No. 833,995. PATENTED OCT. 23, 1906.

G. P. BRAND.

MECHANICAL MUSICAL INSTRUMENT.

APPLICATION FILED OCT. 26, 1900.

4 SHEETS—SHEET 1.

Fig. 2.

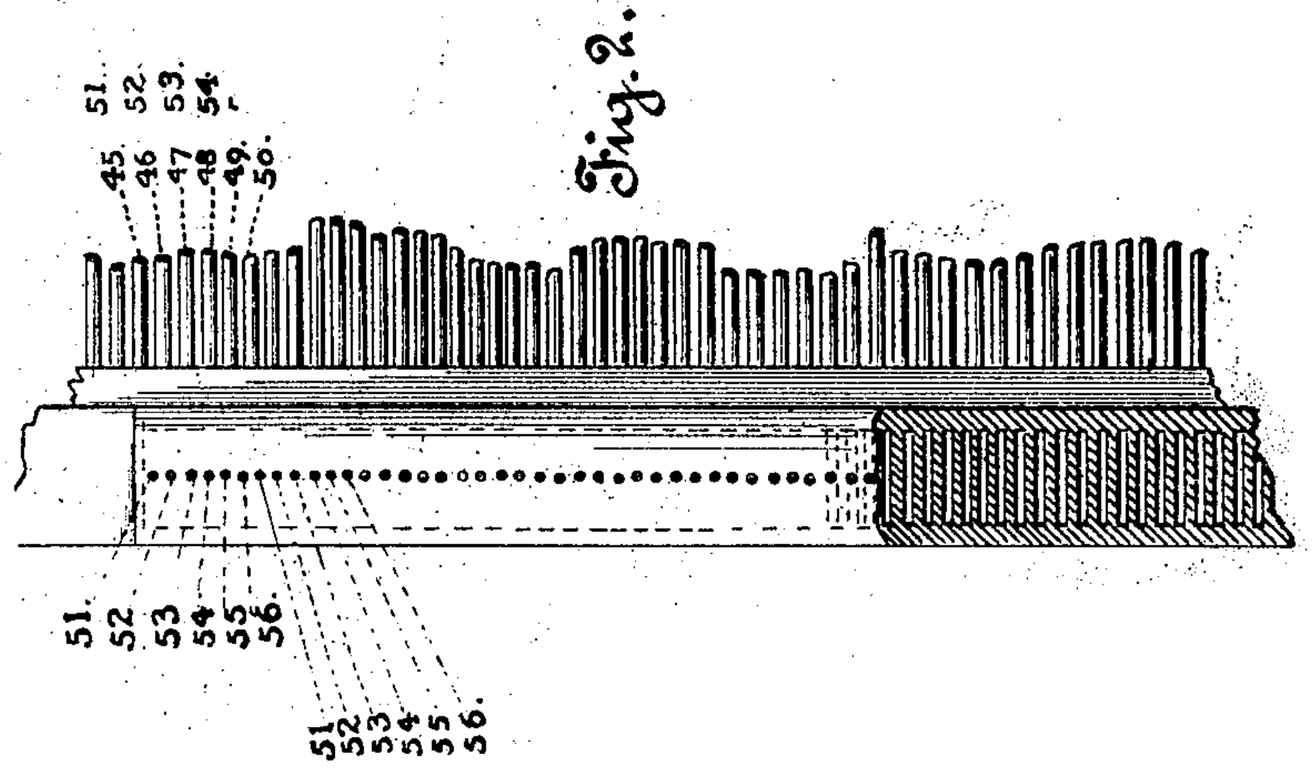
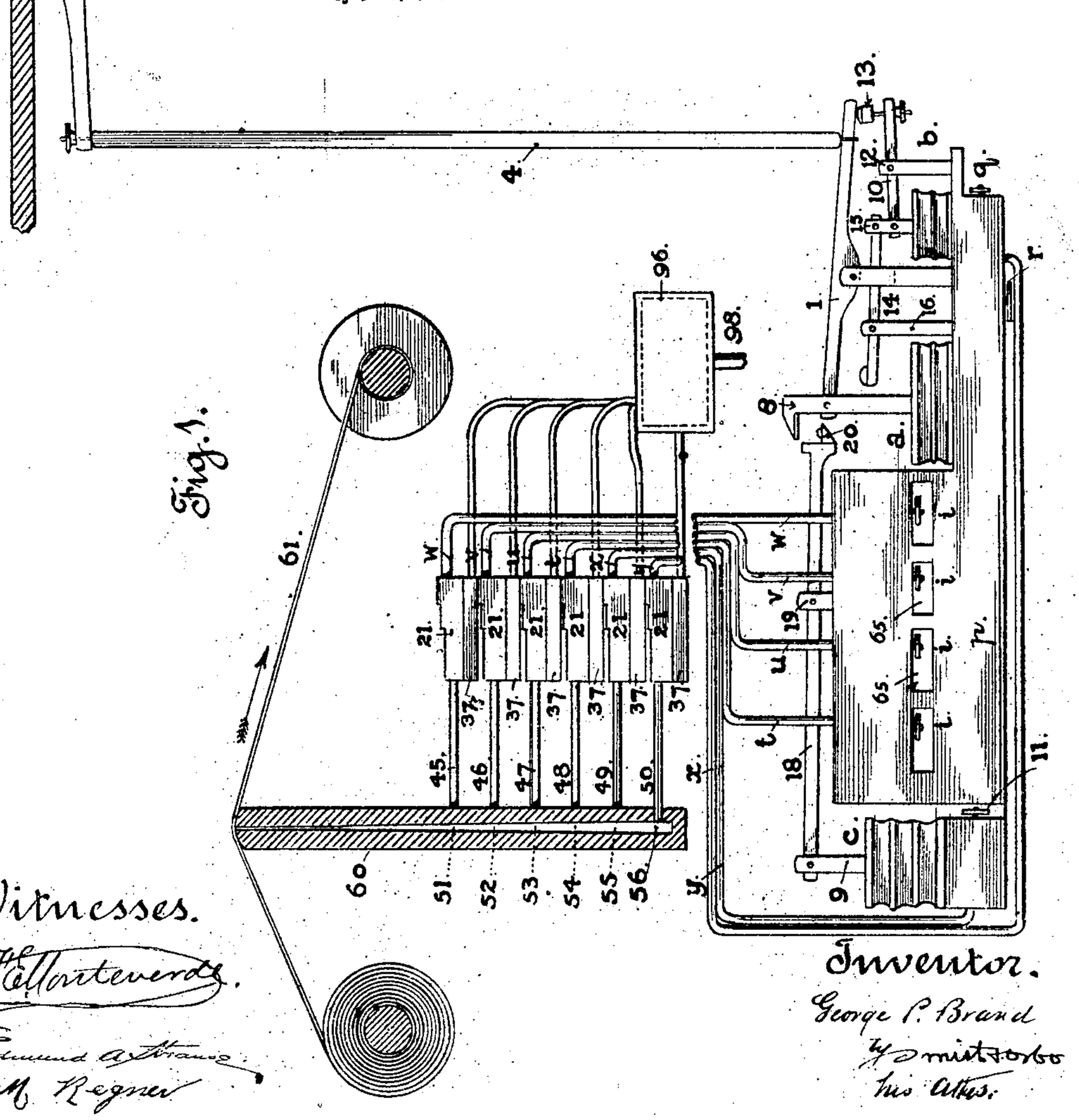


Fig. 1.



Witnesses.

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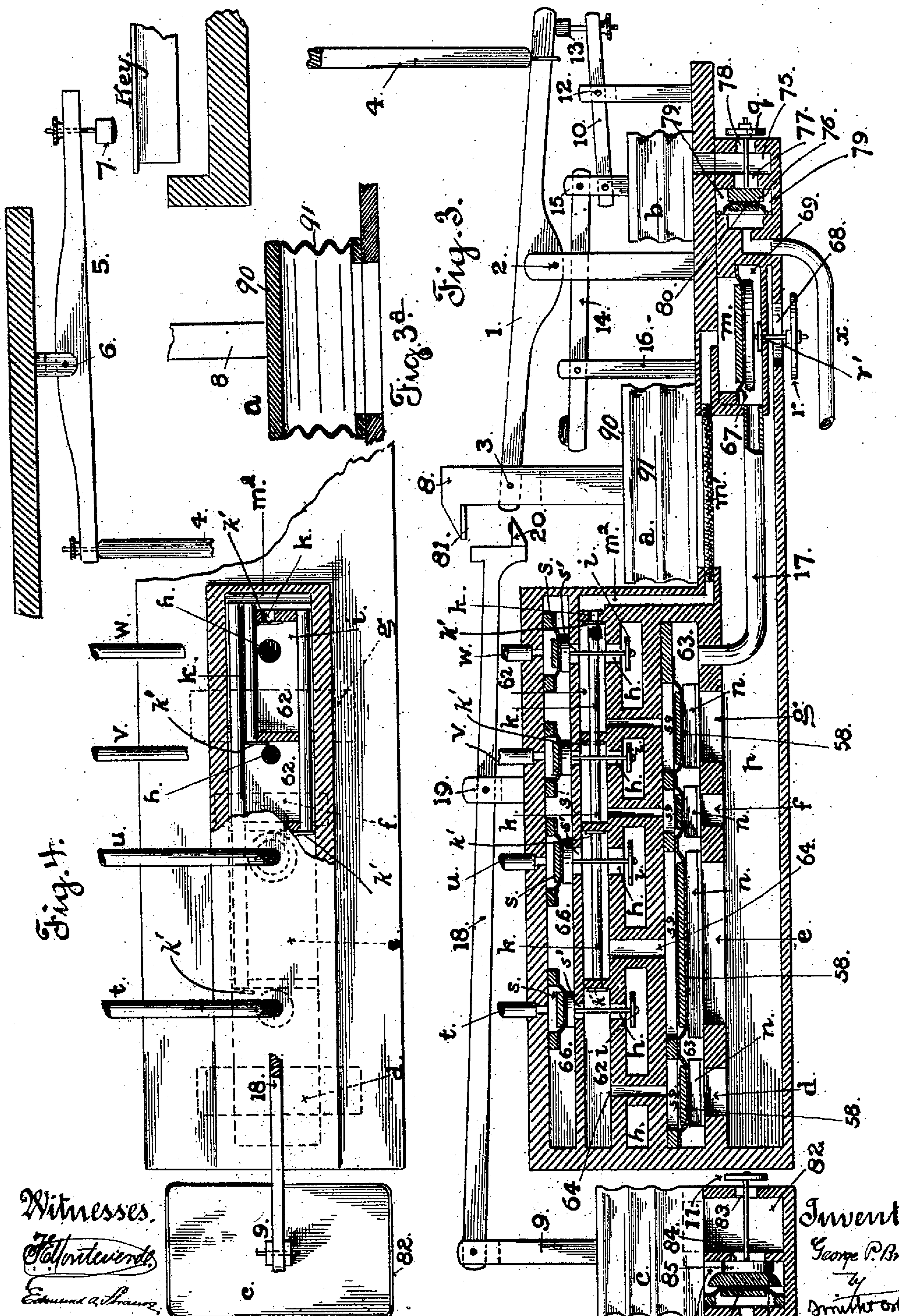
4 SHEETS—SHEET 2.



Witnesses.
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4 SHEETS—SHEET 3.

Fig. 5.

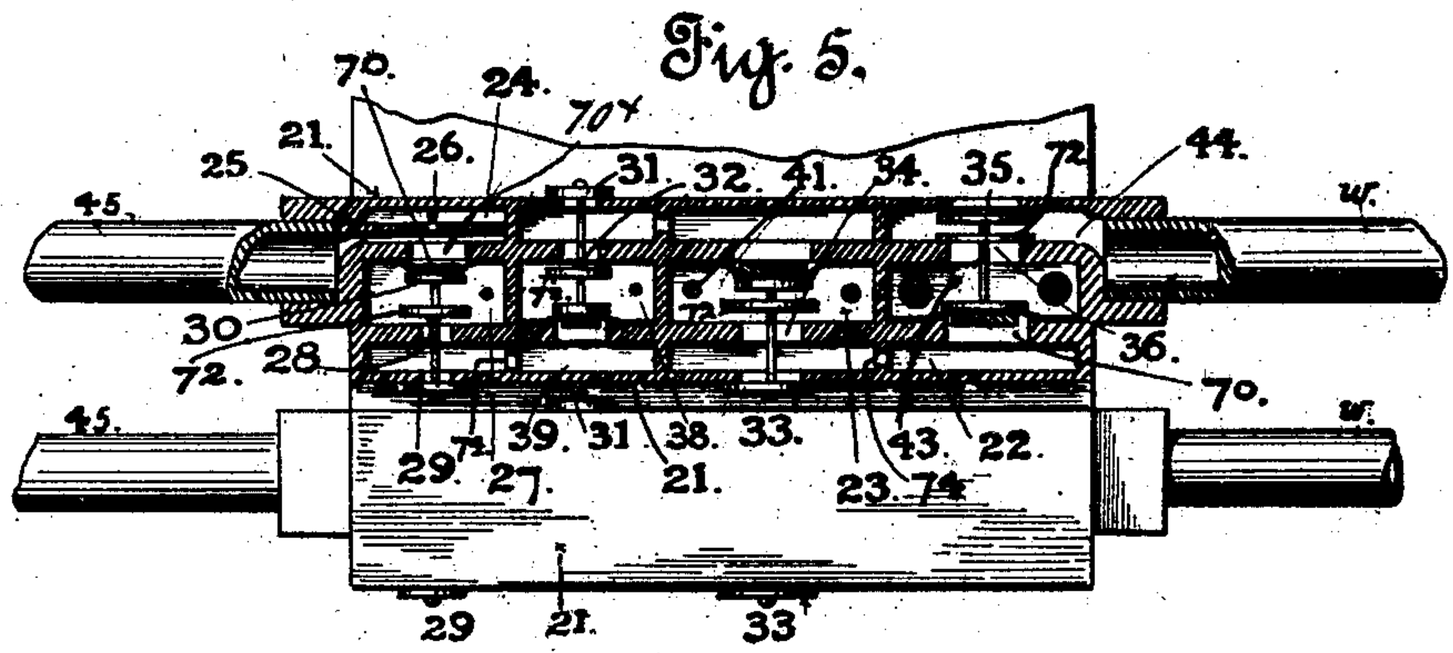

Fig. 6.

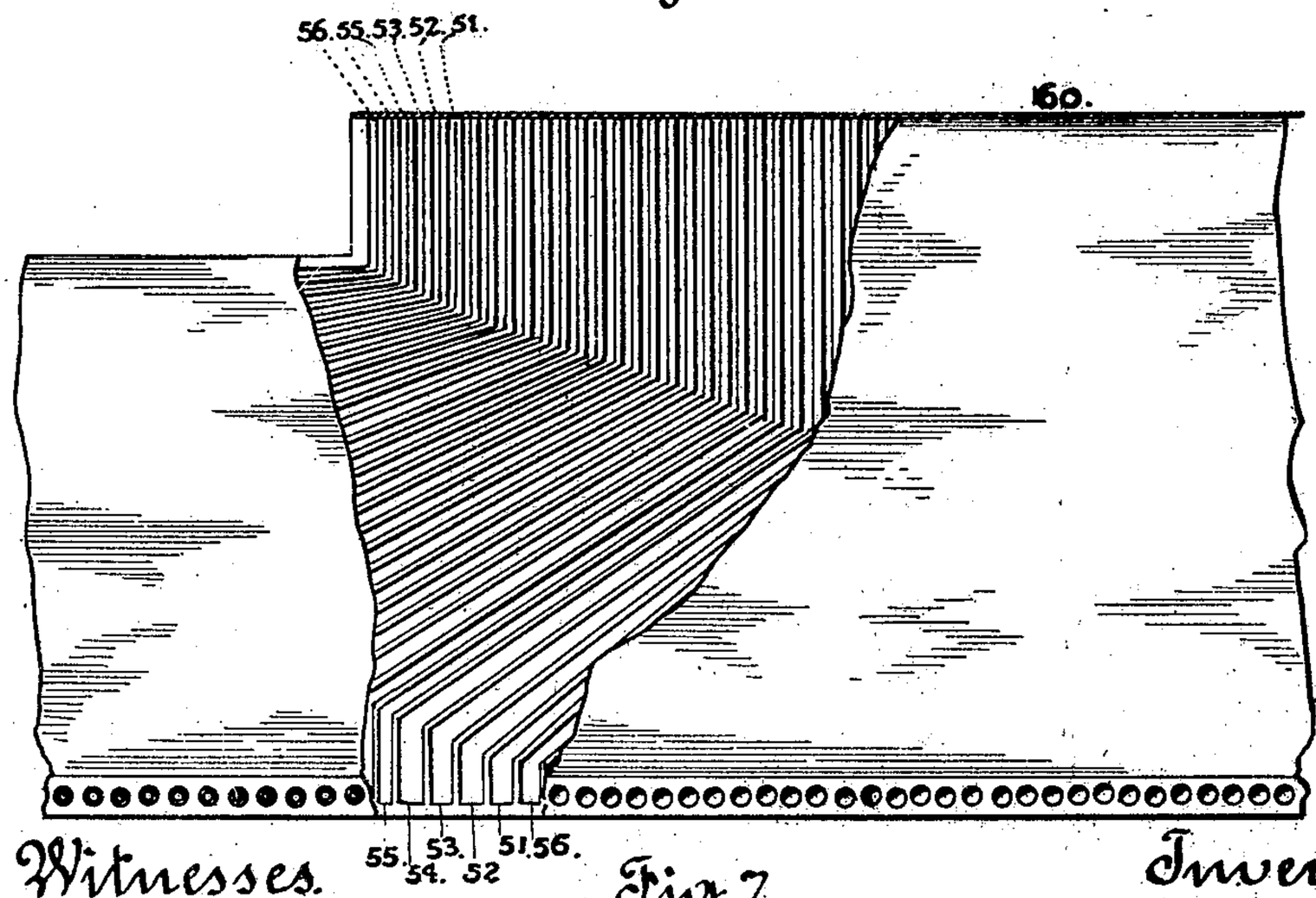

Fig. 7.

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MECHANICAL MUSICAL INSTRUMENT.

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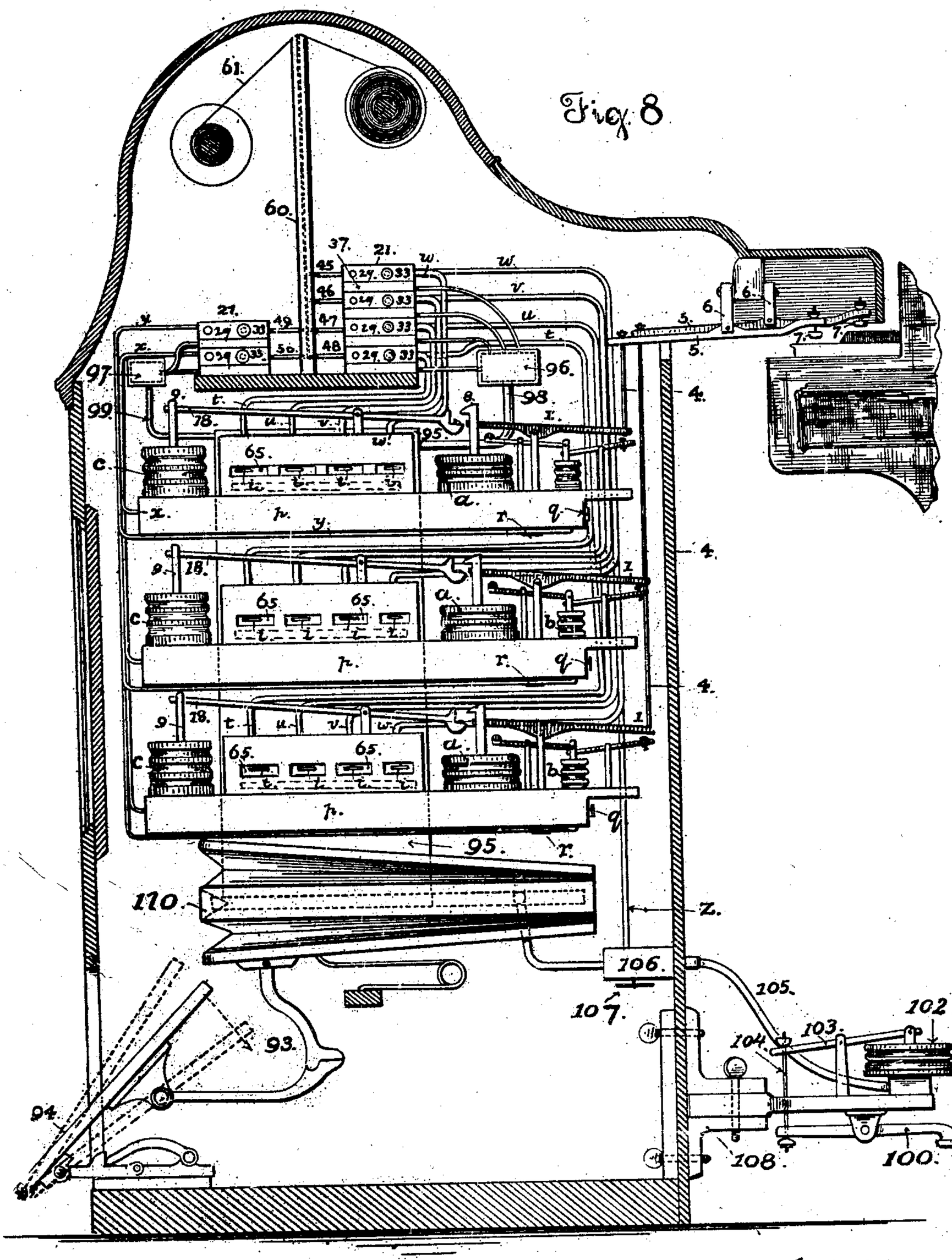
4 SHEETS—SHEET 4.

Fig. 8



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UNITED STATES PATENT OFFICE.

GEORGE P. BRAND, OF SAN FRANCISCO, CALIFORNIA.

MECHANICAL MUSICAL INSTRUMENT.

No. 833,995. Specification of Letters Patent. Patented Oct. 23, 1906.

Application filed October 26, 1900. Serial No. 34,400.

To all whom it may concern:

Be it known that I, GEORGE P. BRAND, a citizen of the United States, and a resident of the city and county of San Francisco, State of California, have invented new and useful Improvements in Mechanical Musical Instruments, of which the following is a specification.

This invention relates to improvements made in devices or appliances that are operated by pneumatic pressure or exhaust through the medium of a moving perforated sheet to play mechanically a keyed musical instrument, such as a piano or an organ.

The objects sought to be attained by these improvements, briefly stated, are to give a different expression to different notes at the same moment of time, whereby I am enabled to obtain the same or approximately the same individuality and variety of expression by mechanical means as are produced by the individual player; also, to give each individual note or series or combination of notes played at the same instant different degrees of power ranging from pianissimo to fortissimo separately and independently of other notes in the scale and to obtain such range of expression in any note or combination of notes throughout the scale through the medium of a single perforated sheet and a single tracker-board.

To such ends and objects my said invention consists in certain novel parts and combination of parts, as hereinafter described, and pointed out in the claims at the end of the specification, reference being had therein to the accompanying drawings, forming a part hereof.

Figure 1 represents in elevation an arrangement of key-operating devices and pneumatic motors with actuating and controlling valves. Fig. 2 is a top view, partly in section, on an enlarged scale, of the tracker-board. Fig. 3 is a side elevation, on an enlarged scale and generally in longitudinal section, of the pneumatic valves that control the exhaust apertures, valves, and passages. Fig. 3ª is a sectional detail of one of the principal pneumatics *a*. Fig. 4 is a top plan of the valve-chest and one of the pneumatic motors, the top of the chest being partly broken away to expose the exhaust chambers and passages and the connections inside. Fig. 5 is a top plan of two sets of multiplying-valves that are interposed between the tracker-board channel and the exhaust-controlling valves of the pneumatics, the rear set of the first-mentioned valves being shown in section. Fig. 6 is a side elevation of one set of multiplying-valves and the exhaust-chest common to that set, the apertures of the valves and exhaust-chest being shown in longitudinal section. Fig. 7 is a front view of a portion of the tracker-board with the outer face broken away to expose the channels within. Fig. 8 is an elevation in transverse section of the inclosing case, showing the chests and connections as the same are arranged therein for operation with the exhaust-bellows and conductors.

In the class of mechanical musical instruments to which these improvements relate more particularly the sounds are produced by the percussive action of a finger or striker upon the key of the instrument operated by a device commonly known as a "pneumatic motor" or a "pneumatic," to which the striker is connected by levers and rods, the stroke being produced either by inflating or by collapsing the pneumatic. In the present construction and application of my improvements the motor is operated on the exhaust principle, because the same is generally better adapted for piano-playing attachments; but in applying the improvements to reed-organs and instruments of that class the mechanism is better operated by pneumatic pressure.

In that part of the invention which comprises means or devices to give a different expression to different notes that occur at the same instant the degree of force or intensity of the stroke is regulated and modified, first, by varying the area of the exhaust-aperture of the pneumatic that actuates the striker, and, secondly, by varying the distance of the striker from the key of the instrument either in advance of the stroke or at the moment the striker begins to descend. In the present construction the first of the operations is effected by a pneumatic *a*, Figs. 1 and 3, having a plurality of exhausting-apertures *d e f g*, through one or more of which the pneumatic is connected with the exhausting-chamber to collapse it and having connection also with the atmosphere through a common air-inlet 68, through which the motor is inflated.

The valve controlling each separate exhausting-aperture is itself controlled by a set or system of what is termed "multiplying-valves" pneumatically operated by the variations in pressure on opposite sides of the valves, which variations of pressure are produced and regulated through the medium of a separate channel in the tracker-board for each valve.

The valve of each exhausting-aperture is held to its seat by the excess of atmospheric pressure on the back of the valve, due to the difference of area between the face of the valve directly exposed to the pressure and the opening beneath the valve, and, on the other hand, the exhausting-aperture is opened by reversing the atmospheric conditions on opposite sides of the valve, which is effected by cutting off the pressure that holds the valve to its seat and opening the valve by the pressure beneath it. The valves *n* employed for this purpose are of the kind known as "puff-valves," consisting of a block or body somewhat larger than the outlet it covers and a diaphragm 58, of flexible material, such as leather or rubber, secured on the top of the body and attached to the back or upper part of the chamber behind the valve and inclosing an opening 59, with which the back of the valve is in line. The diaphragm 58 thus serves to retain the valve in line with the aperture it controls and also allows limited movement of the valve toward and away from the seat, while it closes communication between the chamber over the valve and the one in which the valve works. The proper degree of pressure behind the valve *n* to hold the same normally closed is obtained by admitting atmospheric pressure to the chamber 59 through an air way or passage having a separate port *h* for each valve *n* and a valve *i* controlling it. This valve *i* is opened and closed by puff-diaphragms, which in turn is held normally open by atmospheric pressure admitted behind the valve and is closed by the pressure of the atmosphere against the valve-disk *i* the moment the pressure is reduced or removed from above the puff-valve *s*. To this space behind the valve *s* air is admitted to oppose the atmospheric pressure against the valve *i*, through a tubular conductor *t*, *u*, *v*, or *w*, terminating in a valve-chamber 21 at or contiguous to the tracker-board 60. To this last-mentioned chamber atmospheric pressure is admitted or is cut off by means of a balanced valve 35, Fig. 5, having atmospheric pressure in front and exhaust behind it. This valve is itself actuated in one direction to admit atmospheric pressure to the chamber 44 by producing an increase in the degree of exhaust behind the valve, while it is moved in the opposite direction to close the outlet to the atmosphere by increasing the pressure behind the valve. These operations are effected through a channel in the tracker-board connected with the exhaust space or compartment in which the controlling-valve 35 works, the air being admitted to or cut off from the channel in the usual way by the traveling music-sheet 61, as will be more fully explained hereinafter.

Every valve *n* controlling an exhausting-aperture is actuated and controlled from a separate channel in the tracker-board, and the channels required for the whole number of exhausting-valves of the pneumatic are arranged in close order in the tracker-board, so as to be opened or closed in different combinations of two or more valves by making the slits or perforations in the music-sheet of the required width. Varying the area of the exhaust-outlet of the pneumatic *a* in this manner produces different degrees of force or intensity in the blow given by the key-operating device, and many different effects are thus produced in every note independently of all the other notes in the scale.

The valves *n* when seated on the exhausting-apertures *d e f g* have atmospheric pressure on both sides, but are held to their seats by the excess of pressure upon their back or bottom faces, due to the difference in area between the exhausting-aperture and the back face of the valve, and, on the other hand, the valve is opened and held off its seat by cutting off the atmosphere from the chamber 59 behind the valve and connecting the same with a channel 66. Communication is established between the exhaust-chest 66 and the space 59 above the valve *n* by closing the valve *i* by the action of the puff-diaphragm valve *s*, or atmospheric pressure is admitted to the space behind the valve *n* by the opening of said valve *i* and the closing of the puff-diaphragm *s*, the compartment 62 being open to the atmosphere outside by way of the port *h* to the valve-chest 64. Its accompanying controlling-valve and connecting-passages are duplicates in construction of the other valves in the chest, so that a description of the set of valves governing one exhaust, as *d*, will answer for all the remaining valves.

In the present application of these improvements the pneumatic *a* takes air from the atmosphere outside the chest through an inlet-aperture 68 in a compartment *p*, upon which the pneumatic is seated. In the top of the same compartment are the apertures *d*, *e*, *f*, and *g*, opening into an exhaust-chamber 63 above. The valve *n*, controlling the outlet *d*, is attached to the bottom of the chamber 59 immediately under a passage 64 by its flexible diaphragm 58 surrounding that opening, and that confined space is connected with a second compartment or chamber 62, by means of which either atmospheric pres-

sure or suction is brought to bear behind the valve *n* by opening and closing the puppet-valve *i*.

Communication is established between the exhaust-chest 66 and the space 59 above the valve *n* by raising the puff-diaphragm valve *s*, thereby closing the valve *i*, or atmospheric pressure is admitted to the space behind the valve *n* by opening the valve *i* and closing the puff-diaphragm *s*, the compartment 62 being open to the atmosphere outside by way of the ports *h* and the valve-chest 65.

Each valve *i* is secured to a diaphragm-valve *s* by a stem common to both, the diaphragm being attached to the top of the exhaust-chest 66 and being situated immediately underneath an aperture formed thereon and performing the function of a puff to operate the valve *i* by pneumatic pressure derived through an air-conduit *t*, *u*, *v*, or *w*. The diaphragm-valve *s* also controls the port *s'* between the exhaust-chest 66 and the chamber 62 underneath. The duct *t*, *u*, *v*, or *w* when opened to the outside atmosphere transmits the pressure thereof to the space above the diaphragm *s* and opens communication through the passage *h* between the space 59 above the diaphragm 58 and the outside atmosphere, thereby holding the valve *n* to its seat.

The pressure of the exterior atmosphere applied against the face of the valve *n* from beneath when the aperture 68 is open is opposed by the pressure that is admitted through the port *h* and passage 64 against the back of the valve, and the superficial area of the back being greater than the face the valve *n* is held to its seat as long as the conductor *t* is open to the atmosphere. On the other hand, when the passage *t* is closed the pressure on the back of the puff or diaphragm valve *s* is removed and the lower disk *i* is lifted and held to its seat by the pressure against the lower face of that valve. The result of this is to cut off the pressure on the back of the valve *n* and establish communication with the exhaust-chest 66 alone, so that the valve *n* is then acted on by atmospheric pressure from beneath. The effect of this is to insure a quick and delicate action of the valve and make the same responsive to comparatively light degrees of pressure.

The inlet-valve *r* is common to all the exhausting-valves, and the same is operated by each valve *i* separately, as well as by different combinations of two or more valves *i*, to admit atmosphere-pressure to the pneumatic *a* when the exhausts are closed and to cut off that pressure at the moment when any one or more of the exhaust-apertures may be opened.

The valve *r*, controlling the outlet 68, is connected by its stem to a diaphragm 67, inclosed in a chamber 69 at one end of the compartment *p*, and the confined space *m* above the diaphragm 67 is connected by a separate tube *m'* and passage m^2 with the several compartments 62 by separate tubes *k*, Figs. 3 and 4, the space below the diaphragm 67 being in communication with the exhaust-compartment 63 of the valve-chest through a tube 17. The difference in the area of the valve *r* and the diaphragm 67 gives an excess of pressure on the upper side of the diaphragm 67 to hold the valve *r* open; but immediately on closing any one of the valves *i* this pressure is cut off from above the diaphragm 67, so that the pressure of the atmosphere against the diaphragm *r* will close the aperture.

A flap-valve *k'* is arranged in each compartment 62 over the end of the tube *k* connecting said compartment 62 with the passage m^2 for the purpose of closing the tube automatically by the air-pressure in that particular compartment whenever one or more of the other compartments 62 are put in communication with the exhaust-chest 66.

The movement of any one of the valves *i* to its seat is sufficient to reduce the pressure upon the diaphragm 67, and thereby close the valve *r*, and as the valve *r* acts in unison with the particular exhaust-valve *n*, controlled by the valve *i*, which has been seated, the pneumatic *a* is immediately exhausted, the exhaust-valve *n* gradually returning to its seat by gravity. During this operation the tension in the passage *p* and the chamber 69 is equalized through the aperture *r'*, through which the stem of the valve *r* projects, thereby causing the pneumatic *a* to remain collapsed until the reopening of the valve *i*.

The apertures *d e f g* are made of different area in order to furnish a greater number of exhaust-outlets of different areas by operating two or more of the valves in varying combinations at the same instant than could be obtained by the use of the same number of apertures having equal areas.

Each of the conductors *t u v w* terminates in an individual chamber or compartment 44 in a valve-chest 21 adjacent to the tracker-board, and each one is supplied with air from the outside through an inlet-port in the side of the chest 21, said port being controlled by a balanced disk valve 35. In addition to the pressure admitted through that inlet the connecting-passage communicates with an exhaust-compartment 43, controlled by the same valve.

In one position the valve 35 cuts off communication between the exhaust 43, and that one of the set of conductors *t u v w* which is connected with it and opens the passage to the atmosphere, and in the other position it reverses the conditions and connects the conductor *t*, *u*, *v*, or *w* with the compartment 43 and the corresponding diaphragm *s* of the valve *i* in the valve-chest of the pneumatic, the

valve 35 being actuated by a puff 70 that has atmospheric pressure on one side 22 of it and exhaust on the other, 43. The movements of puff 70 and actuating-valve 35 close the conductor to the atmosphere and open it to the exhaust-space 43 as often as the pressure of the atmosphere is admitted behind the diaphragm or puff 70. The last-mentioned puff 70 is one of a set of valves controlling ports that decrease in area and are interposed between the channel in the tracker-board and the valve 35, controlling the inlet to the conductor leading to the main valve-chest. In this primary chest as many valves are combined in series as may be found necessary to give an initial-pressure inlet of the smallest area practicable in the end of the tracker-board. In the present construction four valves, each controlling an inlet for the atmosphere outside the chest, are arranged in a graduated series in a common valve-chest having a separate compartment for each valve and an exhaust-chamber 37 common to all the valve-compartments, the whole number forming a multiplying-valve series having the peculiar feature and function of gradually increasing the area of the primary inlet through the channel in the tracker-board until the required degree of pressure is obtained to operate the valve *i*, controlling the exhaust-passage, by the initial atmospheric pressure admitted through the inlet-aperture in the tracker-board, and the whole set is arranged in a single chest mounted on or connected with a common exhaust-chamber.

The valve-chest 21 is divided by transverse partitions into as many sections as there are pressure inlets and valves employed, and each section is divided by longituidnal partitions, as shown in Fig. 5, into three lines or series of compartments, of which the middle ones, 27 38 41 43, are continuously open to the exhaust-chamber 37 beneath through apertures in the floor of the compartments, while the two outer compartments of the section are in communication with the atmosphere outside the chest through inlet-ports in the outer walls of said chest, said ports being controlled by puppet-valves 29 31 33 35. One of those outer compartments in each section is also connected with the middle compartment through a port 28 32 34 36 in the dividing inner wall, and both that port and the inlet-port in the outer wall are controlled by a valve composed of the outer disks before mentioned and a disk 72 on the same stem operating by a short movement to open one port and close the other. The valve-stem is attached to the button 30 of a puff or diaphragm 70, covering an opening 70^{x} in the partition of the exhaust-compartment and having one side exposed to the exhaust and the opposite side to the condition or degree of pressure existing in the outer passage when the latter is opened to the atmosphere outside the chest. The construction and arrangement of these passages and valves are the same in all the sections of the chest excepting in the first two sections of the valve-chest nearest the tracker-board, in which the outer compartments behind the diaphragms of the valves are in communication with the exhaust-chest. By virtue of this construction the actuating-diaphragm of each valve is balanced by the exhaust on both sides as long as the compartment behind the diaphragm is cut off from the outside atmosphere, and the outer disk or head of the valve is then held to its seat on the inlet-port by the atmospheric pressure outside, and this condition remains as long as the inlet at the tracker-board is closed to the atmosphere by the music-sheet. On the other hand, the equilibrium between the two exhaust-compartments in the same valve-section—as, for example, in the two spaces 24 27 in the first section—is broken by admitting the outside atmospheric pressure to the compartment behind the diaphragm 70 through the passage 25 from pipe 45 and that pressure on one side in conjunction with the exhaust on the opposite side of the diaphragm being greater than the pressure against the valve-disk 29 the port governed by that valve is opened whenever the tracker-board channel is uncovered. Through this opening the outside pressure is admitted also into the compartment 39 behind the diaphragm 30 of the next valve 31, as the adjoining spaces or compartments are connected through an aperture 74 in the cross-partition between them. The valves operate in this manner one upon the other throughout the series, producing a gradual increase of pressure by increasing the area of the air-inlets and the exhaust-apertures progressively until the required degree of power is obtained in the last section of the valve-chest to shut off the atmospheric pressure and open the communication between the exhaust-passage 44 and the exhaust-chest 43. In the last section of the multiplying-valve chest the inlet and exhaust valves 35 72 are set to operate contrary to those in the remaining sections, whereby the pressure-inlet stands normally open and the exhaust-aperture is closed, while the other valves hold the contrary positions as long as the channel of the tracker-board 60 is closed. This construction is illustrated in Fig. 5 of the drawings, where the multiplying-valve series is composed of four sections with air inlet and exhaust apertures of gradually-increasing areas, giving an accumulation of power through which the atmospheric pressure that is admitted through a minute aperture in the nose or end of the channel-board 60 is regularly increased through the action of one valve upon the other in ascending

order until the required area is attained at the last valve to operate quickly the diaphragm-valve *s*, through the medium of which the exhaust-valves *n* are controlled. The passage 25, behind the diaphragm 30 of the first valve, connects with the channel in the tracker-board 60 and is in communication also with the exhaust-chamber 37 through an aperture 26 and space 24. On the opposite side of the same diaphragm the compartment 27 opens into the chamber 37 through an aperture in the bottom, and the same compartment has communication with the outer passage through the port 28, controlled by the valve-disk 72. An aperture 74 in the wall between the same outer passage and the similar outlet-passage behind the diaphragm of the second valve 31 connects the two passages together, so that atmospheric pressure is admitted behind the second diaphragm through the port controlled by the first valve 29. In the same way the pressure is transferred from one side of the diaphragm to the other in the several sections throughout the series by the opening or closing movement of one pressure-inlet valve, and thus changing the conditions of pressure or exhaust on opposite sides of the diaphragm of the next adjacent valve. In a valve thus constructed it will be seen that the atmospheric-inlet valve will be held to its seat by atmospheric pressure as long as that pressure exceeds the degree of tension in the middle compartment; but as soon as the space behind the actuating-diaphragm is opened to the atmosphere the pressure against the outer face of the inlet-valve is opposed by the air admitted behind the diaphragm, and the low tension in the middle compartment then allows the atmospheric pressure to operate the valve that thereupon closes the port 28.

The number of multiplying-valves series required to operate separately and independently the four exhausting-valves *n*, covering ports *d e f g* of the pneumatic motor, are arranged one above another upon individual exhaust-chests 37 in convenient position between the main valve-chest and the tracker-board 60, and the chests 21 are connected by the pipes or conductors *t u v w* with the several compartments behind the diaphragms connected with the valves *i* in the main chest and by tubes 45 46 47 48 with the four channels 51 52 53 54 in the tracker-board, the latter tubes being connected individually to the first chamber of the primary valve 29 in each chest.

The channels terminating in the tracker-board are arranged in close relation and at such short intervals apart that the whole number can be uncovered to admit the exterior atmosphere through a relatively narrow slit not exceeding in width the slit used in the ordinary music-sheet at the present time in instruments of this class. In practice the multiplying-valves can be so graduated in number and in size of aperture as to control the exhausting-valves of the pneumatic through a hole in the tracker-board not larger than the hole made by a fine cambric-sewing needle, and thus enabling the whole number of channels required for operating an individual key or note and modifying its character to be brought within a small compass in the tracker-board.

Variations in the character of the blow upon the key are produced by changing the distance between the striker and the key either in advance of its movement toward the key or at some point therein before it is brought in contact with the key and also by checking or retarding the stroke or movement of the lever to which the striker is attached. These effects are produced through the medium of auxiliary pneumatics mounted on the valve-chest of the principal pneumatic or in proximity thereto, so as to be operated directly from the same exhaust-chest or conductor leading from the exhaust-bellows or through passages connecting the auxiliary pneumatic therewith. These additional devices to modify the character of the stroke are illustrated in the details, Figs. 3 and 4 of the drawings. The pneumatic *b*, being mounted over a channel 75, connecting with an exhaust-compartment 79 by a port 77 and also with the outer atmosphere through a port 78, takes in air when the latter port is uncovered. These ports are controlled by a puppet-valve *q*, having a disk covering the outer port and a disk 76 on the same stem controlling the exhaust-port. The movements of that valve are produced by the variations in the pressure on opposite sides of a diaphragm 80, attached to the valve 76 and to the marginal edges of an opening in the wall of the passage 79 behind it, with which the last valve-chamber in a multiplying-valve chest 21 is connected by a conductor *x*. Through the connection X atmospheric pressure on the diaphragm 80 causes the valve *q* to open the port 78 to the passage 75, which thereby has atmospheric pressure as long as the valve 35 in the chest 21 stands open, and the pressure against the front of the valve *q* is counterbalanced by the pressure against the back of the diaphragm 80, thereby causing said diaphragm to hold the valve *q* open. Upon closing the valve 35 in the primary chest, however, the conductor *x* is closed to the atmosphere and the exhaust-chamber 43 in the multiplying-valve chest is brought into communication with the back of the diaphragm 80 through the connection established when the port 36 in the primary valve is opened. The result of this is to substitute an exhaust for atmospheric pressure upon that side of the diaphragm 80 and cause the admission-valve *q* to close by atmospheric pressure. The movements of the pneumatic

b produced by its alternate inflation and collapse operate on a stop-lever 10, pivoted at 12 on a fixed support and attached to a post 15 on the head of the pneumatic *b*. An adjustable stop 13 in the free end of the lever 10 rests directly under the outer end of the lever 1, actuated by the principal pneumatic, and by contact with that end of the lever it raises or lowers the end of the striker-lever 5 to a greater or less extent, according to the inflation or deflation of the pneumatic *b*. By that means the finger 7 on the free end of the lever 5 is set toward or away from the key a greater or less distance, and the length of the stroke is varied accordingly. This adjustment may be effected either in advance of the downward movement of the striker or during the movement of its descent by uncovering the controlling-channel 56 in the tracker-board in proper time with relation to the other channel or channels that are brought into play to actuate the pneumatic *a*, in which case the admission of air through the tracker-board channel 56 and duct *y* acts through the valve *q* to deflate the pneumatic *b*, thereby raising the free ends of the levers 10 and 14, so that they protrude into the path of the lever 1 and retard its action. The movement of the lever 1 at such time also regulates or modifies the length of movement of the principal pneumatic, because the lever 1 is pivotally attached at 3 to the post 8 of the pneumatic. An additional stop-lever 14 is sometimes employed to check or control the movement of the lever 1, and thereby further modify the character of the stroke given by the lever 5—as, for example, for cushioning or checking the movement of the lever 1 to produce piano effects. This lever 14 is pivoted to a fixed support 16 and is pivotally attached at the outer end to the post 15 of the pneumatic *b*. The character of the blow made by the striker is also further modified by a check or retarding device consisting of a lever 18, pivoted at 19 to a fixed support on the principal valve-chest and carrying a stop 20 on the outer end. The head of the post 8 of the principal pneumatic has a shoulder 81 projecting over and in line with the stop 20 on the outer end of the lever 18, and the opposite end of the lever is attached to the post 9 on the head of a pneumatic motor *c*, so as to throw upward the stop 20 to meet the shoulder on the post 8 whenever the auxiliary pneumatic *c* is collapsed by connection with the exhaust. The action of this stop-lever on the lever 1 has the effect to retard the movement of the lever in its downstroke, because the principal pneumatic *a* in its collapsing movement is compelled to pull against the pneumatic *c*, to which the lever 18 is connected. This last-mentioned pneumatic motor *c* is mounted on a chest 82, to which air is admitted to inflate the pneumatic, through a port 83, controlled by a puppet-valve 11, and the said chest is connected with an exhaust-chamber 86, through a port 84 in the dividing-wall. A disk valve 85, fixed on the stem of the valve 11, controls the exhaust-port 84 and opens the chamber 82 to the exhaust 86 when the inlet-port 83 is closed, the valve being operated by a diaphragm 88 on the back of the valve-disk 85. Atmospheric pressure is admitted to the space behind the diaphragm 88 through a conductor *y*, leading from a separate multiplying-valve chest 21 at the tracker board, in addition to those that control the actuation of the striker and modify its stroke.

The pneumatic motors *a b c* differ from those used in mechanical musical instruments of this class in having the movable board or head 90 united to the stationary board by a collapsible diaphragm 91 of uniform width on all sides, by virtue of which the movable head maintaining practically a horizontal position in its rising and falling motions gives a direct vertical movement to the post or part connecting the pneumatic with the lever or part to be actuated and applies the power always in a vertical direction. Thus the motion is always uniform for the entire superficial surface of the head, and in the collapsing movement the weight of the head is with and is not opposed to the collapsing force. A pneumatic of this construction is particularly sensitive to variations in pressure and exhaust and is quite delicate and rapid in its action.

In the complete instrument to which these improvements as above described are applied the power to actuate the pneumatics is furnished from a principal exhaust-bellows 110, connected by a rod or pitman 93 with a pedal 94, and the various exhaust-chambers and compartments in the several chests are connected with the bellows by vertical box-conductors or trunks 95, extending upward to the required height at each end of the case. One of these conductors is shown in the sectional view, Fig. 8, and the openings connecting the compartments in the valve-chests are indicated by dotted lines.

The exhaust-chests 37 of the multiplying-valve chests 21 are connected by pipes to common exhaust-chests 96 97, which are in turn connected with the conductors 95 by pipes 98 99.

A pedal-operating lever 100, actuated by a pneumatic 102 through connecting-lever 103 and rod 104, is attached to the back of the case, the connection with the exhaust-bellows being made by a conductor 105 through a valve-chamber 106, having an inlet for the atmosphere controlled by a puppet-valve 107. This valve is the counterpart of the pressure-inlet valves employed in the valve-chests of the principal pneumatics. It is operated in the same manner also through a diaphragm or puff and a tube *z*, connecting the space behind the diaphragm with a con-

trolling-valve 35 72 in a separate chest 21 at the tracker-board. By means of this either pressure or exhaust is transmitted through the conductor *z*, and the valve 107 is opened or closed.

The pedal-operating attachment is secured to the case by an adjustable bracket 108, so constructed as to permit both vertical and lateral adjustment of the pedaling-lever to suit different styles or makes of pianos.

The key-actuating levers or strikers 5 extend horizontally from the body of the case to lie over and at a short distance from the keys, the top of the case being carried over the whole set to inclose them on the top and upon the sides.

The rollers for the note-sheet are provided with bearings in the upper part of the case, and provision is made for operating the same to wind the sheet from one roller upon the other in usual manner of operating the note-sheet in instruments of this class. Motive power for this purpose is usually derived from the principal bellows 110 of the instrument; but as the construction of such operating means forms no part of the present invention a detailed description is considered unnecessary.

Having thus fully described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. In a mechanical musical instrument, a pneumatic motor having exhausting-outlets of different areas, and an inflating-inlet, and means controlled by a tracker-board and a note-sheet for varying at will the area of exhaust and for simultaneously closing the inflating-inlet.

2. A pneumatic motor for musical instruments having exhausting-apertures of different areas, and means controlled by a tracker-board and a note-sheet for varying the area of exhaust to accelerate or retard the collapse of the motor.

3. A pneumatic motor for musical instruments having a plurality of exhausting-outlets, and means controlled by a tracker-board and a note-sheet for opening said outlets singly and in varying combinations of two or more outlets.

4. In a pneumatic motor for musical instruments a plurality of exhausting-apertures of different areas having separate controlling-valves, and means for operating said valves in varying combinations to produce an exhausting-outlet of greater or less extent of area.

5. In a mechanical musical instrument, a pneumatic motor having a plurality of exhausting-apertures of varying areas, a controlling-valve to each outlet and pneumatic means actuating each valve independently and controlled by a separate channel in a tracker-board and a note-sheet adapted to uncover two or more of the said channels at the same instant.

6. In a mechanical musical instrument a pneumatic motor having a plurality of valve-controlled exhaust-apertures and a valve-controlled inlet-aperture, means for actuating said exhausting-valves and inlet-valve through the medium of a traveling note-sheet and a tracker-board having a separate channel for each valve-actuating means.

7. The combination, with a pneumatic motor, of an exhausting and inflating passage having a valve-controlled pressure-inlet, a plurality of exhausting-apertures, pneumatically-actuated valves to said exhausting-apertures and to said pressure-inlet and means for automatically controlling and actuating said valves.

8. A valve-chest, for a pneumatic motor, having a passage communicating with the atmosphere through a valve-controlling inlet, and with an exhaust-chamber through a plurality of apertures, a pneumatically-operated valve controlling each of said exhausting-apertures, a compartment behind the pneumatic of each valve, a passage connecting said compartment with a chamber which is in communication alternately with the outer atmosphere and with an exhaust-chamber through separate ports, a valve-controlling said ports and operating to close one port and open the other whereby the pressure is admitted to or is cut off from the back of the exhausting-valve according to the direction in which the controlling-valve is moved, and pneumatic means operated by a channel in a tracker-board and a note-sheet for actuating said controlling-valve.

9. In an attachment for playing a piano or a similar keyed instrument, the combination of a striking device for each key, a pneumatic motor actuating the same, and means controlled by a tracker-board and a note-sheet for varying the length of movement of the striking device of each key to graduate the action thereof upon the key separately and independently of the corresponding devices of the other keys.

10. In an attachment for playing a piano or similar instrument, a pneumatic motor having exhausting-outlets of different areas operating to graduate the force of stroke thereof, means connecting the motor with a key-striking device, and means operated by a tracker-board and note-sheet for varying the exhaust.

11. The combination with the principal pneumatic *a*, and its valve-chest and controlling-valves, the striker-lever 5, and means connecting the movable head of the pneumatic with the striker; of the auxiliary pneumatic *b*, stop-lever 10 attached to the head thereof, and pneumatic means controlled by a channel in a tracker-board and a note-

sheet for operating the auxiliary pneumatic with relation to the principal pneumatic, as described, to vary the length of stroke of the striker-lever.

12. The combination with the principal pneumatic, a striker-lever 5 and means connecting the lever with the movable head of the pneumatic; of the auxiliary pneumatic *b*, stop-levers 10, 14, means connecting the said levers with the head of the auxiliary pneumatic, and means actuating the principal pneumatic and auxiliary pneumatic through the medium of separate channels in the tracker-board and a note-sheet.

13. In a pneumatic action for an automatic or mechanical musical instrument or player; a pneumatic motor for each of a series of the sound-producing devices of a musical instrument; a tracker having a plurality of apertures, comprising a separate group for each sound-producing device; the pneumatic motor having a plurality of outlets with exhausting-valves; an inlet to reinflate the motor, having a valve normally open and means for closing all of the outlets when the inlet is opened.

14. In a pneumatic action for an automatic or mechanical musical instrument or player; a pneumatic motor for each of a series of the sound-producing devices of the instrument; a tracker having a plurality of apertures, comprising a separate group for each sound-producing device, and a perforated music-sheet therefor, the pneumatic motor for any one of the sound-producing devices, having a plurality of exhausting-outlets with valves therefor; an inlet-valve normally opened; and means controlled by the tracker and a perforated music-sheet, for operating the exhaust-valves singly and in varying combinations of two or more valves.

15. A pneumatic key-motor, having a plurality of exhaust outlet-valves; inlet means for inflating the motor; and means for cutting off the inflating supply of air when any one or more of the outlet-valves are open.

16. A pneumatic key-motor, having a plurality of exhaust-valves; an inlet inflating-valve; said inflating-valve being held closed by the exhaust when any one or more of the exhaust-valves are open.

17. A pneumatic key-motor having a plurality of exhaust outlet-valves; an inlet inflating-valve, normally open, and means for closing the inflating-valve when the exhaust is cut off.

18. A pneumatic tracker; a collapsible pneumatic key-motor, having a plurality of exhaust outlet-valves controlled by a corresponding number of apertures in the pneumatic tracker; the motor normally inflated and open to the outside air and the exhaust-valves closed; a reinflating-valve; said motor to be collapsed by the opening of any one or combined number of the exhaust-valves; and reinflated by the reinflating-valve when the exhaust-valves are closed.

19. A pneumatic tracker; a pneumatic key-motor having a plurality of exhaust outlet-valves controlled by a plurality of apertures in the pneumatic tracker; and an inflating-valve, to act in combination with any one, or combined number of the exhaust outlet-valves.

20. A pneumatic tracker; a pneumatic key-motor, having a plurality of exhaust-outlets for collapsing the motor, controlled by a plurality of tracker means; and an inflating-valve acting in common with one and all of the exhaust-valves.

21. The combination with the prinicipal pneumatic, and a striking device connected therewith, of an auxiliary pneumatic, a checking-lever having a stop on the head of the pneumatic, said lever being attached to the auxiliary pneumatic, and pneumatic means adapted to operate the principal pneumatic and the said auxiliary pneumatic through the medium of separate channels in a tracker-board and a note-sheet.

In testimony that I claim the foregoing I have hereunto set my hand and seal.

GEORGE P. BRAND. [L. S.]

Witnesses:

EDWARD E. OSBORN,

M. REGNER.