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ELECTRONIC PIANO AMPLIFIER

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This invention is concerned generally with the musical arts, and more particularly with an electronic piano. As well known, the piano is found substantially throughout the world, and is probably the most popular of all solo instruments. Conventional pianos are quite large and heavy. This limits the places in which a piano can be used, and renders a piano a more or less stationary instrument. Furthermore, once a piano has been built, its characteristics remain constant, except for detuning and the like with age, use, and atmospheric conditions. The relative emphasis of the bass and treble tones of a piano, the harmonic content of the notes relative to the fundamental, and perhaps other features can be controlled to some degree in manufacture. However, this degree is quite severely restricted, and no change can be made after manufacture. Furthermore, there are many effects that just cannot be obtained on a piano.

Accordingly, it is an object of this invention to provide an electronic piano having many advantages that are not possessed by conventional pianos, including light weight, portability, playing that can be heard only by the pianist, no detuning with age, wear and atmospheric conditions, and the possibility of changing the characteristics of the instrument as may be desired.

It is another object of this invention to provide an electronic piano having plug-in parts or circuits for varying the tonal characteristics of the piano. It is further an object of this invention to provide circuits and parts for an electronic musical instrument providing for obtaining various voices or effects of different musical instruments in what is basically an electronic piano.

Other and further objects and advantages of the present invention will be apparent from the following description when taken in connection with the following drawings, wherein:

Fig. 1 is a perspective view of a piano constructed in accordance with the principles of this invention;

Fig. 2 is an enlarged end view thereof with certain parts broken away;

Fig. 3 is a fragmentary detail view of the music desk assembly at the front of the piano;

Fig. 4 is a horizontal sectional view of the piano as taken along the line 4—4 of Fig. 2;

Fig. 5 is a schematic wiring diagram of the amplifier;

Fig. 6 is a schematic wiring diagram of a tremolo and voicing circuit;

Fig. 7 is a schematic wiring diagram of a phase shift oscillator similar to a portion of Fig. 6;

Fig. 8 is a schematic wiring diagram of the controls forming a part of and cooperating with the tremolo and voicing circuit;

Fig. 9 illustrates certain response curves of portions of the circuits; and

Fig. 10 is generally similar to Fig. 9 with the addition of tremolo.

Referring now in greater particularity to the drawings, and first to Figs. 1 and 2, there will be seen an electronic piano designated generally by the numeral 20 and including a case 22 preferably made of wood or plywood. The case is relatively low in height, and relatively wide and shallow. The case is supported by four legs 24 which preferably are detachable. A foot pedal 26 is connected to the piano by means of a flexible control such as the well known Bowden cable 28 for playing forte. The piano includes a keyboard 30 having a plurality of white and black keys, and additionally includes a music desk 32, further details of which will be set forth hereinafter. At the end of the case there is provided a panel 34 having a volume control 35 including an on-off switch. The panel 34 further is provided with an earphone jack 36, with a speaker jack 38 for accommodating an auxiliary speaker, with an auxiliary output jack 40 for connection to an amplifier of higher power, and with a record input jack 42 for connection of a phonograph or record player. A record volume control 44 is provided for controlling the amplification of the record player relative to the piano volume.

The tone generating mechanism may be seen in Fig. 2 and includes a plurality of vibratile reeds 46 mounted on a frame 48, and having the ends thereof in capacitive association with a pickup 50. An electrical charge is established between the reeds and pickup, and the capacity between the reeds and pickup varies upon vibration of the reeds, the electrical charge thereby generating alternating current voltages proportional to the vibration of the reeds. Such alternating currents are amplified and acted on by the electronic circuits hereinafter to be set forth, and then are applied to a loudspeaker for the production of audio musical tones.

A main rail 52 extends across the piano, and a plurality of hammers 54 is pivoted on this rail. There is one hammer for each reed 46, the reeds being equal in number to the white and black keys 30. A lever 55 is pivoted at the bottom of the main rail, and carries a jack or fly 56 for actuating the hammer 54, there being one such lever and jack or fly for each hammer. The lever 55 is moved by a capstan screw 58 on the inner end of each key 30.

The lever 55 in each case also acts on a damper release rod 60 to pivot the corresponding damper 62 out of engagement with the corresponding reed 46. An eccentric rotary mechanism 64 also is provided, and is controlled by the foot pedal 26 for simultaneously releasing all of the dampers.

The music desk 52, shown in Figs. 1 and 2, and shown in detail in Fig. 3, is provided at the left end thereof with a plurality of controls, and at the right end thereof with a generally similar plurality of controls. The significance of these controls will be made apparent hereinafter. For the present time, it simply will be stated that the controls at the left comprise three rotary knobs 66, 68 and 70, respectively labeled "Depth," "Speed," and "Acc." Beneath the three rotary knobs, there are provided three on-off switches 72, 74, and 76, respectively labeled "Trem.," "Full" and "Solo." At the right end of the music desk, there are three similar control knobs 78, 80, and 82, respectively labeled "Acc.," "Speed" and "Depth." Beneath the three knobs at the right side, there are provided three on-off switches 84, 86, and 88, respectively labeled "Solo," "Bright" and "Trem."

The amplifier 90 is shown physically in Fig. 4, and schematically in Fig. 5. The amplifier is provided with power through a separable connector 92 mounted on the back of the case 22, and cooperative with a flexible connecting wire (not shown) for connection to the usual A-C. outlet. A loudspeaker 94 is mounted within the case, opening through louvers (not shown) in the back thereof, and is connected by means of flexible wires 96 to a suitable connector in the amplifier. The amplifier is more or less
conventional in physical appearance, and most of the circuit arrangements in so far as the basic amplifier are concerned are not claimed to be new with this invention. A power supply indicated generally at 98, and of more or less conventional design. The power supply is connected to the separable connector 92. The power supply 98 feeds a B+ bus 100, and this bus is connected directly to the center tap 102 of the primary winding 104 of an output transformer 166. The secondary winding 108 of this transformer is grounded at one end, and at the other end is connected to a bus 110. This bus is connected to one of the female connectors 112 of a separable connection 114 on the chassis, and to which the wires 96 are connected by a male plug. Another one of the female members 116 of the connector 114 is grounded, while a third female member 118 is connected to a fixed contact 120 of the earphone jack 36. The movable contact 122 of the earphone jack is connected to the bus 110. A second fixed contact 124 of the earphone jack is connected through a resistor 126 of lower value to ground at 128. The ring 130 of the jack also is triode. The speaker jack 38 has the ring 132 thereof grounded, while the movable contact 134 is connected to the bus 110. No fixed contacts are provided in this jack other than the ring 132.

When an earphone plug is inserted into the jack 36, the movable contact 122 is moved from the fixed contact 120 to the fixed contact 124. The bus 110 thus is grounded through the low resistor 126, and the same impedance is presented to the output transformer 106 as when the speaker is in circuit. This results in energization of the earphones in parallel with the resistor 126, and in removal of the loud-speaker 94. On the other hand, if it is desired to operate the earphones and the speaker, or the loud-speaker 94 plus an auxiliary loud-speak, an appropriately connected plug is inserted in the jack 38. This connects the earphones or external speaker in parallel with the speaker 94, and the impedance presented to the output transformer is substantially constant.

The primary winding 104 of the output transformer 106 is fed by a pair of power output tubes 136 in push-pull arrangement, the plates being connected to the ends of the winding 104. A resistor 138 and capacitor 140 in series therewith are connected across the winding 104 to control the frequency output of the speaker. The plates of the tubes 136 are provided with power through the center tap connection 102 of the transformer, and the screen grids are supplied with power from a wire 142 connected through a dropping resistor 144 to the B+ bus 100. The cathodes are connected in common at 146, and through a cathode network comprising a parallel resistor 148 and capacitor 150 to ground. The grids are grounded through grid resistors 152, as will be understood.

The grids of the push-pull tubes 136 are connected through capacitors 154 to a phase inverter comprising a triode tube 156, which preferably forms one-half of a twin triode. Power is supplied to this tube through a decoupling resistance-capacitance network 158 from the wire 142. The phase inverter stage 156 is fed from an amplifier stage including a triode tube 160. The triode tube 160 preferably comprises the other half of the twin triode including the tube 156, the twin triode tube hereinafter being identified by the numeral 162. An additional decoupling capacitor 163 is connected to the plate of the tube section 160, this tube section otherwise being energized through the resistor 158.

The grid of the amplifier tube 160 is energized through a potentiometer 164, and this potentiometer is provided with a screwdriver adjustment 166 (Fig. 4), thereby forming a master volume control which may be utilized to compensate for characteristics of individual amplifiers, or for installation of the piano in any particular room or location.

From the junction of the resistor 158 and the decoupling capacitor 163, a wire 166 leads to the grid of resistor 168 and shunting capacitor 170, and thence to a load resistor 172. The load resistor is connected to a jack 174 for connection to the tone generators comprising the reeds 46 and pickups 50. The variable potential drop across the resistor 172 as effected by vibration of the reeds, and consequent change in immitance, in combination with a capacitance of the alternating current signals previously referred to. The jack 174 leads through a shielded lead 176 and a coupling capacitor 178 to the grid of a preamplifier including a triode tube 180. This triode tube preferably comprises one-half of a twin triode 182, and is energized through a load resistor 184 and a resistor 186 from the junction of the resistor 188 and capacitor 163. The output of the amplifier including the tube 180 is connected through a wire 188 to pin receptacle #6 of a socket 190. Contact #1 of the socket 190 is grounded and contact #5 is connected to the sliding tap 192 of a potentiometer 194. One end of the potentiometer 194 is grounded, while the other end is connected to the grid of an amplifier tube 196, preferably forming the other half of the twin triode 182. The output of the amplifier tube 196 is connected to the master volume control potentiometer 164 previously noted.

The record input jack 42 is connected through a potentiometer 198 controlled by the record volume control knob 44 to the grid of the amplifier tube 196. This grid, receiving the amplified output of the tone generators, also is connected through a capacitor 200 to the auxiliary output jack 40.

The provision of the auxiliary output jack 40 at the particular position shown, namely following the preamplifier stage and a shaping circuit shortly to be set forth, particularly with the phonograph or other input connected to the same point, is of considerable importance. Another feature of great importance is a plug-in shaping circuit, and additional circuits which may be plugged in place thereof. More specifically, there is provided a plug 202 cooperable with the socket 190. The plug is provided with a metal cap or shell, and this is connected to pin #1 of the plug 202, a conventional octal plug being provided. Pin #6 of the plug is connected through a capacitor 204 and a series connected resistor 206 to pin #5. Thus, the output of the preamplifier stage including the triode tube section 180 is connected through the series combination of the resistor 206 and capacitor 204 to the sliding tap 192 of the potentiometer. The frequency response of the amplifier is controlled by the values of the capacitor 204 and resistor 206. When it is desired to vary the frequency response, such as to produce tones simulating different types of pianos, or even different types of instruments, or to balance an instrument for a particular installation or pianist, all that is necessary is to remove one of the plug-in circuits, and to insert another having different values of either or both the capacitor and resistor.

Various additional effects can be obtained with an auxiliary chassis or tremolo and voicing circuit. Various musical effects can be simulated such as a bass viola, a celeste, or other instruments, and many novel musical effects.

Reference now should be had to Fig. 6 wherein there is shown a tremolo and voices schematic diagram. For purposes of brevity, this hereinafter will be referred to as the tremolo 208, the parts being shown physically in Fig. 4. The tremolo 208 comprises four parts which are separately shown in Fig. 6. The tremolo 208 is included with the upper part of the amplifier 3. The tremolo 208 preferably forms one-half of a twin triode 212. The plate of the tube 210 is connected to a B+ junction point 214, and also by means of a wire 216 to contact #4.
of a socket 218. The cathode of the tube 210 is grounded, and the control grid is connected to a phase shifting network which also is connected to the plate. The network consists of a grid resistor 218 connected to the grid and to ground, and a grid capacitor 222 connected to the grid and to a junction point 224. The junction point is connected to a capacitor 226 which leads to the junction 228 between a capacitor 230 and a resistor 232. The other side of the capacitor 230 is connected to the B+ line 216, while the opposite side of the resistor 232 is grounded. The junction 224 is connected by means of a wire 234 to contact #7 of the socket 218.

Section B comprises a high pass formant including a triode tube 236 which preferably comprises the other half of the twin triode 212. The plate of tube 236 is connected through a load resistor 238 to the B+ junction point 214. This junction point is connected to a resistor 240, which in turn is connected to a resistor 242, an electrolytic capacitor 244 being connected between these two resistors and to ground. The high side of the resistor 242 is connected to another grounded electrolytic capacitor 246, and also to a wire 245 leading to pin #3 of an octal plug 250.

The cathode of the tube 236 is grounded through a resistor 252. The grid of the tube 236 is connected through a resistor 254 to a wire 256 which continues as a shielded lead to contact #9 of the socket 218. The wire 256 is additionally connected through a capacitor 258 to a shielded lead connected to pin #6 of the plug 250. In addition, the grid is connected through a resistor 260 to a filter 262. This filter comprises a pair of resistors 264 and 266 connected together and to a grounded capacitor 268. The resistor 264 also is connected to the resistor 260, and to a capacitor 270. The resistor 266 is connected to a wire 272 and to a capacitor 274. The capacitors 270 and 274 are connected together and are grounded through a resistor 276.

The wire 272 is connected through a capacitor 278 to the plate of the tube 236, and to a resistor 280. This resistor is connected to another resistor 282, the junction being grounded through a capacitor 284, and the resistor 282 is connected to a shielded lead 286 leading to contact #5 of the socket 218.

The components of the high pass formant are properly related to one another so as to emphasize the higher frequencies, while relatively discriminating against the lower frequencies.

Section C of the tremolo 208 is another phase shift oscillator, this one operating on about five to seven cycles per second. It is generally similar to the phase shift oscillator of section A, and comprises a triode tube 288 preferably comprising one-half of a twin triode 290. The cathode of the tube 288 is grounded, while the plate is connected to a B+ junction point 292. This junction point is connected by means of a wire 294 to a resistor 296. This resistor is connected to the junction between an electrolytic capacitor 298 and a resistor 300, the resistor 300 being connected to the B+ lead wire 248. The plate also is connected by means of a wire 302 to contact #3 of the socket 218. In addition, the plate is connected to a capacitor 304 which leads to a grounded resistor 306 and to a capacitor 308. This capacitor is connected at a junction 310 to a capacitor 312 which is connected to the grid of the tube 288. A grid resistor 314 also is connected between this grid and ground. The junction 310 is connected by means of a wire 316 to contact #8 of the socket 218.

Section D comprises a low pass formant which eliminates the upper harmonic structures of the tones, making them practically pure sine waves. More particularly, Section D comprises a triode tube 318 preferably comprising the second half of the twin triode 290. The cathode is grounded through a resistor 320, and the plate is connected through a resistor 322 to the B+ junction point 292. The plate also is connected through a capacitator 324 to a wire 326, and this wire is connected through a resistor 328 to the junction between a grounded capacitor 330 and a resistor 332. The resistor 332 is connected through a shielded lead 334 to contact #6 of the socket 218.

The grid of the triode 318 is connected through a resistor 336 to the wire 256. The grid also is connected through a resistor 339 to a low pass filter 340. This filter comprises a pair of resistors 342 and 344 connected together, the common connection being grounded through a capacitor 346. The resistor 344 is connected to the plate wire 326, and also is connected to a capacitor 346. This capacitor is connected to the junction between a grounded resistor 348 and a capacitor 350. The resistor 342 and capacitor 350 are connected together, and this connection also is connected to the grid resistor 338.

The low pass formant is such, as previously has been noted, as to pass the bass tones, while substantially eliminating higher frequencies.

It will be observed that the filaments 352 of the tubes of the tremolo are connected to pins #7 and #8 of the plug 250. Filament lead connections are made to the corresponding contacts of the socket 190, but are not shown since all filament wiring has been omitted from Fig. 3 for clarity of illustration. The connection of the wire 249 to pin #3 of the plug 250 previously has been indicated, and it will be appreciated that a B+ connection is made to contact #3 of the socket 190, although this has been omitted from Fig. 3 for simplicity of illustration. This connection preferably would be directly from the power supply to contact #3 of the socket 190.

Before proceeding with a description of the controls used in conjunction with the tremolo, it is thought that it would be helpful to set forth the operation of the tremolo on the amplifier by way of a somewhat simplified wiring diagram. Thus, in Fig. 7 there is shown a simplified circuit which corresponds to the six to eight cycle phase shift oscillator, and it will be understood that the circuit for the five to seven cycle oscillator is similar in operation, and generally differs only in the values of circuit components. Many of the parts are similar to those previously described, and are identified by similar numerals with the addition of the suffix a. The input jack 174a to which the tone generators are connected is shown as connected through the capacitor 178a to the grid of the preamplifier tube 180a. The grid and cathode resistors for this tube are shown, as is the tone generator biasing resistor 172a. It will be seen that the wire 188a is connected through a coupling capacitor 354 to the output, being shunted by a resistor 356. The wire 188a also is connected through a resistor 358 to the sliding tap 360 on a plate resistor 362 connecting the plate of the tube 210a to the B+ supply. The phase shifter network remains identical with that previously disclosed, and it will be observed that the junction point 224a is connected to a variable resistor 364, this resistor being grounded.

The phase shift oscillator comprising the tube 210a and phase shifting network operates in the normal manner of a phase shift oscillator. Variation of the resistor 364 determines the frequency of the phase shift oscillator, and this frequency preferably is set at about six to eight cycles per second. The output of the oscillator is picked off the load resistor 362 by the tap 360, and the magnitude of the oscillations as transmitted through the resistor 358 depends on the position of the sliding tap 360 on the resistor 362. Due to the connection of the resistor 358 to the plate lead wire at 188a, it will be seen that the phase shift oscillator shunts the output of the amplifier preamplifier stage including the tube 180a.

Hence, the oscillations of the phase shift oscillator are imposed on the output of the preamplifier stage, and the magnitude of the tremolo oscillations is determined, as noted before, by the position of the sliding tap 360,
The principles of operation of the tremolo, both in the six to eight and in the five to seven cycle sections are similar to those just described with regard to the simplified diagram of Fig. 7, although the controls and results obtained by the use thereof are considerably more complex.

Reference now should be had to Fig. 8 for an understanding of the controls operable with the tremolo and voicing circuit of Fig. 6, these controls being mounted on the deck or drop rail 32 and including the switches previously identified, and variable resistors operable by the knobs on the music desk. The control mechanism includes a plug 366 cooperative with the socket 218. Pin 1 of the plug is grounded, and is connected to certain shielded leads for grounding the same. Pin 2 is connected through a shielded lead to the center, movable contact 368 of the switch 74. The movable contact normally engages a fixed contact 370, but it is movable to engage a second fixed contact 372. Pin 3 is connected to the sliding tap 374 of a variable resistor 376, the latter being grounded through a resistor 378. The variable resistor 376 is for depth control, and is operated by the knob 66. Pin 4 is connected to a sliding tap 380 of a variable resistor 382 grounded through a resistor 384. The resistor 382 comprises a depth control, and is operated by the knob 82.

Pin 5 is connected through a shielded lead to the center, movable contact 386 of the switch 84. The movable contact 386 normally engages a fixed contact 388, and is movable into engagement with a fixed contact 390. Pin 6 is connected through a shielded lead to the center, movable contact 392 of the switch 76. This switch, like the previously identified switches, is a single pole, double throw switch. The movable contact normally engages a fixed contact 394, but is movable therefrom into engagement with a fixed contact 396.

Pin 7 is connected through a wire to the center, movable contact 398 of the switch 88. This movable contact normally engages a fixed contact 400, but is movable therefrom into engagement with a fixed contact 402. The movable contact also is connected to a variable resistor 404 having a sliding tap 406 theron grounded through a resistor 408. The variable resistor 404 comprises a speed control operated by the knob 89. Pin 8 is similarly connected to the movable, center contact 410 of the switch 72. This contact normally engages a fixed contact 412, but is movable therefrom into engagement with a fixed contact 414. The movable contact also is connected to a variable resistor 416 having a sliding tap 418 thereon grounded through a resistor 420.

Pin 9 is connected through a shielded lead to a movable contact 422 of the switch 86. This switch comprises a double pole, double throw switch, and the contact 422 normally engages a fixed contact 424, but is movable therefrom into engagement with a fixed contact 426.

The switches heretofore identified additionally are connected by various parts in addition to those heretofore shown and described. Thus, moving from left to right in Fig. 6, the fixed contact 412 and the shielded lead to the center, the fixed contact 414 is not connected to anything. The fixed contact 370 of switch 74 is connected through a resistor 428 and a capacitor 430 in series therewith to the fixed contact 424 of the switch 86. The movable contact 368 of switch 74 is directly connected by means of a wire 432 to the second movable contact 434 of the switch 86. This movable contact normally engages a fixed contact 436, but is movable therefrom into engagement with a second fixed contact 438.

The fixed contact 372 of the switch 74 is directly connected to the fixed contact 396 of the switch 76. In addition, it is connected to the sliding tap 440 on a variable resistor 442, the latter being connected to the fixed contact 394 of the switch 76. The variable resistor 442 comprises the accentuation control operable by the knob 70.

The fixed contact 388 of the switch 84 is connected to a variable resistor 444, and a sliding tap 446 thereon is connected through a resistor 448 to the second fixed contact 438 of the switch 86. The resistor 448 also is connected to the fixed contact 390 of the switch 84.

The second switch contact 426 of the switch 86 is open circuited, as is the first and the second pair 436. The first pair is open circuited, and the second contact 426 is open circuited.

For use of the electronic piano simply as a piano, such as might be used by a student or in the home, or otherwise, the piano is used simply with one of the plug-in wave shaping circuits comprising the capacitor 204 and resistor 206. However, many persons, including those who would use such an instrument with a dance band, wish to obtain additional effects. This is done simply by incorporating the aforementioned controls in the music desk of the piano, and by plugging in the tremolo plug 250 into the socket 190, and similarly connecting the plug 366 and socket 218. It would be from the foregoing circuit and connections that might be used by the musician, since such connections will be apparent to anyone skilled in the art. However, it might be noted that when all of the switches 72, 74, 76, 84, 86 and 88 are in the off position, the piano operates simply as a piano. Specifically, the preamplifier output is not connected to the contact #6 of the socket 190 is connected by means of the pin #6, capacitor 258, and wire 256 to the contact #9 of socket 218. This contact is engaged by the pin #9 of the plug 366, and this pin is connected to the movable contact 422 of the switch 86. This movable contact engages the fixed contact 424, and the circuit is continued from this contact through the capacitor 430 and resistor 428 to the fixed contact 370. This fixed contact is engaged by the movable contact 368, which in turn is connected to pin #2 of the plug 366. Pin #2 engages contact #2 of the socket 218, and this is directly connected by a shielded lead to pin #5 of plug 250. This pin in turn engages the contact #5 of the socket 190, and this of course is connected to the sliding tap 190 on the volume control resistor 194. From the foregoing it will be seen that the series connected capacitor 430 and resistor 428 replace the previously mentioned capacitor 204 and resistor 206 of the plug-in circuit. Various additional effects can be obtained by operating the center switches, and by varying the speed, depth and accentuation of the various parts of the circuit.

With reference to Fig. 9, it will be seen that the low pass formant comprising the section D of the tremolo and voicing circuit 298 provides a frequency response curve as indicated at 450, peaking at about eighty cycles per second, and tapering downward therefrom in a nearly linear fashion. The frequency response of the high pass formant, comprising section B, is shown at 452, and it will be seen that this rises from minus twenty decibels along a nearly linear curve to a peak at about thirty-five hundred cycles. It will be observed that the peak of the high pass formant is at about eighty cycles per second, while the low pass formant. The combined total response is indicated in dashed lines at 454, and it will be seen that this drops off slightly in the bass region, but is generally linear through a large portion of the keyboard limits of the piano. It will be appreciated that changes in the value of the circuit components of the formant circuits would alter the curves relatively, and hence alter the total output curve. The curve shown is one which results in a crescendo.

When the six to eight cycle per second tremolo is switched on, it causes a tremulant variation of the high pass formant as illustrated at 456 in Fig. 10. Similarly, when the five to seven cycle per second tremolo is switched on, it causes a tremulant variation of the low pass formant as illustrated at 458. The resultant, combined total
response curve is rather complex. It comprises a component illustrated in solid line at 460 due to the high pass formant tremulant, the tremulant being most noticeable in the upper range, and a component 462 due to the low pass formant tremulant which is most noticeable in the lower range.

The bass tremolo is clearly defined, and the treble tremolo is clearly defined. Between the frequencies of about 150 cycles per second and 900 cycles per second, the combination of the two tremolos forms a chorus. For instance, by using a very slow tremolo in the bass, a bass viola can be simulated. In the treble, a very fast tremolo can be set up to simulate a celeste. The chorus effect in the center of the keyboard is controlled by the difference in frequency between the treble tremolo and the bass tremolo. The phasing effects of the two oscillators give various effects of build up and cancellation but can be controlled by the pianist, and the possible combinations are practically limitless.

From the foregoing it will be seen that an improved amplifier for an electronic piano has been presented. Novel plug-in circuits having been provided for varying the response characteristics of the amplifier, and provision has been made for connection of the amplifier to an additional amplifier or amplifying system outside of the piano, such provision following the plug-in shaping circuit. Furthermore, additional plug-in circuit means are provided for controlling the wave shapes by the addition of tremolos, the frequency and intensity of which can be adjusted to provide various effects simulating known musical effects, and also giving rise to novel musical effects.

The specific examples of the invention as herein shown and described will be understood as being set forth by way of illustration only. Various changes in structure will no doubt occur to those skilled in the art, and will be understood as forming a part of this invention insofar as they fall within the spirit and scope of the appended claims.

The invention is hereby claimed as follows:

1. An electronic musical instrument of the type including vibrating reeds or the like with electrical pick-ups therefrom, an amplifier having an input operatively connected to said pick-ups and an output connected to a means for converting electric oscillations from said reeds into sound, said amplifier having circuits having at least two different wave shaping characteristics, and two tremulant generators of different phase shift characteristics, each of said tremulant generators being associated with a respective wave shaping circuit.

2. An electronic musical instrument as set forth in claim 1 wherein one of the two different wave shaping circuits relatively emphasizes bass oscillations and discriminates against treble oscillations, and the other of the wave shaping circuits relatively emphasizes treble oscillations and discriminates against bass oscillations.

3. An electronic musical instrument as set forth in claim 1 and further including means for switching said tremulant generators and said wave shaping circuits in and out of said amplifier.

4. An electronic musical instrument as set forth in claim 1 wherein one of the tremulant generators is adjustable over a predetermined range of frequencies and the other of said tremulant generators is adjustable over a different predetermined range of frequencies.

5. An electronic musical instrument of the type including a plurality of generators respectively producing complex electrical oscillations corresponding to musical tones and comprising successive notes of at least a plurality of octaves, a plurality of keys respectively controlling the operation of said generators, an amplifier having an input operatively connected to said generators and an output connected to a means for converting electric oscillations from said generators into sound, said amplifier having circuits having at least two different wave shaping characteristics, and two tremulant generators of different phase shift characteristics, each of said tremulant generators being associated with a respective wave shaping circuit.

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