Nov. 1, 1966 J. C. COOKERLY ET AL 3,283,056

CONTROLLED HARMONIZATION FOR MUSICAL INSTRUMENTS

Filed Feb. 8, 1962 2 Sheets-Sheet 1

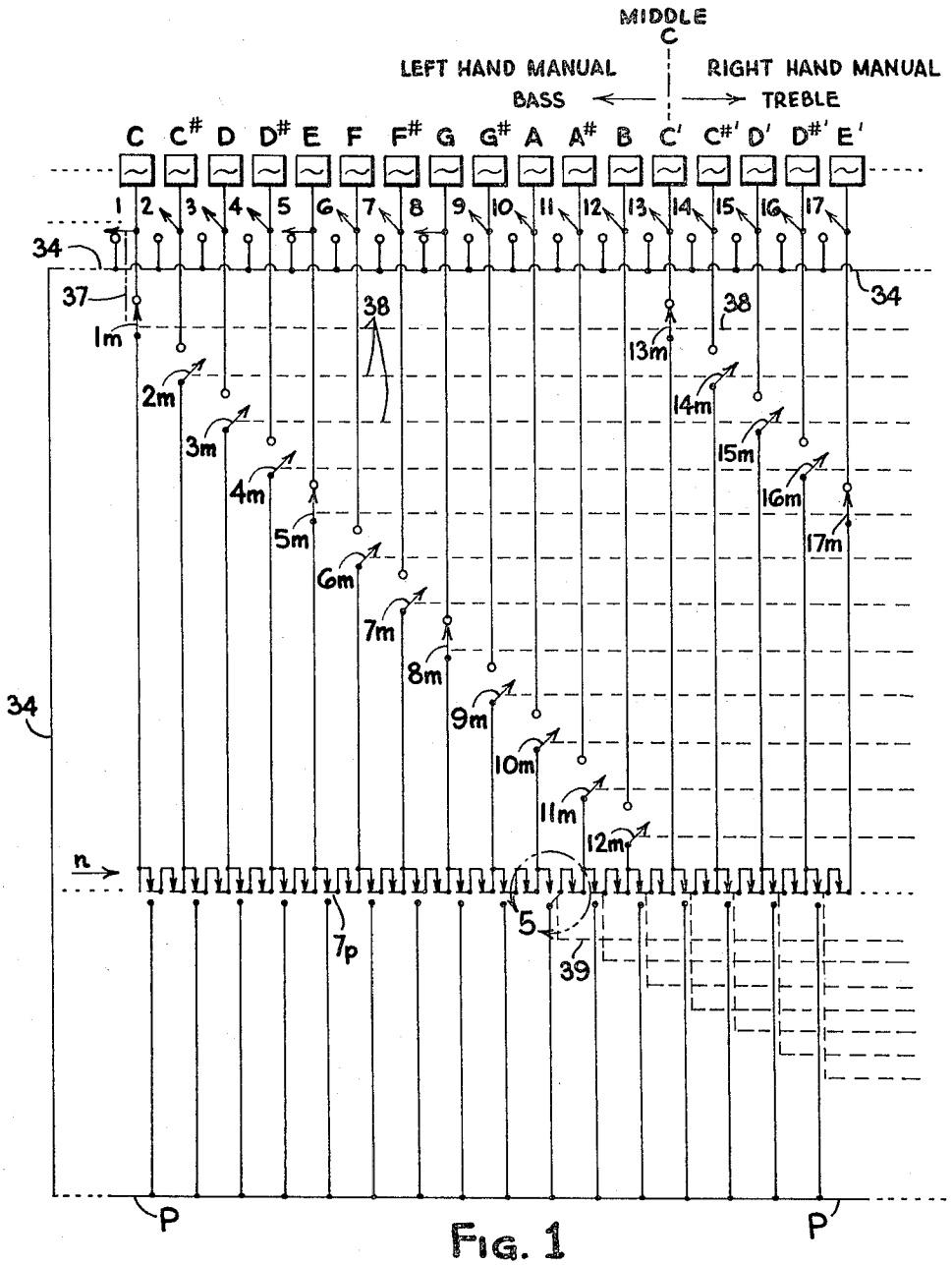


FIG. 1

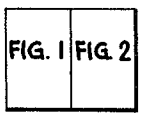


FIG. 3

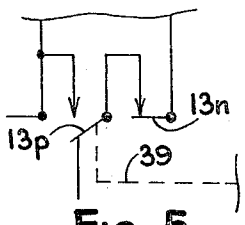


FIG. 5

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2 Sheets-Sheet 2

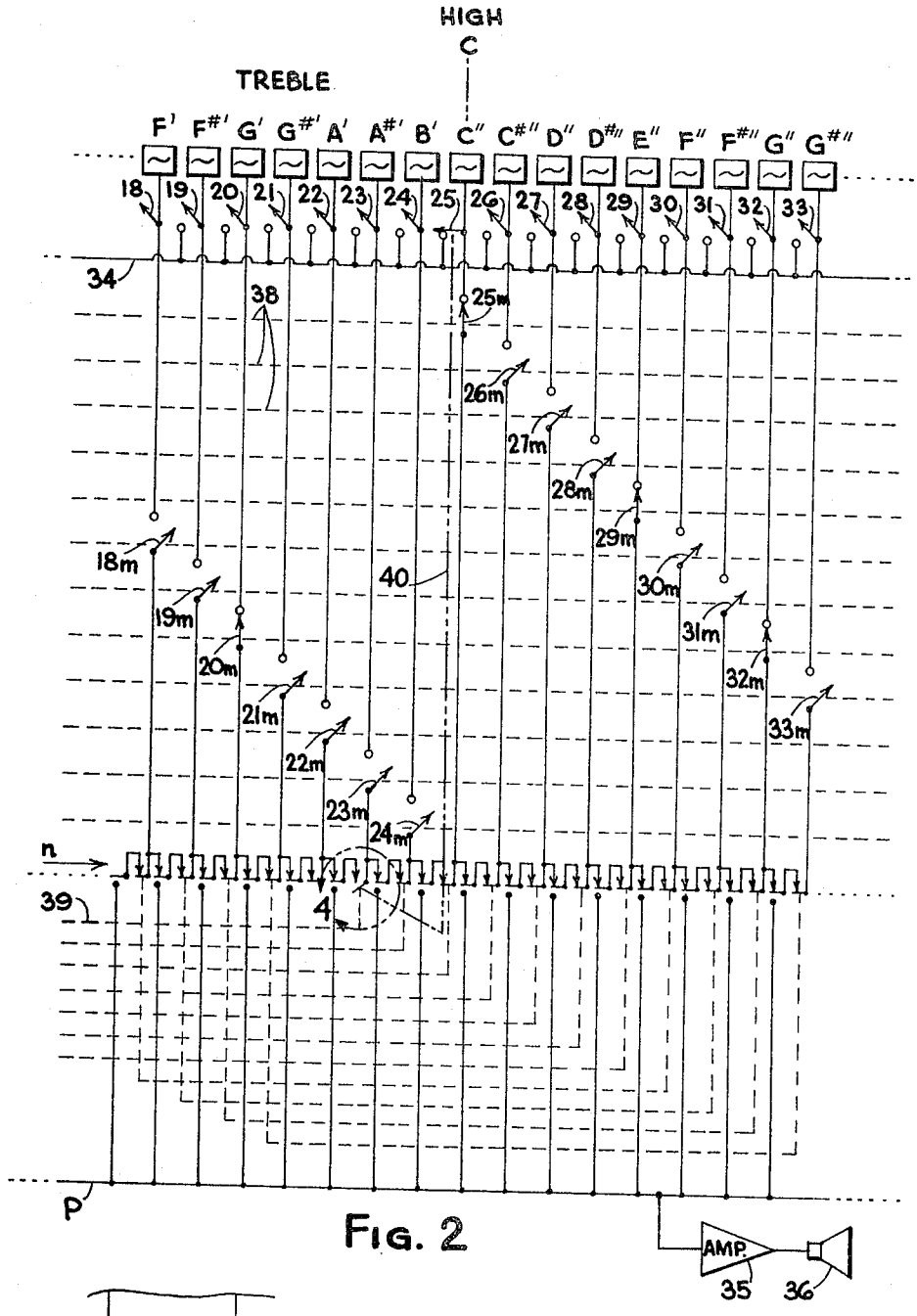


FIG. 2

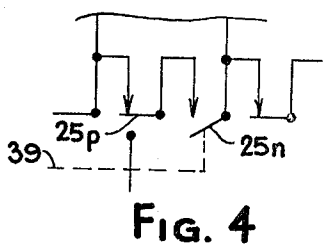


FIG. 4

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CONTROLLED HARMONIZATION FOR MUSICAL INSTRUMENTS

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16 Claims. (Cl. 84—1.01)

This invention relates generally to music and more particularly to a novel means for controlling or filling-in harmonization while playing a musical instrument.

Many musical instruments such as organs, pianos, accordions, and the like include both left and right hand manuals or at least tones or notes including both bass and treble clefs. In playing such an instrument, chords are conventionally formed with the left hand on the left hand portion of the manual or on an actual manual designed for the left hand, and the melody tone or note played with the right hand on the treble portion of the manual or on a separate right hand manual.

The sound resulting from the foregoing can be greatly enhanced if actual chords are played along with the melody tone or note by the right hand. Towards this end, skilled musicians will oftentimes complement the right hand melody note by filling-in or adding further notes corresponding to those played in the chord of the left hand. This technique usually requires a considerable degree of skill, particularly if the melody note changes rapidly over given measures during which the same left hand chord is held.

With the foregoing in mind, it is a primary object of the present invention to provide a novel means for providing filled-in right hand chords as though the same were actually played with the right hand corresponding to the chords played with the left hand simultaneously with the sounding of the melody note, even though the musician depresses only a single note with his right hand, to the end that a fuller musical rendition results.

More particularly, it is an object of this invention to provide an automatic means for effectively "readying" or placing in ready condition a plurality of treble notes corresponding to bass notes sounded in a left hand chord so that the conditioned notes will automatically sound whenever a single melody note to be played with the chord is sounded, all in a completely automatic manner with the result that playing of an instrument incorporating left and right hand manuals is considerably simplified.

Another object of the invention is to achieve the foregoing objects without introducing any disharmonies.

Briefly, these and many other objects and advantages of this invention are attained by incorporating in a musical instrument a first means responsive to the selection of bass notes by the left hand for partially completing the coupling or keying circuits of harmonically related or octavely related treble signal sources or notes to be played. These partially completed circuits or notes are not actually played when a person depresses the keys by the left hand but are merely placed in a "ready" condition.

There is then provided second means responsive to the playing of a single note by the right hand to play automatically conditioned notes simultaneously therewith. When the left hand chord is changed, the conditioned treble notes are correspondingly changed so that when the melody note corresponding to the changed chord is

sounded, the changed treble notes will similarly be sounded. There is thus provided a "controlled harmonization" in a completely automatic manner, the musician being required only to play a single melody note with his right hand and yet providing musical sounds exactly the same as though full chords had been played with the right hand simultaneously with those played by the left hand.

A better understanding of the invention as well as various further features and advantages thereof will be had by referring to the accompanying drawings illustrating one embodiment thereof, wherein:

FIGURES 1 and 2 show together in schematic form bass and treble tone generators operable by suitable manuals incorporated within a representative musical instrument in which the present invention finds utility;

FIGURE 3 illustrates the manner in which FIGURES 1 and 2 should be placed in side-by-side relationship to enable proper presentation of the manuals;

FIGURE 4 is an enlarged fragmentary view of a portion of a switch means incorporated within the circular arrow 4 of FIGURE 2; and,

FIGURE 5 is an enlarged fragmentary view of another portion of the switch means enclosed within the circular arrow 5 of FIGURE 1.

Referring to FIGURES 1 and 2, placed together as illustrated in FIGURE 3, there is shown a plurality of individual signal sources such as tone generators, each being marked by the notes C, C#, D, D#, E, F, F#, G, G#, A, A#, B, C′, C#′, D′, D#′, E′, F′, F#′, G′, G#′, A′, A#′, B′, C″, C#″, D″, D#″, E″, F″, F#″, G″, and G#″. It is to be understood that the showing represents only a portion of the bass and treble notes of the instrument, there being no limit on the number of individual tone generators. It will be noted that notes octavely spaced from the other corresponding notes are provided with primes or double primes, there being represented notes on either side of middle C and high C. Since octave notes have frequencies constituting whole integer multiples of the bass notes, other signal sources such as frequency doublers or dividers may be substituted for some of the upper or lower tone generators, respectively.

Associated with each of the tone generators is a first switch means comprising a plurality of individual solo and accompaniment switches number 1–33 consecutively. Each of these switches is arranged to be individually connected to a common line 34 in turn connecting to an output line *p* shown in the lower portion of FIGURES 1 and 2. The output line *p* connects to a translating system or output means including an output amplifier 35 and output loud speaker 36 for sounding any one of the individual tones from the corresponding tone generator when one of the corresponding switches 1–33 is closed. Closing of the switches in the first switch means is effected whenever the musician depresses a key on the manual corresponding to the particular note he desires to play.

Also connected to each of the tone generators, respectively, in parallel with the switches 1–33, are switches 1*m* through 33*m* constituting a second switch means. Each of these switches is respectively ganged for operation in response to operation of the correspondingly numbered first switch in the first switch means. For example, the switch 1*m* is ganged for operation by the switch 1 as indicated by the dash-dot line 37. In other words, whenever one of the switches 1–33 is closed, the corresponding

parallel switch 1*m*–33*m* will also be closed. The corresponding ganging connections for the other switches are not shown to avoid obscuring the drawing.

As shown in FIGURES 1 and 2, the second switch means including the switches in the group 1*m*–33*m* spaced an octave apart are ganged together. Thus, the switch 1*m* connected to the tone generator for lower C is ganged to the switch 13*m* connected to the tone generator for C′ or middle C as shown in FIGURE 1. Similarly, the switch 2*m* connected to the tone generator for lower C# is ganged to operate simultaneously the switch 14*m* connected to the tone generator for C#′. The ganging connections are designated 38. It should be noted that the same ganged connections will connect the switch 13*m* to the switch 25*m* corresponding to high C or the tone generator for C″. Similarly, the other octavely spaced switches are ganged together for simultaneous operation.

With the foregoing arrangement, it will be evident that any particular note played by accompaniment keys on the left hand manual or in the bass will cause simultaneous closure of one of the switches, for example 1*m*–12*m*, closing of this latter switch in turn closing all of the switches spaced an octave away in the right hand, solo or treble manual. In the particular example shown in FIGURES 1 and 2, the switches 1 and 1*m* are shown closed in view of the ganging connection 37, the switches 5 and 5*m* are shown closed and the switches 8 and 8*m* are shown closed. These switches correspond to the notes C, E, and G constituting the C major triad chord played with the left hand on accompaniment keys. This C chord will be sounded through the switch connections 1, 5, and 8 connecting to the common output line 34 and thence to the output line *p*. The closing of the switches 1*m*, 5*m* and 8*m* simultaneously will cause closing of the switches 13*m*, 17*m*, and 20*m* and the switches 25*m*, 29*m*, and 32*m* as shown in FIGURE 2. Closing of these latter switches, however, merely places certain tone generators for the octavely spaced C, E, and G notes in a ready or given condition to be played through the output. However, in the absence of further operations, the solo notes in the treble manual closed by the latter mentioned switches will not be sounded.

Connected to the various vertical lines including the switches 1*m*–33*m* is a bus line *n*. This bus line includes a third switch means in the form of a plurality of series connected pairs of switches. The vertical lines from the switches 1*m*–33*m* connected between the various pairs; the two switches in each pair are in turn connected in series.

As a specific example, the pair of switches in FIGURE 4 comprise a first switch 25*n* and a second switch 25*p*. The first switch is a single pole, single throw switch, and the second switch is a single pole, double throw switch. Each of the second switches in each of the pairs when operated are arranged to connect to the output line *p* by way of the vertical conductors as illustrated in FIGURES 1 and 2. Each of the first switches when operated will simply open the bus line *n*.

As is evident from FIGURES 1 and 2 taken together, the first switches in each of the pairs are ganged to the second switches in other pairs spaced a plurality of pairs away. For example, the first switch in the pair of switches enclosed within the circular arrow 4 of FIGURE 2 is ganged to the second switch of the air enclosed within the circular arrow 5 of FIGURE 1. This second switch is designated 13*p* in FIGURE 5, the ganging connection being indicated by the dashed line 39. The number of pairs between the pairs of switches 25*n* and 25*p* and 13*n* and 13*p* represent a given portion of the bus line *n*. The first switch 25*n* delineates or determines the upper limit of this given portion of the bus line and the second switch 13*p* in the other pair shown in FIGURE 1 delineates or determines the lower limit.

In addition, each of the first switches in each pair of the right and, solo manual or treble portion of the bus line *n* is respectively ganged for operation in response to operation of the note positioned two half tones above the note of the tone generator connected adjacent the particular pair in question. Thus, the first switch 25*n*, for example, is ganged as indicated by the dash-dot line 40 for simultaneous operation by the switch 25. The switch 25 connects the tone generator for the tone C″ whereas the first switch 25*n* is connected to the tone generator A#′ or two half tones lower than C″ when the switch 23*m* is closed. The reason for having the individual switches in the treble portion of the manual ganged to corresponding first switches in the various pairs, positioned two half tones therebelow will become clearer as the description proceeds.

With particular reference to FIGURE 5, it will be evident that when the switch 13*p* is operated as shown to engage one of the vertical lines connecting to the output line *p*, all of the tone generators connected to the bus line *n* to the right of switch 13*p* will be connected to the output line *p* up to the switch 25*n* illustrated in FIGURE 4. Thus, with the switches in the particular positions shown in FIGURES 1 and 2, the tone generators C′, E′, and G′ will connect through the switches 13*m*, 17*m*, and 20*m* and the series connected pairs of switches in the bus line *n* to the switch 13*p* and thence to the output line *p*. The tone generators C″, E″, and G″ connected to the bus line through the closed switches 25*m*, 29*m*, and 32*m*, respectively, however, will not be connected to the output line *p* because of the opening of the switch 25*n* illustrated in FIGURE 4 which isolates the remaining right hand portion of the bus line from the output.

From the foregoing description, it will be clear that any chord played with the left hand accompaniment in the left hand manual will effect closing of corresponding individual switches within the group 1–13. It will also be evident that closing of these switches will effect closing of corresponding ganged switches within the group 1*m*–12*m* as already described and thereby effect simultaneous closing of the switches disposed octaves apart from the switches closed.

Assuming that the C chord is played with the left hand to close the switches as shown in FIGURES 1 and 2, if the melody note to be played with the C chord happens to be high C in the treble or right hand manual, the playing of this single high C note will result in closing of the switch 25 as illustrated in solid lines in FIGURE 2 so that this note C″ will sound through the common line 34 and the output amplifier 35 and speaker 36. Closing of the switch 25 will also, through the ganging connection 40, effect operation of the first switch in the pair located two half tones downwardly from the note C″ as described in conjunction with FIGURE 4. Operation of this first switch opens up the bus line *n* to isolate the right hand side of the manual as also described heretofore.

Simultaneous with the operation of the switch 25*n*, there will be operated the switch 13*p* shown in FIGURE 5 through the ganging connection 39 as described heretofore so that the portion of the bus line *n* between the switches 13*p* and 25*m* will be connected to the output line *p* through the series connected switches. Thus, it will be immediately evident that with the single high C note sounded, there will simultaneously be sounded automatically the notes G′, E′, and C′ through the readied switches 20*m*, 17*m*, and 13*m*.

Similarly, if a melody note other than C″ had been played, for example E″, the various notes in the treble portion of the manual corresponding to the chord notes played by the left hand encompassed within the range D′ to D″ would be sounded.

If a plurality of spaced melody or solo keys are depressed simultaneously, such as C″ and G″, the lower switch (corresponding to 13*p*) actuated by the G″ key will interrupt or break that isolated portion of the bus bar defined by the depression of the C″ key, and reconnect the broken-off portion to the output or collector *p*. However, the bus bar portion normally isolated or de-

fined by actuation of only the G'' key is broken or interrupted by the open switch 25*n* to ensure that no fill-in takes place between any tones produced by depression of keys of the solo manual.

The purpose for disposing the first switch in each pair two half tones below the actual note played in the right hand is to avoid the possibility of dissonance as a consequence of two notes spaced only a half tone apart being played simultaneously. For example, if C#'' should be played as the melody note and the normally readied note C'' heard simultaneously therewith, there would be a sharp dissonance whereas the same dissonance would not be evident if the spacing were at least an octave plus a half note lower.

It will be appreciated that the particular range or given portion of the bus line selected may be extended by changing the number of pairs of switches disposed between the ganging portion as indicated by the ganging connections 39. In the particular example set forth, the selected portion of the bus line corresponds to an octave or twelve half tones. This could be extended to eighteen half tones in which event operation of the switch 25*n* would result in operation of the corresponding second switch 7*p*, which is further spaced by six half notes.

By means of the various switching structures as shown, the playing of only a single key in the right hand corresponding to a solo melody note will result in the rendition of a full solo-manual controlled chord, the same as though the complete chord had been played with the right hand, an accomplaniment chord then being keyed. This chording will change automatically with changes in the chord played by the left hand so that the accompaniment added to the single melody note played by the right hand is completely automatic.

While, for the sake of illustration, mechanical type switching has been shown, it will be understood, of course, that electronic switches could be substituted therefor such as effected by transistors, diodes, and equivalent switching devices.

What is claimed is:

1. In a keyed musical instrument including a series of tone signal sources and an output means, each of said signal sources including a coupling circuit for coupling the tone signal source to the output means, the combination comprising:

(a) first means, responsive to the depression of given tone-producing keys, for partially completing the coupling circuits of a predetermined number of harmonically related signal sources; and

(b) second means, responsive to the depression of a further single tone-producing key, for completing the partially completed coupling circuits, thereby coupling said predetermined number of signal sources simultaneously therewith to said output means.

2. In a musical instrument including a series of tone signal sources an output means, each of said signal sources including a coupling circuit, and, left and right-hand key manuals for controlling the application of tone signals from said sources to said output means by means of the coupling circuits, the combination comprising:

(a) first means, responsive to the depression of tone-producing keys in said left-hand manual, for partially completing the coupling circuits of a predetermined number of harmonically related signal sources; and

(b) second means responsive to the depression of a further single tone-producing key in said right-hand manual, for completing the partially completed coupling circuits, thereby coupling said predetermined number of signal sources simultaneously therewith to said output means.

3. In a musical instrument including a series of tone signal sources an output means, each of said signal sources including a coupling circuit, and, left and right-hand key manuals for controlling the application of tone signals from said sources to said output means by means of the coupling circuits, the combination comprising:

(a) first means, responsive to the depression of tone-producing keys in said left-hand manual, for partially completing the coupling circuits of a predetermined number of harmonically related signal sources;

(b) second means responsive to the depression of a further single tone-producing key in said right-hand manual, for completing the partially completed coupling circuits by partially completing a group, less than all, of musically adjacent coupling circuits which includes said first-mentioned partially completed coupling circuits, thereby coupling said predetermined number of signal sources simultaneously therewith to said output means.

4. A musical instrument according to claim 3, in which the uppermost pitch of the tone signal sources having said group of musically adjacent coupling circuits is at least two half tones lower than the pitch of said tone signal source which has said single tone-producing key in said right-hand manual.

5. A musical instrument according to claim 3, in which the pitches of the tone signal sources having said group of musically adjacent coupling circuits comprise at least the major portion of one octave.

6. A musical instrument according to claim 3, in which the pitches of the tone signal sources having said group of musically adjacent coupling circuits comprise one octave.

7. In a musical instrument including a series of tone signal sources, left and right-hand manuals having keys corresponding to said signal sources, and an output means, the combination comprising:

(a) first switch means respectively responsive to said keys of said manuals and operative to connect one of said tone signal sources to said output means when the corresponding key is depressed;

(b) a bus line;

(c) second switch means, responsive to actuation of said first switch means in said left-hand manual, for each connecting at least one octavely related one of said tone signal sources to said bus line; and

(d) third switch means responsive to depressing of a single key in said right-hand manual for isolating a given portion of said bus line and connecting such portion to said output means so that said tone signal sources connected to said given portion are coupled to said output means when said single key is depressed.

8. In a musical instrument including a series of tone signal sources, left and right-hand manuals having keys corresponding to said signal sources, and an output means, the combination comprising:

(a) first switch means respectively responsive to said keys of said manuals and operative to connect one of said tone signal sources to said output means when the corresponding key is depressed;

(b) a bus line comprising a plurality of series connected pairs of switches, the first switch in each pair being a single-pole single-throw switch, and the second switch in each pair being a single-pole double-throw switch;

(c) second switch means, responsive to actuation of said first switch means in said left-hand manual, for each connecting at least one octavely related one of said tone signal sources to said bus line at a point between said first and second switches in each pair; and

(d) each first switch in each pair being ganged to operate simultaneously with said second switch of another of said pairs of switches positioned a plurality of said pairs therefrom and associated with a lower pitch tone signal generator, said first and

second ganged switches being responsive to depression of a single key in said right-hand manual for isolating a given portion of said bus line, and said second ganged switch being operative to connect such given portion to said output means, said first switch means of said single key being connected to a tone signal source having a pitch at least two half tones higher than that of the tone signal source connected to said first switch in each of said pairs.

9. A musical instrument as claimed in claim **8** in which said given portion of said bus line includes at least nine sucessive pairs of said switches.

10. An electrical musical instrument comprising in combination:

(a) a series of tone signal sources having frequencies comprising a chromatic musical scale;

(b) a translating system for converting tone signals into audible tones;

(c) a series of solo keys and a series of accompaniment keys, each mechanically operative to couple one of said tone signal sources electrically to said translating system; and

(d) fill-in means responsive to simultaneous depression of any one of said solo keys and a number of said accompaniment keys, and operative to electrically couple a number of said tone signal sources in the octave below said one solo key to said translating system, said number of tone signal sources being those which are productive of tones harmonically related to tones produced by said number of accompaniment keys.

11. An electrical musical instrument comprising in combination:

(a) a series of tone signal sources having frequencies comprising a chromatic musical scale;

(b) a translating system for converting tone signals into audible tones;

(c) a series of solo keys and a series of accompaniment keys, each mechanical operative to couple one of said tone signal sources electrically to said translating system; and

(d) chord fill-in means responsive to simultaneous depression of any one of said solo keys and a chord-producing number of said accompaniment keys, and operative to electrically couple a group of said tone signal sources in the octave below said one solo key to said translating system, said group of tone signal sources being productive of tones harmonically related to tones produced by said chord-producing number of accompaniment keys.

12. Automatic fill-in means for a musical instrument having a series of jointly audible chromatic tone signal sources, an output means, each of said signal sources including a coupling circuit, and solo keys and accompaniment keys for controlling the application of tone signals from said sources to said output means by means of the coupling circuits, comprising:

(a) means responsive to depression of a solo key for partially completing the coupling circuits of a consecutive series of the tone signal sources located musically in the octave below such solo key; and

(b) means responsive to depression of accompaniment keys for completing the partially completed coupling circuits of those of such partially completed coupling circuits of said series of tone signal sources as are harmonically related to the depressed accompaniment keys.

13. An electrical musical instrument comprising in combination:

(a) a series of tone signal sources having frequencies comprising a chromatic musical scale;

(b) a translating system for converting tone signals into audible tones;

(c) a series of solo keys and a series of accompaniment keys;

(d) a plurality of switches for each of said keys, and simultaneously actuatable by the associated key;

(e) a series of circuits respectively operative to couple said tone signal sources to said translating system by means of one of said plurality of switches, for producing an audible tone in response to depression of the associated key; and

(f) further circuitry interconnecting the other of said plurality of switches, and operative to couple another of said tone signal sources to said translating system in a manner that simultaneous depression of both one solo and one accompaniment key will effect production of a tone signal in the octave below said one solo key and harmonically related to the tone signal produced by depression of the accompaniment key.

14. An electrical musical instrument comprising in combination:

(a) a series of tone signal sources having frequencies comprising a chromatic musical scale;

(b) a translating system for converting tone signals into audible tones;

(c) a series of solo keys and a series of accompaniment keys;

(d) a plurality of switches for each of said keys, and simultaneously actuatable by the associated key;

(e) a series of circuits respectively operative to couple said tone signal sources to said translating system by means of one of said plurality of switches, for producing an audible tone in response to actuation of the associated key;

(f) further circuitry connecting in electrical series the other of said plurality of switches of the accompaniment keys with the other of said plurality of switches of the solo keys;

(g) circuit means coupling said further circuitry to said signal sources for effecting operative coupling thereof to said translating system; and

(h) means by which a series of solo keys are individually adapted to close a series of said other switches in the octave immediately below each such solo key.

15. Automatic fill-in means for a musical instrument having a series of jointly audible chromatic tone signal sources, an output means, each of said signal sources including a coupling circuit, and solo keys and accompaniment keys for controlling the application of tone signals from said sources to said output means by means of the coupling circuits comprising:

(a) a series of switches respectively associated with each of said keys and actuatable thereby;

(b) circuitry interconnecting the individual solo-key switches in electrical series with individaul accompaniment switches, and comprising a part of the coupling circuits; and

(c) means actuated by each of said solo keys by which there is isolated a closed series of said solo-key switches in the octave immediately below each said solo key;

whereby the simultaneous depression of both a solo key and an accompaniment key will automatically produce an added tone, harmonically related to the tone produced by the depression of the accompaniment key, in the octave below the tone produced by the depression of the solo key.

16. Automatic fill-in means for a musical instrument having a series of jointly audible chromatic tone signal sources, an output means, each of said signal sources including a coupling circuit, and solo keys and accompaniment keys for controlling the application of tone signals from said sources to said output means by means of the coupling circuits comprising:

(a) means responsive to depression of a plurality of spaced solo keys for partially completing the coupling circuits of a consecutive series of the tone signal

sources all located musically below the lower of such depressed solo keys; and

(b) means responsive to depression of accompaniment keys for completing those of said partially completed coupling circuits of said series of tone signal sources which are harmonically related to the depressed accompaniment keys;

whereby fill-in is provided only below the lowermost depressed solo key.

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