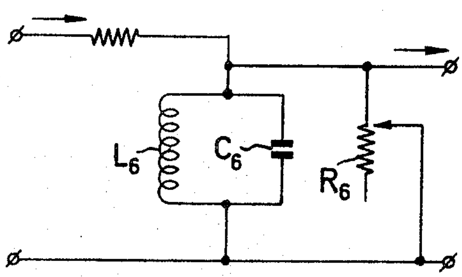

FIG.1

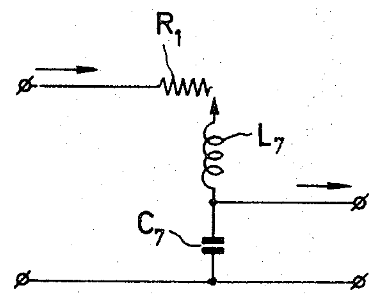

FIG.2

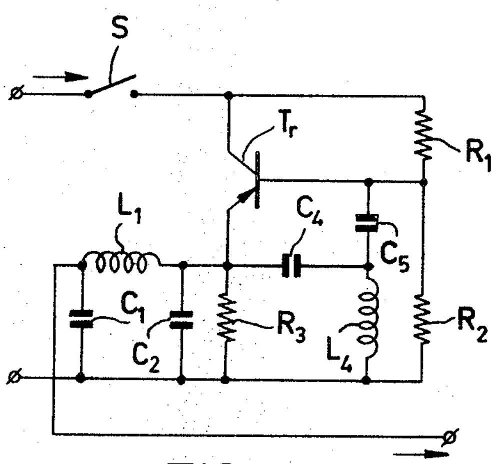

FIG.3

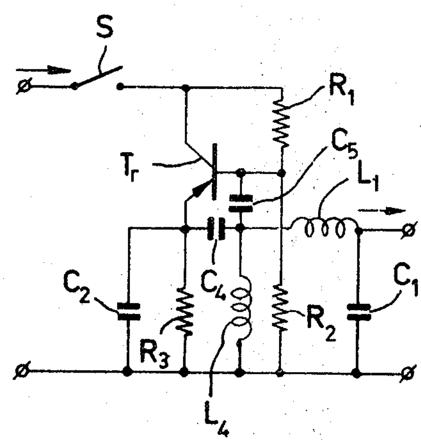

FIG.4

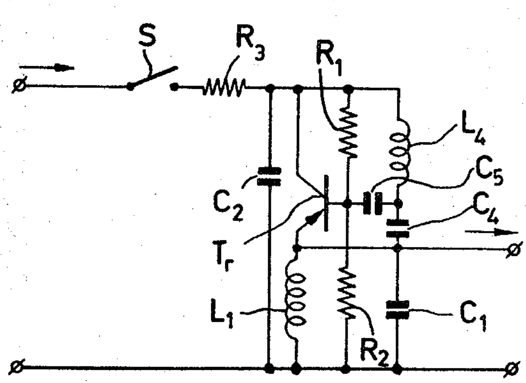

FIG.5

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ELECTRONIC MUSICAL INSTRUMENT PROVIDED WITH GENERATORS AND INDIVIDUAL FORMANT FILTERS

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Int. Cl. G10h *3/00, 1/02*
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ABSTRACT OF THE DISCLOSURE

An electronic musical instrument is constructed of multi-frequency filters, each of which is provided with a resonant circuit and a selectively operable key for varying the resonance quality factor of the resonance circuit. The timbre of a resulting signal will be directly affected by the variation occurring in the quality factor as determined by the operation of the key, the frequency to which the resonant circuit is tuned being relative to the frequency of the applied signal. The key may be directly tied to a variable resistor connected to a resonant circuit which in turn is tuned to a fundamental frequency or a harmonic of the fundamental frequency. Alternatively, operation of the key may cause a variation of resonance quality factor by varying the operating point of a transistor circuit having a predetermined resistive ratio over a range of operating points.

The invention relates to an electronic musical instrument provided with generators and individual formant filters. The term "individual formant filter" is used to signify a formant filter associated both with a given key and with a given voice, like a pipe organ has at least one given pipe for each key and each voice.

In such a known musical instrument, the voltage of a generator provided with harmonics is supplied to a number of series-connected resonant circuits one of which is tuned to the fundamental tone, whilst the remaining circuits are each tuned to a different harmonic thereof, these signals being separately derived and being recombined in an adjustable ratio. The tone thus obtained has a constant amplitude and timbre.

According to the invention, the filters may have more than one resonant frequency, whilst the frequency characteristic and the Q factor or factors being varied by operation of the keys and being adjusted to new stable values, whilst they reassume their original shape and value or values after the key has been released.

As a result, the timbre of the tone changes during the switching-on and switching-off process which phenomenon also occurs in organ pipes so that a reliable imitation of these pipes can be obtained.

In musical instruments which use at least twelve tone generators and in which the octave tones are obtained by frequency division or -multiplication, gate circuits are frequently used for switching the signals.

In one embodiment of a musical instrument according to the invention, a complex signal determining the pitch is continuously applied to the formant filter, the Q factor being varied by depression of the key so that the output signal only then assumes a perceptible value. This has the advantage that the formant filter at the same time fulfills the function of a gate.

With large output signals and low noise- and hum levels, there is a possibility of the gate not attenuating the signal below the threshold of perceptibility when a key is

depressed. In a further embodiment of a musical instrument according to the invention, this may be avoided in that by depression of a key a complex signal determining the pitch is applied to the formant filter.

In a particularly suitable embodiment of a musical instrument according to the invention, in which the musical instrument is provided with individual generators for each key and each voice, the formant filter forms part of the part of the generator determining the pitch. This has the additional advantage that the crosstalk which is in direct proportion to the number of operating generators, is considerably less disturbing than with continuously operating generators, whilst moreover the frequencies of the generators of each key are nevertheless all in harmonic relation to each other.

In another embodiment of an electronic musical instrument according to the invention, one of the resonant frequencies of the filter determines the ultimate pitch of the generator, whilst the higher resonant frequencies determine the ultimate formant. Thus, the pre-tone produced in given organ pipes can be imitated. The term "pretone" is used to signify the start of the organ pipe at a pitch the frequency of which is at least approximately a harmonic or subharmonic of the tone produced immediately after the start.

In another embodiment of a musical instrument according to the invention, the resonant frequencies are at least approximately in a ratio of small integers.

In another embodiment, the filter has two resonant frequencies which are at least approximately in a ratio of 1:2. Thus, the characteristic pretone of an open organ pipe is obtained which starts at the second harmonic of the fundamental tone and then passes into this fundamental tone. Moreover, the formant filter may be of comparatively simple construction.

This also applies to another embodiment of a musical instrument according to the invention for the imitation of a stopped organ pipe, in which a filter is used which has two resonant frequencies which are at least approximately in a ratio of 1:3.

The invention will now be described more fully with reference to the following figures, of which:

FIG. 1 shows a circuit arrangement, in which a complex signal determining the pitch is continuously applied to the formant filter,

FIG. 2 shows a circuit arrangement, in which a complex signal determining the pitch is applied to the formant filter by depression of a key.

FIGS. 3 and 4 show generators which are suitable for the imitation of flue pipes, and

FIG. 5 shows a generator for the imitation of reed pipes.

FIG. 1 shows a simplified construction of a circuit arrangement, in which a complex signal determining the pitch is continuously applied to the formant filter in this case comprising a resonant circuit constituted by an inductance L_6 and a capacitor C_6, whilst by the depression of a key, as a result of which the cursor of the variable resistor R_6 eliminates the short-circuit of this resistor, the Q factor is varied so that the output signal only then assumes a perceptible value. It will be appreciated that the resistor R_6 may be replaced by other components, for example, a CdS-cell which is continuously illuminated, which illumination is reduced or eliminated upon depression of a key, or a conducting transistor which is cut off entirely or in part upon the depression of the key. If desired, swing-over may be applied. The formant filter, which is shown in this case as a single resonant circuit, but which, if desired, may have the form of a multiple resonant circuit, at the same time fulfills the function of a switch.

In FIG. 2, the signal is applied to the formant filter comprising the series resonant circuit L_7, C_7 only after depression of the key in that the cursor of resistor R_7 switches off this resistor so that the Q factor of the series resonant circuit is varied. Also in this embodiment, the resistor R_7 may be replaced by other components, for example, by a CdS-cell which is illuminated by depression of a key or by a transistor which is released entirely or in part upon depression of the key.

In FIG. 3, the formant filter determining the frequency is a π-filter comprising the inductance L_1 constituting the bridge of the π, two capacitors C_1 and C_2 constituting the limbs of the π, a resistor R_3 being connected in parallel to the capacitor C_2, and a series resonant circuit consisting of the capacitor C_4 and an inductance L_4, the inductance L_4 being connected to the junction of capacitors C_1, C_2 and the resistor R_3. The junction of inductance L_1, capacitors C_2 and C_4 and resistor R_3 is connected to the emitter of a transistor Tr, the base of which is connected on the one hand through a blocking capacitor C_5 to the capacitor C_4 and the inductance L_4 and on the other hand through resistors R_1 and R_2 determining the bias voltage of the base to the collector of the transistor Tr and to the junction of capacitors C_1, C_2, resistor R_3 and inductance L_4, respectively, which junction is connected to the positive terminal of the supply voltage. The other terminal of the supply voltage is connected through a switch S, which is closed upon depression of a key, to the collector of transistor Tr.

In the circuit arrangement of FIG. 4, the series-combination of L_1 and C_1 is not connected in parallel with capacitor C_2 but in parallel with the inductance L_4.

This whole system has two resonant frequencies which are determined so that the ratio x of these frequencies is at least approximately an integer, preferably two for an open pipe and three for a stopped pipe. By a suitable choice of the values of the capacitances, inductances and resistors inclusive of the dissipation resistances, the increments of the circuit arrangement can be chosen to be substantially equal for the said two resonant frequencies. This determines the response of the pipe and the location of the formant. When the resistor R_3 is made variable, the ratio between the increments may be adjusted so that the desired pretone is produced. It can be shown that substantially equal increments can be obtained for the resonant frequency by choosing from a collection of associated values of the capacitances, inductances and resistors, so that for each value of the fundamental tone, usable values of the inductances and capacitors are available.

The circuit arrangement of FIG. 5 is particularly suitable for the imitation of reed pipes. In this circuit arrangement, the supply voltage is supplied through a switch S operated by the key to a capacitor C_2, the junction being connected on the one hand to the collector of transistor Tr and on the other hand to the inductance L_4, the other end of which is connected through blocking capacitor C_5 to the base of transistor Tr, which base is connected on the one hand through resistor R_1 to the collector and on the other hand through resistor R_2 to the other terminal of the supply voltage. The junction of the inductance L_4 and the blocking capacitor C_5 is connected through capacitor C_4 to the parallel resonant circuit comprising the inductance L_1 and capacitor C_1 and the emitter of transistor Tr_1. The other end of the parallel resonant circuit is connected to resistor R_2 and capacitor C_2. The single resonant circuit comprising the inductance L_1 and the capacitor C_1 may of course also be constructed in the form of a multiple resonant circuit.

Upon depression of a key, the capacitor C_2 is charged through a resistor R_3, as a result of which the direct voltage of the generator gradually increases and hence the mutual conductance of the transistor is slowly varied, so that especially at the start, strong nonlinear effects are produced which are characteristic of a reed pipe.

In this circuit arrangement, it is not always desirable that the ratios of the resonant frequencies should be small integers, since especially with regal voices, it is not necessary for a harmonic relation to exist between the resonant frequencies of the tube bodies and of the reeds.

What is claimed is:

1. An electronic musical instrument including a formant filter for providing a desired output signal and having at least one resonant frequency and an original Q factor value, said filter comprising an input for receiving an input signal, said filter having a key associated therewith, means coupling said key to said filter and responsive to depression of said key, to vary said Q factor of said filter and pass said desired output signal, and to release of said key to restore said Q factor to said original value.

2. An electronic musical instrument as claimed in claim **1**, wherein said signal is a complex signal determining the pitch and is continuously applied to the input of said formant filter, the Q factor being varied by depression of said key so that said output signal assumes a perceptible value only upon said depression.

3. An electronic musical instrument as claimed in claim **1**, wherein said signal is a complex signal determining the pitch applied to said formant filter by depression of the key.

4. An electronic musical instrument as claimed in claim **1**, further including a generator for determining the pitch of said input signal, and said formant filter forms part of said generator determining said pitch.

5. An electronic musical instrument as claimed in claim **4**, wherein a first resonant frequency of said filter determines the ultimate pitch of said generator and a higher resonant frequency determines the ultimate formant.

6. An electronic musical instrument as claimed in claim **5**, wherein said resonant frequencies are at least approximately in a ratio of small integers.

7. An electronic musical instrument as claimed in claim **5** wherein said filter has two resonant frequencies which are at least approximately in a ratio of 1:2.

8. An electronic musical instrument as claimed in claim **5** wherein said filter has two resonant frequencies which are at least approximately in a ratio of 1:3.

9. An electronic musical instrument including a generator and a formant filter providing a desired output signal in response to the depressing of a key associated therewith, said generator and filter comprising a first resonant circuit, a second resonant circuit, a transistor connected to both first and second resonant circuits for providing an initial frequency and Q characteristic to said resonant circuits, switch means responsive to depressing of said key for connecting a source of potential to said transistor, and capacitor means connected to said transistor and responsive to activation of said switch means for controlling the variation of the conductance of said transistor in response to said activation, said activation thereby varying said frequency and Q characteristics and providing said desired output signal.

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84—1.21, 1.24; 334—40, 82