators producing flue tones embodying the principles of this invention and reed producing tone generators whose operating potential is desired from a conventional pure direct current supply.

A noise generator G, may be used to provide the air hiss effect which occurs with organ pipes and also to provide low frequency random fluctuations in amplitude such as also occur in organ pipes. When the noise generator power source is selected by means of switch **13**, the diode **14**, rectifies the noise signal to provide a direct current with random fluctuations for oscillator power. The unrectified "noise" is also applied to the amplifier through capacitor **15** and resistor **16** to produce an air hiss effect which is prominent during the transient condition. As light from lamp **11** is also directed on light responsive resistor **17**, a part of the noise will be shunted to ground by capacitor **18** as the light dependent resistor **17** becomes more conductive. This results in additional simulation of the classic organ pipe in which the air noise is most prominent during the transient "chiff" condition.

In actual use standard direct current power supply **3** would not be used whenever switch **19** or **20** is in a closed position, otherwise key clicks would be heard whenever keys were depressed. It is interesting to note that the use of the noise generator as an operating potential results in the production of a more organistic attack or speech. Undoubtedly this is due to the similarity in the nature of wind or air pressure as used in a pipe organ and the electrical noise generator which provide an electronic equivalent of wind. The noise generator and its associated amplifier may be considered to be an "electronic blower." The noise generator G employed is of a standard type such as a model 455B manufactured by the Grason-Stadler Co. of West Concord, Massachusetts. Amplifier **22** is a standard audio frequency type whose power is dictated by the size of the organ with which it is to be used. All of the flue stops of a four manual instrument are presently operating satisfactorily with the noise generator feeding a 70 watt power amplifier. It should be understood that the noise generator and its associated amplifier constitute a noise generator and, therefore, in referring to this device it is not deemed necessary to make separate reference to the amplifier.

It has been established that among the transient phenomena of organ pipes is a random variation of steady state pitch and intensity. In other words, instead of maintaining an exact frequency such as does an electronic oscillator, an organ pipe will shift on both sides of a mean frequency and intensity. Such an effect is obtained with this invention, however, the amount of frequency variation is dependent, of course, upon how sensitive the oscillator is to change in supply potential.

If the oscillator is stable frequency wise with variation in supply potential, the result will be mainly variations in output intensity. With such a condition, it may be desirable to inject some of the random voltage into a portion of the oscillator circuit which will provide frequency variations which correspond to the random voltage input. This can be achieved by connecting a capacitor Z or a resistor Y between the keyed input potential and the base of the transistor. It should be understood that the choice of where to inject this voltage is mainly a matter of convenience and will generally depend upon the type of oscillator that is used. The amount of random voltage which is injected, of course, will determine the "activity" or variations around the mean frequency.

The system of using a noise generator as an operating potential is especially feasible with transistors and other similar solid state devices because of the low operating power which is required.

The function of resistor **23** and capacitor **24** is to filter the rectified operating potential to a proper degree so that only lower frequency fluctuations are present in this operating potential. Another purpose is to act as a speech control. Proper selection of these two components will give correct time delay to the initial speech as well as a gradual decay to the sound of any note after a key is released.

If it is desired to eliminate the air noise, this can be accomplished by opening switch **19**. In actual practice this switch may be controlled by a stop key of the organ console. If an intermmediate amount of air noise is desired, it can be obtained by opening switch **19** and closing switch **20**. In this case the air noise signal must pass through resistance **21**. The amount of resistance inserted at this point will determine the level of this intermediate air noise condition.

FIG. 2 shows an arrangement for incorporating the air noise system previously described in connection with FIG. 1, with any electric or electronic organ system, irrespective of the type of tone generation system that is employed. To avoid redundancy of descriptive matter, those parts or elements shown in FIG. 2 which are similar to the parts or elements disclosed in FIG. 1, have been designated by corresponding reference characters, but for purposes of differentiation, the exponent "*a*" has been added to such reference characters in FIG. 2. In FIG 2, two tone generators T are represented with the associated keys **2***a*. The keys would be equipped with an extra set of contacts **25** for the purpose of keying the light responsive relay. A noise generator G*a* would be provided to supply the noise signal as well as the current to energize the lamps **11***a*.

When a key **2***a* would be depressed, in addition to the tone signal, an air noise electrical equivalent would flow through capacitor **15***a* and resistor **16***a* to the combination amplifier and loudspeaker **10***a*. When the lamp **11***a* reaches full intensity, the air noise would be partially shorted out to a degree dependent on the size of capacitor **18***a*. It is interesting to note that a wider band of noise frequencies are included during the transient period than during the steady state period. This is caused by the bypassing effect of capacitor **18***a* which offers less reactance to the higher frequencies. Selection of switch **20***a* instead of switch **19***a* will result in a lower order of air noise

intensity as previously described in connection with FIG. 1.

Of course, it will be apparent to those skilled in this art that the novel electronic organ system developments specifically shown and described, can be changed and modified in various ways, without departing from the invention herein disclosed and more particularly defined by the hereto appended claims.

I claim:

1. An electronic musical instrument having in combination with playing keys, contacts co-operatively associated with said keys, amplifier-loudspeaker units, and tone generators which require an operating potential; an operating potential source comprising an electrical noise generator and at least one light dependent resistor connected between any tone generator and an amplifier-loudspeaker unit in such manner that a transient effect is obtained whenever the operating potential is applied to any tone generator by the actuation of a respective key and its co-operatively associated contact.

2. An electronic musical instrument comprising, a combinned amplifier and loudspeaker, one or more electronic tone generators which require an operating potential, a relatively pure source of direct current to supply the said potential, a second operating potential source that includes an electrical noise generator, a switch for selecting either of said operating potential sources, a connection from each of the tone generators to the combined amplifier and loudspeaker, and at least one light dependent resistor connected between any respective tone generator and the amplifier so as to provide a transient effect when said switch is closed.

3. An electronic musical instrument comprising; a plurality of electronic tone generators; an operating key and contact for each generator; two operating potentials of approximately equal voltage one of which provides a relatively pure direct current and the other one of which provides a noise modulated current; a switch for selecting either of said operating potentials; a wave shaping circuit for each generator; a combined amplifier and loudspeaker connected to the output of said wave shaping circuit; a light dependent resistor connected across a portion of any wave shaping circuit; a connection between any operating key contact to the amplifier through a series connected resistor and capacitor; a second light dependent resistor connected between the midpoint of said series connected resistor and capacitor, and the common ground; and a lamp in close proximity to both light dependent resistors, which lamp is connected so that it will glow whenever an operating key is depressed.

4. An electronic organ or the like comprising, a plurality of tone generators each of which is associated with a playing key, a combined amplifier and loudspeaker for said tone generators, an electrical noise generator connected to a supply bus, a contact on each playing key which feeds the output of the noise generator to the audio amplifier whenever a respective key is depressed, a light dependent resistor and a capacitor connected between the common ground and the noise line of any playing key, and a lamp also connected between ground and any playing key so that a transient air noise is produced whenever a playing key is depressed.

5. An electronic organ or the like comprising in combination with one or more electronic tone generators which require an operating potential, and a series of connectively combined playing keys, contacts, impedances, and rectifiers; an operating potential source which includes an electrical noise generator and a combined audio amplifier and loudspeaker for converting the output of the tone generators into sound, a connection from the operating potential to each tone generator through a respective key contact and rectifier, a connection through an impedance from each key contact to an element of its associated tone generator which is frequency sensitive to voltage changes, a wave shaping circuit associated with each tone generator, a light dependent resistor associated with each wave shaping circuit, a noise line connection between any respective key and the audio amplifier, a second light dependent resistor connected between the noise line and ground, a lamp in close proximity to said light dependent resistors, and a connection from any respective key contact to the lamp whereby upon depression of a respective key transients are produced during the period of initial speech as well as during the steady state period.

6. An electronic musical instrument of the type having the usual playing keys and associated switches, comprising at least one tone generator, an amplifier-loudspeaker means, a source of operating potential comprising at least one electrical noise generator, and at least one light-dependent resistor interconnecting said tone generator and said amplifier-loudspeaker means.

7. An electronic musical instrument in accordance with claim 6, which includes a relatively pure source of direct current as a second operating potential, and a switch for selecting either the noise generator including operating potential or said direct current as the source of operating potential.

8. An electronic organ or the like in accordance with claim 4, wherein said light dependent resistor and capacitor establish a light controlled variable impedance.

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