KEYBOARD OSCILLATOR CIRCUIT

Richard H. Campbell, Jr., Gifford, N.H., assignor to The Seeburg Corporation, Chicago, Ill., a corporation of Delaware

Filed June 26, 1964, Ser. No. 378,296
2 Claims. (Cl. 84—1.01)

This invention relates generally to electronic musical instruments and more particularly to an oscillator circuit for such instruments which can be frequency controlled in a manner to derive the tone frequencies individual to the keys of a keyboard for the full tone frequency range of the keyboard.

A feature of the invention is the provision of all solid state components in a novel tone generator circuit that permits a wide range of tones to be generated with accuracy and repeatability in a circuit which is inherently stable to achieve consistent reproduction which is maintained for long periods of time and is relatively simple to recalibrate, i.e. retune, by means of simple adjustments than can be made in the home.

Further features of the invention include an output key selector for applying the oscillator derived tone frequency to suitable voice circuits and voice selection means for selectively emitting individual tone signals after the key which produced such signals has been released by the player.

Other features and objects of the invention will become apparent from the following detailed description taken in conjunction with the single figure of the drawings which shows a schematic wiring diagram of the oscillator and associated circuit.

In the preferred embodiment of the invention shown in the drawing a two-level power supply is employed, the details of which are now shown. For this purpose any conventional power supply arrangement can be used to produce at terminal 11 a positive fifteen volt source and at terminal 12 a positive twenty-eight volt source with a fifty volt supply regulated relative to the fifteen volt supply so that the difference in voltage between terminals 11 and 12 is maintained constant within very narrow limits. A keyboard voltage divider 20 is connected between the terminals 11 and 12 via a path which runs from terminal 11 through an adjustable resistor 13 and a series of fixed resistors 14, 15, 16, 17, 18, 19, 21 and a line connecting resistor 21 to terminal 12. As indicated, between resistors 14 and 15 a desired number of additional resistors may be present in the voltage divider. A shunt resistor 22 is connected from the terminal 11 to the junction of resistors 19 and 21.

A set of tuning contacts 23 is connected with one transfer contact 24 for each resistor 15 through 19 of the voltage divider 20. As illustrated for example, for the resistor 16, the transfer contact 24 is normally engaged contact 25, which is connected to the next transfer contact of the set of switches 23. When the key of the keyboard, not shown, corresponding to the tone controlled by the switch 24 is depressed, the transfer contact 24 makes contact with contact 26, thereby applying to the transfer contact 24 the voltage existing at the junction of resistors 15 and 16. As indicated for all of the switches of the set 23 the transfer contacts 24 normally engaging the contacts 25 are connected to the next lower voltage transfer contact so that upon actuation of any key a voltage is applied serially through the remaining lower voltage steps of the set of switches 23 to apply the selected junction voltage from the voltage divider 20 to a storage capacitor 27. Thus, as illustrated, if the transfer contact 24 for resistor 16 is transferred to contact 26, the capacitor 27 will be charged to the difference in potential between the positive fifteen volt supply from terminal 11 and the voltage existing at the junction of resistors 15 and 16. It will be noted with the arrangement of the set of switches 23 that if two keys are depressed simultaneously resulting in the transfer switching of two contacts 24 of the set, only the lower voltage contact is effective to transfer a potential to the capacitor 27.

The voltage across capacitor 27 determines the base potential of a transistor 31 which forms the input of a solid state integrator feedback network 32, the output of which on line 33 is a low impedance voltage source, the magnitude of which represents the level of charge of capacitor 37. This voltage is applied through a resistor 34 and an adjustable resistor 35 to the emitter of a transistor 36 which operates to convert the voltage input to a constant current output representative of the voltage level on line 33. The collector of transistor 36 is connected to charge a capacitor 37 relative to ground. The capacitor 37 is connected across the junction of an uni-junction transistor 38. The transistor 38 has one base connected to ground at 39, an emitter lead 41 connected to the junction of capacitor 37 and the collector of transistor 36 and the other base electrode is connected through a 680 ohm resistor 42 to the positive fifteen volt supply from terminal 11.

In the operation of the circuits just described the charge across capacitor 27 is translated by the solid state memory circuit 32 into a voltage on line 33 which accurately represents and maintains the level of the voltage divider 20 which has been selected by one of the switches 24. The voltage on line 33 is converted into a constant current analogue by the transistor 36 and charges the capacitor 37 until the voltage across the capacitor 37 reaches the breakdown voltage level for the emitter 41 of the uni-junction transistor 38. Upon breakdown of the junction of the transistor 38 the capacitor 37 is discharged, the junction of transistor 38 becomes nonconductive and the relaxation oscillation consisting of alternately charging and discharging capacitor 37 occurs at a frequency determined by the current magnitude delivered by the transistor 36. This wave across capacitor 37 is utilized to derive tone frequency signals which are integrated related to the frequency of the relaxation oscillation across capacitor 37.

The wave across capacitor 37 is coupled to two cascaded flip-flop stages 43 and 44 which operate as binary counters to produce an output on line 45 which is a square wave of one-half the relaxation oscillation input frequency and from line 46 a square wave which is one-half of the frequency of the square wave on line 45. The square waves on lines 45 and 46 are coupled to output terminals 47 and 48 respectively whenever diodes 51 and 52 are conductive. Thus for a frequency range of the uni-junction oscillator from 128 to 512 cycles per second the output on terminal 47 will correspond to the eight foot output tone range of 64 to 256 cycles per second and the tone range on terminal 48 will correspond to the sixteen foot output of 32 to 128 cycles per second.

For enabling the diodes 51 and 52 to pass the tone signals to the output terminals 47 and 48, a set of keying contacts 53 is provided. As shown this keying circuit has an individual contact 54 ganged with the corresponding transfer contact 24 of the switch 23. As an alternative construction a single contact could be employed actuated by any individual transfer switch 24 of the set of contacts 23. Actuation of any key in the keyboard to operate the one contact 24 will also operate the keying contact 54 associated therewith to apply positive potential from terminal 11 to a line 55 which is connected to a diode 56 poled to be conductive when the positive voltage is applied by the switch 54.
When diode 56 is conductive a large storage capacitor 57 is charged to a fixed voltage corresponding to the supply voltage from terminal 11. The capacitor 57 is connected to the base of a transistor 58 and the voltage across the capacitor 57 determines the base voltage of the transistor 58. With capacitor 57 charged to a positive potential the transistor 58 becomes conductive applying positive potential from terminal 11 to the midpoint of two resistors 61 and 62 which are bridge connected with two additional resistors 63 and 64 to control conduction of the diodes 51 and 52. Just as long as transistor 58 is conductive the potential applied to the diodes 51 and 52 through resistors 61 and 62 renders the diodes 51 and 52 conductive and applies the tone signals from the flip-flops 43 and 44 to the output terminals 47 and 48 respectively.

When the keying contact 54 is open due to the release of the key which actuated it to a closed position, the line 55 is an open circuit and diode 56 becomes nonconductive due to the positive potential on capacitor 57. The charge on capacitor 57 leaks off through a relatively large resistor 65 thereby maintaining the transistor 58 conductive in a substantially continuous manner if successive keys of the keyboard are played relatively rapidly. In order to introduce a dying away effect of the sound a pair of resistors 66 and 67 are arranged to be connected from ground 68 to the junction of diode 56 and charging resistor 59 for the capacitor 57. By means of switches 71 and 72, two resistors 66 and 67 may be connected as alternate discharge paths for the capacitor 57 and by selecting the values of the resistors 66 and 67 different discharge time constants can be obtained. Accordingly, with switches 71 and 72 closed, the charge on capacitor 57 leaks off in a relatively rapid manner and the transistor 58 is cut off shortly after the key which actuated switch 54 is released, thereby controlling the time in which the diodes 51 and 52 become nonconductive to stop the transmission of tone signals to the output terminals 47 and 48. With either or both of switches 71 and 72 open, a longer sustained tone is achieved.

From the foregoing description the operation of the invention will be apparent to those skilled in the art. Briefly, the disclosed circuit provides an all solid state relaxation oscillator controlled by a frequency control signal derived from a memory circuit which maintains the frequency constant at its established level for each key that is played. The output keying circuit controls the application of the ultimate tone frequency signals to the output terminals and permits sustained or decaying signals to be obtained. The unijunction transistor 38 may be a commercial type 2N2646 and provides with capacitor 37 a relaxation oscillator for maintaining the desired frequency from which the tone frequencies are derived. By adjusting the resistance 13 the voltage increments across the successive resistors 15-22 of the voltage divider 20 can be established thereby determining the tuning spread or frequency increment represented by the voltage across each resistor of the voltage divider 20. By this means the appropriate frequency increment can be obtained to make the successive keys of the keyboard which operate the transfer switches 24 related in accordance with the musical tone scale. By adjusting the resistor 35 the tuning range for the oscillator 38 can be established thereby permitting the frequency range for the total span of voltage increment to correspond to the total frequency range for the keyboard instrument. Thus the complete tuning of the instrument can be accomplished by means of the two adjustments for resistors 13 and 35 in a relatively simple manner and by the nature of the regulated voltage supplies and the inherent stability of the solid state circuits the tuning can be maintained accurately for long periods of time.

Many modifications of the present invention will occur to those skilled in the art and are to be considered within the purview of the invention as defined by the scope of the appended claims.

I claim:

1. A keyboard operated tone generator comprising a unijunction transistor, a capacitor connected across the junction of said transistor, a controlled variable charging circuit for said capacitor said charging circuit including a constant current transistor connected to charge said capacitor and a transistor feedback circuit connected to control said constant current transistor to supply a predetermined range of current values, a keyboard, an adjustable resistor and a plurality of fixed resistors proportioned according to the notes of said keyboard connected in series across a regulated voltage source, a memory capacitor, switch means operated by the keys of said keyboard to charge said memory capacitor to the voltage between adjacent ones of said resistors corresponding to the actuated key of said keyboard, a connection from said memory capacitor to the input of said feedback circuit for controlling said charging circuit to make the relaxation period for charging said capacitor connected across said junction to the voltage breakdown level of said junction inversely related to the tone frequency for said actuated key, means for coupling a pulse wave from said transistor corresponding to the frequency of breakdown of said junction, and means responsive to said pulse wave for deriving a tone frequency wave integrally related to said pulse wave, said adjustable resistor controlling by means of a single adjustment the relative tuning spread between the respective keys of said keyboard irrespective of the tone frequency range of said tone generator.

2. Apparatus according to claim 1 and including a second adjustable resistor series connected between the output of said feedback circuit and said constant current transistor for adjusting the tone frequency range of said tone generator.

References Cited by the Examiner

UNITED STATES PATENTS

2,403,664 7/1946 Langer .................. 331—179
2,483,823 10/1949 George .................. 331—179 X
2,486,208 10/1949 Renstra .................. 331—179 X
2,540,727 2/1951 Hanert .................. 331—179 X
2,792,738 5/1957 Donahue .................. 331—179 X
2,987,577 6/1961 Faulkner .................. 307—88.5 X
3,180,918 4/1965 Harmon .................. 84—1.26
3,196,201 7/1965 McDonald .................. 307—88.5 X
3,214,708 10/1965 Chamberlain ................. 307—88.5 X

OTHER REFERENCES


ARTHUR GAUSS, Primary Examiner.
I. C. EDELL, Assistant Examiner.