July 26, 1966 J. R. BRAND 3,263,018

DIODE DISCONNECT CIRCUIT, FOR ELECTRONIC MUSICAL INSTRUMENTS, ISOLATING VARIABLE LOAD MEANS FROM TONE GENERATOR MEANS

Filed June 21, 1963

Fig. 1

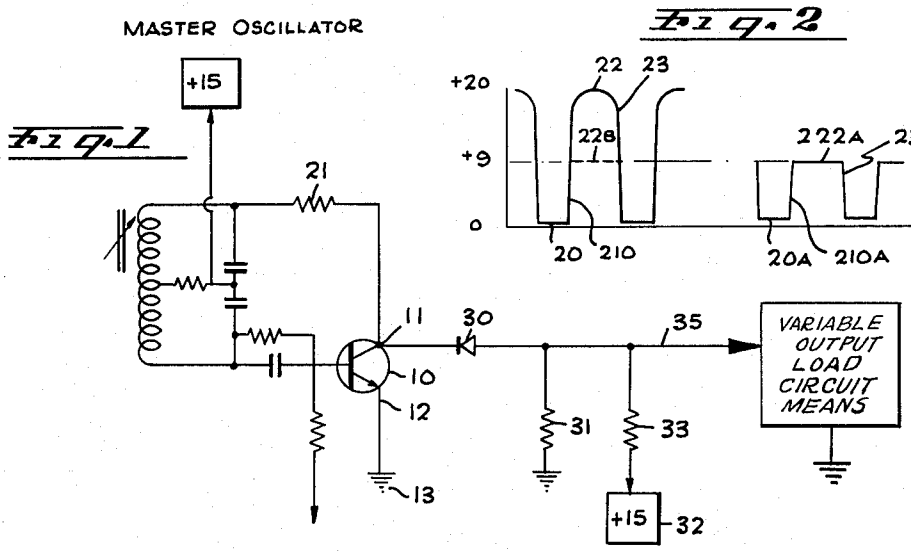


Fig. 2

Fig. 3

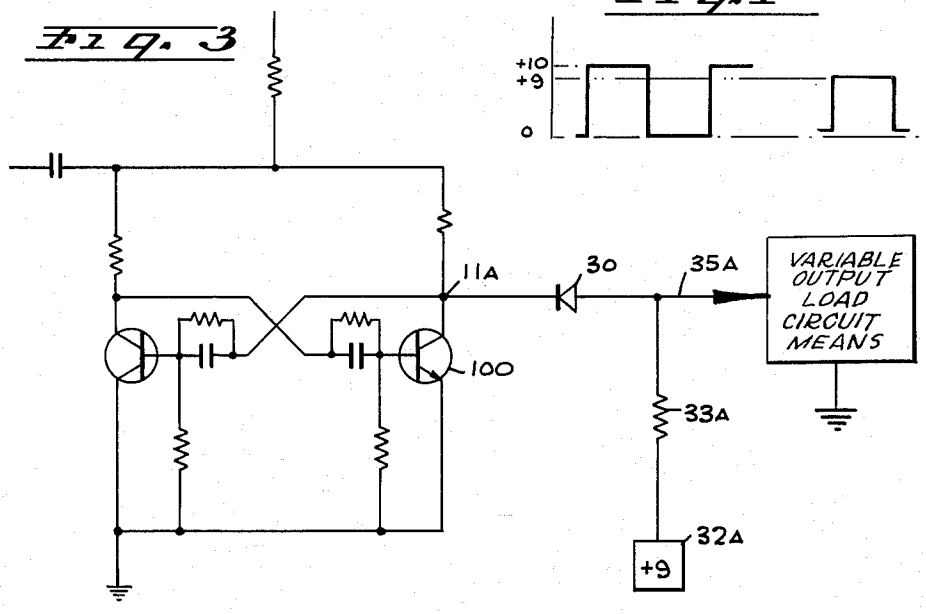


Fig. 4

INVENTOR

JOHN R. BRAND

BY Warren T. Jessup

ATTORNEY

United States Patent Office 3,263,018 Patented July 26, 1966

3,263,018

DIODE DISCONNECT CIRCUIT, FOR ELECTRONIC MUSICAL INSTRUMENTS, ISOLATING VARIABLE LOAD MEANS FROM TONE GENERATOR MEANS

John R. Brand, Northridge, Calif., assignor, by mesne assignments, to Warwick Electronics Inc., Chicago, Ill., a corporation of Delaware

Filed June 21, 1963, Ser. No. 289,594
5 Claims. (Cl. 84—1.01)

This invention relates in general to tone generators, especially as employed in electronic musical instruments, but it relates more specifically to a disconnect system to control a wave form output of a tone generator, and to protect the generator from outside load influences.

This invention is especially suited for electronic musical instruments, such as electronic organs, and therefore the description of the preferred embodiment of the invention herein will be directed to a circuit suitable for such an environment.

In a typical electronic organ environment, master oscillators are used to produce the basic frequency from which various voices and effects are created.

Such master oscillators or generators are designed to produce a useful frequency and magnitude. The generators may be designed to work into any given load and produce a consistently uniform effect. In the typical organ the output load of such a generator may vary widely and consequently the frequency and magnitude of the oscillation may be distorted, and hence the final output sound from the audio system will not be as clear and perfect as desired.

Accordingly, it is an object of the present invention to provide a tone generator system for electronic musical instruments which is relatively unaffected by variations of output load.

It is a further object of the invention to provide a tone generator system producing a resultant substantially rectangular type of output frequency wave form from an originally created wave form of non-rectangular shape.

It is a further object of the invention to provide a diode disconnect system to both isolate a tone generator from output loads, and to limit the magnitude of output oscillation in order to provide a uniform rectangular wave form output.

In accordance with these and other objects which will become apparent hereinafter, a preferred form of the present invention is disclosed in the accompanying drawings wherein:

FIGURE 1 is a circuit diagram of the tuned oscillator system employing a diode disconnect principle according to this invention;

FIGURE 2 is a wave form chart;

FIGURE 3 is a circuit diagram of a bistable tone generator which produces a substantially rectangular wave form, and is controlled by a diode disconnect according to this invention; and

FIGURE 4 is a wave form chart.

In FIGURE 1 of the drawing there is illustrated a transistor **10** having a collector output **11** and an emitter **12** connected to ground **13**. The balance of the circuit illustrated is not specifically described, being a common resonant frequency master oscillator of a type well known in the art.

This type of oscillator operates to produce an output wave form at **11** such as illustrated in the chart of FIGURE 2. The low value part of this wave form is produced by the action of transistor **10** being biased to conduct in saturation to ground **13**. When so conducting, varying loads placed upon the collector at **11** have little or no effect upon the oscillator.

In the cycle of operation, the transistor **10**, after a period of time, ceases conducting almost instantaneously. In the the wave form diagram of FIGURE 2, the result of the conduction period is shown as that portion of the curve indicated by the reference character **20** lying substantially, although not absolutely, at the zero voltage abscissa line of the chart. Whenever the transistor **10** ceases conduction, the voltage which appears across the resistance **21** at the output **11**, begins to build up from the low voltage to the maximum voltage in a substantially instantaneous period of time, as shown by the rising curve portion **21** of the wave form period. Although the transistor is supplied from a 15 volt power source, the "fly wheel" effect of the tuned system will carry the wave to 20 or more volts. However, with time as the voltage increases, the curve **210** becomes greater until an apex region **22** is reached at the maximum voltage.

Shortly after reaching the apex voltage **22**, the tuned system causes transistor **10** to begin conducting again, and almost immediately upon commencement of conduction, the conduction goes completely to saturation, and the curve is substantially vertical in the area **23**. Thus, there is completed a cycle of output from the tuned oscillator as shown in FIGURE 1.

The oscillator, as thus far described, is a sensitive system whose output frequency, amplitude, and wave form may be seriously affected if loaded indiscriminately. Also since the master oscillator is usually used to drive a bistable or similar type frequency divider which produces a rectangular output wave form, it is desirable to likewise produce from the master oscillator a substantially rectangular wave form, such as illustrated in FIGURE 2 to the right of the full wave form, without variation because of such loading. Here it will be seen that the wave form is created by an upright section **210A**, a constant maximum voltage line **222A**, and a return, substantially vertical side **23A**. This rectangular type wave is useful as a source for electronic musical instruments.

According to this invention, the full wave form shown to the left side of the chart is converted into the useful wave form appearing at point **35** shown on the right side of the chart in FIGURE 1, and the oscillator is protected from outside loads in order to maintain the frequency constant and of the desired fixed maximum amplitude.

To accomplish this result, an output isolator device is provided. In the drawing of FIGURE 1, such device is illustrated as diode **30**. This isolator device **30** is characterized by the ability to conduct substantial current loads in one direction, and to conduct substantially no current in the opposite direction. A diode is an ideal fulfillment of this defined characteristic.

This invention employs devices which are controlled by balance of voltage—a device which conducts current more easily in one direction than the other. This is the definition of a diode given in Modern Dictionary of Electronics, published by Howard Sams & Co., First Edition, page 77. Hence, for simplicity, the balance of this description will refer only to diodes for the purpose of explanation.

In the FIGURE 1, a resistor **31** is connected to ground and to the anode side **35** of diode **30**. A source of voltage indicated by the reference character **32** operates through a resistor **33** and is also connected to the anode of diode **30**. This voltage divider system provides a potential of about 9 volts to the diode **30**.

Therefore, when the transistor **10** is conducting to saturation into the ground **13**, the 9 volt system will conduct current through the diode and transistor to ground, and the voltage at the anode side **35** of the diode **30** will be near zero. Note that the bottom portion **20A** of the rectangular wave in the wave chart is higher above the zero abscissa than the bottom portion of the master oscillator

wave form due to the voltage drop across the diode **30**, and transistor **10**.

Whenever the transistor **10** ceases to conduct, and the voltage on the collector **11** rises, the voltage on the anode side **35** of the diode **30** will follow until 9 volts is reached, whereafter the voltage will cease to follow the generator and will hold steadily at the specified voltage of about 9 volts as suggested by the dotted line **22B** bridging between the sides **21** and **23** in the full wave form of the chart.

After the generated wave passes point **22** and returns along the side **23** to the 9 volt level, the voltage on the anode side of the diode **30** drops sharply, along with the collapse of the generated wave, down to substantially zero once again. Thus, the output wave on the anode side of diode **30** is substantially that shown in the rectangular form to the right in the wave form chart FIGURE 2, and will be seen to be the lower portion of the full wave form to the left. The sides **210A** and **23A**, therefore, are not precisely vertical as would be ideal, but are sufficiently close for the purposes intended.

As thus described, the full wave form of the generator is converted into a useful rectangular wave form, but in addition the sensitive generator is not disturbed by outside loads, because when the diode **30** is conducting, transistor **10** is under saturation current and therefore there is no possibility of disturbing the generator. Conversely, when the diode **30** is not conducting, then it does not matter what kind of loading is placed on the outside circuit, because diode **30** isolates the generator from such outside influences.

The FIGURE 3 of the drawing illustrates a bistable type of tone generator. The purpose of showing the FIGURE 3 is to illustrate the fact that the present invention is operable with any type of tone generator, the only limitation being that the output of the tone generator must be operable with an output means which alternately shunts the output to a low potential, or even to zero potential at ground. In both instances, that is in FIGURE 1 and FIGURE 3, this effect is obtained by the use of a transistor.

In the FIGURE 3, the diode **30** is shown to be biased by a source **32A** operating through a resistance **33A**. In this instance, the voltage is supplied across the resistance at the desired level of operation rather than to use a voltage divider. The operation and effect is identical to that described in connection with the voltage divider of FIGURE 1.

In the bistable generator of FIGURE 3, a substantially rectangular wave, as shown in the wave form chart of FIGURE 4, is produced from the collector **11A** at a voltage peak above that desired for the output. During the period when the transistor **100** is cut off, the diode **30** will be reverse biased and no current will flow from the source **32A** through the diode, and consequently the voltage appearing at point **35A** during this interval will be the full 9 volt potential of source **32A**. During the period when the transistor is conducting heavily the diode **30** will likewise be conducting and the potential at point **35A** will be near zero but slightly higher than the corresponding potential at **11A** due to the voltage drop across the diode **30**. It will then be seen that the peak to peak output voltage of the multivibrator and diode disconnect system in FIGURE 3 corresponds very closely to that of the master oscillator and diode disconnect system of FIGURE 2. Thus for all frequencies required by the musical instrument whether they be generated by the master oscillator or the bistable dividers, the output wave form will be essentially rectangular and of approximately the same amplitude.

While the instant invention has been shown and described herein in what is conceived to be the most practical and preferred embodiments, it is recognized that departures may be made therefrom within the scope of the invention which is therefore not to be limited to the details disclosed herein but is to be afforded the full scope of the claims.

What is claimed is:

1. A tone generator system for electronic musical instruments having variable load circuit means, comprising:
- regenerative tone generator means having output means which alternately develops a low internal impedance and a high internal impedance; and
- output isolator static passive unidirectional means connected between said output means and said load circuit means, said output isolator means being operative to connect said generator means to the load circuit means during periods of low internal generator impedance and disconnect it from said load circuit means during periods of higher internal impedance whereby the frequency of the tone generator means is unaffected by variations in said load circuit means.

2. In the tone generator system defined in claim **1**, said isolator means comprising a diode poled for nonconduction during high internal impedance of the output means.

3. A tone generator system for electronic musical instruments, comprising:
- a regenerative tone oscillator utilizing a transistor;
- said transistor operating in a regular recurring cycle of:
  - (a) heavy conduction, followed by:
  - (b) light conduction;
  - (c) a return to heavy conduction; and
- a diode output isolator connected to said transistor, and having variable external loading and a direct current power source connected to the side of said diode isolator opposite said tone oscillator, said diode isolator being poled to conduct during heavy conduction of the transistor and to substantially disconnect the external loading during the periods of light conduction of said transistor, whereby the frequency of the tone generator is unaffected by variations in said external loading.

4. A tone generator system for electronic musical instruments comprising:
- regenerative tone generator means having
- a three element current valve having first, second, and third elements,
- said third element controlling the impedance between the first and second elements operative to shift the impedance recurrently between high and low values,
- a variable load circuit fed by the tone generator means,
- and an isolator network connecting the load circuit to the first and second valve elements comprising
- series diode means,
- a source of D.C. voltage, and
- resistance means connecting said source to said diode means adjacent the load circuit,
- said diode means being poled to block current flow during high impedance between the first and second elements, whereby the frequency of the tone generator means is unaffected by variations in said load circuit.

5. A tone generator system for electronic musical instruments having variable load circuit means, comprising:
- regenerative tone generator means having output means which develops an output voltage varying cyclicly between two extremes with a relatively low output impedance during one extreme and a relatively high output impedance during the other extreme,
- an isolator network connecting the output means of the generator means to the load circuit means comprising
- series diode means,
- a source of D.C. voltage, and
- resistance means connecting said source to said diode means adjacent the load circuit,
- the voltage applied to said diode means by said source being intermediate the output voltage extremes and the diode means being poled to block said other extreme of output voltage from said source, whereby the frequency of the tone generator means is unaffected by variations in said load circuit means.

(References on following page)

5

References Cited by the Examiner

UNITED STATES PATENTS

2,884,544	3/1959	Warnock	307—88.5
3,026,487	3/1962	Walsh et al.	331—109
3,041,541	6/1962	Gerr	307—88.5
3,064,205	11/1962	Wagner	331—109

6

OTHER REFERENCES

Millman and Taub: Pulse and Digital Circuits, McGraw-Hill Book Co., Inc., 1956, FIG. 4–7(d), page 111.

ARTHUR GAUSS, *Primary Examiner.*

J. HEYMAN, J. ZAZWORSKY, *Assistant Examiners.*