(No Model.) 6 Sheets—Sheet 1.

# F. R. GOOLMAN.

## ELECTROPNEUMATIC PIANO PLAYER.

No. 603,184. Patented Apr. 26, 1898.

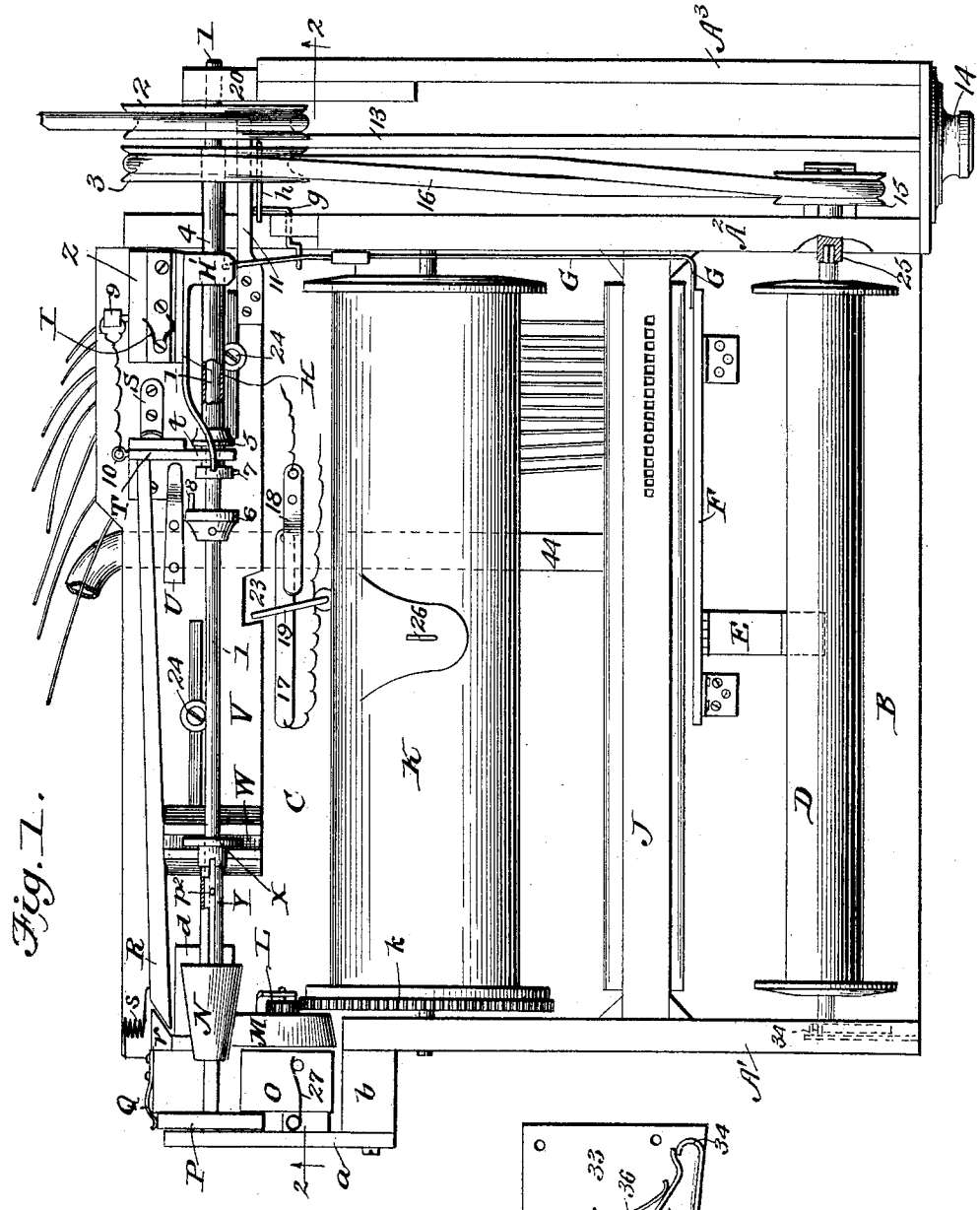

Fig. 1.

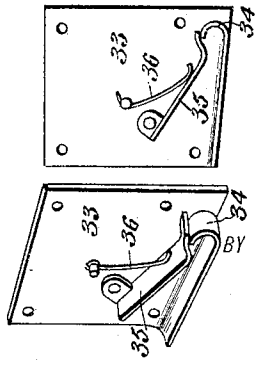

Fig. 5.

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## ELECTROPNEUMATIC PIANO PLAYER.

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Fig. 2.

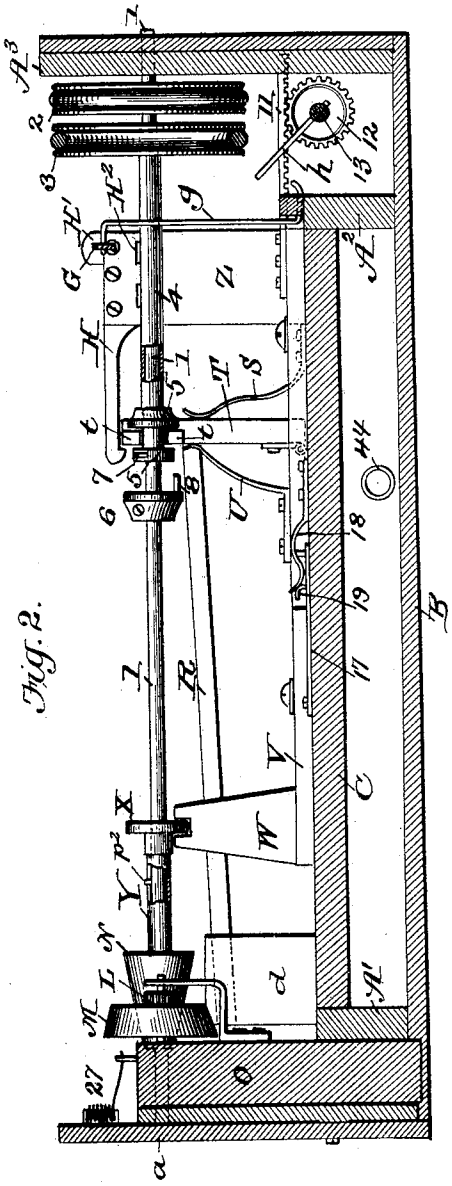


Fig. 3.

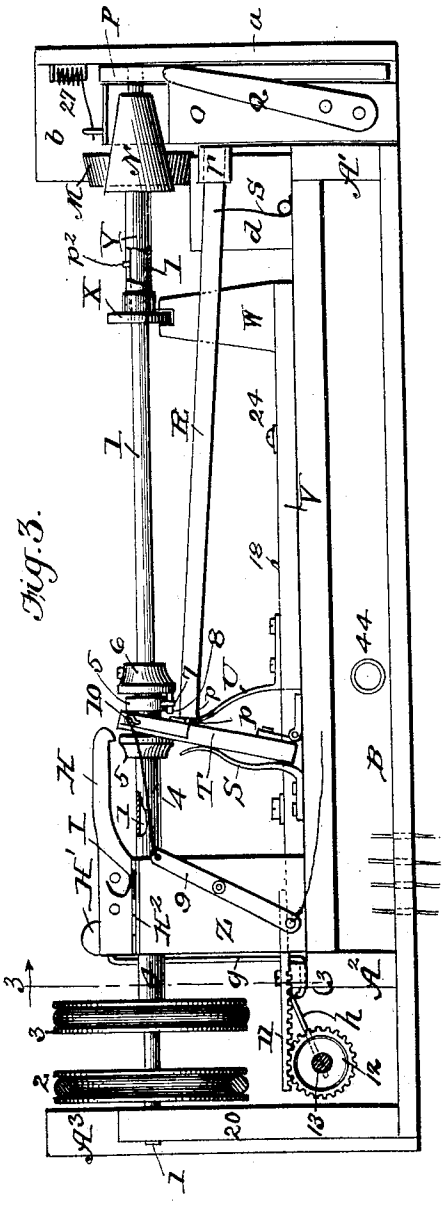
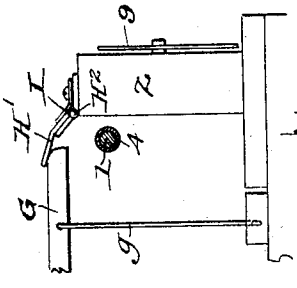


Fig. 3a.



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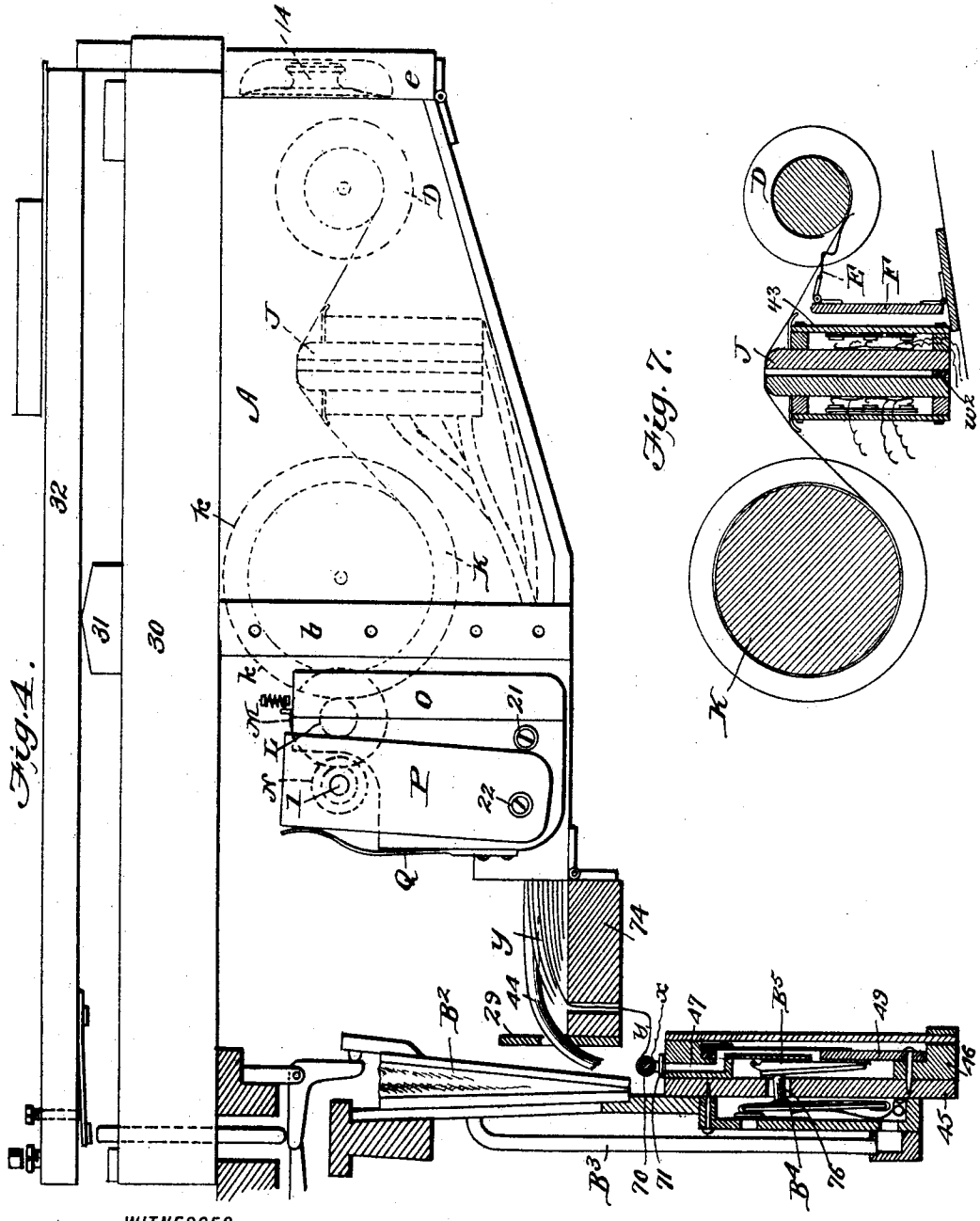
## ELECTROPNEUMATIC PIANO PLAYER.

No. 603,184. Patented Apr. 26, 1898.

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## ELECTROPNEUMATIC PIANO PLAYER.

No. 603,184. Patented Apr. 26, 1898.

Fig. 6.

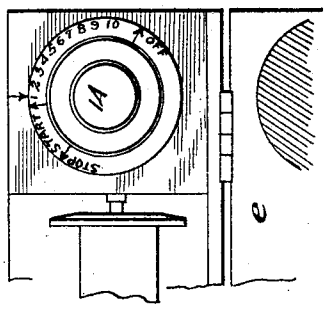



Fig. 8.

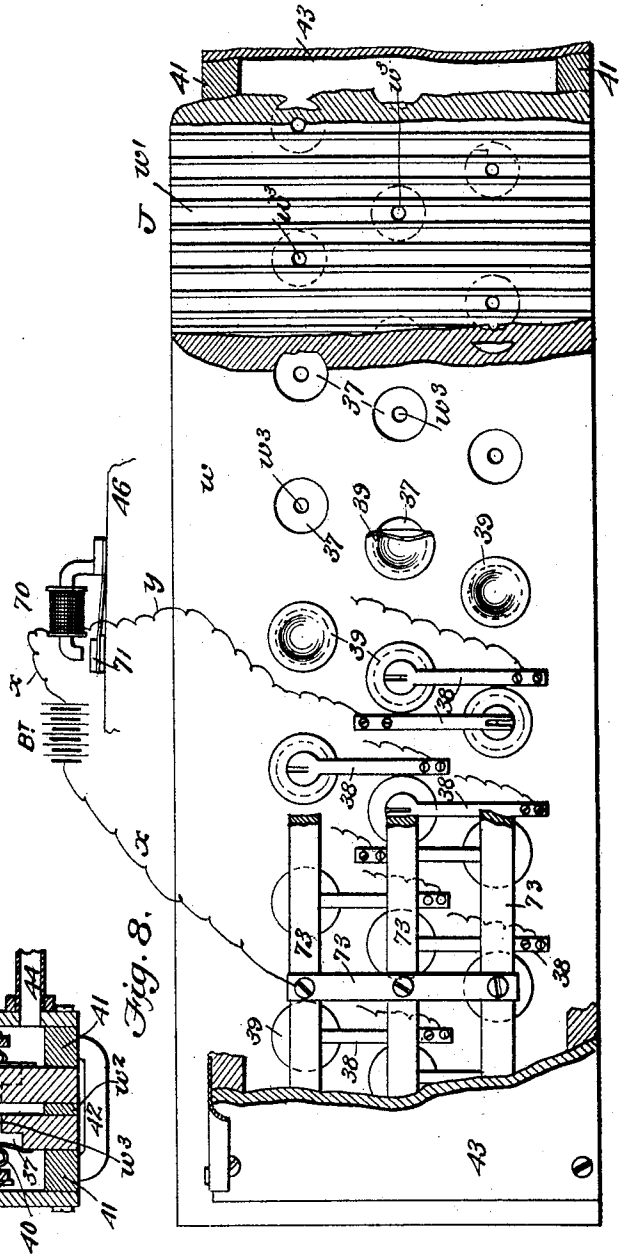
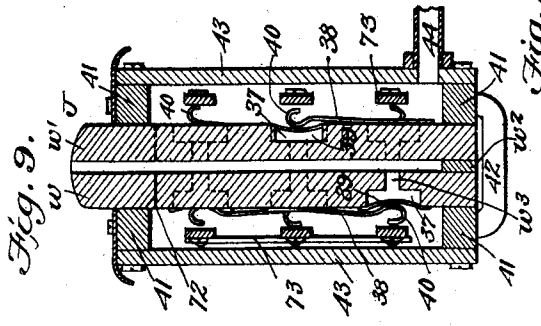



Fig. 9.

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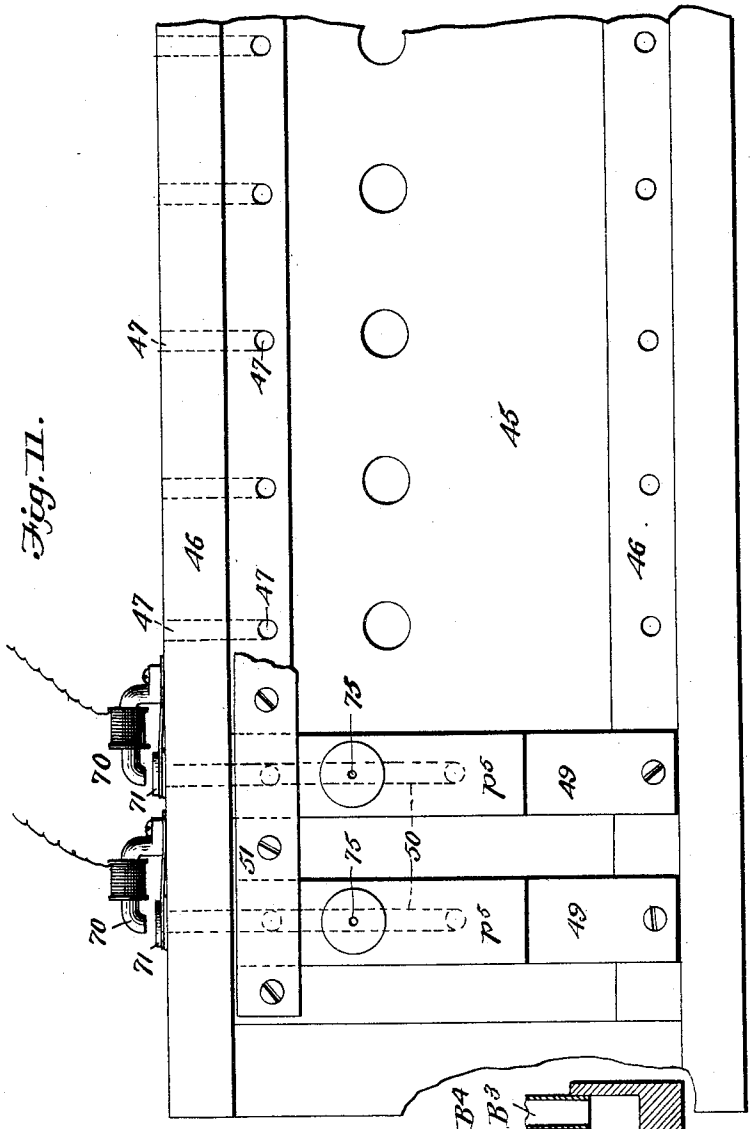
## ELECTROPNEUMATIC PIANO PLAYER.

No. 603,184. Patented Apr. 26, 1898.

Fig. 11.

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## ELECTROPNEUMATIC PIANO PLAYER.

No. 603,184. Patented Apr. 26, 1898.

Fig. 13.

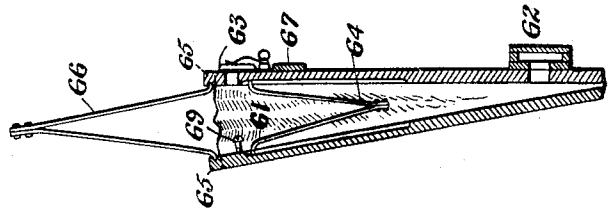
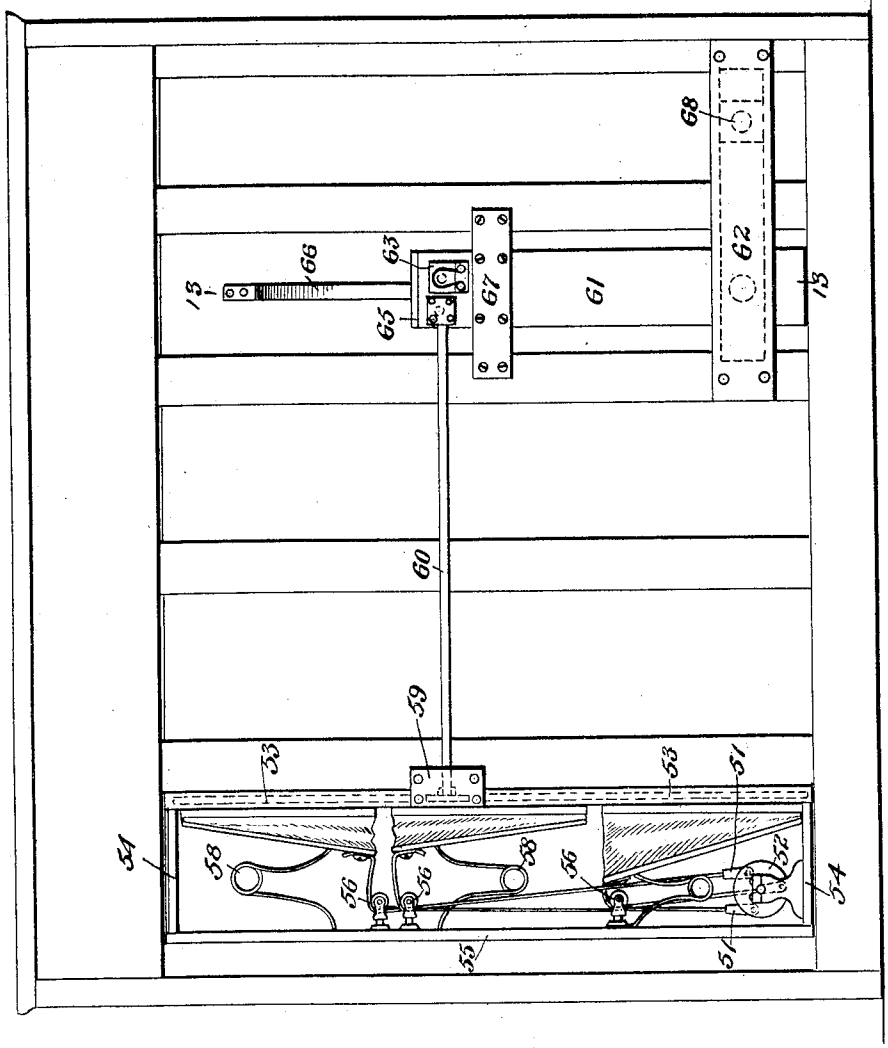



Fig. 12.

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# UNITED STATES PATENT OFFICE.

FRED R. GOOLMAN, OF LOS ANGELES, CALIFORNIA, ASSIGNOR OF THREE-FOURTHS TO JOHN WEBER AND JOHN N. GOOLMAN, OF SAME PLACE.

## ELECTROPNEUMATIC PIANO-PLAYER.

SPECIFICATION forming part of Letters Patent No. 603,184, dated April 26, 1898.

Application filed May 5, 1897. Serial No. 635,105. (No model.)

*To all whom it may concern:*

Be it known that I, FRED R. GOOLMAN, of Los Angeles, in the county of Los Angeles and State of California, have invented a new and Improved Electric Autopneumatic Piano-Player, of which the following is a specification.

My invention is in the nature of an improved electric autopneumatic piano-player in which the valves and pneumatics, the metronome, and rerolling devices for the music are set into action by the combined use of electro-magnets with suitable circuits and pneumatic appliances operating in conjunction therewith; and it consists in the peculiar construction and arrangement of parts hereinafter shown and described.

Figure 1 is a plan view of the music-drawer, showing the working parts, looking from above. Fig. 2 is a vertical section of the working parts of the drawer on line 2 2, Fig. 1, looking in the direction of the arrow and showing the working parts as set in position for playing. Fig. 3 is a rear view of the drawer, looking from the back or in the opposite direction from the arrows in Fig. 1 and showing the mechanism as it appears when the trip is thrown and in position for rewinding the music-roll. Fig. $3^a$ is a cross-sectional detail on line 3 3 of Fig. 3. Fig. 4 is a vertical cross-section showing the piano-key bed 30 and center rail 31, key 32, and the operating mechanism under the key-bed and showing the front of the drawer, which is hinged and made to let down. Fig. 5 are details of the inside of the bearing for one end of the music-roll. Fig. 6 shows the knob and dial of the starting, stopping, and regulating mechanism, with a portion of the front of the drawer, the lid or front *e* of which is let down and recessed immediately opposite the knob, so that it may close over it and conceal it. Fig. 7 is an end view in section of winding-drum K, the air-duct bridge J, music-roll D, trip E, and trip-board F, showing the manner in which the trip E engages the music-sheet in the act of tripping the rerolling device. Fig. 8 is a side view of the electro-pneumatic air-duct bridge J, with side piece 43 and a portion of one side of the block broken away, showing the grooves leading to the holes and recesses 37, the sag-leathers 39, spring 38, and contact-pieces and frame with circuit-wire connections. Fig. 9 is a vertical cross-section of the air-duct bridge, showing ducts, sag-leathers 39, springs 38, electric contact-points 40, recesses 37, connecting-tube 42, and exhaust-tube 44. Fig. 10 is a cross-section of the valve-board, valve-cells, check-valve, and lifting-pneumatic. Fig. 11 is a front view of a portion of the valve-board with the cover removed, showing two of the lifting-pneumatics 49 in position, with a portion of the metal strip 51 and the holes 47, leading from the valve 71 and connecting with lifting-pneumatics $B^5$, also showing the magnets 70. Fig. 12 is a view of the back of an upright piano, showing the position of the pumping device and main sustaining-bellows, springs, and connections. Fig. 13 is a view in section, on line 13 13 of Fig. 12, of the main sustaining-bellows, showing the manner in which it is constructed and connected to the air-trunk.

The following is a description of the improvements in my autopneumatic piano-player.

To end boards A', $A^2$, and $A^3$, Fig. 1, are fastened bottom boards B B, forming a drawer open at front and back, with a narrow space at the right formed by the boards $A^2$ and $A^3$. Between the end boards A' and $A^2$ at the back part of the drawer is placed a rest-board C, Figs. 2 and 3, on which the mechanism rests. This board is raised a short distance from the bottom of the drawer to allow the wires from the electric-air-duct bridge to pass under it.

A main shaft 1, Figs. 1 and 3, is provided at one end with a bearing 20 on the end of board $A^3$ and at the other end has a movable bearing P, Figs. 1 and 4. On said shaft is a fixed driving-pulley 2, which receives motion from a motor and transmits it to all the working parts in the drawer. On said shaft 1 is also mounted a sleeve 4, in which the shaft turns freely. On one end of this sleeve is a fixed pulley 3, and on the other end a grooved collar 5. The shaft is also provided with a fixed collar 6, situated near the end of the sleeve 4. On the other end of this shaft is a second sleeve Y, provided with a slot, so that it may be moved longitudinally, but pre-

vented from turning on the shaft by means of a pin $p^2$ through the shaft and through the slot in the sleeve. On one end of this sleeve is a fixed collar X, and on the other end is placed a cone-pulley N, which engages a friction-wheel M. On the rest-board C, Figs. 1 to 3, are a stationary standard Z, a horizontal slide V, a hinged arm T, a spring S, and a fixed block *d*.

The slide V is provided with a lug W, Fig. 3, and a rack-bar 11. The hinged arm T is provided at the top with a fork *t* to engage the grooved collar 5. Between the arm T and the block *d* is placed a rod R, which is provided at one end with a pin *p*, Fig. 3, passing into arm T, and at the other end is wedge-shaped (see Fig. 1) and is held in position by a spring S.

On the stationary standard Z are mounted a latch H, Figs. 2 and 3, a spring I, Figs. 1, 3, and $3^a$, and a lever 9. This lever 9 is fulcrumed upon the back of said standard to work in a vertical plane, while the latch H is hinged about a horizontal axis parallel to the shaft 1. This latch H is secured to one leaf of a hinge which is mounted upon the top of standard Z, and the axis of which hinge is shown at $H^2$. The latch H has also an arm or projection H', (see Fig. $3^a$,) which may be pushed backward by a bar G against the tension of a spring I.

At the back and at the left side is an extension, Fig. 1, to the drawer, formed by a piece *b* and thin board *a*. The object of this extension is to provide a space for the block O, to which the movable bearing P is attached. The block O (see Fig. 4) is free at the top, so that it may move slightly backward and forward, swinging on a pin 21 at the bottom. On this block O is pivoted the bearing P, in which the cone end of the shaft 1 turns. The pivot 22 is near the bottom, as shown in Fig. 4, allowing the top to move backward and forward in the same direction with the block O, only to a greater extent. On the block O (see Fig. 1) are also journaled the friction-wheel M and pinion L.

On the rest-board C, Figs. 1 and 2, is placed a brass strip 17, and a flat spring 18 is arranged above it and when unrestrained lies flat against the subjacent strip 17. These two parts form the terminals of an electric circuit controlling the motor, and when the spring 18 is in contact with strip 17 the circuit is complete and the motor is in operation. A horizontal arm 19 is, however, arranged to turn about a vertical axis and extends above the plane of strip 17 and out of contact with it and into range of engagement with the curved end of the spring 18, so that when the arm 19 is swung under the spring 18 it lifts it out of engagement with the subjacent strip and breaks the electric circuit.

The slide V has a notch in it, as shown at 23, Fig. 1, and the slide is secured to the rest-board C by screws through slots, as shown at 24.

Between the end boards A' and $A^2$ are placed a winding-drum K, an electric-air-duct bridge J, and a tripping-bar G, Fig. 1, reaching from the tripping-board F to the projection on the latch H. On the inside at the front end of board A' is placed on the left the bearing for one end of the music-roll D, as shown in detail in Fig. 5. To form this bearing, a plate 33 has at its lower edge a curled flange 34, that receives the pivot of the music-roll, which pivot is retained by a yielding latch 35, pressed toward the curled flange 34 by a spring 36. The other end of the music-roll is held in position by means of a short shaft 25, on which is a fixed pulley 15, and said shaft has a square hole in the end into which the square pivot on the music-roll is fitted. In the narrow space in the drawer formed by boards $A^2$ and $A^3$ is placed the regulating-shaft 13, connecting the knob 14, Fig. 1, with pinion 12, Fig. 2. The reroll-belt 16, Fig. 1, is also placed in this space.

The drawer is hinged to a rail 74 on the pneumatic-action, as shown in Fig. 4.

The operation of the drawer mechanism is as follows: The pneumatic action being in place in the piano and the drawer being connected below the keyboard, when it is desired to insert a music-roll I first let the drawer down about the hinge on rail 74, take a music-roll D, and place the squared pivot into the square hole in the end of shaft 25, Fig. 1, which is the driving-clutch, and the other pivot (which is round) is inserted into the spring-bearing which is shown and described in Fig. 5. I then pass the end of the music-sheet over the air-duct bridge J, and the ring with which the sheet is provided is fastened onto the hook 26 on the winding-drum K. I then close the drawer and turn the knob 14 to the left to the point marked "Start," Fig. 6. This rotates pinion 12, Fig. 2, which engages rack 11 and moves the slide V with it to the left. The notch 23 in the slide, Fig. 1, strikes the arm 19, moving it from under the spring 18, allowing the spring to strike brass strip 17, closing the electric circuit, and starting the motor, which gives power by means of a belt to pulley 2, which is fixed on shaft 1, rotating it, and which in turn rotates the cone N, which is in engagement with friction-wheel M, to which pinion L is attached. Said pinion engaging with a gear *k* on winding-drum K causes the drum to rotate slowly, winding the music-sheet and drawing it over the air-duct bridge J, and as the perforations in the sheet pass over and uncover the openings in the air-duct bridge the notes will be sounded by the pneumatic-action, as hereinafter described. While the winding and playing of the music-sheet are going on the mechanical parts are in positions shown in Fig. 2. The movable arm T is held in the position shown by the latch H, and the fork *t*, being in the groove in collar 5, holds it and the sleeve 4, on which pulley 3 is mounted, in the position shown, so that the pin 7 on collar 5 cannot

engage pin 8 on fixed collar 6. This admits of the shaft 1 turning freely in the sleeve 4, so that while the driving-pulley 2 and shaft 1 are turning forward the pulley 3 and sleeve 4 are turning slowly in the opposite direction, caused by belt 16 and pulley 15 responding to the unwinding of the roll D, for as the music is unwound from the music-roll it turns the pulley 15, which causes the belt 16 to turn the sleeve 4 and pulley 3, which are perfectly free. When the music-sheet has all run off of the roll, a large square hole in the end of the music-sheet (see Fig. 7) as it passes the trip E allows the bend in said trip to pass into the large hole and catch, as shown in Fig. 7, and the sheet being in motion carries the trip backward, pushing the tripping-board F back on its hinge, which throws the tripping-bar G, Fig. 1, backward, the end of which passes under the projection on latch H, throwing it up, as in Fig. 3. This releases the movable arm T, Figs. 2 and 3, which is provided with a stout spring S, which throws the arm to the left of Fig. 2 the moment it is released. The fork *t* on the arm carries the collar 5 and sleeve 4 to the left until the pin on collar 5 engages with pin 8 on fixed collar 6, and this causes pulley 3 to rotate forward with main shaft, and the belt 16 drives in reverse direction the reroll-pulley 15, Fig. 1, rewinding the music-sheet on the music-roll. When the arm T is released and springs to the left of Fig. 2, (or right of Fig. 3,) it pushes the rod R, and the wedge-shaped end of this rod (see Fig. 1) in passing under a lug *r* on block O causes the block to move backward slightly. This disengages pinion L from gear *k* on the winding-drum, allowing it to turn freely backward while music is being rewound, so that it will be seen that the rewinding is entirely automatic and almost instantaneous, as all the parts act simultaneously, for by simply throwing the trip by means of a hole in the music-sheet the latch H releases the arm T, the arm moves collar 5 into contact with collar 6 and at the same instant disengages pinion L from gear K. The pulley 3 drives the rewinding-pulley 15 very rapidly, so that when the sheet is rewound onto the music-roll the ring on it slips from the hook on the drum automatically. When the trip is thrown and the rewinding is going on, the motor and pumps are still going. Therefore if the air-chambers were not released the music would be played backward at a rapid rate, causing a perfect jumble of sound. I provide for this by means of the lever 9, Fig. 3. When the arm T is released, as described, it pulls the top end of the lever 9 with it by means of a wire from the lever to an eye 10 on arm T. To the lower end of the lever 9 is attached a wire which passes through guides on the action to a vent-valve on the air-chamber, (not shown,) for which I make here no claim, as it is shown in my prior application, Serial No. 605,944, filed September 15, 1896. It will be seen that the act of opening this vent-valve relieves the air tension simultaneously with the rerolling. To stop the motor, the knob 14, with dial-markings, is turned to the right till the word "Stop" comes to the top. (See Fig. 6.) This draws the slide V to the right of Figs. 1 and 2. The notch 23 in the slide pulls the arm 19 under the spring 18, lifting it from the strip 17, breaking the electric connection, and the motor stops. At the same time the finger U on the slide comes into contact with the arm T, pushing it back again until caught by the latch H, and the pins 7 and 8 are thrown out of engagement, as in Fig. 2, leaving the reroll device free again. At the same time the rod R is drawn back, allowing block O to be thrown back by spring 27, Fig. 1, into its normal position, bringing pinion L into engagement again with gear *k* on the winding-drum ready for playing again. It will be seen that when the slide V is moved to the left of Fig. 2 by the knob 14, as described, the lug W on it will move the collar X, sleeve Y, and cone N in the same direction, bringing the larger portion of the cone into contact with the friction-wheel M. Therefore the end bearing P of the shaft must move laterally to allow the large portion of the cone to engage with wheel M. For this purpose the bearing P, Fig. 4, is pivoted to block O, as shown in Fig. 4, and is held in contact by spring Q, keeping a pressure on the bearing which keeps the cone in perfect contact with the friction-wheel all the time and in all positions.

The object of the cone is to enable the music to be played fast or slow, as required, and the music is numbered to correspond with the numbers on the dial, so that by turning the knob until the number on the dial indicates the same number that is on the music the speed will be adjusted for that piece.

If at any time it should be desirable to stop and reroll a piece of music before it is played through, turn the knob 14, Fig. 6, to the left to its extreme limit till the word "Off" on the dial comes to the top. That will bring the pin *h*, Fig. 2, on metronome-rod 13 into contact with the double crank *g*, Fig. 1, and the upper end of said crank is connected to the tripping-bar G, so that when the pin *h* strikes the bent foot of crank *g* it throws the end of the tripping-bar G up under the latch H and trips it the same as if the music had run off and thrown the trip, causing it to reroll at once.

The air-duct bridge J in this improved music-drawer is electropneumatic and is constructed as follows:

Referring to Figs. 8 and 9, the main body of the block is made of two pieces of hard wood *w w'*, one of which, *w'*, is grooved crosswise, as shown in Fig. 8, and the two pieces are glued together, thus forming a block with small square ducts through it with openings at the top, as shown in Fig. 7. The bottoms of said ducts are closed with suitable pieces $w^2$, glued in, as shown in Fig. 9. A system of small

holes $w^8$, Figs. 8 and 9, are drilled in the sides of the block in such a manner that each hole intersects one of the ducts mentioned, and each of these small holes is counterbored with a large bit, forming external recesses, as shown at 37. Over these recesses are glued pieces of valve-leather 39 in such a manner that they form flexible diaphragms and will sag or bend in when the pressure of the small springs 38 comes upon them. These springs are arranged on the sides of the block in the spaces between the recesses, as shown in Fig. 8, so that the rounded end will rest on the piece of leather 39 over the recess. There is a small projection on the rounded end of each of these springs which is curved outward, as shown in Fig. 9 at 40. These projections are for the purpose of making electrical contact with the frames 73. Said frames are light and made of metal and secured to the sides of the air-duct bridge immediately in front of the springs and recesses, as shown in Figs. 8 and 9. Said frames are connected to the sides of the air-duct bridge at top and bottom, and at the end are glued narrow pieces of wood 41, as shown in Fig. 9, forming a frame around the recesses, springs, and contact-framework. On this ledge or frame so formed are screwed thin boards 43, with gasket-leather between them and the frame to make them air-tight. In this way air-tight chambers are formed on opposite sides of the air-duct bridge, which chambers are connected together by means of the tube 42, as shown in Fig. 9. A tube 44 is attached to and communicates with a chamber on one side of the air-duct bridge. This tube leads to and communicates with the vacuum-chambers of the valve mechanism, the object of this tube being to keep the air exhausted from the chambers on the sides of the air-duct bridge. To each of the springs 38 is attached an electric wire, said wires passing out of the chambers at convenient points, being carried back under the winding-drum and rest-board and along rail 74 (see Fig. 4) and pass down each in its proper order to small magnets 70 on the valve-board, as shown in Figs. 4, 8, and 11. Under each of the magnets 70 is placed a small valve 71, Fig. 10, covering the port or opening 47. These valves have an iron top, forming an armature, so that they may be attracted to the magnet. From such magnet 70 one wire $x$ leads to a battery $B^6$ and the frame 73 of the air-duct bridge, while the other wire $y$ leads to its contact-spring 38, as shown in Fig. 8, so that when contact is closed between 38 and 73 the magnet 70 is energized and valve 71 opened. Each wire $y$ passes in its proper order through a hole in the rest-board C and along the rail 74, (see Fig. 4,) a thin board back 29 preventing said wires from coming in contact with the striking-bellows. The action of this electropneumatic air-duct bridge J is very similar to that described in my prior application, Serial No. 605,944, filed September 15, 1896, the difference being that the port 47, leading into the lifting-pneumatic, in the first application was opened by a perforation in the music-sheet passing the open end of a duct in the air-duct bridge, which opening was connected to the port 47 by a small tube, while in the present device the port 47 is opened by a small magnet 70, lifting the valve 71, as shown in Fig. 11. The operation is as follows: When the instrument is started to play, the sheet of music begins to move over the air-duct bridge, and as soon as a perforation in the sheet uncovers an opening in the bridge the air is admitted to one of the recesses 37 (see Fig. 9) of the bridge, and the air in the chambers on the sides of the bridge being exhausted by means of the tube 44 the moment the air is admitted to the recess 37 the suction in the chamber draws the diaphragm 39 out, lifting the end of the spring 38, bringing the point 40 into contact with metal pieces on the frame 73, Figs. 8 and 9. This completes the electric circuit, causing the magnet 70 to act instantly, lifting the valve 71, Figs. 4 and 11, admitting air to the lifting-pneumatic, which causes the pneumatic $B^5$ to lift valve $B^4$, exhausting air from striking-bellows $B^2$ through tube $B^3$, and causing striking-bellows $B^2$ to lift a piano-key and sound a note. The instant the perforation passes the opening in the air-duct bridge and an imperforated part covers the opening the spring 38, Fig. 9, presses the leather 39 back again into the recess, breaking contact at 40, and the magnet 70, Fig. 8, releases the valve 71, allowing it to close instantly. It will be seen that if there were no vents in the ducts in the air-duct bridge the leathers 39 over the recesses would have a tendency to be drawn out continuously by the suction in the vacuum-chamber, for the slight leakage of air through the music-sheet would allow it to be so drawn out, thereby keeping constant electrical contact. Therefore in order to let this leather act instantly, so as to return and repeat rapidly, there is made a small vent-hole 72, Fig. 9, leading from the ducts into the chambers. This allows the air in the duct to become equal in suction or partial vacuum with that in the vacuum-chamber, so that the moment the opening at the top of the duct is closed by the music-sheet there is no resistance to the spring 38 returning instantly. This action is the same in all the parts of this air-duct bridge, making a perfect and very rapid-repeating instrument, requiring the slightest amount of air to make it act instantly, as only enough air is required to fill the small recess. Therefore very small holes can be used in the music-sheet, making it possible to get a greater range of the keys of the instrument with comparatively narrow music-sheets.

The improvement in construction in the valve-boards and vacuum-chambers shown in Figs. 10 and 11 is very important. In my prior application the small lifting-pneumatics $h$ were arranged in long rows on covers placed

on the valve-boards, forming air-tight chambers, and all the small lifting-pneumatics were provided with pins to push up the check-valves in the valve-cells on the opposite side of the valve-board. In the new and improved arrangement of the lifting-pneumatics it will be seen that they are all attached to the valve-board and may be adjusted and regulated independent of the cover-board, thereby making it far more convenient to assemble and regulate all parts and test them before the covers are put on, while in the old arrangement, the lifting-pneumatics being on the covers, when the cover was placed in position on the valve-board it was impossible to see any of the parts, so as to discover if the adjustments were perfectly correct, and even after they were regulated any warping of the thin board on which they were mounted would throw them out of regulation, and in order to regulate any one of them again the entire set must come off with the cover-board, whereas in this improved arrangement when once the parts are arranged and regulated they can never change. This new plan of arrangement makes the manufacture more convenient, as the parts are interchangeable and may be duplicated, and the resulting instrument is much more solid and compact.

By reference to Figs. 10 and 11 it will be seen that the board 45 forms the base upon which all the other parts are mounted. To this board is attached a frame 46, made of hard wood and rabbeted out to form ledges for the board 49 of the lifting-pneumatics $B^5$ to rest upon, as shown in Fig. 10. In this frame 46 are drilled holes through the top in the manner shown in Fig. 10 at 47, which holes communicate with openings in the small boards 49, which (see Fig. 11) are made of thin narrow pieces of hard wood of proper length, with two small holes bored through them, one hole near the top and the other near the middle, and reaching from one hole to the other is a small groove 50. (Shown in Fig. 10.) On the back of the board is glued a piece of thick paper $p^5$, which converts the groove into a duct leading from one hole to the other, leaving the openings on the front. Around the opening at the top is glued a piece of soft leather $l^2$, so as to make a tight joint when it is fastened to the ledge on the valve-board, with the opening communicating with the hole 47, as shown in Figs. 10 and 11. The manner of securing these pneumatics to the ledge is by means of a metal strip 51 at the top end. This strip is secured to the ledge by screws between the boards 49, the lower ends of the boards 49 being fastened with screws, as shown in Fig. 11. In this arrangement the lifting-pin is attached to the check-valve, as shown in Fig. 10 at 76, instead of to the lifting-pneumatic, as in my prior application, so that any individual cell may be removed and adjusted as to length without having to remove the cover on the vacuum-chamber.

The action of the lifting-pneumatics and valves is substantially the same as to work performed as described in my first application, the improvement being in the construction of parts. In my first application it will be seen that the vents for these small lifting-pneumatics were on the top piece of the pneumatic, just back of the lifting-pin. In the present arrangement the vent is placed in the paper strip which is glued over the groove 50, as seen at 75 in Fig. 11, round punchings being used for convenience of regulating the size of the vents, as required.

I will now describe a new pumping device adapted to be placed in any modern upright piano without having to cut or disfigure the piano in any way, reference being had to Fig. 12, showing a back view of an upright piano. The position as to motor and driving-wheel is the same as in my former case, the shaft from the main wheel passing back through a small hole in the sounding-board and having a three-way crank, as shown at 52, and a suitable bearing. The shaft and cranks are so located as to come between the end of the piano-frame and the first stanchion, as shown in Fig. 12.

The pumping or exhaust bellows are three in number and are constructed as follows: A thin wind-chest 53 is made the proper length to admit of its standing on the sill of the piano and under the pin-block and of such width that it will not project beyond the back of the instrument when placed in position. To this chest 53 are secured end pieces 54 54 and side piece 55, forming a frame of suitable size to fill the space between the stanchions of the piano. On this wind-chest and facing the side board 55 are placed the three exhaust-bellows, arranged as shown in Fig. 12. On the side piece 55 are secured small pulleys 56, and the crank-wrists are provided with bearings 51, so constructed as to admit round belting to be attached to them. Any suitable cordage or belting may be used. The cords are passed up from the cranks and over the pulleys 56 and secured to the swinging ends of the pumping-bellows, each bellows being provided with a spring 58, which keeps a tension on the cords. As the bellows work by suction only, the pull is always one way, and as the crank pulls and expands the bellows the springs are compressed, and as the cranks return the springs return the now slack bellows and maintain a tension on the cord, so that in this way there is no noise from working joints or pitmen which have to push and pull. The exhaust-bellows are provided with check-valves constructed so as to work perfectly noiselessly.

To the air-chamber 53 is secured a block 59, provided with suitable openings for the purpose of connecting a pipe 60. This pipe leads to the main sustaining-bellows 61, also placed between the stanchions, as shown in Fig. 12. This main bellows is shown in section, Fig. 13, taken on line 13 13, Fig. 12,

which section shows the air-trunk 62, safety-valve 63, interior spring 64, and supporting-board 67.

The air-trunk 62 has an opening 68 (shown in dotted lines) for attaching a tube for connecting with the pneumatic-action inside of the piano.

The supplemental spring 66 is intended to be used only where it is desirable to have the instrument play very loud, as in public halls, &c. This makes it possible to give the instrument any desired power, to play loud for large halls or soft for the parlor. The interior spring 64 is considered sufficient for all ordinary purposes, as the expression of the instrument is perfectly controlled, as described in my first specifications, by the pedal-action. When the extra or supplemental spring 66 is not required, its ends may be conveniently dislodged from seats in the top edges of the bellows and again put in position when required.

The safety-valve 63 is provided so that when the pumps have exhausted the air in the vacuum-chambers and the sustaining-bellows said safety-valve opens slightly in an automatic manner to keep an even stress all the time. The arrangement for this purpose is very simple and yet very positive. A screw 69 is placed in the moving portion of the bellows in such a position that when the bellows is collapsed the screw passes through the opening under the valve and lifts it. This allows the bellows to start to open again; but the instant it starts to open the valve closes again, keeping it up to the same stress all the time.

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

1. In an automatic piano-player, an air-duct bridge, comprising a block channeled with parallel air-ducts, each duct having a lateral opening terminating in an enlarged recess covered by a flexible diaphragm, and electrical contact-points arranged outside the diaphragm and adapted to be brought into electrical connection by the bulging or lateral movement of the diaphragm from pneumatic action substantially as described.

2. In an automatic piano-player, an air-duct bridge comprising a block channeled with parallel air-ducts, each duct having a lateral opening terminating in an enlarged recess covered by a flexible diaphragm, and also an independent lateral vent-opening, electrical contact-points arranged outside the diaphragm and adapted to be closed by the movement of the diaphragm from pneumatic action, and an inclosing board or casing covering said electrical contacts and also the lateral vent-holes of the channels, substantially as and for the purpose described.

3. In an automatic piano-player, an air-duct bridge comprising a block channeled with parallel air-ducts, each duct having a lateral opening $w^3$ terminating in an enlarged recess 37 covered by a flexible diaphragm 39 and also a vent-opening 72, contact-springs 38 pressing on the diaphragm, metal contact-frame 73, and an inclosing casing 43, substantially as and for the purpose described.

4. In an automatic piano-player, an air-duct bridge comprising a block channeled with parallel air-ducts and having on each side lateral openings terminating in enlarged recesses covered by flexible diaphragms, electrical contact-points arranged outside the diaphragms, on each side, and arranged to be closed by them, an inclosing-case board 43 for each side, and communicating equalizing-pipe 42 for connecting the chambers on opposite sides of the channeled block substantially as shown and described.

5. In an automatic piano-playing device, the combination with the music-drums, and air-duct bridge, of a supporting-frame composed of bottom B and end boards $A'$ $A^2$ $A^3$, the boards $A^2$ and $A^3$ forming an end chamber beyond the music-drums, a regulating-shaft with operating-knob and a rerolling-belt both extending through this end chamber to the back and combined with mechanism for operating the music-drums substantially as and for the purpose described.

6. In an automatic piano-playing device, the combination with the music-drums and air-duct bridge, of a main drive-shaft 1 arranged parallel with the drums and behind them, and having drive-pulley 2, sleeve 4 with rerolling-pulley 3 at one end and clutch mechanism for the shaft at the other, sleeve Y with collar X and cone-pulley N all connected to revolve with but slide on said shaft, gears connecting the cone-pulley to the winding-drum, a rerolling-pulley 15 and belt 16 for the music-roll, and a shifting device for the two sleeves substantially as shown and described.

7. The combination with the perforated music-sheet, of the tilting board F hinged at its lower end and carrying at its upper end the tripping-hook E adapted to engage with the perforated music-sheet, the thrust-bar G attached to the tilting board and extending back to the rear end of the device and arranged to operate on the music-roll-reversing mechanism, whereby the positive dragging action of the music-sheet is made to reverse the music-roll at any point along the music substantially as described.

8. In an automatic piano-playing device, the combination with the music-drums and air-duct bridge, of the main shaft 1 having drive-pulley 2, the sleeve 4 with pulley 3 on one end and clutch on the other end, shifting arm T for the clutch, latch H for the shifting arm, the sleeve Y with collar X and cone-pulley N all sliding on shaft 1 but locked to revolve with it, driving-gears connecting the cone-pulley to the winding-drums, the horizontal slide V carrying lug W, finger U, and notch 23, a regulating-shaft 13 for operating this

slide, and an electrical switch-arm actuated by the slide, substantially as and for the purpose described.

9. In an automatic piano-playing device, the combination with the main actuating-shaft 1, of the longitudinally-adjustable cone-pulley N, the laterally-adjustable bearing P for the said shaft, the laterally-adjustable block O connected to bearing P by a pivot and spring and carrying the friction-pulley M and pinion L, and the winding-drums with gear *k* substantially as shown and described.

10. In an automatic piano-playing device, the combination of the main shaft 1 having friction cone-pulley N, the adjustable block O carrying friction-pulley M and gear L, the music-roll K with gears *k*, the bearing P pivoted to block O and carrying one end of the shaft 1, the lug *r*, springs Q, and *s*, rod R with inclined end bearing against the lug, and the hinged shifting arm T, for disengaging the rotating gears L *k* to allow the winding-drum to rotate backward during the rerolling of the music substantially as set forth.

11. In an automatic piano-playing device, the combination with the music-drums, the air-duct bridge, and the actuating devices for the drums as described, of means for rerolling the music at any point before the completion of the piece, comprising a reversing mechanism, a regulating-knob 14 and rod 13 with pin *h*, double crank *g* operated upon by said pin by an extreme adjustment of the rod, the tripping-rod G arranged to be lifted by said crank, and the releasing-latch H arranged to be lifted by the rod G for unlocking the clutch of the reversing mechanism substantially as shown and described.

12. The music-drawer of the piano-playing device having in one end a bearing composed of a plate 33 with flanged and curled bearing 34 and pivoted spring-latch 35, and having at the other end a short shaft 25 with revolving pulley and clutch connection for the music-roll drum as shown and described.

13. In a piano-playing device, the pneumatic and its chamber, comprising a valve-board 45, rabbeted frame 46 with air-duct 47 opening through its top, pneumatic-boards 49 bearing bellows $B^5$ and air-duct 50 and secured in the rabbet of the frame 46 substantially as shown and described.

14. In a piano-playing device the pneumatic, its chamber and valve, comprising a valve-board 45, rabbeted frame 46 with air-duct 47 opening through its top, pneumatic-boards 49 bearing bellows $B^5$ and air-duct 50 secured in the rabbet of the frame, valve 71 with armature back closing the air-duct 47 and resting on top of frame 46, and the electromagnet 70 operating upon said valve substantially as shown and described.

15. In a piano-playing device, the pneumatic, comprising board 49 with bellows on one side, an open channel 50 on the other side communicating with said bellows, and a separate closing-strip $p^5$ applied to the back of board 49 to close in channel 50 and having a vent-hole 75 through the same substantially as and for the purpose described.

16. In a piano-playing device, the construction and arrangement of the pneumatic its chambers and valves, consisting of valve-board 45, with holes through it rabbeted frame 46 with air-ducts 47 opening through the top pneumatics secured in the rabbets and communicating with said air-ducts, and valves $B^4$ placed upon the opposite side of the valve-board and having pins 76 extending through the holes in the valve-board to contact with the pneumatics substantially as and for the purpose described.

17. In a pneumatic piano-playing device, the combination with the upright stanchions in the back of an upright piano, of a wind-chest 53, 54, 55 arranged between said stanchions flush with the backs of the same, pumping-bellows arranged therein and provided with compressing-springs 58 and pulleys, and distending-cords for the bellows passing around said pulleys and connecting with driving mechanism and working noiselessly substantially as described.

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Witnesses:
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