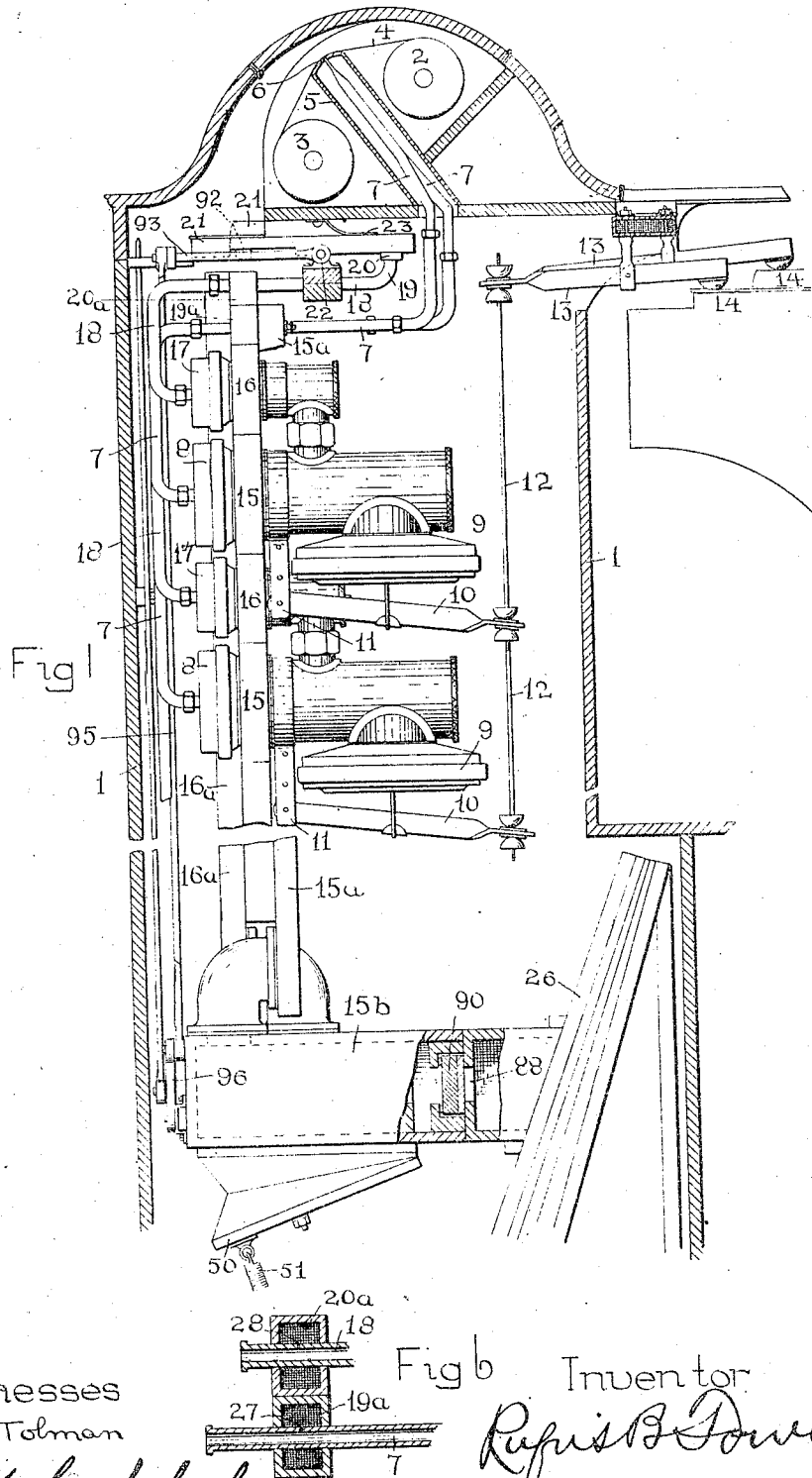


R. B. FOWLER.
PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS.
APPLICATION FILED MAY 2, 1904.

Patented Mar. 4, 1913.

5 SHEETS-SHEET 1.

1,054,760.



Witnesses
Roy D. Tolman
Penelope Lombard

Fig 2

Inventor

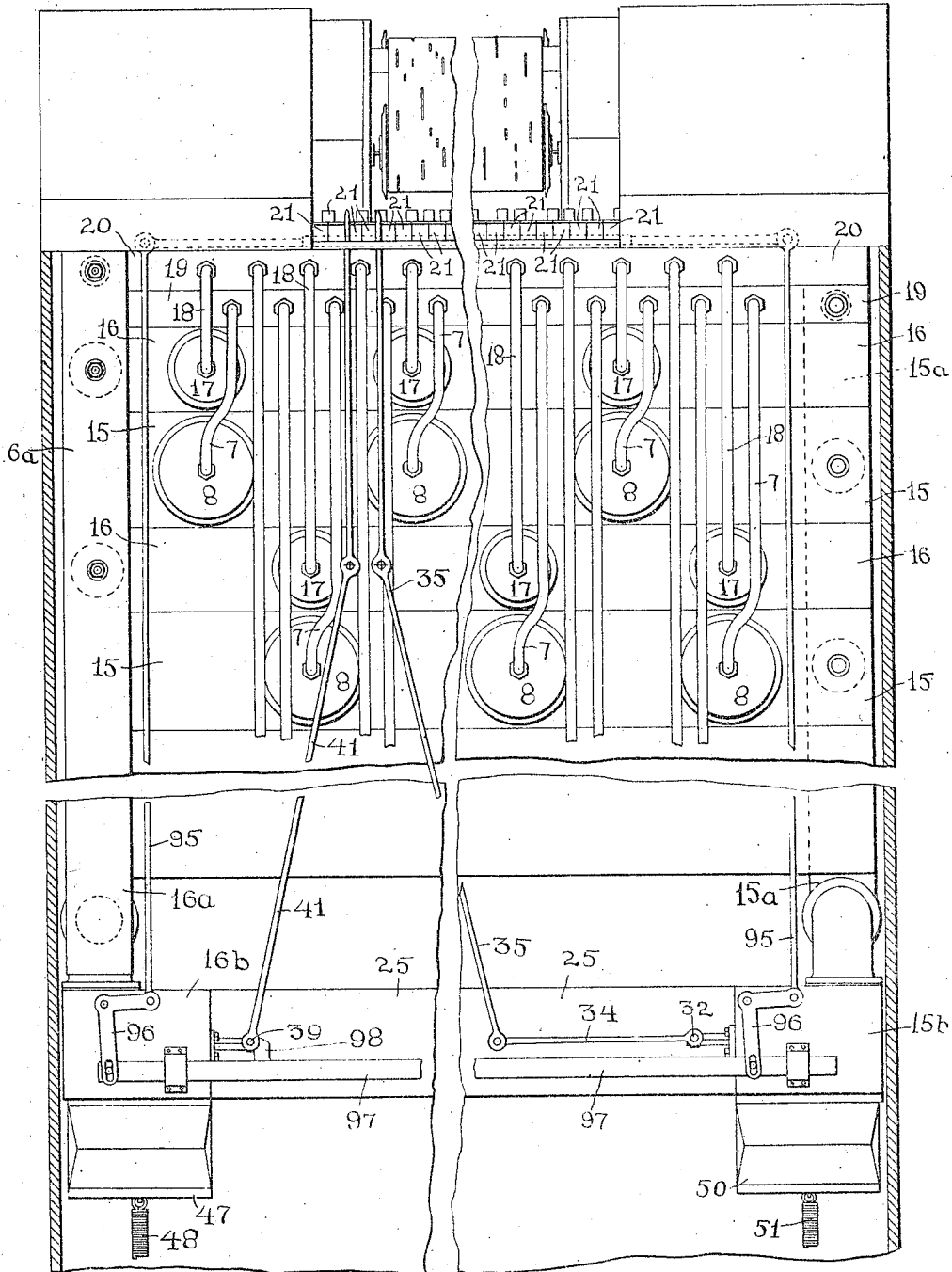
Rufus B. Fowler

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5 SHEETS—SHEET 2.



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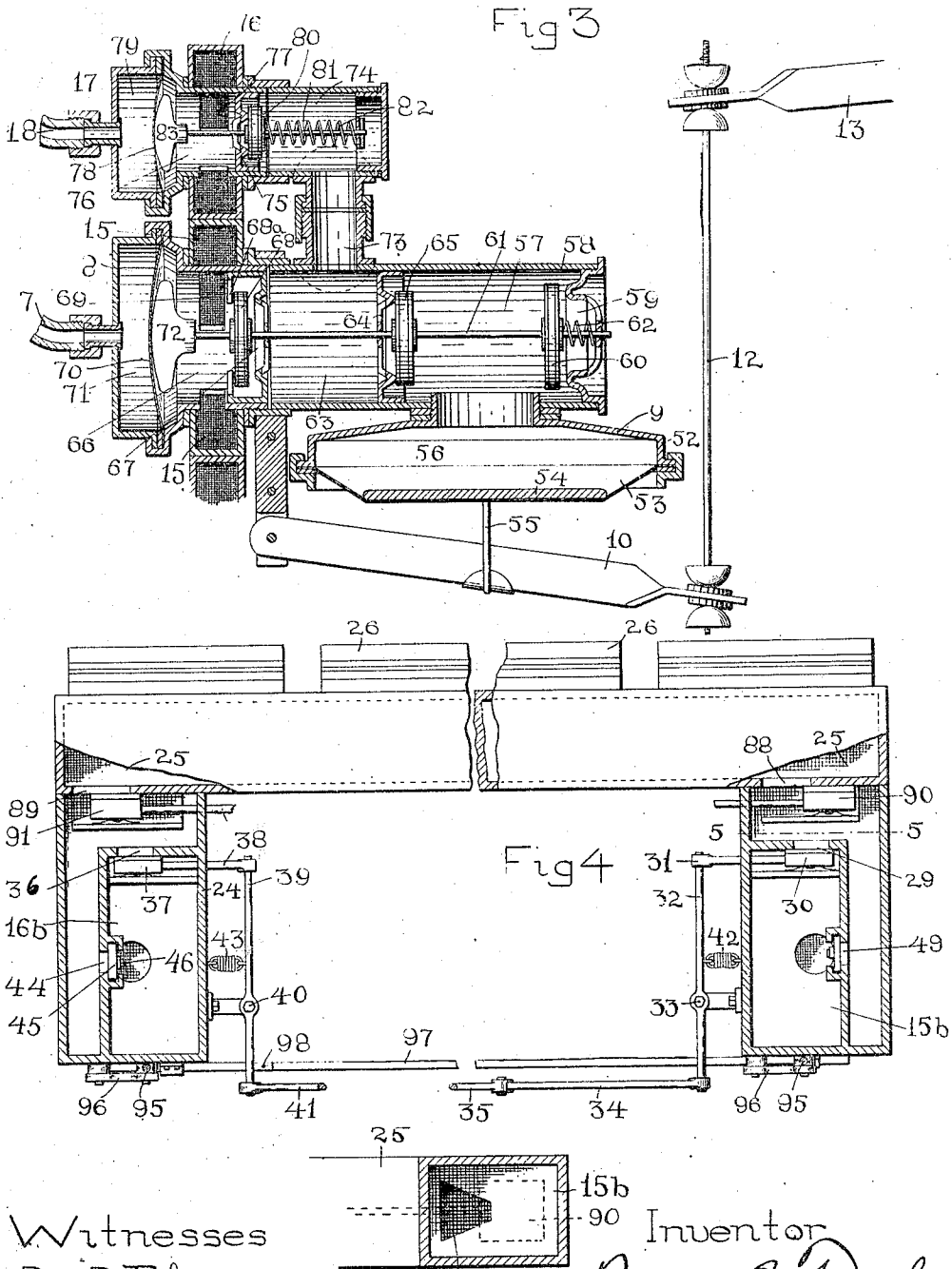
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5 SHEETS—SHEET 3.



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6 SHEETS-SHEET 4.

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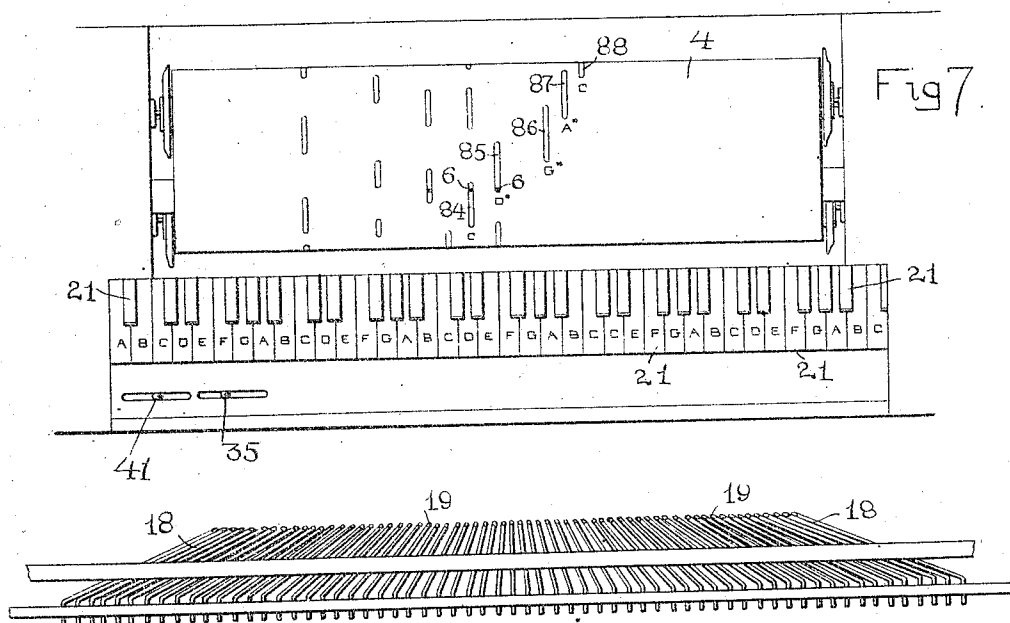


Fig 8

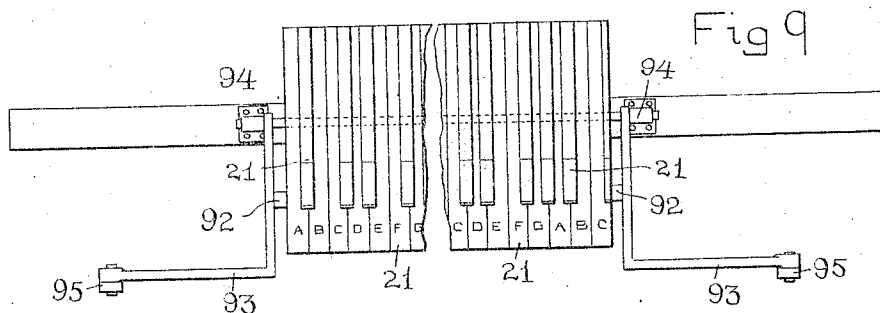


Fig 9

Witnesses

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5 SHEETS—SHEET 5.

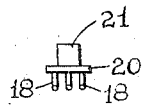
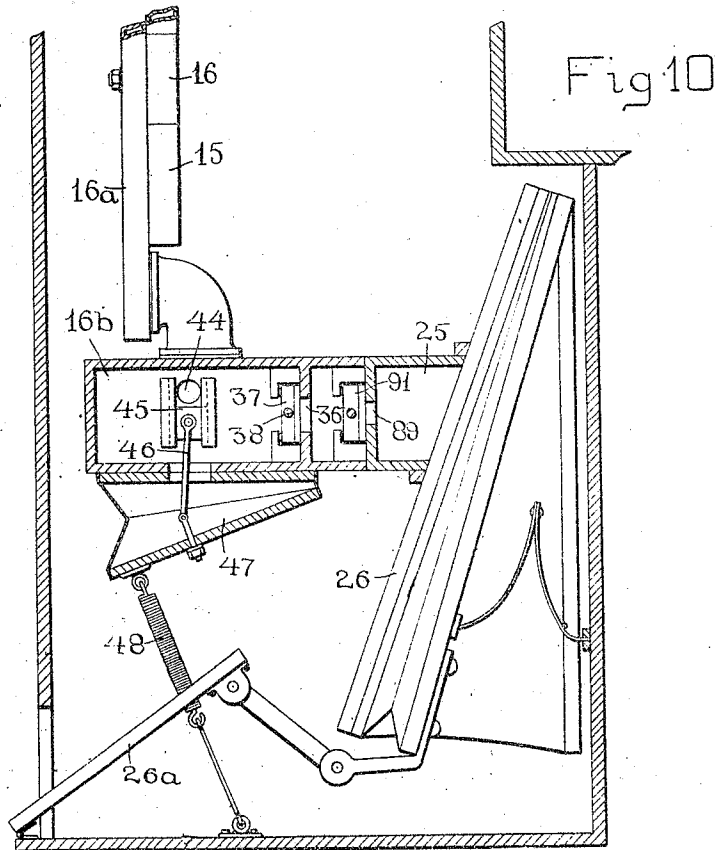


Fig. 11.

Witnesses

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UNITED STATES PATENT OFFICE.

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PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS.

1,054,760.

Specification of Letters Patent.

Patented Mar. 4, 1913.

Application filed May 2, 1904. Serial No. 205,877.

To all whom it may concern:

Be it known that I, RUFUS B. FOWLER, a citizen of the United States, residing at Worcester, in the county of Worcester and Commonwealth of Massachusetts, have invented a new and useful Improvement in Pneumatic Actions for Musical Instruments, of which the following is a specification, accompanied by drawings forming a part of the same, in which—

Figure 1 represents an end view of so much of a pneumatic action for musical instruments as is necessary to illustrate the character and mode of operation of my present invention with the inclosing case shown in sectional view. Fig. 2 is a front view. Fig. 3 is a vertical sectional view through that portion of the action comprising the valve and motor pneumatics. Fig. 4 is a top view of a detached portion of the action showing the sliding valves for controlling air passages leading to the bellows. Fig. 5 is a sectional view on line 5—5, Fig. 4, showing a front view of an air passage with the position of the closing valve represented by broken lines. Fig. 6 is a sectional view of the vent chambers. Fig. 7 is a top view of the accenting keys and perforated music sheet. Fig. 8 is a view of the upper ends of the key controlled pipes. Fig. 9 is a top view of a portion of the accenting keys and rocking lever actuated thereby for varying the force of an accented note. Fig. 10 is a side view of the suction bellows and connected wind chests, shown in sectional view, and Fig. 11 is a view of the rear end of one of the accenting keys with valves attached thereto.

Similar reference letters and figures refer to similar parts in the different views.

My present invention relates to a pneumatic mechanism employing a perforated music sheet for actuating a series of key strikers for depressing the keys of a musical instrument, such for example as a piano, and the object of my invention is to enable the operator to control at will the force applied to any individual key striker for the purpose of accenting any one or more of the tones produced.

In the embodiment of my invention I employ a perforated moving music sheet for opening and closing the ducts of a tracker board, by which air is periodically admitted to valve actuating pneumatics for the purpose of controlling air passages between a

vacuum chamber and motor pneumatics which are operatively connected with the key strikers as is common in that class of musical instruments known as piano players.

The object of my present invention is to provide means by which any one of the tones sounded by the piano may be increased in force or accented and I accomplish this result by providing an auxiliary vacuum chamber having a greater air exhaustion than the main vacuum chamber, and connected by a valve controlled air passage with each of the motor pneumatics, and providing means comprising a series of keys or manuals for controlling said air passages at the will of the operator.

By the mechanism hereinafter described the motor pneumatics are individually connected with a main vacuum chamber by the movement of the perforated music sheet over the tracker board, causing the key strikers to be individually operated with a force determined by the air exhaustion in the main vacuum chamber as in piano players now in use, but by the use of a series of keys or manuals corresponding to the key strikers, I enable the performer to connect at will any one of the motor pneumatics with an auxiliary vacuum chamber, having a greater air exhaustion than the main vacuum chamber, so that the force of the key striker actuated by said motor pneumatic will be increased and the tone sounded thereby accented.

In order to facilitate the accenting of desired tones I arrange a series of keys or manuals in the instrument corresponding to keys of the piano which are acted upon by the key strikers, and I place upon or contiguous to each of the natural or white keys a letter to indicate the note corresponding to the tone of the piano in each of the octaves, and I print upon the music sheet contiguous to the perforations of those notes which are to be accented, a letter indicating the corresponding tones of the piano, thereby enabling the operator without any knowledge of music to correctly accent any of the marked notes by depressing the key in any particular octave marked with a letter corresponding to that upon the music sheet.

In carrying out my invention I do not wish to confine myself strictly to the minor details of construction as hereinafter set forth, but I believe it to be broadly new in

instruments of the class described to provide a series of individual keys or manuals corresponding with the keys of the piano, actuated by the key strikers, and providing a mechanism capable of being controlled by said keys, whereby the force of the key strikers can be individually varied at the will of the operator.

Referring to the accompanying drawings 1 denotes the inclosing case for a pneumatic action for musical instruments embodying my invention, 2 and 3 denote music rolls from which a perforated music sheet 4 is unwound from roll 2 and wound upon roll 3 during the operation of the mechanism, roll 3 being rotated by a motor, not shown, which may be of any known form of construction now employed in pneumatic actions of this class. 5 denotes a tracker board containing a series of ducts 6 which are closed by the music sheet and are opened to the admission of air during the passage of the perforations over the ducts 6. Communicating with each of the ducts 6 are pipes 7 leading to a series of valve pneumatics 8 by which valve controlled passages are opened and closed connecting motor pneumatics 9 alternately with a vacuum chamber and with the outer air. The motor pneumatics 9 are operatively connected with levers 10 pivoted at one end to brackets 11 and having their free ends connected by links 12 with pivoted key strikers 13 which extend over keys 14, 14 of a piano and are arranged to depress the piano keys by the action of the motor pneumatics 9 as the latter are controlled by the action of the valve pneumatics 8, said valve pneumatics 8 being in turn controlled by the opening and closing of the openings 6 in the tracker board by the perforated music sheet 4. By the operation of the valve pneumatics 8, when air is admitted to the openings 6, the interior of the motor pneumatics 9 is closed to the outside air, and connected with vacuum chambers 15 from which air has been exhausted by any suitable means, such for example as a foot bellows, causing the motor pneumatics to be collapsed by the atmospheric pressure upon the outside, thereby actuating the key strikers 13 to depress the piano keys 14 with a force proportioned to the amount of air exhaustion from the vacuum chambers 15, and thereby causing a tone to be sounded pianissimo or fortissimo or with any intermediate force. The construction and arrangement of key strikers 13, motor pneumatics 9, valve pneumatics 8, tracker board 5, and perforated music sheet 4 are substantially the same as the comparable parts in piano players now in use.

The object of my present invention is to enable any one of the tones sounded upon the piano to be accented at the will of the performer and independently of the air ex-

haustion from the vacuum chambers 15, and I accomplish this result by a separate series of vacuum chambers 16, preferably arranged contiguous to and paired with the vacuum chambers 15. The vacuum chambers 16 are connected with the motor pneumatics 9 by valve controlled passages which are opened and closed by the action of valve pneumatics 17 having inlet pipes 18 for admitting air thereto provided with open ends 19 which are normally closed by a valve 20 attached to the end of a key 21 pivoted at 22 and acted upon by a spring 23 to depress the end of the key and normally hold the valve 20 in contact with the open end 19 of the air pipe 18 leading to the valve pneumatics 17. For convenience in construction the vacuum chambers 15 and 16 are arranged one above the other in a vertical plane with their edges in contact, thereby forming a support for each other and above the vacuum chambers 15 and 16 are placed two vent chambers 19^a and 20^a. The vent chamber 19^a and vacuum chambers 15 are connected to and communicate with a vertical pipe 15^a leading to an air chest 15^b and the vent chamber 20^a and vacuum chambers 16 are connected to and communicate with a vertical pipe 16^a leading to an air chest 16^b.

The air chests 15^b and 16^b communicate with the opposite ends of a common air chest 25 from which air is exhausted by a bellows 26, and operated by a foot pedal 26^a in the usual manner in instruments of this class. The air exhaustion in the vent chamber 19^a and vacuum chambers 15 will be uniform, as they all communicate with a common pipe 15^a, and the air exhaustion in the vent chamber 20^a and vacuum chambers 16 will also be uniform as they communicate with a common air pipe 16^a. The pipes 7 leading from the tracker board to the primary pneumatics 8 will pass through the vent chamber 19^a and are provided with vent holes 27, Fig. 6, to allow air to be exhausted from the pipe 7 when the ducts of the tracker board are closed. The pipes 18 leading to the auxiliary valve pneumatics 17 likewise pass through the vent chamber 20^a and are provided with vent holes 28 to allow the pipes 18 to be exhausted when their open ends 19 are closed by the key valves 20. An opening 29 between the air chests 15^b and 25, Fig. 4, is controlled by a sliding valve 30 having a valve stem 31 connected with one end of a lever 32 pivoted at 33, and having its opposite end connected by a link 34 with a vertical lever 35, arranged to be operated by the performer to control the size of the opening 29 and regulate the movement of air from the air chest 15^b into the air chest 25, and thereby control the air exhaustion in the vacuum chambers 15 and vent chamber 19^a. The air chest 16^b communicates with the air chest 25 through an opening 36 whose

size is determined by a sliding valve 37 having a valve stem 38 connected to one end of a lever 39 pivoted at 40 and connected at its opposite end with a vertical lever 41 arranged to be operated by the performer and thereby control the air pressure in the vacuum chambers 16 and vent chamber 20^a.

The openings 29 and 36 are normally closed by the valves 30 and 37, which are held in their closed positions by springs 42 and 43 and the communication between the air chests 16^b and 25 is accomplished by means of an opening 44 having a sliding valve 45 connected by a link 46 with the hinged leaf of a regulating bellows 47. The bellows 47 is normally held open by a spring 48 attached to the case of the machine. Air is exhausted by the foot bellows 26 from the air chest 25 and also through the opening 44 from the air chest 16^b, pipe 16^a, vacuum chambers 16 and vent chamber 19^a until the air exhaustion in the air chest 25 is sufficient to allow atmospheric pressure upon the regulating bellows 47 to counteract the tension of the spring 48 and close the opening 44 by the sliding valve 45. The amount of air exhaustion therefore from the vacuum chambers 16 and vent chamber 19^a will be determined by the tension of the spring 48. The air chest 15^b is likewise provided with a similar valve controlled opening 49, regulating bellows 50 and spring 51 having a suitable tension to give the desired air exhaustion in the air chest 15^b and consequently in the vacuum chambers 15 and vent chamber 20^a. I make the tension of the spring 48 greater than the tension of the spring 51 so that the air exhaustion in the vacuum chambers 16 and vent chamber 20^a will be greater than the air exhaustion from the vacuum chambers 15 and vent chamber 19^a. If any one of the motor pneumatics 9 be connected with a vacuum chamber 16 instead of a vacuum chamber 15, the air exhaustion produced within the motor pneumatic will correspond with the air exhaustion from the vacuum chamber 16 and the force exerted by the motor pneumatic through the lever 10, link 12, and key striker 13 will be correspondingly increased over the force exerted when said motor pneumatic is connected with a vacuum chamber 15, thereby accentuating the tone produced by the particular key striker actuated by said motor pneumatic. The method of connecting at will a motor pneumatic with either a vacuum chamber 16 or a vacuum chamber 15 is illustrated in the sectional view shown in Fig. 3. The motor pneumatic 9 consists of a cup shaped shell 52 having a flexible diaphragm 53 on which is supported a follower 54 connected by a link 55 with the pivoted lever 10. The interior chamber 56 of the motor pneumatic communicates with an air space 57 in a hori-

zontal tube 58 from which the shell 52 is supported. The air space 57 communicates with the outside air through an opening 59 arranged to be closed by a valve 60 carried on a valve stem 61, but normally held open by a spiral spring 62 so as to admit air to the chamber 56 of the motor pneumatic. The air space 57 is also connected with an air space 63 by means of an opening 64 which is normally closed by a valve 65 carried on the valve stem 61. The air space 63 is also connected with an air space 66 through an opening 67 arranged to be opened and closed by a check valve 68 capable of sliding on the valve stem 61, but having its movement limited by the spurs 68^a. The air space 66 communicates with the vacuum chamber 15 through openings 69 and is separated by a flexible diaphragm 70 from an air chamber 71, which is connected by a pipe 7 with one of the openings 6 in the tracker board. Pressing against the diaphragm 70 by the tension of the spiral spring 62 is a follower 72 in which is mounted the valve stem 61. The air space 63 communicates by an air passage 73 with an air space 74 which communicates by an opening 75 with an air space 76 communicating by an opening 77 with a vacuum chamber 16. The air space 76 is separated by a flexible diaphragm 78 from an air space 79 which communicates with a pipe 18, the opposite end of which is normally closed by a valve 20 attached to a pivoted key 21. The opening 75 between the air spaces 74 and 76 is normally closed by a valve 80 attached to a valve stem 81 and normally held against its valve seat by a spiral spring 82. The valve stem 81 is mounted in a follower 83 which is held against the flexible diaphragm 78 by the tension of the spring 82.

The operation of the valve mechanism shown in Fig. 3 is as follows:—Whenever a perforation in the music sheet passes over an opening in the tracker board, air is admitted through the pipe 7 to an air space 71 upon one side of the flexible diaphragm 70 and as a partial vacuum exists in the air space 66 on the opposite side of the flexible diaphragm 70 owing to its communication with the vacuum chamber 15, from which air has been exhausted by the bellows 26, the flexible diaphragm is moved to the right, thereby sliding the valve stem 61 against the tension of the spiral spring 62, until the valve 60 has closed the opening 59, thereby cutting off the communication between the chamber 56 of the motor pneumatic and the outside air. Simultaneously with the closing of the valve 60, the valve 65 is opened, making a direct communication between the chamber 56 of the motor pneumatic and the vacuum chamber 15, into which air rushes from the motor pneumatic 9, allowing the diaphragm 53 to be raised by the atmos-

pheric pressure beneath it, thereby swinging the lever 10 and key striker 13 to depress one of the keys of the piano, the force of the blow exerted by the key striker 13 being determined by the amount of air exhaustion from the vacuum chamber 15. If it is desired to accent a note sounded by the piano key when struck by the key striker 13, one of the keys 21, corresponding to the piano key to be struck, is depressed by the performer, thereby lifting one of the valves 20 and opening one of the pipes 18 through which air rushes to the air space 79 upon one side of the flexible diaphragm 78, and as the air in the space 76 is partially exhausted by its communication through the opening 77 with the vacuum chamber 16, the flexible diaphragm 78 will be at once pushed to the right, sliding the valve stem 81 against the tension of the spiral spring 82, and thereby opening a communication between the vacuum chamber 16 and the air space 63, and as the air exhaustion in the vacuum chamber 16 is greater than the air exhaustion in the vacuum chamber 15, the sliding check valve 68 will be moved on the valve stem 61 toward the right, thereby closing the opening 67 and preventing an inrush of air into the air space 63 from the air space 66, which would tend to equalize the air pressure in the two vacuum chambers 15 and 16. The communication is thus established between the air space 63 and the vacuum chamber 16 by the depression of the key 21 just before the perforation in the paper corresponding to the tone to be sounded reaches a duct of the tracker board. When the perforation in the music sheet reaches the tracker board, air is admitted through the pipe 7 to the air space 71, thereby sliding the valve stem 61 to close the valve 60 and open the valve 65 when the air from the chamber 56 of the motor pneumatic will rush through the opening 64 upward through the air passage 73 and into the vacuum chamber 16, thereby causing the key striker 13 to be actuated with a force corresponding to the air exhaustion in the vacuum chamber 16. If the keys are narrower than the keys of the piano, the open ends 19 of the pipes 18 will slightly converge as shown in Fig. 8. In order to enable the proper keys 21 to be depressed by a performer unacquainted with the music played, I place upon the keys 21 the letters *a*, *b*, *c*, *d*, *e*, *f*, and *g*, to denote the corresponding notes of each octave as shown in Fig. 7, and at the beginning of each perforation required to be accented I place a corresponding letter upon the music sheet 4 as shown in Fig. 7. The lower letter *c* on said music sheet indicating that the key marked *c* of the middle octave is to be depressed as the perforation 84 approaches one of the openings 6 in the tracker board. The next note at the right

marked *d* sharp indicates that the corresponding key in the middle octave is to be depressed as the perforation 85 approaches the opening 6 in the tracker board. In like manner the keys of *g* sharp and *a* sharp of the middle octave are to be depressed as the perforations 86 and 87 approach the tracker board; and as the perforation 88 approaches the tracker board the key of *c* in the first octave above the middle is to be depressed. If none of the keys are depressed during the movement of the perforated sheet over the tracker board, the key strikers will be actuated in the same manner as in pneumatic musical instruments of this class now in common use, and the proper key strikers will be selected by the perforations of the music sheet as it is moved over the tracker board, while the force imparted to each striker can be controlled by the manipulation of the lever 35 and valve 30, by which the communication between the air chests 15^b and 25 can be varied by the performer independently of the regulating bellows 50; but whenever an additional force is required to be given any individual key striker in order to accent a tone, one of the keys 21 is depressed by the performer before the corresponding perforation in the music sheet reaches the tracker board, and any desired variation in the amount of accent or extra force imparted to the key striker may be controlled by the performer through the lever 41 and valve 37, thereby varying the communication between the air chests 16^b and 25 independently of the regulating bellows 47.

Interposed between the wind chests 15^b and 16^b and the wind chest 25 are openings 88 and 89, closed at will by sliding valves 90 and 91 having their valve stems connected with hand levers, not shown, in order to allow the openings 88 and 89 to be closed; and entirely shut off all communication between the vacuum chambers 15^b and 16^b and the foot bellows, which is required during the re-winding of the music sheet upon the roll 2.

Beneath the keys 21 is a bar 92 which I term a universal bar, attached at each end to the bent arms 93, which are pivoted at one end at 94 and connected at their free ends by links 95 and bell cranks 96 with the horizontally sliding bar 97. The bar 97 is provided with a spur 98 arranged to contact with the lever 39, Fig. 4. The bar 92 is arranged to be depressed when any one of the keys 21 is depressed, thereby sliding the bar 97 toward the left as shown in Fig. 2 and rocking the lever 39 to withdraw the valve 37, and increase the opening 36, thereby allowing the air to flow more freely from the wind chest 16^b into the wind chest 25 and increasing the air exhaustion from the vacuum chambers 16 and vent chamber 130

20 with a consequent increase in the force of the key striker corresponding to the key 21 which has been depressed.

I am aware that it has been proposed to accent one or more of the tones produced by the action of the key strikers by the employment of a motor pneumatic, which may be connected at will with either one of two vacuum chambers having differing states of air exhaustion, by means of valve controlled passages, one of said passages being opened and closed as determined by the movement of the perforated music sheet over the ducts of the tracker board and the other valve controlled passage being opened and closed as determined by the opening and closing of an air pipe by the performer. It is however broadly new to employ individual keys or manuals corresponding to the individual key strikers, and exposed to view and arranged to be depressed individually by the performer, either at will, as indicated by an arbitrary mark on the music sheet, or without regard to the position of the mark on the sheet.

While I contemplate the employment of as many keys or manuals as there are key strikers, so that the force of each key striker may be controlled by its own corresponding key, I do not wish to confine myself to such use, as a lesser number may be employed if desired. Neither do I wish to confine myself to the use of a single key for each of the valves closing the ends of the air pipes 18, as it will be obvious that two or more of said valves can be attached to one key as shown in Fig. 11, where three of the valves 20 are attached to a single key 21. In the same manner the valves including an entire octave can be attached to and raised by a single key. Although it has been proposed to employ two vacuum chambers of differing air exhaustion, and to connect the motor to either by valve controlled passages, no means have been employed, so far as I am aware, to maintain a uniform air exhaustion on opposite sides of the valve operating diaphragms, while said diaphragms were not in action. I accomplish this by maintaining two separate vent chambers in which the air exhaustion is the same as the air exhaustion in the corresponding vacuum chambers, and by placing a check valve 68 between the vacuum chambers 15 and 16, thereby preventing the equalizing of the air pressures in the two vacuum chambers, and causing the pipes 7 and 18 to vent into said vent chambers having the same air exhaustion as the vacuum chambers 15 and 16, so that the air pressure upon the opposite sides of the valve operating diaphragms, when the pipes 7 and 18 are closed, will always be the same.

Although I have shown and described a pneumatic mechanism in which a motor

pneumatic for actuating a key striker is connected at will with either one of two vacuum chambers having differing degrees of air exhaustion. I do not confine myself to this construction and I do not claim such an arrangement as new.

My present invention relates particularly to the employment of keys or manuals arranged to be depressed at will by the performer, whereby corresponding key strikers are actuated with an increased force, and I have illustrated this feature which, so far as I am aware is broadly new, in connection with two vacuum chambers having differing degrees of air exhaustion as a convenient means of illustrating the use of individual keys or manuals corresponding with the key strikers for the purpose named.

I have shown my invention as applied to a pneumatic mechanism adapted to operate upon the keys of a musical instrument by means of motor pneumatics through the medium of pivoted levers or key strikers, but the employment of a series of keys or manuals corresponding with the series of motor pneumatics, whereby each individual tone may be accented at will, is equally applicable to a pneumatic mechanism in which the motor pneumatics are directly connected with the note producing mechanism of the instrument to be played, as in a so called "interior player."

What I claim as my invention and desire to secure by Letters Patent is:—

1. In a musical keyboard instrument, the combination with a series of tone producing mechanisms and means for actuating said tone producing mechanisms, of means for varying the force of said actuating mechanisms with reference to each of said tone producing mechanisms individually and independently of the other tone producing mechanisms, and individual keys or manuals arranged in a series corresponding to the keys or manuals of the instrument operatively connected with said force varying means.

2. In a musical keyboard instrument, a series of tone producing mechanisms, an actuating mechanism for each of said tone producing mechanisms, means for separately varying the actuating force of each of said tone producing mechanisms, a series of keys or manuals corresponding with said tone producing mechanisms individually connected with said separate force varying means.

3. The combination with a series of motor pneumatics corresponding with the tones to be produced and means for actuating each of said motor pneumatics independently with different degrees of force, of a series of keys or manuals corresponding to the keys of a keyboard instrument for individually controlling the degree of force applied to each actuating means.

4. The combination with a series of motor pneumatics corresponding with the tones to be produced, mechanism for actuating each of said motor pneumatics independently of the others with different degrees of force, means for connecting each of said motor pneumatics with said independent actuating mechanisms, comprising a series of keys or manuals corresponding with the series of tone producing mechanisms.

5. The combination with a series of automatic mechanisms, each arranged to operate a single tone producing mechanism, means for applying different degrees of force to each automatic mechanism, means for determining the degree of force to be applied to said automatic mechanism, and a separate key or manual arranged to operate each force determining means, said keys or manuals arranged in series to correspond with the keys of a keyboard instrument.

6. The combination with a series of tone producing mechanisms, each arranged to produce a single tone, separate means for actuating each of said tone producing mechanisms with different degrees of force independently of the other tone producing mechanisms, and means for connecting each of said tone producing mechanisms with its separate actuating mechanisms, comprising a series of keys or manuals corresponding with the keys or manuals of the instrument.

7. The combination in a keyboard musical instrument, with a series of automatic mechanisms each arranged to produce a single tone, means for actuating each of said tone producing mechanisms with different degrees of force, and a separate key or manual operatively connected with each of said actuating means, with said keys or manuals arranged to correspond with the keys or manuals of the instrument.

8. The combination with a series of tone producing mechanisms, of individual auto-

matic mechanisms for actuating each of said tone producing mechanisms, with different degrees of force, means for connecting said tone producing mechanisms with each of said actuating mechanisms at will, comprising a key or manual corresponding to each of said tone producing mechanisms.

9. In a musical keyboard instrument, the combination with a series of pneumatic mechanisms, each adapted to produce a single tone, of a series of separate vacuum chambers having different degrees of vacuum arranged in pairs, means for connecting each of said pneumatic mechanisms alternately with either vacuum chamber in said pairs of vacuum chambers at will, comprising a key or manual corresponding to the individual tone producing mechanism.

10. In a musical instrument, the combination of a tone producing mechanism, comprising a motor pneumatic, a main vacuum chamber, an auxiliary vacuum chamber, valve controlled passages connecting said motor pneumatic with each of said vacuum chambers, a key or manual for controlling the connection between said motor pneumatic and said auxiliary vacuum chamber by the depression of the free end of said key, and means for restoring said key to its normal position.

11. In a musical instrument of the class described, the combination with a series of tone producing mechanisms, and means for actuating said tone producing mechanisms, of a series of keys or manuals corresponding with said tone producing mechanisms connected with said actuating mechanisms and arranged to be depressed by the performer, whereby the force applied to said tone producing mechanisms is varied.

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Witnesses:

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