Aug. 25, 1964 D. M. PARK 3,146,290

ELECTRONIC MUSIC CIRCUIT

Filed Sept. 23, 1963 2 Sheets-Sheet 1

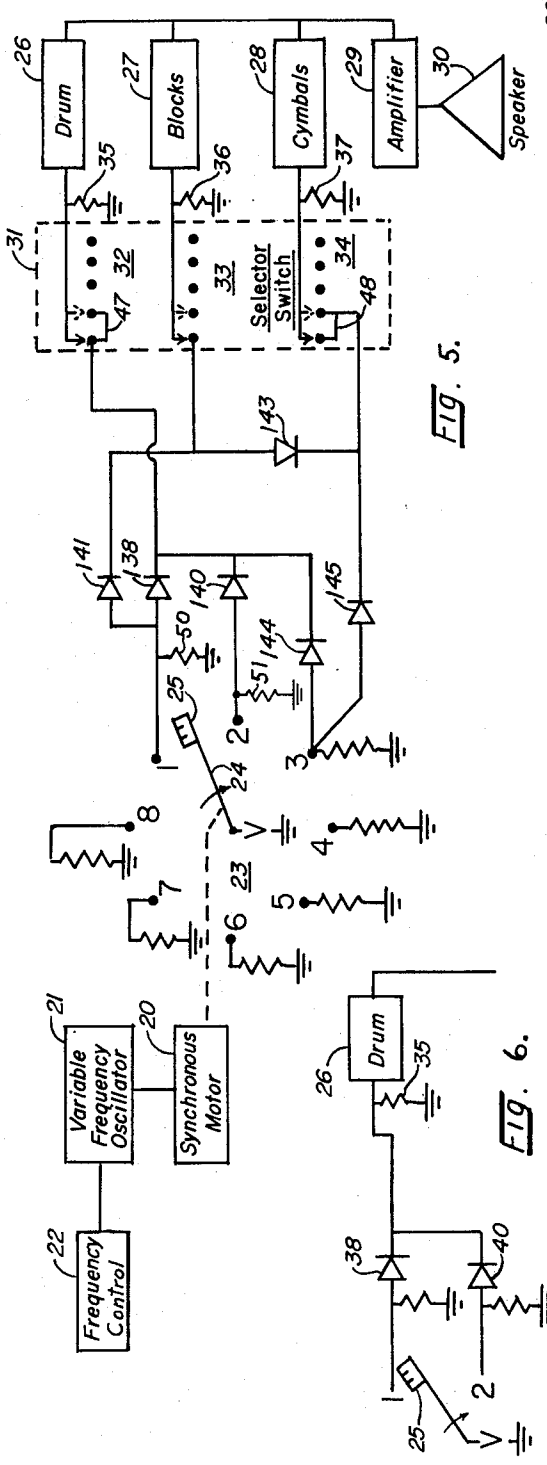



FIG. 5.

FIG. 6.

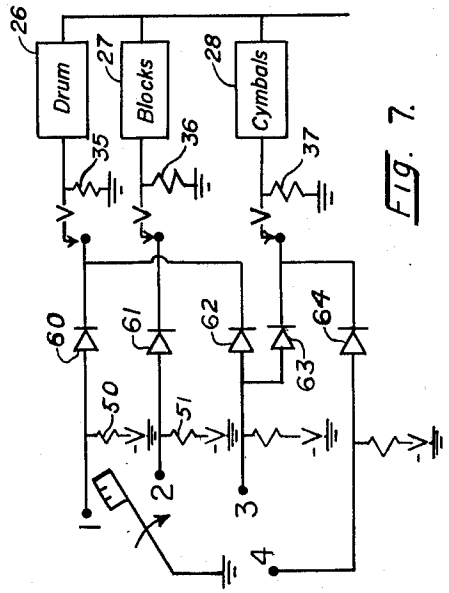



FIG. 7.

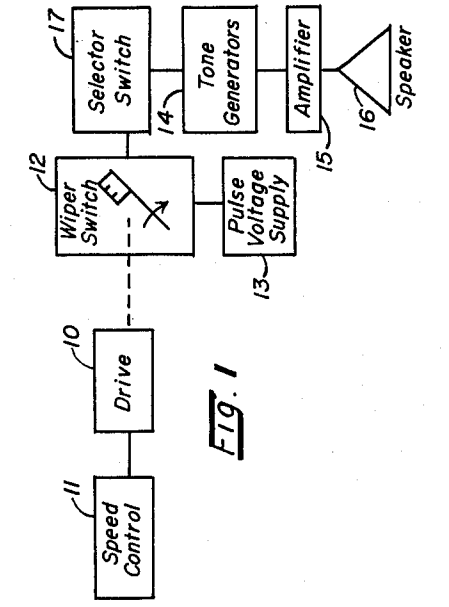



FIG. 1

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ELECTRONIC MUSIC CIRCUIT

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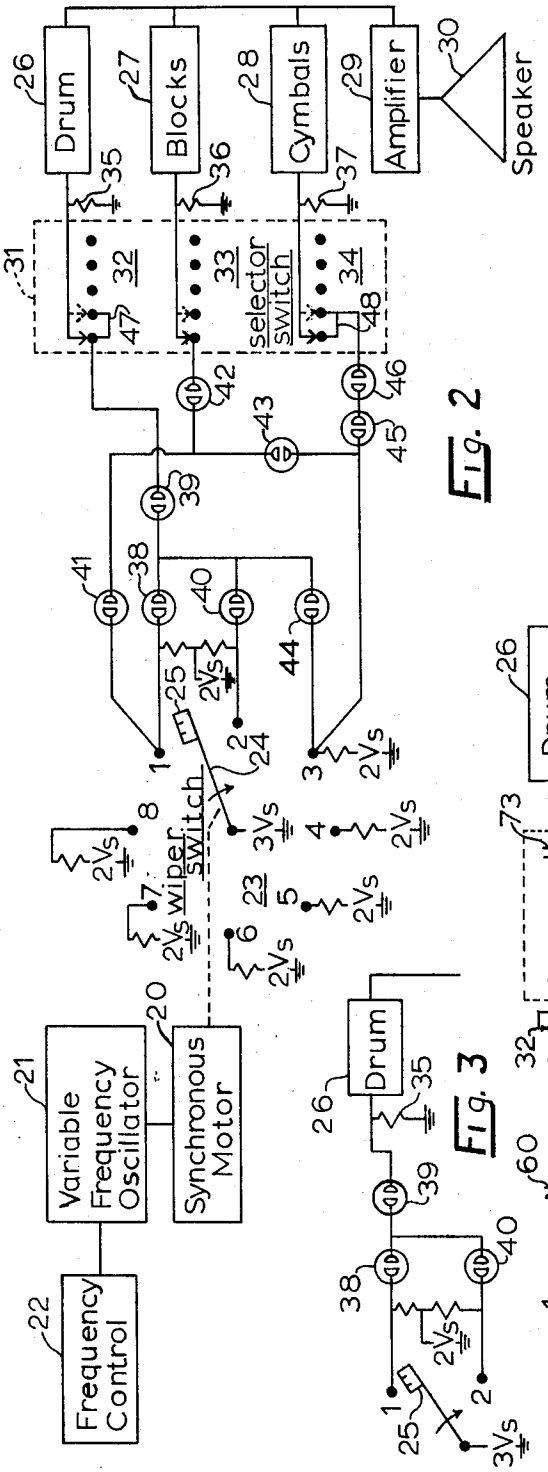



Fig. 2

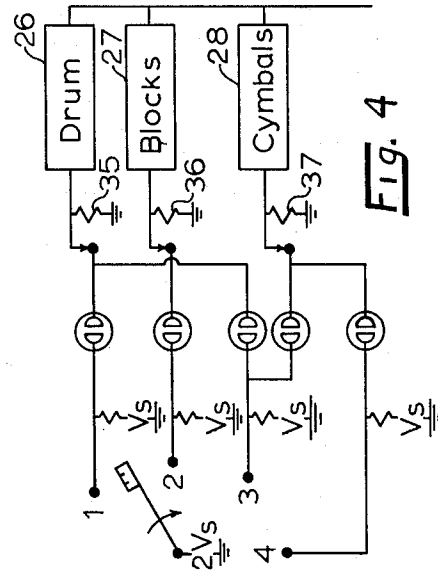



Fig. 4




Fig. 3

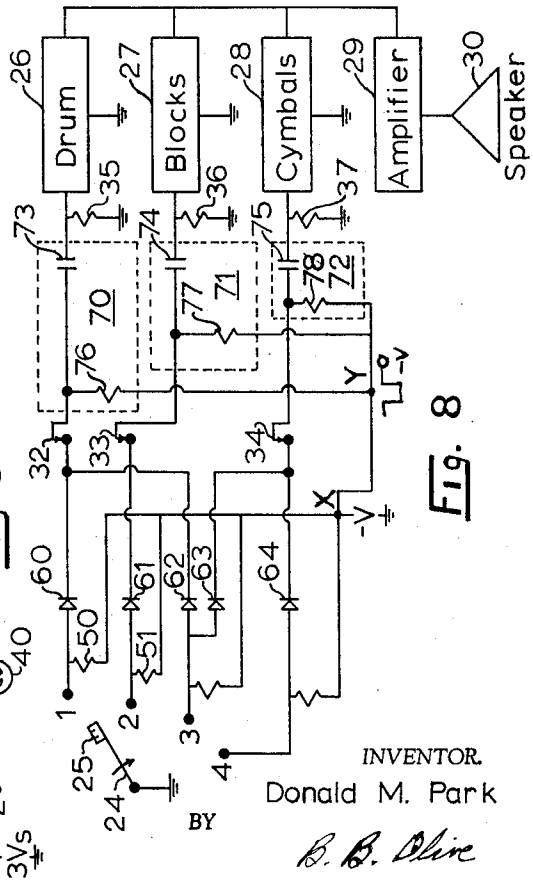



Fig. 8

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United States Patent Office 3,146,290 Patented Aug. 25, 1964



3,146,290

# ELECTRONIC MUSIC CIRCUIT

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Filed Sept. 23, 1963, Ser. No. 310,533
16 Claims. (Cl. 84—1.03)

This invention relates generally to electronic music circuits and, more particularly, to a rhythm control circuit for music instruments which generate percussion sounds electronically.

This application is a continuation-in-part of my copending application "Gaseous Glow Tube Controlled Musical Instrument," Serial Number 166,159, filed January 15, 1962, now Patent No. 3,105,106, granted September 24, 1963, and the description therein is incorporated herein by reference.

One of the more popular electronic musical instruments is known as a "side-man," and its purpose is to produce percussion rhythms. The side man is usually comprised of ten or more "instruments" such as bass drum, tom toms, blocks, cymbals and the like which may be electronically combined to produce rhythms such as the tango, rhumba, fox trot or waltz. The "instruments" are produced electronically by phase shift oscillators or other noise generators, and when played manually or automatically as accompaniment with an electronic organ, they produce pleasing repetitive musical effects. Since the side-man furnishes a concrete example of where my invention may be applied, it is in connection with a side-man type circuit that my invention is explained.

In prior art side-man devices the switching speed, that is, the rhythm speed or tempo, from one instrument to another is controlled by a conventional mechanical variable speed drive. This has introduced various well-known noise and mechanical problems. A conventional wiper switch and wiring has been employed with the drive which has required the use of substantially large numbers of brushes, connection wires and contacts. Due to the number of contacts and various mechanical components required to produce conventional rhythms, the prior art side-man systems have further required a relatively large motor drive and generally have not been found adaptable to complex rhythms. Since speed control has required a manual mechanical movement, the tempo of any particular rhythm has had to remain substantially constant.

It is, therefore, a general object of this invention to provide an improved rhythm control and instrument selection device for electronic musical circuits.

It is another object of the invention to provide such a circuit which gives maximum latitude to complex rhythms.

A further object is to provide such a circuit which permits the rhythm tempo to be electrically controlled by the person playing.

A still further object is to provide an improved rhythm control and instrument selection circuit which has relatively low voltage requirements.

Still another object is to provide such a circuit which does not require bias voltages.

A further object is to provide such a circuit wherein the pulse control elements conduct only unilaterally.

A still further object is to provide such a circuit which produces an audio output which is substantially free of commutator noise.

Other aims and advantages of the invention will become apparent from the following description and appended claims.

In the drawings:

FIG. 1 is a schematic diagram illustrating the principal components of a side-man system;

FIG. 2 is a schematic diagram illustrating one specific



side-man system including an embodiment of the invention using gas discharge tubes;

FIG. 3 is a portion of the diagram of FIG. 2;

FIG. 4 is a schematic diagram of a side-man system including a modified embodiment of the invention using gas discharge tubes;

FIG. 5 is a schematic diagram illustrating a side-man system including another embodiment of the invention using diodes;

FIG. 6 is a portion of the diagram of FIG. 5;

FIG. 7 is a schematic diagram of a side-man system including a modified embodiment of the invention using diodes; and

FIG. 8 is a schematic diagram of another modified embodiment of the invention using diodes.

In accordance with the present invention, there is provided an electronic music circuit having a plurality of tone generators to be selectively pulsed at given times: a pulse generator including a first set of terminal points, a voltage pulse source, and means selectively connecting the source to the first terminal points in predetermined time sequence; switching means including a second set of terminal points operatively connected to respective ones of the tone generators; a network of circuits establishing principal electrical paths from particular first terminal points to particular second terminal points and to the respective tone generators connected thereto, portions of the principal paths being in common, thereby establishing secondary paths between various pairs of the first terminal points; means placed in each of the paths and adapted to establish the principal paths as pulse-transmitting paths responsive to the source and the secondary paths as non-pulse-transmitting, thereby enabling the first terminal points to be electrically isolated one from the other while connected to a plurality of the principal paths.

Generally speaking, the purpose of a side-man device is to provide a source of repetitive percussion rhythms. The conventional side-man circuit is equipped with means to selectively establish a limited number of both rhythms and tempos. FIGS. 1, 2, 3, and 4 and the description related thereto are, to some extent, repetitions of the disclosure set forth in my referred-to copending application Serial Number 166,159. However, since the purpose of this application is to disclose an additional embodiment based on diodes, the description of Serial Number 166,159 is repeated for the purpose of comparing the embodiments and showing the invention in a generic sense. FIG. 1 illustrates the general system employed. The drive **10** of the conventional system is a constant speed motor, and the speed control **11** consists in practice of a roller which can be moved back and forth along the radius of a disc driven by the constant speed motor. The roller in turn acts to drive a wiper switch indicated at **12** which, through a series of wiper brushes and a considerable number of concentrically arranged terminal points serves to selectively transmit pulses from a voltage source indicated at **13** through conventional wiring to any one or combinations of various phase shift oscillators that act as the designated tone generators **14** and whose output is fed to an amplifier **15** and speaker **16**.

In order to be able to change from one rhythm to another in the conventional system, the pulses are fed through a multi-wafer selector switch **17** that has a movable terminal point on each wafer subject to a common manual control. By moving the selector switch **17**, predetermined circuits can be established between the wiper switch **12** contacts and selected tone generators **14**. In order to accomplish all of the desired rhythms usually desired, the conventional wiring system necessarily employs several concentric rows of terminal points in the wiper switch **12** and a rather complex multi-bank selector switch **17**. This is particularly true since the conventional

system does not provide any means to tie the wiper switch contacts into more than one rhythm circuit. The present invention on the other hand provides a circuit means which allows the wiper switch terminal points to appear in a plurality of rhythm circuits while maintaining the terminal points in electrical isolation. The present invention is especially concerned with simplified means for establishing the speed or tempo, and for establishing circuits between the pulse generator section, that is, the wiper switch, and the music section, the tone generators.

Dealing first with the matter of tempo and the diagram of FIG. 2, the present invention employs a synchronous motor **20** driven by a variable frequency oscillator **21** which is under an appropriate frequency control **22**, thereby governing the motor speed and consequently the tempo. The motor **20** may be of the familiar clock timing motor type since the invention allows a substantial reduction in wiper switch contacts which in turn substantially reduces the wiper switch load that must be driven. A suitable type oscillator is a resistance-capacitance type oscillator with either resistance or capacitance control and in a power class sufficient to meet the nominal power required to operate a timing motor. With such an arrangement, speed or tempo may be controlled electrically by regulating the position of a resistor or capacitor. Through any of several well-known arrangements, the resistor or capacitor positioning may be adapted for remote operation thereby enabling remote operation of the tempo.

Motor **20** is connected to a wiper switch generally designated at **23** and drives a constantly rotating wiper arm indicated at **24**. Wiper arm **24** is electrically connected to a voltage source labeled as "$3V_s$" in the drawing and whose meaning is explained later on. As the wiper arm rotates, it periodically connects this source of voltage in consecutive time sequence through a wiper brush **25** to the eight contacts shown. The number of wiper contacts will, of course, vary. The wiper switch may, for example, have a much larger number of contacts distributed over several concentric rows and contacted by several brushes. For purposes of simplification, only a limited number of contacts are shown. It should be pointed out here however, that one of the advantages of the invention is that the number of wiper switch contacts required is greatly reduced as compared to the conventional system, and, as will be seen later, even this simple array of eight wiper switch contacts provides a relatively wide selection of rhythms.

Depending on the speed of rotation of wiper arm **24** as controlled by the frequency control **22**, the eight contacts thus receive periodic voltage pulses at time intervals determined by this speed. These pulses are used to trigger selected ones of the tone generators. For purposes of simplification, the invention is explained with the use of three tone generators, namely, a drum indicated at **26**, blocks indicated at **27**, and cymbals indicated at **28**. The number of tone generators may vary, and it is not uncommon to find as many as ten separate tone generators in side-man circuits. The outputs of the tone generators are combined and fed to an amplifier as indicated at **29** and to a speaker as indicated at **30**.

Connected to the tone generators is a selector switch generally designated at **31**, and whose purpose is to furnish a manual switching means whereby after the circuits between the wiper switch **23** and selector switch **31** are fixed, the selector switch **31** can be manually moved to various positions so as to change the particular tone generators to which the voltage pulses are directed. Selector switch **31** is illustrated as comprising three wafers or banks **32**, **33**, and **34**, each of which by way of example has five contacts and a slider connected to respective ones of the tone generators. For example, it will bee seen that the slider for bank **32** is connected to the drum **26**, the slider for bank **33** is connected to the blocks **27** and the slider for bank **34** is connected to the cymbals **28**. It will be understood that the sliders are physically connected so that they change position together and are controllable by a single manual control knob, not indicated. In this way, the operator can switch to different positions so as to select only a particular tone generator or a particular combination of tone generators.

The output of each slider is fed through suitable tone generator input resistors **35**, **36**, **37** to ground. Pulsing of particular tone generators will thus depend on the position of the selector switch sliders and the speed or tempo at which they are pulsed will depend on the the speed of the motor **20** which in turn will depend on the setting of the controlling electrical element of frequency control **22**. We will now look to what is one of the most important aspects of the invention, namely, the manner in which circuits are made between the pulse generator, the wiper switch, contacts and the contacts feeding the tone generators and which allows a plurality of connections to be made to each wiper switch contact.

An important aspect of the circuits between the wiper switch and selector switch is the employment of gaseous glow tubes, and before proceeding to the actual circuitry, an explanation is made of those characteristics of these tubes that are of particular interest to the invention. Examples of these tubes are found in the very inexpensive neon Ne–2 and Ne–96 types. Here, it is important to recognize that until such a tube breaks down or fires, there is near perfect electrical isolation between the tube electrodes. Another characteristic of interest is that the voltage across the tube immediately prior to firing is substantially higher than is the voltage across the tube after the tube has been fired.

In explanation of the invention, the label "$V_s$" is used to mean the voltage across the tube necessary to sustain firing after the tube has fired. Thus, "$3V_s$" means three times this voltage and "$2V_s$" means twice this voltage. In the one embodiment illustrated, it will be seen that the $3V_s$ source is used to pulse a particular tone generator through a particular circuit containing gaseous tubes adapted to fire when under the influence of this source, whereas the $2V_s$ sources are used as bias voltages to prevent other circuits and tone generators from being activated by preventing firing of the tubes even though they are tied into the circuits that are activated. In a further embodiment hereafter described a $2V_s$ source and $V_s$ biasing voltages are used for similar purposes.

To illustrate how the gaseous tubes are employed to reduce contacts and circuits and to enhance the programming possibilities, three of the wiper switch contacts are illustrated as they might be wired into an actual side-man circuit. In the selector switch, two typical positions are shown, one in solid lines and one in dotted lines, and as previously mentioned, the tone generators are limited to three in number so as to simplify the explanation. While a relatively simple circuit arrangement of this kind brings out the invention, it should be appreciated that the invention's greatest advantages are exhibited in a more complex circuit since more wiper switch contacts, more circuits and more rhythms would be involved, giving more opportunity for the invention to be applied through circuit simplification.

Referring to FIG. 2, when the selector switch sliders are in the lefthand position indicated in solid lines, the respective instruments will be connected through their respective sliders to the left-hand selector switch contacts such as the contacts furthest to the left in wafer banks **32**, **33**, and **34**. Assuming the selector switch sliders are in such position, circuits are established and can be traced between the wiper switch contacts and the instruments. Limiting ourselves to contacts **1** and **2** of the wiper switch and the left-hand contact of wafer bank **32**, we can trace circuits such as illustrated by FIG. 3, representing a portion of FIG. 2.

In FIG. 3, it can be seen, for example, that a circuit

between the $3V_s$ pulse source and drum **35** is completed when the brush **25** contacts contact **1** of the wiper switch. This circuit will include gaseous tubes **38** and **39** in series, which are adapted to be fired by the $3V_s$ source so as to cause a controlling voltage to appear across the input resistor **35**. Now, when brush **25** reaches contact **2**, it will be seen that a separate circuit to the drum **26** is established which includes the previously mentioned gaseous tube **39** and in addition a separate gaseous tube **40** which is selected so as to have a similar firing characteristic. From this it can be seen that contacts **1** and **2** are tied together and that the gaseous tube **39** is common both to the contact **1** circuit and the contact **2** circuit being discussed. However, by biasing the contact **1** circuit and the contact **2** circuit with the $2V_s$ voltage illustrated, any tendency for the $3V_s$ pulse to fire tubes **38** and **40** simultaneously is avoided. In this particular instance it is convenient to use a common $2V_s$ to bias both circuits. With such a basic arrangement, it can be seen that each of the wiper switch contacts can actually be tied into several principal circuits and that at least some of the gaseous tubes may appear in a plurality of circuits.

Reverting to FIG. 2, it will be seen that blocks **27** are tied into contacts **1** and **3** of the wiper switch **23**. As to contact **1**, the circuit connecting the blocks with the wiper switch includes gaseous tubes **41** and **42**. It is to be further seen that contact **3** of wiper switch **23** is tied into the drum **26** through gaseous tubes **45** and **46** and the left-hand contact of wafer **34** of selector switch **31**.

With the arrangement described in FIG. 2, as the wiper arm **24** brings brush **25** in contact with contact **1** of wiper switch **23**, the $3V_s$ voltage will pulse circuits to the drum **26** and blocks **27** but not the cymbals **28** even though the cymbals are tied into this contact **1**. Then, as the wiper arm **24** continues to rotate in the arrow direction indicated, brush **25** will contact the contact **2** which will act to pulse the drum **26** but not the blocks **27** or cymbals **28** even though both are tied back into lines which connect with this contact **2**. Upon reaching contact **3**, all three instruments will be pulsed and accordingly the sound coming out of speaker **30** will represent a blending of all three tones.

While not shown, it is obvious that each of the eight wiper switch contacts can be tied into various circuits and can be used to establish circuits in the manner of the circuits explained in connection with the first three contacts. In each instance the electrical contacts in the pulse generator, the wiper switch, are electrically isolated one from the other because there is never enough potential difference to fire the gaseous tubes along the secondary path connecting the contacts. Thus, the gaseous tube circuits described serve to direct the pulses along the correct principal paths, to the correct instruments and at the correct times.

Referring next to the dotted line positions of the wipers in selector switch **31**, it will be assumed that the selector switch has been rotated so as to bring each wiper to the second contact from the left. Here, the circuits are revised substantially from the circuits previously discussed. For example, with the selector switch wipers in the positions indicated in dotted lines, both contact **1** and contact **2** of the wiper switch when connected to the $3V_s$ source will act to pulse the drum **26** but no other instrument. Contact **3** when connected to the $3V_s$ source will pulse the drum **26** and cymbals **28** under this arrangement. To have this change in musical arrangement, it will be noticed that only the short leader connections **47**, **48** are required. It should further be noticed that the wiper switch contacts remain effectively isolated even though tied together and into a plurality of circuits.

In FIG. 4, there is shown a portion of FIG. 2 with a different glow tube arrangement which illustrates a further embodiment of the invention. For purposes of simplification, only portions of the pulse generator and selector switch sections are shown. In the embodiment of FIG. 4, it will be seen that instead of having two tubes in series in each of the principal paths, only one tube is employed. Accordingly, a lesser pulse voltage indicated as $2V_s$ may be used to open the paths for pulse transmission and a lesser biasing voltage indicated as $V_s$ may be used to block the paths connecting the wiper switch contacts. The reader will understand that the general operation of the one-tube-per-path system is similar to the previously discussed two-tubes-per-path system with the exception of the voltages employed, and therefore, no further detailed discussion is believed necessary.

Although the circuits of FIGS. 2, 3, and 4 represent substantial improvements over the prior art, the glow discharge tubes employed therein require substantial voltages in order to make them break down or fire. Of course, these voltage requirements are multiplied when two or more of the tubes are used in series. Also, additional voltages are required to bias the glow discharge tubes. Moreover, since the glow discharge tubes generally conduct bilaterally (in both directions) when they fire, certain precautions, such as accurate voltage control or the use of additional discharge tubes, have to be taken to avoid undesirable pulses throughout the circuit. The description now turns to an alternative embodiment which the reader can compare with the foregoing description based on gas tube circuitry and from which the invention can be seen in its broadest aspect.

In the circuits of FIGS. 5 through 8, diodes rather than glow discharge tubes are employed as the means adapted to establish the principal paths as pulse-transmitting paths responsive to the voltage source and the secondary paths as non-pulse-transmitting. One of the main features of the glow discharge tubes employed in the circuits of FIGS. 2, 3, and 4 is the amplification which is achieved by reason of the negative resistance characteristic due to the difference between the breakdown and sustaining voltages of the gaseous tube, and it was originally believed that the operation of these circuits was somewhat dependent on this amplification effect. However, it was then surprisingly discovered that an improved circuit could be obtained by the use of diodes which do not provide any amplification effect. The diodes also have extremely low voltage requirements and do not usually require bias voltages. Furthermore, the diodes conduct only unilaterally and, therefore, do not require additional circuit elements or other precautions to prevent the transmission of undesirable pulses throughout the circuit. In addition, whereas the negative resistance characteristics of the glow discharge tubes make it virtually impossible to eliminate all commutator noise, the diodes exhibit only positive resistance in their current-voltage characteristics and, therefore, can be used in circuits which substantially eliminate all commutator noise.

Stated differently, within the broad concept of simplifying the commutator construction and switching circuitry between the commutator and tone generators, the gas tube as well as a preferred kind of diode can be employed in the principal and secondary paths of the invention's circuitry for blocking and current transmission as required. A number of different diodes are suitable for use in the circuits of FIGS. 5–8, but the preferred diodes are those having characteristics approaching as closely as possible the characteristics of an ideal diode. In other words, the diodes should have extremely high back resistance and an extremely low forward resistance. Although it is preferred to use diodes having back resistance sufficiently high to substantially prevent leakage through the diode, means may be provided to short out any such leakage, as hereinafter described. The solid-state silicon diodes are especially useful in this invention, although many other diodes are also suitable.

To illustrate how the diodes are employed to reduce contacts and circuits and to enhance the programming possibilities, three of the wiper switch contacts are illustrated in FIG. 5 as they might be wired into an actual

sideman circuit. As in FIG. 2 above, two typical positions are shown in the selector switch, one in solid lines and one in dotted lines, and the tone generators are limited to three in number so as to simplify the explanation.

Referring now to FIG. 5, the motor **20** is connected to a wiper switch generally designated at **23** and drives a constantly rotating wiper arm **24** connected to a voltage source "V." As will be apparent from the ensuing description, the voltage "V" must be sufficiently high to cause the diodes when connected in series therewith in a forward direction, such as diode **138**, **140**, **141**, **144** or **145**, to conduct and to operate the various tone generators **26**, **27**, and **28**. As the wiper arm rotates, it periodically connects the voltage "V" in consecutive time sequence through a wiper brush **25** to the eight terminal points or contacts shown. The number of wiper contacts will, of course, vary with different musical devices. For example, the wiper switch may have a much larger number of contacts distributed over several concentric rows and contacted by several brushes. For purposes of simplification, only a limited number of contacts are shown.

Referring to FIG. 5, when the selector switch sliders are in the left-hand position, indicated in solid lines, the respective instruments will be connected through their respective sliders to the left-hand selector switch contacts such as the contacts furthest to the left in wafer banks **32**, **33**, and **34**. Assuming the selector switch sliders are in such position, the circuits are established and can be traced between the wiper switch contacts and the instruments. Limiting ourselves to contacts **1** and **2** of the wiper switch and the left-hand contact of wafer bank **32**, we can trace circuits such as illustrated by FIG. 6, representing a portion of FIG. 5.

In FIG. 6, it can be seen that a circuit between the pulse source "V" and the drum **26** is completed when the brush **25** contacts contact **1** of the wiper switch. This circuit includes a diode **138**, which is made to conduct by the pulse source "V" so as to cause a controlling voltage to appear across the input resistor **35** for the drum **26**. When the brush **25** reaches contact **2**, it can be seen that a separate circuit to the drum **26** is established which includes a diode **140** similar to the diode **138**. It can be seen that the principal paths between contacts **1** and **2** and drum **26** are partly in common and that although contacts **1** and **2** are tied together through a secondary path, the diodes **138** and **140** prevent conduction of a pulse from either of the contacts back through the secondary path to the other contact. With such a basic arrangement, it can be seen that each of the wiper switch contacts can actually be tied into several principal circuits with the assurance that a pulse from any of the contacts will be directed to the appropriate tone generator.

It is important to note at this point that since the diodes conduct only unilaterally, they prevent the transmission of undesirable pulses throughout the system. Also, the diodes require no bias voltage whatever. As mentioned above, it is preferred to use diodes having extremely high back resistance in order to prevent leakage. However, as an extra precaution, a resistor such as **50** or **51** is connected from the input side of each diode to ground so as to short out any leakage which may occur through the diodes.

Referring to FIG. 5, it can be seen that the blocks **27** are tied into contacts **1** and **3** of the wiper switch **23**. Contact **1** is tied into the blocks **27** through a diode **141**, and contact **3** is tied into the blocks **27** through a diode **145**. It can also be seen that contact **3** is tied into the drum **26** through a diode **144**, and into the cymbals **28** through the diode **145**.

With the arrangement shown in FIG. 5, as the wiper arm **24** brings the brush **25** into contact with contact **1** of the wiper switch **23**, the pulse voltage "V" pulses circuits to all three instruments, i.e., the drum **26**, blocks **27**, and cymbals **28**, and the sound coming out of the speaker **30** represents a blending of all three tones. Then as the wiper arm **24** continues to rotate in the direction indicated by the arrow, the brush **25** contacts the contact **2** which acts to pulse the drum **26** but not the blocks **27** or the cymbals **28**; even though both these instruments are tied back into lines which connect with the contact **2**, the diodes block the transmission of pulses from contact **2** to these instruments. When the brush **25** contacts contact **3**, the drum **26** and the cymbals **28** are pulsed, but the blocks **27** are not pulsed because of the diodes **138** and **143**.

While not shown, it is obvious that each of the eight wiper switch contacts can be tied into various circuits and can be used to establish circuits in the manner of the circuits explained in connection with the first three contacts. In each instance, the electrical contacts in the pulse generator (the wiper switch) are electrically isolated one from the other because the diodes conduct only unilaterally and, therefore, never conduct along the secondary paths connecting the contacts. Thus, the diode circuits described serve to direct the pulses along the correct principal paths, to the correct instruments, and at the correct times.

Referring next in FIG. 5 to the dotted line positions of the wipers in selector switch **31**, it will be assumed that the selector switch has been rotated so as to bring each wiper to the second contact from the left. Here, the circuits are revised substantially from the circuits previously discussed. For example, with the selector switch wipers in the positions indicated in dotted lines, contact **1** of the wiper switch, when connected to the pulse source "V," will pulse the drum **26**, and contact **3** will pulse the drum **26** and the cymbals **28** under this arrangement. To have this change in musical arrangement, it will be noticed that only the short leader connections **47** and **48** are required. It should further be noticed that the wiper switch contacts remain effectively isolated even though tied together and into a plurality of circuits.

Although the pulse voltage supply "V" is shown in FIG. 5 as being connected between the wiper arm **24** and ground, it will be understood that this voltage supply can be connected anywhere in series with the principal electrical paths between the wiper brush contacts and the tone generators **26**, **27**, and **28**. One such modification is illustrated in FIG. 7. For purposes of simplification, only portions of the wiper switch **23**, the selector switch **31**, and the various connecting circuits are shown in FIG. 7. In the embodiment of FIG. 7, the pulse voltage supply "V" is connected in series between each wafer bank **32**, **33**, or **34**, and the respective tone generator input resistor **35**, **36**, or **37** connected thereto. The diodes **61** through **64** are maintained in normally non-conducting states by a bias voltage "—V" between the leakage-shorting resistors, such as **50** or **51**, and ground. The "—V" bias must be at least as high as the main voltage pulse source. It will be readily apparent that the operation of this system is similar to that of FIG. 5 and, therefore, no further detailed discussion is believed necessary.

Although the circuits illustrated in FIGS. 5 and 7 are satisfactory for many applications, especially in relatively low-cost electronic organs, these circuits produce a small amount of commutator noise. However, even this small amount of noise is eliminated by the improved circuit of FIG. 8. The embodiment of FIG. 8 is similar to that of FIG. 7 except that the pulse voltage supply comprises a resistance-capacitance network generally indicated as **70**, **71**, or **72** connected to ground through a common voltage source indicated as "—V." Each of the resistance-capacitance networks **70**, **71**, and **72** is connected between one of the wafer banks **32**, **33**, or **34** and the

input resistor of the respective tone generator connected thereto. The capacitor **73**, **74**, or **75** of each RC network is connected in series with the selector switch **31** and the respective tone generators **26**, **27**, and **28**; while the resistor **76**, **77**, or **78** or each RC network and the common voltage source "—V" are connected in parallel with the input resistor **35**, **36**, or **37** of the respective tone generators.

During operation of the circuit of FIG. 8, the capacitors **73**, **74**, and **75** are charged by the "—V" source while the wiper brush **25** is passing between the wiper switch contacts. Of course, the capacitor values must be chosen such that they charge sufficiently fast with the particular voltage source and commutator speed employed. Then during commutation, i.e., while the brush **25** is in contact with one of the wiper brush contacts, the particular capacitor or capacitors connected to that contact discharges through the wiper arm **24** to ground, thereby supplying a voltage pulse to the respective tone generator connected to the discharging capacitor. In the particular arrangement shown in FIG. 8, for example, when the brush **25** is in contact with contact **1**, capacitor **73** is discharged, thereby pulsing the drum **26**. When the brush engages contact **2**, capacitor **74** is discharged, thereby pulsing the blocks **27**. When the brush engages contact **3**, both capacitor **73** and capacitor **75** are discharged, thereby pulsing the drum **26** and the cymbals **28**. When the brush engages contact **4**, capacitor **75** is discharged, thereby pulsing the cymbals **28**.

In the special RC pulse generating system shown in FIG. 8, it has been found that it is important that diodes rather than neon tubes be employed to establish the various pulse-transmitting and non-pulse-transmitting paths. It is believed that the diodes are essential because the negative resistance characteristic of the neon tubes produces a sustained oscillation when such tubes are used with the RC network, whereas the diodes do not have negative resistance characteristics and, therefore, cannot oscillate. Thus, the combination of the diodes with the RC voltage supply system produces an audio output which is surprisingly free of commutator noise.

While various specific forms of the invention in its broad and narrow concepts have been illustrated and described herein in some detail and in the referred-to copending application Serial Number 166,159, it will be understood that variations thereof may be employed without departing from the spirit and scope of the invention. For example, other drive and speed control arrangements could be used in combination with the pulse generator section. A multivibrator oscillator and various other electrical indexing rotating devices could, for example, furnish the power and timing requirements of a system employing the diode circuits of this invention.

As a further alternative, the connection between points X and Y in FIG. 8 may be removed, and an electronic gate voltage level, represented by the wave symbol at point X, varying from zero to minus V voltage inserted at point X which enables voltage control of point X. By voltage controlling point X, all principal paths are controlled simultaneously so as to be able to gate the entire rhythm pattern such as a rhumba which contains many instruments operating in a complex pattern. The very establishment of the principal paths becomes dependent upon the level. If zero voltage is present at X, the resistors **76**, **77**, and **78** discharge the diode side of all condensers **73**, **74**, and **75** and does not allow conduction in any of the diodes in the gated network. When X is at minus V, potential condensers **73**, **74**, and **75** charge to minus V, enabling diodes **60** to **64** to close the principal paths where the commutator grounds points **1**, **2**, **3**, and **4**. It is apparent, of course, that the gate network shown in FIG. 8, for example, may be a small part of a more complex network making up a larger system. Thus, the invention meets a further, not heretofore mentioned, object of providing control rhythm selection with a voltage gate.

What is claimed is:

1. In an electronic music circuit having a plurality of tone generators to be selectively pulsed at given times: a pulse generator including a first set of terminal points, a voltage pulse source, and means selectively connecting said source to said first terminal points in predetermined time sequence; switching means including a second set of terminal points operatively connected to respective ones of said tone generators; a network of circuits establishing principal electrical paths from particular first terminal points to particular second terminal points and to the respective tone generators connected thereto, portions of said principal paths being in common, thereby establishing secondary paths between various pairs of said first terminal points; means placed in each of said paths and adapted to establish said principal paths as pulse-transmitting paths responsive to said source and said secondary paths as non-pulse-transmitting, thereby enabling said first terminal points to be electrically isolated one from the other while connected to a plurality of said principal paths.

2. An electronic music circuit as claimed in claim 1 wherein said switching means includes manual control means allowing each of said tone generators a choice of particular ones of said second terminal points to which it is connected, thereby enabling said tone generators to be selectively connected to particular ones of said first terminal points.

3. An electronic music circuit as claimed in claim 1 wherein said means for connecting said source to said first terminal points comprises a rotating-type switch, a synchronous motor drive, a variable frequency drive source, and a frequency control for said drive source, thereby enabling the tempo of said music to be determined by the setting of said control.

4. In an electronic music circuit having a plurality of tone generators to be selectively pulsed at given times: a pulse generator including a first set of terminal points, a voltage pulse source, and means selectively connecting said source to said first terminal points in predetermined time sequence; switching means including a second set of terminal points connected to respective ones of said tone generators; a network of circuits establishing principal electrical paths from particular first terminal points to particular second terminal points and to the respective tone generators connected thereto, portions of said principal paths being in common, thereby establishing secondary paths between various pairs of said first terminal points; diodes placed in each of said paths and adapted to establish said principal paths as pulse-transmitting paths responsive to said source and said secondary paths as non-pulse-transmitting, thereby enabling said first terminal points to be electrically isolated one from the other while connected to a plurality of said principal paths.

5. An electronic music circuit as claimed in claim 2 wherein said diodes have a back resistance sufficiently high to substantially prevent leakage through said diodes.

6. An electronic music circuit as claimed in claim 5 wherein said diodes are silicon diodes.

7. An electronic music circuit as claimed in claim 5 wherein means are provided for shorting out any leakage through said diodes.

8. In an electronic circuit having a plurality of electrical devices to be selectively pulsed at given times: a pulse generator including a first set of contacts, a voltage pulse source, and means selectively connecting said source to said first contacts in predetermined time sequence; switching means including a second set of contacts connected to respective ones of said devices; a network of circuits establishing principal electrical paths from particular first contacts to particular second contacts and to the respective drives connected thereto, portions of said principal paths being in common, thereby establishing secondary paths

between various pairs of said first contacts; diodes placed in each of said paths and adapted to establish said principal paths as pulse-transmitting paths responsive to said source and said secondary paths as non-pulse-transmitting, thereby enabling first contacts to be electrically isolated one from the other while connected to a plurality of said principal paths.

9. An electronic circuit as claimed in claim 8 wherein said switching means includes manual control means allowing each of said devices a choice of particular ones of said second contacts to which it is connected, thereby enabling said devices to be selectively connected to particular ones of said first contacts.

10. An electronic circuit as claimed in claim 8 wherein said means for connecting said source to said first contacts comprises a rotating-type switch, a synchronous motor drive, a variable frequency drive source, and a frequency control for said drive source thereby enabling the speed of said pulse generator to be determined by the setting of said control.

11. An electronic circuit as claimed in claim 8 wherein said diodes have low forward resistance and back resistance sufficiently high to substantially prevent leakage through said diodes.

12. In an electronic music circuit having a plurality of tone generators to be selectively pulsed at given times: a set of terminal points and a network of circuits establishing principal electrical paths from particular terminal points to particular tone generators, portions of said principal paths being in common, thereby establishing secondary paths between various pairs of said terminal points; a voltage pulse source including a capacitor connected in series with each of said principal electrical paths, and a resistor and a voltage source connected in series with each other from one side of said capacitor to ground, said resistor and said voltage source being in parallel with each of said tone generators; means for operatively connecting said voltage pulse source to selected ones of said terminal points in predetermined time sequence; and means placed in each of said paths and adapted to establish said principal paths as pulse-transmitting paths responsive to said source and said secondary paths as non-pulse-transmitting, thereby enabling said terminal points to be electrically isolated one from the other while connected to a plurality of said principal paths.

13. An electronic music circuit as claimed in claim 12 wherein said means adapted to establish said principal paths as pulse-transmitting paths and said secondary paths as non-pulse-transmitting, exhibits only positive resistance in its current-voltage characteristics.

14. In an electronic music circuit having a plurality of tone generators to be selectively pulsed at given times: a first set of terminal points, switching means including a second set of terminal points operatively connected to respective ones of said tone generators, and a network of circuits establishing principal electrical paths from particular first terminal points to particular second terminal points and the respective tone generators operatively connected thereto, portions of said principal paths being in common, thereby establishing secondary paths between various pairs of said first terminal points; a voltage pulse source including a capacitor connected in series with each of said principal paths between each of said second terminal points and the respective tone generator operatively connected thereto, and a resistor and a voltage source connected in series with each other from between each of said capacitors and said second terminal points to ground, said resistor and said voltage source being in parallel with the respective tone generator associated therewith; means for operatively connecting said voltage pulse source to selected first terminal points in predetermined time sequence; and diodes placed in each of said paths and adapted to establish said principal paths as pulse-transmitting paths responsive to said source and said secondary paths as non-pulse-transmitting, thereby enabling said first terminal points to be electrically isolated one from the other while connected to a plurality of said principal paths.

15. In an electronic music circuit having a plurality of tone generators to be selectively pulsed at given times: a pulse generator including a first set of terminal points, a voltage source, switching means operatively connecting said voltage source to said first terminal points in predetermined time sequence, and a resistor-capacitor circuit operatively connected between said voltage source and said first terminal points so that the capacitor charges when said switching means is not connected to any of said points and discharges when said switching means including a second set of terminal points is operatively connected to respective ones of said tone generators; a network of circuits establishing principal electrical paths from particular first terminal points to particular second terminal points and to the respective tone generators connected thereto, portions of said principal paths being in common, thereby establishing secondary paths between various pairs of said first terminal points; and a diode placed in each of said paths and adapted to establish said principal paths as pulse-transmitting paths responsive to said source and said secondary paths as non-pulse-transmitting, thereby enabling said first terminal points to be electrically isolated one from the other while connected to a plurality of said principal paths.

16. In an electronic music circuit having a plurality of tone generators to be selectively pulsed at given times: a pulse generator including a first set of terminal points, a voltage source comprising an electronic gate voltage level, switching means operatively connecting said voltage source to said first terminal points in predetermined time sequence, and a resistor-capacitor circuit operatively connected between said voltage source and said first terminal points so that the capacitor charges when said switching means is not connected to any of said points and discharges when said switching means including a second set of terminal points is operatively connected to respective ones of said tone generators; a network of circuits establishing principal electrical paths from particular first terminal points to particular second terminal points and to the respective tone generators connected thereto, portions of said principal paths being in common, thereby establishing secondary paths between various pairs of said first terminal points, the establishment of said principal paths being dependent upon the level of said source; and means placed in each of said paths and adapted to establish said principal paths as pulse-transmitting paths responsive to said source and said secondary paths as non-pulse-transmitting, thereby enabling said first terminal points to be electrically isolated one from the other while connected to a plurality of said principal paths.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 2,200,235 | Aufiers | May 7, 1940 |
| 2,541,051 | Hanert | Feb. 13, 1951 |
| 2,607,255 | Bourn | Aug. 19, 1952 |