

June 7, 1966

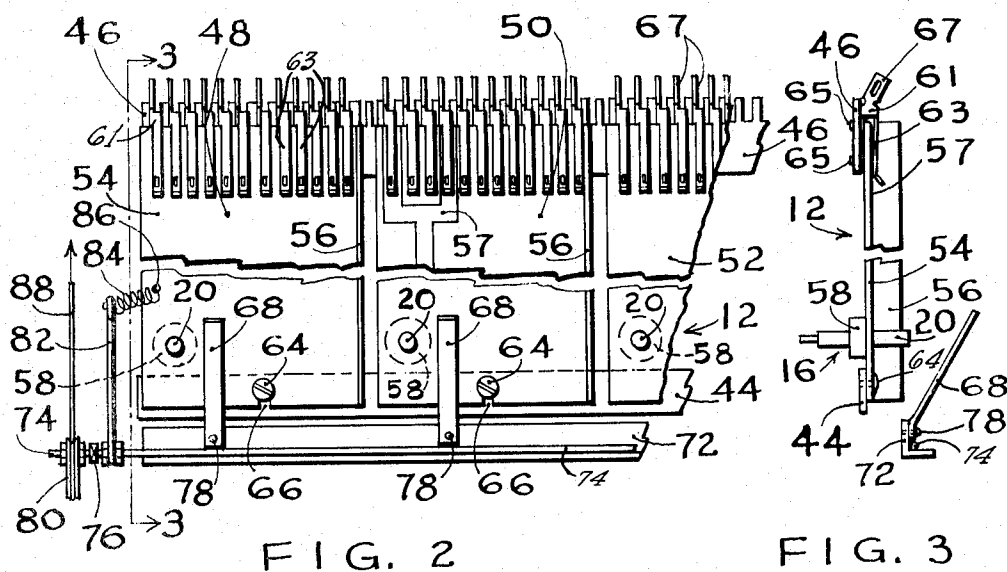
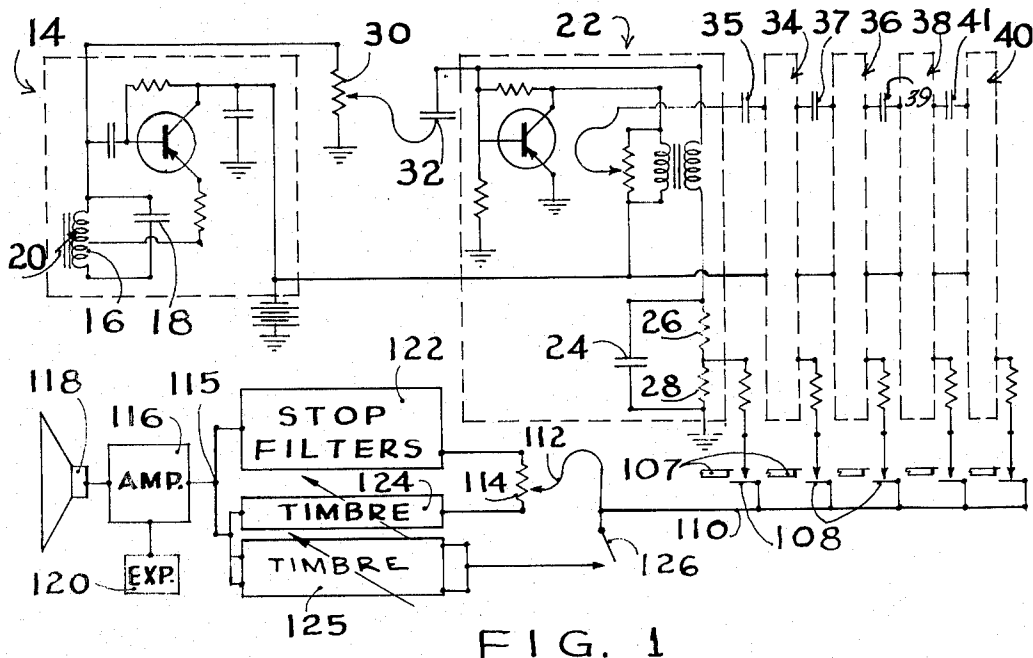
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3,255,296

PLAYER CONTROLLED DYNAMIC VARIATION OF PITCH AND/OR TIMBRE

Filed March 2, 1961

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

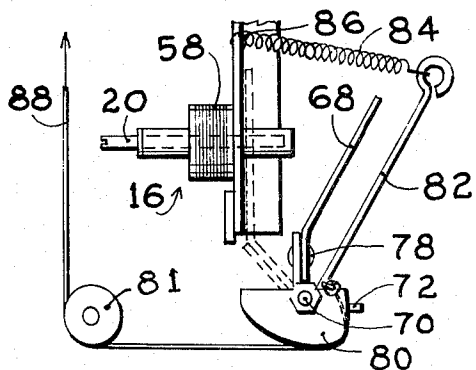


FIG. 4

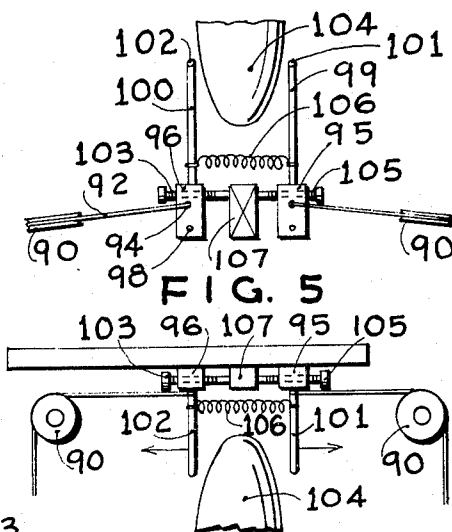


FIG. 5

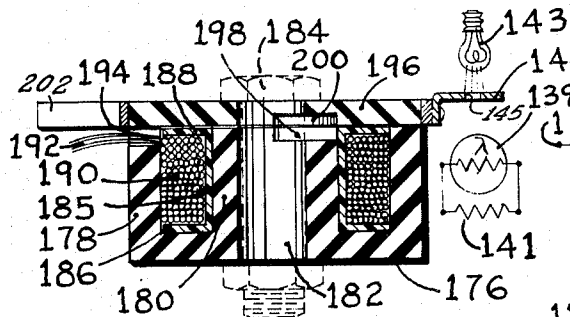


FIG. 10

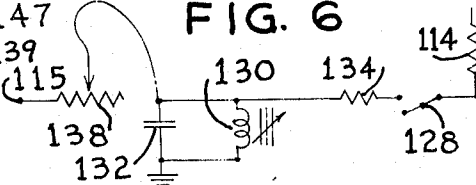


FIG. 6

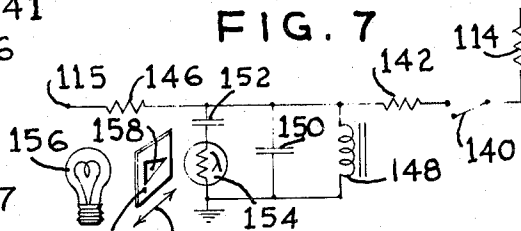


FIG. 7

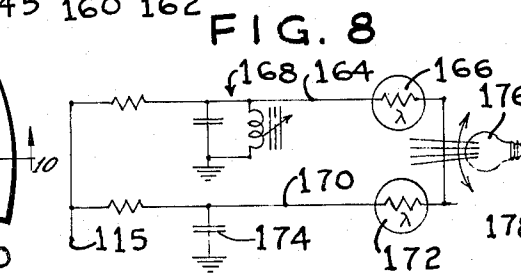


FIG. 8

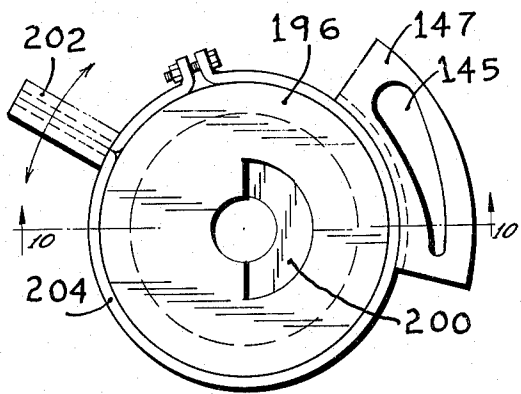


FIG. 11

FIG. 9

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3,255,296

PLAYER CONTROLLED DYNAMIC VARIATION OF PITCH AND/OR TIMBRE

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Filed Mar. 2, 1961, Ser. No. 92,974

3 Claims. (Cl. 84-1.24)

This invention relates to electrical musical instruments, and includes among its objects and advantages an improved system for producing a wide range of distinctive variations in the pitch and/or timbre of a tone that is otherwise of constant pitch and timbre, with the player able to control the extent and duration of the effect at will. Other objects and advantages of the invention will become apparent as the description proceeds.

In the accompanying drawing:

FIGURE 1 is a block and schematic circuit diagram of equipment according to the invention;

FIGURE 2 is a partial rear elevation of a tone generator;

FIGURE 3 is a section on line 3—3 of FIGURE 2;

FIGURE 4 is an enlarged detail of the end of one pitch control;

FIGURE 5 is a plan diagram of connections for operating two different controls by movement of the player's knee;

FIGURE 6 is an elevation of the parts illustrated in FIGURE 5;

FIGURE 7 is a schematic diagram of one type of formant means for varying the timbre of the delivered tones;

FIGURE 8 is a schematic diagram of a different type of formant;

FIGURE 9 is a schematic diagram of means affording selective instantaneous availability of two different types of timbre modifications;

FIGURE 10 is a section of a variable inductor on line 10—10 of FIGURE 11; and

FIGURE 11 is a bottom plan view of the cover for the inductor of FIGURE 10.

In the embodiment selected to illustrate the invention, the tone generator includes twelve chassis 12, each adapted to deliver signal for one of the twelve notes of the chromatic even-tempered scale in a plurality of different octaves.

Any such signal has three significant characteristics: (1) the extent of the excursion constituting the oscillation is named "amplitude" when the variation is of electric potential, and "loudness" or "volume" when the effect is acoustical. (2) the number of complete cycles per second is named "frequency" or "pitch." (3) the shape of the excursion is named "wave shape" in an electric oscillation, and "timbre" when the manifestation is acoustic. These are well known terms in this art. They are enumerated here because each of them may occur under either of two conditions. One, first condition is "dynamic" in the sense that the effect depends instantaneously on the movement or effort of the player at the instant. Thus the loudness conditioned by the conventional expression foot pedal is dynamic in the prior art and in this disclosure. The other, second form is non-dynamic and is changed by stop adjustments by the player, which adjustments remain unchanged until the player does something new to change them. These changes are usually made quickly during intervals when no sound is altered by the change.

One of the advantages or objects of the invention is the obtaining of dynamic variations in pitch and in timbre, as distinguished from the non-dynamic adjustments afforded by the prior art.

The organ disclosed in this application duplicates the

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prior art in having dynamic control of loudness, and also in having an assortment of non-dynamic controls for adjusting the other characteristics of the signal or note, but other dynamic controls of pitch and of timbre are also available, as described hereinafter.

The master oscillator 14 is of the Hartley type, and tuned to produce the desired note in the sixth octave, which, for the note A, is 3,520 cycles per second. This frequency is determined by the values of the inductance 16 and the capacitor 18. Precision tuning may be accomplished by adjusting the position of the ferro-magnetic core 20, which is axially movable to vary the pitch over a suitable range.

All the lower octaves are produced by suitable transistor blocking oscillators 22, 34, 36, 38 and 40.

Most of the features of the invention are applicable to other tone generating systems, but the master oscillator frequency divider system disclosed has certain advantages in connection with the distinctive pitch variation herein disclosed, because only the twelve master oscillators need to be individually controlled by the pitch varying means.

Briefly, the first blocking oscillator 22 is adjusted by timing components including capacitor 24 and resistors 26 and 28. Coupling capacitor 32 and potentiometer 30 are provided for coupling energy from the master oscillator into the first frequency divider 22 and only a small amount of master oscillator signal is sufficient to cause the divider 22 to lock in at a frequency at precisely one-half the frequency of the master oscillator. In like manner, each of the lower frequency dividers is coupled to the next higher frequency divider in such a way that the complete chain is synchronized and each divider produces a pitch exactly one octave lower than the divider from which it is controlled. In the drawing I have illustrated the last four dividers in block form only, with a separate showing for the coupling capacitors 35, 37, 39 and 41.

Distinctive pitch variations may be produced by the sliding or gliding of the tone from one pitch to another. The Hawaiian guitar and the slide trombone are ideally suited to producing such effects, and the violin and cello can do so equally well, but are less commonly so manipulated.

But there are also effects of a different type, produced by other instruments where a player has relatively little control over the pitch, but by the manner in which he manipulates his lips or hands or both, he can change the quality or timbre of the note produced, and the change may or may not be accompanied by more or less noticeable variation in pitch also. For instance, in certain types of jazz music it is common for a trumpet player or clarinetist to begin a note with a difference in timbre, and perhaps a relatively slight pitch deviation, then gradually bring the tone to normal quality and pitch. Accordingly, the word "portamento" is applicable to either the pitch portamento or the timbre portamento herein described, and the qualifying adjectives are available to indicate specifically either of the two kinds of portamento.

What is desired then, is player-controlled means for varying the pitch or quality or both, of the sounds produced by the organ, to imitate the effects above described. With the instrumentality herein disclosed it is also possible to produce other interesting distinctive variations not as yet known to be capable of being produced at all with known acoustic instruments.

Tone generator

Referring now to FIGURES 2 and 3, I have indicated a lower structural support 44 and an upper structural support 46 on which twelve generator chassis may be mounted. In FIGURE 2 I have indicated two such chassis 48 and 50 and part of a third at 52.

Each chassis, as indicated in FIGURE 2, comprises

a main panel 54 of insulating material, stiffened by a flange 56 up one side. The coil 58 and ferro-magnetic core 20 of the adjustable inductor 16 are located at the lower left-hand corner, with the coil just under main panel 54. The components of the master oscillator and all five of the frequency divider oscillators are assembled compactly on the main panel 54. As the details of the mechanical arrangement, per se, constitute no part of the present invention, this description has not been encumbered with them.

Briefly, each panel has a conventionally produced printed circuitry with a plurality of conducting strips 57 (see FIGURES 2 and 3) extending up to its upper edge. The upper support carries downwardly opening clips 61 adapted to straddle the upper edge of the panel 54 and make electric contact with strips of conductive material at 57 printed on the face of the panel 54. After the panel is thus correctly positioned with respect to the upper support 46, a fastening screw 64 may be inserted in a notch 66 in the lower edge of the panel, and both mechanical and electrical assembly is complete.

The support 46 carried the clips 61 each having a finger 63 pressed resiliently against the panel 54 and against one of the strips 57, if there happens to be one located under it. The clips have ears 65 for anchoring them in place, and conventional electrical terminals 67.

Dynamic pitch variation

Player-operated means are provided for simultaneously varying the pitch of all the master oscillators in the same direction and to a proportional extent. I have indicated means for accomplishing this variation by changing the value of the inductor 16, which means is magnetically analogous to that disclosed in my earlier Patent 2,818,759, issued January 7, 1958. Adjacent each coil 58 is a ferro-magnetic leaf 68 (see FIGURE 4) pivoted at 70 for movement into proximity into the coil 58 or into the remote position indicated in FIGURE 4, to vary the magnetic reluctance of the inductor 16.

The supporting means for the leaves 68, comprises a longitudinal beam 72 of angle section, having a rod 74 extending from its end for pivotal support in a bearing 76. Each leaf 68 is pivoted around its fastening pin 78 so that it can be rotated either clockwise or counter clockwise from the position indicated in FIGURE 2 to vary the extent to which it will move into the magnetic field of the coil 58 and lower the pitch of the master oscillator. The leaves 68 are also flexible so that they can be bent in the plane of view of FIGURE 4 to adjust the position of the active portion of the leaf angularly with respect to the axis of rotation 70. In this way an accurate adjustment can be made in the factory so that all twelve master oscillators will have identical dynamic responses throughout the range of movement of the leaves 68.

Mechanical means are provided to enable the player to rotate the pitch variation support 72 counter clockwise from the position of rest of FIGURE 4, to lower the pitch of all the master oscillators. Beyond the bearing 76 I mount a cam 80 of variable radius. A tension cable, or string 88 rides on the cam and extends rearwardly under a sheave 81, then upwardly and over a sheave 90, and then horizontally and at a slight forward angle at 92 (see FIGURE 5) to have its end affixed at 94 to a block 96 pivoted around a vertical axis at 98.

From the front end of the block 96 a horizontal rod 100 extends first forwardly and then downwardly at 102 to a position just to the right of the right knee 104 of the player, viewing the parts from the position of the player. By varying the shape of the cam 80, the ratio between the movement of the player's knee and the degree of portamento effect can be tailored to any desired relationship, throughout the range of movement. It may be constant, or progressively increasing or decreasing, or increasing at first and decreasing later, etc.

I also provide a second arm 82 extending upwardly and forwardly and connected by a light tension spring 84 to

any convenient stationary supporting structure at 86. The forces acting to rotate the block 96 are from five to 50 times greater than the effective tension of spring 84, which merely keeps the actuating string from lying slack, and supplies the ounce or two of pull needed to swing the pitch portamento leaves 68 over into operative position adjacent the coils 58.

A companion block 95 carries a companion rod 99, extending down at 101 on the other side of the player's knee, for controlling any other desired sound effect, such as the dynamic timbre variation hereinafter described. Both arms 100 and 99 are resiliently held in the positions of FIGURES 5 and 6 by a single tension spring 106, and their undisplaced positions are adjusted by set screws 103 and 105, bearing against an abutment block 107.

Dynamic timbre variations

Referring now to the timbre variation, I have indicated conventional playing keys at 107 (see FIGURE 1) adapted to close key switches 108 for the selective production of the various tones constituting the music. In practice, the keys 107 may close additional switches or operate other controls, not illustrated.

The combined playing signal from the depressed keys is assembled on a bus 110. From the bus 110 a moveable control member 112 delivers the signal to a preselected point in a balancing resistor 114. From the balancing resistor there are two channels to the terminal 115 of the transducer means comprising the amplifier 116 and loud-speaker 118, provided with the conventional expression control at 120 for varying the acoustic volume delivered.

Most of the filters for producing conventional tones corresponding to the various desired stops of the conventional organ are indicated by the block 122. These can be of any conventional type, and may for example be similar to those disclosed in the patent to Winston Kock U.S. Patent No. 2,233,948. In the other channel, the block 124 indicates dynamic timbre channels which may include the type of channels disclosed in connection with FIGURES 7 and 8, and the block 125 may be the dynamic timbre circuitry of FIGURE 9. It will be obvious that with the contact 112 at one end of the resistor 114 all the signal going to the amplifier 116 will come through the stop filters 122, but with the contact at the other end of the resistor practically all the signals will come through the dynamic timbre channels 124, and that movement of the contact point can adjust the relative volumes of the two types of signals to any desired selected ratio.

I prefer to provide the dynamic variation unit of the block 125 with a separate player's stop control 126 so that the operator can use it conjointly with the unit 124 or not, at will.

Referring now to FIGURE 7, one of the channels in the block 124 begins with the stop switch 128 and comprises a formant filter comprising the inductor 130 and capacitor 132. Signal delivered by the stop 128 passes through resistor 134 and resistor 138 to the terminal 115 of the amplifier 116.

The dynamically variable inductor 130 is according to FIGURES 10 and 11. The main cup body has an annular bottom 176 from which the outer wall 178 rises peripherally and an inner wall 180 rises near the axis, leaving a central tubular opening 182 which may receive a pivot bolt 184. The plastic spool 185 may be set in the annular space between walls 178 and 180 and comprises a tubular portion substantially fitting against the wall 180 and top and bottom flanges 186 and 188, between which flanges the winding 190 may be installed, with its leads 192 issuing through small notches 194 in the upper edge of the wall 178.

The cover 196 has pivotal guidance from the bolt 184 and lies in continuous contact with the upper end of the outer wall 178. Above the wall 180 it also has continuous contact to establish a full magnetic circuit over about 180°. 180° of the upper edge of the wall is notched

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downwardly at 198 and a corresponding area at 200 in the lower surface of the cover 196 is recessed upwardly. With the parts in the position of FIGURE 10 substantially one-half of the upper edge of wall 180 has a magnetic path without any air gap up into the cover 196. Rotation of the cover to 180° will bring the notched portion 200 over the full height portion of the wall 180 and the flat portion over the cutaway portion of the wall 180 and substantially all the magnetic flux will have to pass through a substantial air gap, which will materially vary the reluctance of the magnetic circuit.

Suitable means are provided for dynamic rotation of the cover 196. I have indicated a radial arm 202 clamped on the cover by means of a split ring 204. The arm may be connected to the additional player control block 95 to enable the player to introduce the timbre change involved in altering the magnetic circuit. The cup and cover 196 are both of ceramic ferro-magnetic material.

When the formant filter of FIGURE 7 is shifted to filter out all but the very high frequencies, there is an accompanying reduction in volume in the signal passing the formant, which is more than is desirable for the best esthetic effect. Means are provided for compensating for this reduction. Resistor 138 is diagrammatically indicated as variable in FIGURE 7. One selected embodiment of compensating means is the light-sensitive resistor 139 (see FIGURES 10 and 11) with a shunt resistor 141. These two, jointly, provide desirable functioning characteristics and together secure an effectively variable impedance for the element 138 of FIGURE 7. A conventional light source 143 delivers light through the tapered slot 145 in a shutter 147 mounted on the cover 196 of the inductor 130. Rotation of the cover to adjust the formant automatically changes the impedance of the path to terminal 115 to effect the desired automatic compensation.

In FIGURE 8, a second stop switch 140 delivers signal through resistor 142 and resistor 146 to the same terminal 115. Between the two resistors is a resonant circuit comprising an inductor 148 and a main capacitor 150, which may be supplemented by a smaller capacitor 152. Capacitor 152 is in shunt with capacitor 150 but in series with a light-sensitive resistor 154. A light source 156 delivers light through a tapered slot 158 to impinge on the resistor 154, and the slot 158 is in a plate 160, which may be moved to and fro by the operator as indicated by the arrow 162, to produce a dynamic variation of the extent to which the capacitor 152 is cut into the circuit.

It will be obvious that the operator may close stop switches 128 or 140 or both and control the dynamic variation in timbre by varying the inductor 130 or the resistance of the resistor 154 as the case may be.

In the block 125 of FIGURE 1 I have indicated in FIGURE 9 two parallel filter means to impart different timbres to the signal. The upper channel 164 carries a light sensitive resistor 166 in series with a formant filter at 168 similar to that of FIGURE 6. The lower channel 170 includes a light sensitive resistor 172 in series with a low pass filter comprising a capacitor 174 for shunting the relatively high frequencies to ground.

Both channels deliver the modified signal to the same terminal 115. Player control is by a light 176, which may be swung by the player on a pivot 178 to change the timbre from that produced by the upper channel to that produced by the lower channel, with a gradual shift in timbre as the light swings back and forth.

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Others may readily adapt the invention for use under various conditions of service by employing one or more of the novel features involved, or equivalents thereof.

As at present advised, with respect to the apparent scope of my invention, I desire to claim the following subject matter:

1. In a musical instrument of the type having a playing key for each musical semitone and sound sources operatively associated therewith and rendered operative by depressing each key for sounding the corresponding note; modulating means other than said keys and independent of said keys and of the fingers of the operator and operatively associated with said sound sources, for dynamic modulation of said sources to vary the pitch of the sound produced; a player's control element other than said keys and operatively associated with the player; said last mentioned player's control element being moveable continuously and dynamically through a predetermined path; and connections operatively associated with said control element and with said sources for varying the extent of modulation at the will of the player during the sounding of the note; the extent of modulation being a function of the position of said player's control element.

2. Equipment according to claim 1 in which the energy of the sound source is from a power source other than the muscular effort of the player.

3. In an electrical musical instrument; an electrical circuit; means for impressing on said circuit a complicated composite signal of many components; timbre-changing means adapted to be effective at and near a frequency which is characteristic of said timbre-changing means for changing the wave shape of said composite signal by changing the amplitude of components at and near said characteristic frequency; player-activated shifting means for dynamically varying adjustment of said timbre-changing means, to shift the characteristic frequency of said timbre-changing means up and down; said timbre-changing means also acting to change the overall signal volume as said timbre-changing means is adjusted up and down; variable overall volume-control means operatively connected to act on the entire signal; and an automatic connection between said last-mentioned overall volume control means and said timbre-changing means for automatically compensating for the volume changes caused by said timbre-changing means by varying said overall volume-control means in the opposite sense.

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