Sept. 2, 1969 J. J. BORELL 3,465,086

COMBINING SYSTEM FOR MUSICAL INSTRUMENTS

Filed Dec. 6, 1965 3 Sheets-Sheet 1

FIG. 1

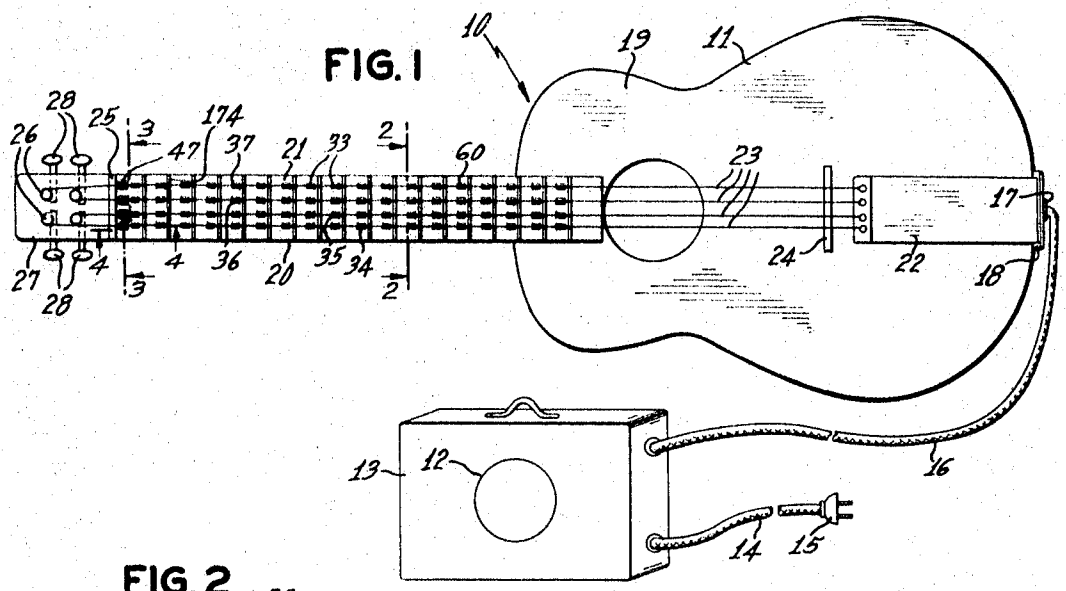

FIG. 2

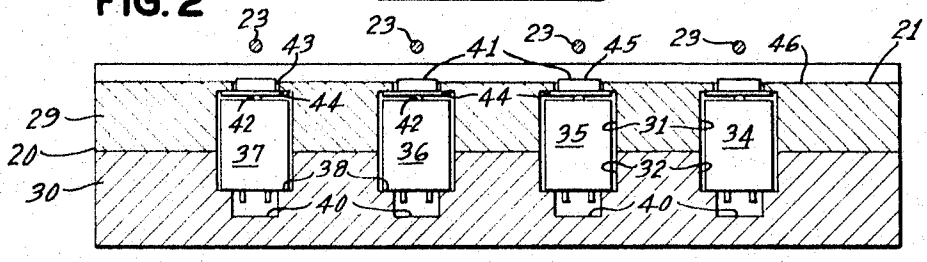

FIG. 3

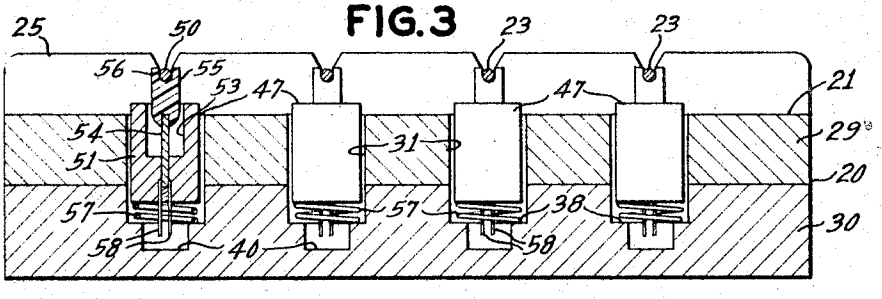

FIG. 4

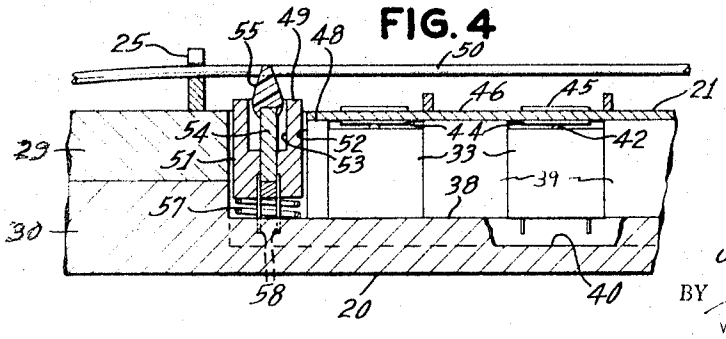

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FIG. 5

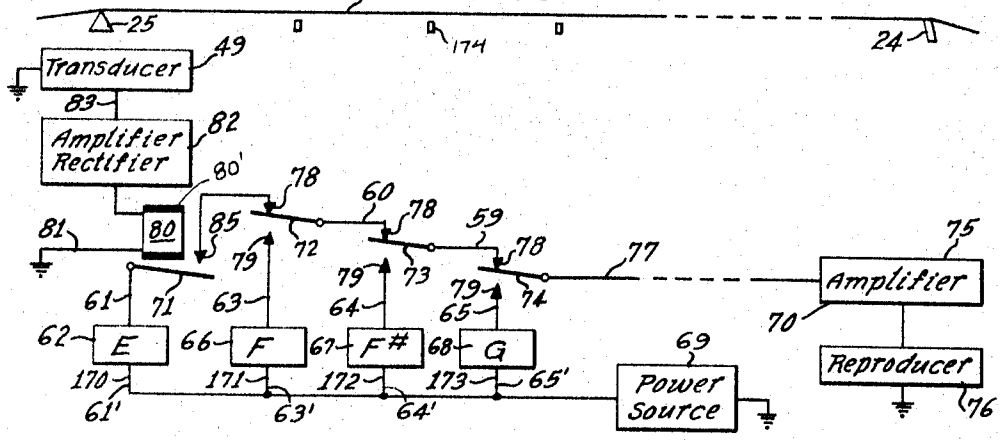

FIG. 6

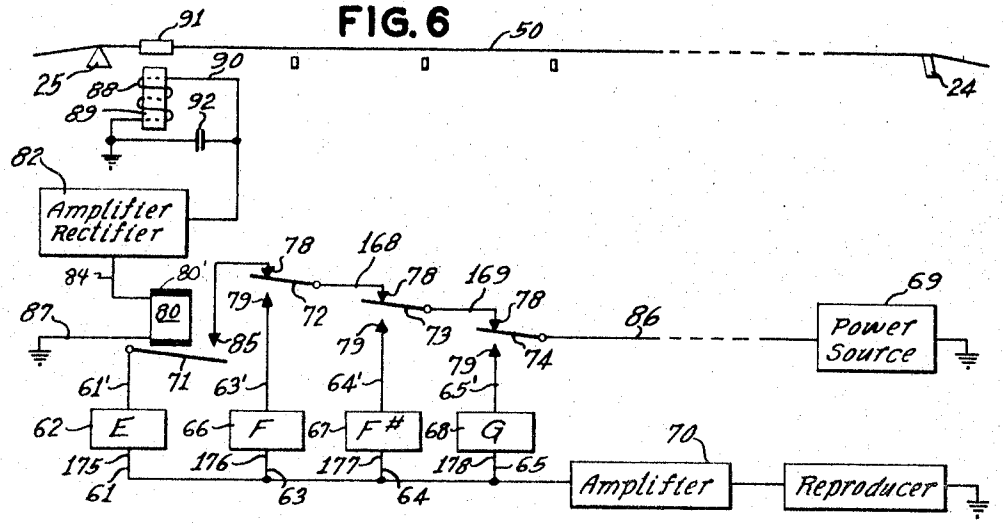

FIG. 9

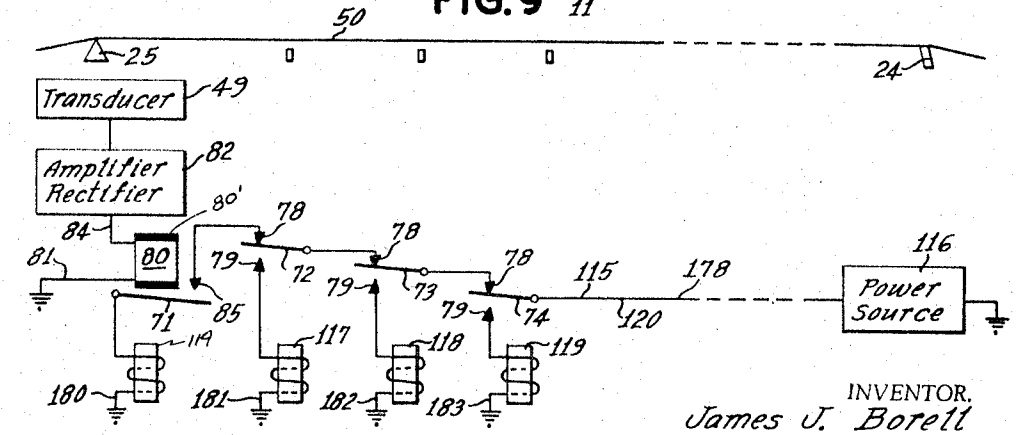

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FIG. 8

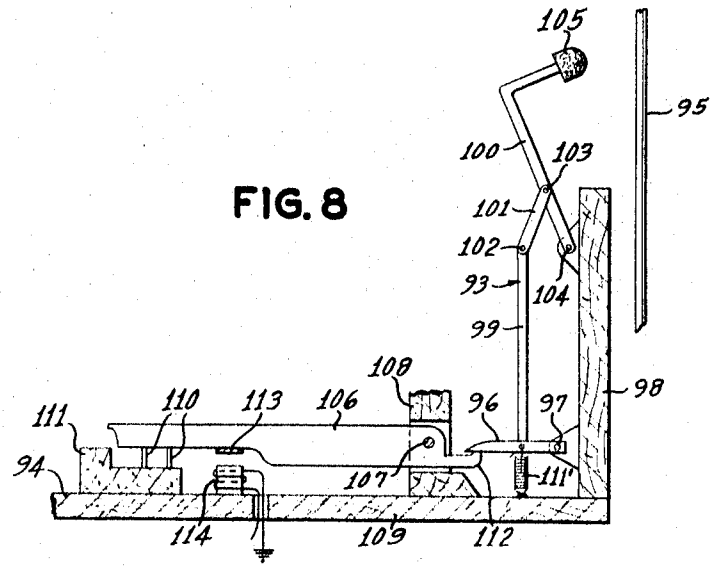
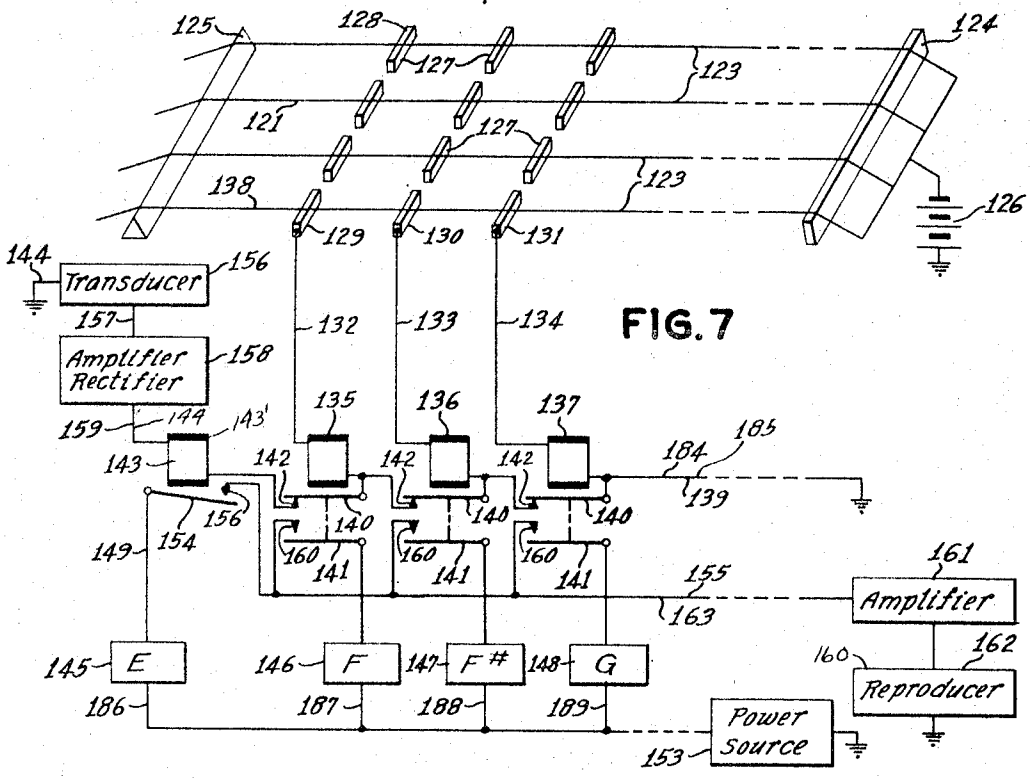


FIG. 7



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COMBINING SYSTEM FOR MUSICAL INSTRUMENTS

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Int. Cl. G10h 3/00
U.S. Cl. 84—1.16 16 Claims

ABSTRACT OF THE DISCLOSURE

This application contains a technical disclosure of a system of combining musical instruments by which musical tones produced by a player on a stringed instrument, e.g. a guitar, may be concurrently and correspondingly reproduced on other musical instruments, e.g. an electric organ or a piano, without special finger manipulations or external playing controls. The system as disclosed consists of electrical circuitry which includes sensors for open tones of unkeyed strings and associated switches, in series combination with switches for keyed strings at each keying position. The circuitry arrangement is such that not only are open tones reproduced but also only the desired keyed tones are reproduced when normal finger manipulations cause strings to be keyed in a plurality of positions, e.g. when playing barred chords.

Summary of the invention

This invention relates to musical instruments and more particularly to combinations of musical instruments which can be played by a single player of one of the instruments.

A general object of the invention is to provide improvements in musical instrument combinations that are playable as for example in duet fashion by a single player and wherein one of the instruments is a string instrument having strings that are keyed through contact with the player's fingers.

Systems for controlling the operation of the tone producing components of certain types of musical instruments from the keyboard of a string instrument which is played in duet fashion therewith are known. These systems, however, suffer from the disadvantage that the components which produce the tones corresponding to the open strings tones of the strings must be controlled by the string instrument player through special finger manipulations that are foreign to the usual finger movements made in playing the string instrument in solo fashion. In addition these systems cannot be used in conjunction with string instruments that entail finger manipulations resulting in the barring of the strings for the reason that with many chords played for example on guitars and chords which involve so-called barred chords, more than one position for keying a single string is frequently involved in the playing of the chord. With known systems this would result in the playing of two tones on the second instrument whereas only one tone can be played on the associated string and is involved thereby in the barred chord being played.

One particular object of the invention is to provide improvements in musical instrument combinations of the kind contemplated herein and which avoid the need for any special finger manipulations by the player of the string instrument when the open string tones are played on the strings in order to control the operation of the tone producing components of the other instrument.

It will be appreciated by those skilled in the art that the tones obtainable from each string of the string instrument must be selected by the player and are playable separately on the string. Prior art systems for playing

other instruments and which are controlled by the player of a string instrument have generally been inapplicable to instruments such as guitars wherein the strings are frequently barred by the player. If such prior art systems were used in a musical instrument combination that included a guitar, two or more tones associated with one of the strings would be produced when many of the barred chords are being played and this of course is undesirable.

One particular object of the invention is to provide a control system in the environment contemplated herein which can be used in conjunction with musical string instruments on which barred chords are playable.

One particular object of the invention is to provide a keying system for the tone producing components of so-called "electronic organs" and wherein the system enables the organ to be played in duet fashion by the player of a string instrument such as a violin, guitar, base violin, mandolin and the like.

Some of the prior art systems for controlling the tone producing components of a musical instrument from the keyboard of a string instrument utilize movable control components which are mounted on the keyboard of the string instrument. Because of the movements associated with the control components, the player of the string instrument secures an abnormal feeling in playing the instrument as compared to the feeling derived when encountering the normal solid and immovable components of an unmodified keyboard.

Consequently, in accord with one aspect of the invention, one object is to provide a system for controlling the tone producing components of an instrument which is played in duet fashion with a string instrument having strings which are keyed against the keyboard of the instrument and wherein the system is one which avoids any abnormal changes on the keyboard that are perceptable to the player's touch during the playing of the string instrument.

Certain prior art systems for controlling a musical instrument from the keyboard of a string instrument have been limited in use to stringed instruments employing strings that are electrical conductors and one aspect of the invention is directed to providing a control system that can be used with stringed instruments provided with strings which are not conductive as for example the gut strings of violins and base violins.

The novel features which are believed to be characteristic of this invention are set forth with particularity in the appended claims. The invention itself however both as to its organization and methods of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawings.

Brief description of the drawings

FIG. 1 shows an embodiment of the invention involving a tenor guitar and an electronic organ, the guitar being shown in top plan view as modified in accord with the invention and the casing for certain components of the organ being shown in perspective and somewhat reduced in comparative size;

FIG. 2 is a transverse vertical section along the lines 2—2 in FIG. 1 and shows the two piece structure of the guitar neck as well as the ends of certain switches which are used in controlling the tone producing components of the organ from the keyboard of the guitar;

FIG. 3 is a transverse vertical section along the lines 3—3 of FIG. 1 and shows the arrangements of certain transducer elements of the control system and which are located at the nut ends of the strings;

FIG. 4 is a vertical section through a fragment of the neck as seen generally along the lines 4—4 of FIG. 1

and shows the arrangement of the transducer and certain switch components associated with the control circuit for the E string of the guitar;

Description of the preferred embodiments

FIG. 5 schematically illustrates the system control circuitry associated with the E string of the guitar, the string and certain parts of the guitar as well as certain components of the organ being diagrammatically shown in the figure;

FIG. 6 schematically illustrates the control circuitry associated with the E string of the guitar in an alternative control system that may be used in accord with the invention, the string and certain components of the guitar and organ again being diagrammatically depicted in the figure;

FIG. 7 schematically illustrates another embodiment of the invention, the strings and certain associated components of a guitar being shown diagrammatically and in perspective, and the system for controlling the tone producing components of the organ being shown schematically and only insofar as the system relates to the E string of the guitar;

FIG. 8 is a fragment of a common type of upright piano and shows one of the actions involved in producing a separate tone on the piano, the action being shown as modified to accommodate certain components that enable the piano string tone to be produced simultaneously with the playing of the corresponding tone on a guitar and through control of the action from the keyboard of the guitar; and

FIG. 9 schematically illustrates a system that may be used for controlling the tone producing components of the piano shown in FIG. 8 from the keyboard of a guitar insofar as the system relates to one of the strings of the stringed instrument.

The embodiment **10** of the invention shown in FIG. 1 includes a tenor guitar **11** that has four strings **23** and also includes an electronic organ **12** which is provided with a case **13** for certain of its components. It will be understood that although a guitar is shown in the illustrated embodiment other string instruments which are provided with strings that are keyed against a keyboard may be adapted to embody the concepts of the invention and that the concepts of the invention may also be used in controlling the tone producing components of instruments other than an organ.

Organ **12** has a chord **14** which is equipped with a plug **15** for connecting the electrical components to a suitable source of electrical power such as the common household circuitry. The system for keying the tone producing components of the organ involves certain circuits having components which are mounted on the guitar **11**, and these components are electrically connected by electrical lead lines which are housed in an interconnecting cable designated at **16**. A multi-component plug **17** is provided at the guitar end of cable **16** and a matching multi-component socket **18** is mounted at the base end of the guitar to enable physical separation of the guitar from the casing **13** when desired.

Guitar **11** has the usual hollow body portion **19** that serves as a sound box for amplifying the string tones, and portion **19** is connected to an elongated neck **20** which provides a fretted keyboard **21** against which the strings are keyed in playing the keyed string tones thereon. The sound box **19** has a tail piece **22** of conventional construction and to which the strings **23** are fastened. Strings **23** are strung over a bridge **24** mounted upright on body **19** and also over the nut **25** at the head **27** of neck **20**. Strings **23** are connected to vertical pegs **26** at the head of the neck, these pegs are in turn connected by worm gear arrangements in the head to laterally extending pegs **28**. Pegs **28** are hand manipulatable to turn pegs **26** and thus enable tuning of the strings **23**.

The system **60** for controlling the tone producing components of the organ involves a separate circuit for each string and each circuit has a separate set of control switches through which the components for producing tones corresponding in pitch to the keyed string tones that are playable on the string are controlled. The switch sets for the respective strings **23** are designated at **34, 35, 36** and **37** respectively, and the switches of the instrument are collectively designated at **33**. In addition to the switches associated with the keyed string tones each circuit also has a sensing device that is shown as a transducer **47** in FIG. 1 and which is provided to sense the open tone producing vibration of the string associated with the circuit. The switches **33** and transducers **47** for the circuits are mounted on the neck **20** of the guitar **11** and to facilitate the arrangement neck **20** has a pair of flat elongated upper and lower pieces **29** and **30** which are provided with confronting grooves **31** and **32** in which the switches and transducers are mounted. These grooves run the length of the keyboard **21** below the strings **23** and the switches **33** are suitably oriented in the grooves and spaced apart by suitable spacer blocks **39**. These blocks along with the switches are supported above the bases of the grooves in piece **30** on shoulders designated at **38**. Groove **32** communicates with the hollow portion of the sound box, and the lead wires for the control switches, although not shown in FIGS. 1 through 4 extend through the down set base portions **40** of the grooves **32** in the circuit arrangement.

Each switch is associated with a separate tone that may be played on the string by appropriately keying the string against the keyboard, and each of the switches **33** is provided with an elongated flat rectangular control button **41** that rests on the switch arm **42** and which is depressed by the player in actuating the switch. These buttons **41** fit in appropriately shaped apertures **43** at the positions for keying the strings and are provided with laterally extending flanges **44** which are located in the grooves of neck piece **29**. The switch arms **42** are spring biased to oppose depression of the control buttons and the flanges **44** serve to limit outward movement of the buttons under the influence of these biasing springs.

The upper faces **45** of the control buttons **41** in the arrangement shown are slightly offset from the face **46** of the keyboard and are normally so held by the biasing springs of the switches until depressed under the influence of the finger pressure exerted by the guitar player in keying the strings.

The devices **47** for sensing the open tone producing vibrations of the strings are located at the nut ends of the strings so that string vibrations producing the keyed string tones are dampened by the players fingers in keying the strings and are thus not sensed by the devices. The sensing devices **47** are shown in the form of piezoelectric transducers which have a quartz crystal **54** that is vibrated when the open tone is played on the string and which responds to the sensed vibration by impressing an electrical potential in an auxiliary circuit to be described hereinafter. Other appropriate types of transducers may also be used such as the magnetostrictive types among others as will be apparent to those skilled in the art from the invention described herein.

Transducers **47** in the embodiment are located in the grooves and are spaced from the adjacent switches by narrow spacer blocks designated at **48**. As seen by reference to the transducer **49** in the circuit associated with the E string **50** of the guitar, each transducer has a casing **51** that fits in a square hole **52** at the nut end of the keyboard and which communicates with the groove therebelow. Casing **51** has a recess **53** at the upper end to accommodate vibratory movement of the piezoelectric crystal, such as the quartz crystal **54**. The crystal **54** is mounted upright in the recess **53** as shown and is equipped at its upper end with a grooved string contacting member **55** which may be made from polyethylene or other suitable material. Member **55** engages the string **50** in the groove as seen in FIG. 3 and this affords a direct mechan-

ical coupling with the string 50. The casing 51 is supported on the shoulders 38 through a coiled compression spring 57 which constantly urges the transducer upwardly and which thus serves to maintain the mechanical coupling between the transducer and the string. The leads 58 for picking off the potential from the crystal are imbedded in the base of the casing and are, of course, in electrical contact with opposite faces of the crystal 54. These leads 58 project below the base of the casing and are connected to suitable electrical lead lines (not shown in FIGS. 3 and 4) of the auxiliary circuit to be described hereinafter.

As previously indicated the control system 60 has a separate circuit for each string and the circuit for producing audible organ tones corresponding in pitch to the open and keyed string tones of string 50 is designated at 59 in FIG. 5. Circuit 59 is schematically illustrated in reference to the components of the organ which produce audible tones corresponding to the open string tone of string 50 and to the next three higher pitched keyed string tones of the chromatic scale which are playable on the string, namely the F, F♯ and G tones. It will be understood that although circuit 59 is shown only insofar as it relates to the E, F, F♯ and G tones that the arrangement is similar to the components associated with the balance of the keyed string tones that are playable on the string.

The circuit 59 associated with the E string of system 60 has a plurality of circuits such as those designated at 170, 171, 172 and 173 for producing audible tones which correspond in pitch to the musical tones that are playable on string 50 and each of the circuits has a common translation system 70 for audibly reproducing the electrical tone signals. Each audible tone producing circuit component of circuit 59 has a separate tone signal producing or generating circuit, the signal generating circuits for the E, F, F♯ and G tones being designated at 62, 66, 67 and 68 respectively. These tone signal generating circuits are connected to a common power source 69 in circuit 59 by power lines designated at 61′, 63′, 64′ and 65′ respectively. Each audible tone producing circuit also has a separate switch which is controlled by the player of the string instrument to feed the tone signal corresponding in pitch to the musical tone which is being played on the string to the amplifier 75 of the translation system 70 so that the signal is translated and audibly reproduced at the same time the corresponding tone is being played on the string. The switches associated with the tone signals corresponding to the E, F, F♯ and G musical tones are designated at 71, 72, 73 and 74 respectively, and are connected in the readout lines 61, 63, 64 and 65 of the signal generating circuits. Switches 71, 72, 73 and 74, arranged in series, are normally open and the switch arms of the switches associated with the keyed string tones are adapted upon actuation to engage contacts designated at 79 to feed the tone signal into the common readout line 77. These switches 72, 73 and 74 are also associated with the signals corresponding to the musical tones of lower pitch than the musical tone with which the switch is associated and are provided with contacts 78 in line 77 so that when the switch is actuated to feed its signal to the translation system, the switch arm disengages the contact 78 in line 77 and thus opens the readout lines associated with the lower pitch signals.

Thus as the player of the string instrument keys string 50 to play the F♯ tone on the string, he depresses the string 50 into contact with fret 174. As he does this, he exerts a pressure against the control button of switch 73 causing the switch arm to become disengaged from the contact 78 associated therewith and to engage the contact 79 in readout line 64. This actuation of switch 73 closes the readout line 64 and enables the tone signal to be fed to the amplifier from which the amplified signal passes to the loudspeaker or the reproducer 76. Simultaneously, the readout lines for circuits 170 and 171 are opened so that it is impossible for the tone signals produced by circuits 62 and 66 to be fed to the translation system for reasons of any switching action attributed to switch 71 or 72.

The switch 71 associated with the open tone of string 50 is controlled by the player automatically by playing the open tone on string 50. To accomplish this, an auxiliary control circuit 81 is provided for sensing the vibration of string 50 at the nut end of the keyboard and for automatically actuating the switch 71 when the open tone producing vibration is sensed thereat. Circuit 81 includes the transducer 49 which, as previously shown, is coupled to the E string at a position where the open tone producing vibrations of the string can be sensed and the transducer serves to control a relay 80 having the switch 71 as component. The electromagnet 80′ of relay 80 is energized when the vibration is sensed and thus responds to the potential impressed in the circuit by the transducer to draw the arm of switch 71 into engagement with the switch contact 85 in line 77. The transducer 49 is connected to an amplifier and rectifier circuit designated at 82 so that the potential 83 impressed on the circuit 81 by vibration of crystal 54 is suitably amplified and rectified to facilitate the relay action. Vibration of crystal 54 is of course prevented at the nut end of string 50 when the string is keyed by the player to play the keyed string tones thereon.

It is believed obvious that by virtue of the arrangement only the tone signal associated with the musical tone which is being played on the string 50 is simultaneously reproduced in the translation system. As such more than one of the control buttons for the switches associated with the keyed string tones of any string can be encountered by the player in playing barred chords on the instrument while nevertheless only producing the one tone associated with the tone being played on the string.

An alternate system 168 for controlling the tone producing components of the organ is shown in FIG. 6 insofar as it relates to the circuit 169 associated with the E string 50 of the stringed instrument. Like the system described in reference to FIG. 5 system 168 includes a sepa- barred chords and thus engage the control buttons associated with the E string being shown in FIG. 6 insofar as it relates to the audible tone producing circuits 175, 176, 177 and 178 associated with the E, F, F♯ and G musical tones that are playable on string 50.

The readout lines 61, 63, 64 and 65 in this instance are electrically connected with the translation system 70 and the switches 71, 72, 73 and 74 are arranged in series in the power line 86 that connects with the power source 69 so that the switches control the power fed to the tone generating circuits 62, 66, 67 and 68. The switches 72, 73 and 74 associated with the keyed string tone are provided with one set of contacts 79 which are respectively connected in the electrical feed line 63′, 64′ and 65′ to circuits 66, 67 and 68. The other contacts 78 of these switches are in the power line 86, and the switch arms of switches 72, 73 and 74 are spring biased to engage the switch contacts 78.

The switch arm of the relay switch 71 is connected in the power line 61′ for circuit 62 and when the switch is actuated it engages contact 85 in line 86. It is believed evident that by virtue of the arrangement of these switches that as each of the switches associated with the keyed string tones is actuated, the power line 86 is opened at the switch so that the switches associated with the lower pitch tones are cut off from the power source. This arrangement like the arrangement in FIG. 5 enables the player to play barred chord and thus engage the control buttons associated with any one string at more than one position while nevertheless only reproducing the signal associated with the highest pitched tone.

The auxiliary circuit for controlling the relay switch 71 is in this instance designated at 87 and includes a circuit 90 for sensing the open tone producing vibration of string 50. String 50 carries a small tubular element 91 in this embodiment and which is fixed to the string immediately adjacent the nut 25. Element 91 is made of ferromagnetic

material and vibrates with the string when the open tone is played thereon. Circuit **90** includes a coil **88** that has a permanent magnetic core **89** which is mounted on the neck of the guitar immediately adjacent element **91** in this system. In this arrangement the coil is in close proximity to the element **91** yet is not mechanically coupled to the element and serves to sense the vibration of the element **91** and to induce a potential in circuit **90**. Circuit **90** is preferably tuned to a frequency closely approximating the open tone producing vibration of string **50** as by a condenser **92** so as to bypass spurious frequencies. The output of circuit **90** is fed to a suitable amplifier and rectifier circuit **82** and from which the output **84** is fed to the electromagnet **80'** of the relay **80**. Relay **80** is controlled when the open tone producing vibration is sensed by coil **88** and the electromagnet **80** responds to the induced potential to automatically close the circuit associated with the switch component **71** of the relay.

The dampening action of the player's fingers in keying the string **50** serves to control the vibrations sensed by the coil and of course the switches associated with keyed string tones are actuated in direct response to the finger pressure exerted by the player against the control buttons in playing the keyed string tones on the string.

System **169** has the same advantages as system **60** in that more than one of the arms of the switches associated with the keyed string tones of a string may be depressed with only the highest frequency tone signal associated with the depressed switches being reproduced.

FIGS. 8 and 9 may be taken together and illustrate the invention when the instrument played in duet fashion with the guitar is a piano. FIG. 8 shows a typical action **93** for keying the E string **95** of an upright piano **94**. The action **93** includes a lever **96** which is pivoted as at **97** to an upright mounting plate **98**. The lever **96** has an elongated element **99** which is fixed to the lever and pivotally movable therewith about the axis of pivot **97**. Element **99** is linked to the striking arm **100** of the action by a link **101**, and the link is connected to element **99** and arm **100** by pivots designated at **102** and **103**. Arm **100** is pivotally connected to plate **98** beneath pivot **103** as at **104**, and the pad **105** of arm **100** is arranged in working alignment with string **95**. The key **106** of the action is pivoted as at **107** to a board **108** which in turn is fixed to a mounting plate **109** of the piano. The key **106** is guided at the front by the usual pegs **110** that are adapted to slide in recesses not shown. These pegs are mounted on a peg board **111** of the piano. Lever **96** is biased by spring **111** as seen in FIG. 8 and when key **106** is depressed the end **112** of the key lifts lever **96** and through the linkage **101** causes the pad **105** of arm **100** to strike the string **95** and thus produce the audible tone.

In adapting the keys of the piano so that they respond as the corresponding tones are played on the string instrument, a piece of ferromagnetic material in the form of a small plate **113** is fixed to the base of each key. Each action also has an electromagnet such as the one shown in FIG. 8 at **114** and which is mounted on plate **109** immediately below the plate **113** associated with the action so that when the magnet **114** is energized key **106** is drawn downwardly and thus produces the desired action to secure the piano tone.

FIG. 9 shows the system **115**, for controlling the piano actions so that the tones corresponding to those played on the guitar are simultaneously produced by the piano, insofar as the system relates to the E, F, F♯ and G tones that are playable on the E string **50** of the guitar.

Like the other systems, system **115** has a circuit associated with each string, the circuit which is associated with the tones produced on the E string being designated at **178**. Circuit **178** has a plurality of circuits which are respectively associated with the tones that are playable on string **50**, the circuits associated with the E, F, F♯ and G tones being designated at **180**, **181**, **182** and **183** respectively. In this embodiment switches **71**, **72**, **73** and **74** are connected in series with the power source **116** and each switch has an electromagnet associated with it and which is energized when the switch is actuated. The electromagnets associated with switches **72**, **73** and **74** are designated at **117**, **118** and **119** respectively and of course each of the electromagnets is mounted on the piano beneath the piano key associated with the desired tone. The auxiliary circuit **81** for automatically actuating switch **71** in response to sensing of the open tone producing vibration of string **50** is the same as that utilized in system **60** and serves to automatically close switch **71** by drawing its arm into engagement with contact **85** in power line **116**, thus to energize the electromagnet **114** and thereby produce the corresponding tone on the piano. As previously mentioned the switch arms of switches **72**, **73** and **74** as well as the others associated with the keyed string tones are spring biased to engage the contacts **78** in line **120**. As each switch is actuated the arm disengages the contact **78** associated therewith and engages the contact **79** in the line leading to the electromagnet associated with its circuit. It is believed obvious that by virtue of the series arrangement each of the switches associated with the keyed string tones is adapted to complete a circuit which causes production of a piano tone corresponding to the keyed string tone with which the switch is associated and simultaneously opens the power lines of the circuits associated with the lower frequency tones of string **50**.

FIG. 7 schematically illustrates another embodiment of the invention, certain components of a four string tenor guitar **121** being shown schematically therein along with certain components of an electric organ **122**. The components of the guitar are schematically shown in perspective, the strings **123** being strung between the bridge **124** and nut **125**. The strings **123** in this instance are of conductive material and are connected at the bridge end of the guitar to a suitable DC power source **126** illustrated as a battery in the embodiment. The frets **127** associated with the keyed string tones of strings **123** are also of conductive material and are insulated from each other on the keyboard **128**. Each of the frets **127** is divided into sections which are insulated from each other, and each fret section is associated with one of the keyed string tones that may be played on the strings of the guitar.

The system for controlling the tone producing components of the organ is designated at **184** and includes four circuits which are respectively associated with the strings **123**, only the circuits **185** associated with the E string **138** being shown in FIG. 7 and there only insofar as it relates to the tone producing components of the organ which are associated with the E, F, F♯ and G string tones that are playable on string **138**.

Frit sections **129**, **130**, and **131** are respectively associated with the F, F♯ and G tones that are playable on the E string **132** of the guitar, and are located beneath the string. These sections are contacted by the string when the player keys the string against the keyboard **128** in playing the selected keyed string tone associated with the section, and each fret section serves as a switching element in an auxiliary circuit associated with the tone. The auxiliary circuits of the organ and which are associated with the F, F♯ and G tones of the string **138** are designated at **132**, **133** and **134**. These auxiliary circuits are provided with separate relays designated at **135**, **136** and **137** and these relays are connected to a common ground line **139**. Each relay in the auxiliary circuits associated with the keyed string tone is controlled by the player in keying the string to play the keyed string tone and has a pair of switches **140** and **141** which are mechanically coupled for simultaneous actuation by the relay. Switches **140** of relays **135**, **136** and **137** are connected in series in the ground line **139** and the switch arms are spring biased to normally engage the switch contacts **142** in the line in the absence of the relay action. The relay

143 of the auxiliary circuit 144 associated with the open string tone of string 138 is connected in series with the switches 140 and it is deemed evident that when a relay associated with one of the keyed string tones is energized that the ground lines of the auxiliary circuits associated with the keyed string tones of lower frequency are opened by the relay action.

The audible tone producing circuits of the open organ which are associated with the E, F, F♯ and G tones playable on string 138 are designated at 186, 187, 188 and 189 respectively and of course produce tone signals corresponding in pitch to the associated tones that are playable on string 138. The tone signal producing circuits associated with the open tone and first three keyed string tones are designated at 145, 146, 147 and 148 respectively, and these signal producing circuits are connected to the power source 153 as seen in FIG. 7. When the organ is in use these circuits are constantly generating the tone signals. The output tone signal line 149 of circuit 145 is fed to the switch arm of the switch component 154 of relay 143 and as automatically fed into the readout line 155 and thus to translation system 160 when relay 143 is energized to draw the arm into engagement with the switch contact 156. The open tone of the string 138 is sensed by transducer 156 which is mechanically coupled to string 138 in the manner shown in the embodiment depicted in FIGS. 1 through 8. The voltage 157 impressed in the auxiliary circuit 144 associated with the open string tone as when the transducer crystal is vibrated, is fed through an amplifier and rectifier circuit 158, and the DC output 159 of this circuit is used to energize the electromagnet 143' of relay 143.

The control switches 141 of the relays associated with the keyed string tones are normally open. However when the auxiliary circuit associated with a keyed string tone is energized for reasons of the switching action that transpires when the string is depressed by the player into contact with the fret section associated with the tone, the switch arm of the control switch 141 is drawn into engagement with the contact 160 of the switch and which in turn is connected to feed the signal associated with the switch into the readout line 155. The readout line of course is connected to the translation system 160 and like the other embodiments includes an amplifier 161 and loudspeaker 162.

One advantage to the system depicted in FIG. 7 lies in the ability to mount the transducer closer to the bridge end of the string if desired because the relays associated with the keyed string tones open the ground line for relay 143 and thus prevent actuation of the switch 154 when the keyed string tones are being played on string 138 and which could be sensed by the transducer. Yet another advantage to the system shown in FIG. 7 lies in the absence of components between the frets and which may be objectionable to some players of the stringed instrument because of the abnormal feeling obtained when pressing the string against movable components on the keyboard.

While only certain preferred embodiments of this invention have been shown and described by way of illustration, many modifications will occur to those skilled in the art and it is, therefor, desired that it be understood that it is intended in the appended claims to cover all such modifications as fall within the true spirit and scope of this invention.

What is claimed as new and what it is desired to secure by Letters Patent of the United States is:

1. The combination comprising a first musical instrument including a musical string having musical tones which are separately and selectively playable thereon including an open tone and keyed string tones, a second musical instrument including circuit means associated with said string for producing audible tones respectively corresponding in pitch to said musical tones, said circuit means being controllable by the player of said first musical instrument to produce said audible tones separately and in accord with the musical tones playable on said string, said circuit means having a plurality of circuits, each of said plurality of circuits being associated with a respective one of said musical tones and having a control switch actuatable to complete its circuit and thereby to produce an audible tone corresponding in pitch to said one of said musical tones, the control switches of all of said plurality of circuits being arranged in series in said circuit means, said circuit means further having an auxiliary circuit associated with the one of said plurality of circuits which is associated with said open tone for sensing vibration of said string and automatically actuating the circuit control switch of said one of said plurality of circuits in response to said sensing.

2. The combination in accord with claim 1 wherein said auxiliary circuit comprises sensing means mechanically coupled to said string for mechanically sensing vibration thereof, and means controlled by said sensing means for actuating said circuit control switch.

3. The combination in accord with claim 1 wherein said auxiliary circuit comprises transducer means for sensing vibration of said string and for impressing an electrical potential in said auxiliary circuit, and means responsive to the impressed potential for actuating said circuit control switch.

4. The combination in accord with claim 1 wherein said auxiliary circuit comprises sensing means for sensing vibration of said string and for inducing an electrical potential in said auxiliary circuit, and means responsive to the induced potential for actuating said circuit control switch, said sensing means including ferromagnetic material means vibratable by the player of said first musical instrument in playing said open tone.

5. The combination in accord with claim 1 wherein said first musical instrument has a keyboard, wherein said auxiliary circuit comprises transducer means mounted at the nut end of said keyboard and mechanically coupled to said string thereat for sensing vibration of said string at said nut end and for impressing an electrical potential in said auxiliary circuit, and means responsive to the impressed potential for actuating said circuit control switch, said combination further comprising spring means carried by said first musical instrument at said nut end for maintaining the mechanical coupling between said transducer means and said string.

6. The combination comprising a first musical instrument including a musical string having musical tones which are separately and selectively playable thereon including an open tone and keyed string tones, said instrument further including a keyboard against which said string is keyed in playing said keyed string tones thereon, a second musical instrument including circuit means associated with said string for producing audible tones respectively corresponding in pitch to said musical tones, said circuit means being controllable by the player of said first musical instrument to produce said audible tones separately and in accord with the selection of the musical tones played on said string, said circuit means having a plurality of circuits, each of said plurality of circuits being associated with a respective one of said musical tones and having control switch means actuatable to complete its circuit and thereby to produce an audible tone corresponding in pitch to said one of said musical tones, the control switch means of all of said plurality of circuits being arranged in series in said circuit means, each of the control switch means of the circuits associated with said keyed string tones being adapted and arranged in the circuits associated with the musical tones of lower pitch than the musical tone associated with its circuit to break the circuits associated with said tones of lower pitch upon being actuated.

7. The combination in accord with claim 6 wherein said circuit means further has an auxiliary circuit associated with the one of said plurality of circuits which is associated with said open tone for sensing vibration of said string and automatically actuating the circuit con-

trol switch means of said one of said plurality of circuits in response to said sensing.

8. The combination in accord with claim 6 wherein said circuit means further has an auxiliary circuit associated with the one of said plurality of circuits which is associated with said open tone, said auxiliary circuit comprising sensing means mechanically coupled to said string for mechanically sensing vibration thereof, and means controlled by said sensing means for automatically actuating the circuit control switch means of said one of said plurality of circuits in response to said sensing.

9. The combination in accord with claim 6 wherein said circuit means further has an auxiliary circuit associated with the one of said plurality of circuits which is associated with said open tone, said auxiliary circuit comprising transducer means for sensing the open tone producing vibration of said string and for impressing an electrical potential in said auxiliary circuit, and means responsive to the impressed potential for automatically actuating the circuit control switch means of said one of said plurality of circuits in response to said sensing.

10. The combination in accord with claim 6 wherein said circuit means further has an auxiliary circuit associated with the one of said plurality of circuits which is associated with said open tone, said auxiliary circuit comprising sensing means for sensing vibration of said string and for inducing an electrical potential in said auxiliary circuit, and means responsive to the induced potential for automatically actuating the circuit control switch means of said one of said plurality of circuits in response to said sensing, said sensing means including ferromagnetic material means vibratable by the player of said first musical instrument in playing said open tone.

11. The combination in accord with claim 6 wherein said circuit means further has an auxiliary circuit associated with the one of said plurality of circuits which is associated with said open tone, said auxiliary circuit comprising transducer means mounted at the nut end of said keyboard and mechanically coupled to said string thereat for sensing vibration of said string at the nut end thereof and for impressing an electrical potential in said auxiliary circuit, and means responsive to the impressed potential for actuating the circuit control switch means of said one of said plurality of circuits.

12. The combination comprising a first musical instrument including a musical string having musical tones which are selectively and separately playable thereon including an open tone and keyed string tones, said instrument further including a keyboard against which said string is keyed by the player's fingers in playing said keyed string tones thereon; and a second musical instrument including circuit means associated with said string for producing audible tones respectively corresponding in pitch to said musical tones, said circuit means being controllable by the player of said first musical instrument to produce said audible tones separately and in accord with the musical tones playable on said string; said circuit means having translating means for audibly reproducing electrical tone signals, and a plurality of circuits that include said translating means, each of said plurality of circuits being associated with a respective one of said musical tones, having signal producing means for producing an electrical tone signal corresponding in pitch to said one of said musical tones, and further having circuit control switching means actuatable to complete its circuit and thereby to produce an audible tone corresponding in pitch to said one of said musical tones; the circuit control switching means of all of said plurality of circuits being arranged in series in said circuit means, said circuit means further having an auxiliary circuit associated with the one of said plurality of circuits which is associated with said open tone having sensing means arranged to sense the open tone producing vibration of said string, and means controlled by said sensing means for automatically actuating the circuit control switching means of said one of said plurality of circuits; and each of the circuit control switching means of the circuits associated with said keyed string tones being controllable by finger pressure exerted by the player of the first instrument in keying said string.

13. The combination in accord with claim 12 wherein each of said plurality of circuits has a signal readout line for feeding the electrical signal to said translating means, wherein the circuit control switching means of each of said plurality of circuits is located in the signal readout line of its circuit and is adapted upon actuation to close the line thereat, and wherein each of the circuit control means of the circuits associated with said keyed string tones is further associated with the signal readout lines of the circuits associated with the musical tones of lower pitch than the keyed string tones of its circuit and is adapted upon actuation to open said readout lines.

14. The combination in accord with claim 12 wherein each of said plurality of circuits has a power line electrically connected to a power source for energizing the signal producing means of its circuit, wherein the circuit control switch means of each of said plurality of circuits is located in the power line of its circuit and is adapted upon actuation to close the power line thereat, and wherein each of the circuit control means of the circuits associated with said keyed string tones is further associated with the power lines of the circuits associated with the musical tones of lower pitch than the keyed string tone of its circuit and is adapted upon actuation to open said power lines.

15. The combination in accord with claim 12 wherein each of the circuit control switching means of the circuits associated with said keyed string tones has an auxiliary control circuit associated therewith for actuating the circuit control switching means thereof, wherein said string is of electrically conductive material and is connected to a power source, wherein said keyboard has frets and each fret has an electrically conductive fret section associated with one of said auxiliary control circuits, and wherein each of said auxiliary control circuits is energized through contact made between said string and its associated fret section.

16. The combination comprising a first musical instrument including a musical string having musical tones which are separately and selectively playable thereon including an open tone and keyed string tones, a second musical instrument including circuit means associated with said string for producing audible tones respectively corresponding in pitch to said musical tones, said circuit means being controllable by the player of said first musical instrument to produce said audible tones separately and in accord with the musical tones playable on said string, said circuit means including a circuit associated with said open tone for sensing vibrations of said string and automatically actuating said circuit means in response to said sensing.

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