Fig. 1b
My invention relates generally to electrical musical instruments and more particularly to a novel accordion type instrument capable of producing a wide variety of musical effects, the instrument including a novel tone signal generating equipment, a novel form of console and controls for selecting the tones to be played, and a novel form of control mechanism for determining the rhythm effects, including means for controlling the attack and decay of the tones.

Most everyone, at sometime during his life, aspires to play a musical instrument. A considerable number of people commence learning to play some instrument such as the piano, organ, or accordion, choosing these instruments in preference to the solo orchestral instruments because they may render a complete musical selection without need of accompaniment. Of those who have this desire, only a very small percentage acquire sufficient proficiency to perform acceptably. The many hours of hard and concentrated practice required to attain acceptable proficiency proves to be too great a deterrent for most aspirants. The playing of these instruments is made difficult chiefly through the necessity of playing more than one key simultaneously with one hand.

It is a relatively simple matter for the novice to play the melody part since this requires playing only one key at a time with one hand. Most everyone knows how to "pick out" simple melodies on a piano keyboard. The difficulty arises in playing the harmony chords and bass notes, which requires left hand dexterity of a high order for the playing of the most simple music. In the accordion, this difficulty is reduced somewhat by sounding a complete chord upon depression of but a single button. However, the problem of using the left hand for both the chord and bass buttons, and frequently playing them simultaneously, proves very difficult for the amateur.

In the instrument of the present invention, the player's right hand is usually used to play only the single melody notes. The player's left hand depresses only one of a number of buttons of an accordion type keyboard corresponding to the chord harmony (major, minor, seventh chords, etc.). The actual sounding of the chord accompaniment may be independently controlled by an auxiliary wrist-operated control, or may be caused as an incident to the depression of the button. The sounding of the bass notes is controlled by a pair of foot-operated pedals. One pedal sounds the "root" bass while the other sounds the "fifth" bass of the chord selected by the depression of a button on the accordion type keyboard. Thus the melody, chord accompaniment, and bass notes may be played independently or simultaneously with any rhythm effects that may be desired. The volume or expression is independently controlled with the player's right knee. The manual dexterity required is extremely slight in that the fingers of each hand need operate only one key at a time. The player soon realizes that the bass notes virtually "play themselves" and all the other motions are simple and repetitive and very soon feel "automatic." Experience has shown that with the instrument of my invention anyone who can "pick out" a melody on a keyboard can play the selection in a finished and professional manner after an exceedingly short practice period.

The character of music which it is possible to play on the instrument is homophonic as distinguished from polyphonic or contrapuntal music. As examples, homophonic music includes the popular songs, ballads, folks songs, waltzes, marches, polkas, and many other forms of musical composition in which the predominant characteristics are melody, harmony, bass, and rhythm. Polyphonic music (such as the fugue and canon), is much more complex, frequently involving two or more melodies sounding simultaneously as in the symphony and sonata forms. Most people prefer to hear and play homophonic music and the instrument is designed chiefly for playing such music.

Through the use of a novel but relatively simple electronic tone generating system, especially designed for this console arrangement of keys, buttons, and pedals, the instrument, although extremely easy to play, possesses a tonal grandeur equalled by combining resources found only in the largest pipe organs and orchestras.

Due to the simultaneous sounding of several complex tones derived from different generators of the same note having slightly different pitches, there is present a "complex chorus effect" which gives the instrument the over-all tonality of a true ensemble of orchestral instruments. If these generator resources were to be provided in quantities to meet the requirements of the usual two manual and pedal type of organ console the cost of the generating equipment would be increased to a prohibitive extent. It appears that this instrument, while costing less than a good accordion, is unequalled for varied and beautiful tonal resources by any other single instrument.
A further object is to provide a musical instrument having great tonal resources upon which proficiency in playing homophonic music may be quickly and easily acquired by anyone with little or no experience in a keyboard instrument.

A further object is to provide a console having a group of harmony buttons, each of which has circuits for tentatively determining both the chord tones and the bass tones which may be utilized with the particular chord.

A further object is to provide a console having a group of bass pedals which in themselves are not identifiable with absolute pitches but rather are determinative of the inversion of the particular chord button depressed, through sounding an appropriate bass tone.

A further object is to provide a group of bass-tone pedals having pitch-determining locking circuits and nonlocking envelope-determining circuits, such that the bass tones will continue to sound with decaying intensity envelopes of a reverberative character after the pedals are completely released.

A further object is to provide a group of bass tone pedals having a control circuit which is adjustable with respect to its attack and decay characteristics.

A further object is to provide a console having a chord envelope control for transmitting the chord signal tentatively determined by a harmony button, and in which the envelope is adjustable with respect to its attack and decay characteristics.

A further object is to provide a group of generators of variable tone quality for accompaniment purposes.

A further object is to provide an improved electrical musical instrument having a chord tone generating system which supplies signals for the harmony chords, which signals are additionally selectively connected to control the operation of a multi-stage bass-tone frequency-divider generator whose output is productive of deep complex bass tones having a desirable series of harmonics.

A further object is to provide a manual of playing key operated switches which not only control the transmission of the signals from the accompaniment generators, but also are connected to a solo melody section tuning circuit in such manner as to transmit the solo at the highest pitched of a plurality of depressed keys, thus making it possible for one hand to play both the solo and an accompaniment, these two effects being selectively different with respect to quality, pitch, register, volume, and dynamic envelope.

A further object is to provide a double accompaniment system in which one form of accompaniment is provided by the accordion buttons and chord envelope control, and in which another form of accompaniment is provided under the control of a manual of playing keys.

A further object is to provide an improved instrument capable of producing a very wide variety of solo tones covering many of the orchestral instrument families, as well as multi-octave organ effects, with selective vibrato of adjustable extent, and also with adjustable envelope control.

A further object is to provide an improved instrument having an improved solo accent apparatus for producing dynamic emphasis.

A further object is to provide a manual for producing composite solo tones of a chorus character, employing simultaneously both the solo instrument generator output and the accompaniment generator output.

A further object is to provide a vibrato apparatus which may be applied selectively either to the solo tones, to the accompaniment tones, or to both.

A further object is to provide a unitary vibrato means for applying direct current pulses at a vibrato rate to the grid circuits of a group of accompaniment oscillators to produce corresponding vibrato frequency variations in their outputs.

A further object is to provide a console having a chord envelope control for accenting or emphasizing a relatively soft chord signal selected by a chord button.

Other objects are to provide improved modifications and variations of component parts of a musical instrument of the general type described in the foregoing objects whereby similar or related musical results may be attained.

Other objects will appear from the following description, reference being had to the accompanying drawings in which:

Figure 1 is a diagram indicating the relationship of Figs. 1a, 1b, 1c and 1d;

Figures 1a, 1b, 1c and 1d together constitute a schematic wiring diagram of a preferred form of the complete instrument;

Figure 2 is a block diagram of the complete instrument;

Figure 3 is a perspective view of the console of the instrument;

Figure 4 is a fragmentary plan view of the accordion keyboard;

Figures 5, 6 and 7 are transverse sectional views of the accordion keyboard taken on the lines 5--5, 6--6 and 7--7 respectively of Fig. 4;

Figure 8 is a transverse sectional view of the accordion bar and its support taken on the line 8--8 of Fig. 7;

Figure 9 is a horizontal sectional view taken on the line 9--9 of Fig. 6 and showing particularly the arrangement of the accordion button operated switches;

Figure 10 is a diagram illustrating the notes composing the various chords and constituting a key for the construction of the button operated accordion selecting levers and the circuits controlled thereby;

Figure 11 is a fragmentary vertical sectional view of an organ section key and the switches operated thereby;

Figures 12 and 12a show a schematic wiring and block diagram of a modification of the accordion section signal generating system and the accordion button operated switching mechanism;

Figure 13 is a diagrammatic illustration of a transposing switch mechanism forming part of the generating system of Fig. 13;

Figure 14 is a plan view of a button keyboard for the modified form of the accordion section of the instrument shown in Figs. 12, 12a and 13;

Figures 15 and 15a together constitute a schematic wiring and block diagram of a second modification of the accordion section of the instrument;

Figure 16 is a plan view of the keyboard for the accordion section of the modification shown in Figs. 15 and 16;

Figure 17 is a fragmentary front elevational view of a further modification of the invention illustrating the accordion section as supported by and playable with a conventional piano;

Figure 17a is a fragmentary vertical sectional view of the combination shown in Fig. 17;

Figure 18 is a fragmentary sectional view of
a modified form of actuating mechanism for the accordion section of the instrument;

Figure 19 is a sectional view of the pneumatic control valve mechanism to be used with the apparatus of Fig. 18;

Figure 20 is a fragmentary vertical sectional view of a piano action controllable by the apparatus shown in Figs. 18 and 19;

Figure 21 is a vertical sectional view of manually operated bellows for supplying air under pressure to the apparatus shown in Figs. 18 and 20;

Figure 22 is a phonographic type of signal generator for the accordion section of the instrument, and includes a schematic wiring diagram of the associated circuits;

Figure 23 is a fragmentary sectional view taken on the line 23-23 of Fig. 22;

Figure 24 is a combined block and schematic wiring diagram showing a further modification of the invention;

Figure 25 is a fragmentary plan view of a "10 Bass" button keyboard for operating the various combinations of the switches shown in Fig. 24; and

Figure 26 is a diagrammatic view indicating the manner in which the key buttons of Fig. 25 are arranged to operate various combinations of the switches shown in Fig. 24.

GENERAL DESCRIPTION OF THE INVENTION

Referring particularly to Fig. 3, the instrument comprises a console 30 which may be of any desired construction but is preferably of the form shown. The console 30 includes two legs 32, a case 34 and a speaker housing 35, the latter preferably provided with a screened sound opening 38. The instrument is equipped with a root bass tone controlling pedal 40 and a fifth bass tone controlling pedal 42, and may, if desired, be provided with a chord control pedal 44.

A lever 46 projects from beneath the keyboard of the instrument and is adapted to be engaged by the right knee of the player to control the over-all volume of the output of the instrument.

The instrument includes a manual keyboard 47, preferably consisting of thirty-seven keys 48 of the conventional pianoforte type. In addition, the instrument has an accordion type button keyboard 50 comprising ninety-six key buttons 54 which are operated in the manner of accordion chord and bass buttons.

An accordion tone intensity envelope bar 55 is located in front of the accordion button keyboard 50 and is adapted to be engaged by the heel portion or wrist of the left hand while one of the buttons 54 is held depressed by a finger. Arranged directly above the two keyboards are control or stop tablets 71 to 99 inclusive which, as will appear hereinafter, control the various operations in the instrument such as the vibrato, the selection of the tone quality for the melody, tone sections of the instrument relative to the accordion section, may be controlled. The console may be constructed of wood and may include a music rack 66. The quality of the tones produced, the addition or lack of vibrato, and various octave coupler effects are controlled by the stop tablets 71-99, as for example:

Tablet No.
71. Volume—soft
72. Accordion sustain
73. Accordion mute
74. Pedal fast decay
75. Organ strings
76. Organ flutes
77. Accordion and organ vibrato
78. Solo wide vibrato
79. Solo small vibrato
80. Bass
81. Tenor
82. Soprano
83. Solo woodwinds
84. Solo fast attack
85. Solo accent
86. Deep tone
87. Full tone
88. First voice
89. Second voice
90. Brilliant

The instrument includes a melody or solo tone generating system controlled by keys 48, and a set of sixteen oscillators which supply signals for the production of the organ chords likewise under the control of the keys 48, the control being such that when a plurality of keys 47 of the keyboard 48 are simultaneously depressed, as in playing a chord, the tonal output will consist of tones derived from the sixteen oscillators providing the depressed keys are not of adjacent semitones, or in some instances adjacent full tones. The highest of a plurality of contemporaneously depressed keys 48 will control the sounding of the tone produced by the solo or melody generating system.

EXPLANATION OF BLOCK DIAGRAM, FIGURE 2

The foregoing general description of the invention may be amplified by reference to the block diagram, Fig. 2. In this diagram, manually operable parts are indicated by rectangles or circles bounded by light lines while the electrical parts and their controls are indicated by rectangles bounded in heavy lines. Dotted lines connecting light rectangles or circles with heavy rectangles indicate that the part operated by the player set forth in the light rectangle has some effect or control function upon the electronic or control part in the heavy rectangle.

Light full lines connecting the rectangles indicate that the component named in one of the rectangles has a controlling effect on the component named in the other rectangle. The heavy lines connecting the heavy rectangles which terminate in arrowheads indicate the direction of flow of tone signals to the component named in the rectangle at the arrowhead.

Considering first the solo section of the instrument, it will be noted that there is provided a solo oscillator 100 which, upon suitable operation of the solo wide vibrato tablet 78 or solo small vibrato tablet 79, receives a control signal from a vibrato switch tube and controls 102, the latter causing transmission of the vibrato signal from a vibrato oscillator 104 to the solo oscillator 100.

As previously indicated, the highest of a plurality of contemporaneously depressed keys of the keyboard 47 controls the effectiveness of solo tuning coils and contacts 106 and these coils determine the frequency at which the oscillator...
The solo oscillator 100 supplies a signal to two cascaded stages of solo frequency dividers 108, supply tone signals to register selectors 110 which are controlled by the bass tablet 89, tenor tablet 81 and soprano tablet 82.

From the register selectors 110 the signals of two different family types are supplied to a tone factor 112, the tone of the solo oscillator 100 being the woodwinds and strings. When the solo-woods tone control 83 is operated tones of the woodwind family will be transmitted to the solo preamplifier 114, but when the tablet 83 is not operated tone signals of the string family will be transmitted to the solo preamplifier 114. The output of the solo preamplifier 114 is supplied to tone quality controls 116 which are selectively utilized by operation of the deep tone tablet 86, full tone tablet 87, first voice tablet 88, second voice tablet 89 and brilliant tablet 90. The solo signal, as modified by the tone quality controls 116 is transmitted to the input of solo control tubes 118 which control the intensity envelopes of the transmitted tone signals. The keys of the keyboard 47, in addition to their other functions, operate solo keying contacts 120 which provide a control potential on the solo control tubes 118. The character of the tone intensity envelopes may be varied by selective operation of solo fast attack tablet 84 and solo accent tablet 85. The signal output of the solo control tubes 118 is transmitted to a solo volume control 122 which is manually varied by the solo balance knob 64 to supply the solo signal in desired amplitude to a mixer 124. The amplitude of the over-all signal output of the mixer 124 may be adjusted to be soft or loud by the soft tablet 71. The output of the mixer is supplied to a main preamplifier 126 and the output of the latter is supplied to a power amplifier 128 through a capacity volume control 130 which is varied by the expression lever 46. The power amplifier supplies a speaker 131 for translating the electrical signals into sound.

The keys of the keyboard 47, in addition to their previously described functions, also operate organ keying contacts 132 and organ tuning contacts 134. The organ keying contacts 132 may be utilized to control the supply of operating voltages to each of the sixteen organ oscillators 136 to determine at which of the two or three semi-tone interval frequencies selected oscillators 136 shall oscillate, while the organ keying contacts 132 are utilized to control the supply of operating voltages to each of the sixteen organ oscillators 136. These oscillators receive a vibrato signal from the vibrato switch tube and controls 102 whenever the accordion and organ vibrato table 77 is operated.

Output signals of two different tone families, namely, basses and flutes, are derived from the sixteen organ oscillators 136 and supplied to organ tone quality selectors 138, and whether signals of either or both of these tone quality families are transmitted to an organ volume control 140 is determined by the selective operation of the organ strings tablet 75 and organ flutes tablet 76. The organ volume control 140 may be adjusted by the organ balance knob 63 and the tone signals of the desired volume are thus transmitted to an organ preamplifier 142, the output of which is transmitted to the mixer 124.

The key buttons of the accordion button board 50 effect the operation of accordion and pedal tuning and selecting contacts 144 which receive tone signals from six accordion oscillators 145. Whether the oscillator 145, as well as each of the two cascaded stages of the solo frequency dividers 108, supply tone signals to register selectors 110 which are controlled by the bass tablet 89, tenor tablet 81 and soprano tablet 82.

From the register selectors 110 the signals of two different family types are supplied to a tone factor 112, the tone of the solo oscillator 100 being the woodwinds and strings. When the solo-woods tone control 83 is operated tones of the woodwind family will be transmitted to the solo preamplifier 114, but when the tablet 83 is not operated tone signals of the string family will be transmitted to the solo preamplifier 114. The output of the solo preamplifier 114 is supplied to tone quality controls 116 which are selectively utilized by operation of the deep tone tablet 86, full tone tablet 87, first voice tablet 88, second voice tablet 89 and brilliant tablet 90. The solo signal, as modified by the tone quality controls 116 is transmitted to the input of solo control tubes 118 which control the intensity envelopes of the transmitted tone signals. The keys of the keyboard 47, in addition to their other functions, operate solo keying contacts 120 which provide a control potential on the solo control tubes 118. The character of the tone intensity envelopes may be varied by selective operation of solo fast attack tablet 84 and solo accent tablet 85. The signal output of the solo control tubes 118 is transmitted to a solo volume control 122 which is manually varied by the solo balance knob 64 to supply the solo signal in desired amplitude to a mixer 124. The amplitude of the over-all signal output of the mixer 124 may be adjusted to be soft or loud by the soft tablet 71. The output of the mixer is supplied to a main preamplifier 126 and the output of the latter is supplied to a power amplifier 128 through a capacity volume control 130 which is varied by the expression lever 46. The power amplifier supplies a speaker 131 for translating the electrical signals into sound.

The keys of the keyboard 47, in addition to their previously described functions, also operate organ keying contacts 132 and organ tuning contacts 134. The organ keying contacts 132 may be utilized to control the supply of operating voltages to each of the sixteen organ oscillators 136 to determine at which of the two or three semi-tone interval frequencies selected oscillators 136 shall oscillate, while the organ keying contacts 132 are utilized to control the supply of operating voltages to each of the sixteen organ oscillators 136. These oscillators receive a vibrato signal from the vibrato switch tube and controls 102 whenever the accordion and organ vibrato table 77 is operated.

Output signals of two different tone families, namely, basses and flutes, are derived from the sixteen organ oscillators 136 and supplied to organ tone quality selectors 138, and whether signals of either or both of these tone quality families are transmitted to an organ volume control 140 is determined by the selective operation of the organ strings tablet 75 and organ flutes tablet 76. The organ volume control 140 may be adjusted by the organ balance knob 63 and the tone signals of the desired volume are thus transmitted to an organ preamplifier 142, the output of which is transmitted to the mixer 124.

When it is desired that the accordion chord be sounded without depression of the accordion bar 56 or the operation of accordion pedal 44, the accordion sustain tablet 72 is operated to close a switch 150 thereby to cause transmission of the accordion chord signal from the low pass filter to the organ preamplifier 142, and hence to the mixer 124 and output system of the instrument.

In addition to the functions previously described, the accordion and pedal tuning and selecting contacts 144 supply tone signals, of pitch related to the "root" and "fifth" of the chord selected, to a pedal switch mechanism 152. To determine whether the "root" or "fifth" signal shall be supplied to pedal frequency dividers 154, the player will operate either the "root" pedal 40 or the "fifth" pedal 42. The pedal frequency dividers 154 comprise a pulse sharpening device and two stages of alternate pulse responsive frequency dividers. The pulse sharpening device and the frequency divider stages supply signals of successively lower octave pitches and of successively increasing amplitude to a pedal control tube 156 which has its operating bias controlled by the pedal switch mechanism 152. The rate of the decay of the tone signals transmitted through the pedal control tube 156 is determined by the position of the pedal fast decay control 158 and the pedal control tube output is supplied to a pedal volume control 150 which is adjusted by the pedal balance knob 62 so as to determine the amplitude of the bass pedal control signals which are supplied to the mixer 124, and hence to the common output system of the several sections of the instrument.

From the foregoing description of Fig. 2 it will be clear that the instrument comprises a unification of four tonal sections, namely, the solo section, the organ section, the accordion section and the bass section. These various sections are interrelated through the manually operable means.
by which they may be played, through the source of modulating vibrato frequency, through the amplifier or other controls. To achieve most desirable musical results from the instrument, not only the relative volumes but the variety of tone qualities produced by the several sources of tone signals should be carefully balanced and voiced so as to obtain a desirable and harmonious and musically interesting tonal ensemble.

Having generally described the instrument as a whole, the various component parts will now be described in detail. It will be understood that the various components may differ widely in the details of their construction and in the arrangement of the various circuits employed and that the components disclosed herein are intended as illustrative and representative of such equivalent components, elements and circuits by which substantially equivalent results may be obtained.

SOLO SECTION GENERATING SYSTEM

Figs. 1a, 1b, 1c and 1d, when connected in the arrangement shown in Fig. 1, illustrate a schematic circuit diagram of a preferred form of the invention.

The solo section tone signal generating system is illustrated mainly in Figs. 1a and 1b. The solo oscillator comprises a pair of triodes 155 and 160, the plates of which are connected to a suitable +B potential source, indicated as +285 v., through load resistors R161 and R162 respectively. The grid of triode 156 is connected to the grid of triode 158 through a blocking capacitor C163 which is in series with a resistor R164, while the plate of triode 159 is connected to grid of triode 160 through a blocking capacitor C165 which is in series with a resistor R166. The grid of the triode 158 is connected to a conductor 167 while the grid of the triode 160 is connected to ground through R168 as well as R169 which is in series with R168. The cathodes of the triodes 159 and 160 are connected to ground through biasing resistors R169 and R170 respectively.

The frequency of oscillation of the solo oscillator 100 is determined by an LC mesh which includes capacitors C171, connected between the conductor 167 and ground, a plurality of rough tuning capacitors C172, and a plurality of fine tuning capacitors C174, the latter groups of capacitors being adapted to be successively connected in parallel with capacitors C171 by the operation of switches 175 and 176. The inductive reactance of the resonant tuning circuit for the solo oscillator 100 is provided by a plurality of inductances L178 connected in series between conductor 167 and ground. One or more of these inductances L178 is included in the oscillating circuit by operation of the keys 48. Each of the keys (except the lowermost key 48) is adapted to operate a switch 180 which has one pole connected to the junction between the adjacent inductances L178 and the other pole of which comprises a grounded bus-bar 182. The inductances L178 are separate inductance elements each comprising a core which may be adjusted to vary the value of the inductance slightly so as to provide for initial tuning to the semitone frequencies of the tempered equal-tempered scale.

The signal appearing across the cathode resistor R163 is conducted to the register selectors 110 (Fig. 1b) through a conductor 186. The oscillations of the solo oscillator 100 are transmitted to a rectifying and pulse sharpening triode 190 (Fig. 1a) through a blocking capacitor C206. The signal appearing across the resistor R200 is transmitted through a conductor 206 to the register selectors 110 shown in Fig. 1b.

The signal appearing on conductor 206 is impressed upon the grid 210 of a rectifying and driving triode 212, which together with triodes 214 and 216 (Fig. 1b) and their associated circuits, constitutes a frequency divider of the alternate pulse-responsive type operable to divide the frequency generated by the solo oscillator 100 by a factor of 2. (See my prior Patent No. 2,420,286.) A grid return resistor R218 (Fig. 1a) connects the grid 210 to ground while the cathode of the triode 212 is connected to a conductor 219 which is connected to ground through biasing resistors R217 (Fig. 1b) which have a by-pass capacitor C221 in parallel therewith. The plates of the triodes 212 and 216 are respectively connected to a source of plate potential indicated as terminals +285 v. through load resistors R221 and R222 respectively. The signal appearing upon the plate of triode 212 is impressed upon the grids of triodes 214 and 216 through capacitors C224 and C225. The grids of the triodes 214 and 216 are connected to ground through grid return resistors R226 and R227 respectively. The plate of triode 214 is connected to the grid of triode 216 through a mesh comprising a series resistor R228 and capacitor C230 which are in parallel with a resistor R232. In a similar manner, the plate or triode 216 is connected to the grid of triode 214 through R234 in series with C236, these elements being in parallel with R238. A useful rectangular wave shape tone signal, an octave lower than that provided by the solo oscillator 100, is derived from the plate of triode 214 through the resistor R230, capacitor C240, and conductor 242. R220 together with a resistor R231 form a voltage divider and plate load resistance for triode 214, R231 being connected to a +285 v. terminal and having a by-pass capacitor C233 in parallel therewith.

The signal appearing upon the plate of triode 216 is transmitted to the input circuit of a rectifying and driving triode 226 which is similar to triode 212 in its circuit arrangement, associated components and function. The output of the triode 235 is supplied to the second frequency divider stage which comprises triodes 237 and 239 which correspond, respectively, in function and circuit arrangement with the triodes 214 and 216 except for slight changes in the values of the various associated circuit components to allow for the lower frequency at which the second frequency divider stage operates. A signal from the plate of triode 235 is transmitted to the input circuit of a triode 241 through a blocking capacitor C242 and an RC network, the plate of the triode 241 is connected to a +285 v. terminal through a pair of voltage dividing resistors R243 and R244, the latter being shunted by C245. The junction of resistors R243 and R244 is connected to a conductor 246 through a blocking capacitor C247. A signal is similarly derived from the plate circuit of triode 237.
through a blocking capacitor C248 and thus impressed upon a conductor 249. In a similar manner a signal is derived from the plate of triode 235 through a blocking capacitor C230 and conductor 251. Direct current flow through the signal conductor 186 is prevented by a blocking capacitor C253 (Fig. 1b).

The output signals appearing on the conductors 186, 242 and 249 are of generally rectangular shape and are of successively lower octave pitches. These rectangular, or substantially square, signal waves are tonally representative of musical tones of the clarinet family, that is, they consist of a fundamental frequency and a long series of odd harmonic overtones.

The signals appearing upon the conductors 208, 251 and 246 are, however, of sharp peak forms and are representative of string tones, that is, brilliant tones having a fundamental frequency and a long series of both the odd and even harmonic overtones.

The signals appearing on conductors 186, 242 and 249 have their high frequencies substantially attenuated by filtering meshes 252 and are adapted to be supplied to a collector conductor 254 under the control of said stop tablets 80, 91 and 82. When switch 255, operated by the stop tablet 82, is in its dotted line position the signals will be muted, that is, they will be of the woodwind family of which the clarinet tone is typical, whereas when the switch 255 is in full line position the tone quality of the signals supplied to collector conductor 260 will be of a string type, the very sharply peaked output waves appearing on the conductors 208, 251 and 246 having their high frequencies attenuated by the various filtering meshes by which these conductors may be connected to the collector conductor 254.

**SOLO SECTION OUTPUT SYSTEM**

The signals appearing on the collector conductor 260 are impressed upon the grid 254 of a preamplifying triode 266 and are connected to ground by resistor R266 and a filtering capacitor C268. Self-bias is provided by a cathode resistor R259 while plate current is supplied from a +290 v. source through a load resistor R70. The plate 210 of triode 265 is connected through a decoupling resistor R272 and blocking capacitor C274 to the ungrounded terminal of the primary of a transformer 276. The secondary 278 of the transformer 276 has a center tap 280 and has its terminals respectively connected to the control grids of control pentodes 282 and 284.

**Solo tone intensity envelope controls**

Referring to Fig. 1a, the keys 48 of the manual, in addition to operating the switches 190 as previously described, respectively operate parallel switches 266 which upon closure connect a conductor 268 to ground through the common bus-bar 182. It will be noted that conductor 268 is normally maintained at a suitable positive voltage by being connected (Fig. 1b) to a voltage divider comprising resistors R290 and R291, and this voltage divider is connected between a +285 v. terminal and ground and the juncti

**Conductor 285 is connected to the cathodes of pentodes 282, 284 through a series of resistors R300, R301 and R302. A conductor 304, connecting R300 and R301, is connected to ground through a capacitor C306. A capacitor C308 may be connected in parallel with R301 by moving a switch 310 to its dotted line position by the stop tablet 85. The conductor 304 is connected through R312 and C314 to the center tap 280 of the secondary 278, the center tap being also connected to ground through R316 and C318 in parallel. Resistor R312 may be shunted when switch 310 is moved to its full line position and a switch 210 is closed to connect the control of the oscillator.

The potential on conductor 285 is normally determined by the voltage divider R290, R291 to be at approximately +30 v. which is, of course, impressed upon the cathodes of pentodes 282, 284 through R300, R301 and R302. However, when the conductor 285 is connected to ground by one of the key-operated switches 266, the cutoff bias is removed and the only bias then available is furnished by the voltage drop occurring in self-bias resistors R302, R301 and R300. These resistors are of sufficient magnitude to prevent grid current flow and a minimum of distortion is thus produced. When the switches 310 and 265 in the positions shown, the potential on the center tap 280, and hence on the control grids of pentodes 282 and 284, is substantially at ground potential by virtue of the connection through R316. R312 is of high value and serves to prevent a voltage across C214 from building up when switch 320 is in its open position. It should be noted that R312 is connected through switch 310 across switch 320 thereby making the static potential on capacitor C314 the same whether switch 320 is opened or closed. Thus the pentodes 282, 284 will commence transmitting the signal at an attack rate determined by the values of R300 and C306, these values being normally selected so as to produce a reasonably prompt attack, free from undesirable transients or key clicks.

Upon release of the playing key the conductor 285 is no longer connected to ground and the potential of the cathodes commences to rise at a rate determined mainly by the values of R302, R301, C305 and R300. The values of these circuit components are chosen so as to produce a smooth decay envelope devoid of undesirable transients.

When it is desired to produce tones with percussive attack envelopes the solo accent button 85 is operated to move switch 310 to its dotted line position. Under these circumstances when the playing key 48 is operated and the conductor 285 thereby connected to ground, the potential on the cathodes will rise rapidly since C306 shunts R301, and upon commencement of current flow through the pentodes the blasing effect normally provided in part by R301 is effectively not present. However, as current commences
flowing through R30, the potential across C308 increases and thus R30 gradually becomes more and more effective as a self-bias resistor for the pentodes and the gain of the pentodes will therefore decrease after an initial high gain condition. This rapid increase followed by a decrease in gain occurs after the key is depressed and causes a percussive accent.

When it is desired that the tone intensity envelopes shall have a slow attack the tablet 84 is operated to close switch 320. (As shown the switch 320 is in fast attack position.) Under these conditions the capacitor C314 will be connected to the control grid of the triode grid will be reduced at the same time that the potential on the cathodes is reduced. The pentodes 222, 224 will therefore temporarily remain cut off. However, as the charge across C314 and C315 is dissipated through R316, the grids will gradually increase in potential relative to the potential on the cathodes, and thus render the pentodes conductive in a smooth manner because of the variable mu characteristics of the pentodes 225, 226. After a short time (for example, 200 milliseconds) the slow attack portion of the intensity envelopes will then commence and the envelopes will continue sounding at a constant intensity until the key is released. When this occurs the potential on conductor 288 returns promptly to a positive value, such as +30 v., and as above explained, produces a transient free decay envelope.

Solo tone quality controls

The secondary of the output transformer 284 has one terminal grounded and the other terminal connected by conductor 324 to one pole of a plurality of switches 325 which are respectively operated by the tablets 56 to 59. The other poles of these switches 325 are respectively grounded through compensating resistors 326 for a purpose which will presently be described.

Tablets 56 to 59 also operate normally closed switches 330 which are connected in series between ground and the ungrounded terminal of the primary of transformer 276, by a conductor 332. The switches 330 respectively shunt tone control meshes which, as is well known in the art, attenuate certain frequencies more than others so as to produce changes in the intensity of the signal. When the switches 330 are closed it will be apparent that the primary of transformer 276 is effectively short-circuited so that no signal will be transmitted through this transformer. When one of these switches 330 is opened the impedance or filtering mesh which it normally shunts is rendered effective to modify the signal appearing across the primary winding of transformer 275, and when more than one of these switches 330 is opened the amplitude of the signal across the primary winding of transformer 276 is correspondingly increased and it is for this reason that resistors R328 are connected across the secondary of transformer 274. As the switches 330 are opened, the load provided by resistors R326 across the output of transformer 274 compensates for the increase in load provided by the input of transformer 276 so that irrespective of how many of the tablets 56 to 59 are operated the intensity of the tone signal on conductor 324 will remain substantially constant.

The conductor 324 transmits the output of the solo section of the instrument to the solo volume control 122 (Fig. 1) operated by the solo balance knob 64. This knob controls the position of the contactor of a potentiometer R340, one terminal of which is connected to the contactor 224. The other terminal is connected to ground through a resistor R341. The movable contactor of this potentiometer is connected through resistor R342 to a conductor 344.

OUTPUT SYSTEM COMMON TO ALL SECTIONS OF INSTRUMENT

The conductor 344 is connected to the grid of a triode 346 through a decoupling resistor R348. The cathode of triode 346 is connected to ground through a self-bias resistor R350 while the control grid is connected to ground through a grid return and signal load resistor R352. A decoupling resistor R354 is connected between the cathode of triode 346 and a terminal 355 to which a connection may be made during initial tuning and testing of the instrument. The plate of triode 346 is connected to a +280 v. terminal through a load resistor R356 shunted by a filter capacitor C356. The plate of triode 346 is also connected to a stationary capacitor plate 350 forming part of the capacity volume control 130. In addition to the plate 350 this capacity volume control includes a stationary capacitor plate 352 and a movable plate 364, the latter being determined by the expression lever 46. The plates 350, 352 and 364 may be arranged in a form similar to the customary variable multplate air dielectric tuning capacitors.

The capacitor plate 352 is connected to the plate of triode 346 through a mesh which is adapted to compensate for the frequency response characteristics of the ear at different intensity levels. This mesh comprises a section comprising R370 and C371 in parallel, this section being connected in series with a similar section comprising R372 and C373 in parallel, the junction between these two sections being connected to ground through C374 and R375 in series. The plate 352 is connected to ground through C376 in series with R371, these latter two components being shunted by R378.

The movable plate 364 of the capacity volume control 130 is connected to the grid of an amplifying triode 380 through a conductor 361 and a series grid resistor R382. The movable plate 364 is also connected to ground through filter capacitors C384 and C388 etc., to improve the quality of the signal. When both of these capacitors are connected to ground through a +19 v. terminal of the power supply through R386. The +19 v. potential is impressed upon the grid of triode 380 through R386, R388 and R392 and is similarly impressed upon the grid of a triode 380 through a load resistor R392. The cathodes of triodes 380 and 390 are connected together and are connected to ground through a relatively high value common cathode load resistor R393. One of a pair of phonograph input terminals 396 is connected to the grid of triode 390, the other input terminal being connected to ground.

The plates of triodes 380 and 390 are connected to a +285 v. terminal through load resistors R395 and R399 respectively. The plates of these triodes are also coupled to the control grids of power tubes 400 and 401 through blocking capacitors C402 and C403 respectively. The cathodes of tubes 400 and 401 are connected to ground and negative grid bias is provided through common resistor R404 and individual resistors R406 and R407 respectively, the junction being between the latter two resistors connected to ground through a filtering capacitor C406. The screen
2,645,968

grids of tubes 400 and 401 are maintained at a suitable operating potential by connection to a +285 v. terminal while the plates of these tubes are connected to the ends of the primary winding of an output transformer 408, the center tap of which is connected to a plate current source terminal +395 v. The secondary of transformer 408 has a center tap connected to ground and has terminals connected to the speaker 131. One terminal of the secondary of transformer 408 is also connected to the conductor 383 through visible feed back capacitor C412 which may be adjusted to control the over-all gain of the power amplifier 128.

VIBRATOR OSCILLATOR.

The vibrator oscillator 104 provides a vibrato frequency to the signal generating system of the solo section of the instrument as well as to other sections of the instrument as will hereinafter appear. As shown in Fig. 1a the vibrator oscillator 104 is coupled to a switch tube 420 through a blocking capacitor C422 and a limiting resistor R424. Negative grid bias is provided by a connection of the grid of switching triode 420 through R424 and R425 to a -2.5 v. terminal of the power supply, this terminal being also connected to the vibrator oscillator 104 to provide grid bias voltage thereon. The plate of the switch tube 420 is connected to a +295 v. plate voltage source through a relatively high value load resistor R426. The plate of tube 420 is also connected to capacitors C426 and C429. These capacitors may respectively be connected to the control grid of solo oscillator triode 155 by switches 430 and 431 respectively, these switches being operable by stop tablets 76 and 75. When either of the switches 430 or 431 is in the full line position and the triode 420 is conducting, the associated capacitor is effectively connected to ground through the triode 420 and a by-pass capacitor C432 by which its cathode is connected to a -4 v. terminal, which for alternating current is effectively ground potential. A cathode bias resistor R433 is connected in parallel with the capacitor C432. The plate of the switch tube 420 is effective alternately to increase and decrease the capacitance in the tuning circuit of the solo oscillator 100 by rendering either or both capacitors C426, C429 effective in the tuning circuit, and thus the frequency of the oscillation of the solo oscillator 100 will be caused to vary at the vibrato rate, namely, the frequency at which the vibrato oscillator 104 operates. When the switches 430 and 431 are moved to their dotted line positions they respectively connect the conductor 151 to ground through compensating capacitors C434 and C435. The stop tablets may be operated so that either or both of the capacitors C426, C429 are in circuit and thus produce either a small, a wide or a very wide vibrato effect. The construction and operation of the vibrato oscillator, the switch tube and associated circuits and parts are more fully disclosed and claimed in my copending applications Serial Nos. 111,743, filed August 22, 1949, Patent No. 2,589,424 issued January 1, 1952.

ORGAN SECTION GENERATING SYSTEM.

The generating system for the organ tone signals comprises sixteen oscillators of which three representative oscillators are shown in Fig. 1a. Some of these oscillators are arranged to supply either of two adjacent semitone frequencies while other oscillators are arranged to supply any one of three semitone frequencies. One of the oscillators which is capable of supplying either of two adjacent semitone frequencies is the F--F oscillator comprising triode 441 having a plate 442, a grid 443 and cathode 444, and includes a resonant circuit which may comprise an inductance L445 having a capacitor C446 in parallel therewith. This resonant circuit may include an elastomer bead capacitor C446 of the same value of C445, connected between a tap 449 on the inductance L445 and a switch 450 operated by the F playing key 45 in the octave above middle C. The switch 450, when closed, connects C446 to a conductor 452, which is connected to ground through a low value resistor R453 as well as through a portion of an autotransformer coil L454. The tap 449 is located so that approximately 65 per cent of the turns of L445 are between this tap and a terminal 456. A blocking capacitor C457 connects the terminal 456 at one end of the resonant mesh L445--C446 (or L445-C445-C446) to grid 443. The other terminal 458 of the resonant mesh is tapped to a conductor 450 and is thus connected to ground through R453 and a portion of L454.

Varying bias is impressed upon the grid 443 through a resistor R452 connected to a conductor 455 which leads to the cathode of switch tube 420, thereby to introduce a vibrato effect in the output of the oscillator. The oscillator triode 441 is normally not in oscillation since it is supplied with plate current only upon closure either of a switch 456 or a switch 457, these switches being connected to plate 442 through an attack resistor R456. A capacitor C458 in series with a resistor R478 is connected across the attack resistor R456 and this mesh, together with a capacitor C472, provides time delay so as to cause the gradual attack and decay in the intensity envelopes of the tone signals produced by the oscillator. A suitable operating potential is impressed upon the plate 442 upon closure of either switch 456 or 457, since the other poles of these switches are connected to a +295 v. terminal through a conductor 476.

The terminal 456 of the oscillator is connected by a decoupling resistor R478 to a signal collecting conductor 473. The form of the signal wave between the terminal 456 and ground is substantially a sine wave with but slight harmonic development, characteristic of flute tones, these flute-like tone signals appearing on the conductor 473. The collector conductor 475 may be connected to ground through a decoupling resistance R486 when a switch 482 operated by the stop tablet 75 is in its full line position. When the switch 482 is moved to its dotted line position the collector conductor 475 is connected to an organ section signal conductor 484 through R489 and R486, while at the same time the conductor 484 is connected to ground through a filter capacitor C485. The signals derived from the cathode through the autotransformer L454 are supplied to a switch 490 through a decoupling resistor R492. Closure of switch 490 results in impressing a signal of high harmonic development, characteristic of a tone of the string family, upon the output conductor 494. The switch 490 is operated by tablet 75 which simultaneously operates a switch 493 which is adapted to connect the conductor 476 to the conductor 484. The purpose of the switch 494 is to cause the addition of some of the flute tone signals with the organ tone signals to enrich harmonically the tone.
signals of complex quality derived through the autotransformer L454. The conductor 484 is connected to a potentiometer resistance R496 (Fig. 1c), the other terminal of which is connected to ground through R497. The movable contact of the potentiometer R496 is adapted to be adjusted by the organ balance knob 63. The movable contact is being connected through a decoupling resistor R498 to the grid of a preamplifier triode 500. The cathode of triode 500 is connected to ground through a self-bias resistor R502, while the grid is connected to ground through a grid return resistor R503. A coupling resistor R505 is also connected to ground through coupling resistors R506 and R505, the junction of which is connected to switch 150 for coupling a signal from the accordation section of the instrument to the organ preamplifier tube under certain circumstances which will more fully appear hereinafter. The plate of triode 500 is connected to a suitable source of operating potential, indicated as a terminal +280 v., through a load resistor R511 which is shunted by a filtering capacitor C512. The plate of the triode 500 is connected to conductor 344 through a decoupling capacitor R514. The grid of triode 500 is also connected to the output system of the instrument. In most homophonic music the highest note of the treble chord constitutes the melody note of the selection. By having the solo section provide a signal of different tone quality and intensity than the signal provided by the organ selection, the chord may usually be heard with the superposed solo note.

When it is desired to have the organ generating system generate signals devoid of the vibrato effect the player may close switch 528 (Fig. 1c) by operation of the accordation and organ vibrato control tablet 77, thus connecting the conductor 484 to ground. The resistors R462, which impress the vibrato frequencies on the grids of the oscillators, are of relatively high value, in the order of 2 megohms. It will be noted that the high value resistors R462 and the grid capacitors C457 are of such values that a considerable degree of phase shift at the fundamental frequency of oscillation is produced. The amount of phase shift used is sufficient to change the frequency of the oscillator approximately 3 percent. When this is the case variations in the voltage of the grids to which the grid resistances R462 are connected, are effective to cause further distortion of the wave shape of the plate current signal and thus introduce further phase shift which results in periodic changes in frequency to produce the desired vibrato effect. It is only when the resistance-capacitance mesh (R462-C457) are made current limiting that the vibrato effect is achieved by varying the grid bias. If R462 and C457 were not current limiting, the variation in vibrato bias supply would result main in amplitude modulation, that is, a tremolo effect, which is not nearly as desirable as the vibrato effect.

**ACCORDION SECTION GENERATING SYSTEM**

The accordion section generating system comprises six oscillators, each capable of oscillating at one of two adjacent semitone frequencies. The six oscillators thus cover a range of one octave. These oscillators are designed to provide two tone signals of pitch corresponding to the desired button controlled reed tones of an accordion, and have their outputs controlled by the accordion keyboard 50 which preferably comprises 96 buttons arranged in twelve vertical files according to the note designation of the chord in the octave, and in eight horizontal rows, each row representing a different type of chord, namely: the major-6th; 9th; major; minor; 7th; diminished; augmented; and minor 7th. (See Fig. 4.)

The six accordion oscillators, shown in Fig. 1d, are similar except for slight differences in the values of their components to render them operative at their particular oscillating frequencies, and therefore but one such oscillator has been shown in detail. This oscillator comprises a triode 530 having a resonant circuit comprising a tuning inductance L532 and a capacitor C534. One terminal of inductance L532 and one terminal of the capacitor C534 are connected to ground while the other terminals of these components are connected to the grid of triode 530 by a current limiting capacitor C536. A tap on L532 is connected to the cathode and the cathode is connected to a switch contact 538 through a tuning capacitor C540. The grid of triode 530
is also connected to the vibrato signal conductor 466 through a high value current limiting resistor R542, to introduce a varying bias at the vibrato frequency derived from the cathode circuit of the switch tube 540 (Fig. 1c). The triode 539 has its plate connected to a suitable operating potential source terminal +280 v. through a load resistor R544. The output signal from the oscillator E—F1 is supplied to a “root” bus-bar 553 and a “fifth” bus-bar 554 through a decoupling resistor R550 and switch contactors 559 and 562 respectively.

An accordion tone signal is derived from the plate of the triode 539 through a high pass filtering mesh comprising capacitor C568, a grounded resistor R558, and a decoupling resistor R560, the latter being connected to the contactor 562 adapted to make contact with a signal bus-bar 551 connected to a terminal X, which also appears in Fig. 1c. The tuning contactor 559 is adapted to make contact with a tuning bus-bar 552 which is connected to ground.

Whenever one of the key buttons 54 (Fig. 3) of the accordion button board 50 is depressed it will operate two contacts 559 and 566 (Fig. 1d) to supply signals of the required frequencies to the bus-bars 553 and 554. In addition, it will operate a contactor 558 to supply a signal to the signal bus-bar 551 and it may, if one of the elements of the chord called for by the depressed button is the lower of two of the semitone pitches capable of being supplied by the oscillator, operate a contact 550 to tune a particular oscillator to the lower of its two semitone frequencies.

The manner in which these contactors 539, 555, 559 and 562 are operated will be described hereinafter, it being understood for the present, that depression of one of the key buttons 54 will result in supplying signals of the three, four, or five pitches required for the desired chord and, in addition, will result in supplying to the “root” bus-bar 553 a signal corresponding to the “root” of the selected chord, and will supply a signal to the “fifth” bus-bar 554 a frequency corresponding to the “fifth” of the selected chord. Signals only twelve semitone frequencies are supplied by the accordion oscillators 440, the chord actually sounded may be first or second inversion of the selected chord. As will appear hereinafter, the over-all effect of the chord will be determined by the sounding of the pedal bass note, and the character of the chord (apart from the bass tone) is the first or second inversion will not be perceptible to the listener.

The signals composing the notes of the chord, as previously indicated, will be impressed on the signal bus-bar 551 and hence will be present on the terminal X appearing in both Figs. 1c and 1d. It will be noted that the terminal X is connected to the grid of the accordion control tube 148 through a resistor R564 and capacitor C556, the junction 561 between the latter elements being connected to ground through a capacitor C568. R564 and C568 form a low pass filter which greatly attenuates the high frequencies. The attenuation will be all the greater the lower the order of the filter 554—C568 through the voltage divider formed by resistors 508 and 509. The accordion section signals will thus be combined with the organ section signals and transmitted to the output system of the instrument at a relatively reduced amplitude.

In some instruments the pedal 44 may be used to cause sounding of the accordion chord in place of, or as a supplement to the accordion bar 56.
In such instruments the pedal 44 is arranged to operate a switch 587 which is connected in parallel with switch 588. It will be noted, by referring to Figs. 1a and 1b, that the vibrato signal for the solo oscillator 100 is derived from the plate circuit of switch tube 425, while the vibrato signals for the organ oscillators 136 (e.g., triode 441) and for the chord oscillators 146 (e.g., triode 550) are derived from the cathode of the switch tube 425. The solo vibrato is therefore 180° out of phase with respect to the vibrato on the organ and chord tones. Assuming the vibrato signal to be a positive pulse signal, the grid of tube 550, while receiving one pulse signal, will receive the other, thus arriving at its grid 1 3/4 second before the next pulse occurs. However, this will be slightly sharp and the organ and chord tones will be slightly flat. During the following 1/3 of a second the condition will be reversed. This results in the production of a rich chorus effect whenever tones, having the same fundamental, or having partials of the same nominal pitch derived respectively from the solo section and from the organ or chord sections, are produced at the same time. This chorus effect and various ways it may be produced are more fully disclosed and claimed in my co-pending application, Serial No. 223,376, filed August 27, 1943, and more particularly shown and claimed in my co-pending application Serial No. 11,453, filed February 27, 1943, now abandoned.

The combined signals from 587, 588 and 586 are transmitted through a blocking capacitor C610 to a low pass filter mesh 619 comprising three series resistors R612, four bypass capacitors C620 and a load resistor R623, the output of the filter 610 being coupled to the grid of triode 156 through blocking capacitor C624. The cathode of triode 156 is connected to a +38 v. terminal, while the grid is connected to a -50 v. terminal through a grid resistor R626 and a dc resistor R628. The -50 v. on the grid of triode 156 normally biases the tube beyond cutoff and no signal is transmitted through it. However, when either the "root" or "fifth" pedal is depressed, switch 535 or switch 537 is closed to connect resistor R522 to ground and thereby raise the potential on the grid of triode 156 to a value sufficient to permit normal operation of the tube. The value of R522 is such that the triode 156 approaches ground potential such that the triode 156 will commence transmitting the signal with a smooth gradual attack intensity envelope. The switches 535 and 537 are spring returned with the pedals that operate them, and upon release of the depressed pedal, the grid of triode 156 will again return to its cutoff -50 v. bias potential at a rate determined by the values of R628 and the combined capacitances of C635 and C636. A normally open switch 533 is also adapted to connect the conductor 632 to ground for rendering the control tube 155 effective to transmit signals. The switch 533 is operable to a doted line position to connect the grid of triode 938, through R599 and C594, to the "root" bus bar 555 instead of the grid operated switch bar 552. The switches 535 and 537 are operable by a common control member 533.

When it is desired that the pedal-controlled notes should be sounded with slow decay, the pedal fast decay switch 74 is operated to close switch 640 and thereby shunt C636 by a low value anti-spark resistor R642. Substantially the
full value of the capacitor C635 is then effective in the attack and decay circuits with a result that the decay portions of the tone intensity envelopes will be longer, that is, the decay will be slower.

Plate voltage for triode 156 is supplied from a 4-280 v. terminal through load resistor R344 which is shunted with a high harmonic filtering capacitor C646, and the output signal is transmitted to terminal Y through a blocking capacitor C646. The terminal Y appears also in Fig. 1e and is connected to one terminal of a potential divider whose upper leg consists of resistance R350 and a fixed resistance R651. Resistance R650 and R551 are connected in series between the terminal Y and ground while the contactor of the potentiometer, which is operated by pedal balance knob 62, is connected through a decoupling resistor R532 to the grid of preamplifier triode 346. The signal provided by the pedal section of the instrument is thus combined with the signals provided by the other sections of the instrument and transmitted to the output system of the instrument.

The “soft” table 71 (Fig. 1e) is connected to operate a switch 654 which, when closed, connects condenser 354 to ground through a resistor R558 by which a portion of the signals supplied by the solo, organ, and accordion sections, and a lesser portion of the signal supplied by the pedal section of the instrument, are shunted to ground. Thus R348 provides a simple form of bass pedal compensation, whereby the bass pedal tones are attenuated less than the tones produced by the other sections of the instrument when the “soft” table 71 is operated.

In lieu of the bass signal generating system above described, a generating system of the type employed in the solo section may be used, in which event each of the chord buttons would be effective to tentatively tune the oscillator to two different pitches corresponding to the suboctaves of the root and fifth of the selected chord.

**ACCORDION KEYBOARD AND SWITCH MECHANISM**

The accordion keyboard and the switch mechanism operated thereby is best shown in Figs. 4 to 10. The keyboard, shown in plan view in Fig. 4, comprises a molded plastic keyboard plate 660 having ninety-six openings 662 formed therein as guides for key buttons 54, the latter being arranged in eight generally horizontal rows and twelve vertical rows, preferably differently colored as indicated by the stipling, the horizontal rows being marked with the chord designations “major-i-6th,” “ninth,” “major-x,” “minor,” “seventh,” “diminished,” “augmented” and “minor 7th” at the left-hand end of the rows and marked with abbreviations of these chord designations such as “A,” “G,” “Fa,” “F,” “E,” “C,” “D,” “A,” “B,” and “F♯” as generally indicated in Fig. 3, but for convenience are shown as marked upon the keyboard plate 660. For quick visual identification, the buttons and the vertical rows Eb, C, A, and F♯ are distinctly colored, as indicated by stipling the other buttons 54.

As best shown in Figs. 5 and 6, the keyboard plate 539 is suitably reinforced around the openings 662 so as to provide ample guiding surfaces for the vertical gliding movement of the key buttons 54. The low bosses 683 around the opening 682 on the upper side of the plate 680 tend to prevent dust and dirt from falling through the clearance spaces between the buttons and the walls of these holes. The key buttons 54 have enlarged heads 666 at their lower ends which rest upon upwardly projecting parts of switch selecting levers 680, of which there is one for each key button 54. These selecting levers 680 are pivoted on a rod 652 suitably mounted in a keyboard frame 694 which comprises a number of channels, angles and plates forming a rigid supporting structure for the operating parts, and serves as a base for the keyboard plate 680 secured thereto by screws 686. Each of the levers is normally swung counterclockwise by a compression coil spring 698 against an upper limit stop 699. The springs 699 are arranged in echelon since they are of greater diameter than the spacing of selecting levers. The downward or clockwise swinging movement of the levers 690 is limited by a downstop 709, these stops being supported by a channel 702 forming part of the frame 694. The levers 690 are stamped of thin sheet metal and are provided with a number of dimples 704 which serve to space them from one another and thus to prevent them from adhering to one another due to the accidental presence of oil.

The lower edges of the levers 690 are provided with a number of projections 706 which are adapted to depress switch actuators 708. There are, of course, ninety-six levers 690, that is, one for each of the 96 key buttons 54, but there are only twenty-four actuators 708. As best shown in Fig. 5, these actuators 708 are in the form of sheet metal levers pivoted on a rod 710 carried in the frame 694 and normally urged clockwise (Fig. 5) each by a separate compression coil spring 712. Alternate actuators 708 have discs 714 made of an insulating material suitably riveted thereto while the intermediate actuators have similar discs 715 of insulating material riveted thereto. The insulating discs or washers 714, 715 are of different sizes, those secured to the leftmost (Fig. 6) actuators being larger than the others to make certain that the switches closed by these six actuators will close first and open last as buttons 54 are depressed and released.

To reduce noise, the upper edges of the actuator 708, where they may be engaged by projections 706 of the levers 690, are protected by inverted U-shaped felt pads 716 which are secured to the actuators by staples 718, the latter projecting through suitable openings adjacent the upper edges of the actuator 708.

The insulated discs 714 are arranged to engage and operate the rearward row of switch contactors 538, 562 and 555 (see Fig. 9) while the insulating discs 715 are similarly adapted to engage and operate the forward row of switch contactors 538, 592 and 555. These switch contactors are in the form of thin flexible resilient switch arms having contact wires 720 welded to the lower surfaces of their free extremities. The switch arms 533 are adapted to make contact with the bus-bar 552 which is shown in Fig. 9 as comprising two sections joined by a conducting jumper 722 while the switch arms 562 are adapted to make contact with a bus-bar 551, likewise shown in Fig. 9 as comprising two sections joined by a conducting jumper 723. Similarly the switch contactors 555 are arranged to make contact with the bus-bar 553 while switches 556 make contact with the bus-bar 554.

The bus-bars 551, 552, 553 and 554 are prefer-
ably staked to an insulating plate 724 (Fig. 6) and have solder lugs 726 projecting through the plate 724 for attachments of connecting wires. The plate 724 is provided with a manually changeable knob 722 by which the plates 723 and 724 may be moved longitudinally. This longitudinal movement is provided so that the bus-bars carried by the plate 724 may be shifted relative to the contacts which engage them to present fresh surfaces to the contact wires 720 on these contacts and thereby assure completion of the circuits by these contacts in spite of the presence of dust or other foreign particles which might be present accidentally, even though the switch mechanism is suitably enclosed to prevent admission of dust.

As previously indicated, the arrangement of the projections 706 on each key lever 590 differs from the arrangement of the projections on all other key levers. Thus depression of each of the key buttons 54 will result in operation of a set of contacts 538, 555, 556, 562 differing from the set operated by any other key button.

The manner in which the projections 706 are arranged may best be understood by reference to the diagram Fig. 10, which may be used to indicate the pitches to which the accordion oscillators 146 are tuned by the depression of the various buttons 54 and also to indicate which of the buttons 555 and 556 are operated to supply the "root" and the "fifth" frequencies for controlling the frequency of operation of the pedal section of the instrument. In Fig. 10 the various types of chords are designated by joined radial arrows pointing to the particular notes of which the chord is composed, while the dotted line radial arrows point to the note designations of the "root" and "fifth" notes of the chords. If one imagines the chord designations with their arrows as being stationary, and the circular row of note or pitch designations as being rotatable (or vice versa) one can determine all of the notes of the chord as well as the "root" and the "fifth" for all of the different types of chords in all different keys.

While, for example, as indicated in Fig. 10, the major chord comprises the notes C—E—G, the pedal "root" being likewise shown as "C" and the pedal "fifth" as "G." If one desired to determine the notes of the major chord in the key of D♭, these could be determined by mentally rotating the circular row of key designations in Fig. 10 one step counterclockwise so as to bring the D♭ designation below the first arrow of the major chord arrows and then one could read from the chart that the major chord in D♭ comprised the notes D♭, F and A♭, the "root" being D♭ and the "fifth" being A♭. In a similar manner the notes, as well as the "root" and "fifth," of all other chords in all other keys may be readily determined from Fig. 10. The information thus determined may be utilized to fix the number and positions of the various projections 706 on the levers 590 and the wire connections to the switch contact arms 538, 555, 556, 562.

The particular mechanical constructional features, the arrangement of the key button keyboard, and the switch mechanism operated thereby, do not form a part of my invention but are disclosed and claimed in the copending application of Laurens Hammond, Serial No. 169,902, filed June 23, 1950. The accordion bar 55 which is located directly in front of the built-up switch bar 59 (Fig. 4) is preferably made of a hollow inverted box-like plastic molding having suitable internal reinforcing webs 756 to 759, as best shown in Figs. 7 and 8. This bar is mounted upon an angle shaped bracket 740 secured to the keyboard frame 744 and having upwardly extending arms 742 surrounded by felt strips 744 which form the primary guides for the sliding movement of the accordion bar 55. The bar 55 is resiliently held in its uppermost position by a pair of coil springs 746 compressed between the bar and the bracket 740. Upward movement of the bar 55 is limited by a pair of felt stops 748, 745 which are suitably secured to the bracket 740 and which are engaged by small angle brackets 750 secured to the bar 55 by screws 751. Felt stoppers 752 are cemented or otherwise suitably secured within the bar 55 near the ends thereof and are adapted to engage the upwardly extending end portions 754 of the bracket 740. Excessive longitudinal sliding movement of the bar 55 is prevented by the engagement of transverse webs or ribs 756, 757, 758 and 759 with suitable felt covered portions of the bracket 740. A wire 766 is hooked into a suitable opening 761 formed in the plate 752 which is press-fitted into suitably grooved parts of the chord bar 55. The wire 760 extends downwardly through a suitable opening in the lower flange of bracket 740. The lower end of the wire 760 has a rearwardly bent portion 764 (Fig. 8) which lies beneath the end of a flexible filament switch arm 766, having a contact wire 767, and normally holds the latter from making contact with a fixed contact 768. The parts 766 and 768 are suitably insulated from each other and secured by a suitable bracket 770 to the horizontal flange of the bracket 740.

The chord bar 55 may be struck at the middle or at either end and nevertheless cause depression of the central portion thereof sufficiently to permit the switch arm 766 to make contact with the switch arm 768, these parts having previously been referred to collectively as switch 580. For example, if the right-hand end of the chord bar 55 is depressed the springs 745 will be compressed and the bar will pivot around the left-hand upset 748 so that the central portion of the accordion bar will be moved downwardly a sufficient distance to close the switch 760. Thus the player need not operate the chord bar with any degree of carefulness since the switch 580 will be closed irrespective of which portion of the chord bar the player presses downwardly.

It will be recalled that switches 538 are operated to tune the accordion oscillators 146, and it is highly desirable, in order to avoid undesirable transients, that the tuning be effected prior to the time that the oscillators are connected to the output circuit. This is accomplished not only by positioning the contacts 538 closest to the pivot rod 892, but also by providing larger washers 714, 715 on the switch actuators 708 associated with the switches 538.

The fact that the buttons 54 are not fastened to the selecting lever 690 is of substantial advantage in that the buttons are free to slide up and down without any tendency to be caught.
2,645,968

27

28

rods 171 and 172 (Figs. 4 and 6) each supported by four posts 173 secured in the keyboard plate 606. The posts at the ends of the rods 171 and 172 have sockets to receive the ends of the rods while the rods for operating the intermediate posts. Thus the posts project somewhat above the level of the rods and make it possible for the player easily to locate the button to be depressed by his tactile sense.

It will be understood that the switches operated by the actuating lever 175 could be constructed in self-energizing circuits, the solenoids operating tone controlling instrumentalities of any suitable musical instrument for selecting the chord and bass tones to be sounded upon depression of the chord bar and bass pedals.

SOLO AND ORGAN KEY SWITCHES

The switches operated by playing keys 48 may be of the construction shown in Fig. 11. Each key is secured to or formed integrally with a key bar 186, which in turn is secured to an L-shaped bracket 785. The up-turned rearward end of this bracket is riveted to the upper end of a leaf spring 184 and the lower end of the latter is suitably secured to a support 186 fixed in the console. A switch actuating bar 188 of insulating material has suitable openings through which project the switch arms 450, 457, 180 and 288, these switches being secured in a pair of insulating uprights 190 which are rigidly mounted in the console. These switches and their mountings are preferably of the construction shown in the patent to Laurens Hammond, No. 2,009,204. It will be noted, however, that the spacing between the contact of switch arm 450 and the contact of bus-bar 452 is less than the spacing between the contact of switch arm 451 and bus-bar 474, similarly the spacing between the switch 130, 132 is less than the spacing of the contacts of the switch 265, 282. This is necessary, or at least highly desirable, because the organ oscillators 136 should be tuned to their required frequencies by the closure of switch 500, 452 prior to the time that plate current is supplied to these oscillators by the closure of switch 487, 474; thus precluding the possibility of transmitting to the output undesirable transients which may occur during the tuning of the oscillators.

For a similar reason the switches 139, 132 should be closed to tune the solo oscillator 100 before the switch 265, 282 is closed to render the solo control tubes 282, 284 capable of transmitting the signals from the solo generating system. The key 45 is provided with a forwardly projecting lip 792 for engagement with the customary up and down stops.

OPERATION

The instrument shown in Figs. 1a, 1b, 1c, 1d, operates in the following manner: The musician seated at the console will operate the main switch to supply current to the power supply system with the result that the tubes will be present on the various terminals thereof. Operating potentials will immediately be applied to the six accordion oscillators 145 as well as to the vibrato oscillator 104 and switch tube 420. The solo oscillator 108, together with the associated solo frequency dividers 193 will also commence operation, at the lowest F frequency since all of the inductances L178 will be effectively in the tuning circuit of the solo oscillator. Assuming that the solo oscillator has been initially tuned by adjustment of the tuning control switches 175 and 176, the instrument will be in condition for playing.

Then, depending upon the character of the selection the player wishes to render he will operate various combinations of the intermediate keys and the pedal keys. He may desire the accordion mute and therefore operate the tablet 12. He may desire the organ section to provide string tones and will operate the tablet 18 accordingly, and if he desires these string tones to be combined with the organ flute tones, he will additionally operate the stop tablet 76. Assuming that he wishes the solo section to provide the bass and tenor octave tones he will operate tablets 86 and 81 which will determine the pitch of the tones provided by the solo section, in this case with the octave coupler effect. He will also determine the quality of the solo tone desired by operating one or more of the tablets 85 to 90.

If he is playing in a small room he may desire to operate the soft tablet 71 and may, if he desires, operate such other controls as the tone family selector 112 by means of tablet 83, the accordion sustain tablet 12, and the pedal fast decay tablet 74. Optionally he may adjust the balance between the various sections by operation of the balance controls 62, 63 and 64, although ordinarily this balance will not be changed frequently.

Having thus set up the various controls to the desired positions, he may commence playing the selection. The instrument is played in a manner using the right hand to play the keys of the manual keyboard 47, to control the sounding of the notes of the melody and sometimes treble accompaniment chords, while the left hand operates the key buttons 54 of the accordion button board 50 and the left foot is used selectively to operate the pedals 40 and 42 while the right knee operates the expression lever 46.

In the rendition of many selections, especially by the least skilled musicians, the right hand will be used to play a single note melody sequence while the accompanying chords will be caused to be sounded by depression of the desired key buttons 54 at intervals, providing the accordion sustain switch 150 is closed. The chords may then be accentuated, if desired, by depression of the accordion bar 56. If the switch 150 is open, the depression of the selected more than twelve buttons 54 will not cause the chord to sound until the accordion bar 56 is depressed. At intervals the accordion bar 56 is depressed to cause sounding of the accordion chord with a pleasing rhythmic pattern in the intensity envelope. At similar or probably less frequent intervals, one of the pedals 40 or 42 is operated to cause sounding of the "root" or "fifth" of the chord selected by the depressed accordion button 54. It will be noted that the player need merely select between the "root" and "fifth" bass tone and in this respect the playing of the instrument of this invention is easier and more simple than the playing of an accordion. In addition to selecting the chord by the depression of one of the chord buttons, the player of an accordion must also select and depress one of a group of bass tone controlling buttons to cause the sounding of a bass tone. In accordions there are frequently several similar groups of buttons for the control of the bass tones so that the player must become familiar with the positions of many more than twelve buttons in order to be able to select and conveniently depress the desired bass note controlling
button at the time the chord selecting button is depressed.

In the course of playing a composition the musician may readily operate the various stop tablets and the balance control knobs to change the quality, accent, and relative volume, and thus it is possible to produce an extremely wide variety of musical effects. These may be enhanced occasionally by playing both the melody and the chords, such as a transition chords, upon the keyboard 47. Special counter-melody and other polyphonic effects may be obtained by using both hands on the keyboard 47. Despite the wide variety of musical effects which may be obtained by the expert, a highly creditable performance is obtainable merely by the operation of a single key of the keyboard 47, a single button 54 of the accordon button board 50, and one of the pedals 40, 42. When played in this simple manner any person having but the slightest appreciation of the technique of playing the instrument may with very little practice or experience produce excellent homophonic music. Nevertheless the resources of the instrument are sufficient to maintain the interest of the expert musician. There are so many different possibilities of registration and control that the experienced musician may render a solo of such many musical effects that the overall musical effect will be that of hearing an orchestra rather than a single instrument. The facility with which the accordon chords may be emphasized by the operation of the accordon bar 50, and the ease with which the sounding of the bass pedal tones may be controlled makes the instrument very useful for the production of dance music, either when played alone or as a part of a small orchestra.

While the instrument is designed primarily for use in the home it will be useful, as above indicated, in connection with orchestras and also in a wide variety of entertainment fields such as in radio, television, musical accompaniment for motion pictures, and also for use in schools, churches and other institutions.

The overall dimensions and the weight of the instrument are sufficiently small that it is readily portable.

The several sections of the instrument are combined in such a manner that more than the aggregate of the possible outputs of the individual sections is obtained by their combination. For example, the utilization of the single keyboard to control the sounding of notes in both the solo section and the organ section makes it possible to reduce substantially the number of tone signal generators in the organ section. Similarly, by using the chord button keyboard 50 as a means for preselecting two possible bass tones signals, one of which may be selected by operation of the desired pedal 40 or 42, the player is relieved of the necessity of individually selecting the bass tones to be sounded and leaves to him only the requirement of selecting either the “root” or the “fifth” bass tone by the operation of these pedals. Also by utilizing a part of the organ tone signal transmitting channel for the transmission of accordon tone signals the accordon tones may be sounded merely by depression of the accordon key buttons 54 without the necessity of using the accordon bar 59 and the playing of the instrument is thereby further simplified for the beginner.

As the player advances in skill and knowledge in the playing of the instrument, a large number of different possibilities are successively made available to him with his acquirement of improved technique. The instrument is designed to possess a simplicity not previously attained in any instrument capable of producing such wide range of musical effects, while at the same time having sufficient tonal resources to enable the highly skilled musician to obtain musical results not herefore attainable on any single instrument played by a single individual.

A unique and musically interesting effect may be produced on the instrument by playing a glissando passage, especially when the solo section is set up for a tone quality differing substantially from that of the organ section. Of course, playing in this manner is equivalent to rapid legato playing in that there are two keys depressed at one time alternately with one key at a time.

In playing up the scale in this manner, upon depression of the first key, both the solo section and the organ section sound the same note having a tone quality which is a mixture of their individual qualities. Upon depression of the second key, while holding the first key depressed, the next higher semitone is sounded by the solo section with its distinctive quality while the organ section may continue to sound the first note. Then upon release of the first key, both the solo section and the organ section again sound the note of the second key in a quality which is a combination or mixture of the solo and organ qualities.

When playing in this glissando manner proceeding down the scale, upon the depression of the first key, both the solo section and the organ section sound the same note of a mixed quality. Upon depression of the second key, while holding the first depressed, the solo section will continue to sound the first note and the organ section will sound the next lower semitone, the second note. Then, upon release of the first key, both the solo section and the organ section will again sound the same note, that is, the second note, and so on.

The effect of this transition successively over a number of notes is somewhat like that of reverberation and also gives to the listener the distinct impression that he is hearing a duet of different instruments, or even a trio of different instruments somewhat like that heard, for example, when one or more trombones and violins of an orchestra are being played in a glissando manner. The multiple source effect is enhanced by the fact that the different tone qualities are heard in succession thus creating the impression that there are several instruments playing the same glissando passage but that they are not exactly in time. The over-all effect is one which adds substantially to the musical interest in the rendition.

Countless other novel and interesting effects may be obtained by the extremely large number of different possible settings of the controls.

When a novice is first learning to play the instrument he may prefer to operate the control member 639 to close the switch 533 and move the switch 595 from its full line to its dotted line position. The grid of the input tube 596 of the pedal frequency divider system is then connected directly to the root bus 553 by the switch 595 and the bass control tube 156 is rendered effective to transmit signals from the frequency divider system. Consequently, operation of a chord control button 54 will cause immediate sounding of a low frequency bass tone having a pitch suboctavely related to the root of the chord select-
ed by the chord button. According to the position of the accordion sustain tablet 12, the accordion bar 55 may be operated to sound or to emphasize the chord selected by the chord button 54.

Operation of the control member 69 renders the pedals 40 and 42 completely ineffective. Playing the instrument thereby requires merely manipulation of the accordion and pianofone keyboards with the hands, but of course the variety of musical effects obtainable is reduced.

MODIFICATION SHOWN IN FIGS. 12, 12a, 13 AND 14

In some instances it may be desirable to reduce the cost and simplify the accordion section of the instrument by utilizing twelve oscillators, one for each note of the octave and to provide but thirty-six key buttons. An instrument section of this character is shown in Figs. 12, 12a, 13 and 14. As will appear hereinafter the number of key buttons may be reduced to eighteen (or thirty-six), if desired, merely by the use of the multiple switch for transposing the chords whenever the music being played changes to a different key.

As shown in Fig. 12, there are provided twelve oscillators for the notes F (174.6 C. P. S.) to E (329.63 C. P. S.), these oscillators bearing reference characters 530 to 541 inclusive. These oscillators may be alike in circuit arrangement, except for slight variations in the values of the components, and each comprises a resonant tuning circuit 542 coupled to the input of a triode 544 in a manner to secure oscillation.

A vibrato frequency is impressed on the oscillators by the use of a suitable vibrato apparatus 546 having an electromagnetic drive, or the vibrato frequency may be supplied from a vibrato oscillator and switch tube such as the vibrato oscillator 104 and switch tube 420 shown in Fig. 1a and previously described. The vibrato apparatus includes a plurality of contacts 547 which are grounded throughout half of each vibrato cycle at the rate of about 6 to 7 C. P. S., the contacts being connected to the grid circuits of the triodes 544 through incremental tuning capacitors C84, for producing the customary vibrato effect.

The plate of each of the triodes 544 is connected to a terminal identified by the pitch note designation of the oscillator followed by an "o," as Fo, and these terminals are adapted to be connected to one of twelve other terminals designated P1 to P12 inclusive.

Fig. 13 is a diagrammatic illustration of a manually operated transposing switch by which the various terminals Fo to Eo may be connected selectively to terminals P1 to P12. In Fig. 13 the terminals P1 to P12 are indicated as connected to sliding contacts 552 which are mechanically connected together so as to be rotatable with respect to a circular set of contact segments 554. The contact segments are connected to the terminals Fo to Eo respectively. It will therefore be apparent that, as the contacts 552 are rotated relative to the segments 554, a transposition of the connections of the terminals P1 to P12 with respect to their connection with terminals Fo to Eo is effected without changing the sequential nature of the connections. This transposing switch is represented, in Fig. 13 by dotted lines connecting terminals Fo and P1, F0 and P2, etc.

Referring to Fig. 12 a plate load resistor R586 is connected to the terminal P1 and the other terminal of this resistor is connected to ground through a capacitance C690, the junction between R585 and C690 being connected to terminal F1 by an attack resistor R589. The mesh comprising R589 and C690 prevents excessively rapid build up and decay of the signals produced by the oscillator when the terminal F1 is connected to and disconnected from a source of plate voltage.

The signal is derived from the plate of the oscillator triode 544, that is, from the terminal P1, through a blocking capacitor C692 and a terminal P2. As will hereinafter appear, the signals on the terminals such as P2 are utilized for control of the bass pedal frequency dividing section of the instrument.

A second signal is derived through a decoupling resistor R584 and impressed upon a signal collector conductor 556 which is connected to the accordion input terminal of the output system of the instrument, such as the terminal X of Fig. 1c.

As previously indicated, the instrument may comprise an accordion button keyboard of limited range, it being necessary only that the vertical rows for the chords in the key of C, comprising vertical rows F, C, G, D, A, and E, be provided. However, if desired the keyboard may be extended to include thirty-six buttons, as shown in Fig. 14, and should include a chord bar 577 preferably as long as the keyboard. The key buttons 576 are mounted in a plate 586 which is provided with a window 585 through which are visible the chord designations.

A knurled wheel 570 is manually operable to rotate the transposing switch 582, 584 and at the same time to operate a drum or tape 572 bearing markings indicating the key designations. Key buttons 576 for the chords built on the notes C and G are shown in Fig. 12a, and are intended as being illustrative of the eighteen (or thirty-six) buttons employed in the keyboard for this form of the invention. Each of the buttons 576 in a vertical row, such as those in the C row, is arranged to operate the same twelve switches 578. Further, each of the buttons 576 in a horizontal row operates additional switches, the keys 575 in the upper horizontal row for the major, augmented, or major-forth chords, operates switches 589 to 595 inclusive. In a similar manner the middle horizontal row of buttons for the minor, or minor seventh chords operate switches 586 to 589 inclusive, and the buttons 575 in the lower horizontal row operate switches 590 to 597 inclusive.

The switches 576 which are operated by the vertical row of "C" keys 576 are connected respectively to terminals C1, C2, etc. and C2, C12, etc. (as indicated in Fig. 12a) of the oscillators which may be required to provide a signal for the production of any of the chords built on the note C. Similarly the switches 578 for the other vertical rows of keys are connected to appropriate terminals of the oscillators 530 to 541, as shown in Fig. 12a. When the major with the added 6th chord is desired, the operator, in addition to depressing the selected key button 576 in the upper horizontal row for the major, raises a switch 592 which closes a switch 599. When the augmented, the minor seventh, or the diminished seventh chord is desired, the musician in addition to depressing one of the buttons 576 depresses a pedal 900, which may be similar to the pedal 44, Fig. 3. This pedal is adapted to operate switches 501 to 510. One pole of each of the switches 591 to 907.
is connected to a suitable source of plate current indicated as a terminal B-. The switches 908 to 910 are connected through a conductor 928 to the pedal input terminal of the output system, such as the "fifth" bus-bar 554 (Fig. 1d) to which the switch 899 is also connected.

The various bus-bars 914 to 925 to which one pole of switches 878 and switches 890 to 917 and 886 to 929 are connected, have suitable legends applied to their terminals indicating the character of the chord or the pedal input to the output system to which they are connected.

It will be noted that the bus-bar 922 is connected to the pedal "root" input terminal of output system, such as the "root" bus-bar 533, (Fig. 1d).

The operation of the various switches shown in Fig. 12a results in effecting the production of the desired chord, as will now be explained by referring to their operation of the chords in the key of C.

If the key button 876 in the key of C and in the upper horizontal row is depressed either the major, the augmented, or the major fourth, and the switches 876 to 910 are closed, the oscillator 837 will be connected to a B- terminal. In addition, depression of the major key button will close switches 890 and 891 thus impressing the plate voltage on bus-bars 816 and 817. As a result, and because of the closure of the switches 878 which make a connection between these bus-bars, the oscillators for the notes E and G namely oscillators 841 and 832 will be supplied with plate current and commence oscillation. Closure of switches 892 and 903 will not have any effect since these switches are in series with switches 894 and 899 respectively, which are open.

Closure of the switch 878 connected to the terminal C2 results in impressing the frequency of the oscillator 837 on bus-bar 922 and hence on bus-bar 816 (Fig. 1d), and is thus available to determine the frequency of operation of the pedal frequency dividers whenever the "root" pedal 40 is depressed. Closure of the switches 878 connected to the terminals F2 and A2 does not have any effect because the bus-bars 925 and 929 are not connected to the output conductor 928, because of open switches 908 and 910. Closure of the switch 878 connected to the terminal G2 results in impressing a signal from the terminals G2 of the oscillator 832 to the bus-bar 924 which, through switches 894 and 910 is connected to conductor 938, and thus determines the pitch of the bass note which will be sounded when the "fifth" pedal 42 is depressed. Thus, the oscillators for the notes C, E, and G are supplied with plate current and appropriate signals from the C and G oscillators and are supplied to the output system for the control of the pedal frequency dividing section of the instrument. In addition, the C, E, G oscillators supply signals to conductors 895 and hence to the output system under control of accordian bar 56 and associated control transformer 72 so that the output of these oscillators will be connected to the pedal section of the instrument to supply signals necessary to cause the pedal tone generating system to provide either the root and the perfect fifth, the root and the diminished fifth, or the root and the augmented fifth, as may be required.

When the augmented chord is desired, the pedal 900 is depressed and this, through switch 904, disconnects the plate current supply from bus-bar 918 and connects it to bus-bar 919. Thus, the oscillators C, E, and A6, instead of oscillators C, E, and G, will be supplied with plate current and rendered operative. In addition, operation of switch 910 selects the Ab oscillator 833 instead of the G oscillator 832 to provide the pedal augmented fifth, if desired.

If the major or 6th chord is desired the switch 898 is depressed to close switch 899 thereby to connect bus-bar 920 to the B- terminal, and as a result, the A oscillator 834 will be rendered operative in addition to the oscillators for the notes C, E, and G.

When the key 876 in the vertical C row and in the middle horizontal row is depressed, the minor chord C, E, G will be rendered operative. Assumed that neither of the latter are operated, and only the above-mentioned key button 876 is depressed, closure of the switch 876 connected to terminal C1 will result in supplying plate current to the C oscillator 837 since the bus-bar 914 is connected to a B+ terminal. In addition, depression of the C major key button will close switches 890 and 891 thus impressing the plate voltage on bus-bars 816 and 817. As a result, and because of the closure of the switches 878 which make a connection between these bus-bars, the oscillators for the notes E and G namely oscillators 841 and 832 will be supplied with plate current and commence oscillation. Closure of switches 892 and 893 will not have any effect since these switches are in series with switches 894 and 899 respectively, which are open.

When the switch 876 in the lower horizontal row and in the vertical row C is depressed to produce the C seventh chord, the bus-bars 914, 915, 916, 917 and 921 will be connected to B+ terminals and the oscillators for the notes C, E, G and Bb will be rendered operative. In addition, the terminals C2 and G2 will remain connected to bus-bar 922 and terminal 926 respectively, to provide the pedal root and pedal perfect fifth, and signals for the pedal frequency divider section of the instrument.

When the button 876 in the lower horizontal row and in the vertical row C is depressed to produce the C seventh chord, the bus-bars 914, 915, 916, 917 and 921 will be connected to B+ terminals and the oscillators for the notes C, E, G and Bb will be rendered operative. In addition, the terminals C2 and G2 will remain connected to bus-bar 922 and terminal 926 respectively, to provide the pedal root and pedal perfect fifth, and signals for the pedal frequency divider section of the instrument.

When the diminished seventh chord is desired, in addition to depressing the key button 876 on the lower horizontal row for the vertical row C, the musician operates the chord change pedal 900 and thus the bus-bars 914, 915, 917 and 920 will be connected to B- terminals, and the oscillators for the notes C, E, F and A will be rendered operative and thus supply signals of corresponding pitch to the output system of the instrument. In addition, the terminal 928 will be disconnected from bus-bar 924 by the opening of switch 900 and the bus-bar 923 will be connected to the terminal 926 due to the closure of switch 908. Thus, the player will have available for controlling the pedal frequency dividers, signals of the frequencies C and F since the terminals C2 and G2 will be connected respectively to bus-bars 922 and 928.

From the foregoing, it will appear that depression of any one of the key buttons 876 will cause the oscillators required for the production of the desired chord to be supplied with plate current and thus cause them to operate, and in addition, appropriate output terminals of the selected oscillators will be connected to the pedal section of the instrument to supply signals necessary to cause the pedal tone generating system to provide either the root and the perfect fifth, the root and the diminished fifth, or the root and the augmented fifth, as may be required.
MODIFIED ACCORDION TONE SIGNAL GENERATING SYSTEM AND CONTROLS

The means for generating the tones or the electrical signals corresponding to the musical tones of the chords played under control of the chord button key board may assume various forms, one such modification being shown in Figs. 15, 15a and 16. In Fig. 15 there are shown four oscillators, a root oscillator 956, a 3rd oscillator 960, a 5th oscillator 962 and a 7th oscillator 958. These four oscillators take the place of the twelve oscillators shown in the previously described embodiment (Figs. 12 and 12a), and in an instrument constructed to sell at a low price, in which a very low production cost is determinative, a generating system of this type will prove practical.

The four oscillators are of identical circuit arrangement and a description of the root oscillator 956 will suffice for the description of all of these oscillators. The root oscillator 956 comprises a triode 956, the cathode of which is connected to ground, and the grid of which is connected to a resonant tuning circuit through grid bias resistor R958 and capacitor C960 in parallel. The tuning circuit comprises an inductance L962 which is connected between the grid of triode 956 and ground and which is in parallel with one of four capacitors C964, C965, C966 and C967 (Fig. 15a) upon operation of selected key buttons 968. There may be but twelve keys 968 and they may be arranged in a manner indicated in Fig. 16, in three horizontal and four vertical rows preferably with the chord key designations which appear as legends on the keyboard plate 959, through which the keys project. Each of the keys 968 operates four switches 970 which are arranged respectively to connect certain terminals of the oscillators 950, 951, 952 and 953 to a common set of bus-bars 972, 973, 974 and 975. These bus-bars are connected to the ungrounded terminals of the capacitors C964 to C967 respectively. The inductance L962 is provided with a plurality of taps, which for the root oscillator 956 have the note designation followed by the letter "R," these taps of the oscillator 950 being respectively connected to correspondingly lettered poles of the key switches 970.

An inductance L960 is connected between a tap on the inductance L962 and a switch contact 984 which is adapted to make contact with a grounded vibratory reed 986. The reed 986 is maintained in vibration at a vibrato frequency of about 6 to 7 cycles per second by a suitable electromagnetic drive indicated as an electromagnet L968 co-operable with the reed 986, or a suitable magnetic weight 987 carried thereby. The inductance L968 is adapted to be energized by engagement of the reed 986 with a contact 990, thereby to complete the circuit including a source indicated as 6.5 v. A. C. The inductance L969 has a resistor R992 in parallel therewith to reduce sparking at the contact 990 with the reed 986. As the reed 986 vibrates it periodically connects the inductance L989 between ground and the tap on inductance L962 throughout one-half the cycle of oscillation of the reed, thus changing the tuning of the oscillator by a small amount sufficient to produce a desirable vibrato effect.

The plate of the oscillator 956 is connected through a feedback coil L989 to a terminal 998. The terminal 998 is supplied with a suitable source of plate current through a load resistor R997 connected to a conductor 1000.

The supply of plate current to the triode 956, as well as to the triodes of the other oscillators, is effected by the closure of switches 1001. A conductor 1002, connected to a suitable B+ terminal is adapted to be connected to conductor 1004, by closure of any of the switches 1001 upon operation of one of the chord character selecting bars 1006 to 1011 and tablets 1012. Since the conductor 1002 is connected to a suitable B+ terminal of the power supply system, it will be clear that depression of any of the bars 1006 to 1012 will cause the oscillators 950 to 953 to be supplied with plate current, for as will appear from Fig. 15 the conductor 1054 is connected to conductor 1006 through resistor R1014. When closed, conductor 1006 is connected to ground through a capacitor C1016, which with R1014, forms an attack and decay controlling mesh to prevent the production of any undesirable transients which might occur if the plate current source were directly connected to the plates of the triodes 956 of the oscillators 950 to 953.

The outputs of the oscillators 950 to 953 are derived through blocking capacitors C1018 and decoupling resistors R1019, the signals thus being collected on a conductor 1028 which leads to the accordion output of the instrument such as the terminal X shown in Fig. 1c.

In addition to supplying signals for the accordion tones, the oscillators 950 to 953 supply signals for the control of the frequency of operation of the first of the pedal frequency dividers 154 (Figs. 2 and 1d), depending upon the selection operation of one of four pedals 1022, 1023, 1024 or 1025. These pedals are arranged respectively to operate switches 1032, 1033, 1034 and 1035, thereby selectively to connect the outputs of the oscillators 950 to 953 to a conductor leading to the input of the first pedal frequency divider stage, such as the conductor 593 (Fig. 1c). The switches 1032 to 1035 are connected to the plate circuits of the oscillators 950 to 953 through decoupling resistors R1036, R1037, R1026 and R1039 respectively. In addition to operating one of the switches 1032 to 1035 each of the pedals 1022 to 1025 operates a common switch 1040 thereby to connect to ground a conductor leading to the biasing mesh of the mesh control the output of the pedal section of the instrument, such as the conductor 632 of Fig. 1c.

The pedal switches 1032 to 1035 are provided with a suitable intercoupling latching mechanism so that depression of one of the pedals will result in the release of the switch associated with the previously depressed pedal, and that the switch associated with the last depressed pedal will remain closed after the pedal has been released. The operation of switch 1040 is preferably not affected by this latching mechanism but is arranged to be closed and opened directly with the depression and release of any of the pedals, and is arranged to be closed only after one of the switches 1032 to 1035 has been closed.

It will be recalled that each of the accordion buttons 958 operates four switches 970 to connect the four bus conductors 972 to 975 respectively to taps on the inductance L989 of the oscillators 950 to 953 thereby to cause the oscillators to be tuned to the desired pitches upon depression of any one of the chord selecting bars 1006 to 1012. Capacitors C1042, C1043, C1044 and C1045 are connected between conductors 973, 974 and 975 and conductors 1046, 1047, 1048 and 1050. By operation of a variety of switches means 75 of the chord selecting bars 1006 to 1012, the ca-
2,645,968

2,645,968

2,645,968

It will also be clear that the four oscillators 950 to 953 will respectively supply signals to the pedal control switches 1037 to 1035, so that the depression of any one of the pedals 1022 to 1025, thus closing one of the mentioned switches and subsequently closing switch 1040, a signal corresponding to the root, 3rd, 5th or 7th of the chord will be supplied to the first pedal frequency divider through the conductor 953 (Figs. 15 and 16). The latching mechanism associated with the switches 1032 to 1035 will upon depression of one of the pedals release any of the switches which has previously been closed and maintain closed the switch associated with the depressed pedal after the pedal has been released. The switch 1040, however, opens upon release of the pedal. Thus the pedal tone will have an intensity envelope characterized by smooth attack and long gradual decay.

While the accordion section of the instrument shown in Figs. 15, 15a and 16 may be slightly more difficult for an accordionist to play, in that it requires the depression of at least one key button and one chord selecting bar for the selection of a particular chord, to a person unfamiliar with the arrangement of the buttons of an accordion type keyboard it may be played more easily than the previously described embodiments.

The accordion section of the instrument shown in Figs. 15, 15a and 16 has, however, the distinct advantage of reducing the cost of this section of the instrument, primarily because of the reduction in the number of oscillators required, and in the simplification of mechanism and structure of the keyboard, due to the reduction in the number of key buttons. It also has the advantage of making available four pedal tones, as compared with the root and fifth only which are available to the musician in playing the accordion section of the previously described embodiments of the invention.

Modification of Figs. 17 and 17a

The invention may be embodied in diverse forms. For example, the accordion and pedal sections may be utilized as an adjunct to a piano, in the manner illustrated in Figs. 17 and 17a. In these figures a conventional piano comprising a customary case 1059, having the usual keyboard 1062, has an accordion section keyboard 50 mounted on a suitable casing 1054 secured to the piano adjacent the front of the piano keyboard. The casing is preferably mounted on the piano in such a position that its right-hand edge is directly in front of the “C” key one octave below middle “C.” The accordion keyboard 50 mounted on the casing 1054 is preferably the construction shown in Figs. 4 to 8 and is connected by a multi-conductor cable 1066 to a tone cabinet 1088 which may be placed on the floor adjacent the end of the piano. The cabinet 1088 contains the accordion tone signal generating system, its various controls, the pedal frequency dividers and associated parts. For example, referring to the block diagram of Fig. 2, the cabinet may enclose the parts 102, 104, 146, 147, 148, 124, 126, 131, 152, 154, 155, 158 and 62.

The pedals 40 and 42 are preferably secured to bars 1090 and 1091 which extend from the cabinet 1088 and are provided with swinging hinges 1092 so that they may be swung upwardly out of the way when the instrument is not in use. The expression lever 46 (shown only in Fig. 3) may be suitably hinged beneath the keyboard of the piano and connected, as by an encased flexi-
ble control wire 1093, to the volume control within the cabinet 1088. The casing 1084 may be secured to the plank beneath the keyboard of the piano by suitable U-shaped clamps or brackets 1094.

The casing 1084 is also provided with control tablets 71, 72, 73, 74 and 77 to control the output of the accordion and pedal section of the instrument to produce respectively: “soft” volume, “accordion sustain,” “accordion mute,” “pedal fast decay,” and “accordion vibrato.”

The instrument shown in Figs. 17 and 17a may be played with the piano to provide the accompaniment chords and bass tones. With this arrangement the musician has at his command easily playable means for the production of the chord accompaniment, the accent thereof by means of the accordion bar 56 and the production of the pedal root and fifth, while his right-hand is free to play the melodic passages on the piano keyboard. The pianist is thus provided with electronic tone production means which may be used greatly to enhance the over-all musical effects which he may produce.

PNEUMATICALLY CONTROLLED INSTRUMENT OF FIGS. 18, 19 AND 20

The broader principles of the invention may be employed for the playing and control of a wide variety of conventional musical instruments, for example, the piano, reed organ, and nearly any keyboard musical instrument. An apparatus by which this may be accomplished is diagrammatically illustrated in Figs. 18, 19 and 20.

In this embodiment the invention the accordion button keyboard may be of the same construction shown in Figs. 4, 5 and 6 except that instead of operating selected switches the key buttons operate selected valves in a pneumatic (pressure or vacuum) control system similar to that used in player pianos. For example, in Fig. 18 there is illustrated one of the 96 accordion key buttons 54 mounted in a keyboard plate 609 and arranged upon depression to pivot clockwise a selecting lever 690. These key levers in turn operate predetermined transverse actuators 708, each of these being positioned to operate one valve stem 1100.

These valve stems are arranged in groups of twelve, the left-most group being provided for determining the root, the middle group to determine the 5th, and the right-most group the notes of the chord.

The valve stems 1100 extend freely through suitable openings 1102 formed in a valve chest top plate 1104. The valve stems 1102 are also vulcanized to an inner rubber-like sheet 1103 which is coextensive with the top plate 1104 and is clamped between the top plate 1104 and the valve chest body 1100. The body 1100 is divided by partitions 1110 and 1111 into three chambers 1112, 1113 and 1114. The valve stems 1100 have valves 1116 secured to their lower ends which co-operate with downwardly facing valve seats 1118. Each of the valve seats has a downwardly extending ferrule 1120 surrounding it, to which suitable tubes 1122 are connected. Each of the tubes 1122 for a valve in the root group is also connected to a valve in the 5th group as by a T 1124 and both tubes are thus connected to a bellows 1126.

This bellows may be of a type to operate on compressed air or on a partial vacuum and may be connected to any tone controlling instrumentality of a musical instrument. For the present it will be assumed that a pressure system is employed. Under these circumstances a blower or other source of pressure indicated by the block 1128 in Fig. 19 is connected to a wind chest 1130 which upon operation of a chord bar 1132 and consequent opening of a valve 1133 supplies air under pressure to a chamber 1134 which chamber is suitably connected to the valve chamber 1114 of Fig. 18 but not shown in extension thereof. The accordion bars 1132 and valve 1133 are normally held in the upward position shown in Fig. 19 by compression coil springs 1135. The stem 1139 connecting the valve 1133 to the accordion bar 1132 is preferably bonded to a flexible elastic sheet 1140 made of a material such as rubber. In a similar manner valves 1142 and 1143 are respectively operable by root pedal 1144 and fifth pedal 1145 to admit air from the wind chest 1130 to chambers 1145 and 1147 respectively, the latter being suitably connected to the chambers 1112 and 1113 respectively of Fig. 18. The valves 1153, 1142 and 1143 are normals toward closed position by the pressure of the air in the wind chest 1130 and the stems 1148 and 1149 of valves 1142 and 1143 and also connected to the flexible resilient sheet 1140 and are thus urged toward their uppermost positions by virtue of the elasticity of the sheet 1140 as well as by any air pressure which may be present in the chambers 1146 and 1147.

It will be apparent that when a key button 54 is depressed the projections 706 of the associated selecting lever 690 will engage and depress predetermined actuating levers 708, and each of these will open valves 1116 to provide open passageways for flow of air under pressure from the chamber 1114 to three or more bellows 1126. Similarly two other valves 1116 will be opened to provide passageways for the flow of air from the chambers 1112 and 1113 respectively to two additional bellows 1126. When a button 54 is held depressed and the chord bar 1132 is depressed, flow of air into the chamber 1134 and hence into the chamber 1114 will result in expanding the bellows 1126 previously connected to the chamber 1114 by the opening of its associated valve 1116 and cause the chord to sound. Similarly depression of either of the pedals 1142, 1143 will permit flow of air under pressure from the wind chest 1130 past valves 1142, 1143 into chambers 1146, 1147 and hence into chambers 1112, 1113 to two of the bellows 1126 associated with the bass tone producing control members of the instrumentality being utilized to produce the music.

As previously indicated this instrumentality may be a piano, reed organ, accordion-like mechanism, or any other musical instrument. One such instrument is particularly diagrammatically illustrated in Fig. 20 as comprising a piano string 1153 which is adapted to be struck by a hammer 1152. The action of the piano by which the hammer is operated to strike the string 1150 is not of particular relevance here and is therefore shown in a simple form intended as representative of any suitable piano action which is adapted to be operated by the clockwise swinging of a key bar 1154 held in place by means of each of the key bars has a felt-padded seat 1158 for engagement by the actuating plunger 1156 of one of the bellows 1126.

The arrangement is such that whenever the bellows 1126 is supplied with air under pressure by the operation of valves controlled jointly by key buttons 54 and accordion bar 1132 or pedals 1144, 1145, the hammers 1152 corresponding to the
notes of the chord and of the selected pedal note will be caused to operate to strike their respective strings 1150 to produce the accompaniment chord as well as the root or fifth bass pedal tone. Natural leakage of air from the system, or escape of air from the pipes 1122 through bleed apertures 1160 (Fig. 20) will permit the operated bellows 1126 to return to their normal positions either by gravity, by a spring forming part of the bellows itself, or by other resilient means of well-known construction.

It will be apparent that by suitable slight changes in the structures of the valves operated by the accordion bar 1132 and by the pedals 1144, 1145, as well as by reversing the operation of the bellows 1126, a suction blower instead of pressure blower may be employed as the pneumatic power source in a manner well-known in the piano art.

In lieu of a suction or a pressure blower, the air pressure necessary for operation of the bellows 1126 may be obtained from bellows 1162, 1163 and 1164, and these bellows may be excited respectively by operation of pedals 1160, 1165, and by an accordion bar 1168 respectively, as shown in Fig. 21. The air inlet valves 1170 of these bellows may be of conventional construction, utilizing the force of gravity or incorporating a spring to hold them in the positions in which they are shown in full lines. In this form of the invention the outlets 1172 of the bellows are respectively connected to ducts 1174, 1175 and 1176 which are connected respectively to the chambers 1112, 1113 and 1114 (Fig. 18).

Thus when a key button 54 is depressed and the accordion bar 1168 is operated the pressure within the bellows 1164 will be increased and air under pressure supplied to the chambers 1174, 1175, and 1176, and thence to each of the bellows 1160 which, due to the opening of their associated valves 1165, are in communication with the chamber 1114. In this way the player has under his control the intensity envelope of the tones produced, in a manner comparable to the control which may be affected by the operation of the bellows of an accordion.

The valves are similarly sounded by operation of either the pedal 1165 or the pedal 1167, compressing their associated bellows 1162 or 1163 and thus supplying air under pressure to either the chamber 1112 or 1113 and thereby operating the bellows 1126 required to cause the sounding of the selected pedal tone.

In the particular embodiments of the invention shown in Figs. 18 to 20 and in Fig. 21 the air supplied through the tubes 1122 may be used to energize vibratory reeds directly instead of controlling such vibrations through intermediary bellows 1125. These modifications further illustrate the scope of one phase of applicant's invention concept whereby the notes of the chord are pre-selected by the operation of an accordion key button which also operates to preselect the root and fifth bass tone and the natural sounding of the chord is controlled by an accordion bar which may also be used to determine the loudness or the intensity envelope of the tone, and further, in which the alternative operation of pedals will cause the sounding of either one of the pedal tones or the chord preselected by the operation of the accordion key button. By illustrating and describing several forms in which this feature of the invention may be embodied, it is believed that it will be clearer to those skilled in the art how this feature of the invention may be adapted and embodied for the control of other musical instruments.

MODIFICATION SHOWN IN FIGS. 22 AND 23

Some of the more fundamental principles of the invention may be incorporated in the quite divergent structures and circuits shown in Figs. 22 and 23. In these figures the tone signals are derived from a photorecord image 1180 mounted for positive rotation on a turntable 1182 driven in a conventional manner by a motor which is not shown. The record 1180 is preferably of a transparent plastic and has pasted beneath it a disk of paper or the like having seventeen different colored concentric circular bands 1183 imprinted thereon so as to be visible through the transparent record. The record above each of these bands has recorded thereon tone signals representative of seventeen different chords, for example the chords F, C, G, D7, Dm, Am, E7, A7, G7, Am, Cm, Fm, Em, G, G7, C7, and C. These tone signals are derived from the discs in such a way that each tone consists of a portion of the note with the same pitch as that on the record plus a portion of a higher pitch note which is produced by the synchronized operation of the triodes 1184 and 1185 connected to the grids of triodes 1182 and 1183.

The record may be made from any suitable musical instrument such as an organ, accordion or orchestral instruments capable of producing full rich chords. In addition to the recording of the chords there are recorded upon these different sound tracks two different carrier frequencies, such as 5,500 and 6,500 C. F. S, which are respectively amplitude modulated by the appropriate bass or pedal root tone signal and the bass or pedal fifth tone signal.

The record is covered by a suitable casing or housing 1184 which is preferably hinged so that it may be raised for replacement of a different record, and is provided with an open window 1185 through which the needle 1186 of a crystal pickup element 1190 (Fig. 23) may project. The crystal pickup 1190 is mounted for limited pivotal movement at the end of a tone arm 1192, the pivot 1194 being so located that the crystal will assume the position shown in Fig. 23 due to the action of gravity. A switch contact arm 1196 is secured to the pickup element 1190 and is adapted to co-operate with a switch arm 1197 suitably fixed to the tone arm 1192.

One of the terminals of the pickup 1190 is connected to ground by conductor 1198 while the other terminal has conductor 1199 connected thereto. The switch arm 1197 has a conductor 1200 connected thereto. The tone arm 1192 is provided with the customary mounting 1202 on the casing 1184 so as to permit it to swing through an arc and also to be swung upwardly so as to raise the needle 1186 from the record 1180.

The signal produced by the pickup 1190 is impressed upon the input of an amplifier 1204, the output of which is coupled to a transformer 1206. The output of the amplifier 1204 is available at the input of a pair of control triodes 1208 and 1209, the signal being impressed upon the grids of these triodes in push-pull. The center tap 1210 of the secondary of transformer 1206 is connected through a resistor R1212 to a negative cut-off bias terminal indicated as a terminal C and is connected to the input of a control triode 1209 through R1214. The center tap 1210 is also connected to ground through a capacitor C1215. The cathodes of triodes 1208 and 1209 are connected together and are connected to ground through a common self-bias resistor R1218.
The plates of triodes 208, 209 are connected to the end terminals of a primary winding 220 of a transformer 221, the center tap of the primary winding being connected to a suitable source of plate current indicated as a B+ terminal. The secondary 222 of transformer 221 has one terminal connected to ground and the other terminal connected to a condenser 224. The signal appearing upon conductor 224 upon the input of a low-pass filter 226 having a high frequency cutoff of 5,000 C.P.S. The output of the filter 226 is supplied to a polarity reverser 228 (which may comprise a single triode or a transformer) which upon closure of a switch 1250 in its output circuit will cause a signal to be impressed through a decoupling resistor R1235 and a condenser 224 across a coupling and load resistor R1236 which is in series with a variable resistor R1238, the latter serving as a variable volume control. A signal appearing across R1236 in series with R1238 is impressed upon the input of a power amplifier 1240, and the amplified signal is supplied to a speaker 1242.

The output signal from the filter 226, in addition to passing through the polarity reverser 228, is impressed upon a chord control tube 1244, which is similar to the control tube 148 (Fig. 1e) previously described and which is normally biased beyond cutoff by having its grid connected to a C- terminal. The bias on the tube may be changed so as to cause the transmission of the signal through the tube by operation of a chord control button 1240 which, upon operation, closes a switch 1240 and thereby removes the cutoff bias on the control tube in a manner similar to that previously described with reference to the control tube 148 of Fig. 1e. The output signal from the chord control tube is combined with the signal output of the polarity reverser 228 (assuming the switch 1230 is closed) so that the chords may be accentuated by the operation of the control button 1246. If desired, the instrument may be played with the switch 1230 open, in which event the chords will sound only upon operation of the control button 1246.

The signal appearing upon the conductor 1224 is also impressed upon a decoupling and tuned filtering mesh comprising resistors R1250 and R1251 in series and inductance L1252 and capacitor C1254 in shunt. This filtering mesh is tuned to be resonant at one of the carrier frequencies, that is, in the example given above, 5,500 C.P.S. The output of this filtering mesh is demodulated by a rectifier diode 1256 and the demodulated signal, which is of the root frequency of the chord, is supplied through a decoupling resistor R1259 to a switch 1260 controlled by the root control button 1262, and is impressed upon the input of a low pass filter 1264 through a conductor 1266. The low pass filter may have a frequency cutoff at about 500 C.P.S. so as to prevent the transmission of any of the carrier frequencies.

Similarly the signal appearing on conductor 1224 is also supplied to a decoupling and resonant filtering mesh comprising R1266, R1269, L1270, and C1271, and is demodulated by a rectifier diode 1272, the demodulated signal being supplied through a decoupling resistor R1273 to a switch 1274 operated by a control button 1275 for the bass or pedal fifth. The input filtering mesh for the diode 1272 is tuned to be resonant at the assumed carrier frequency of 6,500 C.P.S. for the pedal fifth. The switches 1260 and 1274 may be of the same construction as the switches 569, 590, 592 of Fig. 1d. The control buttons 1262 and 1275, in addition to operating these switches, are arranged to operate switches 1216 and 1277, which correspond to switches 563 and 637 of Fig. 1d, and are adapted to render the pedal control tube 1278 conductive of the signal by connecting its grid to ground and thus removing the negative bias provided by the connection of the grid to the C- terminal 1224.

The signals passing through the filter 1264 are impressed upon the grid of the control tube in the manner previously described, and the output of the control tube is impressed across volume balancing resistors R1280 and R1281. R1280 may be in the form of a potentiometer having a sliding contactor connected to the conductor 1234.

To play the instrument shown in Figs. 22 and 23 it is necessary for the player merely to place the pickup needle 1188 on the record 1180 on the particular band 1183 upon which the desired chord is recorded. Noises or transients incidental to placing the needle on the record and removing it thence are prevented from being transmitted to the output system of the instrument by the switch 1186, 1197 which renders the control tubes 1208, 1209 conductive of the signal only after the needle has been placed in a record groove, and also operates to render these control tubes non-conductive and removed from the record groove. In addition to selecting the desired chord by placing the needle 1188 on the recording of a selected chord, the player may depress control button 1246 to provide accent and may depress either the button 1262 or 1275, depending upon whether the root or fifth bass tone is desired. The signals of the tone comprising the chord and the selected root or fifth bass tone are thus supplied to the amplifier 1240 and speaker 1242.

If it is desired that the chord be sounded softly immediately upon closure of the switch 1186, 1197, the switch 1230 is closed, thus making the operation of the chord control button 1246 effective to provide emphasis of the chord when desired. Since the chord control tube causes reversal of the polarity of the signal it is necessary to provide the polarity reverser 1228 so that the output amplifier 1240, operating the control tubes and the polarity reverser will be of the same polarity.

It will be clear from the foregoing that the instrument in Figs. 22 and 23 includes a single instrumentality for selecting the chord to be sounded as well as preselecting the root or fifth bass frequency which are to be sounded depending upon which of the control buttons 1262 or 1275 is operated. Since there is no appreciable limit to the complexity of the tone signals recorded on the record 1180 it will be apparent that the musical output of the instrument may be of any desired quality. Furthermore the instrument may be provided with a number of records 1180 which are similar to each other except for the quality of the recorded tones so as to provide musically desirable variation in registration.

MODIFICATION OFFIGS. 24, 25, AND 26

Many of the novel features of the invention may be incorporated in an instrument which may be played somewhat in the manner of playing a conventional accordion, that is, by playing melody notes on a keyboard, playing the accompanying chords on a button keyboard, and playing the bass notes by depressing a second button of the button keyboard. While, in general, an instrument of this type is more difficult for an ama-
The versatility of instruments embodying various forms of the invention hereof described may apply to be somewhat limited to the professional skilled accordionist. While these instruments are admirably suited to the amateur, the professional accordionist may consider the instruments incomplete since they do not enable him to play bass melodies. In the usual "120 Bass" accordion, it is possible to play any of the bass notes independently while holding down any single chord button. The modified form of the invention shown in Figs. 24, 25, and 26 has a button keyboard which includes two rows of bass buttons as in the standard accordion. This instrument is designed, not only to make it easy for the beginner to learn to play as in the previous modifications, but also, has further possibilities for playing melodic and other contrapuntal effects in the bass section. The button keyboard of the instrument may take the usual "120 Bass" invention form. A control is provided which may be optionally set to either of two positions. In one position the instrument performs in substantially the same manner as the standard "120 Bass" accordion. In another position the control the single row of bass buttons operate in a manner corresponding to the operation of root and fifth pedals 40, 42 or other auxiliary root and fifth controls, described in the above disclosed embodiments of the invention. Moreover, whenever a chord button is depressed, the bass button in the same vertical file is conditioned to play the root bass note with the decay intensity envelope and pitch retaining functions as did the root pedal 40 in the preceding embodiments. The bass button in the file next to the right of that of the depressed chord button functions to play the fifth of the depressed, as did the fifth pedal 42, or other fifth selecting control in the previously described embodiments. For all the chords the root bass will play the same note as it does in the standard accordion but the button to the right may or may not play the same note as it does in the standard accordion. For those chords in which the fifth is related to the root by the interval of a perfect fifth the bass note played will be the same as in the standard accordion. However, when the interval is a diminished or augmented fifth, the note will be correspondingly lowered or raised one semitone from the pitch which is normally played in the standard accordion. Thus the instrument now to be described in detail combines the advantages of the pre-selected bass root and fifth with the independent type of bass tone selection for the more advanced player.

The modification of Figs. 24 to 26 is of the last-mentioned type and preferably comprises twelve oscillators 1310 to 1321 inclusive, the outputs of which are connected by decoupling resistors R1334 to four switches chosen from each group P2 to P7, Q2 to Q7, and R2 to R7, and are supplied to the grid of triodes, these switches being operable to connect the output of the oscillators respectively to conductors 1330, 1331, 1332, and 1333. The conductor 1333 corresponds to the conductor 561 (Fig. 12) and the signals required for the production of the chord, since the oscillators 1310 to 1321 are within the pitch range of F2, F46 to E5, 229.63 C. P. S. The chord signals appearing on the conductor 1333 are supplied to the accordion control tube 148 upon operation of the accordion bar 56 in the manner previously described with reference to the operation of these parts as disclosed in Fig. 1c. The output of the control tube 148 is connected to the power amplifier 129 through a decoupling resistor R1334.

If it is desired that the chord be sounded without the necessity of operating the accordion bar 56, the accordion sustain control 72 is operated to close the switch 150, thereby supplying the signal through a preamplifier 1335 to the decoupling resistor R1334.

The instrument preferably includes a keyboard or solo melody section (of the type shown in Figs. 1 to 11) represented by the block 1340, the output of which is supplied to the power amplifier 129 through an adjustable resistor R1342 for balancing the output of the solo keyboard section with the other sections.

The key buttons 54 shown in Fig. 25 are arranged in the conventional manner of a "120 Bass" accordion having buttons for the major, minor, 7th, and diminished 7th chords, and above these, two rows of buttons for the counterbass and bass accompaniment. (The row of bass buttons has one extra button at its right hand end.) As in the previously described embodiment shown in Figs. 1 to 11, each of the chord buttons is arranged to operate a key lever 1344 (Fig. 26) which is provided with suitable projections 1346 for the operation of certain combinations of switches 19 to 1E, 2F to 2E, 3F to 3E, and 4F to 4E, as well as one or more of three switches 1350, 1351, and 1352.

The conductor 1330 is adapted, upon closing any of the switches 19 to 1E, to supply a signal corresponding to the root of the selected chord to a two stage frequency divider 1354 through a switch 1355 and a decoupling capacitor C1356. The switch 1355 is operable by a suitable stop tablet 1358 which likewise operates a switch 1359. When both of these switches are in their full line positions the cut-off bias on the control tube 156 is removed (by grounding the control grid through switch 1559) and the signal is transmitted through an adjustable volume control 158 to the input of the power amplifier 129.

Thus with the switches 1355 and 1359 in their full line positions, depression of a chord key button will cause signals from such of the oscillators 1310 to 1321 as are required for the production of the chord to be transmitted through conductor 129 to the output system, under the control to the accordion bar 56 and the accordion sustain control 72. In addition, a signal corresponding to the root of the chord selected is impressed upon the two stage frequency divider 1354, and the latter supplies to the output system an octave coupled signal two octaves and one octave lower than the root of the selected chord.

Additional means are provided to enable an amateur to play the instrument more easily and to provide long decay intensity envelopes on the bass and counterbass notes. This means includes the conductors 1331 and 1332 to impressed signals of pitch corresponding to the fifth and root of the selected chord by closure of one of the switches 2F and 2E and one of the switches 3F to 3E. The signals on conductors 1331 and 1332 are impressed upon the control grids of high gain triodes 1360 and 1361 through blocking capacitors C1362 and C1363 respectively. The plates of these triodes are connected to a B+ terminal through a common load resistor R1364. The cathode of triode 1360 is connected
to a +40 v. terminal through R1366, while the grid of this triode is connected to the +40 v. terminal by a grid return resistor R1370. In a similar manner the cathode of triode 1351 is connected to the +40 v. terminal through self-bias resistor R1367, while its grid is connected to earth +40 v. terminal by a grid return resistor R1371. The grids of triodes of triode divider are successively connected to the cathodes of triggering triodes 1372 and 1373, and the plates of the latter are connected to a B+ terminal through R1374 and R1375. The grids of triodes 1372 and 1373 are connected to ground through grid resistors R1365. The plate of triode 1372 is cross-connected to the grid of triode 1373 through a resistor R1378 while the plate of the triode 1373 is cross-connected with the grid of triode 1372 through R1379. The grid of triode 1372 is adapted to be connected to a B+ terminal through a high value resistor R1350 upon closure of switch 1350, while the grid of triode 1373 may be connected to the B+ of the cathode through a similar high value resistor R1351 upon closure of the switch 1351.

Each of the key levers 1344 which is located beneath the bass buttons is provided with a projection such as 1345 for the operation of either switch 1350 or 1351 or 1352 or 1354 or 1362 through a suitable high value resistor R1349 upon closure of the switch 1349. When a button is depressed such as, for example, the button for the bass note F, the B+ voltage will be impressed upon the grid of triode 1372 by closing switch 1350 rendering the latter conducting so that the potential on its cathode, and hence on the cathode or triode 1360, will be raised sufficiently to cut off triode 1360. At the same time the voltage on the plate of triode 1372, and hence on the grid of triode 1372, will drop, and triode 1372 will be rendered non-conducting. Its cathode and the cathode of triode 1361 will have their potential sufficiently lowered to cut off triode 1363. Thus control triode 1361 remains in a conducting condition with R1361 supplying a suitable self-bias voltage. The signal of pitch F impressed upon conductor 1332 will therefore be transmitted through the triode 1351, switch 1355 (then in its dotted line position) and capacitor C1356 to the frequency divider 1354.

Since switch 1355 is open under these circumstances, it is necessary to close switch 1352 to render the control tube 1356 conductive, and this is accomplished by providing a projection 1345 above switch 1352 upon the key lever 1344 operated by the F key button 54.

If instead of desiring to play the note corresponding to the root of the chord (assuming that one of the F chord is depressed) the player wishes to play the fifth, this may be accomplished by depressing the button 54 marked C in the second row of buttons. (If the chord button depressed was the diminished 7th, i. e. F-, the bass note sounded would be B.) The key lever 1346 operated by C bass button will have projections such as 1346 to operate the switch 1351 and the switch 1352 so that a positive potential will be impressed upon the grid of triode 1373, whereupon the latter will be rendered conductive and thereby raise the potential on the cathode of triode 1351 sufficiently to cut off the latter. At the same time the potential on the grid of triode 1372 will be lowered to cut off this tube and thereby render the triode 1350 capable of transmitting the signal impressed on conductor 1331 to the frequency divider 1354. Since switch 1352 will also be closed the signal will be transmitted to the output system through the bass control tube 156.

After release of any of the second row buttons the conducting or non-conducting condition of triodes 1351 and 1361 are restored because of the resistive cross-connection of the grids and plates of triodes 1372 and 1373, and bass note will continue to sound with slow decay, provided one of the F chord buttons is held depressed.

From a consideration of the diagram Fig. 10 and the description thereof, those skilled in the art will be able readily to provide the key levers 1344 with the proper combinations of projections 1345 for the operation of the various switches. It is well to note, however, that the key levers 1344 operated by the bass buttons alternately are provided with projections for operating either switch 1350 or 1351 and that all of the bass buttons additionally operate the switch 1352. The key levers 1344 for the counterbass buttons 54 are provided with only one projection 1345 to cause a signal of pitch corresponding to the button designation to be impressed upon each of the switches. The button in the bass row will be arranged so that alternate buttons in this row will operate the switch 1350, while the remaining buttons will operate the switch 1351. For example, the button for the bass note F, that is the diminished chord, has projections on it to operate switches 54F, 54A, 54B, and 54D to impress signals corresponding to the four notes of this chord (F, A, B, and D) on the conductor 1333. In addition, this key lever would have a projection 1346 to operate switch 25P thereby to impress a signal corresponding to the root of the chord on conductor 1331 and would also have a projection to operate the switch 35B which would impress a signal of the pitch B, that is the fifth (diminished) of the chord upon conductor 1332. If, while holding the F- button 54 depressed (assuming that switches 1355 and 1356 are in their dotted line positions) the player depresses the F bass button he will, through a suitable projection 1345 on the lever 1344 operated by this button, close switch 1351, thus rendering triode 1350 conductive, so that the signal of F pitch (the root of the chord) would be impressed on the frequency divider 1354 to determine the frequency of its output. On the other hand, assume that the tablet 1358 has been operated to move the switches 1355 and 1359 to dotted line position, and that the player, while holding the F- button depressed, depresses the bass button C. The lever 1344 which already has the projection 1346 above the switch 1350, and by closing this switch, as previously described, renders the triode 1351 conductive of the signal corresponding to the fifth (diminished) element of the chord, which is the note B, and this signal will thus control the frequency divider 1354.

If after the preceding operation of the buttons the player depresses the C- key button 54 he will through the projections on the key lever operated by the C- button close switches 4C, 4E3, 4F3, and 4G4 and will in addition close switches 3C and 2F3. Therefore, if while holding the C- button depressed, the player depresses the C bass button he will again close switch 1350 but the
signal on the conductor 1331 will be the signal conducted through the then closed switch 3C, and conducting or the filter tone oscillator through the switch 354. On the other hand, should be, while still holding the C—button depressed, press the G bass button the signal of F9 pitch would be impressed on conductor 1331 and switch 1350 would be closed so as to render the triode 1360 capable of generating a frequency divider to control the pitch of the bass note produced thereby.

In playing the modified form of the instrument shown in Figs. 24, 25, and 26 the professional accordionist will normally operate the stop tablet 1388 to move the switches 1388 and 1389 to their full line positions. He will then be able to operate the chord bass and counterbass buttons 54 in the chord bass and counterbass buttons 54 in the same manner as in playing the accordion, and with equivalent musical results. The amateur will usually prefer to operate the tablet 1388 so that the switches 1388 and 1389 are in their dotted line positions. Under these conditions the musician will depress the chord buttons in the usual manner and when he desires the production of the root bass tone will depress the bass button in the same file as the depressed chord button, while if he desires the fifth bass tone he will depress the bass button in the file immediately to the right of the file which includes the depressed chord button. There will be an additional button at the extreme right end of the bass row of buttons which will be used solely for the production of the fifth bass tone of the chord selected by the right-most file of chord buttons. Thus the player may very easily, while holding a chord button depressed, alternately sound the root bass and the fifth bass of the selected chord by alternately depressing the bass button in the file of the selected chord button and the bass button immediately to the right thereof.

It will thus be apparent that the bass buttons may be used not only to perform functions corresponding to those of the bass buttons of an accordion, but may also be used by the amateur to take the place of the bass pedals 40 and 42 of the embodiment shown in Figs. 1 to 11.

In some of the claims the terms “octave related” and “suboctave” are employed with reference to the pitches of the bass tones. These terms are intended to mean that the bass tones are one, two or even three octaves below the corresponding tones in the accompaniment chords.

As previously indicated, a number of novel features of the invention disclosed herein are disclosed and claimed in copending applications. These may be summarized as follows. The particular circuit arrangement of organ and accordion oscillators, L. Hammond application Serial No. 96,107 filed May 28, 1949; the over-all volume control, J. M. Hanert application Serial No. 141,092 filed February 1, 1960; the solo generating system, J. M. Hanert application Serial No. 51,400 filed September 27, 1948; the tone quality controls used in the solo and pedal bass tone signal generating system, J. M. Hanert applications Serial No. 11,453 filed February 27, 1948, and Serial No. 87,913 filed April 16, 1948; the vibrato oscillator and tube, J. M. Hanert application Serial No. 11,743 filed August 23, 1949; the opposite-polarized vibrato signals on the chord oscillators and on the organ oscillators, John M. Hanert application Serial No. 225,376, filed April 27, 1951; the modification in which the signals are obtained from phonographic recordings (Figs. 22 and 29) is not claimed herein; and the mechanical features of the key button keyboard and its switch operating mechanism, L. Hammond Serial No. 169,992 filed November 20, 1960.

While I have shown and described particular embodiments of my invention, it will be apparent to those skilled in the art that numerous modifications and variations may be made in the form and construction thereof, without departing from the spirit and scope of the invention. I therefore desire, by the following claims, to include within the scope of my invention any such similar and modified forms of the apparatus disclosed, by which substantially the results of the invention may be obtained by substantially the same or equivalent means.

I claim:

1. In a musical instrument having means for producing musical tones throughout the accompaniment chord and bass registers, a control for selecting tones of a chord to be sounded and at the same time tentatively selecting tones in the bass register to be sounded which are suboctave related to the root and the fifth of the selected chord, and additional means to determine whether the one of said tones in the bass register which is to be sounded shall be octavely related to the root or to the fifth of the selected chord.

2. In an electrical musical instrument having generators for producing the tones of at least an octave of the musical scale and having an output system; a keyboard of the accordion chord button type; means controlled by the keyboard for causing transmission to the output system of the signals produced by a plurality of the generators of musical chord related pitches, an electrical bass generating system comprising a plurality of octavely related variable frequency generators, means to impress a frequency from the chord tone generators upon the bass tone generating system thereby to determine the frequencies of operation thereof, and additional means to control the transmission to the output system of signals produced by the bass tone generating system.

3. The combination set forth in claim 2 in which means are provided under the control of the accordion button type keyboard to transmit signals corresponding in pitch respectively to the root and the fifth of the selected chord, and in which pedal operated means are provided to select which of these two signals shall be effective to control the frequency of operation of the bass tone generating system.

4. The combination set forth in claim 3 in which the pedal operated means also controls the transmission to the output system of the frequencies generated by the bass tone generating system.

5. In an instrument of the accordion type, the combination of an electrical melody section; an electrical polyphonic section; a keyboard common to said sections; a chord playing section; an accordion type button keyboard for selecting accompanying chords to be played by the chord playing section; means operated by the player to cause the sounding of the selected chord; an accompanying bass tone producing instrumentality; means controlled by the button keyboard for conditioning said instrumentality for the production of bass tone of either one of two pitches; and pedal-operated means for determining which of the two bass tones shall be sounded.

6. In an electrical musical instrument having an output system, the combination of an accordion type keyboard comprising a plurality of
key buttons, a plurality of sources of electrical musical tone frequency signals, means operated by the key buttons respectively to couple to the output system a plurality of said sources producing tone signals of pitch corresponding to the root and fifth of the chords selected by the key buttons, and a control selectively operative by the player to cause the root or the fifth signal to determine the pitch of the bass tone signal generating apparatus and to cause the latter signal to be transmitted to the output system.

7. In an electrical musical instrument having a keyboard and an output system including electroacoustical translating means, a plurality of means for producing electrical tone signals corresponding to the notes of musical chords and to the bass notes related to pitch in the root and fifth of the chords, manually operated means for causing the last mentioned means to transmit to the output system signals corresponding to the notes of selected chord and to cause transmission to the output system of an electrical tone signal of the selected pitch.

8. In an electrical musical instrument having an output system including electroacoustical translating means, the combination of an electrical solo tone signal generating system; an electrical organ tone signal generating system; an electrical chord tone signal generating system; an electrical bass tone signal generating system; a pianoforte type keyboard having a plurality of keys operable to tune the solo tone signal generating system and to cause transmission from their respective generating systems to the output system of solo tone signals and organ tone signals; an accordion type button keyboard having a plurality of key buttons; means operable by the key buttons to cause the chord tone signal generating system to provide tone signals of pitch corresponding to the notes of selected chords; optionally operable means to cause transmission to the output system of the tone signals provided by the chord signal generating system at a relatively low amplitude; additional means operable at will to cause the signals provided by the chord signal generating system to be transmitted to the output system at a relatively high amplitude; further means operated by the key buttons to cause transmission to the output system of the bass tone signal generating system of tone signals corresponding to the root and fifth of the selected chord, for pitch control of the bass tone signal generating system; means operable at will for determining whether the chord root or fifth shall determine the pitch of the tone signal produced by the bass tone signal generating system and to cause transmission to the output system of the signal generated by the bass tone signal generating system; and means forming part of the output system to control the over-all amplitude of the signals transmitted and translated into sound thereby.

9. An electrical musical instrument having an output system including electroacoustical translating means, comprising an electrical solo signal generating system, a polyphonic electrical organ tone signal generating system, an electrical accompaniment chord tone generating system, a plurality of tone producing apparatus coupled to all of said generating systems to introduce a vibrato effect in the signals produced thereby, an electrical bass tone signal generating system, a pianoforte keyboard to select the tone signals from the solo and the polyphonic organ tone signal generating systems and to cause them to be transmitted to the output system and to determine the pitches of the signals to be supplied by the bass tone signal generating system, and a control operable at will by the player to select which of the pitches determined by the button keyboard shall cause the oscillators to Supply simultaneously to the output system Signals. Corresponding in pitch to the note of a plurality of concurrently operated keys; a polyphonic tone signal generating system including a plurality of generators, each capable of supplying tone signals of less than four adjacent semitone pitches; and means controlled by the keys of the keyboard to cause transmission to the output system of a musical tone signal produced by the solo generating system of pitch corresponding to the lowest of the several semitone pitches which are called for by concurrently depressed keys and which each of the generators is capable of supplying, each key operating to control the production both of a solo tone and one of the polyphonic tones.

10. In an electrical musical instrument having a keyboard and an output system including electroacoustical translating means; the combination of a solo tone signal generating system; means controlled by the keys of the keyboard to cause transmission to the output system of a musical tone signal produced by the solo generating system of pitch corresponding to the lowest of the several semitone pitches which are called for by concurrently depressed keys and which each of the generators is capable of supplying, each key operating to control the production both of a solo tone and one of the polyphonic tones.

11. In an electrical musical instrument having a keyboard and an output system including electroacoustical translating means; the combination of a solo tone generating system; means controlled by the keys of the keyboard to cause transmission to the output system of a musical tone signal produced by the solo generating system of pitch corresponding to the highest of a plurality of keys operated at the same time; a polyphonic tone signal generating system including a plurality of generators individually capable of supplying tone signals of a selectable number of adjacent semitone pitches; pitch selecting means controlled by the keys to cause said generators individually to supply to the output system electrical tone signals of pitch corresponding to the lowest of said plurality of semitone pitches simultaneously called for by depressed keys, each key operating to control the production both of a solo tone and one of the polyphonic tones.

12. In an electrical musical instrument, the combination of an output system having an amplifier including a terminal whose potential with respect to earth determines its gain; a plurality of oscillators operable to supply electrical tone signals at the semitone intervals throughout the range of an octave; a pair of collector conductors; manually operable switch means for causing the oscillators to supply simultaneously to the output system signals corresponding in pitch to the note of a
musical accompaniment chord and for causing the oscillators to supply tone signals of pitches corresponding to the root and fifth of a selected chord to said conductors respectively; a frequency divider system generating an electrical musical tone signal the fundamental of which is a submultiple of a frequency impressed upon the input of the divider system; means for selectively coupling one of said conductors to the input of said divider system; means for coupling the output of the divider system to the output system; and means, operated incidentally to the operation of the means for selectively coupling one of the conductors to the output of the divider system, to change the potential on said terminal gradually to cause the signal from the divider system to be transmitted with a predetermined intensity envelope.

13. An electrical musical instrument for the production of popular music including the major, minor, 7th, and diminished chords, a root bass tone, and a solo or melody tone comprising: an output system including electroacoustic translating means; a solo oscillator having means for tuning it throughout the melody range of popular music and having its output coupled to the input of the output system; a keyboard having keys for controlling the tuning means; more than three and less than seven oscillators for generating the tone signals required for the production of accompaniment chords, each of the latter oscillators having means to tune it to any one of less than four different semitone pitches; a frequency divider for producing root bass tone signals; means to couple the output of the frequency divider to the output system; an accordion type keyboard having key buttons for controlling said last named tuning means; means operable by the key buttons to control the transmission to the output system of the tone signals produced by at least three of the chord oscillators and to cause the transmission to the frequency divider of the signal produced by one of the chord oscillators, and an additional means to control the transmission of the frequency divider to the output system.

14. An electrical musical instrument having an output system including electroacoustic translating means comprising an electrical solo tone signal generating system, an electrical accompaniment chord tone signal generating system, an electrical bass tone signal generating system, a keyboard to select the signals from the solo tone signal generating system and to cause them to be transmitted to the output system, an accordion type button keyboard operable to select the chord tone signals to be transmitted to the output system and to select two signals of different frequencies for determining the pitches of the signals to be supplied by the bass tone signal generating system, and a control operable at will by the player to select which of the two signals selected by the button keyboard shall control the pitch of the signal produced by the electrical bass tone signal generating system and to cause the selected tone signal to be transmitted to the output system.

15. In an electrical musical instrument having an output system; the combination of only six electron discharge tube oscillators normally operating at musical pitch frequencies corresponding to the full-tone intervals of an octave of the tempered musical scale; a plurality of keys corresponding to various chords of the different musical keys; a plurality of switches operable by each of the keys; there being for each key at least three circuits, respectively including only one of the switches operated by the key, to connect the outputs of at least three of the oscillators to the output system; only six circuits controlled respectively by the six of the keys operating switches to tune the six oscillators to pitches which differ from the pitches at which they normally operate by one semitone interval, each of the keys operating one of the switches connecting the outputs of at least three oscillators to the output system, and six of the keys in addition simultaneously operating one of the switches in one of the tuning circuits.

16. The combination set forth in claim 33 in which there is a pedal bass tone generating system, and in which there are additional circuits completed by the key operated switches connected to the outputs of the oscillators supplying the root and the fifth of the chord respectively for supplying frequency indicating signals to the pedal bass tone generating system.

17. In an electrical musical instrument, the combination of twelve normally ineffective sources of electrical musical tone signals of pitches respectively corresponding to the semitones of an octave in use and having a common output conductor; decoupling means for connecting said conductor to all of said sources; a plurality of chord selecting key buttons arranged in files determining the musical key of the chord and in rows determining the character of the chord; a plurality of switches operable by each of said key buttons, circuits respectively including said switches for rendering certain of said sources effective to supply to said common output conductor tone signals forming a musical chord; an electrical bass tone signal generating system; circuits including some of said key button operated switches for transmitting signals corresponding to the root and fifth of the selected chord to the bass tone signal generating system; and additional control means to determine whether the root or fifth signal shall control the pitch of the signals produced by the bass tone signal generating system.

18. An electrical musical instrument to provide accompaniment chords for a piano comprising a casing, an accordion type button keyboard mounted on the casing, means to secure the casing to a piano with the button keyboard directly in front of the piano keyboard and at a level slightly beneath the level of the tops of the piano keys, a plurality of electrical signal generators connected electrically to the keyboard and capable of providing tone signals throughout the range of at least an octave in the accompaniment register, an output system including electroacoustic translating means, a housing including the generators and output system, a pair of pedals extending from the bottom of the housing to a position beneath the piano keyboard, a bass tone electrical signal generating system, means operated by the keys of the button keyboard to select and to transmit to the output system the tone signals of a chord to be sounded and a pair of pitch controlling signals for transmission to the bass tone signal generating system, and means operated by the pedals to determine which of the two bass tone pitch controlling signals shall be effective and to cause transmission to the output system of the electrical signal produced by the bass tone signal generating system.
55 signals; individual filtering meshes respectively coupled to the outputs of said generators for greatly pre-emphasizing the higher frequency components of the signals generated thereby; a signal transmission channel; switching means individual to each of the generators for coupling the outputs thereof to the signal transmission channel; an output system including electro-acoustic translating means; and a means for coupling the output of the transmission channel to the output system including a filtering mesh substantially attenuating the higher frequencies present in the tone signals supplied through the transmission channel, thereby to attenuate switching transients caused by operation of the switching means.

20. In an electrical musical instrument of the accordion type, the combination of twelve continuously operating sources of electrical musical tone signals pitched to correspond with the notes of the chromatic musical scale; an output system; a plurality of chord control buttons for the major, minor and seventh chords operable individually to couple predetermined combinations of the sources with the output system for producing complete musical chords; a bass collector system comprising a plurality of bass control buttons operable individually to couple one of the sources of said predetermined combinations of sources with the bass collector conductor; and a plurality of cascaded frequency divider stages for coupling the collector conductor with the output system for producing an accompaniment tone in a low frequency bass register.

21. In a musical instrument having means for producing musical tones throughout accompaniment chord and bass registers, a single control for selecting tones of a chord to be sounded and at the same time tentatively selecting a tone in the bass register to be sounded which is sub-octavely related to the root of the selected chord, and an additional means to determine whether the tone in the bass register is to be sounded.

22. An electrical musical instrument having a plurality of chord tone controlling elements for determining the musical key and type of chord to be sounded and whether the chord is in root position or an inversion thereof; means also operated by the chord controlling elements to determine the pitch of a bass tone octavely related to the root element of the chord; additional means operated by the chord controlling elements to determine the pitch of a bass tone octavely related to the fifth element of the chord; means to select which of said last two means is to be effective; and an amplitude control element to cause the sounding of the bass tone.

23. In an electrical musical instrument having an output system, the combination of generating means capable of producing electrical musical tone signals of twelve different semitones in at least an octave in the accompaniment range; a plurality of control elements; means operable by each of the control elements to cause the generating means to supply at least three tone signals of pitches corresponding to the root, third, and fifth elements of a chord and a further optionally selectable tone signal; an electrical generating means capable of supplying signals of the pitches of twelve different semitones in at least an octave of the bass range; and optionally operable means effective to cause the selection of said optionally selectable tone signal and to cause the bass tone signal generating means to supply to the output system a signal sub-octavely related to the root of a chord selected by the operation of one of said control elements.

24. In a musical instrument, the combination of generating means capable of producing musical tones of twelve different semitones in at least an octave in the accompaniment range, a plurality of control elements; means operable by each of said control elements to cause the generating means to select at least three tones of pitches corresponding to the root, third, and fifth elements of a chord and a further optionally selectable tone signal; a generating means capable of supplying musical tones of the pitches of twelve different semitones in at least an octave of the bass range; and optionally operable means effective to cause the selection of said optionally selectable tone signal and to cause the bass tone generating means to supply a tone sub-octavely related to the root of a chord selected by the operation of one of said control elements.

25. The combination set forth in claim 1 in which said additional means includes a pair of alternatively effective electrical coupling means, holding means to cause one or the other of the coupling means to remain effective at all times, in which optionally operable self-restoring means are provided for restoring which of the coupling means is to be effective, and in which means are provided to cause continued sounding of the bass tone at progressively decreasing intensity after the self-restoring means has been restored.

26. The combination claim 23, and additional manually operated means operable only on the signals supplied by chord signal generating means to render the output system effective to transmit the chord signals selected by the chord elements.

27. The combination of claim 23, and additional manually operated means operable only on the signals supplied by the chord signal generating means to increase substantially the efficiency of transmission to the output system of the chord signals selected by the control elements.

28. The combination set forth in claim 1 in which said tones are produced pneumatically.

29. The combination set forth in claim 1 in which there is provided a means for causing the chord tones to be selectively sounded at different intensities.

30. The combination set forth in claim 1, in which said controls for selecting tones of a chord are buttons; in which said buttons are arranged in a plurality of files corresponding with pluralities of musical key signatures, and in rows corresponding with the harmonic chord variations; in which an elongated control bar is positioned adjacent the buttons for convenient operation currently with the control buttons; and in which the control bar is operative to vary the intensity at which the chord tones are sounded.

31. The combination set forth in claim 1, in which there is provided a depressible control element so positioned that it may be depressed by one of the player's hands while a finger thereof is operating the control for selecting the tones of a chord to be sounded, and in which means are provided to increase the intensity of the chord tones when the element is depressed.

32. The combination set forth in claim 21 in which the means for producing musical tones throughout the accompaniment chord register
comprises six oscillators each operable at either of two frequencies.

33. In an electrical musical instrument, the combination of twelve normally ineffective sources of electrical musical tone signals of pitches respectively corresponding to the semitones of an octave in the accompaniment range; a common output conductor; decoupling means connecting said conductor to all of said sources; a plurality of chord selecting key buttons arranged in files determining the musical key of the chord and in rows determining the character of the chord; a plurality of switches, each of said key buttons operating at least three of said switches to connect at least three of said sources to the common output conductor; and transposing switches respectively in series with the key button operated switches to alter the selection of the group of three sources which are connected to the output conductor by operation of each of the keys respectively.

34. In an electrical musical instrument for the complete production of popular and homophonic music which includes the major, minor, and seventh chords together with a bass tone as an accompaniment to a solo or melody tone, and having an output system including electro-acoustic translating means; the combination of a monophonic electrical tone signal generator having means for selectively tuning it through a range of at least one octave and having its output coupled to the output system of the instrument; a keyboard of the pianoforte type having a plurality of keys for controlling the tuning means; a plurality of sources capable of supplying electrical musical tone signals of the pitches required for the production of the major, minor, and seventh chords; an accordion type button board having chord buttons; means operable by each of the buttons to cause the trans-

mission of the appropriate tone signals provided by said chord tone signal sources to the output system; an electrical bass tone signal generating system capable of producing electrical musical tone signals throughout a range of at least one octave and of pitch at least one octave lower than the pitch of the corresponding chord tone generator having the same key designation in the chromatic scale; selectively operable means to determine the pitch of the tone signals produced by the bass tone signal generating system; and means for coupling the output of said bass tone signal generating system to the output system of the instrument.

JOHN M. HANERT.

References Cited in the file of this patent

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>520,924</td>
<td>Jackson</td>
<td>June 5, 1894</td>
</tr>
<tr>
<td>1,977,598</td>
<td>Severy</td>
<td>Oct. 16, 1934</td>
</tr>
<tr>
<td>2,162,382</td>
<td>Helm</td>
<td>June 13, 1939</td>
</tr>
<tr>
<td>2,163,096</td>
<td>Kucher</td>
<td>June 20, 1939</td>
</tr>
<tr>
<td>2,166,202</td>
<td>Waters</td>
<td>July 18, 1939</td>
</tr>
<tr>
<td>2,185,932</td>
<td>Skinner</td>
<td>Jan. 2, 1940</td>
</tr>
<tr>
<td>2,266,030</td>
<td>Hammond</td>
<td>Dec. 16, 1941</td>
</tr>
<tr>
<td>2,286,132</td>
<td>Weathers et al.</td>
<td>June 2, 1942</td>
</tr>
<tr>
<td>2,307,829</td>
<td>Hammond</td>
<td>Oct. 6, 1942</td>
</tr>
<tr>
<td>2,332,076</td>
<td>Hammond et al.</td>
<td>Oct. 19, 1943</td>
</tr>
<tr>
<td>2,357,101</td>
<td>Hanert</td>
<td>Aug. 29, 1944</td>
</tr>
<tr>
<td>2,403,090</td>
<td>Larsen</td>
<td>July 2, 1946</td>
</tr>
<tr>
<td>2,458,178</td>
<td>Langer</td>
<td>Jan. 4, 1949</td>
</tr>
<tr>
<td>2,485,751</td>
<td>Larsen</td>
<td>Oct. 25, 1949</td>
</tr>
<tr>
<td>2,505,182</td>
<td>Haller et al.</td>
<td>Apr. 25, 1950</td>
</tr>
<tr>
<td>2,533,461</td>
<td>Illsley</td>
<td>Dec. 13, 1950</td>
</tr>
<tr>
<td>2,539,825</td>
<td>George</td>
<td>Jan. 30, 1951</td>
</tr>
<tr>
<td>2,540,727</td>
<td>Hanert</td>
<td>Feb. 6, 1951</td>
</tr>
<tr>
<td>2,558,040</td>
<td>Jordan</td>
<td>May 29, 1951</td>
</tr>
</tbody>
</table>