United States Patent

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[54] **RC DISTRIBUTED FILTER FOR ELECTRONIC ORGAN**
7 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **84/1.11,** 84/1.19, 323/74, 333/70
[51] **Int. Cl.** **G10h 1/06,** H03h 7/14
[50] **Field of Search** ..... 84/1.01, 1.11, 1.12, 1.14, 1.19–1.23(B); 323/74, 79, 81, 93, 94; 333/70, 70(R), 74, 76

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ABSTRACT: An RC distributed low pass filter employable as a tone coloring filter of an electronic organ, groups of tone signals being introduced at diverse sections of the filter, so that multiple inputs exist, and the entire output of the filter being taken from one point. The inputs are applied across resistances in the shunt paths of the filter.

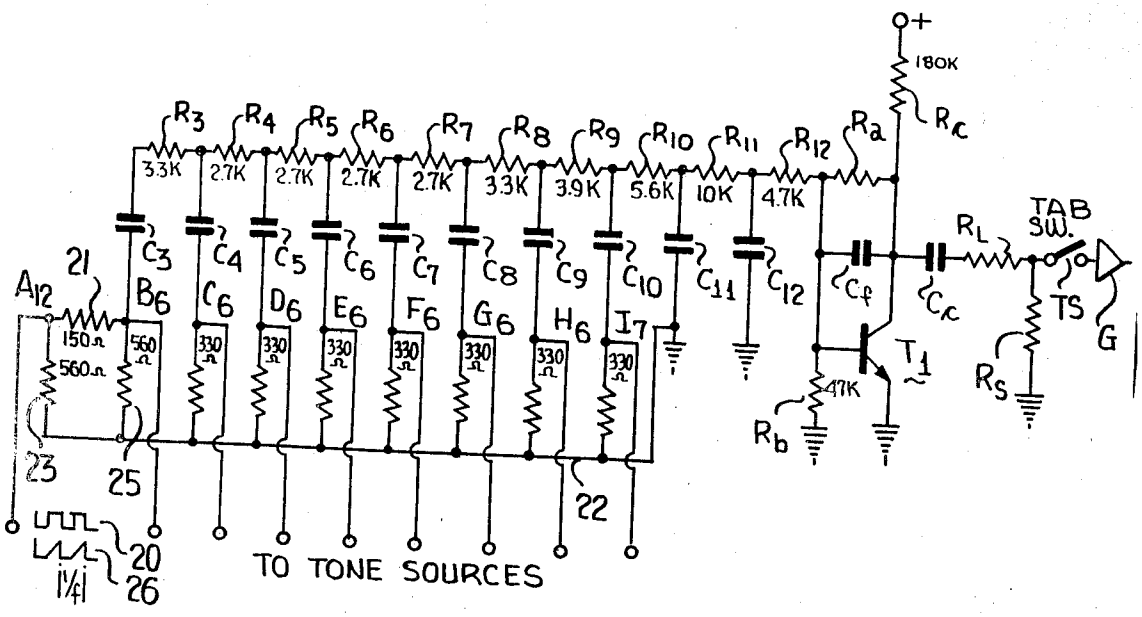


FIG.1

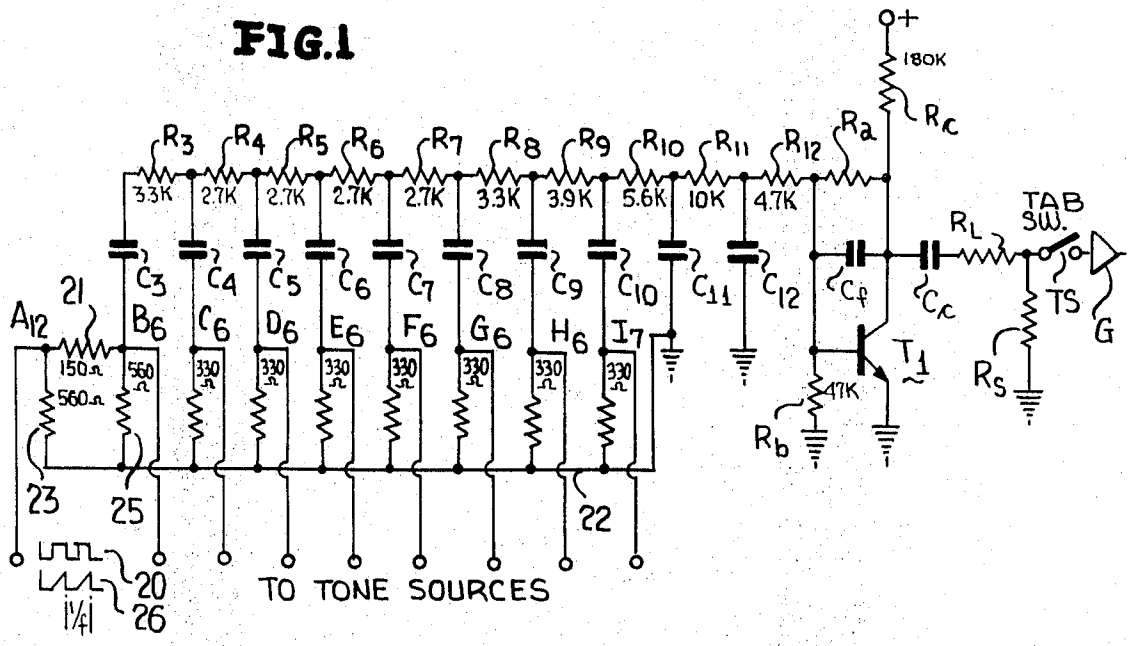
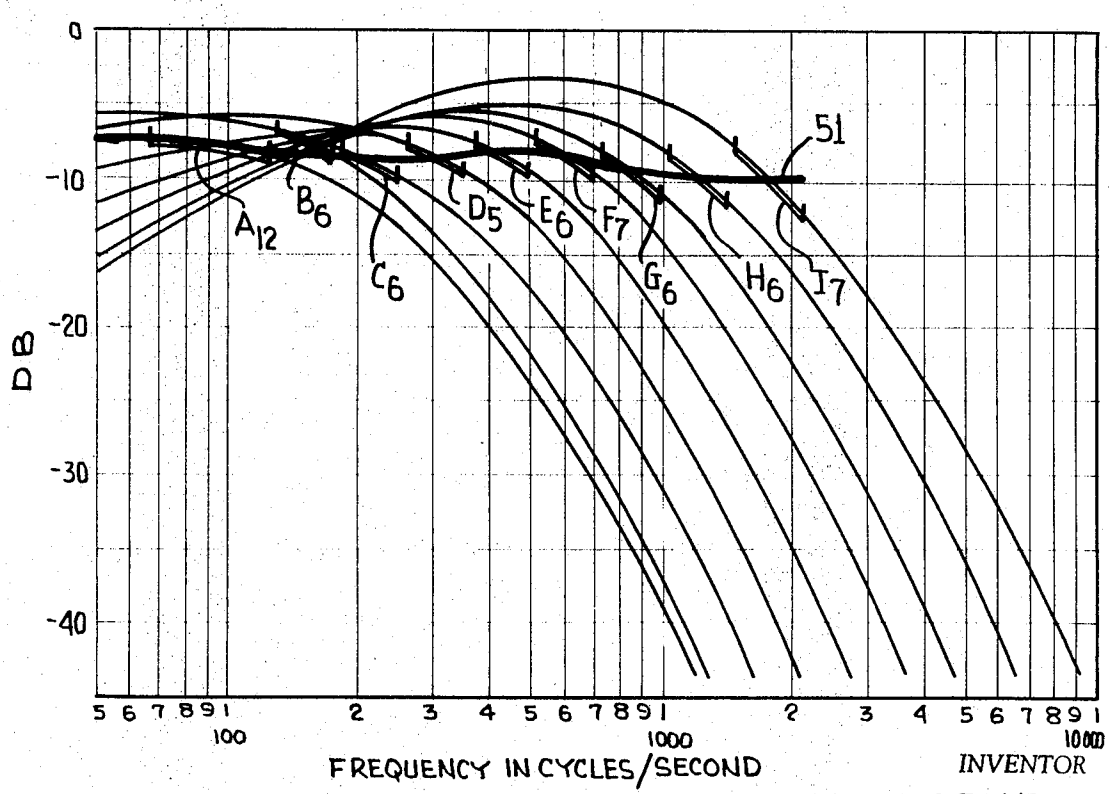


FIG.2



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RC DISTRIBUTED FILTER FOR ELECTRONIC ORGAN

BACKGROUND OF THE INVENTION

It is usual in electric organ practice to generate complex or harmonic rich tones in terms of square waves or sawtooth waves, and to modify the spectrum of the square waves or sawtooth waves by means of voicing filters, to provide an ultimate acoustic wave which sounds like one or another voice of a pipe organ. One of the important voices is the flute, the germane characteristic of which is that it is essentially a sine wave form. The problem presented in the present system is then that of filtering harmonic rich tones, whose fundamental frequencies extend over the musical spectrum, to form essentially sinusoidal waves having those fundamental frequencies.

This clearly can be done in many ways; for example, in the extreme a separate LC filter may be provided for each note. It is desirable, in designing filters, to avoid use of inductances, and it is important to minimize cost of the filtering. This is accomplished, according to the present invention, by utilizing one novel RC ladder network as a filter for the entire musical spectrum and applying different harmonic rich tone signals at different points along the ladder, selected on a frequency basis. I am aware that the use of LC ladder networks for tone color voicing is old.

The conventional or normal RC ladder filter is composed of series resistances and shunt capacitors, the latter being connected between junction points of the resistances and ground. An input to such a filter may be applied at a resistance. According to the present invention, a signal input resistance is inserted between each capacitor and ground, and the input signals are applied across these resistances. This implies that each input signal is applied in series with a shunt capacitor, which then becomes a blocking capacitor for undesired low frequencies which may be present at each input, but also becomes a shunting capacitor for harmonics applied to a lower frequency terminal. Since the shunt capacitors have increasing greater impedances at lower frequencies, the ladder may be extended to many sections with approximately constant peak responses. A specific embodiment employing eight sections is disclosed, but many more than eight may be employed, and the filter will retain approximately constant peak responses despite the large number of sections.

The normal RC ladder network has no low frequency roll off, and no low frequency isolation exists. The presence of input resistances in series with the shunt capacitors of the filter radically modifies operating characteristics, by introducing low frequency roll off and isolation. In addition, if input signal is applied to a junction of a resistance and capacitor located intermediate the ends of the filter, each signal is subject to multiple attenuations, so that the filter cannot have many sections.

SUMMARY OF THE INVENTION

The system includes an RC ladder filter, composed of series resistances and shunt capacities, each capacity being associated with a resistance connected in series with itself, across which input signal is applied. Output is taken from one side of the filter, the lowermost frequencies of a wide frequency spectrum being applied nearer the other end of the filter, and the higher frequencies nearer the output side of the filter.

Complex tone sources, provided by an organ tone generator are selectively connected by key switch means only, to each filter of a given footage, separate filter being provided for each footage of the organ. This implies that a single two contact switch is required as a tab switch for a flute tone coloring filter of a given footage. Adjacent groups of tones can be inserted at each input terminal of the filter, and a few sections added to the filter at the high end for which no input terminals are provided. Further, each filter may be provided with an output amplifier which itself provides high frequency roll-off. It has been found that an entire manual of an organ, on one footage, can be effectively filtered by one ladder network having nine input terminals, to provide flute tones when harmonic rich tones are applied as inputs.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic circuit diagram of a distributed RC tone color filter according to the invention; and

FIG. 2 is a graph showing the responses of the filter of FIG. 1, over its array of input points, as a function of frequency.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, terminal A_{12}, indicates by its notation (1) by A that the lowermost group of frequencies to be filtered is applied to this terminal and (2) by the subscript 12 that 12 tone signals are applied. For flute tones these tone signals would be of square wave configuration, or some equivalent having harmonics which decrease in amplitude as 1/n, where n is the order of the harmonic, and having only odd harmonics. A preferred wave shape employed is shown at 20, 1/f being the period of the wave shape. The terminal A_{12} is connected to a terminal B_6, by series resistance 21 and to ground lead 22 by a shunt resistance 23. The notation B_6 indicates that the second group of tone signals, higher in frequency than group A, contains six tones. Terminal B_6 is connected to ground lead 22 via resistance 25, and to series filter resistance R_3 via filter capacitor C_3.

In the specific embodiment of FIG. 1, signal input terminal A_{12}, B_6, C_6, D_6, E_6, F_6, G_6, H_6 and I_7 are provided and each terminal is connected by a signal input resistance to ground lead 22 and by a shunt filter capacitor, labeled C_3 to C_{10}, respectively, to a series filter resistance, these being identified as R_3 to R_{10}, respectively. The highest frequency tone, applied to terminal I_7, requires additional filter sections to attenuate its harmonics to acceptable level, the primary problem relating to the third harmonic. Therefore, additional filter sections are added on the high side of the filter, specifically composed of C_{11}, R_{11}, and C_{12}, R_{12}.

Following R_{12}, a load resistance R_b to ground is provided. The base-emitter circuit of an NPN transistor T_1 is connected across R_b, and a collector load R_c provided for T_1, a feedback circuit consisting of R_a and C_f in parallel is connected between the collector and base of T_1, which provides roll off for the third harmonic of the highest fundamental frequency in group I_7.

The collector of T_1 is then AC coupled to amplifier G, via tab switch TS, and via a conventional coupling circuit composed of series capacitor C_c, series resistance R_L and shunt resistance R_s.

The values of the circuit components employed in the filter of FIG. 1 depend on the frequency range of the tones to be filtered, *i.e.*, the footages involved. Further, the system may be employed for producing other than flute tones, for example, diapason, which would use the preferred input 26 having all harmonics present at relative amplitude 1/n, and the filter capacitor values may be scaled appropriately to the filtering problem to be solved.

For filtering an 8 foot flute note, circuit values as follows are appropriate:

C_3	.10
C_4	.10
C_5	.082
C_6	.056
C_7	.039
C_8	.027
C_9	.018
C_{10}	.012
C_{11}	.018
C_{12}	.018
C_f	.0022
R_a	100k
C_c	.10
R_L	22k
R_s, mg	1

Resistance values not provided in the schedule are specified in the drawings.

In FIG. 2 is illustrated the response curves for the several input terminals. On the F_6 curve, for example, the double line represents the band of input fundamentals, centered on 600 cps. The third harmonic is then 1,800 cps. and its intensity is down about 17 db. below the fundamental. The filter is so designed that each set of fundamentals applied to an input terminal appears at the output of the filter at somewhere near −10 db. level, the average fundamental characteristic being indicated by line 51. It may be noted that the fifth harmonic for the F_6 band is down about 29 db. relative to the fundamental.

The characteristic of the filter of FIG. 1 is peaked, *i.e.* has low frequency roll off, so that subharmonics as well as harmonics of each input frequency are attenuated, each input terminal seeing a series capacitor as well as a distributed filter having shunt capacitive elements, in proceeding from an input terminal to the filter output terminal.

I claim:

1. An electric organ, comprising:
a plurality of sources of complex tone signal covering plural octaves of the musical scale;
an RC ladder network having sections composed essentially of series resistances and shunt capacitors;
a signal input impedance connected between each of said capacitors and a common reference line;
means connecting said tone sources in groups of proximate tones to the junctions of said capacitors and input resistances;
said ladder network having an output terminal; and
the connections of the tone sources to said junctions being arranged to assure that tones of lower frequencies pass through more of said sections than tones of higher frequencies.

2. An electric organ, comprising:
a plurality of sources of complex tone signal covering plural octaves of the musical scale;
a tone color filter for said electric organ;
said tone color filter consisting of capacitors and resistances arranged in a multisection ladder configuration; and
means connecting said sources of complex tone signal selectively to different filter sections of said ladder configuration.

3. A tone color filter for an electric organ, comprising:
a plurality of signal input terminals arranged in order of increasing frequency;
a common lead;
a coupling resistance connected between each of said input terminals and said common lead;
an output terminal;
a string of series connected resistances terminating at said output terminal;
a shunt filter capacitor connected between each of said signal input terminals and a different point of said string of series connected resistances; and
means for applying harmonic rich tone signals to each of said input terminals.

4. The combination according to claim 3 wherein the tone signals applied to each of plural ones of said input terminals consists of a semioctave of tones.

5. A low pass filter, comprising:
a plurality of junctions;
a common lead;
an input signal coupling resistance connected between each of said junctions and said common lead;
an output terminal;
a string of series connected resistances terminating at said output terminal;
a shunt filter capacitor connected between each of junctions and a different point of said string of series connected resistances.

6. The combination according to claim 5, wherein is provided an input circuit connected to one of said junctions.

7. The combination according to claim 5, wherein is provided plural input circuits connected respectively to plural ones of said junctions.