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The title of the invention has been amended (Guidelines for Examination in the EPO, A-III, 7.3).

(54) Automatic apparatus for the simultaneous reproduction of notes with preset musical frequency intervals provided by look-up tables.

(57) This invention concerns a machine capable of automatically and simultaneously reproducing one or more notes between which there is a pre-set frequency interval, set and taken from look-up tables containing all musically correct harmonies that can be matched with any note, played or sung within the scope of the chord and type of chord chosen.

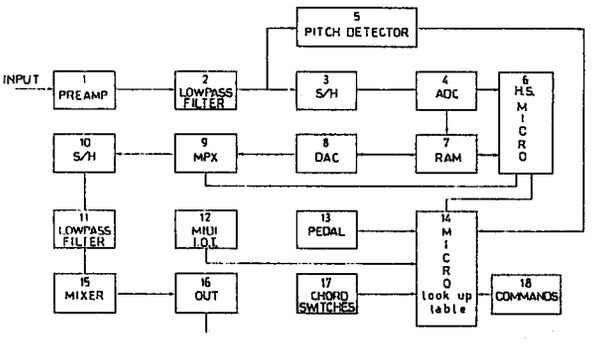

FIG.1

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Description

AUTOMATIC MACHINE FOR THE SIMULTANEOUS REPRODUCTION OF SEVERAL NOTES WITH MUSICAL FREQUENCY INTERVALS PRE-SET ON AND PROVIDED BY LOOK-UP TABLES, CONTAINING ALL THE HARMONIES FOR EACH NOTE, ACCORDING TO THE CHORD AND TYPE OF CHORD CHOSEN.

This patent application for an industrial invention concerns a machine, capable of automatically and simultaneously reproducing one or more notes between which there is a pre-set frequency interval, set and taken from look-up tables containing all musically correct harmonies that can be matched with any note, played or sung, within the scope of the chord and type of chord chosen

The machine according to the invention is designed to be used by musicians that play monophonic instruments, i.e. instruments capable of emitting just one note at a time, thus rendering it impossible to superimpose over this note a musical harmony, in other words a combination of different notes, the formation of which can be different each time, even though the same note is played, depending on the chord chosen by the musician.

The machine according to the invention is also designed to be used by singers in that the human voice is the equivalent of a monophonic instrument.

Having said the above, it should be remembered that each time a played or sung note is to be accompanied by a harmony, the solution always adopted is that of putting the musician alongside an orchestra and the singer together with a backing group.

Recently, the most advanced technology in the musical sector has proposed a machine, a so-called "harmonizer", capable of reproducing starting from a played or sung note and depending on the chord chosen, a harmony with intervals or a set frequency between each note, wherein this frequency can only be altered by acting manually on switches provided for this purpose.

This machine, without doubt valid if the performer always stays on the same chord and the same guide-note, immediately becomes ineffective as soon as the guide-note or the chosen chord are changed.

In fact, as long as the chord remains the same, the harmony emitted by the harmonizer is musically correct only for some of the notes of the scale, as can be seen from the chart that follows, wherein notes and harmonies are indicated with conventional international symbols that are used and recognised.

CHORD	NOTE PLAYED	HARMONY	RESULT
C	E	C	good
	F	C#	bad
	F#	D	bad
	G	D#	bad
	G#	E	acceptable
	A	F	good
	A#	F#	good
	B	G	good
	C	G#	bad
	C#	A	bad
	D	A#	bad
	D#	B	acceptable

In the above example, less than 50% of the notes in the scale can be used in the "C" chord and only three (G,F,C,) can be considered musically correct in the harmony reproduced by the harmonizer.

If the "C" chord is modified to minor, seventh, diminished, raised etc., to be able to have notes in musically correct harmony, it would be necessary to use at least five switches, corresponding to the following pre-selected frequency intervals between the notes which make up the harmony : third minor (3 semitones), third major (4 semitones), fourth (5 semitones), fourth major (6 semitones) fifth (7 semitones).

In the chart which follows, it is made clear how in the same "C" chord, should there be the desire to combine a musically correct harmony with the notes in the scale, it is necessary to resort to at least five different frequency intervals.

CHORD	NOTE PLAYED	HARMONY	INTERVAL
C	E	C	third major
	F	F	fourth
	F#	C	fourth major
	G	E	third minor
	G#	E	third major
	A	E	fourth
	A#	G	fourth major
	B	G	third major
	C	G	fourth
	C#	G	fourth major
	D	G or C	fifth or second
	D #	C	third minor
	E	C	third major

Moreover, it should be said that many musicians or singers are not able to think of the correct frequency interval for the harmony to be associated with the note played or sung, due to the fact that during the performance of a piece, they have to simultaneously bear in mind the following factors :-
- chord used, type of chord, guide-note, position of guide note in the scale, use of pre-selection switches for pre-set frequency intervals. The aim of the instant invention is to overcome the abovementioned limitations, characteristic of the type of harmonizer currently known and in use, by proposing a new machine for the reproduction of sound, which, starting from the guide note and according to the chord and type of chord pre-selected, is able to produce a harmony which is always musically correct made up of notes separated by a pre-established frequency interval, which can be read on special reference tables, which contain in memory all the harmonies which can be correctly associated with any note in the scale, according to a given chord and type of chord.

As is known to those involved in the field of music, the background chords can be inserted by the performer of the piece of music, by means of a pedal keyboard or keyboard; as far as the pedal keyboard and also the keyboard are concerned, the type of chord can be pre-selected, if only one key is pressed by using one pedal, normally known as " chord switches" with four switches, the type of chord being selected by the combination of these switches.

The machine according to the invention essentially works as follows :
When a note is inserted through a microphone, by means of a well-known electronic circuit, called "ADC" (analog to digital converter), this note is transformed to a digital code which can be processed by a microcomputer and memorised so that it can be subsequently reproduced. By means of a special circuit, the frequency of the played or sung note, is registered and calculated; according to the value of this frequency the correct harmony to accompany the note being entered is automatically found on a table containing memorized data which are used for each note in the scale to obtain a correct musical harmony for each type of chord within the same key.

In other words, the memorised data is pre-selected from the table according to the note being entered and according to the name and type of chord pre-established each time by the performer of the piece.

From the reading of the table, the frequency intervals can be obtained which are necessary to find the correct harmony to be associated with the played or sung guide-note and the value of the intervals indicated determines the frequencies of reproduction of the digital recording carried out.

For further clarity of explanation, the description of the machine according to the invention, continues with reference to the attached drawings, reproduced for illustrative and not restrictive purposes, in which :-
-Fig.1 is a functional block diagram of the machine according to the invention.

Block 1 (Preamp), comprises a phase of amplification and impedance adaptation for the various inputs (microphone, line,balanced input for microphone).

Block 2 (lowpass filter), comprises a lowpass filter with a slope of at least 24 db. per eigth.

Block 3 (S/H), consists of a sample and hold circuit, which is able to maintain the signal stable for long enough to allow block 4 to make the analog to digital conversion.

Block 4 (ADC) comprises an analog to digital converter, which converts the analog signal to digital codes.

Block 5 (Pitch detector) consists of a special circuit made up of an adaptive filter and signal compressors; this circuit will extract the basic frequency and send a series of impulses to the micro-processor (block 14), from which the timing of the signal being entered will be determined by means of a counter.

Block 6 (H.S. Micro) comprises a high speed micro-processor, this processor is used to read the data in RAM (Block 7), at varying speeds according to the information supplied by the tables contained in Block 14; it also controls the multiplexer (Block 9)

Block 7 (RAM) consists of a 16-bit memory bank where the ADC data are memorised (Block 4)

Block 8 (DAC) consists of a digital to analog converter able to reconstruct the analog signal from digital codes.

Block 9 (MPX) comprises a multiplexer circuit which allows the output of two or more signals, using only one DAC.

Block 10 (S/H) consists of a sample and hold circuit which allows the stabliizing of the signal during the switching time of the multiplexer.

Block 11 (lowpass filter) consists of a lowpass filter with a slope of at least 24 db. per eigth.

Block 12 (Midi I.O.T) comprises standard MIDI inputs and outputs, where devices equipped with MIDI interface can be connected, to control or be controlled by the machine according to the invention.

Block 13 (Pedal) comprises a pedal keyboard with at least 13 notes, which is used to select the chord note.

Block 14 (Micro look-up table) consists of a micro-processor which reads the tables and sends the information concerning the notes to be reproduced to the rapid microprocessor (Block 6), on the basis of information obtained from the controls (18), the pedal (13), the chord switches (17), the MIDI (12) and the pitch detector (5).

Block 15 (Mixer) consists of various pre-amplifiers and a mixer with various volume controls for each sound being emitted.

Block 16 (OUT) comprises various output sockets which will allow the connection of the machine to the power amplifier line.

Block 17 (Chord switches) consists of a pedal with 4 switches, which, combined, allow the selection of the type of chord.

Block 18 (Commands) consists of various controls which allow the selection of the various functions and a display which will indicate the function selected.

With reference to Fig.1, it can be observed that the played or sung note which has been amplified and filtered by blocks (1) & (2), is sent both to Block (3), where it is temporarily memorised to serve block (4), and to block (5), which extracts the basic frequency of the entering signal and sends it to block (14), where the musically correct intervals for each musical note, each chord and each type of chord are memorised so as to create the harmony.

Block (4) converts the analog signal to a digital code and all the digital codes are registered on block (7) and at the same time, sent to block (6), which is able to read all the data as it is being registered and memorised in block (7) with varying frequencies, in compliance with the indications supplied by block (14), the data emerging therefrom being obtained from that memorised in the table and selected and read each time according to frequency indicated by block (5), the chord indicated by block (13) and the type of chord indicated by block (17).

The data recorded in block (7) and reproduced by block (6) with the correct frequencies established by block (14) is re-converted from digital to analog by block (8) to then be sent to the 'OUT' block (16), by means of processing of the type normally in use, which is activated by the series of blocks (9), (10),(11) and (15).

It should be noted, that block (14) is also equipped to calculate the difference between the frequency of the guide-note being entered which is measured by block (5) and the basic frequency, the value measured by block (5) being within the tolerance range of the aforesaid basic frequency.

In this way, by means of a function selector key, block (14) automatically works out an algebraic sum between the calculated difference and the reproduction frequency so that the notes which make up the harmony reproduced by block (6) are in tune with the note memorised and preselected in the block (14) table, in spite of the fact that the guide note being entered in block (1) has a different frequency to the aforementioned memorized noted.

In conclusion, this means that perfect harmonies are always obtained even if the note entered is slightly out of tune.

Claims

1. Automatic machine for the simultaneous reproduction of several notes with musical frequency intervals pre-set on and provided by look-up tables, containing all the harmonies for each note, according to the chord and type of chord chose, characterised by the fact that it comprises a memory (Block 14), where for each note, each chord and each type of chord the frequency intervals which must exist between the notes of a musically correct harmony and the guide-note entering the machine are memorised, said guide-note being amplified and filtered, its frequency being identified by block (5), converted to digital code (by block (4)) and recorded in a memory (Block 7), so that it can be reproduced subsequently by block (6), with the frequency intervals supplied by block (14), the memorized data thereof being selected each time according to the frequency of the guide-note being entered (this information being supplied by block (5)), to the pre-selected chord (this information being supplied by block (13)) and to the type of chord pre-selected (this information being supplied by block (17));

2) Automatic machine for the simultaneous reproduction of several notes with musical frequency intervals pre-set on and provided by look-up tables, containing all the harmonies for each note, according to the chord and type of chord chose, according to claim 1), characterised by the fact that block (14) is capable of measuring the difference between the frequency of the guide-note being entered (measured by block (5)), and the basic frequency, the value measured by block(5) coming within the tolerance range of the aforesaid basic frequency, and is capable of working out the algebraic sum of the difference calculated and the reproduction frequency.

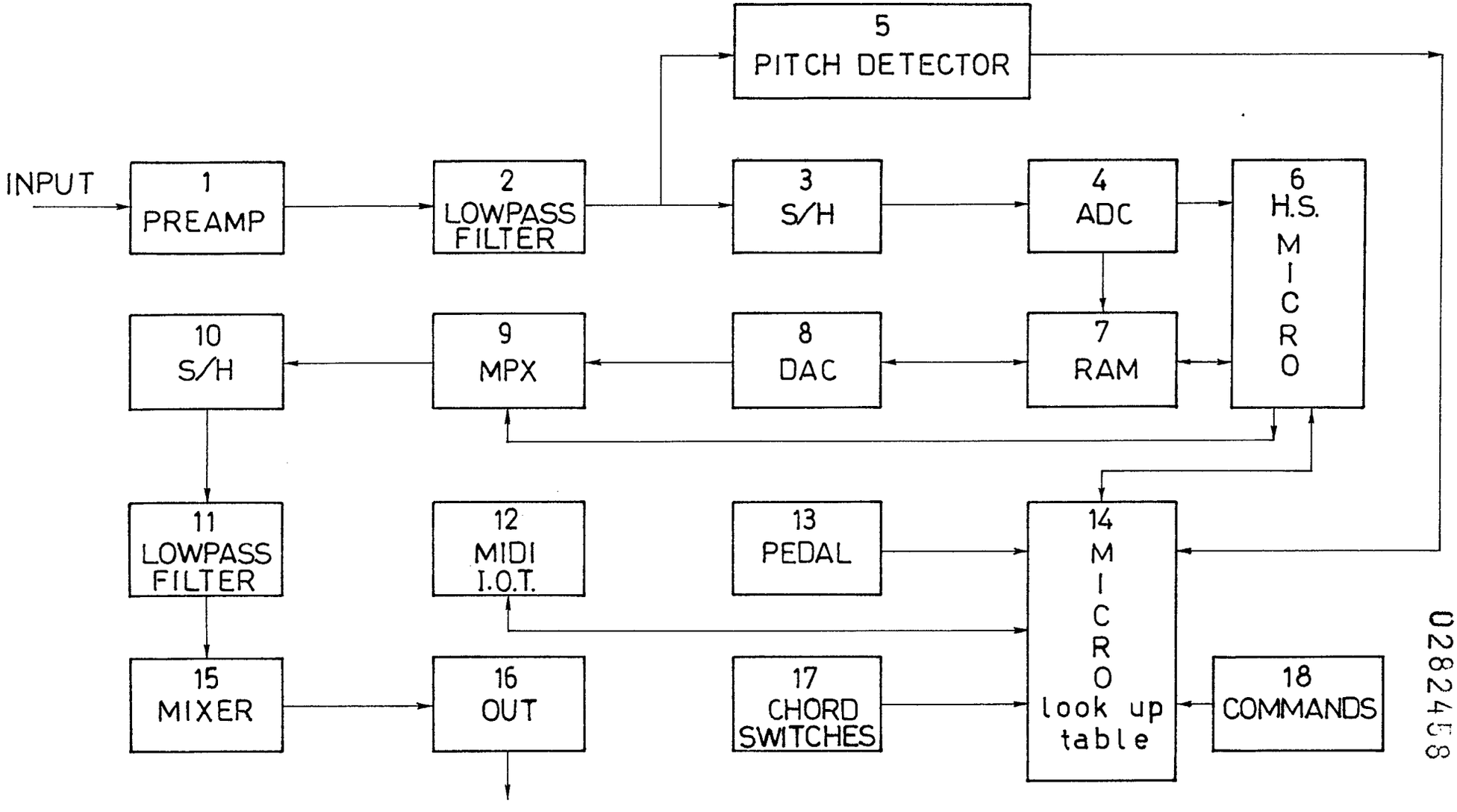

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FIG. 1

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