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3,417,189

KEYING SYSTEM FOR ELECTRONIC MUSICAL PERCUSSION SIMULATOR

Filed March 29, 1965

4 Sheets-Sheet 1

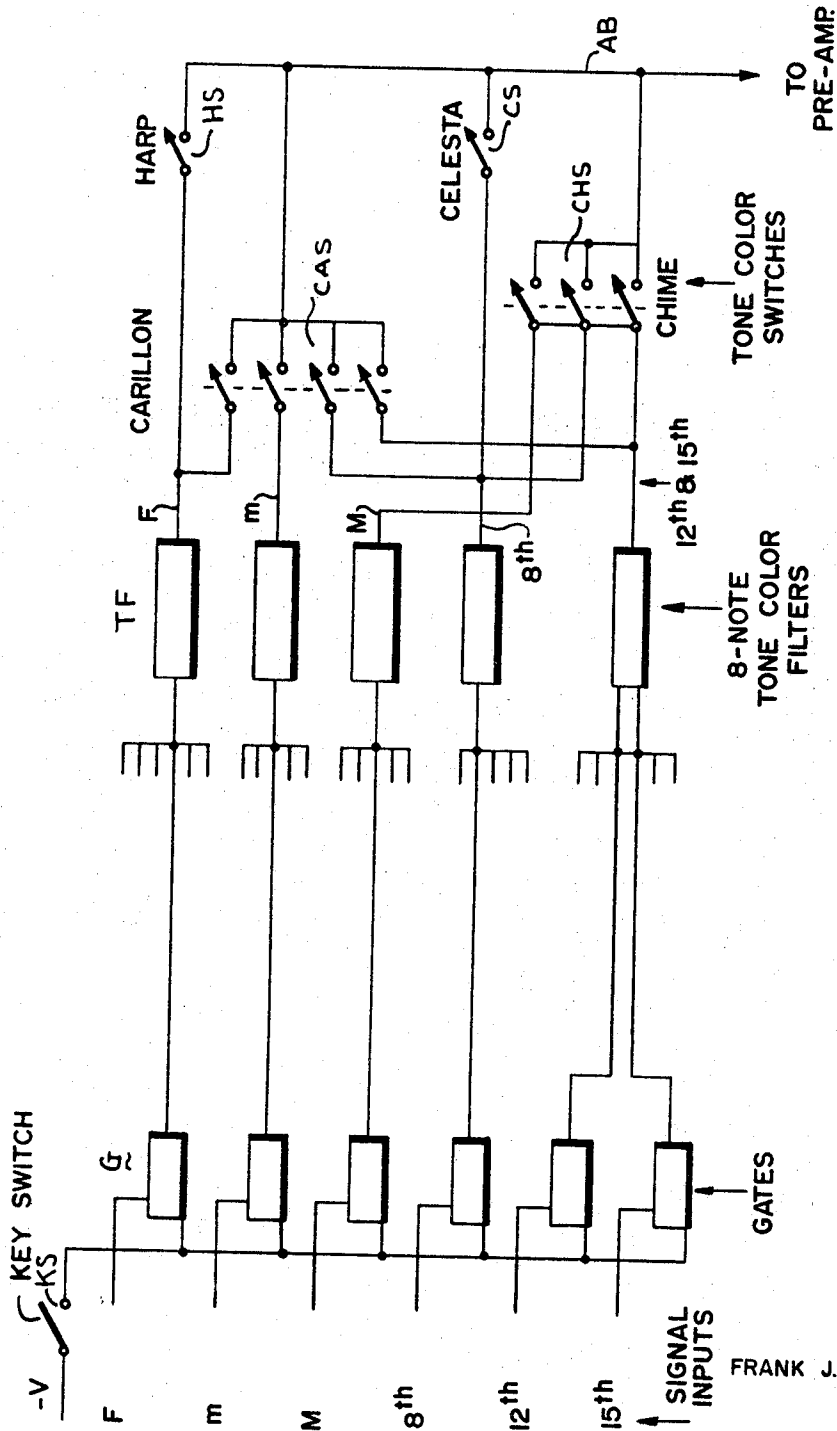


FIG. 1

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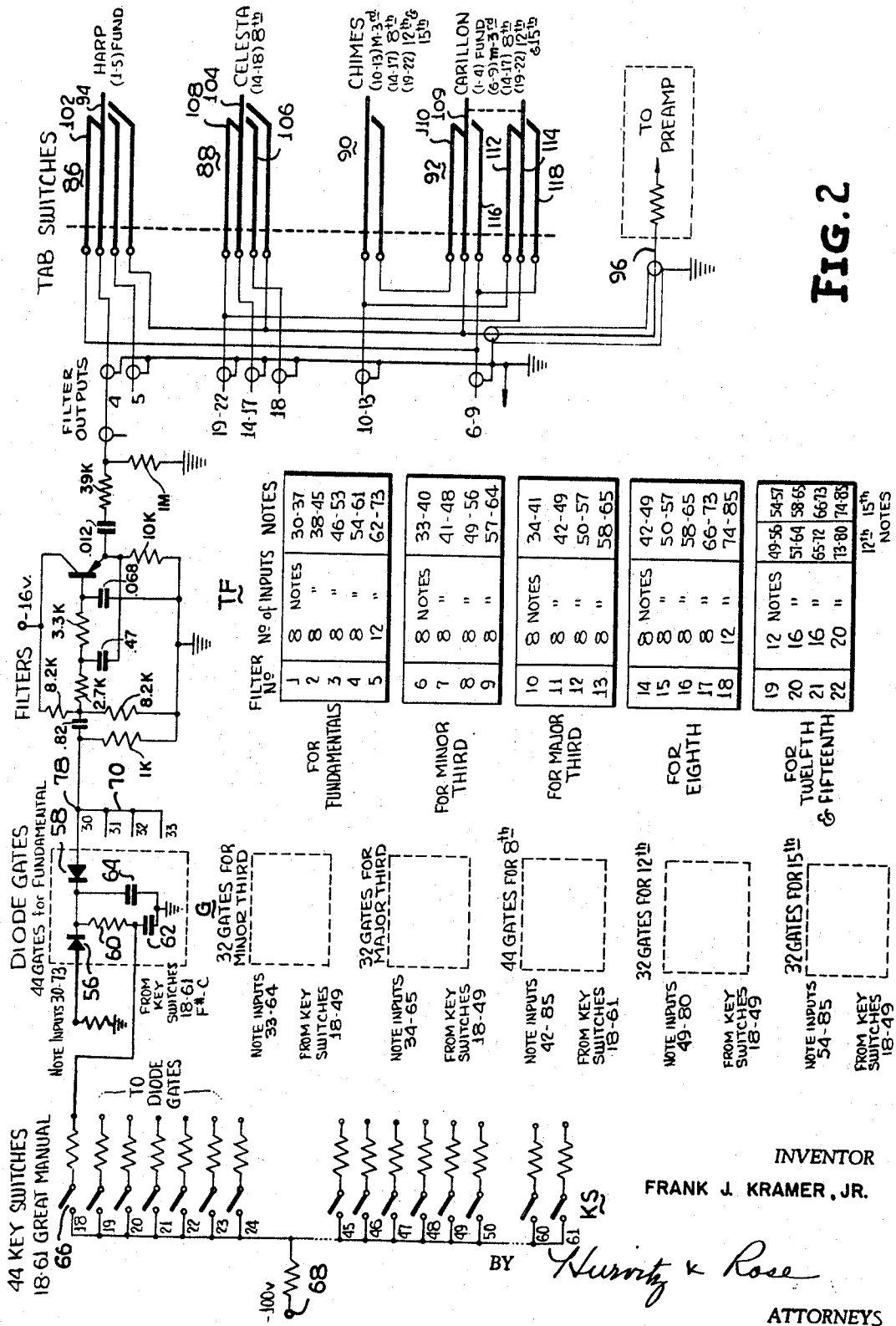
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KEYING SYSTEM FOR ELECTRONIC MUSICAL PERCUSSION SIMULATOR

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4 Sheets-Sheet 2



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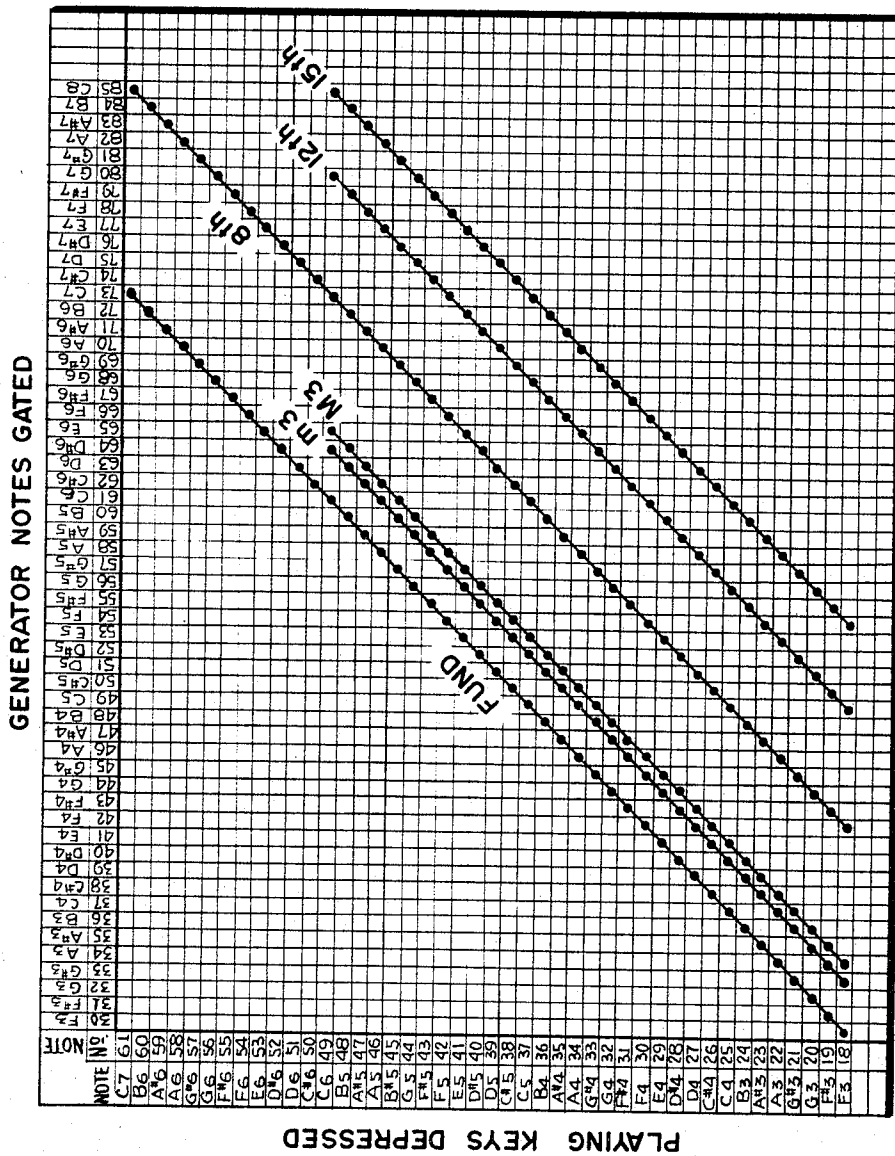
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KEYING SYSTEM FOR ELECTRONIC MUSICAL PERCUSSION SIMULATOR

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4 Sheets-Sheet 3



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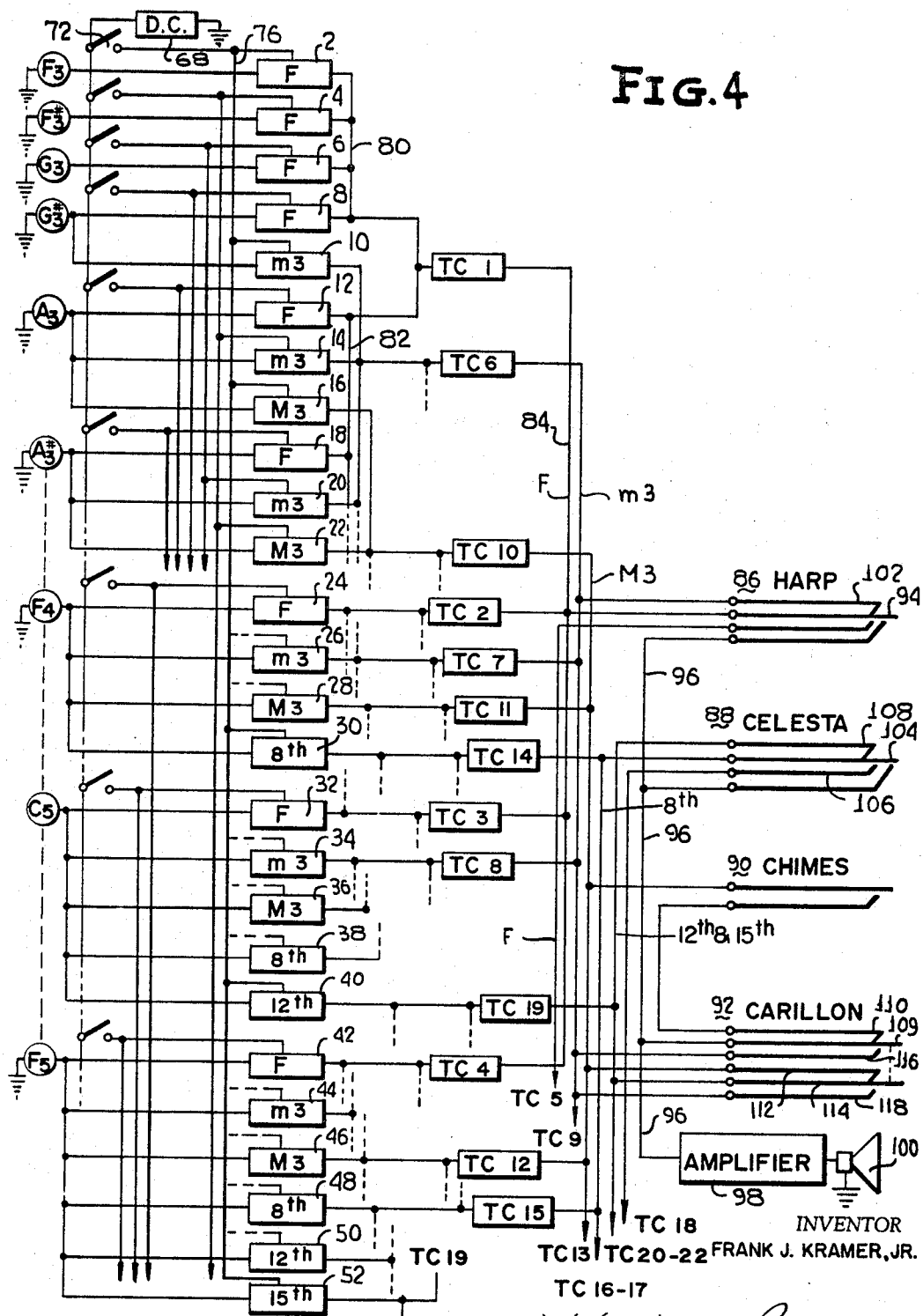
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KEYING SYSTEM FOR ELECTRONIC MUSICAL PERCUSSION SIMULATOR

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4 Sheets-Sheet 4



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KEYING SYSTEM FOR ELECTRONIC MUSICAL
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Baldwin Company, Cincinnati, Ohio, a corporation of
OhioFiled Mar. 29, 1965, Ser. No. 443,354
17 Claims. (Cl. 84-1.19)

The present application discloses an improvement on application Ser. No. 135,101, filed Aug. 28, 1961 now Patent No. 3,223,767, entitled, "Keying Systems for Electric Musical Instruments," in the names of Walter Munch, Jr., and Robert C. Scherer, assigned to the assignee of the present application.

This invention pertains generally to electronic musical instruments, and more particularly to systems for the simulation of percussion instruments, such as chimes, carillon, harp and celesta, in electronic organs.

The tones produced by actual chimes and carillons are quite complex in character, but it is feasible to synthesize them by combining partials derived from continuously-running sources of tone-signals tuned to a chromatic scale, and which are in any event used to produce other organ tones. For instance, a carillon can be simulated by concurrently gating signals from separate sources corresponding to the fundamental (1st partial), the minor third, the eighth (or octave), the twelfth and the fifteenth partials. To produce a gamut of carillon tones, a particular single source may supply, for one tone of the gamut, a signal used as the fundamental of the carillon tone, and for another carillon tone, that same source may supply a signal which is used as a minor third component of the latter tone. These same sources may also be used to provide partials of chimes, harm and celesta tones.

According to the present invention, a simple, asymmetric percussive diode gate is employed for each separate partial usage of a given tone signal, all gates for providing the partials of a given output tone being concurrently actuable by one single-pole, single-throw key switch. When a given signal is used as a fundamental of a tone, one gate is used to pass that fundamental; when that same signal is used as a minor third partial of another tone, another gate is used, and so on. A gate is provided for each partial of every output tone required by the system, and the gates are rendered conductive in groups in response to closure of one key switch. By means of separate filters, the various partials of each output tone are separately filtered to remove harmonics of that note, and to isolate the particles, i.e. F, m, M, 8th, etc. from each other. One filter acts upon a particular signal when it is used as a fundamental, another filter acts upon that same signal when it is used as a minor third, etc. Most of the filters act upon only eight consecutive semi-tone signals, but at the upper end of the tone spectrum, individual filters may act upon more than eight semi-tone signals, for purposes of economy.

In a specific organ, the system of the present invention may apply to 44 key switches, say #18-#61 of the Great manual, covering notes (i.e. signal sources) numbered 30-85. There are then provided 44 gates for fundamentals F, one for each key switch. In addition, 32 gates are provided for minor third (m) partials, which are controlled from key switches 18-49 (notes 33-64). 32 gates are also provided for major third (M) partials, connecting to note inputs 34-65, i.e. key switches 18-49. 44 gates exist for 8th's, corresponding with key switches 18-61 and note inputs 42-85; 32 gates exist for 12th's, for note inputs 49-80 from key switches 18-49, and 32 gates for 15th's, for note inputs 54-85 from key switches 18-49. It will be

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appreciated that each key switch must call forth a plurality of partials, so that, for example, a high numbered key switch, say #49, must call forth note #85, and therefore the number of key switches and the number of notes do not correspond, but the number of key switches equals the number of audible output tones.

The different tone qualities pertaining, respectively, to the chime, the carillon, the harp and the celesta, may all be synthesized from the same set of partials, i.e. fundamentals (F), minor 3^d (m₃ or m), major 3^d (M₃ or M), 8th, 12th and 15th partials. Of these, the harp requires only the fundamental and the celesta only the 8th partial (octave). The carillon requires F, m₃, 8th, 12th and 15th and the chime requires M₃, 8th, 12th, 15th. The system of the invention, i.e. the arrangement of gates and filters, permits identical partials, i.e. F, m, M, etc. to be collected in discrete buses. Synthesis of desired tone colors thus merely involves connecting a suitable bus or buses to a pre-amplifier. Since the 12th, and 15th are always used together and never apart from each other, they can be collected on one bus, if desired.

Excellent tone color can be achieved by gating partials directly from generators, without weighting, and all gates, which for the purpose are percussive gates, can have the same decay times. Nevertheless, for some musical ears it would be desirable that different partials have different amplitudes and/or decay times, in any given tone color. Facility for achieving the latter result is inherent in the present system, since each partial derived from a signal source is provided with an individual gate and that gate can provide any desired decay time and/or weight. The fundamentals of the signal source outputs are selected following the gates, by means of a gamut of relatively narrow band filters, so that each filter can handle a small group of semi-tones (say eight). Singles derived from the filters are collected on buses, from which desired components for forming tones of desired tone color are the selected by stop switches. For example, all fundamentals F can be applied to a single bus, so that only this bus need be selected for harp tones, but this same bus, in conjunction with other buses, can be selected also for carillon tones. Similar reasoning applies to the celesta, in respect to the eighth. A single switching arrangement applies to the remaining partials, since chime tones require M, 8th, 12th and 15th, while carillon tones require F, m, 8th, 12th, 15th. It is necessary, thus, to have buses carrying (1) F, (2) 8th, (3) m, (4) M, (5) 12th and 15th.

It will be noted that F is required for the harp and carillon, that M is required only for chimes, that m is required only for carillon, that 8th is required for celesta, chimes and carillon, and that 12th and 15th are required only by chimes and carillon. These facts lead to simplification of tone color switching by employing plural pole double throw type switches, each having at least one normally closed, as well as at least one normally open set of contacts.

Accordingly, it is a primary object of this invention to provide an improved tone simulating system for an electronic organ, capable of economically and accurately simulating such percussive tones as harps, celesta, chimes and carillon.

It is an important object of this invention to provide a system which requires only one key switch per key, but multiple gates per key, in generating percussive tones including multiple partials, which may have independent decay times.

A further object of the invention resides in the provision of a system for synthesizing certain percussive tones from signal sources of complex character, by selecting tone partials from a small number of buses.

Another object of the invention resides in the provision of a system for enforcing, in response to the selective

actuation of keys of a manual, the simultaneous availability of partials of diverse characters on a small number of buses, the partials being selected to render feasible the provision of plural types of percussive tones by tapping into selected ones of the buses.

It is a further object of this invention to provide a multiple partial percussive system wherein the decay rates and/or weights of the partials of an audible tone may be different one from another.

It is a still further object to provide a multiple partial percussive system wherein the tone colors of tones of one type, as chimes, may be made different one from another.

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of one specific embodiment thereof, especially when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a block diagram showing the derivation of one set of partials, on closure of one key switch, and the treatment of that set of partials to derive one tone of each type available in the system;

FIGURE 2 is a schematized block diagram showing the overall organization of a system according to the invention, for a complete set of key switches;

FIGURE 3 is a chart showing the partials which are called forth in response to each key number, in the present system, and identifies the key number with the notes generated, in terms of musical nomenclature;

FIGURE 4 is a block diagram of part of a system according to the invention, showing in detail the implementation of the block diagram of FIGURE 2.

The basic content of the present system may best be understood by reference to FIGURE 1, which illustrates the manipulation of one set of signals, responsive to closure of one key switch.

On closure of a key switch KS keying voltage is applied simultaneously to six solid state diode gates, G, which are connected to distinct and separate signal sources providing F, *m*, M, 8th, 12th and 15th partials, these being all the partials which may be required for generating one tone, having tone color appropriate to either carillon, harp, celesta, or chime.

The signals passed by the gates proceed to eight-note tone filters, TF. Each filter passes eight notes excluding higher partials of the signal, so that only the fundamental components pass. One filter pertains to F partials, deriving from eight signal sources. A second filter pertains to M signals deriving from eight signal sources, and so on. A given signal source may feed, generally, six gates, i.e. it may provide via one gate a fundamental, via another gate an M, via another gate a 12th, etc. A single filter services only F or M, or *m*, etc., but in general services eight adjacent ones of these.

As seen in FIGURE 1 only one output note can be produced since only one key switch is shown, but this note can have any one of four tone colors. The F partials of this note appears on bus F, the M partials on bus M, etc., so that partials of a designated position proceed to a single bus. The 12th and 15th buses are combined, as is also the 12th and 15th filter TF, since these partials invariably are used together.

Following the filters TF occur tone color selector switches. The switch HS connects a common pre-amplifier bus AB only to the F bus. Similarly, the celesta switch CS connects only the 8th bus to the pre-amplifier bus AB. The chime switch CHS connects the M, 12th, 15th and 8th bus to the pre-amplifier bus AB, while the carillon switch CAS connects F, *m*, 8th, 12th and 15th to the pre-amplifier bus AB.

Clearly, the same set of tone color switches can operate in an organ, keys numbered 18-61 of the Great division key switches, for all the available tone colors and in FIGURE 1 operates in respect to eight key switches (not all shown).

The inclusion of the basic arrangement into a complete

organ is indicated schematically in FIGURE 2. As applied in an organ, keys numbered 18-61 of the Great division are employed. Accordingly, 44 key switches KS apply gating voltage from a negative DC source to gates G, described in detail hereinafter, and selectively render these gates conductive. Since 44 key switches are employed, 44 gates are required for fundamentals F. Since the signal sources are square waves (or may be harmonic rich waves), it is necessary to remove harmonics from the signal sources. This is accomplished by five filters, of which the first four pass, respectively, notes 30-37 (key switches 18-25), 38-45, 46-53, 54-61, and the last passes 12 notes, i.e. 62-73. Thereby only fundamentals F are passed by the filters, the relation of the key switch numbers to the note numbers is charted in FIGURE 3.

In all, twenty-two filters suffice for all notes and tones of the system, the widths of the filters in terms of half tones being indicated in the blocks under TF, and the relation of these to the key switches being indicated in FIGURE 3.

In operation, closure of a single switch, say 72, FIGURE 4, applies gating voltage to a plurality of gates simultaneously, in this case gates 2, 10, 16, 30, 40, 52. These gates pass square wave signals from generators F₃, G₃#, A₃, F₄, C₅, F₅, where the designations represent musical notations. The frequencies of the fundamentals of the signals then represent the fundamental (F), the minor third (*m*₃), the major third (M₃), the 8th, the 12th, and the 15th partials of a percussive tone. Filters TC₁, TC₆, TC₁₀, TC₁₄, TC₁₉, select the fundamentals of the tone signals, respectively, and apply the resultants to buses, labeled in FIGURE 4 according to the partials involved.

Assuming that a harp tone is desired, the harp stop switch 86 is actuated by depressing arm 94. Thereby filter TC₁ is connected at the lower contacts of switch 86, but TC₆ etc. are disconnected. The total tone output is F, which proceeds via line 96 to amplifier 98 and speaker 100. For chimes, for example, the chime switch 90 would be closed, but the upper contacts 102 of the harp switch 86 and 108 of the celesta switch 88 and upper contacts 110, 112 of the carillon switch 92 are closed.

Referring again to FIGURE 4, tone signal sources labeled F₃, F₃#, etc. may be cascaded flip-flops having preferably, but not necessarily, square wave output, are shown coupled to gates 2, 4 . . . 52, which are preferably of the type illustrated in FIGURE 2. In the latter figure, tone signals from a source of square waves for example only, are fed to two series back-to-back diodes 56 and 58, preferably of the silicon type. From the junction of said diodes to ground are connected, as shown, a resistor 60 and capacitor 62 (in series), and in parallel therewith a second capacitor 64. To the junction of resistor 60 and capacitor 62 is connected a key switch 66 in series with a direct current source 68. To the diode 58 is connected a bus 70, to which preferably three other diodes of adjacent gates (such as 4, 6 and 8, FIGURE 4), are connected. These diodes may be selenium diodes packaged in accordance with the teachings of a co-pending application for U.S. Patent, Ser. No. 134,201, in the name of John B. Brombaugh, assigned to the assignee of this application. The capacitor 64 has the function of presenting a low bypass impedance relative to gate through impedance, while the gate is non-conductive, so that feed-through signal during non-conductive gate condition is minimized. Such feed-through occurs largely via the inherent capacitance of the diodes. In conductive gate condition, the shunt impedance of capacitor 64 becomes relatively large, compared with diode resistance, so that signal is not unduly attenuated. While the specific solid state gate illustrated in FIGURE 2 of the accompanying drawing is preferred, other gates may be employed, if desired.

Referring again to FIGURE 4, the gate 2 is actuated by means of a key switch 72 connected as shown to a

direct-current source 68. By means of the bus 76, the direct current from source 68 is transmitted also to gates 10, 16, 30, 40 and 52 which, respectively gate signals from sources $G_3\#$, A_3 , F_4 , C_5 and F_5 corresponding to the partials minor third (m_3), major third (M_3), 8th (octave), 12th and 15th respectively. Thus are concurrently gated by switch 72 all the partials needed for one percussive tone of any character available, according to the teaching of the present system. Desired output tone partials are then separated by tone color filters TC, and selected by one of harp, celesta, chimes and carillon switches, following the filter. The diode gates are percussive, and may be designed to weight partials or to adjust decay times of partials, but this has not proved necessary in practice.

In the illustrated gate G of FIGURE 2, the capacitor 62 is immediately charged upon closure of the key switch 66. This gives a characteristic abrupt rise to voltage at the cathodes of the diodes 56 and 58, providing immediately a gated signal at the output point 78. Upon opening of the key switch 66, the charge on the capacitor 62 is drained off at a rate determined principally by the resistor 60, chosen to give a desired rate of decay of the signal corresponding to a percussive tone. One skilled in the art will realize that decay rates among partials may be adjusted by changing the R-C time constants of the gates.

Again, with reference to FIGURE 4, the signal gated to the bus 80 is fed to a tone-color filter, TC_1 , to which are connected fundamental gates 12, 18 and two other gates (not shown). Filter TC_1 thus selects the signals from eight gates for eight fundamental partials of tones. Similarly, TC_6 is responsive to minor third gates 10, 14, 20 and others (not shown). In a similar fashion TC_{10} handles major third partial signals, TC_{14} affects octaves and TC_{19} for simplicity handles both twelfths and fifteenths. Other filters, such as TC_2 , TC_{10} , etc. affect other partials in groups of eight signals each, except for the twelfths and fifteenths, handled by gates TC_{19} to TC_{22} , which affect sixteen signals each. The specific overall arrangement is indicated in FIGURE 2.

The tone-color filters are preferably, but not necessarily, of the type illustrated at TF in FIGURE 2, wherein the various components are valued as indicated. This provides a broad band-pass characteristic preferably producing a 12 db per octave roll-off. The center of the band-pass characteristic preferably corresponds to the mean frequency of the tone signals served. One skilled in the art will realize that the filters will of necessity be different for different frequency ranges.

The outputs of the filters are collected as shown in FIGURES 2 and 4, the various buses being labeled with the partial signal being filtered. For example, bus 84 is also marked "F." For convenience in switching, as will be explained hereinafter, two of the output buses are broken into two parts, the outputs of filter TC_5 and TC_{18} being taken directly to the stop switches.

The harp stop switch, indicated generally at 86, is fed only from the fundamental filters TC_1 to TC_5 , the switch being actuated to the lower position of leaf 94, at which time the signals from these filters are fed via lead 96 to a suitable output system comprised of an amplifier 98 and loudspeaker system 100. In the off position of stop switch 86, the contact lead 94 engages leaf 102 to which, for reasons to be explained, signals corresponding to minor thirds are connected via the minor third (m_3) bus.

The celesta stop switch, indicated generally at 88, connects in the lower position of leaf 104, leads from the "octave" filters to the output lead 96, previously mentioned, the movable leaf 104 being coupled to filters TC_{14} to TC_{17} , while the leaf 106 is connected to TC_{18} . In the off position (upper) of leaf 104, leaf 108 is contacted, to which, for reasons to be explained, are connected filters TC_{19} to TC_{22} which process the 12th and 15th partial signals.

The chimes stop switch, indicated generally at 90, causes the output of major third filters TC_{10} to TC_{13} to be passed to the output lead 96 via upper-movable leaves 109 and 110 of carillon stop switch 92, which leaves are closed in the off position of the switch 92. Also, by virtue of the connection of the leaf 112 of switch 92 to the major third (M_3) bus, the signals on the 12th and 15th bus are coupled to the output lead 96 via the contact leaf 114. Also, since the leaf 108 of switch 88 is connected to the octave (8th) bus via the leaf 104, octave signals are also passed to the output lead 96 for translation to sound via amplifier 98 and speaker system 100.

When the carillon stop switch 92 is actuated, leaves 109 and 114 are concurrently moved downward, leaf 109 engaging leaf 116 to which is connected the minor third (m_3) bus, so that minor third signals will be carried to the output bus 96 via leaf 109. Also, since the minor third bus has a connection to leaf 102 of switch 86, fundamental signals are carried thereto via leaf 94 (which contacts 102 in the off position of switch 86) for translation to sound via bus 96. Further, when lead 114 contacts leaf 118, which is connected to the minor third bus, the 12th and 15th signals are connected thereto via the leaf 114, which is connected to the 12th and 15th bus. Since, as mentioned before, the 12th and 15th bus is connected to leaf 108, the octave signals are passed via the leaf 104 to the output bus 96 for translation to sound in speaker 100.

Since it is not considered desirable herein to illustrate a complete circuit diagram for a complete organ, reference is made to FIGURE 3 wherein is shown a chart indicating (in conjunction with FIGURE 2) which generator of signal source is gated upon depression of each key from key number 18 (for F_3) to key number 61 (for C_7). For example, a horizontal line from key 18 would show that sources F_3 , $G_3\#$, A_3 , F_4 , C_5 and F_5 are concurrently gated to the output.

While I have described and illustrated one specific embodiment of my invention, it will be clear that variation of the details of construction which are specifically illustrated and described may be resorted to without departing from the true spirit and scope of the invention as defined in the appended claims.

1. A multiple-partial, percussive-voice system for an electronic musical instrument comprising:

- a rank of continuously-running, tone-signal sources corresponding to musical tones and to partials of desired percussive voices,
- a direct-current source,
- a plurality of direct-current-actuable, gradual-decay gates coupled to said direct-current source and to each of a plurality of said sources on a tone-partial basis,
- a plurality of common keying circuits respectively coupled to those of said gates coupled to each of said sources,
- a plurality of collectors each coupled to a plurality of said gates chosen one from each of said plurality of gates connected to consecutive ones of sources, whereby corresponding partials are collected,
- a plurality of filters respectively connected to said collectors,
- a second plurality of collectors respectively connected to ones of said filters corresponding to similar partials,
- an output system, and
- a plurality of switching means coupled respectively between said second plurality of collectors and said output system on a tone-partial basis, whereby a plurality of desired partials of said percussive voices are concurrently derived in said output system.

2. A plural-partial percussive-voice system for an electronic musical instrument, comprising:

- a plurality of continuously-running tone-signal sources corresponding to partials of a desired musical tone,
- a direct-current source,

- a plurality of direct-current-actuable, gradual-decay gates respectively coupled between said tone-signal sources and said direct-current source,
 a common keying circuit coupled between said direct current source and said gates for concurrent actuation thereof,
 a plurality of filters respectively coupled to said gates, an output system, and
 switching means coupling at least some of said filters to said output system, whereby a plural-partial percussive tone is derived in said output system by virtue of a selected combination of partials thereof.
3. The combination according to claim 2, including further switching means coupled between said filters and said output system for selecting a different combination of said signals for derivation in said output system of a different plural-partial percussive tone.
4. The combination according to claim 2, including single switch means coupling one of said filters to said output system for derivation in said output system of a simple percussive tone.
5. A complex-percussive-voice-synthesizing system for an electronic musical instrument, comprising:
 a plurality of sources of tone signals corresponding to notes of a musical scale and to partials thereof,
 a direct-current source,
 a plurality of direct-current-actuable, gradual-decay gates coupled between respective tone-signal sources and said direct-current source, there being a gate for each usage made of a particular source as a partial of a complex tone,
 a first plurality of collector means, each coupling gates from each of said plurality of gates coupled to a particular tone-signal source,
 a plurality of filter circuits respectively coupled to said collector means,
 a second plurality of collector means, each coupled to filter circuits affecting signals corresponding to similar partials,
 an output system, and
 a plurality of switch means selectively operative to couple different combinations of said second plurality of collector means to said output system, whereby to derive different kinds of percussive tones in said output system.
6. A complex-percussion-voice synthesizing system for an electronic musical instrument, comprising:
 a plurality of sources of tone signals corresponding to notes of a musical scale and to desired partials thereof,
 a direct-current source,
 a plurality of first direct-current-actuable, gradual-decay gates respectively coupled between certain at least of said tone-signal sources and said direct-current source, to gate first-partial signals,
 a plurality of second direct-current-actuable, gradual-decay gates respectively coupled between certain at least of said tone-signal sources and said direct-current source to gate second partial signals,
 a plurality of keying circuits respectively connected between said direct-current source and one of said first gates and one of said second gates for concurrent actuation thereof,
 a plurality of first collector means, respectively coupled to groups of said first gates,
 a plurality of second connector means respectively coupled to groups of said second gates,
 a first filter coupled to said first collector means,
 a second filter coupled to said second collector means,
 an output system, and
 switch means coupled to said first filter and to said second filter for selectively coupling said filters to said output system, whereby to synthesize complex percussive tones in said output system.

7. A complex-percussive-tone synthesizing system for an electronic musical instrument comprising:
 a plurality of sources of tone signals corresponding to musical tones and to partials thereof,
 a plurality of fundamental gates respectively coupled to at least some of said sources,
 a plurality of minor third gates respectively coupled to at least some of said sources,
 a plurality of major third gates respectively coupled to at least some of said sources,
 a plurality of octave gates respectively coupled to at least some of said sources,
 a plurality of twelfth gates respectively coupled to at least some of said sources,
 a plurality of fifteenth gates respectively coupled to at least some of said sources,
 a direct-current source,
 a plurality of keying circuits each coupled between said direct-current source and one of said fundamental gates, one of said minor third gates, one of said major third gates, one of said octave gates, one of said twelfth gates and one of said fifteenth gates for concurrent actuation thereof,
 a plurality of collector means respectively coupling together groups of said fundamental gates, groups of said minor third gates, groups of said octave gates, groups of said twelfth and said fifteenth gates,
 a plurality of fundamental filters respectively coupled to said collector means for said fundamental gates,
 a plurality of minor third filters respectively coupled to said collector means for said minor third gates,
 a plurality of major third filters respectively coupled to said collector means for said major third gates,
 a plurality of octave filters respectively coupled to said collector means for said octave gates,
 a plurality of twelfth and fifteenth filters respectively coupled to said collector means for said twelfth and fifteenth gates,
 an output system,
 first switching means selectively coupling said fundamental filters said said output system to produce harp tones therein,
 second switching means selectively coupling said octave filters to said output system to produce celesta tones therein,
 third switching means selectively coupling said major third filters, said octave filters and said twelfth and fifteenth filters to said output systems to produce chimes tones therein, and
 fourth switching means selectively coupling said fundamental filters, said minor third filters, said octave filters and said twelfth and fifteenth filters to said output system to produce carillon tones therein.
8. In an electronic musical instrument, the combination comprising:
 a plurality of tone signal sources corresponding in frequency to notes of a musical scale,
 a lesser plurality of tone-color filters,
 a key switch corresponding to each of said sources,
 a direct-current source,
 a plurality of direct-current-actuable, abrupt-attack, gradual-decay gates having each
 a direct-current input point connected via one of said key switches to said direct-current source,
 a signal input point connected to one of tone-signal sources, and
 a signal output point connected to one of said tone-color filters,
 an output system, and
 a tone-color switch connecting at least one of said filters to said output system, there being a plurality of said gates connected to certain of said tone-signal sources for providing desired components of certain multiple-tone-signal tone-colors.
9. In a chimes-carillon type tone percussion synthesizing

ing system for an electronic musical instrument, the combination comprising:

- a plurality of source of tone signals corresponding respectively in frequency content to a plurality of fundamental and other partials of complex percussion voices, 5
- a lesser plurality of voicing circuits,
- a key switch corresponding to the fundamental of at least some of said sources,
- a direct-current source, 10
- a plurality of direct-current-actuable, abrupt-attack, gradual-decay gates corresponding to said desired fundamentals and other partials having each
 - a direct-current input point connected via a separate path and one of said key switches to said direct-current source, 15
 - a signal input point coupled to one of said tone-signal sources to provide a desired partial of one of said percussive voices,
 - a signal output point coupled to one of said voicing circuits according to a desired filtering for said desired partial,
 - an output system, and
- voicing switches coupled between said voicing circuits and said output system, whereby to select and filter respective partials as desired. 25

10. In an electronic organ, the combination comprising a plurality of sources of tone signals corresponding in characteristics to tones of a musical scale and to components of a percussive type tone, 30

- a playing key-actuable switch,
- a direct-current source,
- a plurality of tone-color filters,
- a plurality of direct-current actuable, abrupt attack, gradual-decay gates each having
 - a signal-input point coupled to one of said signal sources, 35
 - a direct-current input point connected to said direct-current source via said key switch,
 - a signal-output point coupled to one of said tone color filters, 40
 - an output system, and
- a plurality of ganged tone-color switches coupling at least some of said tone-color filters to said output system, whereby said components of said percussive tone are simultaneously derived in said output system to produce a multiple-component percussive voice therein. 45

11. In an electronic organ having a rank of tone-signal sources connectable respectively to an output system by means of a first bank of key switches, collecting means and tone-color filters for producing steady state tones, the combination comprising: 50

- a second bank of key switches operable substantially simultaneously with respective switches in said first bank, 55
- a direct-current source,
- a plurality of percussive-voice filters,
- an output system, and
- a bank of percussive gates having a plurality thereof coupled with each of a plurality of said tone-signal sources on a desired-partial basis, said gates having each, 60

- a direct-current input point connected via one of said key switches in said second bank to said direct-current source, 65
 - a signal output point coupled to said output system via one of said percussion-voice filters,
- whereby each of a plurality of said tone-signal sources supplies signal for partials for each of a plurality of percussive tones as well as for steady-state tones. 70

12. In an electronic musical instrument, a complex percussive voice simulating system comprising a set of tone-signal sources corresponding to notes of an equitempered musical scale, 75

- a plurality of key switches corresponding respectively to said sources,
- a plurality of direct-current-actuable percussive gates coupled to each of said sources on a tone-partial-utilization basis,
- a plurality of percussive voice tone filters,
- circuit means coupling a plurality of said gates to each of said tone filters on a desired tone-filtering basis,
- a plurality of percussive-voice stop switches,
- an output system,
- further circuit means coupling said tone filters to said output system via said stop switches,
- a direct-current source, and
- still further circuit means connecting said direct current source to said gates via said key switches on a desired tone-partial basis.

13. In an electronic musical instrument, the combination comprising:

- a plurality of tone-signal sources corresponding in frequency to notes of a musical scale,
- a direct-current source,
- a plurality of key switches corresponding respectively to at least some of said signal sources,
- a plurality of direct-current-actuable, abrupt-attack, gradual-decay gates having each
 - a direct-current input point connected via one of said key switches to said direct-current source,
 - a signal-input point coupled to one of tone signals sources, and,
 - a signal-output point,
 - a plurality of tone-color filters,
 - a plurality of tone-color switches, and an output system, 5

said signal-output points being respectively coupled through said tone-color filters and said tone-color switches to said output system on a desired-partial basis.

14. In an organ system, a first source of signal having a fundamental frequency F,

- a second source of signal having a frequency m , where m is a minor third above F,
- a third source of signal having a frequency M , where M is a major third above F,
- a fourth source of signal having a frequency which is an eighth above F,
- a fifth source of signal having a frequency which is a twelfth above F,
- a sixth source of signal having a frequency which is a fifteenth above F,
- a source diode gate in cascade with each of said sources of signal,

means for rendering said gates selectively conductive and non-conductive simultaneously, said last means consisting of

- a single key operated switch,
- an amplifier, said amplifier having an input circuit, an acoustic radiator connected in cascade with said amplifier, and
- switch means for at will selectively connecting to said input circuit (1) said first source of signal, (2) said fourth source of signal, (3) said third, fourth, fifth and sixth sources of signal, and (4) said first, second, fourth, fifth and sixth sources of signal.

15. An organ system, comprising

- a gamut of signal sources having fundamental frequencies at values appropriate to the musical scale,
- a plurality of groups of diode gates each consisting of plural diode gates connected in parallel with each other,
- means connecting each group of gates in cascade with a different one of said signal sources,
- a plurality of key switches identified with notes of the musical scale,
- means responsive to closure of each of said key switches

for rendering conductive gates selected one each from different ones of said groups, the selected gates being selected for each signal sources of fundamental frequency F appropriate to that key switch to include an accompanying set of gates which are in cascade with signal sources having fundamental frequencies m , M , 8th, 12th and 15th partials above F , where m is a minor third and M is a major third, 5
 filter means each arranged for passing fundamentals derived from less than twelve adjacent notes of the musical scale derived from said diode gates, said filter means together completely encompassing a selected portion of the musical scale, 10
 means connecting said diode gates in cascade with said filter means suitably to pass only fundamental frequencies derived from said signal sources, 15
 means for applying all signals of frequencies F , m , M , 8th, 12th and 15th on buses, and
 means for connecting switching circuits to said buses for collecting at will frequencies suitable for generating tone colors appropriate to carillon, chime, harp and celesta tones on closure of any one said key switches, 20
16. In a percussive tone generating system,
 a gamut of sources of complex tone signals having fundamentals arranged in frequency according to a chromatic scale, 25
 a plurality of key switches,
 a plurality of percussive gates selectively rendered conductive in groups in response to actuation of each of said key switches, each group responsive to one key switch being connected to certain of said signal sources selected to provide all partials of one desired percussive output tone in terms of fundamentals of the selected tone sources, 30

means for filtering from the signals called fourth by all said gates all harmonics contained in said complex tone signals, and
 tone color switch means connected to and following said means for filtering for at will selecting a desired combination of said partials conforming to a desired percussive tone color.
17. In a tone generating system,
 a gamut of sources of complex tone signals having fundamentals arranged in frequency according to a chromatic scale,
 a plurality of key switches,
 a plurality of gates selectively rendered conductive in groups in response to actuation of each of said key switches, each group responsive to one key switch being connected to certain of said signal sources selected to provide all partials of one desired output tone in terms of fundamentals of the selected tone sources,
 means for filtering from the signals called forth by all said gates all harmonics contained in said complex tone signals, and
 tone color switch connected to and following said means for filtering for at will selecting a desired combination of said partials conforming to a desired tone color.

No references cited.

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