R. A. GALLY.

PNEUMATIC AND SELF PLAYING MUSICAL APPARATUS.

APPLICATION FILED MAY 11, 1903.

1,101,919.

Patented June 30, 1914.

7 SHEETS—SHEET 1.

Fig. 1.

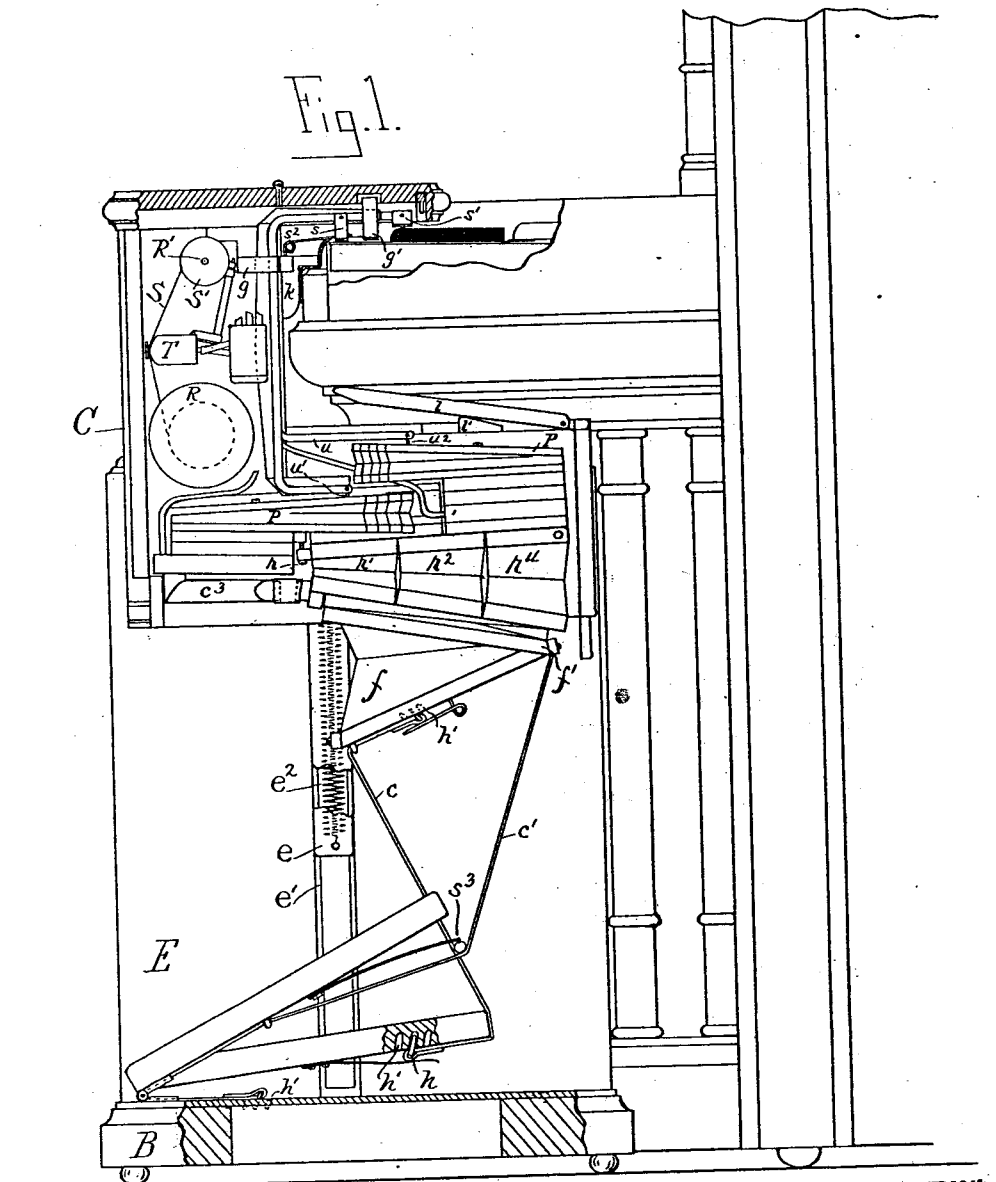


Fig. 1a.

Fig. 1b.

Fig. 1c.

Witnesses:

Wm. Gally

Oscar R. Graham

Inventor:

Robt. A. Gally.

R. A. GALLY.

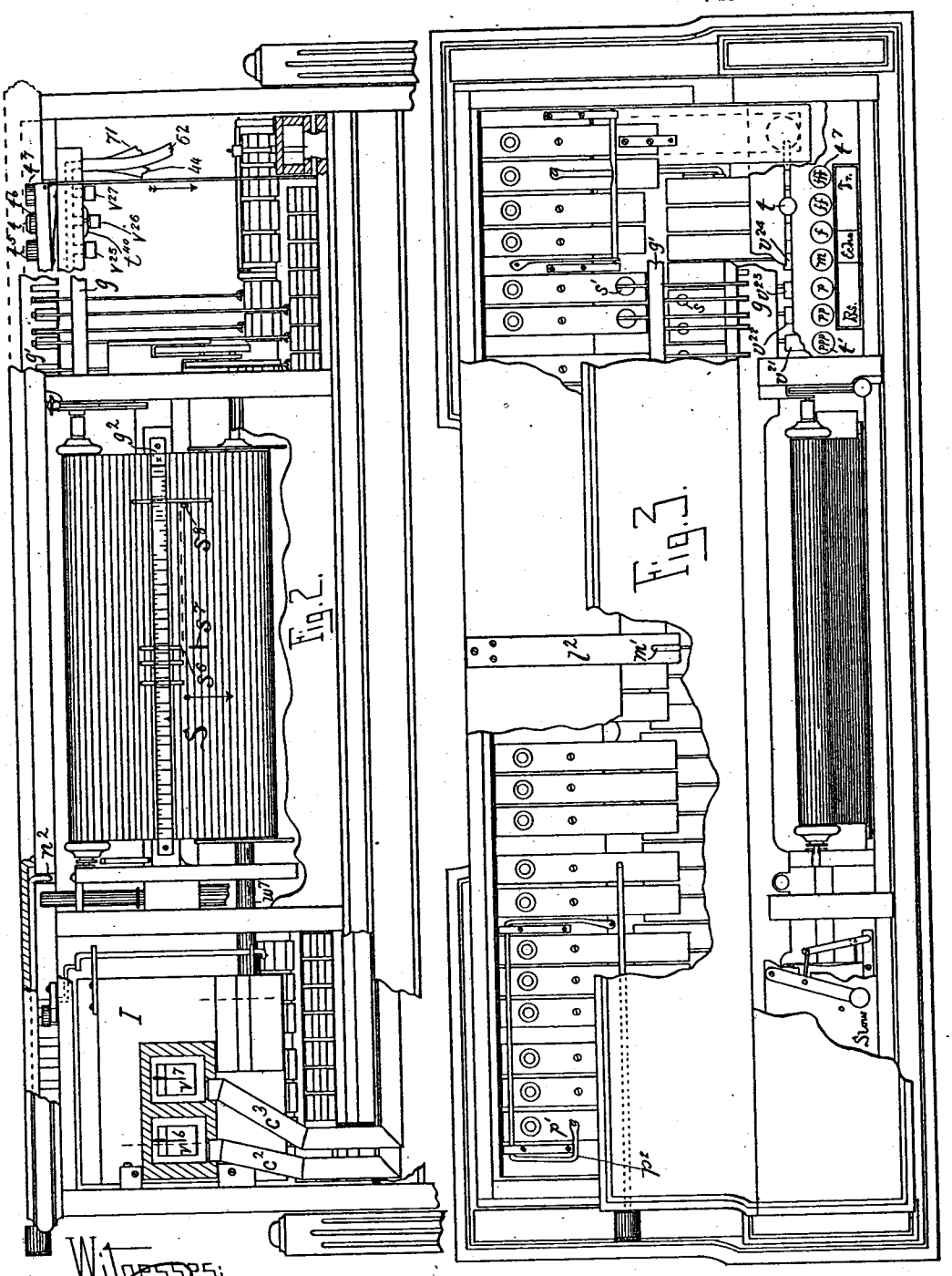
PNEUMATIC AND SELF PLAYING MUSICAL APPARATUS.

APPLICATION FILED MAY 11, 1903.

1,101,919.

Patented June 30, 1914.

7 SHEETS—SHEET 2.



Witnesses:
Benjamin Day
Oscar R. Graham

Inventor:
Robt. A. Gally.

R. A. GALLY.

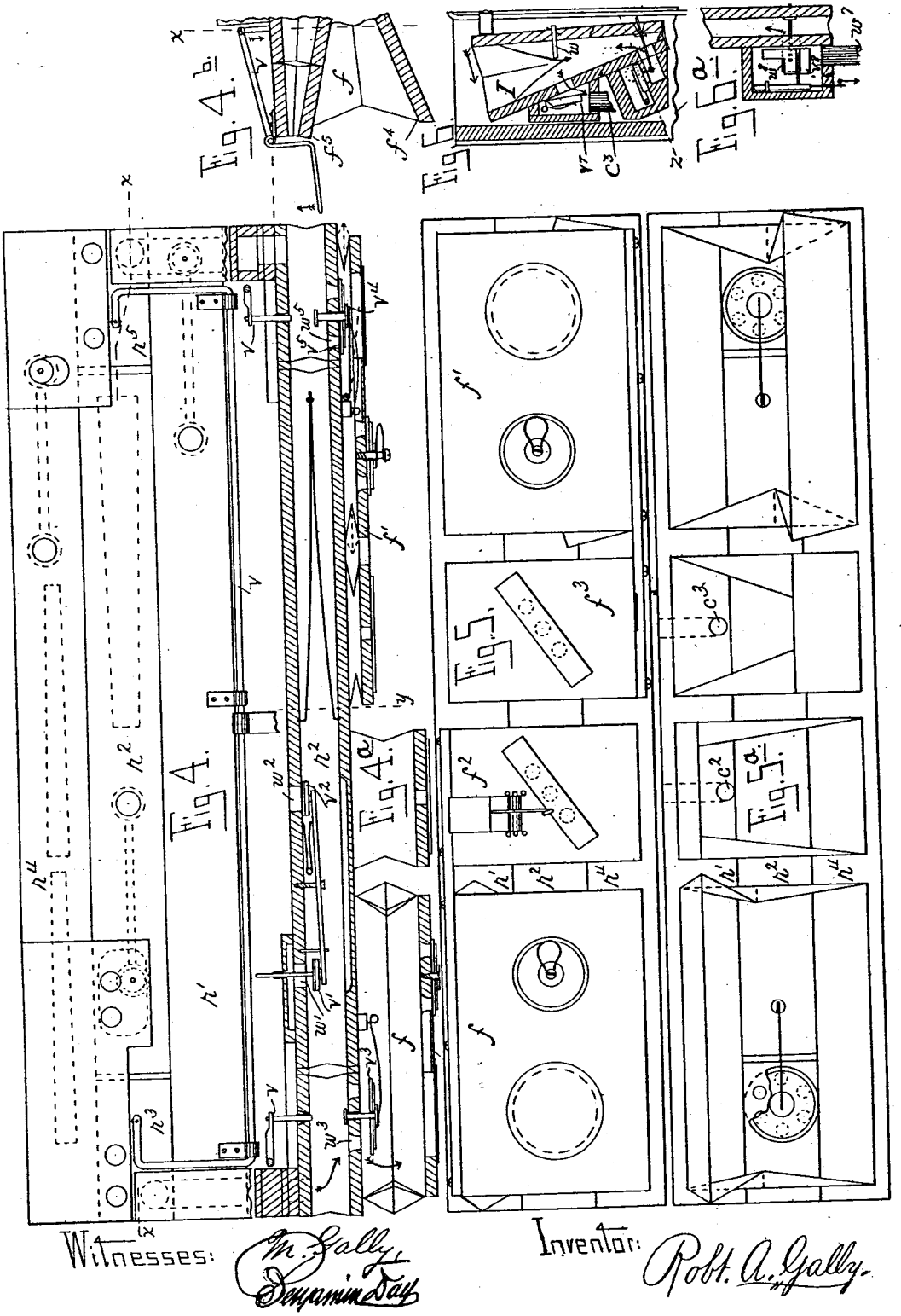
PNEUMATIC AND SELF PLAYING MUSICAL APPARATUS.

APPLICATION FILED MAY 11, 1903.

1,101,919.

Patented June 30, 1914.

7 SHEETS—SHEET 3.



Witnesses: M. Gally, Benjamin Day

Inventor: Robt. A. Gally.

COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

R. A. GALLY.

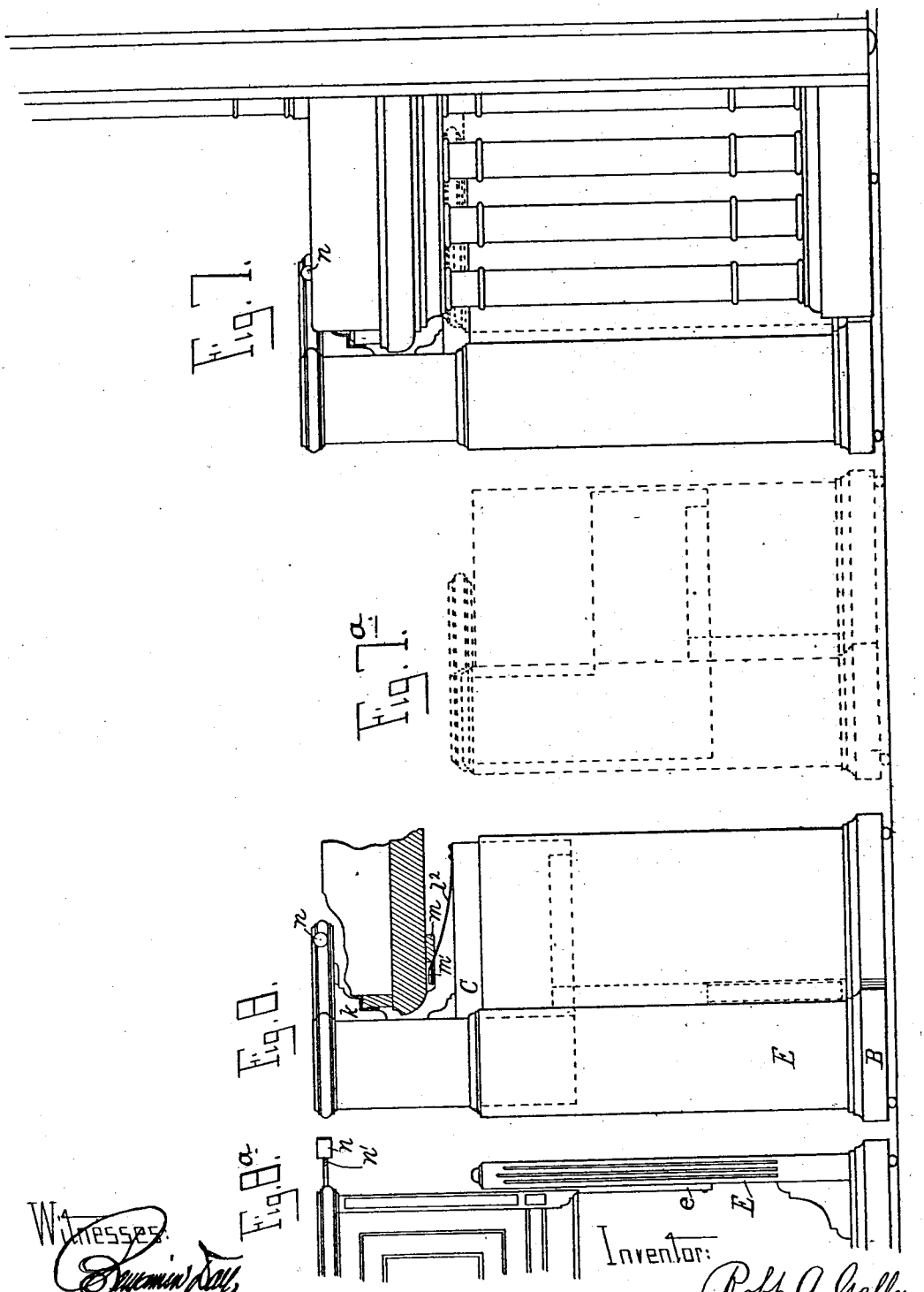
PNEUMATIC AND SELF PLAYING MUSICAL APPARATUS.

APPLICATION FILED MAY 11, 1903.

1,101,919.

Patented June 30, 1914.

7 SHEETS—SHEET 4.



Witnesses:

Benjamin Levy

Oscar A. Graham

Inventor:

Robt. A. Gally.

R. A. GALLY.

PNEUMATIC AND SELF PLAYING MUSICAL APPARATUS.

APPLICATION FILED MAY 11, 1903.

Patented June 30, 1914.

1,101,919.

7 SHEETS—SHEET 5.

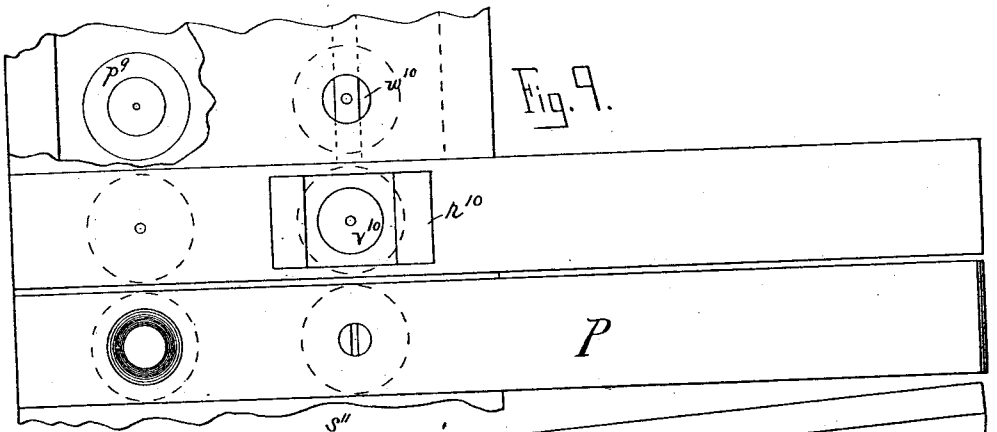


Fig. 9.

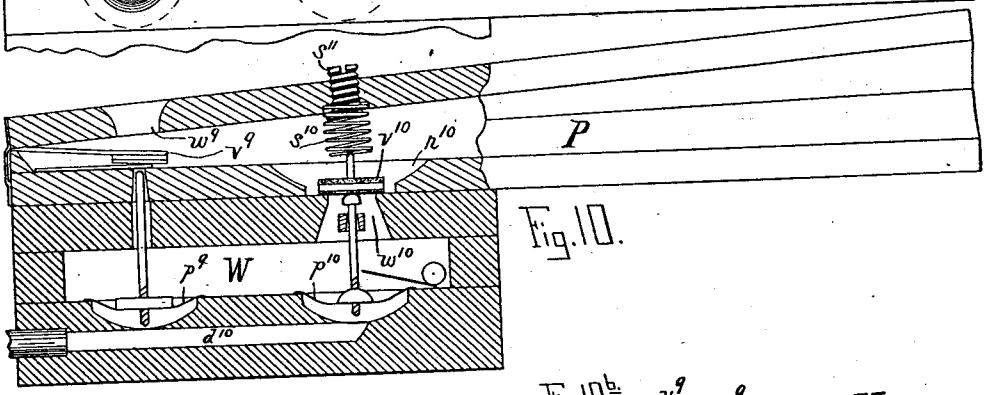


Fig. 10.

Fig. 10a.

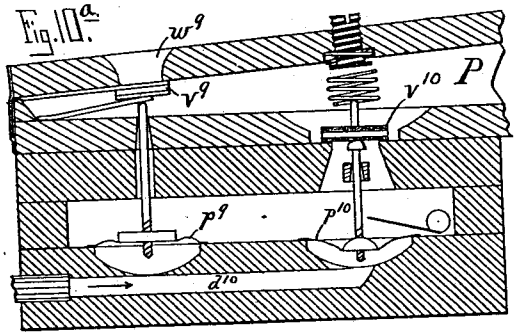


Fig. 10b.

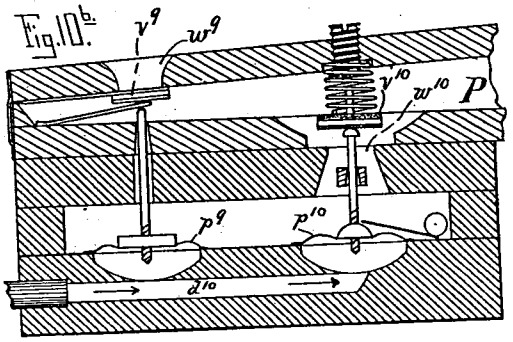


Fig. 10c.

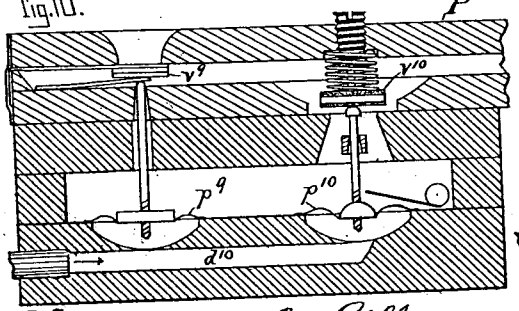
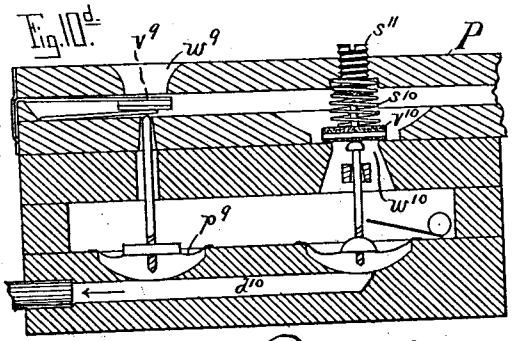


Fig. 10d.



Witnesses: W. Gally. Benjamin Day

Inventor: Robt. A. Gally.

R. A. GALLY.

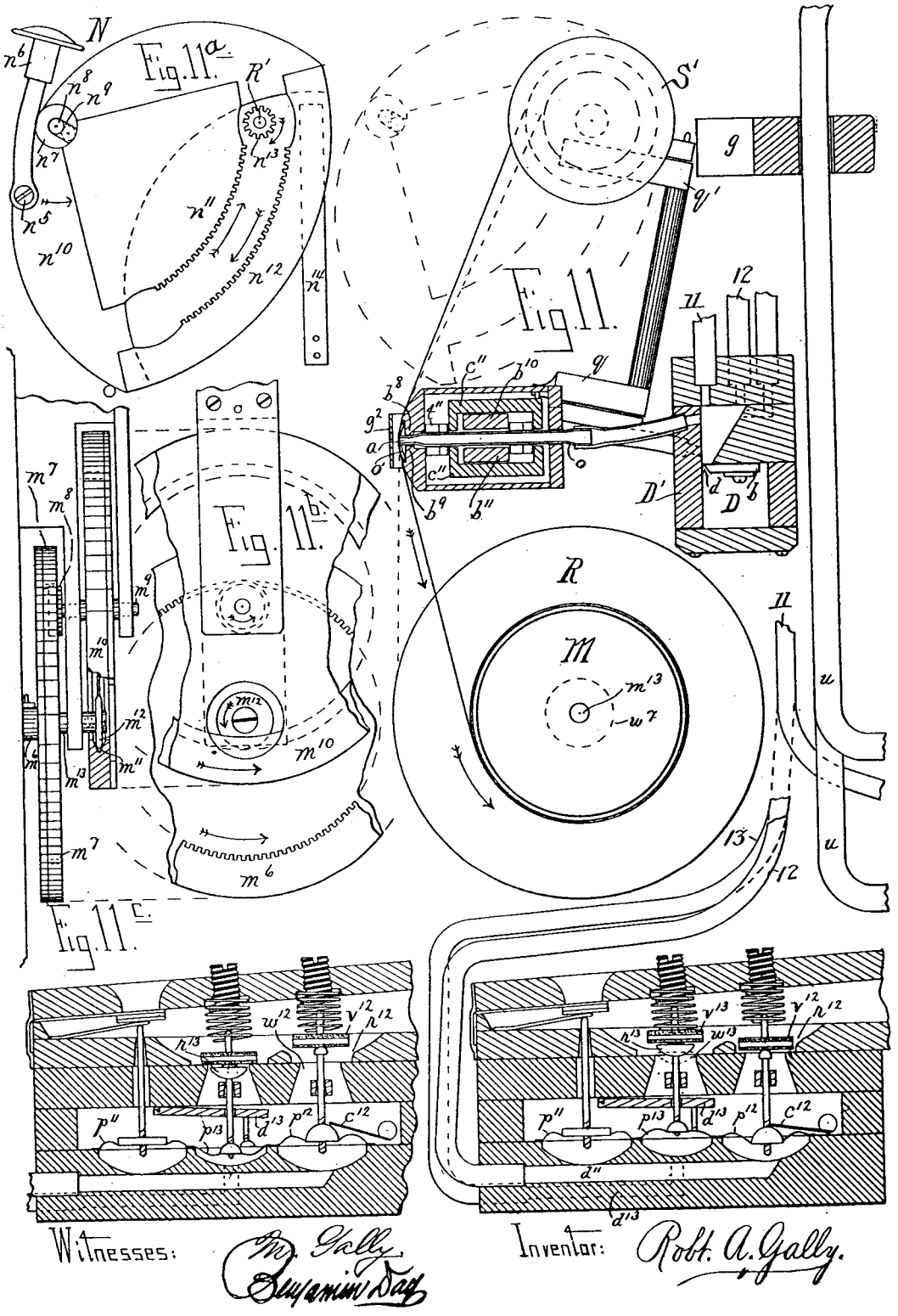
PNEUMATIC AND SELF PLAYING MUSICAL APPARATUS.

APPLICATION FILED MAY 11, 1903.

1,101,919.

Patented June 30, 1914.

7 SHEETS—SHEET 6.



Witnesses:

Inventor: Robt. A. Gally.

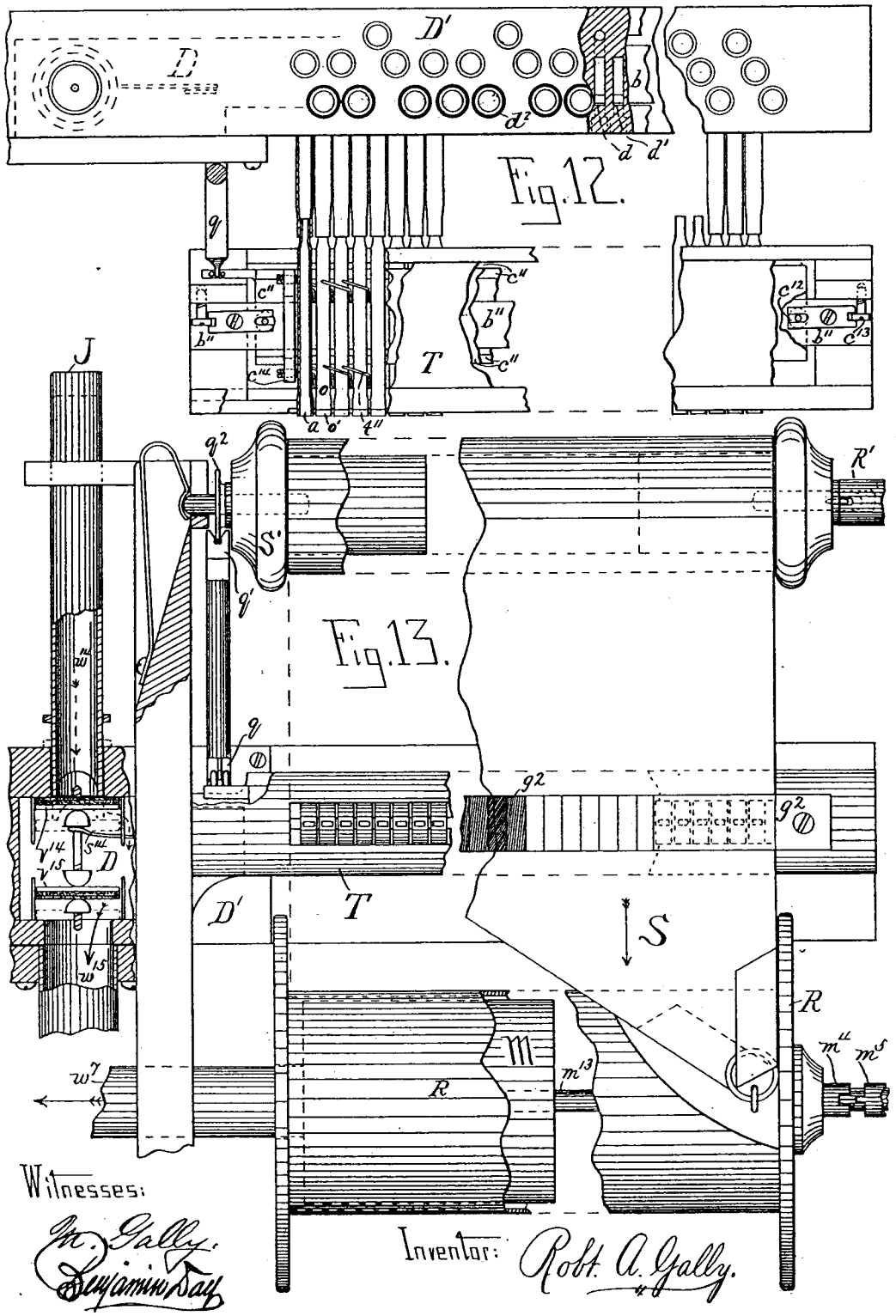
R. A. GALLY.

PNEUMATIC AND SELF PLAYING MUSICAL APPARATUS.

APPLICATION FILED MAY 11, 1903.

1,101,919. Patented June 30, 1914.

7 SHEETS—SHEET 7.



UNITED STATES PATENT OFFICE.

ROBERT A. GALLY, OF BROOKLYN, NEW YORK.

PNEUMATIC AND SELF-PLAYING MUSICAL APPARATUS.

1,101,919. Specification of Letters Patent. Patented June 30, 1914.

Application filed May 11, 1903. Serial No. 156,623.

To all whom it may concern:

Be it known that I, ROBERT A. GALLY, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Pneumatic and Self-Playing Musical Apparatus, of which the following is a specification.

My invention has for its object the simpler and more perfect construction and control of pneumatic devices for actuating musical instruments efficiently, and with regard to the automatic rendering of music with artistic effects of rhythm, dynamics, "part" distinction and phrasing, and the arranging of the necessary mechanism in a very simple, compact and durable form, being particularly well adapted for use as a self-playing attachment for pianos, and of reasonable cost and attractive appearance.

Some of the features of the music-sheets which are especially suitable for use with the devices of this application and are therefore shown herein to some extent are more fully described in my separate applications wherein they are claimed.

In the accompanying drawing Figure 1 is an end view of my invention arranged as a self-playing attachment for actuating the keys of a piano as shown, the casework being largely removed to show the interior arrangements, Figs. 1^a 1^b and 1^c being detail of U-pieces. Fig. 2 is a front view of the principal actuating parts of the same apparatus as Fig. 1, and Fig. 3 is a plan view of the same, having particular reference to the arrangement of the pneumatics and their chests. Fig. 4 is a plan view of bellows from above, Fig. 4^a being a longitudinal section of same taken at the dotted line x x of Fig. 4, and Fig. 4^b is a transverse section of a part of same bellows taken at dotted line y of Figs. 4 and 4^a. Fig. 5 is a plan view of same bellows from below, showing outside of feeders and their outer valves, and Fig. 5^a is a plan view of the same bellows with the feeders laid open to show the interior valves. Fig. 6 is a sectional view of the special bellows for motor which is shown in front view at left of Fig. 2, and Fig. 6^a is sectional plan of the motor-governor valve taken at dotted line z of Fig. 6. Fig. 7 is an end view of the attachment in position at the piano ready to mechanically actuate the keys of the latter, while in dotted lines is shown the same attachment when collapsed and slid under the piano key-bed to economize room, the dotted lines of Fig. 7^a showing the attachment when collapsed and set forward of the piano for use as a seat for one or two persons when manually performing on the piano. Fig. 8 is an end view of the attachment showing more detail of the slides and springs and the checks and guides by which the adjustment and collapse of the attachment is effected, while Fig. 8^a is a front view of the same end. Fig. 9 is a plan view of two power pneumatics and a portion of chest, partly cut away to show interior valves, ports and primary pneumatic, Fig. 10 being an end view, partly sectional, of one such power pneumatic with chest, valves and primaries, while Figs. 10^a, 10^b, 10^c and 10^d are views of the parts at the successive periods of action of the power pneumatic. Fig. 11 is a sectional view of the scale-reader and return-vent bar with two tubes connecting two of its apertures to separate primary actuators of one power pneumatic, while Fig. 10^c is the same pneumatic elements actuating a slower pneumatic movement than in preceding figure. Fig. 11^a is the detail of the rewind device for the music-sheet corresponding to the dotted line showing of Fig. 11. Fig. 11^b is front and end views of the gearing of the take-up cylinder and its motor of Fig. 11 and Fig. 13. Fig. 12 is a plan view of the adjustable scale-reader and the return-vent bar, partly broken away and sectional to show interior arrangement, while Fig. 13 is a front view of the said scale-reader and return-vent bar, together with a music-sheet and its spool and the take-up cylinder and the driving motor therefor contained therein.

The scale of the drawings compared to working size is as follows, reference being had to the drawings filed with this specification: Figs. 1, 1^a, 1^b, 1^c, 2, 3, 4, 4^a, 4^b, 5, 5^a, 6 and 6^a are quarter scale; Figs. 7, 7^a, 8, and 8^a, sixth; while Figs. 9, 10, 10^a, 10^b, 10^c, 10^d, 11, 11^a, 11^b, 11^c, 12 and 13 are all full scale.

To avoid any bulk of a piano playing attachment rising above the keyboard of a piano, yokes or U-pieces as u of Figs. 1 to 1^c, hereinafter called U-pieces, are used to convey to the piano keys the downward movement of the power pneumatic P which are underneath the piano keybed when in operative position, and the tracker apparatus T, take-up roller R, and spindle R′ for the music-sheet spool, as well as space for

such spool and sheet are provided to the front of, and below the upper arm of the U-pieces, all being preferably inclosed in a suitable cabinet or case. The U-pieces can be made of least weight for the required rigidity by forming them from thin Bessemer steel or other suitable sheet material, about 1/32 in. thickness, first cutting or punching them of the shape shown by the dotted lines of Fig. 1[a] and then bending over the ends to form two lapped corner right angles as shown by the continuous lines of the same figure. Lapped corners may be riveted or not. The varying width of metal gives greatest strength at the middle part where most needed, similar to a bridge or roof truss. The same general form can also be stamped or cast in finished shape without bending, as in Fig. 1[b]. The general purpose of the U-piece, with an economy of cost of making, can be obtained by bending a 1/4 in. x 1/16 in. Bessemer steel or equivalent material as shown in Fig. 1[c], although this makes a somewhat greater weight than the other forms. The U-pieces are freely guided in bushed slots in guide-rails g, g', and are also kept in position by the connections u', u^2, from their lower arms to the power-pneumatics P. The upper arms of the U-pieces are provided with strikers or fingers s, s', of two levels, to operate the white and black keys respectively, the strikers s, s' being each at the same distance from the vertical part of their U-pieces as the connections u', u^2, of their lower arms, thus insuring a direct, straight pull or stroke, when a power-pneumatic P acts in its downward pull, avoiding any lost motion, friction or lost power. As relative level of black and white keys vary on different pianos I make the key-strikers s and s' relatively adjustable, either by themselves or together with their actions as shown, r being a regulator for this purpose, this regulator r being a screw passing loosely through a lug on the front of the swingable bellows up into a rigid part of instrument, the turning of the screw r raising or lowering the bellows and the black-key pneumatics and their strikers s' independently of the strikers s. Springs as s^2 serve to overcome the weight of the U-pieces, etc., and raise them and the strikers to permit the quick and free return of the piano key at the end of a note.

The power-pneumatics P are arranged horizontally and with a downward action, and are preferably placed in two or more rows to allow sufficient width of each pneumatic while the entire number correspond in scale spacing to that of the musical instrument keys, the pneumatics being alternated or staggered among the several rows. A very efficient alternation is between black and white key centers, the pneumatics for the black keys being all in one or more particular rows, and those for the white keys in distinct and separate one or more rows. By placing the pneumatics in two rows as shown in Figs. 1, 2 and 3, one row to the rear of the other and in nearly the same plane but somewhat lapped over the other, the operating ends of the pneumatics of each pointing inwardly of the general arrangement and those of each row toward those of the other, a very compact arrangement is made, and economy of vertical space attained, thus achieving an appearance of minimum bulk when incased. With the one row of pneumatics of foregoing arrangement assigned to the black keys and the other row to the white keys, with the actuating connections u', u^2, thereof preferably placed somewhat to the rear of the operating ends of the pneumatics, a power gain of leverage is obtained, the lines of action are in advantageous positions to equalize the power and depth of stroke for the black and white keys respectively, the U-pieces are of minimum length, and a generally simple, convenient and efficient position and operation of parts and combinations secured. The bellows is preferably placed in horizontal plane directly under the rows of power pneumatics P and their chests, the feeders of the bellows being placed on the lower and movable face of the bellows reservoir, this arrangement carrying out the scheme of compactness and allowing direct connection of air from pneumatic chests to fixed part of the bellows and direct connections from the bellows feeders to the power pedals of the structure which are directly below on the base. To keep the pedals at a proper inclination when upper case and bellows feeders are changed in height to various keyboards, each of the connections c, c' is adjustably attached to its pedals by one or more hooks or prongs h adapted to be engaged by any one of several recesses or catches h' on the under side of the pedal, or these recesses or catches may be on the feeder-board, or can be on the floor base if the connections are sufficiently flexible and are first brought around at or near the axis line of the pedal hinge.

The automatic action in the general form above described is of an L shape with an inward extension at the top and thus conforms closely to the musical-instrument keys, keybed, and key-slip, with great economy of space, there being little above the level of the keys or to the front of the key-slip, the bulk of mechanism being underneath the keybed when in operative position. As there is an unfilled space between the bottom of bellows parts and the floor base B the casing of the action parts and bellows may be made only sufficiently large to inclose those parts, making a light appearance and leaving the unfilled space open to give sight to the under paneling of the piano case and also permit-

ting the dropping of the upper case C toward the base B when not in use, thus allowing the collapsed structure to be placed under the piano key-bed or elsewhere in minimum space and with great economy in packing and shipping, and the additional use as a seat or bench for a person when manually performing on the musical-instrument. These features are best accomplished with the construction described as follows: The upper case C inclosing the action is made a trifle shorter than the distance between the uprights E which rise one at each end of the floor base B. To each end of the upper case is secured a guide or slide as e arranged to move vertically in grooves or ways e' in the corresponding upright, thus permitting the raising and lowering of the upper case and action when adjusting to various heights of keyboards, and to collapse the structure when desiring to stow it away or use it as a seat. Springs e^2 act to a little more than exactly counterbalance the weight of the upper case and contained parts to give ease in raising and also to serve to automatically adjust to the key-board level when placing the playing attachment in operative position at the musical instrument. Suitable checks as k, preferably adjustable as to height, are so placed on the attachment case or action as to rest on the key-slip or the check-blocks of the musical-instrument keyboard when in operative relation. Either a wedge, lever cam or eccentric, or a spring heavier than the surplus raising power of spring e^2, or both spring and other element, and preferably adjustable to variations of thickness of keybeds, as by a wedge l', is so placed on the lower part of upper case or action as to press against the lower face of the keybed and bear down the upper case and action checks k against their relative bearing parts of the musical instrument and thus hold the action and its fingers in exact level with the manual keys. These bearers are preferably so arranged that they do not come into full action until the automatic attachment is almost entirely in to its operative position on the keyboard, thus permitting the playing fingers to safely clear the keys until they are well over them and approaching their proper position. These various guides, springs, bearers, checks, etc., can be directly connected to the action parts independently of any case, or working inside a case. By the aid of these devices, any one although of little skill, can place the automatic attachment to the musical instrument, and without the trouble and delay of setting any jack screws, etc., and any incidental variations of floor or carpet are automatically compensated, the only care required being to hold down the upper case until it is started under the keybed, then leave it free to rise and push the attachment in all the way and it automatically levels itself to the keys.

To insure a proper coincidence of the scale of fingers s, s' with the scale of the manual keys, which latter vary as much as 1/16 in. to an octave between different makes or styles of pianos, the scale of the fingers is best when laid out to the average medium scale of key spacing and the fingers s for white keys made of a narrow enough width to always clear the adjacent white keys of long or short key scale, and the fingers s' for black keys wide enough to never miss the proper black keys. As any variation between scale spacing of the fingers and the keys is best averaged by dividing between the extremes, any device for guiding or locking an automatic attachment as to the key-scale should be at or opposite to the middle of the scale instead of at the ends as has heretofore been customary. This also not only saves the trouble of constructing and attaching two or more guides or locks, but obviates error, friction or rattling between widely separated end guides. To have the guide m which attaches to the piano as small a projection as possible, the guide m' of the attachment may be a part of or fastened to the bearer l^2, both guides being preferably placed midway of the scale of the fingers and keys. The guide on the bearer will thus always come closely up to the keybed and its guide on any instrument used. When the attachment is to be placed to a keyboard the bed of which has a front molding extending below its front bottom edge, or when the attachment is to be temporarily used on an instrument, or to be set to an instrument which is not owned by the user, and so under any such circumstances it is not possible or desirable to affix any guides to the instrument case, it is nevertheless necessary to have some guide against accidental displacement relatively to the keys of the instrument, and therefore guides n are provided at each end of the attachment, disposed in such position as to bear against the inner face of the check-blocks, truss-caps or other suitable steady part of the instrument but most convenient above the keyboard in full view. These guides are preferably faced with soft material on their bearing ends, and are made with adjustments to fit them to various instruments. It is preferable to have two adjustments, one fine, as a screw n', the other quick, as a catch n^2, although a single adjustment may be used. With the device as shown in Figs. 1, 3, 8 and 8a the L shaped end n^2 can be instantly released by a quarter-turn and the guide drawn out for use and locked by turning the L into the proper notch, or closed in when not in use; and a fine adjustment can be secured by the screw n' to the head.

To secure the necessary variations of dynamics and tempo to the music played by the mechanisms of this invention, peculiar feeders, reservoirs, composite bellows and regulators are employed, which will now be described.

The two feeders f, f' to the bellows are shown with the feeder for the right pedal having its opening edge and fold at the same side of the reservoir as the opening edge and fold of the latter, while the feeder for the left pedal has its opening edge and fold at the hinge side of the reservoir and its feeder hinge at the opening edge of the reservoir, in both cases the feeders being on the moving-board of the bellows. The left feeder f will usually serve the reservoir without the pull of the feeder changing the spring resistance of the reservoir, while the right feeder f' will act in like manner when moved at a speed only sufficient to naturally feed the reservoir through the intercommunicating windways v^5, but when the right feeder f' is moved rapidly it will "choke" the windways to the reservoir by attempting to draw more air than those windways will freely pass, and the consequent resistance to the feeder movement will cause it to pull on the moving-board of the reservoir and increase the tension of the air therein. Thus short quick accents or permanent sudden rise of tension can be secured by skilful pedaling. There may be a controllable variation or closure v^4 to the capacity of the windway between one or both feeders f, f', and the reservoir, said closure v^4 being adapted to be swung and set to various distances from the seat of valve v^5 and thus check said valve entirely closed or to only slightly open, and thus vary the degree of action or change it from expression to ordinary feeding, although the feeder f' so placed hinge to hinge with the moving-board of the reservoir will often have some expression action effect on the air tension whether "choked" or not. Such expression feeders can be operated on either a single or composite reservoir chamber, and will also be effective for accenting on a reservoir having a steady weight or compensated spring even resistance.

The composite bellows consists of two or more reservoir chambers, combined together and having a common movement, three chambers being shown herein, r', r^2, r^4. Spring or equivalent resistance to give tension to the air of the bellows is arranged to act constantly against the moving parts of the combined chambers, means being provided to throw into action any one or several of the chambers at one time, thus varying the air-tension proportionately to the inverse ratios between the constant resistance and the various active areas of composite reservoir. The constant resistance may be variable, as ordinary bellows springs; or invariable as weights or by my arrangement of springs in Patent #546,956, issued Sep. 24, 1895. To secure the greatest variety of air-tensions from a given number of chambers the chambers should be made of varied areas one to another and in such ratio that each one and every combination will give a different effective area, allowance being made for positions of each chamber, the spring resistance, and the hinge, as to their relative leverage. For three chambers, proportionate effective areas of 1, 2 and 4 will give all variations from 1 to 7 inclusive, a very satisfactory number, as musical dynamics are graded in seven degrees, *ppp*, *pp*, *p*, *m*, *f*, *ff*, *fff*. The several chambers can be formed by attaching the various folds or ribs between two bellows-boards, but it is easier and more effective to construct several separate reservoir chambers or frames and join them together after their folds or ribs are completed. For strength of parts and durability the several chambers of the composite reservoir are arranged parallel to each other and to the common bearing or hinge line, and at successive distances therefrom in a general plane, as thereby the strain of tension upon the hinge will not be shifted by the changes of activity from one chamber to another against the common resistance and hinge. To avoid any lapse of air-tension during shifts from one tension to another continuously active reservoir chambers r^3, r^5 are provided which may also serve the purpose of giving a substantial basic air-tension degree upon which to build the variation series and thus have the differences between degrees, and the entire variation, more moderate than without such continuously active chamber, as is often desirable for musical expression. The shifting of activity from one chamber or combination to another should be effected by ports which will not only open each such chamber to active tension of air when in use but will also open such chamber to the free air when not in use and other chambers are, so that the inactive chamber will then be free to move. The control of such ports may be by mechanical or any other means, pneumatic means being now shown. The feeders f, f' are connected to exhaust the air from the action chests, their connecting ports being either direct to the rigid chests, trunks or other air service spaces of the action, or through the continuous service bellows chambers r^3, r^5 and wind boxes above them, as shown in Figs. 4 and 4^a, but whichever way the feeders are connected to the action service the intermediate ports have self-acting valves on their seats toward the feeders, and the feeders have ports to the outside air having self-acting valves on their outer seats. The reservoir chambers r', r^2, r^4

which are for interchangeable or combinable use each have a port w' between it and the general air-service of constant bellows chambers r^3, r^5 and the feeders and another port as w^2 leading from such chamber to the outside free air. Valves as v', v^2 to these ports are arranged so that one is closed as the other is open, the normal condition being with valve-port w^2 open while valve-port w' is closed by the tension of air on valve v', and at a pneumatic as p' is worked from the general air-service and connected by a crank-shaft p^2 to open valve v' and close valve v^2 whenever any personal or automatic control causes pneumatic p' to operate, as by opening the valve v^{26} by depression of button t^6 directly, or by the slide controller 4 being moved into position over valve v^{26} so that wedge t^{20} of controller t wedges down valve v^{26} and allows button t^6 to drop as shown, valve v^{26} then admitting air through tube v^{36} to the primary pneumatic p' to operate the latter. By means of this valve action any particular one or combination of reservoir chambers can be thrown into active condition to produce a desired air tension, the valves v^{21} to v^{27} having their ports arranged to respectively vent the requisite ones and combinations of the tubes 71, 62 and 44 to control reservoirs r', r^2, r^4, in proper units and combinations to each of the said valves.

For manual control of several tensions produced by various combinations of the plural chambers of a composite bellows, whether such chambers are of equal effective areas or of varied areas, it is convenient to employ a single particular controller to actuate each combination, thus saving the annoyance of specially determining the particular combination of individual controllers to be used for the desired degree of tension. For this purpose there are as many controllers t', t^7 as there are degrees of tension, each controller t', t^7 being connected by tubes or otherwise to suitable means as pneumatic p' to operate the valves; or valve as v' of its particular combination or individual chamber to render such chambers or chamber active, the manually actuated parts of the set of controllers being preferably arranged in a convenient order or plan for prompt selection when using, say in regular series from light to heavy tension, the reservoirs being operated in order and combinations as follows: (r^1 r^2 r^4), (r^2 r^4), (r^1, r^4), (r^4), (r^1 r^2), (r^2), (r^1).

To simplify the manual operation and obtain rapid changes of tension in a serial order of variation, a single controller t may be employed either in combination with and to operate the individual controllers t' to t^7 and valves v^{21} to v^{27} as above described, or the single controller to varied degrees may be employed alone, in either case the valves as v' being actuated by pneumatics as p^1 or otherwise. Such single controller as t is arranged to move in a suitable straight or curved line, the several single and combination tensions being operated by the wedge t^{20}, controller t at several corresponding positions of its movement by its actuation of valves as v^{23} to v^{27} to bring into action the proper respective units and combinations of reservoirs, the several degrees being preferably in regular order of tension from light to heavy, as described in close of last paragraph, thus enabling the most rapid and smooth crescendo and diminuendo by the self-playing or other musical devices which are served by that composite bellows. It is well to have both the single controller and the multiple in an instrument, as by the multiple device sudden and extreme shifts are more accurately made and any actuating of valves and chambers of any unnecessary intermediate degrees is avoided, while the single controller has its own advantages, although either the single or multiple may be embodied in an instrument without the other. The controller, single or multiple, may be for manual, knee or pedal operation by a person, or operated by automatic devices.

Connections by tubes from one, several or all of the pneumatics as p' of the valve-shifting devices of the composite bellows chambers to corresponding apertures or equivalents of the tracker devices enable the direct control of tension from the music-sheet S. In a chord or assembled group of notes which are to have their commencement of sounds together, but wherein it is desired to control one or more of the notes to sound more prominently than the others, the secondary notes are positioned slightly in advance of the important ones and a lowered tension or efficiency of attack is secured during the first part of the operation of the self-playing devices of the secondary notes by a perforation as s^8 in the music-sheet arranged to control devices which act to reduce the tension or power by any suitable means, as the change of reservoirs r', r^2, r^4, said perforation continuing until the time for the attack of the important notes of the same group, when the said perforation ceases and causes the consequent change of reservoir and the tension or power to increase and thus accent only those notes the perforations of which were not advanced. In a piano the greater speed of movement of the piano hammer under high tension or power of actuating will cause the advanced and the normal note-perforations to produce an approximately even attack of tone of the notes of a group. Where the music has a much more frequently successive occurrence of important notes than of secondary notes, this system of reducing the tension or power on the secondary notes is

much simpler than any device for increasing the tension or power for the important notes, a less amount of expression perforations and actuating being required for the reducing than for the other.

Very fine degrees of variation of tension or capacity of a bellows, whether simple or composite reservoir, are obtained by the following described device for adjustably setting the limit of movement of the bellows reservoir chamber or chambers: A port or ports as w^3, w^5 connect each of the two or more feeders to the air chamber which is continuously served, and valves v^3, v^5 are arranged to keep each of these ports normally closed during the return action of its feeder. Adjustable valve actuating means v are placed in position to open the valves v^3, v^5 when the bellows reservoir movement reaches the desired point, such opening of the valves causing one feeder to pump air from the other without altering the quantity of air in the reservoir; and thus not changing its position; and as bellows give a definite air tension to a certain position, and vary with the change of position and consequent alteration of fold and spring resistance, the adjustment of the means v to various points of action by the bellows will control all degrees and variations of capacity or tension within its degrees of changes from varied positions.

With any variable tension air service for expression or other purpose of a self-player, whether having a simple or composite reservoir, it is necessary to provide a means for equalizing the tension of air used to drive the air-motor for propelling the music-sheet, and even when the air-service of the main action is of equalized tension the "sagging" and "jumping" of the air tension owing to the sudden attack and release of many notes at a time, especially in piano playing, will cause irregular speed of the motor unless special governing means are provided. To overcome these defects a separate and independent reservoir I is now provided to store air service for the music-sheet propelling motor as M, and this reservoir I is supplied by special feeders f^2, f^3 which connect to this reservoir I only, but are operated by the same motive means (as pedals) as are the feeders f, f' of the main air service. Conveyances c^2, c^3 connect the respective feeders f^2, f^3 to the independent reservoir I, the service valves v^6, v^7 of these feeders being conveniently placed at the reservoir I to enable their direct control by the moving board of said reservoir and its means w, one to each valve, while also allowing their ordinary automatic action as feeder valves. When the various feeders f, f', f^2, f^3, are in regular operation f and f' will render the necessary air-service for the main air-chests, etc., while feeders f^2, and f^3 serve the reservoir I for the music-sheet motor. Whenever the service is overabundant for the main chests only, their feeder supply is checked by means w and the opening of valves v^3, v^5, while if the reservoir I requires continuance of service from its own feeders f^2, f^3, it may be had without overserving the main air chests. On the other hand, whenever the reservoir I has secured its abundance of service from its feeders f^2, f^3, the means w will throw valves v^6, v^7, open so the feeders will neutralize each other, and if main chests, etc., require a continuance of service from their own feeders f, f', it may be had without overserving the reservoir I and the music-sheet motor. An additional advantage to the use of the independent reservoir I for serving the motor is that the air service thereof may be of comparatively low tension compared to that for the heavy degrees of action of the note playing pneumatics and thereby a great saving of friction, wear, noise and leakage of the motor be effected compared to that when a common high tension is employed for the entire instrument. About 2 1/2 in. water-column air-tension is desirable for the motor, while for the note-striking pneumatics the tension should vary from 2 in. to 12 in., even to 15 in. for accents.

As a reservoir, either common to the whole instrument, or independent for the motor alone as herein shown is inclined to vary its air tension owing to the change of its folds and the altering of its spring resistance at the different points of its movement, a compensating device is desirable to secure an even speed of the motor run from said reservoir. It is also desirable to set the speed of the motor to various degrees to suit the musical composition to be rendered. In Figs. 6 and 6a is shown in detail a single device which effects both these objects. An L-shaped valve as v^8 controls a windway or port w^8. This valve is moved longitudinally to vary the set speed of the motor M to which the windway w^8 connects by a continuing pipe or conveyance w^7. The setting of the speed may be effected by automatic means or by hand controlled connections, a convenient form of the latter being shown in Figs. 2 and 3 hereof. The valve w^8 has a slot engagement with the time-setting means and the valve is thus free to move transversely to the movement of its time setting movement. A suitable free jointed connection is provided between the valve w^8 and the moving-board or similar part of reservoir I, as shown. As the moving-board of said reservoir I moves inward it causes the valve v^8 to move transversely and gradually diminish the amount of opening of windway w^8 and thus compensate the rise in tension of the contracted reservoir I. The diminution of opening of windway w^8

will always be in the same ratio to the extent of movement of the moving-board of reservoir I at any and every time-set position of the valve v^8 and will therefore correctly equalize the variation of the reservoir tension and maintain whatever steady motor-speed is set. The adjustment of the valve v^8 to the proper ratio of diminution of windway w^8 to the contraction of reservoir I is readily secured by the regulating of the connection between valve v^8 and the moving-board of reservoir I by a screw-threaded wire as shown or other suitable variable connection.

In playing a percussion-tone instrument such as a piano, by pneumatic action, the forcing of the bellows pumping until the reservoir is at its limit of movement and then exerting an excess force on the feeders to produce an extreme force of stroke does not in practice accomplish the result expected, an extreme degree of loud touch similar to the result on an organ expression bellows, for the reason that with the piano the loudness of tone depends on the quickness rather than the mere force of the key-stroke, and this the usual foot pedal movement is not rapid and sensitive enough to effect. By introducing a spring element as S^3 into the connecting means between the foot pedal and the feeder f' as shown in Fig. 1 it becomes practical to force an excess power of stroke from the pneumatics. The spring s^3 is made somewhat stronger than the power required to operate the feeder f' when it is inducing the highest tension of air producible by the spring action of the bellows reservoir, consequently the action of this pedal and feeder up to that degree of air tension will be the same as if the connection were of the ordinary kind. When the air of the reservoir has been brought to the highest degree of its own spring tension, the reservoir being then at its extreme tension limit of movement, an excess force on the pedal will bring into action the spring s^3 which will cause very quick acting pull on the feeder f' and so produce an excess tension of air capable of the most rapid movement of the pneumatics to effect extreme fortissimo strokes of the keys.

In forming the covering material to a hinged feeder, pneumatic, or other collapsible bellows chamber it is difficult to cause the covering material to make a smooth, tight joint around the corners of the boards, as the edge of the opening end of the feeder board stands at an angle to the true line from one board to the other. All error of fit may be easily overcome at no cost by sawing the opening end f^4 of the feeder-board at the angle to its own plane which coincides with the line from that edge of that board to the line of attachment f^5 of the covering material of that fold to the other board when they are at their spread position as shown by feeder f in Fig. 1 and Fig. 4^b.

Bellows feeders of usual form when put to high tension and rapid operation, as in piano-players, are apt to soon wear out at their corner folds, as the folds of two adjacent sides of the feeder (or reservoir) work to and from each other at their meeting fold as the feeder is worked, thus causing a "sawing" of the covering material at the meeting place of the folds, and this "sawing" soon causes a leakage and requires patching. Feeders f^2, f^3 are shown of the usual form of fold, while feeders f, f' have an improved form and fold at their corners as shown in Figs. 4^a and 5 which overcomes the defect just described. In the improved feeder the fold of the front of the feeder is made to extend beyond the corner of the feeder at the joint of the fold, while the folds of the adjacent sides of the feeder are kept well within the limits of the boards as shown. When the feeder is opening the extended corners of the front fold take up and draw taut the slack of material yielded by the side folds, and as the feeder closes the reverse action of the folds causes the corner part of the covering material to be taken up by the side folds as it is yielded by the extended corner of the front fold. By a careful proportioning of the extended corner to the amount of fold and extent of feeder stroke as shown, the durability of the feeder is greatly prolonged over the usual style as now in general use. Similar folds can be used on reservoirs, or pneumatics.

The weight of the piano hammers and resistance of the damper springs varies greatly from bass to treble of the scale, the "touch" of the keys grading from 7 to 5 units in the scale of 58 notes shown as included for operation by the piano-player herein set forth. It is therefore desirable to proportion the power of stroke of the playing mechanism accordingly, and this is accomplished by the varied area, stroke and leverage of the pneumatics P as shown in Figs. 1 and 3. By this means the power of stroke is uniformly graded to suit the "touch" of the piano action, producing a perfect musical effect of scale, glissando and arpeggio passages of compositions when automatically rendered. Economy of power of operation is also gained by the reduced size of the treble pneumatics, and at the same time greater speed of stroke for the high notes, which is effective for tone production: besides which a more rapid repetition can be attained with the small pneumatics in the treble where it is most needed.

The expression means thus far described will give all grades of power at various

times, and will even give two degrees of touch to different ones of several notes of a chord or group arranged to commence sounding once, but fully artistic music requires that in some cases many different degrees of touch are required to one such chord or group, besides various rapidly successive dynamic degree changes, accents, and emphases of notes in compositions of such brilliant or elaborate character as could not be easily and well done by the changes of bellows tension or capacity. For these and many other purposes, especially the artistic reproduction of musical performances recorded by my special mechanism and methods set forth and claimed in separate applications therefor, the following described construction of the pneumatics and valves is novel and effective.

The dynamic degree of tone of a note played upon a piano or other percussion tone instrument is governed by the speed of stroke of the key, the power applied to move the key only counting as overcoming the inertia and friction, because the hammer leaves connection with the jack and key before the hammer reaches the string, consequently the dynamic degree of tone is in proportion to the weight of the hammer and its speed of impact on the string. The speed of movement of air at any tension which causes the motion of a given quantity thereof through an opening, is proportionate to the size of the opening, wherefor a variation of the size or amount of valve-opening to a given size pneumatic will proportionately vary the speed of movement of such pneumatic and correspondingly vary the dynamic degree of tone produced by the action of the pneumatic on a piano key and its hammer and string. A variation in the shape or size of the aperture or perforation which controls the primary pneumatic means will correspondingly vary the speed of movement of such primary means and the valves to the power pneumatic which are actuated by said primary, and by this method the variation of stroke can be governed, but with the construction of primary pneumatics and their valves in the usual forms heretofore in use this variation would be limited, besides being impractical on account of the loss of air and the noise thereof when the primary valves moved slowly, both valves being on one rod and connected to a single primary pneumatic. These difficulties are overcome and many advantages gained by the employment of two or more primary pneumatics and two or more independent valves to each power pneumatic, one desirable construction of this novel principle being shown herein although numerous modifications are possible and yet tributary to this broadly new generic idea.

In Figs. 9 to 10^d, P is a power-pneumatic or secondary attached to one outside face of a wind-chest W which is connected to the air exhaust means of the apparatus. This power pneumatic P has an opening or recess r^{10} in its fixed board to allow air to be exhausted from this power pneumatic through a port w^{10} in the face board of the exhaust chest when the valve v^{10} of that port is opened by the action of its primary pneumatic p^{10}, thus causing the collapsing or "positive" operative movement of power pneumatic, while a port w^9 in the moving-board of this power pneumatic allows the return movement thereof when its valve v^9 is open during the inactive condition of its primary pneumatic p^9, this same port w^9 being closed by valve v^9 acted upon by its primary pneumatic p^9 whenever the exhaust valve v^{10} and port w^{10} are open to the power pneumatic P, thus preventing any loss of air by passage through both ports at one time. The two primary pneumatics p^9, p^{10}, are shown as connected to one duct d^{10} which is controlled from an aperture of the scale-reader, which aperture is opened to various degrees or at various speeds by suitable special perforations in the music-sheet, or the single duct to the two primaries can be controlled from two or more separate apertures variably used singly and separately, and this system of one duct to two primaries of a single power pneumatic or secondary can be controlled by key, stop, or swell pedal valves to the duct, or the duct can be controlled by auxiliary pneumatics and valves. And the two primary valves can be operated by a single oblong pneumatic arranged to be free to rise at one end in advance of the other. Also, the secondary pneumatic as P can operate additional valves to other pneumatics for increase of power or other purpose. Or the two or more primary pneumatics can each be controlled by an independent duct and aperture. The music-sheet S shows perforations of varying widths to control varied operations of the primary pneumatics p^9, p^{10} and their power pneumatics P, but many improved styles of varied perforations, etc., and connections to primary pneumatics are set forth in a separate application, 90,935, filed Jan. 23, 1902. The operation of these pneumatics is as follows: When the pneumatics are normally at rest valve v^9 is open and valve v^{10} is closed, and the power-pneumatic P is open to the outside air only and therefore inactive.—Fig. 10. The first admission of air to duct d^{10} serves to inflate primary p^9 and close valve v^9 against port w^9 to seal power-pneumatic P from the outside air while the exhaust-port w^{10} is still closed by reason of its valve v^{10} having a greater proportionate resistance to its primary p^{10} than that of the flushing valve v^9 to its primary p^9,—Fig. 10^a. The

second portion of air through duct d^{10} inflates primary p^{10} and opens valve v^{10} to exhaust power-pneumatic P through port w^{10}, the power-pneumatic now starting to collapse and thereby exert its power, Fig. 10^b. In the next stage of operation, Fig. 10^c, the primaries and valves having continued to be held as before from the air inflation through duct d^{10}, the power-pneumatic P has completed its power action by collapsing to its full limit, and by such movement has forced back the valves v^9, v^{10}, and their primary-pneumatics p^9, p^{10} to almost their initial normal position, thus preparing them for a quick subsidence to inactive position with a minimum size of return vent to the primaries. The spring s^{10} between the moving board of power-pneumatic and the exhaust valve action serves to aid the quickness of return of said valve, especially when the action of the power-pneumatic is of very short duration or of slow speed and the valves and primaries are not well returned toward their seats, the spring s^{10} then serving to accelerate the return of valve and prevent loss of air through the two ports at once. Screw s^{11} or equivalent means serves for regulating the closeness of return of valve v^{10} to its seat and the relation of such return to the collapsed position of the power-pneumatic. It is best that the regulator and spring be set to do their principal work during the bottom of stroke after hammer of piano has left jack and the speed of stroke of key no longer affects the power of tone. In Fig. 10^d is shown the condition at the moment the inflation of air of duct d^{10} ceases, valve v^{10} instantly going to its seat by the action of spring s^{10} and draft of air on port w^{10}, the valve v^9 opening less quickly because of less force therefor, thus preventing loss of air through the two ports being open at one time. The remainder of return movement of power-pneumatic P is then accomplished by the flush of outside air through port w^9, the valve v^9 thereof having gone the remaining short distance to its seat by its own weight aided by the influx draft of air through port w^9 and the natural pull of the formed leather of the primary. The depressed position of valve v^9 gives a full advantage to the port w as the power-pneumatic P returns to rest, while its close position to that port at the bottom of stroke of power-pneumatic serves to restrict the power-pneumatic to a short return movement on quick repetition action and so adapt it on a tapered or curved rise to its sides, varies its diameter and consequent clearance of the valve at the requirements of "close repetition" of a piano action. From foregoing it is evident that the inflation of primaries can be as slow or fast as desired, according to the admission of air through duct service, and no appreciable air will escape through the two ports at one time in any event. Thus the speed of operation (collapse) of the power-pneumatic can be graded and varied at will, the speed or extent of rise of valve v^{10} being controlled by the variation of amount, pressure or speed of air admitted to the primary p^{10} from the controlling aperture of its duct d^{10}.

The separation of the two primary valves of the power-pneumatic (exhaust and flush) to separate movement has many advantages besides the expression action, as each valve seats independently to its own port-face, thus avoiding any variations or impediments of action which arise with two valves having common movement when atmospheric or other causes change the distance between the seats or alter the thickness of the valves or their relative adjustment. Also the independent movement of the exhaust or "positive" valve allows it to be thrown wide open to the full capacity of its port, which is one-quarter its diameter (or more when allowing for friction). This is a great saving over the old combined valves, as with them it has always been necessary to limit their throw to one-half or less of their free service, that is one-eighth or less of the diameter of the port, a grave loss by friction, and of space required for valves and pneumatics of a given efficiency, besides constant trouble from atmospheric changes altering or entirely closing the operation. With the primary valves inside the power-pneumatic the air travel is of minimum distance and number of changes of direction, the valves are accessible without opening the chests, and the power-pneumatics are guarded against leaks from one to another.

The ports of any pneumatics in musical instruments are improved by enlarging or tapering the port-hole on its side away from its valve as the "cutting" of the air across the outer edge of the hole is avoided, the air has less sharpness of turn around the inner edge of the hole and valve, and then a much less distance of restricted travel for the air, thus saving loss of power and speed of air by friction and preventing any noise from the operation of the air. In the first construction made of the present style of pneumatics there was a very pronounced and unpermissible noise from their much exposed valve ports when tried without tapering, which noise was entirely obviated so soon as the holes were tapered. The best results are obtained by a curved taper.

When desired the recess r^{12} for the exhaust valve v^{12} can be made to closely surround the valve at its seated position, and being enlarged at its upper part, as shown in Figs. 11 and 11^c, instead of the recess being of great freedom of air travel as in Figs. 9 to 10^d. The recesses as in Figs. 11 and 11^c

serve to preserve an air-draft pull on the exhaust valve when slightly open, that is almost the same or a little greater than the air pressure on that valve when seated. This enables a carefully graded air inflation of primary p^{12} to cause the valve v^{12} to open but a trifle, while if the recess were large and free the valve would be more apt to jump wide open as soon as its seating pull ("pluck") was overcome. The grading of the recess to the various points of valve rise enables a control to any point desired, the draft on the valve being definitely graded; thereby fine gradations of speed of power-pneumatic stroke can be obtained. The third primary-pneumatic, p^{13}, in Figs. 11 and 11^c, is connected to a duct and aperture independent of the primaries p^{11}, p^{12} and this third primary controls an extra exhaust port w^{13} to the power-pneumatic. By the optional operation of this extra exhaust port, and its opening at same time with the regular port w^{12} or at various degrees of time thereafter, numerous gradations of stroke-speed of power-pneumatic can be effected, and without necessarily varying the size of either actuating perforation of a music-sheet. The flush-valve v^9 and stroke-valve v^{12} are always operated together whether the extra valve v^{13} is operated or not, primary means p^{11}, p^{12}, effecting such operation, a main tracker aperture connecting by tube 12 to p^{11} and p^{12} to control v^9 and v^{12} together, and an auxiliary tracker aperture connecting by tube 13 to p^{13} to optionally operate v^{13}.

The return of the primary pneumatics after their inflation (action) is accomplished by the renewal of equal air-tension inside and outside the primaries by means of a separate return-vent connected to each one of the ducts d^{10}, d^{11}, or their extensions, which return-vents can each be placed inside the chest W or at any other position where it can connect the air on the inside and outside of the said primary-pneumatics, but it is most convenient and efficient to have the return-vent as near to the operating vent (aperture) as possible on the principle of construction shown and claimed in my issued Patent #545,156, Aug. 27th, 1895. That feature of return-vent position is now shown with an improvement whereby all the return-vents d, d', etc., may be simultaneously regulated by one adjustment bar b which can be set by the binding screws thereof to any amount of opening of vents desired, and by removal of said bar b any accumulation of dirt can be removed from the ducts behind the bar. The construction now shown is arranged for use with an adjustable compound scale-reader, the return vents d, d', etc., being placed in a chamber D near the scale-reader and the walls of which chamber serve as a meeting-rail for the flexible tubes (preferably straight to avoid collapse) from the elements or parts of the scale-reader and the continuing tubes, ducts or grooves leading to the action, whether the latter be flexible or rigid, but preferably metal tubes of fairly stiff qaulity to insure against damage, commonly lead or tin. Means are also provided for instantly freeing all the return-vents at one time by a reverse blast of air to that passing through them when in operation with the pneumatics. This freeing or cleaning is best accomplished by means substantially as shown which can be adjusted to cut off the normal air-connection to the chamber D containing the several return-vents and at same time leave an opening through which a blast of air can be served by the user's lungs or a suitable bellows to clear all the return-vents by such blast of air passing through them in direction the reverse of that of their operative use. The normal condition of chamber D is connected to the same air service and tension as chests W, such air connection being through conductor W^{15}, valve v^{15} thereto being held open by a spring s^{14} which also holds closed valve v^{14} to the reverse-air tube J. When cleaning the vents d, d', etc., it is only necessary to press down tube J, closing v^{15} and opening valve v^{14}, when a blast of air can be sent through windway w^{14} of tube J and all the vents of chamber D cleaned. By this method in any suitable form of adaptation an entire set of return-vents can be instantly cleaned which would require from thirty minutes to an hour to do by the present usual custom of sucking out through one aperture at a time by a small pump and tube, and this "sucking" method is very inefficient because the resistance and friction of the closed ducts and chambers prevent the quick draft of air necessary to carry out dust and dirt, and which draft is fully obtained by the arrangements now stated and claimed.

The arrangement of the tubes in rail D is of a compact and novel style, aiding their inserting and tracing. The tubes for the "sharp" notes are all in one row, grouped in twos and threes alternately, while the tubes for the same letters of "natural" notes are in an adjacent parallel row, each "natural" tube being set diagonally to the left (bass) of the corresponding "sharp" tube, constituting a "two and three" grouping of the natural tubes. The "natural" tubes which have no corresponding "sharp" tubes (musically notated as e and b) are located to the rear of and diagonally to the left of the respective two and three groups of "natural" tubes. It is apparent that this enables the instantaneous locating of a particular tube or socket therefor without the use of any gage or plan. It also enable the "sharp" tubes to be all connected at the

first of assembling when it is most convenient to run those tubes to the chest of "sharp" pneumatics at the rear of the action. For great convenience in locating the "sharp" tubes, their sockets are designated by contiguous mark or ring, a desirable style of which is shown by the heavy black circular lines in Fig. 12 at rail D'.

The tubes for the "sharp" notes, are best arranged to be tied in the groups of two and three, or a joint group of five, and in any tied group or singly are best and most directly connected to their respective "sharp" pneumatics of the "sharp" chest at the rear of the action by leading said "sharp" tubes between the U-pieces or similar key-actuators, preferably at the spaces between the groups of "sharps" actuators. Electric wires are to be considered as equivalents of tubes for the purposes stated in this and preceding paragraph, both being note connections.

To diminish the power of stroke of the pneumatics as P without shifting the bellows tension, as when only a momentary diminution is desired, or when only a part of the scale is to be affected, as in accompaniment part of the music, checks c^{12} and diminishers d^{13} are now employed to restrain the passage of air through valve-ways w^{12} and w^{13} as will now be described.

Check c^{12} consists of a pivoted "fan" or other suitable mechanical means for stopping the rise of primary-valves as v^{12}. In Fig. 11^c this check c^{12} is in inoperative position, being too far raised to check the full rise of valve v^{12}, while in Fig 11 the check c^{12} is depressed and prevents the valve v^{12} from rising more than a small part of its full efficiency of windway, thereby causing a slow stroke of the power pneumatic. Such checks c^{12} can be easily arranged for separate control of as many divisions of the scale as desired and without the complication or expense of dividing the wind-chests W or the bellows. The division herein employed is between middle c' and b notes of the musical scale, making treble and bass independent control by checks c^{12}. The treble and bass checks c^{12} are actuated by the tilting tablet marked "Echo" in Fig. 3, by which either one or both checks at once can be made to act. As it often occurs that a melody note will "cross" the accompaniment division above described, the melody note being in the same division of scale with the accompaniment notes which are softened by check c^{12}, it is desirable to arrange the auxiliary valves v^{13} to include the notes immediately above and below the point of division, musical notes a to d' being so adapted in the present construction, as shown by the tracker scale gage g^2 in Fig. 2, wherein the notes a to d' are duplicated immediately to the right of the main scale, these extra tracker controls being connected to the auxiliary valves v^{13}. It is thereby possible to increase the power of any one of these notes in a softened division of the scale by opening the auxiliary valve v^{13} to that note. The duplication of the middle notes only of the scale of the tracker and music-sheet are not broadly claimed herein, same being a part of my application #90,935, filed Jan. 23, 1902, for "music sheets," etc.

To diminish the air service to the power pneumatics either with or without checking the rise of their valves v^{10}, v^{12}, v^{13} by the size of the perforation of the music-sheet or the checks c^{12}, a diminisher d^{13} is employed. In the present case this diminisher is only arranged with the six auxiliary valves v^{13} at the middle of the scale, which can be controlled independently of the other devices, but diminishers may be employed for any or all other notes of the instrument. In Fig. 11^c the diminisher d^{13} is in lowered position and the windway w^{13} is free for its full action on the power-pneumatic when valve v^{13} is opened fully. In Fig. 11 the diminisher d^{13} is raised by the action of a controlling pneumatic whose rod is shown, and in this position the diminisher d^{13} restricts the passage of air through windway w^{13} and thereby reduces effect on the power-pneumatic. With either check c^{12} or diminisher d^{13} in action, a pneumatic and valve as p^{12}, v^{12} or p^{13}, v^{13} can be given a sudden opening and yet the air action on the power-pneumatic be of low speed, which is desirable for some "touch" effects. To further control the passage of air through windway w^{13} the action-nut or button r^{13} is made of a size almost filling the windway w^{13} so that when the pneumatic p^{13} is flushed slowly from an aperture of the tracker the rising of valve v^{13} does not immediately free the pluck or draft of air, the button r^{13} being held back in its movement by the air current and at the same time allowing but a small portion of air to pass through the windway w^{13}, with the result of a well controlled restricted effect on the power-pneumatic.

To gain variable position manual control of the diminishing stroke of the key-actuating pneumatics P a movable or flexible strip or guard as g^2 is placed in position over the apertures a of the tracker or scale-reader T and so that the guard g^2 is above the sheet S when in operation, and when it is desired to diminish the key-stroke of some particular part of the scale of notes the guard g is flexed, depressed or moved into position to partially obstruct the passage of air through the particular apertures a which control the notes desired to be softened. The strip g^2 as herein shown is preferably made of a material such as celluloid, which is sufficiently transparent to permit the music-sheet S to be viewed as it passes under

the guard g^2. This strip g^2 is provided with marks, characters, divisions, colorations or variations of its form indicating the notes of the musical scale of the tracker apertures a and the perforations of the music-sheet S. A very desirable way of so indicating the musical scale on the guard g^2 is by coloring the sharp note positions by means of transparent colored ink or dye applied to the celluloid, preferably to its under side to avoid its injury from the user's hand. By means of the transparent note-scale guard g^2 it is easy to ascertain the pitch of any of the apertures or perforations as the guard g^2 allows a perfect view of whatever is under it as well as the sheet immediately preceding and following that position. The flexibility of the guard g^2 aids the inserting and removing of the music-sheets without detaching the guard.

With any large scale of automatic music-sheet it is desirable that some compensation be provided for its expansion and contraction, &c., to justify its perforations or equivalent note-indications with the note-control apertures of a tracker or equivalents thereof. Certain arrangements of such compensating devices are shown in applicant's issued Patent #685,270, Oct. 29th, 1901, which embraces adjusting means by which the adjustable tracker may be manually set to the particular length of the music-spool in use at the time. In the present application are shown means by which the adjustable compound scale-reader or tracker T will be automatically set to any length of and regulated to any variations of the spool while in position, whether the spool is operating or not; and the present spacing means have numerous novel advantages. With the expression valve-pneumatics of the present instrument and graded music-sheet perforations for their control, it is better to have the apertures of the scale-reader adjustable individually rather than to average the adjustment in groups or sections of a tracker with several note-apertures to each group or section as formerly, and for this present and any other uses where an accuracy of justification is needed the individual elements with a single note-control to each are best, as shown herein, besides the advantages of an apparatus where each note-control is separate from and insured against interference from or with all others, and the further gain in opportunity of using metal or other durable material superior to wood, especially in tropical climates.

As the term "tracker", "tracker-board", "tracker-bar" or "tracker-range" has become settled in usage in this art to denote a single board or bar containing an entire scale of pneumatic duct apertures, or a section thereof comprising a considerable number of apertures of the scale, the term "scale-reader" is employed herein to denote any aggregation of "note-reading" apertures or equivalents whether contained in a single board or bar or in "sections" each containing several "note-readers" and hereinafter called a "note-reading part", or having a single note-reading aperture or equivalent to each "note-reading element"; as such single note devices will hereinafter be called. The "scale-reader", having two or more sections ("parts"), or "elements", to its scale series is now termed a "compound scale-reader", and when variable as to its spacing and length of scale is specified as an "adjustable compound scale-reader."

As any single adjusting member, to vary the spacing between all the elements or parts of an adjustable scale-reader would be very difficult to construct for a large number of closely centered elements or parts, it is preferable to employ individual spacing means between each element or part and the next one, such as the tilting plates t^{11} shown herein, or wedges or other equivalent means. To gain leverage and a natural direction of movement for the action of their spacing means, it is best to have the ends of the tilting plates shaped at an angle to their spacing parts, forming a crank-like device, the arms being at an angle more nearly approaching the general line of the series of such arms than do their spacing parts, thus enabling a better movement by a common controlling means as c^{11}, than if each such tilting plate extended straight out its entire length, as could be done. With the crank-wise bent spacing-means as t^{11} it is desirable to shape the bent parts so they will each neatly guide to the other sides of one or more of the elements or parts and thus prevent any displacement of the spacing-means from its true transverse position to the general alinement of the scale-reader. Each spacing-means has most efficient action when extended beyond the elements or parts at both sides of their general line, thus insuring true action thereof by the controlling means. The individual spacing-means as t^{11}, especially when numerous, are best adjusted by a single controller movement, but when desired, may be individually adjusted, as when with long sections or parts of several notes each. Such a single controller is shown, designated c^{11}, arranged to actuate all the spacing-means t^{11} at one movement by pressing on the entire series and causing them to tilt to a greater degree and thus spread apart all the elements or parts at once and to an equal amount between each and every one and the adjoining one. The spacing-means t^{11} being free of attachment to the controllers c^{11} or the bars b^{11} will slide lengthwise of the scale together with the elements or parts and thus the cumulative action of the spacing movements is per-

mitted, and the entire scale adjusted. Two series of spacing-means are shown, front and rear respectively, that their combined action may keep all the elements or parts truly parallel to each other and at always equal angle to the face line of the scale-reader, although in some cases a single series, or even one intervening spacing means between only two parts might answer the conditions. Rigidly placed bars b^{10}, b^{11}, support the tilting-plates t^{11} against the pressure of the controlling-means c^{11}. Although the variation of width of paper of a 10 in. width music-sheet is about 1/10 in., the individual variation to each note-space of its scale is only about 1/600 in., as there are usually 6 notes to the inch. The same statement is true whatever the spacing of the scale of the music-sheet, the co-efficient of expansion being the same for the material used, paper, which is usually about .01 with full change of atmospheric conditions, so a music-sheet having a scale of 100 notes would shift the end perforation an entire scale unit to the next aperture beyond unless the apertures were adjusted; and other scale numbers of notes proportionately. Therefore the movement of space variation of each spacing-means t^{11} will be only 1/600 in., and the movement of its crank-arm say 1/300 in., consequently some very accurate arrangement of the controlling means is necessary, and one that will at some point have a much greater movement than 1/300 in. For these reasons the controller c^{11} is arranged to slide longitudinally a moderate distance, preferably to an extent equal to the sum of the variation of space of all the spacing-means, and its active movement in direction similar to that of the expansion of the scale-reader caused thereby, although this particular amount and direction of longitudinal movement is only necessary when utilizing the same controller as the counter-acting-means for causing the contraction of the adjustable scale-reader. Diagonal slots c^{12}, inclined planes, toggles, or equivalent means are employed to cause the controller-means c^{11} to have a slight transverse action when longitudinally moved, and by the transverse action move all the tilting-plate spacing-means as t^{11} by an equal movement against the arms or ends of each, causing an equal expansion of every space between elements or parts. Regulating screws c^{13} or other suitable means may be provided by which to set the angle and degree of transverse action of the controller-means c^{11}. To cause the elements or parts of the scale-reader to contract when the controller-means is given a return movement, and thus release its pressure on the spacing-means, springs or other independent devices can be employed to move against the moving end of the series of elements or parts and thereby compress them and their spacing-means to a shorter scale measure, but such pressure means would be inconvenient, and if a spring, cause needless friction. Therefore it is best to have counter-acting-means controlled by the movement of the controller-means and acting oppositely thereto on the adjustment action, and arranged to have its movement equal to that of the cumulative total of all the spacing-means movements but acting oppositely thereto. By this means both the expansion and contraction movements will be positive, and of least possible friction, and are controllable by one shifting means either manual or automatic. As the controller return movement is in the same direction as the contractive movement of the scale-reader a lug c^{14} or other connection placed on or connected to the controller-means and arranged to act against the moving end-member of the scale-reader will cause the scale-reader to contract throughout its series of elements or parts, and to an equal amount between each two elements and parts, as governed by the reverse action of the spacing-means.

As wider music-sheets of paper, etc., require adjustable spools or flanges to guide the paper under its varying conditions of width it is very convenient to have the adjusted length or spread of the spool automatically regulate the adjustment of the spacing and length of the scale-reader to correspond therewith. Such spool may be of a manually adjustable, or of a semi-automatically adjustable style, or be self-compensating as in my issued Patent #669,342 Mch. 5th, 1901, this last named being the best for the purpose. An arm q of a rocker is arranged to engage and shift the controller-means c^{11} to vary the adjustment of the spacing and length of the scale-reader, and the arm q' of this rocker (in this instance of equal motion with the arm q) is arranged to be shifted by the collar q^2 of the music-spool, the collar being on the longitudinal adjusting end of such spool. Or the shifting means can be arranged to be regulated directly or indirectly by or from any variable part of the spool as the flange, hub, or bearing pin, so long as such part has movement corresponding to the variation of the width of the music-sheets; and the shifting means may be directly mechanical, or with intervening pneumatic or electrical aids, and yet be within the broad scope of the invention claimed herein. The feature of a single shifter and common controller means to a plurality of elements or parts (sections) of an adjustable scale-reader (or tracker), of whatever particular construction the details may be, may be utilized for control by action of the varying sheet, without intervention of the spool, as by pressure from the edge of the sheet or from a series of perforations in

the sheet, even a single line of such perforations answering instead of one line for each section as formerly, and by this unified control in any adaptation, a simplicity of construction and operation will be had, whether from the sheet direct or by intervention of the spool, claims herein being intended to cover either the direct or indirect control. Manual means of shifting these adjusting devices may be used in lieu of spool or direct sheet control, or manual control in same apparatus with an automatic form.

The elements of a compound scale-reader, having but a single note-reading aperture to each, are of so slender a form as to require construction from some strong material such as metal, and to be easily formed and avoid rust or corrosion, nickel, brass or German silver will be found desirable. Each element o is preferably of circular tubular form at its end which connects to the action leaders or ducts, which are necessarily of a flexible nature, as rubber tubes, near the elements, to allow of the movement of adjustment, but may continue toward the action by either flexible or rigid tubes or other duct connections. It is therefore convenient and cheap to use solid drawn-tube from which to form the elements. Each element aperture a is generally required to be of a rectangular form, and it is therefore necessary to prevent the turning of the element o and its aperture a from its true position. Both the shape of the aperture a and its guidance can be secured by a single feature of construction, the flattening of the aperture end of the tubular element o as shown in drawings herein, the two flattened sides of the element o serving to guide it between suitable guides as b^8, b^9 to a true scale alinement. It is best that the guides of any compound scale-reader be placed as near as possible to the face line over which the music-sheet is to travel, to thereby insure accurate alinement and level of the several elements or parts. To secure a larger bearing face for the music-sheet the aperture ends of the elements o may be extended or turned over into lips or faces o'. These lips or faces may also serve to guide the elements to a true face-line level for the music-sheet by being held by suitable guideways, or by a bearing surface underneath the lips and to which the music-sheet presses then when in operation and thus secures a very accurate leveling to a single line bearing to which the elements were similarly leveled when being trued and polished. In constructing such an element from a tube it is only necessary to slit the end of the tube a distance equal to the extension for the intended lip, flatten that end part of the tube in a die and expand the two lips to proper shape by a second die movement. When desired, a part (section) of several apertures, or an entire scale-reader, may be constructed from these elements by attaching them together, also, the peculiar form of elements described may be used with other styles of adjusting means than those herein.

Cylinders or equivalent propelling devices in self-playing musical instruments or attachments have heretofore been arranged with engaging means at their middle part to connect or engage the music-sheets, which sheets have been correspondingly made with their attaching or connecting features of their forward ends placed midway between the two sides of the sheet. This construction has necessitated the exact centering of the forward end of each sheet when completing it, and the sheet being preferably slanted at its forward end to enable its easy start when placing in operative position, no sides of sheet were in position to insure guidance to center at the start. In the present construction the engaging means of the cylinder R or other propelling device is placed at or near one end thereof to engage the music-sheet S at one side of its forward end, and the sheet is slanted away from such side of its forward end back to its other side when a slant end is desired. With this construction the engagement is effected with the edge of the sheet for guidance, the guiding edge is protected from wear by the finish of end, and the making of the sheet is simplified by saving centering of end. This construction is especially desirable with an adjustable music spool or an adjustable compound scale-reader, or both together, the engaging means of cylinder and sheet and the forward end of sheet being placed at the same end of scale as the fixed position end of scale-reader and music-spool, all gaging to the one end and adjusting toward the other.

For economy of space with simplicity of gearing, and small expenditure of power, the motor M is placed within the take-up cylinder or hollow roller R as shown in Figs. 11 and 13. A tube or windway w^7 is firmly held in a fixed position and supports the motor M centrally to the axis of roller R, the windway w^7 conveying the motive air service for propulsion of motor M. The roller R surrounds the motor M but is free to revolve about the motor, the roller having its running bearing on tube w^7. A shaft m^{13} extends from the inner end of the motor M and is revolved by the action of the motor. This shaft has a driving means m^{12} on its farther end as shown in Fig. 11^b. This driving means may be a pinion but as its revolution is of high speed, about 900 per minute maximum, it is best to use the friction drive now shown and thereby avoid noise. Such friction drive is effected by making the driving means m^{12} of a disk of leather or other suitable gripping material, and providing the next wheel (m^{10}) of the train with a groove m^{11} on the inner edge of its

outer flange, and into which groove m^{11} disk m^{12} runs and so propels the wheel m^{10}. The wheel m^{10} revolves with its own spindle m^9, at the inner end of said spindle being a pinion or equivalent driving means m^8 which is carried by and revolves with the spindle m^9 and its wheel m^{10}. The pinion m^8 engages the teeth of the internal gear m^7, and thereby revolves gear wheel m^7 and its attached axial sleeve m^6. The sleeve m^6 and its gear wheel m^7 revolve loosely on shaft m^{13} and have an intermediate shifting clutch m^5 which is moved into position to engage clutch m^4 of roller R and thereby causes the roller R to be driven by the action of the motor M through the intermediate speed reducing gearing m^4 to m^{13}, and when it is desired to free the roller R from the motor and gearing, as for reverse rolling of the music-sheet S, the clutch m^4 is moved into the position shown in Fig. 13. The speed of pinion m^8 being comparatively low, about 150 per minute maximum, and the driving resistance six times greater than disk m^{12}, it is expedient to use the pinion m^8 for the slow drive, although the friction means could be substituted. Both the large wheels, m^4, m^{10}, having their driving engagement internal there is secured a minimum of loss of power and of wear, a maximum of steadiness of movement, and a freedom from noise, besides great compactness of arrangement with large sized wheels and quick drop of speed. With the gearing as shown and the motor M run at 900 rev. the speed is reduced to 25 rev. of the roller R, which is correct for rapid tempo playing from music-sheet S, lower speeds being secured by setting the valve v^6 to reduce the speed of the motor.

The rewinding of the music-sheet S upon its roller S′ from off the take-up roller R after the playing of a selection, is attained by means of the rewinding device N shown in detail in Fig. 11ª. In my application #60,328, filed May 15, 1901 for "rewinders," etc., I show a double straight rack, and a pinion moved thereby, the rack being connected to a slide-bar by swinging links. The present arrangement does away with the separate slide-bar and the links, the device now shown being comprised in a single piece of mechanism N of a curved quadrant form which is especially adapted to the space available in the present instrument, besides securing simplicity and durability. A main plate n^{10} is stamped of sheet metal into the form of a crescent, this being economically done by feeding a strip of the metal under a round punch step by step, the outer curve of each crescent being cut from the inner curve of the following one. To this plate n^{10} is then affixed a quadrant n^{12} (or other convenient sector) of a circular gear having external teeth, and opposed to the arc of the gear sector n^{12} is affixed the quarter section of an annular gear n^{12} having internal teeth, the two arcs of the gear teeth thus facing each other. Affixed to a stationary part of the instrument is a journal-pin n^8, and to the plate n^{10} is attached a hub n^7 having a journal slot n^9 disposed in the common radial line of the arcs of the two sectors of gears n^{11}, n^{12}. The teeth of the gears n^{11}, n^{12} are sufficiently far apart that the pinion n^{13} of music-clutch spindle R′ will clear between the teeth of n^{11}, n^{12} when midway thereof. The gears n^{11}, n^{12} are of such arcs and so positioned on plate n^{10} that their centers will correspond to the two respective positions at either end of slot n^9 occupied by the journal-pin n^8 when the entire mechanism N is moved in the direction of its slot n^9. These two gear-arc centers must also be correct to cause the exact meeting of the pitch lines of their respective gears n^{11}, n^{12} with the pitch line of pinion n^{13} as each said gear is brought into operation with that pinion by the shifting of the mechanism N along its slot n^9 on journal-pin n^8. Motion is imparted to mechanism N by means of a hand-operated knob and rod n^6, which is thrown over on its pivot n^5 into horizontal position when in use. When so used, and a thrust is exerted upon knob n^6 the mechanism N is held to a bearing at the front of its slot n^9 upon journal-pin n^8 and as the thrust is continued the entire mechanism swings upward on said pin n^8 as its fulcrum center, the teeth of gear n^{11} being into mesh with and causing pinion n^{13} to revolve spindle R′ and music spool S′, cylinder, or other driving means or motor part adapted to move a music-sheet. When the power or knob n^6 is reversed to a forward pull the spring n^{14} or equivalent friction retarding means between a stationary part of the apparatus and a suitable part of the mechanism which moves with the gears n^{11}, n^{12}, prevents the gears from swinging downwardly as they clear the pinion n^{13}, and as the pull continues to slide mechanism N forward along its slot n^9 on the journal-pin n^8 the gear n^{12} is brought into mesh with pinion n^{13}, the pull then exerting itself to swing said gear n^{12} on pin n^8 as its fulcrum center and thereby revolves pinion n^{13} in the same direction as by movement of gear n^{11}, the pinion n^{13} being always driven in its one proper direction by any operation of mechanism N. The position of pivot n^5, knob and rod n^6, may be placed at whatever distance from journal-slot n^9 proportionate to radial distance from slot n^9 to the gear arcs gives the most desirable leverage for operation. This feature enables a considerable increase of speed from the hand movement over what is accomplished by a straight rack movement. It is evident that the mechanism N can be constructed by casting, bending or say any

method other than described, although the method above stated is considered desirable for accuracy. It is also apparent that this mechanism N can be driven by other reciprocating power than hand, as by foot movement, pneumatic, etc., and that friction gears can be substituted for toothed ones.

Many of the devices herein set forth, such as the novel divided primary valves, etc., are capable of use with manual key control as well as automatic, or with electric control; and in any and all the features of invention claimed herein it is to be understood that the claims are intended to cover the general uses to which said mechanisms may be put in any musical instrument or attachments, except such claims as may in their specific terms limit or determine a more restricted scope.

The graded pneumatics P here shown and described in a preceding part of this application, are of different lengths, stroke and leverage as hereinbefore set forth, the pneumatics P being larger in the bass part of the series than in the treble, and of several lengths and consequent powers in the various parts of the scale. The grading of pneumatics is not claimed herein, being claimed in my Patent #891,801, issued June 23, 1908.

What I claim as my invention is:

1. A self-playing musical apparatus having actuating motors and key-actuating U-shaped pieces, each U-shaped piece having an upper and substantially horizontal arm adapted to operate a manual key or lever of a musical instrument with which the apparatus may be connected, a middle part substantially vertical, and a lower and substantially horizontal arm connected to the actuating motors of the self-playing apparatus.

2. In an automatic attachment for playing upon key-boards of musical-instruments, a U-shaped piece having an upper arm in position to go over the upper face of a manual key and a substantially vertical part and a substantially horizontal lower part extended to go around the end of the key and underneath the keybed or key frame when in use, and automatic actuating mechanism connected to the lower arm of the U-shaped piece to pull down or strike the manual key when operating.

3. In combination, a manual keyboard of a musical instrument or apparatus, and an automatic attachment for playing upon the same having U-shaped pieces with their upper arms extending over and in position to strike or press down their respective manual keys, the said U-pieces extending around the ends of the keys and underneath the key bed or key frame, and actuating mechanism attached to the under arms of the said U-shaped pieces.

4. A self-playing musical apparatus having key-actuating U-shaped pieces each consisting of a strip of sheet metal or equivalent, the end parts thereof being turned at right angles to and lapped over the middle part in the same plane as that of the middle part.

5. A self-playing musical apparatus having key-actuating U-shaped pieces which are each of greater width of stock than their thickness.

6. A self-playing musical apparatus having key-actuating U-shaped pieces which are each of greater width of stock than their thickness, the said width being varied in each, and greatest in the middle part of each compared to the arms.

7. An automatic attachment for playing upon key-boards of musical instruments, having a series of key-actuating U-shaped pieces, and a guide-rail or guides which guide the said U-shaped pieces to positions corresponding to the positions of the various keys of a musical key-board.

8. In an automatic attachment for playing upon key boards of musical instruments, a series of key-actuating U-shaped pieces adapted to actuate a scale of black and white keys, the U-shaped pieces corresponding to the black keys having their key-striker parts at a higher level than those for the white keys.

9. In an attachment for automatically playing upon the keyboard of a musical instrument, separate series of key-actuating parts arranged correspondingly to the black and white keys respectively, and means for adjustably varying the relative levels of the two series of key-actuating parts one to the other.

10. In an automatic attachment for playing upon key-boards of musical instruments, a series of key-actuating U-shaped pieces corresponding to the common key-scale, the upper arms of the said U-shaped pieces which correspond to the black keys being longer than those for the white keys.

11. A self-playing musical apparatus having actuating motors, and a series of key-actuating U-shaped pieces the lower arms of which extend to varied lengths to connect several corresponding lines or rows of actuating motors.

12. In an automatic attachment for playing upon key-boards of musical instruments or apparatus, one or more U-shaped pieces adapted to press down or strike manual keys and actuating mechanism connected to the lower arms of said U-shaped pieces at positions substantially in vertical line with the key-striking parts of the upper arms of the same U-shaped pieces.

13. A self-playing musical apparatus having actuating motors, and a series of key-actuating U-shaped pieces of varied length

as to their middle parts between their arms, to connect to several lines or rows of actuating motors at varied levels.

14. In an automatic attachment for playing upon key-boards of musical instruments, actuating pneumatics of bellows form arranged in two rows lengthwise of and below the keyboard level, the operating ends of the pneumatics of each row pointing inwardly toward those of the other row, and the said operating ends of one row partially overlapping those of the other row.

15. In an attachment for automatically playing upon the key-board of a musical instrument, vertically adjustable key-actuating mechanism, a spring counterbalance thereto, and bearers of said mechanism in position to bear against the under part of a musical instrument and limit the rise of the key actuating mechanism.

16. In an attachment for automatically playing upon the key-board of a musical instrument, vertically adjustable key-actuating strikers and mechanism, leveling checks in suitable position on said mechanism to press downwardly upon a rigid part of the musical instrument when the attachment is combined therewith and the key-actuating strikers are in operative position with the manual keys, and an upwardly acting bearer on the attachment adapted to engage the instrument case and hold the leveling checks against the instrument.

17. In an attachment for automatically playing upon the key-board of a musical instrument, vertically adjustable key-actuating mechanism and automatic locking means for setting the key-actuating mechanism and musical instrument keys to properly operative relative level.

18. An attachment for automatically playing upon the key-board of a musical instrument and having a vertically adjustable bearer provided with a guide fixed as to lengthwise position and which guide is adapted to engage with a corresponding guide on the under part of the musical instrument.

19. In a music self-playing apparatus; tone-producers of percussion tones, actuator pneumatics adapted to operate said tone-producers, air-service connection to said pneumatics, and a bellows reservoir with feeders or pumps therefor attached to its moving-board, the opening edges and folds of both reservoir and feeder or pump being at the same side of the bellows, and power connections to said feeder or pump controllable to various degrees of force and speed of stroke, to thereby affect the air tension of the reservoir and its expression action upon the pneumatic strokes for the tone production.

20. In a music self-playing apparatus; tone-producers of percussion tones, actuator pneumatics adapted to operate said tone-producers, air-service connection to said pneumatics, and a bellows reservoir with a feeder or pump attached to the moving-board of the reservoir, and having air communication between said feeder and reservoir, and controlling means disposed and connected to vary or close the said communication for production of expression effects by the air of the bellows.

21. In a music self-playing apparatus; actuator pneumatics adapted to operate tone-producers, and tone-producers, and a composite bellows comprising two or more reservoir chambers of different areas one to another, with their moving parts joined or connected to move together as one.

22. In a music self-playing apparatus; actuator pneumatics adapted to operate tone-producers, and tone producers, and a composite bellows comprising two or more reservoir chambers of different areas, their moving parts joined or connected to move together, and an opposing spring or weight which is common to the two or more reservoirs.

23. In a music self-playing apparatus; actuator pneumatics adapted to operate tone-producers, and tone producers, and a composite bellows, comprising two or more reservoir chambers with their moving parts combined and moving together on a single hinge line, the said common line being at one side of the combined area of the moving-boards, and the chambers arranged in successive positions in a general plane with the said line and at various distances therefrom.

24. In a music self-playing apparatus; actuator pneumatics adapted to operate tone-producers, and tone producers, and a composite bellows comprising two or more reservoir chambers with their moving parts combined together and having a common hinge, the hinge being at one side of the combined area of the moving-boards, and the chambers arranged in successive positions in a general plane with the said hinge and at various distances therefrom.

25. In a music self-playing apparatus; actuator pneumatics adapted to operate tone-producers, and tone producers, and a composite bellows comprising two or more reservoir chambers of varied areas or capacities and having their moving parts combined to move together, an opposed tension device common to all, and valve mechanism to throw in and out of operation any desired one or combination of reservoirs, to produce corresponding variations of air tension.

26. In an automatic musical instrument or attachment, tone-producers, pneumatics for actuating same, a tracker or scale-reader for controlling the various musical notes, a composite bellows comprising two or more reservoirs of varied area or capacity to each

other, and means connected to and automatically controlled from the tracker or scale-reader to automatically bring into operation various single reservoirs or combinations of reservoirs of said composite bellows.

27. In a music self-playing apparatus; actuator pneumatics to operate tone-producers, and tone-producers, and a composite bellows comprising two or more reservoir chambers arranged to be interchangeably and combinably used, and one or more controlling devices each connected to throw into action a certain combination of said chambers.

28. In a music self-playing apparatus; actuator pneumatics adapted to operate tone-producers, and tone producers, and a composite bellows comprising two or more reservoir chambers arranged to be interchangeably and combinably used, and several controlling devices each connected to throw into action a certain different one or combination of said chambers.

29. In a music self-playing apparatus; actuator pneumatics adapted to operate tone-producers, air-tension devices arranged to be used interchangeably or combinably, and a single controlling device connected to throw into successive action in a certain order various ones or combinations of said air-tension devices.

30. In a music self-playing apparatus; actuator pneumatics adapted to operate tone-producers, and tone producers, and a composite bellows comprising two or more reservoir chambers, valve mechanism to throw in and out of operation any desired one or combination of reservoirs, and air tension reservoir means independent of the optionally operative reservoirs of said composite bellows and connected to the wind service of the instrument or attachment to operate during any lapse of action by the composite bellows reservoirs when they are shifting from one tension to another.

31. In a music self-playing apparatus; actuator pneumatics adapted to operate tone-producers, and tone producers, and a composite bellows comprising two or more reservoir chambers of varied areas, capacities or air tensions, valve mechanism to throw in and out of operation any desired one or combination of reservoirs, and air tension reservoir means independent of the optionally operative reservoirs of said composite bellows reservoirs and connected to the wind service of the instrument or attachment to operate during any lapse of action by the composite bellows reservoirs when they are shifting from one tension to another.

32. In a music self-playing apparatus; actuator pneumatics adapted to operate tone-producers, and tone producers, and a composite bellows comprising two or more reservoir chambers of varied areas or capacities having their moving parts joined or connected to move together, a spring or weight resistance opposed to and common to the two or more reservoirs, valve mechanism to throw in and out of operation any desired one or combination of reservoirs, and air tension means independent of the optionally operative reservoirs of said composite bellows and connected to the wind service of the instrument or attachment to operate during any lapse of action by the composite bellows reservoirs when they are shifting from one tension to another.

33. In a music self-playing apparatus; actuator pneumatics adapted to operate tone-producers, and tone-producers, and an air-tension reservoir of varying capacity, two or more feeders combined therewith, valve controlled ports for discharging surplus tension from the reservoir into the feeders and from an active feeder to another feeder, connections between the said valves and a moving part of the reservoir, and adjustable means for setting the action of the said valves to various positions of said moving part and the corresponding capacities or tension of the reservoir.

34. In a music self-playing apparatus; actuator pneumatics adapted to operate tone-producers, and tone producers, and an air-tension reservoir of varying capacity, and feeders thereto, and adjustable feeder efficiency controlling means for controlling the amount of the capacity or tension of said reservoir to various degrees.

35. In an automatic musical instrument or attachment; tone-producers, pneumatics for actuating same, served by variable tension air, one or more feeding means for supplying said tension, a music-sheet propelling apparatus, an air-motor connected to the music-sheet propelling apparatus, feeding means for supplying suitable independent air tension to said motor, and a common driving-power means connected to both said feeding means.

36. In an automatic musical instrument or attachment, musical tone-producing and actuating devices, variable tension bellows thereto, a feeder to said bellows, a music-sheet propelling apparatus; an air-motor to the music-sheet propelling apparatus and independent tension bellows to said motor, a feeder to said motor serving bellows, and a pedal connected to both said feeders and arranged to actuate both at the same time.

37. In an automatic musical instrument or attachment; tone-producers, actuator pneumatics adapted to operate said tone-producers, a wind-motor adapted to propel music sheets, separate air-feeder means in-

dependently connected to the playing-apparatus and the sheet-motor apparatus respectively, a driving means common to both feeder means, and separate automatic checking means to the air service of each feeder.

38. In a musical self-playing apparatus; tone-producers, pneumatics for operating the same, an air-motor in combination with and arranged to operate a music-sheet propelling apparatus, a service controlling port, and valve-means to said port and means adapted to move said valve in a certain direct line to equalize the service, and means adapted to move said valve moving in a direct line transverse to the equalizing movement.

39. An air-motor in combination with and arranged to operate a music-sheet propelling apparatus, a bellows reservoir connected to the service of the motor, and having a movable member, a regulating valve-port and valve between the reservoir and the motor, a connection from the bellows reservoir member to the regulating valve moving it in a certain direct line to equalize the air service to the motor, and controlling means connected to the valve moving it in a direct line transverse to the other movement.

40. An air-motor in combination with and arranged to operate a music-sheet propelling apparatus, an L-shaped speed-controlling valve thereto, an air-service port under the inside corner of the L-valve, a bellows controlled connection to move the valve in one direction of the L, and independent means for moving the valve in the other direction of the L.

41. An air-motor in combination with and arranged to operate a music-sheet propelling apparatus, an L-shaped speed controlling valve thereto, an air-service port under the inside corner of the L-valve, bellows controlled connection to move the valve in one direction of the L, adjustable means for regulating the moving of the valve by the bellows, and independent means for moving the valve in the other direction of the L.

42. In a pneumatic action for a musical instrument or attachment therefor, a power-pneumatic or secondary, exhause and flush connections thereto, and separate ports and valves to its exhaust and flush connections respectively, said valves being within said power-pneumatic, and independent of each other, and primary pneumatic means outside of said power-pneumatic, and operatively connected to said valves.

43. In a pneumatic action for a musical instrument or attachment therefor, a power pneumatic or secondary, exhaust and flush connections thereto, and separate ports and valves to its exhaust and flush connections respectively, said valves being independent of each other, and each having separate primary pneumatic controlling means, both said primaries being subject to similar air conditions, and the primary to the flush-valve arranged to close that valve, and both said valves being within said power pneumatic.

44. In a pneumatic action for a musical instrument or attachment therefor, a power pneumatic or secondary, exhaust and flush connections thereto, and separate ports and valves to its exhaust and flush connections respectively, said valves being within said power-pneumatic, independent of each other, and each having its own separate primary pneumatic controlling means, both said primaries being subject to similar air conditions.

45. In a pneumatic action for a self-playing musical-instrument or attachment therefor, a tracker having an aperture, a power-pneumatic or secondary, exhaust and flush connections thereto, and separate ports and valves to its exhaust and flush connections respectively, primary pneumatic means to said valves, said valves being independent of each other and separately controlled by primary pneumatic means to each, both of which primaries are subject to similar air conditions and having connections to and operated by the same tracker aperture, and both said valves being within said power pneumatic.

46. In a pneumatic action for a musical instrument or attachment therefor, a tracker having an aperture, a power pneumatic or secondary, exhaust and flush connections thereto, and separate ports and valves to its exhaust and flush connections respectively, primary pneumatic means to said valves, said valves being independent of each other and separately controlled by primary pneumatic means and a tracker aperture, the ratio of resistance of one of said valves to its primary controlling means being greater than that of the other valve to its primary controlling means when in normal positions ready to commence operation, both said primaries being subject to the same air tension and having connections to one tracker-aperture.

47. In a pneumatic action for a musical instrument or attachment therefor, a wind-chest or box, one or more power-pneumatics or secondaries placed on an outside face of a side of said chest or box, and one or more controlling valves and wind ports to such power pneumatics or secondaries within the said power pneumatic and on the same side of the chest or box, and primary pneumatic means on the interior opposite side of the chest or box and operatively connected to the said controlling valves.

48. In a pneumatic action for a musical instrument or attachment therefor, a wind chest, a power pneumatic or secondary hav-

ing one or more controlling valves thereto placed inside the power pneumatic or secondary, primary pneumatic means inside of said chest, and actuating connections from said primary means to said valves.

49. In a pneumatic action for a musical instrument or attachment therefor, a bellows-shaped power pneumatic or secondary having a recess or opening through its fixed board, in which recess or opening are located one or more controlling valves of the power pneumatic or secondary, primary pneumatic means outside of the said power pneumatic or secondary, and actuating connections therefrom to said valves.

50. In a pneumatic action for a musical instrument or attachment therefor, a power-pneumatic or secondary means having within it one or more valves for controlling its operation, and independent pneumatic means outside the power-pneumatic or secondary means arranged to actuate one or more of said controlling valves in a movement in direction opposite to that of the action of the power-pneumatic or secondary means, the power-pneumatic or secondary means arranged relatively to the one or more controlling valves so as to partially return said one or more valves to normal position by the action of the power-pneumatic or secondary means.

51. In a pneumatic action for a musical instrument or attachment therefor, a power pneumatic or secondary means having one or more valves for controlling its operation and independent pneumatic means to actuate the one or more valves oppositely to that of the action of the power pneumatic or secondary means, the power pneumatic or secondary means arranged relatively to the said one or more controlling valves to partially return said one or more valves to normal position by the action of the power pneumatic or secondary means.

52. In a pneumatic action for a musical instrument or attachment therefor, a power pneumatic or secondary, a primary valve-means thereto having the direction of its action opposite to that of the power pneumatic or secondary, and an adjusting means on a moving part of said power pneumatic or secondary and arranged to engage and thereby return the said primary valve-means toward its seat by the action of the power pneumatic or secondary.

53. In a pneumatic-action for a musical instrument or attachment therefor, a power-pneumatic or secondary having within it a controlling valve opening by a movement opposed to the direction of that of the action of the power pneumatic or secondary, independent pneumatic means outside of said pneumatic or secondary arranged to actuate said valve, and a spring mounted on the moving member of said power pneumatic and opposed to said valve.

54. In a pneumatic action for a musical instrument or attachment therefor, a power pneumatic or secondary, a valve to control said power pneumatic or secondary, and a spring pressed against the direction of action of said valve by the moving part of said power pneumatic or secondary to aid the return of said valve to its normal position.

55. In a pneumatic action for a musical instrument or attachment therefor, a power pneumatic or secondary having a controlling valve opening by a movement opposed to the direction of action of the power pneumatic or secondary, independent pneumatic means outside of the power pneumatic or secondary arranged to actuate said valve, and a spring pressed against the direction of action of said valve by the moving part of the power pneumatic or secondary.

56. In a pneumatic action for a musical instrument or attachment therefor, line of ports, each of said ports having a valve or rod and being tapered or enlarged as to its face which is not valved, and a single strip valve-rod-guide inset across the enlarged part of each of the several ports of said line.

57. In a pneumatic action for a musical instrument or attachment therefor, a pneumatic, a port connecting thereto, a valve to said port, and an air-restricting means near to the edge of the valve and its seat.

58. In a pneumatic action for a musical instrument or attachment therefor, a pneumatic, a port connecting thereto, a valve to said port, and an air-restricting means near to and surrounding the edge of the valve and its seat.

59. In a pneumatic action for a musical instrument or attachment therefor, a pneumatic, a port connecting thereto, a valve to said port, and an air-restricting means near to the edge of the valve and its seat, said air-restricting means being graded to varied degrees of restriction at various heights of the valve rise.

60. In an auto-pneumatic musical apparatus; pneumatics and valves actuated thereby, a series of return-vents connected to said pneumatics, and an adjustable regulating or reducing piece applied over said series of return-vents.

61. A pneumatic scale-reader having operating apertures therein continued by ducts, a series of return-vents connected to said ducts, and an adjustable regulating or reducing piece applied over said series of return vents.

62. In an auto-pneumatic musical apparatus; pneumatics and valves actuated thereby, a series of return-vents connected to said pneumatics, and an adjustable regulat-

ing or reducing piece removably attached over said series of return-vents.

63. A pneumatic scale-reader having operating apertures therein continued by ducts, a series of return-vents connected to said ducts, and a regulating or reducing piece removably attached over said series of return-vents.

64. An auto pneumatic-action for operating tone-producers, and a compound adjustable tracker or scale-reader, a joining-rail near thereto, and flexible tubes connected to said tracker and to said joining rail near to the scale-reader, and continuing inflexible tubes from said rail to the pneumatics of the action.

65. In a musical apparatus, note actuating devices, controlling connections thereto, a joining rail for connections for the note-actuating devices having the connections for the "sharp" notes grouped together in several groups separated from the connections for the "natural" notes.

66. In a musical apparatus, note-actuating devices, controlling connections thereto, a joining rail for the connections for the note-actuating devices having the connections for the sharp notes grouped together in alternating groups of two and three in one series; having its connections for the natural notes of the same scale letters as the sharps grouped in groups of two and three similar to the sharps and adjacent to said sharps and corresponding therewith in their order; and having the connections for the semitone natural notes *b* and *e* of the musical scale arranged separately from the groups of two and three but in relative position thereto.

67. In a musical apparatus, note actuating devices, controlling connections thereto, a joining rail for the connections for the note actuating devices having attaching places for the sharp note connections in separate grouping from the natural note connections and with distinguishing marks or rings.

68. In a pneumatic musical apparatus, power pneumatics for actuating musical devices, primary valves to control the action of said power-pneumatics, and one or more controllable checks to the primary valves to regulate the amount of their rise from their seats.

69. In a pneumatic musical apparatus, power pneumatics for actuating musical devices, separate valves for the direct actuating and return movements respectively of each of said power pneumatics, and one or more controllable checks to said separate actuating valves to limit their rise from their seats.

70. In a pneumatic musical apparatus, power pneumatics for actuating musical devices, valves to directly control the action of said power pneumatics, and one or more controllable checks to the said valves of part of the scale to regulate the amount of their rise from their seats to a different degree than the other primary-valves of the scale, all these valves being on the same air-tension.

71. In a pneumatic musical apparatus, separate main expression regulating devices to each of two or more divisions of the scale, power-pneumatics, main primary valves to all the notes of the two or more divisions, and auxiliary primary-valves to the power pneumatics adjacent to the dividing point of the scale only, independent controlling devices arranged to actuate the auxiliaries and thereby emphasize their respective notes, and controlling connections from said controlling devices to said auxiliary primaries.

72. In a pneumatic action for a musical instrument or attachment therefor, a power-pneumatic or secondary having two or more controlling valves directly effecting the positive action or movement of the said power-pneumatic or secondary, each said positive controlling valve separate and independent from the other, a single flush-valve to said power-pneumatic, and primary pneumatic-means connected to directly operate said flush-valve and one positive-valve always coacting therewith, and to optionally operate the additional positive-valve or valves.

73. In a pneumatic action for a musical instrument or attachment therefor, a tracker, a power pneumatic or secondary having both exhaust and flush controlling-valves with their actuating primary pneumatic means connected to one tracker aperture, and also having an additional and optional additional positive valve to said power pneumatic or secondary, the said additional positive valve having its own independent primary pneumatic means connected to a separate and individual tracker aperture, for optional operation to add force or speed to the positive action of the power pneumatic or secondary.

74. In a pneumatic musical apparatus, power pneumatics for actuating musical devices, actuating and return valved air ports to each said power pneumatic, and controllable air diminishing means to each of the actuating ports arranged to variably regulate the passage of air through said actuating ports without affecting the return ports.

75. In a self-playing musical instrument or attachment, a tracker or scale-reader adapted to be operated by a music-sheet, a transparent strip or guard over the position for the music sheet on said tracker or scale-reader and musical scale indications on said strip or guard.

76. In a self-playing musical instrument or attachment, means for propelling a mu-

sic-sheet, a music sheet and a transparent strip or guard over such music-sheet, and indications on said strip or guard to correspond with visible elements of such music-sheet.

77. In a self-playing apparatus for keyboard musical instruments: automatic note-actuating mechanism, and a perforated music-sheet carrier mounted to be alternatively moved to a position immediately in front of said keyboard and partly above the bottom of the keyboard, or a position underneath said keyboard.

78. A portable player for keyboard musical instruments, provided with a vertically adjustable casing and key-actuating mechanism, the casing and said mechanism adapted to lower to pass freely beneath the keyboard and keybed of a musical instrument, and said mechanism being provided with connections for engaging and operating the upper face of the keys of said instrument when said case and mechanism are in raised position.

79. A portable player for keyboard musical instruments provided with a casing, and key-actuating mechanism adapted to pass freely beneath the keyboard and keybed of the instrument, and provided with connections for engaging and operating the keys thereof, and having means for carrying and operating a perforated music sheet for controlling the said player, said carrying means being mounted to be moved to and from a position in front of the keyboard.

80. A portable player for keyboard musical instruments, provided with a casing, and key-actuating mechanism adapted to pass freely beneath the keyboard and keybed of the instrument when out of use, and provided with connections for engaging and operating the upper face of the front of the keys thereof, and having means for carrying and operating a perforated music-sheet for controlling the said player, said carrying means being mounted to be alternatively moved to a position immediately in front of the keyboard or a position beneath the keyboard.

81. In a self-playing apparatus for keyboard musical instruments; automatic key-actuating mechanism, and a movable support having music-roll carrying means and key-actuating fingers, said support being mounted to be alternatively moved up in front of the keyboard and with the fingers over the keys, or moved down underneath the keybed.

82. In a music self-playing apparatus; tone producers, actuator pneumatics adapted to operate said tone-producers, a constantly active air reservoir, a plurality of air tension governors, an opposed tension device common to all the said plurality of governors, and valve mechanism to throw in and out of operation any desired governor or combination of governors.

83. In a music self-playing apparatus; tone-producers, actuator pneumatics adapted to operate said tone-producers, a plurality of air tension governors each effecting a different degree of air tension, and manually-operable means for successively throwing said governors into action in the regular order of the variation of their degrees of air tension.

84. In combination: sound producing devices having a manual keyboard for their manual operation, self-playing means for the automatic operation of said devices from a music sheet, and movable means for supporting such music sheet, said supporting means mounted to be moved forward and up to a position immediately in front of said keyboard and downward and back to a position underneath said keyboard.

85. In combination: sound producing devices having a manual keyboard for their manual operation, self-playing means for the automatic operation of the sound producing devices from a music sheet, and movable means for supporting such music sheet, said supporting means mounted to be moved forward and up to a position immediately in front of said keyboard and downward and back to a position underneath said keyboard.

86. In combination: sound producing devices having a manual keyboard for their manual operation, self-playing means for the automatic operation of said devices from a music-sheet, and movable means for supporting such music sheet, said supporting means mounted to be moved to a position in front of said keyboard and to a position underneath said keyboard.

87. In combination: sound producing devices having a manual keyboard for their manual operation, self-playing means for the automatic operation of the sound producing devices from a music sheet, a music sheet, and movable means for supporting such music sheet, said supporting means mounted to be moved to a position in front of said keyboard and to a position underneath said keyboard.

88. In combination: sound producing devices having a manual keyboard for their manual operation; self-playing means including a tracker, cylinder and spindles, for the automatic operation of said devices from a music-sheet; and movable means for supporting said tracker, cylinder and spindles, said supporting means mounted to be moved forward and up to a position immediately in front of said keyboard and downward and back to a position underneath said keyboard.

89. In combination: sound producing devices having a manual keyboard for their manual operation; self-playing means including a tracker, cylinder and spindles, for the automatic operation of said devices from a music sheet; a music sheet; and movable means for supporting said tracker, cylinder and spindles, said supporting means mounted to be moved to a position in front of said keyboard and to a position underneath said keyboard.

90. In combination: sound producing devices having a manual keyboard for their manual operation; self-playing means including a tracker, cylinder and spindles, for the automatic operation of the sound producing devices from a music sheet; a music sheet; and movable means for supporting said tracker, cylinder and spindles, said supporting means mounted to be moved forward and up to a position immediately in front of said keyboard and downward and back to a position underneath said keyboard.

91. In combination: sound producing devices having a manual keyboard for their manual operation; self-playing means including a tracker, cylinder and spindles, for the automatic operation of the sound producing devices from a music sheet; a music sheet; and movable means for supporting said tracker, cylinder and spindles, said supporting means mounted to be moved to a position in front of said keyboard and to a position underneath said keyboard.

92. A self-playing musical apparatus having a tracker adapted to be operated by a music sheet, actuating devices adapted to operate sound producing devices, controlling connections from said tracker to said actuating devices, and a movable means for supporting such music sheet, said supporting means mounted to be alternatively moved forward and up to a position immediately in front of the manual keyboard of the sound producing devices and downward and back to a position underneath said keyboard.

93. A self-playing musical apparatus having a tracker adapted to be operated by a music sheet, actuating devices adapted to operate sound producing devices, controlling connections from said tracker to said actuating devices, and a movable means for supporting such music sheet, said supporting means mounted to be alternatively moved to a position in front of the manual keyboard of the sound producing devices and to a position underneath said keyboard.

94. A self-playing musical apparatus having a tracker, cylinder and spindles adapted to coöperate with a music sheet, actuating devices adapted to operate sound producing devices, controlling connections from said tracker to said actuating devices, and a movable means for supporting said tracker, cylinder and spindles, said supporting means mounted to be alternatively moved forward and up to a position immediately in front of the manual keyboard of the sound producing devices and downward and back to a position underneath said keyboard.

95. A self-playing musical apparatus having a tracker, cylinder and spindles adapted to coöperate with a music sheet, actuating devices adapted to operate sound producing devices, controlling connections from said tracker to said actuating devices, and a movable means for supporting said tracker, cylinder and spindles, said supporting means mounted to be alternatively moved to a position in front of the manual keyboard of the sound producing devices and to a position underneath said keyboard.

96. In a self-playing apparatus for keyboard musical instruments: automatic actuating mechanism, and a movable support having music-roll carrying means and key-actuating fingers, said support being adapted to be alternatively raised to a position with the fingers over the keys, and the roll-carrying means adjacent to the keys, or lowered to a position below the level of the keybed.

97. In a self-playing apparatus for keyboard musical instruments: automatic actuating mechanism, and a movable support having music-roll carrying means and key-actuating fingers, said support mounted to be alternatively raised to a position with the fingers over the keys, or lowered to a position below the level of the keybed.

98. A portable player for keyboard musical instruments, comprising a floor supported base and power producing pedals thereon, and a vertically adjustable support adjustably mounted on said base and having music-roll carrying means and key actuating fingers thereon, said support adapted to be raised to a position with the fingers over the keys, or lowered to a position below the level of the keybed.

99. A portable player for keyboard musical instruments, comprising a floor supported base and power producing pedals thereon, and a vertically adjustable support adjustably mounted on said base and having music-roll carrying means, key actuating fingers, and a roll propelling motor thereon, said support adapted to be raised to a position with the fingers over the keys, or lowered to a position below the level of the keybed.

100. A portable player for keyboard musical instruments, comprising a floor supported base and bellows actuating pedals therewith, and a vertically adjustable support adjustably mounted on said base and

having music roll carrying means, tracker bar, key-actuating finger and a bellows on said support, said support adapted to be raised to a position with the fingers over the keys, or lowered to a position below the level of the keybed.

101. A portable player for keyboard musical instruments, comprising a floor supported base and bellows actuating pedals therewith, and a vertically adjustable support adjustably mounted on said base and having music roll carrying means, tracker bar, key actuating fingers, and a sheet propelling motor on said support, said support adapted to be raised to a position with the fingers over the keys, or lowered to a position below the level of the keybed.

102. In an automatic musical instrument or attachment therefor, tone-producers and actuating pneumatics therefor; automatic expression means for diminishing the stroke of said pneumatics; a tracker having an expression aperture, and connections therefrom to said expression means; and a music sheet having two or more note-perforations arranged to be sounded together, and coöperating with said tracker and having the front of the perforation of an accented note of said note-perforations having simultaneously struck notes positioned rearward of the front of the perforation of an unaccented note of the same, and an expression perforation in the sheet entirely in advance of the perforation to be accented and adapted to coöperate with the expression aperture to diminish the stroke on the unaccented notes when said expression perforation uncovers said expression aperture.

103. In an automatic musical instrument or attachment therefor; tone-producers and actuating pneumatics therefor; automatic expression means for diminishing the stroke of said pneumatics; a tracker having an expression aperture, and connections therefrom to said expression means; and a music sheet having two or more note-perforations arranged to be sounded together, and coöperating with said tracker and having the front of the perforation of an accented note of said note-perforations having simultaneously struck notes positioned rearward of the front of the perforation of an unaccented note of the same, and an expression perforation in the sheet having its front end in advance of the front end of the perforations of the unaccented note and adapted to coöperate with the expression aperture to diminish the stroke on the unaccented notes when said expression perforation uncovers said expression aperture.

104. In an automatic musical instrument or attachment therefor: tone-producers and actuating pneumatics therefor; automatic expression diminishing means for weakening the stroke of said pneumatics; a tracker having an expression aperture, and connections therefrom to said expression diminishing means; and a music sheet having two or more note-perforations arranged to be sounded together, and coöperating with said tracker and having the front ends of the perforations of the accented and unaccented notes out of transverse alinement with each other, and an expression perforation in the sheet having its front end in advance of the front end of the perforations of the accented note or notes and coöperating with the expression diminishing aperture to diminish the stroke on said unaccented notes when said expression perforation uncovers said expression aperture.

105. In an automatic musical instrument or an attachment therefor; tone-producers and actuating pneumatics therefor; automatic expression means for diminishing the stroke of said pneumatics; a tracker having an expression aperture, and direct connections therefrom to said expression means; and a music sheet having two or more note-perforations arranged to be sounded together, and coöperating with said tracker and having the front ends of the perforations of the accented and unaccented notes out of transverse alinement with each other, and an expression perforation in the sheet having its front end in advance of the front end of the perforation of the unaccented notes and adapted to coöperate with the expression aperture to diminish the stroke on the unaccented notes when said expression perforation uncovers said expression aperture.

106. In an automatic musical instrument or attachment therefor: tone-producers and actuating pneumatics therefor; automatic expression means for diminishing the stroke of said pneumatics; a tracker having an expression aperture, and connections therefrom to said expression means; and a music sheet having two or more note-perforations arranged to be sounded together, and coöperating with said tracker and having the front ends of the perforation of the accented and unaccented notes out of transverse alinement with each other, and an expression perforation in the sheet having its front end in advance of the front end of the perforations of the rearward notes and adapted to coöperate with the expression aperture to diminish the stroke on the unaccented notes when said expression perforation uncovers said expression aperture.

107. In an automatic musical instrument or attachment therefor: tone-producers and actuating pneumatics therefor; automatic expression means for varying the stroke of said pneumatics; a tracker having an expression aperture, and connections therefrom to said expression means; and a music sheet having two or more note-perforations

arranged to be sounded together, and co-operating with said tracker and having the front end of the perforations of the accented and unaccented notes out of transverse alinement with each other, and an expression perforation in the sheet having its front end in advance of the front ends of both forward and rearward of said note-perforations and adapted to coöperate with the expression aperture to diminish the stroke on the unaccented notes when said expression perforation uncovers said expression aperture.

108. In combination; a pneumatic self-playing musical apparatus, a bellows, and a collapsible and expansible air chamber connected thereto, an L shaped valve interposed between them and movable in direct lines in two directions corresponding to the main lines of the L, a connection from a movable member of the chamber to said valve to control one of its said movements to thereby equalize the air service, and a controller and a connection therefrom to said valve to control the other of the said movements to thereby set different degrees of air service.

109. In combination: a pneumatic self-playing musical apparatus, a bellows, and a collapsible and expansible air chamber connected thereto, a valve interposed between them and movable in direct lines in two directions, a connection from a movable member of the chamber to said valve to control one of its said movements to thereby equalize the air service, and a controller and a connection therefrom to said valve to control the other of its said movements to thereby set different degrees of air service.

110. In a pneumatic action for a musical instrument or an attachment therefor, a note-actuating power pneumatic or secondary having stroke and return ports, and independently acting primary pneumatics and valves to its stroke and return ports respectively, both said primaries subject to similar air conditions, and the primary pneumatic means coacting with the stroke valve port to actuate it to several degrees of opening.

111. In a pneumatic action for a musical instrument or attachment therefor, a note-actuating power pneumatic or secondary having stroke and return ports, and independently acting primary pneumatics and valves to its stroke and return ports respectively, both said primaries subject to similar air conditions, and the primary pneumatic means coacting with the stroke port valve to actuate it to several distances from its seat.

112. In a pneumatic action for a musical instrument or attachment therefor; a note actuating power pneumatic or secondary having separate ports and valves for stroke and return respectively; a pneumatic controlling means to the return valve, and another pneumatic controlling means to the stroke valve only, both said means being subject to similar air conditions; and a single tracker aperture and controlling connections therefrom to both said pneumatic controlling means, the return valve pneumatic controlling means adapted to fully operate that valve when a small perforation of a music sheet is opened to said aperture, and the stroke valve pneumatic controlling means adapted to fully open that valve only when a large perforation of a music sheet is opened to said aperture.

113. In a selfplaying musical apparatus: a power pneumatic or secondary having a plurality of primary pneumatics subject to similar air conditions one to another and arranged for controlling the operation of said power pneumatic or secondary; a tracker bar having apertures adapted to be controlled by a perforated music sheet; and an air duct connection directly to each of said primaries from a single aperture of the tracker bar corresponding to that particular pneumatic or secondary.

114. In a self-playing musical apparatus: a power pneumatic or secondary having a plurality of primary pneumatics, an air chamber connected to the wind inducing apparatus, each primary contained in said chamber, and arranged for controlling the operation of said power pneumatic or secondary; a tracker bar having an aperture adapted to be controlled by a perforated music sheet; and an air duct connection directly to each of said primaries from the single aperture of the tracker bar corresponding to that particular power pneumatic or secondary.

115. In a self-playing musical apparatus; a power pneumatic or secondary having a plurality of primary pneumatics subject to similar air conditions one to another and arranged for controlling the operation of said power pneumatic or secondary; a tracker bar having an aperture adapted to be controlled by a perforated music sheet; a perforated music sheet; and an air duct connection directly to each of said primaries from the single aperture of the tracker bar corresponding to that particular pneumatic or secondary, and both said valves being within said power pneumatic.

116. In a self-playing musical apparatus: a power pneumatic or secondary having a plurality of primary pneumatics, an air chamber connected to the wind inducing apparatus, each primary contained in said chamber, and arranged for controlling the operation of said power pneumatic or secondary; a tracker bar having an aperture adapted to be controlled by a perforated music sheet; a perforated music sheet; and an air duct connection directly to each of said primaries from the single aperture of

the tracker bar corresponding to that particular power pneumatic or secondary.

117. In a self-playing musical apparatus: a power pneumatic or secondary having a plurality of valves for controlling its operation; a plurality of primary pneumatics subject to similar air conditions one to another and arranged for controlling said valves; a tracker bar having an aperture adapted to be controlled by a perforated music sheet; and an air duct connection directly to each of said primary pneumatics from the single aperture of the tracker bar corresponding to that particular power pneumatic or secondary.

118. In a self-playing musical apparatus: a power pneumatic or secondary having a plurality of valves for controlling its operation; a plurality of primary pneumatics, an air chamber connected to the wind inducing apparatus, each primary contained in said chamber and arranged for controlling said valves; a tracker bar having an aperture adapted to be controlled by a perforated music sheet; a perforated music sheet; and an air duct connection to each of said primary pneumatics from the single aperture of the tracker bar corresponding to that particular power pneumatic or secondary.

119. In a self-playing musical apparatus: a power pneumatic or secondary having a plurality of valves for controlling its operation; a plurality of primary pneumatics subject to similar air conditions one to another and arranged for controlling said valves; a tracker bar having an aperture adapted to be controlled by a perforated music sheet; and an air duct connection directly to each of said primary pneumatics from the single aperture of the tracker bar corresponding to that particular power pneumatic or secondary.

120. In a self-playing musical apparatus: a power pneumatic or secondary having a plurality of valves for controlling its operation; a plurality of primary pneumatics, an air chamber connected to the wind inducing apparatus, each primary contained in said chamber and arranged for controlling said valve; a tracker bar adapted to be controlled by a perforated music sheet; and an air duct connection to each of said primary pneumatics from the single aperture of the tracker bar corresponding to that particular power pneumatic or secondary.

121. In a self-playing musical apparatus: a power pneumatic or secondary having a plurality of valves for controlling its operation; a plurality of primary pneumatics subject to similar air conditions one to another and arranged for controlling said valves; a tracker bar having an aperture adapted to be controlled by a perforated music sheet; and an air duct connection directly to each of the said primary pneumatics from the single aperture of the tracker bar corresponding to that particular power pneumatic or secondary; said primary pneumatics being of varied ratios of power one to another as compared to their respective valve's resistance.

122. In a self-playing musical apparatus: a power pneumatic or secondary having a plurality of valves for controlling its operation; a plurality of primary pneumatics, an air chamber connected to the wind inducing apparatus, each primary contained in said chamber and arranged for controlling said valves; a tracker bar adapted to be controlled by a perforated music sheet; and air duct connection to each of said primary pneumatics from the single aperture of the tracker bar corresponding to that particular power pneumatic or secondary; said primary pneumatics being of varied ratios of power one to another as compared to their respective valve resistance.

123. In a self-playing musical apparatus: a power pneumatic or secondary having a plurality of valves for controlling its operation; complete primary pneumatic means, air chambering connected to the wind induction apparatus, each primary contained in said chamber and arranged for controlling said valves, said valves being of varied ratios of resistance one to another as compared to the power of said primary pneumatic means.

124. In a self-playing musical apparatus: a power pneumatic or secondary having a plurality of valves for controlling its operation complete primary pneumatic means, an air chamber connected to the wind inducing apparatus, such primary means contained in said chamber and arranged for controlling said valves; said valves so that one of said valves will operate from a smaller perforation in the music sheet than another of said valves.

125. In an auto-pneumatic musical apparatus: a pneumatic tracker, a plurality of primary valves movable independently one to the other, but having controlling connections from a single aperture of said tracker, a wind chest, and primary pneumatic means to said valves located entirely within said wind chest.

126. In an auto-pneumatic musical apparatus; a pneumatic tracker, a plurality of primary valves movable independently one to the other but having controlling connection from a single aperture of said tracker, a wind chest, and primary pneumatic means to said valves located entirely within said wind chest, the primary valves having a varied resistance one to the other relatively to the actuating air service from said tracker aperture.

127. In a pneumatic action for musical apparatus: a wind chest having a port, a valve

over said port on the outside of said chest, a pneumatic inside said chest and connected to said valve to operate the valve, and a power pneumatic attached to the outside of said chest over said valve and into which the air of said port leads.

128. In a pneumatic action for musical apparatus: a wind chest, a pneumatic within said chest, a power pneumatic element attached to the outer face of said chest, an intermittently opened windway from the chest to the power pneumatic element and an intermittently closed windway from the power pneumatic element to the outer air, valve means to both said windways and contained within said power pneumatic element, and connection means from the pneumatic within the chest to said valve means for intermittently operating said valve means.

129. A pneumatic scale reader having operating apertures therein continued by ducts, a chamber adjacent to said apertures, return vents to said ducts in said chamber, and a single means for adjusting all said vents.

130. An auto-pneumatic action for actuating tone producers, a tracker for controlling said action, a tube rail separate from said tracker, flexible tubes extending from said tracker to said rail and inflexible tubes extending from said rail to said action, to permit movement of said tracker relatively to said action.

131. In a self-playing musical apparatus: a tracker adapted to be operated with a music sheet, and a transparent strip or guard over the face of said tracker and indications on said guard relating to such music sheets.

132. In a pneumatic musical apparatus; a power pneumatic, a valve-means for controlling its operation and contained within said power pneumatic, a suction chamber exterior to said power pneumatic, a second pneumatic in said chamber, and connective-means from said second pneumatic to said valve-means.

133. In a pneumatic musical apparatus, a power pneumatic having a moving board and a fixed board, a valve chamber in said fixed board, having its ends slanted inwardly larger, and a controlling valve for said power pneumatic in said chamber.

134. In a pneumatic action for a musical instrument or attachment therefor, a power pneumatic or secondary having within it a controlling valve, independent pneumatic means outside of said pneumatic or secondary arranged to actuate said valve, and a coil spring opposed to said valve and mounted on a moving member of said power pneumatic.

135. In a pneumatic action for a musical instrument or attachment therefor, a power pneumatic or secondary having within it a controlling valve, independent pneumatic means outside of said pneumatic or secondary arranged to actuate said valve, and a spring opposed to said valve and mounted on a moving member of said power pneumatic.

136. In a pneumatic action for a musical instrument or attachment therefor, a power pneumatic or secondary having a fixed member, a recess therein, a controlling valve in said recess, independent pneumatic means outside of said pneumatic or secondary arranged to actuate said valve, and a coil spring opposed to said valve.

137. In a pneumatic action for a musical instrument or attachment therefor, a power pneumatic or secondary having a fixed member, a recess therein, a controlling valve in said recess, and independent pneumatic means outside of said pneumatic or secondary arranged to actuate said valve, and a spring opposed to said valve and mounted on a moving member of said power pneumatic.

138. In an automatic musical instrument or attachment therefor, tone-producers and actuating pneumatics therefor; automatic expression means for diminishing the stroke of said pneumatics; a tracker having an expression aperture, and connections therefrom to said expression means; and a music-sheet having two or more note-perforations arranged to be sounded together, and coöperating with said tracker and having the front of the perforation of an accented one of said note perforations positioned rearward of the front of the perforation of an unaccented note of the said perforations, and an expression perforation in the sheet entirely in advance of the perforation to be accented and in substantially transverse alinement with the front part of the perforation of the unaccented note, and adapted to coöperate with the expression aperture to diminish the stroke on the unaccented notes when said expression perforation uncovers said expression aperture.

139. In an automatic musical instrument or attachment therefor, tone-producers and actuating pneumatics therefor; automatic expression means for diminishing the stroke of said pneumatics; a tracker having an expression aperture, and connections therefrom to said expression means; and a music-sheet having two or more note-perforations arranged to be sounded together, and coöperating with said tracker, and having the front of the perforation of an accented one of said note perforations positioned rearward of the front of the perforation of an unaccented note of the said perforations, and an expression perforation in the sheet entirely in advance of the perforation to be accented and in substantially transverse alinement with the front part of

the perforation of the unaccented note, and adapted to coöperate with the expression aperture to diminish the stroke on the unaccented notes when said expression perforation uncovers said expression aperture.

140. In an automatic musical instrument or attachment therefor: tone-producers and actuating pneumatics therefor; automatic expression means for diminishing the stroke of said pneumatics; a tracker having an expression aperture, and connections therefrom to said expression means; and a music sheet having two or more note perforations arranged to be sounded together, and coöperating with said tracker and having the front end of the perforations of the accented and unaccented of said note-perforations out of transverse alinement with each other, and an expression perforation in the sheet having its front end in advance of the front ends of both forward and rearward of said note-perforations and adapted to coöperate with the expression aperture to diminish the stroke on the unaccented notes when said expression perforation uncovers said expression aperture.

141. The combination with a tracker-board having a supplemental duct connected with pneumatic mechanism for softening or diminishing the accompaniment notes of a piece of music, of a music-sheet having the accompaniment-note perforations arranged slightly in advance of the theme-note perforations, and provided with a series of supplemental perforations adapted to register with the supplemental duct of the tracker-board, said supplemental perforations being arranged entirely in advance of the theme-note perforations and subtantially in line with the front ends of the accompaniment-note perforations and co-acting with said supplemental duct to effect said softening or diminishing when said supplemental perforation uncovers said supplemental duct.

142. The combination with a tracker-board having a supplemental duct connected with pneumatic mechanism for softening or diminishing the accompaniment notes of a piece of music, of a music-sheet having the accompaniment-note perforations arranged slightly in advance of the theme-note perforations, and provided with a series of supplemental perforations adapted to register with the supplemental duct of the tracker-board, said supplemental perforations being arranged entirely in advance of the theme-note perforations and transversely opposite the accompaniment-note perforations and co-acting with said supplemental duct to effect said softening or diminishing when said supplemental perforation uncovers said supplemental duct.

143. The combination with a tracker-board having a supplemental duct connected with pneumatic mechanism for softening or diminishing the accompaniment notes of a piece of music, of a music-sheet having the accompaniment-note perforations arranged slightly in advance of the theme-note perforations, and provided with a series of supplemental perforations adapted to register with the supplemental duct of the tracker-board, said supplemental perforations being arranged entirely in advance of the theme-note perforations and having their rear ends terminating closely to the transverse alinement with the front ends of the immediately following theme-note perforation and co-acting with said supplemental duct to effect said softening or diminishing when said supplemental perforation uncovers said supplemental duct.

144. A power-pneumatic means, an actuating port connected to said power pneumatic means, and a valve-means to said port, said power pneumatic means and valve-means being so combined and disposed that the stroke of the power pneumatic means returns the valve-means toward the port.

145. A power-pneumatic means, an actuating port connected to said power pneumatic means, and a valve-means to said port, and a primary pneumatic actuating means to said valve-means, said power pneumatic means and valve-means being so combined and disposed that the stroke of the power pneumatic means returns the valve-means toward the port.

146. A power-pneumatic means, an actuating port connected to said power pneumatic means, and a valve-means to said port, and a primary pneumatic actuating means to said valve-means, said power pneumatic means and valve-means being so combined and disposed that the stroke of the power pneumatic means returns the valve-means toward the port, and against the action of the primary pneumatic actuating means.

147. In a pneumatic action for a musical instrument or attachment therefor, a line of ports, each of said ports having a valve and rod, and a single strip valve-rod-guide inset across the enlarged part of each of the several ports of said line.

148. In an auto-pneumatic musical apparatus: a tracker bar having a plurality of apertures therein, a continuing duct to each said aperture, a return-vent to each said duct, and a unitary regulating member adapted to increase or decrease all said vents by a single movement of said regulating member.

149. In an auto-pneumatic musical apparatus: a tracker bar having a plurality of apertures therein, a continuing duct to each said aperture, a return-vent to each said

duct, and regulating means co-acting with all said vents and adapted to alter the size of all said vents at one actuation.

150. In an auto-pneumatic musical apparatus: a tracker-bar having a plurality of apertures and return-vents thereto, and means for altering the efficiency of all the return-vents at one actuation of said means.

151. In an auto-pneumatic musical apparatus: a plurality of primary pneumatics, actuating apertures and return-vent means to all said primary pneumatics, and means for altering the efficiency of the return-vent means of all said primary pneumatics at one actuation of said means.

ROBT. A. GALLY.

Witnesses:
IRENE CRAWFORD,
JOSEPH A. FARLEY.