

SPECIFICATION

Improvements in or relating to electronic tone generators and musical instruments

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This invention relates to electronic tone generators and musical instruments and has for its object to provide improved entirely electronic tone generators and musical instruments capable of producing very pleasing and musically effective tones.

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According to this invention an electronic tone generator or musical instrument wherein sound output of pleasing and musically effective tonal quality is obtained by electronically producing and combining a plurality of signals representative of a plurality of tones and reproducing the same by an electro-acoustic transducer is characterised by the provision, in combination, of an oscillator of predetermined frequency; means for producing pulses of at predetermined short intervals; at least one memory for storing musical scale and time data; at least one memory input counter for reading out from said memory data stored therein; at least two first programmable counters for dividing output signals from said oscillator to provide notes in a musical scale in accordance with data stored in said memory, said first programmable counters being synchronously controlled in accordance with data stored in said memory; at least one second programmable counter controlled in accordance with time data stored in said memory for determining the tone timing, said second programmable counter being connected to supply output to the memory input counter and to receive input from said pulse producing means; and means for combining outputs from said first programmable counters or signals derived from said outputs and supplying the combined resultant to electro-acoustic reproduction means.

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One embodiment of the invention includes two memories each with its own input counter; means for synchronously reading out from said memories data stored therein; two first programmable counters for dividing output signals from the oscillator to provide notes in a musical scale in accordance with data stored in the memories, said first programmable counters being respectively controlled by data stored in a respective memory; two second programmable counters controlled by time data stored in the respective memories for determining times, said second programmable counters being connected to supply outputs to the respective memory input counters and to receive input from said pulse producing means; and means for combining outputs from the first programmable counters or signals derived from said outputs and supplying the combined resultant to electro-acoustic reproduction means.

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Apart from the electric acoustic transducer the apparatus shown in Figure 2 can be incorporated readily in an integrated circuit structure such as a C-MOS integrated structure.

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The invention is illustrated and further explained in connection with the accompanying drawings in which:-

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Figure 1 is a block diagram provided for the pur-

pose of preliminary explanation;

Figure 2 is a block diagram of an embodiment of this invention;

Figure 3 shows three waveforms each having less overtone components than a rectangular wave;

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Figures 4(a), 4(b) and 4(c) show forms of wave shaping circuits which can be used in the embodiment shown in Figure 2; and

Figure 4(d) is an explanatory graphical Figure.

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Referring to Figure 1 which is a block diagram of a generator or instrument having a programmable counter which regenerates scale and time data memorised by a memory. In Figure 1 scale and time data memorised by a memory 1 is read out in accordance with addresses designated by an address counter 2. A programmable counter 4 frequency divides pulses produced by an oscillator 3 in accordance with scale data memorised by the memory circuit, the division ratio being changed in correspondence with the memorised scale data. Output from the programmable counter is amplified by an amplifier 5 and fed to an electro-acoustic transducer such as a loud speaker 6. In order to make the sounds produced more pleasing to the listener the amplifier 5 may be arranged to change the waveform by including therein suitable filtering means. Another way of achieving this result is to synchronise the amplifying ratio of the amplifier 5 with the data read out from the memory 1 and change said amplifying ratio so as to provide a desired output waveform envelope from said amplifier 5. Time data stored in the memory 1 is read out simultaneously with the above-mentioned reading out of scale data and used to vary the division ratio of a programmable counter 8. In order to determine time, the counter 8 divides pulses from a generator 7, which produces pulses of shortest time and thus a rhythm is provided. Preferably the generator 7 produces its output by dividing pulses from the oscillator 3.

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The apparatus shown in Figure 1 cannot produce more than a mere main melody or tune and its sound output quality is not pleasing for it is monotone in character and such an apparatus is considered generally to be markedly inferior, as regards musical quality to an ordinary so-called music box. It has, of course, the advantages which result from the use of electronic circuits including that one electronic instrument can produce various different tunes; there is no spring which the user must wind; and the tone quality, such as it is, the speed at which a tune is played, and the starting and stopping of performance, are easy to control. However, because of the poor musical quality, such instruments have not achieved any great popular success.

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The present invention seeks to provide improved electronic tone generators and musical instruments which have the foregoing advantages but without the foregoing disadvantage and which have sufficiently good musical qualities as to be pleasing to the average listener, especially since they are capable of playing a main melody with an accompaniment thereto.

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Figure 2 is a block diagram of one embodiment of the invention. The apparatus comprises a generator

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22 which produces the shortest time period pulses required; an oscillator 21 (preferably the output from generator 22 is obtained by frequency dividing pulses from the oscillator 21); first and second memories 23 and 23' which memorise data of scale and time; first and second counters 24 and 24' which designate addresses for the memories; first and second programmable counters 25 and 25' which divide pulses produced by oscillator 21 and which make melodies by being caused to change their division ratios in accordance with the scale data stored in the first and second memories respectively; first and second programmable counters 27 and 27' which achieve time determination by dividing pulses from the oscillator 22 by being caused to change their division ratios in correspondence with time data stored in the memories 23 and 23'; first and second waveform shaping circuits 28 and 28' which shape the output waveforms from the programmable counters 25 and 25' respectively; first and second waveform envelope forming circuits 29 and 29' fed with output from the circuits 28 and 28' respectively; a summation amplifier 30 which sums and amplifies the outputs from the circuits 29 and 29' and weights them with respect to one another in a desired manner; an electro-acoustic transducer such as a loud speaker 31 which receives the output from the amplifier 30; and means for synchronising the first and second address counters 24 and 24' by signals applied at a terminal 32.

When the outputs from the address counters 24 and 24' are unchanged; the programmable counters 25 and 25' produce tones of the same frequency in succession since the division ratios of said programmable counters 25 and 25' remain unaltered. When the contents of the address counters 24 and 24' take one count forward, tones having the frequencies of the next notes are produced, since the inputs to the programmable counters 25 and 25' from the memories 23 and 23' respectively determine the division ratios of said counters. The speeds at which the contents of the address counters 24 and 24' go forward are changed in accordance with time in dependence upon what is the shortest time in a desired tune. To give a concrete example, if a quaver is the shortest time in a desired tune, the oscillator 22 is regulated to produce a pulse with a period of a quaver; the memories 23 and 23' are stored with melody (scale) together with such division ratios as will divide the pulse frequency by two in the case of a crotchet or into four in the case of a minim ... and so on; data in the memories 23 and 23' is read out sequentially and the items of data, divided one by one, are read out and applied to the address counters 24 and 24' respectively; and the speeds at which the address counters go forward are changed in correspondence with times. As will now be seen the embodiment of Figure 2 makes use of a common generator for two systems (there could be more) which have respective memories. One memory is stored with the data of a main melody and the other is stored with the data of an accompaniment. The respective memories are stored with their data independently and the outputs of the two systems are summed, amplified, and weighted in a desired man-

ner and the summed and weighted resultant is transformed into sound. Since a main melody and an accompaniment have to synchronise with each other, a means to synchronise them is required. The means employed is as follows:— because the data corresponding to absence of a generated tone (i.e. the data corresponding to the rest condition), the "O" address in the memory 23 is used to reset the address counters 24 and 24' simultaneously and as a control means to set both systems to the "waiting" condition, for no tone is generated while the address counters are in the reset condition.

The envelope forming circuits 29 and 29' are not essential and may be omitted, though their provision is, in general, preferred as resulting in more pleasing tones. One form of envelope forming circuit is an amplifier, the amplifying ratio of which can be varied in response to externally applied signals.

The wave form shaping circuits 28 and 28' though not essential are generally important for the achieving of good musical effect. If rectangular waves are used, the wave form shaping circuits can be omitted and, to this extent, the apparatus can be simplified. However, if waves having less overtone components than a rectangular wave are used for at least either the main melody or its accompaniment, the wave forming circuits considerably enhance the musical quality. Since the use of a rectangular wave results in a little "harder" tone as compared with the use of a wave with less overtone components, it is advantageous to use a rectangular wave for the main melody and a wave of less overtone components for the accompaniment. Very satisfactory results are obtained by using, as shown in Figure 3(a), a rectangular wave which has been passed through a low-pass filter or, as shown in Figure 3(b), a triangular wave, or, as shown in Figure 3(c), a sine wave, as the wave of less overtone components.

Figures 4(a) and 4(b) show circuit arrangements which can be used as wave form shaping circuits, in an instrument in which a rectangular wave is used for the main melody and a wave shaped by passing a rectangular wave through a low-pass filter is used for the accompaniment. Because an output wave produced from the programmable counter is not suitable for providing a pleasantly melodious tone, a flip-flop 35 is used to divide the rectangular wave from the programmable counter by two and produce a rectangular wave of half duty. This rectangular wave of half duty is used for the main melody. Figure 4(b) shows a wave form shaping circuit comprising a flip-flop 35' and a low-pass filter 36 the output from which is used for the accompaniment.

Figures 4(c) and 4(d) illustrate one way of shaping a sine wave or a triangular wave. As shown in Figures 4(c) and 4(d), one period of the wave is sampled at suitably close intervals by a sampler or address counter 134, data in a memory 133 which digitizes and memorises the sampled peak values and is read out, and the digital data read out is converted into analog form by a digital-to-analog converter 132. The velocity of designating an address in the memory can be changed by changing the velocity with which the address counter 134 advances, using

pulses from the programmable counters. Thereby it is possible to change the frequency. A circuit as shown in Figure 4(c) is able to produce any of a very wide range of wave forms. Consequently, by using

5 circuits as shown in Figure 4 for a main melody and an accompaniment respectively, it is possible to simulate the sounds of different ordinary musical instruments.

Although in the foregoing explanation it has been
10 assumed that one system is used for the main melody and the other for an accompaniment, this invention is not limited to such use for, whether or not the apparatus is used in this manner, it will provide considerably improved tonal and musical quality as compared with a "single" system as
15 shown in Figure 1. The practical improvement effected by the invention is, however, most marked when it is used for a melody and its accompaniment.

Apart from the electro-acoustic transducer the
20 apparatus in the embodiment illustrated can be readily incorporated in an integrated circuit structure such as a C-MOS integrated circuit structure. This is very advantageous from the viewpoint of economy of occupied space and has particular advantages if it
25 is desired to combine an electronic tone generator or musical instrument with an apparatus for some quite different purpose and which also employs an electronic integrated circuit structure, since, in many cases, the same chip can be used for all the inte-
30 grated circuits.

CLAIMS

1. An electronic tone generator or musical instrument wherein sound output of pleasing and musically effective tonal quality is obtained by elec-
35 tronically producing and combining a plurality of signals representative of a plurality of tones and reproducing the same by an electro-acoustic transducer characterised by the provision, in combination, of an oscillator of predetermined frequency;
40 means for producing pulses of at predetermined short intervals; at least one memory for storing musical scale and time data; at least one memory input counter for reading out from said memory data stored therein; at least two first programmable
45 counters for dividing output signals from said oscillator to provide notes in a musical scale in accordance with data stored in said memory, said first programmable counters being synchronously controlled in accordance with data stored in said mem-
50 ory; at least one second programmable counter controlled in accordance with time data stored in said memory for determining the tone timing, said second programmable counter being connected to supply outputs to the memory input counter and to
55 receive input from said pulse producing means; and means for combining outputs from said first programmable counters or signals derived from said outputs and supplying the combined resultant to electro-acoustic reproduction means.

60 2. An apparatus as claimed in claim 1 and which includes two memories each with its own input counter; means for synchronously reading out from said memories data stored therein; two first programmable counters for dividing output signals from
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accordance with data stored in the memories, said first programmable counters being respectively controlled by data stored in a respective memory; two second programmable counters controlled by time data stored in the respective memories for determining times, said second programmable counters being connected to supply outputs to the respective memory input counters and to receive input from said pulse producing means; and means for combining outputs from the first programmable counters or signals derived from said outputs and supplying the combined resultant to electro-acoustic reproduction means.

3. An apparatus as claimed in claim 1 or 2
80 wherein wave shaping means are inserted in at least one of the signal paths between the first programmable counters and said output combining means.

4. An apparatus as claimed in any of the preceding claims wherein envelope forming means are
85 inserted in at least one of the signal paths between the first programmable counters and said output combining means.

5. An apparatus as claimed in any of the preceding claims wherein said output combining means is
90 an amplifier equipped with means for weighting with respect to one another the signals it receives.

6. An apparatus as claimed in any of the preceding claims wherein one of the memories is stored with main melody data and another is stored with
95 accompaniment data.

7. Apparatus as claimed in claim 6 wherein the waveform used for the main melody is a waveform with more overtone components than that used for the accompaniment.

100 8. An apparatus as claimed in claim 6 wherein rectangular waves are used for the main melody and the accompaniment.

9. An apparatus as claimed in claim 6 wherein a rectangular waveform is used for the main melody
105 and a sine wave is used for the accompaniment.

10. An apparatus as claimed in claim 6 wherein waves shaped by passing rectangular waves through low-pass filters are used for the main melody and the accompaniment.

110 11. An apparatus as claimed in claim 1 or 2 wherein waves shaped by passing rectangular waves through a low-pass filter are used for the main melody and a substantially sine wave is used for the accompaniment.



pulses from the programmable counters. Thereby it is possible to change the frequency. A circuit as shown in Figure 4(c) is able to produce any of a very wide range of wave forms. Consequently, by using

5 circuits as shown in Figure 4 for a main melody and an accompaniment respectively, it is possible to simulate the sounds of different ordinary musical instruments.

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9. An apparatus as claimed in claim 6 wherein a rectangular waveform is used for the main melody and a sine wave is used for the accompaniment.
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10. An apparatus as claimed in claim 6 wherein waves shaped by passing rectangular waves through low-pass filters are used for the main melody and the accompaniment.

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