Dec. 24, 1968 A. HONIG 3,417,648

MATRIX KEYBOARD PIANO INSTRUMENT

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Fig. 1

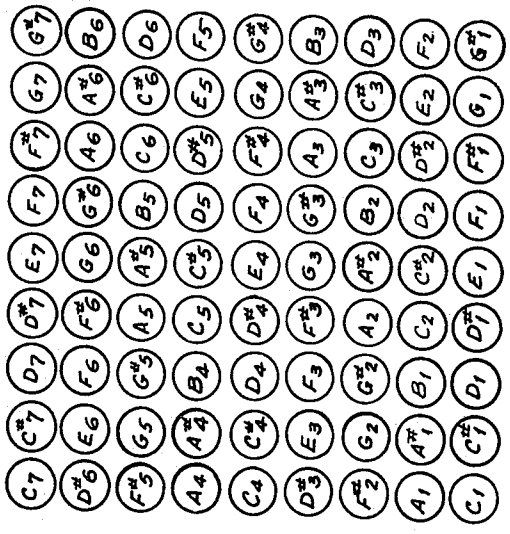


Fig. 2

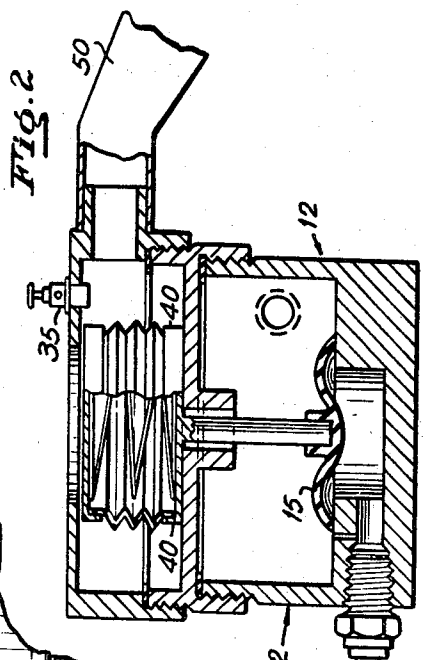
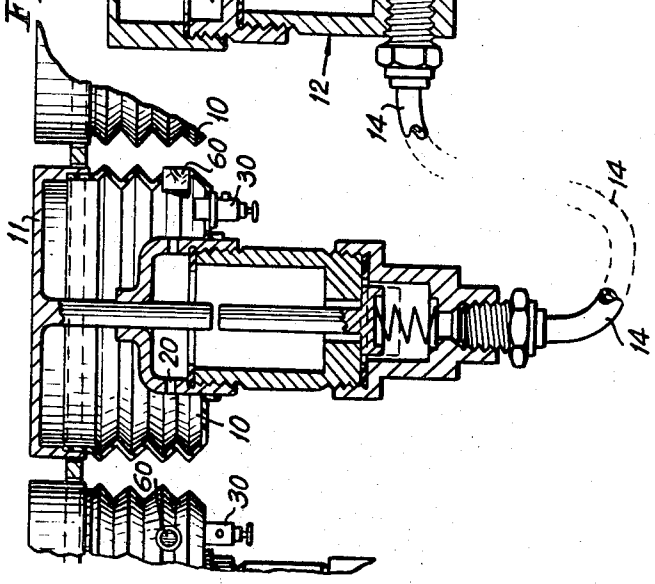


Fig. 3



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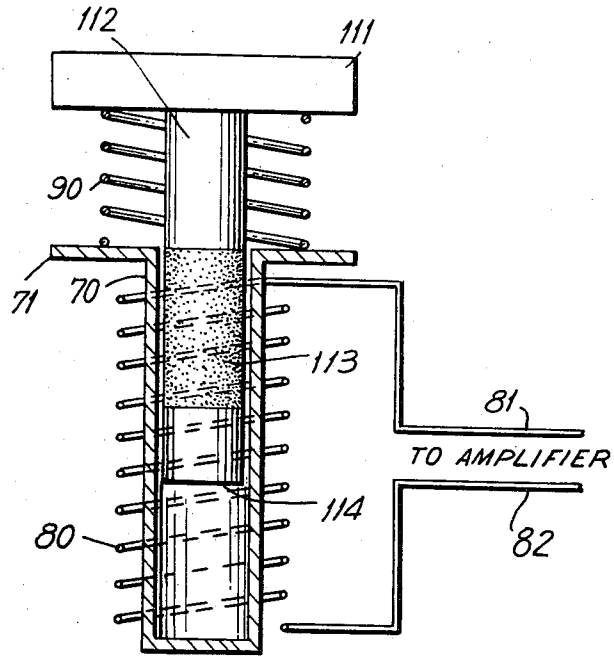
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Fig. 4



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MATRIX KEYBOARD PIANO INSTRUMENT

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15 Claims. (Cl. 84—423)

ABSTRACT OF THE DISCLOSURE

This invention relates essentially to a keyboard for use in combination with a pneumatic piano instrument. Said keyboard having a plurality of keys in a two-dimensional array corresponding to musical notes in a like chromatic succession, whereby a piano will respond to the actuation of said keys.

This invention makes possible the transformation of a conventional piano into an essentially new instrument, capable of entirely new musical production. This is accomplished by the introduction of a matrix keyboard which couples into presently existing or slightly modified pneumatic piano instruments.

Keyboards for musical instruments have been arranged in their present system for many years. Improvements in the arrangement of the keys for the musical tones have not been provided. This is especially so with regard to keyboards for instruments such as the piano, or the like. An arrangement commonly utilized on pianos includes a linear array of tones of uniformly ascending or descending pitch. This arrangement has several limitations. For example, chords which must include spaced tones, are limited to relatively small intervals in a particular register of the piano. Additionally, large melodic intervals are necessarily performed slowly and non-legato in comparison to closely spaced tone intervals. Furthermore, in most instances only the fingertips of the player of the instrument must be utilized due to the dissonance associated with the chromatic array of adjacent notes. The first two of these limitations have already been recognized by several famous composers, among whom are Hindemith and Toch, who wrote music on mechanical pneumatic player piano rolls to overcome these limitations. Clearly, this was not an adequate solution, since there is no way to have a performer, and hence no possibility of artistry or spontaneity.

It is a cardinal object of this invention, therefore, to provide a piano-type instrument amenable to manual performance, with special keyboard configurational advantages and without the limitations imposed by a linear piano keyboard, as described above.

This is done by creating a two dimensional matrix for the keyboard and providing a satisfactory linkage or coupling from the keyboard to a pneumatic piano instrument.

It is further envisaged that several such matrix keyboards can be mounted on the surfaces of a compact geometrical form such as a cube or parallelepiped. Four surfaces of a cube are readily accessible to a stationary performer, which enables him to control up to 4 complete piano instruments which can be played simultaneously and interwovenly, giving rise to striking stereo musical effects. A particular use of only two matrix keyboards allows control of two pianos, one of which may be tuned ¼ of a tone interval different from the other. A performer and composer thus has available an effective complete quarter-tone piano-type instrument.

The matrix keyboard piano instrument is provided with tone intensity control. In a simple version, this is provided by a pedal operated butterfly valve in the vacuum line of the pneumatic piano. In this case, the matrix keyboard can be attached to existing pneumatic pianos with essentially no modifications. In another novel and high performance version, a key and pneumatic system is described which provides individual note "action" control, whereby the tone intensity depends on the speed with which the key controlling the tone is depressed, as on conventional piano keyboards. This system requires a simple modification of existing pneumatic pianos.

An "action" control keyboard system for use with electromagnetically actuated pianos is also described.

The keyboard arrangement set forth herein will allow various effects to be devised according to special various keyboard arrangements. No matter what the arrangement, however, the configuration will permit a great number of keys to be arranged on the keyboard while still enabling ease of playing of the instrument.

With these objects in view, the invention consists of the novel features of construction and arrangement of parts which will appear in the following specification and recited in the appended claims, reference being had to the accompanying drawings in which the same reference numerals indicate the same parts throughout the various figures, and in which:

FIG. 1 is a schematic configuration of a particular desirable keyboard embodying this invention.

FIG. 2 is a sectional elevational view taken through one embodiment of a pressure responsive device utilized to activate a musical tone on a pneumatic piano, at variable tone intensity.

FIG. 3 is a sectional elevational view taken substantially through the center of one key device of an individual note "action" control keyboard.

FIG. 4 is a sectional elevational view in schematic, taken through another embodiment of a pressure responsive device utilized to activate a musical tone of a piano at variable tone intensity.

It will be realized that the arrangement set forth herein is merely by way of example and other arrangements of keys could be devised within the scope of the operation of this invention.

The arrangement disclosed in FIG. 1 is, however, a simple chromatically ascending arrangement in which close melodic groups can be easily played in the "horizontal" direction and wide intervals can be managed with facility along the "vertical" and "diagonal" directions.

The section of the keyboard shown in FIG. 1 consists of 81 tones or keys arranged in a tone system. Adjacent notes or keys in a horizontal direction are spaced in ascending or descending chromatic order, so that adjacent tones might be played by moving a finger to the right or left as on a conventional keyboard. Referring to the lowermost line of FIG. 1, however, if one were playing a chromatic scale, when the note to the extreme right of FIG. 1 were reached, the finger would have to pass upward one line and to the left side of the second row from the bottom of FIG. 1, to play the next note or key. This grouping of the keys will permit large intervals of notes to be played with one hand without movement of the hand. Thus, the player of the instrument may move from one register to other registers merely by spreading his fingers in a vertical direction, while he may play all the notes in a single register by moving his fingers horizontally over one, two or three horizontal lines of the keyboard. In this particular arrangement, the "vertical" direction produced major 6th intervals and the diagonal yields minor sevenths.

Thus, there is provided above a two dimensional keyboard array which may be utilized to obtain effects never before possible. Groups of notes may at times be activated by pressing downward with the hand through more than just fingertips as was only possible heretofore; for example the side of the hand can produce sequentially or simulta-

neously successive major sixth intervals in the "vertical" direction with the keyboard arrangement of FIG. 1.

Of course, it will be realized that arrangements other than the seven register, eighty one note square configuration shown in FIG. 1 are possible.

For example, an arrangement whereby all whole notes or whole tone intervals are in adjacent relationship may be provided along the horizontal rows, with alternate horizontal rows in chromatic relation.

Thus, many arrangements are possible within the concept of two dimensional matrix keyboards set forth herein, and in addition, one may easily change from one keyboard to another, for a given instrument with a simple cross-connected plug-in box.

In FIGS. 2 and 3 there is disclosed a method of operating the keyboard utilizing a pneumatic valve or the like to give "action" control for individual notes of a pneumatically driven piano.

In FIG. 3 a sectional elevational view of a single keyboard valve is shown, in schematic. Other keys in the keyboard will each have similar arrangements. The advantage of the arrangement shown is that individual tone intensity can be made to respond to the velocity with which a key is depresed, thereby yielding similar "action" to that existing on manual standard piano keyboards. The arrangement includes a bellows **10** surrounding the keyboard valve intake air hole **20**, a one-way air intake valve **60**, and a bleeder opening **30** to limit the pressure in excess of atmospheric pressure which is built up when the keys are struck and the bellows are compressed. The excess pressure depends on the velocity with which the key **11** of the keyboard is depressed and on the opening of bleeder **30**. This excess pressure within the bellows **10** can be utilized to produce a widened vacuum port **40** in the piano activator assembly **12**. Thus, it will be seen therein, as in FIGS. 2 and 3, that a pressure build up within the bellows **10** can be transmitted through the line **14** to the activator **12**. This excess pressure will cause the diaphragm **15** to move upward more strongly than under the influence of only atmospheric pressure, thereby opening the vacuum port **40** to an extent depending on the excess pressure in **14**. The combination of the extent of opening of port **40** and the size of the opening of bleeder **35** determine the vacuum in pneumatic **50** and thus the intensity of the struck note. Since bleeder **35** has a fixed opening, the note intensity depends on the velocity with which key **11** is depressed. Bleeders can be adjusted for proper dynamic range. One-way valve **60** allows maintenance of atmospheric pressure while the key is held depressed and quick recovery when the key is released.

It is to be noted that if individual note intensity variation is not required, then the bellows assembly **10**, **30** and **60** of FIG. 3 can be dispensed with, and then no modification would be required on the pneumatics of standard pneumatic piano actions; air line **14** would simply be connected directly to the tracker bar holes. For certain types of musical compositions, this would suffice, especially if a foot pedal is utilized to control a butterfly valve in the main vacuum line so as to control the general loudness.

Thus, it will be seen that there is provided herein a simplified arrangement for operating a keyboard such as disclosed in FIG. 1 and in the specification herein.

It is to be noted that although the pneumatic piano is at present most feasible, modifications may be added for an electromagnetically actuated piano. An "action" control could be produced with a key which moves a small magnet through a coil and thus provides a velocity dependent voltage which can be amplified and thence directly activate an electromagnetic piano action.

More particularly, as illustrated in FIG. 4, the key **111** will have a longitudinally extending projection **112**. A permanent magnet **113** may be affixed at the end of the projection **112** or may be wrapped around an extension thereof. The key **111** will be positioned so that in its downward movement, the permanent magnet **113** associated therewith will be caused to move longitudinally through a stationary coil **80** positioned in a corresponding relationship thereto.

A core of ceramic material or the like may be provided. likewise, an annular flange **71** may be provided at the open end of the core **70**. A spring **90** may be circumposed about the projection **112** of the key **111** and retained between the lower surface of the key **111** and upper surface of the flange **71** to maintain the key in its uppermost position. The leads **81** and **82** from the stationary coil **80** may be connected to an amplifier, not shown.

In operation, the key will be depressed and the permanent magnet **113** attached to the moving key induces a voltage in the stationary coil proportional to the velocity of key depression, that is, proportional to the movement of the magnet with respect to the coil. This voltage from the coil is transmitted over the leads **81** and **82** to be amplified as desired, so as to activate an electromagnetically operated piano. The holding switch provided at the bottom of the key trajectory insures maintaining the sounding note until the key is released despite the transient nature of the induced voltage which was used to activate the sounding note.

While there are above disclosed but a limited number of embodiments of the structure and product of the invention herein presented, it is possible to produce still other embodiments without departing from the inventive concept herein disclosed, and it is desired, therefore, that only such limitations be imposed on the appended claims as are stated therein, or required by the prior art.

What is claimed is:

1. A keyboard for use in combination with a pneumatic piano instrument, said keyboard comprising a key support structure, a plurality of keys arranged in a two-dimensional array on said support structure, said array comprising successive rows of keys corresponding to musical notes, each row corresponding to a chromatic succession of notes and each successive row succeeding from the last note of the preceding row, means mounting said keys on said support structure for resiliently yieldable finger depression relative to said support structure, and operating means connected to each key for operating respective tones of a piano instrument.

2. A keyboard according to claim **1**, said operating means being responsive to the speed of key depression for operating respective tones at an intensity corresponding to the speed of key depression.

3. A keyboard according to claim **2**, said operating means comprising a pneumatic chamber contractile upon depression of an associated key to increase pressure in the chamber, and restrictive bleeder means on said chamber for relieving pressure build-up in the chamber, whereby the amount of pressure built up corresponds to the speed of key depression.

4. A keyboard according to claim **1**, further including a butterfly valve in the main vacuum line to control the general loudness.

5. A keyboard according to claim **2**, said operating means comprising an electromagnetic coil associated with each key, and a magnetic core connected to each key for movement therewith through a respective coil to produce a voltage corresponding to the speed of key movement.

6. A keyboard according to claim **1**, said key-support structure having at least a pair of faces, said plurality of keys being arranged on one face of said support structure, a second plurality of keys arranged in a second two-dimensional array on another face of said support structure, said second array comprising successive rows of keys corresponding to musical notes, each row corresponding to a chromatic succession of notes and each successive row succeeding from the last note of the preceding row, additional means mounting said second plurality of keys on said support structure for resiliently yieldable finger depression relative to said support structure, and addi-

tional operating means connected to each of said second plurality of keys for operating respective tones of a second piano instrument.

7. A keyboard according to claim 6, said operating means being responsive to the speed of key depression for operating respective tones at an intensity corresponding to the speed of key depression.

8. A keyboard according to claim 7, said operating means comprising a pneumatic chamber contractile upon depression of an associated key to increase pressure in the chamber, and restrictive bleeder means on said chamber for relieving pressure build-up in the chamber, whereby the amount of pressure built up corresponds to the speed of key depression.

9. A keyboard according to claim 6, further including a butterfly valve in the main vacuum line of each of said first and said second piano instruments to control the general loudness of each.

10. A keyboard according to claim 7, said operating means comprising an electromagnetic coil associated with each key, and a magnetic core connected to each key for movement therewith through a respective coil to produce a voltage corresponding to the speed of key movement.

11. A keyboard according to claim 1, said key support structure having a plurality of faces, said plurality of keys being arranged on one face of said support structure, an additional plurality of keys arranged in a two-dimensional array on each additional face of said support structure, each of said additional arrays comprising successive rows of keys corresponding to musical notes, each row corresponding to a chromatic succession of notes and each successive row succeeding from the last note of the preceding row, additional means mounting said additional pluralities of keys on said support structure for resiliently yieldable finger depression relative to said support structure, and additional operating means connected to each of said additional pluralities of keys for operating respective tones of an additional number of piano instruments.

12. A keyboard according to claim 11, said operating means being responsive to the speed of key depression for operating respective tones at an intensity corresponding to the speed of key depression.

13. A keyboard according to claim 12, said operating means comprising a pneumatic chamber contractile upon depression of an associated key to increase pressure in the chamber, and restrictive bleeder means on said chamber for relieving pressure build-up in the chamber, whereby the amount of pressure built up corresponds to the speed of key depression.

14. A keyboard according to claim 11, further including a butterfly valve in the main vacuum line of each piano instrument to control the general loudness of each.

15. A keyboard according to claim 12, said operating means comprising an electromagnetic coil associated with each key, and a magnetic core connected to each key for movement therewith through a respective coil to produce a voltage corresponding to the speed of key movement.

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