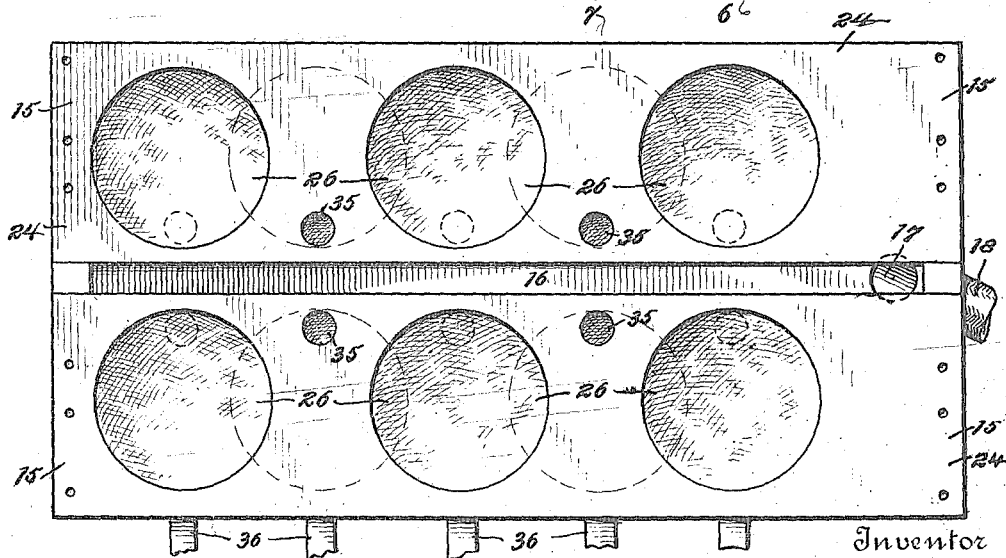
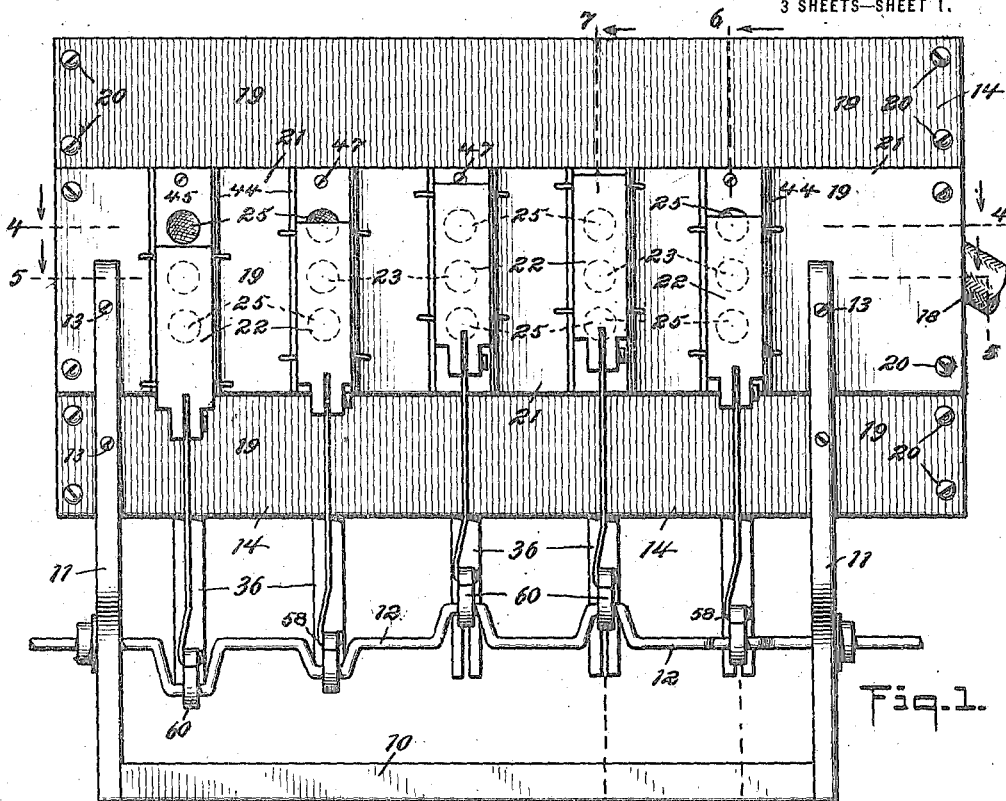


F. G. LYNDE.  
PNEUMATIC MOTOR.  
APPLICATION FILED JUNE 16, 1916.

1,270,426.

Patented June 25, 1918.

3 SHEETS—SHEET 1.



Witnesses  
*E. H. [Signature]*

Fig. 2.

By his Attorney

Inventor  
Frank G. Lynde

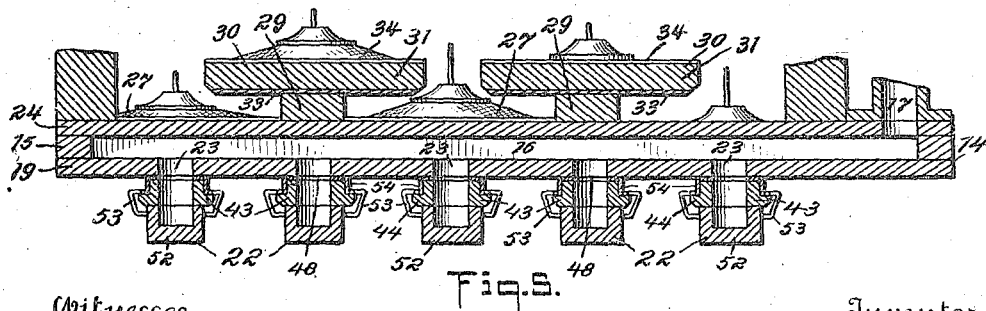
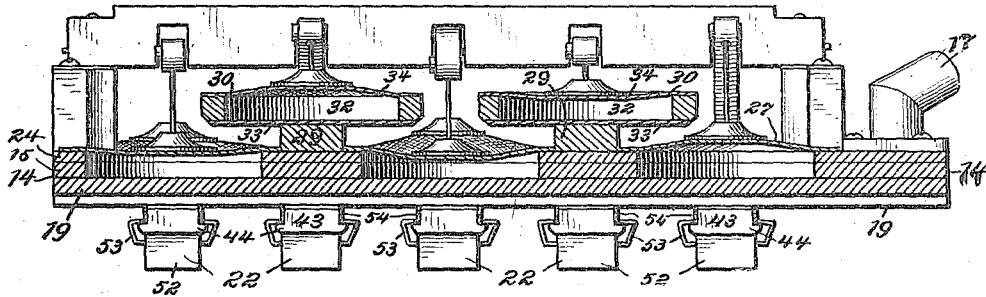
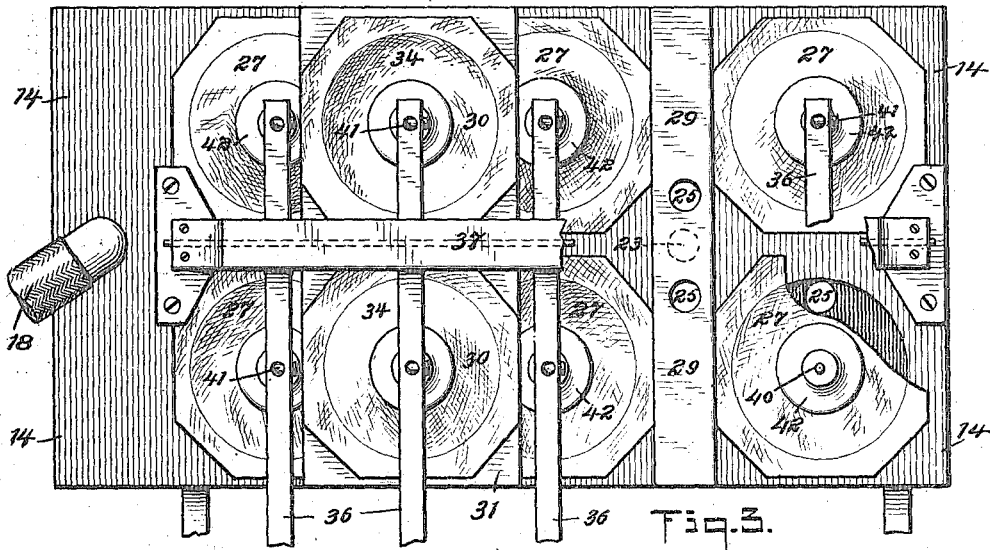
*W. S. Oston.*

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Witnesses  
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3 SHEETS—SHEET 3.

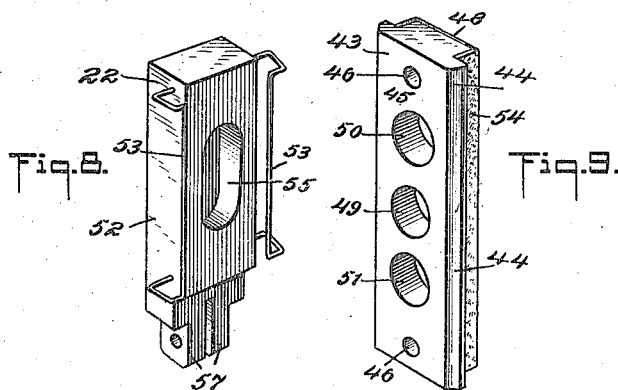
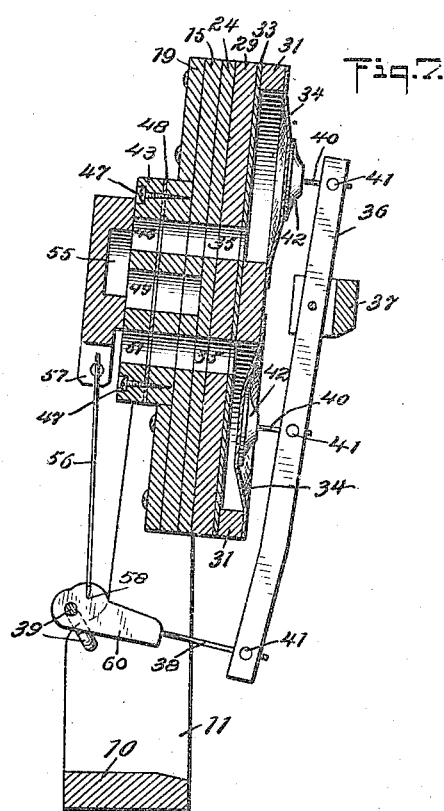
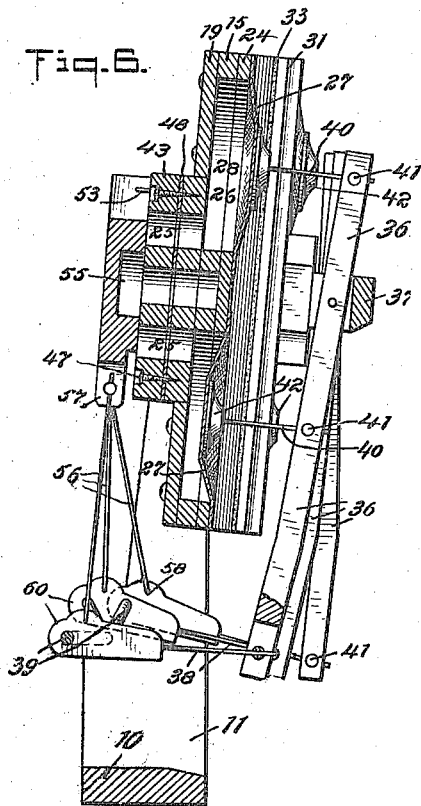
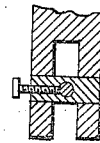


Fig. 10.



WITNESSES  
*[Signature]*

INVENTOR  
Frank G. Lynde  
BY *[Signature]*  
ATTORNEYS

# UNITED STATES PATENT OFFICE.

FRANK G. LYNDE, OF NEWARK, NEW JERSEY, ASSIGNOR TO LAUTER COMPANY, OF  
NEWARK, NEW JERSEY, A CORPORATION OF NEW JERSEY.

## PNEUMATIC MOTOR.

1,270,426.

Specification of Letters Patent. Patented June 25, 1918.

Application filed June 16, 1916. Serial No. 103,918.

*To all whom it may concern:*

Be it known that I, FRANK G. LYNDE, a citizen of the United States, residing at Newark, county of Essex, and State of New Jersey, have invented certain new and useful Improvements in Pneumatic Motors, of which the following is a specification.

My invention relates in general to a pneumatically actuated motor of general application and particularly relates to such a motor designed for driving the take-up spool actuating mechanism in player pianos.

The usual practice at present is to mount the take-up motor to one side of the spool box with the different points or power members of the motor arranged in line, but, with the usual form of accordion pneumatics used in connection with such devices, the size and number of the points are necessarily restricted by the available space at this part of the piano.

One of the primary objects of my invention is to provide a simple form of motor of greater driving power than is at present used, but which at the same time, can be accommodated within the space limitations at present occupied by devices of this character, so that in general one feature of the invention relates to the designing of a powerful motor with small dimensions in the direction where available space is limited.

Incidental to the desideratum of a powerful motor, a further object of the invention is to provide a motor which can be actuated easily and quietly and which will have a high degree of efficiency so that practically all of the wind power delivered to the motor may be utilized in driving the spool actuated shaft.

Still another object of the invention is to provide a motor which can be constructed from a minimum number of separate parts with the least possible amount of workmanship, which can be readily assembled without any necessity for extreme caution in fitting the parts, which can be readily removed as a unit from the piano and in which certain of the parts may be demounted from each other, so as to provide ready access to the several wind passageways and valvular parts for cleaning and repairing.

Another object of the invention is to provide a type of pneumatic which will avoid the objection to the accordion type of pneuma-

tics now in general use and which economically transform the pneumatic energy into mechanical energy with the least possible transmission losses.

Devices of this character are very sensitive to climatic changes which cause the parts to warp and creep on each other, so that in addition to a minimum number of parts, it is another object of the invention to arrange these parts so as to offer the greatest possible resistance to distorting strains without adding any material particularly for this purpose.

Incidental to the object relating to ease of operation another object is to provide an improved type of valvular control which can be actuated easily and in proper periodicity and which will be entirely sealed against leakage therethrough.

Various other objects and advantages of the invention will be in part obvious from an inspection of the accompanying drawings and in part will be more fully set forth in the following particular description of one form of mechanism embodying my invention, and the invention also consists in certain new and novel features of construction and combination of parts hereinafter set forth and claimed.

Referring to the accompanying drawings:

Figure 1 is a front view in elevation of a preferred embodiment of my invention and showing a portion of the spool mechanism actuating shaft;

Fig. 2 is a view in front elevation of the device shown in Fig. 1 with the front plies and attached parts removed;

Fig. 3 is a view in rear elevation of the device shown in Fig. 1 with parts broken away to show internal construction;

Figs. 4 and 5 are horizontal sectional views taken respectively on the lines 4—4 and 5—5 of Fig. 1, looking in the direction indicated by the arrows;

Figs. 6 and 7 are vertical sectional views taken respectively on the lines 6—6 and 7—7 of Fig. 1, looking in the direction indicated by the arrows;

Figs. 8 and 9 are parts of the valvular mechanism shown at the front of the motor in the several figures; Fig. 8 being a perspective view of the sliding valve block and Fig. 9 being a similar view of the guide block or valve seat, and Fig. 10 is a per-

spective view showing an enlargement of the pivotal connections with the valve lever.

In the following description and in the claims, parts will be identified by specific names for convenience of expression but they are intended to be as generic in their application to similar parts as the art will permit.

The motor includes a supporting frame 10 within the uprights 11 of which is journaled the driven multi-crank shaft 12, designed to be connected with the mechanism to be driven, such as the take-up spool in the spool box (not shown). This frame is usually supported on the tension box and between the spool box and adjacent side frames of the casing. Demountably supported on the frame and suitably affixed thereto, as by means of the screws 13 is the pneumatic organization for actuating the shaft and arranged so that this organization and its attached parts may be readily separated from the frame. The organization includes a motor which comprises primarily a vertically disposed combined support and tension box 14, preferably in the form of a flat board, of some material depth compared to its thickness and designed to take up the vertical strains thereon with the least possible amount of strain resisting material. This board may be considered as made up of three thin flat wooden plies, the inner ply 15 of which contains a longitudinally disposed wind passageway 16 which may itself have sufficient capacity to be termed a tension reservoir chamber, connected by means of a plug 17, with some suitable source of pneumatic power indicated diametrically by the hose connection 18. The front ply 19 of the box is preferably made up of a series, in this case shown to be three, vertically disposed and containing parallel strips, all of which may be demountably attached to the tension box preferably by means accessible from the front of the device, such as the screws 20 (see Fig. 1).

The middle strip 21 is designed to carry the valvular pneumatic tension controlling mechanisms 22, the detached parts of which are shown in Figs. 8 and 9 and more particularly hereinafter described. This middle strip is drilled therethrough to provide a plurality of sets of ports, one set of three vertically spaced ports for each valvular mechanism and with the middle port 23 of each set opening into the passageway or reservoir 16. The upper and lower ports 25 of each set are designed to place the pneumatics in communication with their correlated valvular control mechanisms. The rear ply 24 is provided with two lines of pockets 26 (see Fig. 2) disposed on opposite sides of the passageways 16, each line including three pockets positioned relatively close to each other and each alining spec-

tively with their corresponding pockets in vertical alinement across the passageway. The vertically disposed pairs of pockets in the box are positioned in rear of the first, third and last valvular mechanisms mounted across the face of the box. The pockets are circular in outline and relatively shallow with the outer sides thereof closed by flexible diaphragms 27 suitably fastened as by gluing to the rear face of the tension box 14 as shown more particularly to the right of Fig. 3.

By this means a series of pneumatic is formed, the movable sides of which are substantially the segment of a sphere and this peculiar form of pneumatics for use in this particular organization constitutes one of the important features of this invention. Each of the pneumatics so formed is designed to be opened to its correlated valvular mechanism through a compartment 28 extending through the middle ply and opening into the port 25. In order to enlarge the air chamber of the pneumatic, the part of the compartment 28 contained within the inner ply may have a cross-sectional area corresponding to and alining with the pocket 26 as shown in Fig. 6. The construction thus far described, discloses a bank of pneumatics disposed in one plane and substantially contained within the outline of the tension box and as so constructed a complete six point motor is formed.

In order to form the ten point motor illustrated, while preserving the dimensions of the individual pneumatics and without utilizing any more space across the front of the box, the four additional pneumatics 30 may be mounted in a second plane positioned back of the pneumatics contained in the tension box. For the purpose of supporting the two extra pairs of pneumatics, vertically disposed supporting strips 29 are affixed to the back of the box and are each centered between the vertically disposed pairs of pneumatics in the tension box. Each of the supporting strips is mounted directly on the back of the box and centered with respect to the second and fourth valvular mechanisms on the front of the box. Each of the pneumatics 30 is formed of an open end flat block 31 having an opening 32 extending therethrough similar in size and configuration to the pockets 26. The side of the opening 32 adjacent the supporting strip is closed by means of a thin backing plate 33 constituting the immovable side of the pneumatic and the means by which the pneumatic is fixed to the supporting strip. The outer side of each pneumatic is closed by a flexible diaphragm 34 similar to the previously described diaphragm 27. Each of the pneumatics 30 is in communication with its correlated valvular mechanism, by means of passageways 35 extending through

the supporting strips and through the tension box as shown more particularly in Fig. 7.

By means of this construction it is possible to have the rear bank of pneumatics overlap the bank of pneumatics carried by the tension box and the staggered arrangement of these pneumatics, such as illustrated in Figs. 4 and 5 permit of the installation of ten pneumatics with relatively large air spaces within the space usually occupied by six pneumatics of less capacity. The pneumatics so arranged utilize the depth provided in piano constructions of conventional design without requiring any more front room for the more powerful motors, thus necessitating the use of but small space in the piano, and incidentally providing a compact construction.

Each pair of pneumatics, considered vertically, is designed to actuate a lever 36 and all of the levers are operatively connected to the crank-shaft 12 to rotate the same by the vibration of the diaphragms as is usual with such shafts.

The levers are pivoted intermediate their lengths to a horizontally disposed supporting bar 37 and the lower end of each rod is connected by means of a link 38 to one of the cranks 39 of the shaft 12. The cranks are arranged in series, one in advance of the other by an angular offset constituting a fraction of the rotation equal to the reciprocal of the number of cranks, as is usual with such constructions. Each pair of diaphragms vertically grouped is so arranged that when one is distended, the other is collapsed and the diaphragms are pivotally connected to the levers by means of actuating rods 40 pivotally connected to the levers on opposite sides of the fulcrum thereof, by means of set pins 41, which may form a loose pivotal connection between the levers and rods and also constitute a means for adjusting the normal position of the diaphragm with reference to the lever actuated thereby.

Each of the rods 40 is conducted to the center of its diaphragm by means of a button 42 and the parts are so arranged that the diaphragm will have a straight line collapsing and distending movement practically for its full possible length from one of the positions shown at one side of Figs. 6 and 7 into the other position shown in these figures.

Each of the pneumatic control valvular mechanisms includes a long metal guide plate 43 more particularly shown in Fig. 9, which plate is substantially T-shaped in horizontal cross-section to provide outwardly beveled side guiding flanges 44 and a smooth metal front face 45 designed to minimize friction. Opposite ends of the plate are provided with screw holes 46 designed to accommodate fastening screws 47 to hold the guide

plate demountably in position on the front of the middle strip 21. Preferably a fabric sheet 48 is positioned between the inner side of the guide plate and the adjacent front face of the middle strip, as shown in Figs. 6 and 7 to minimize any possible leakage at this place and at the same time insuring an easy demounting of the valvular mechanisms from the motor proper. Each of the guide plates is provided with three equally spaced ports extending therethrough, the middle port 49 designed when in position to register with the middle port 23 leading from the passage 16. The end ports 50 and 51 are designed to align respectively with the upper and lower ports 25 of the front ply or with the passageway 35 leading to the rear bank of pneumatics.

The movable part of the valvular mechanism includes a slide block 52 mounted for reciprocatory movement vertically and longitudinally on the face 45 of its corresponding guide block. This slide block is held in position on the guide block by means of a pair of bent wire guide rods 53 the end portions of which are fitted to extend beneath the flanges 44 and the middle portions of which are arranged to bear resiliently against the fabric covered face 54 of the stem portion of the guide plate. The inner face of the slide block is provided in a pocket 55 having a dimension lengthwise sufficient to cover the middle port 49 and one of the end ports 50 or 51 depending upon the limiting position of the slide block in either of its reciprocatory directions but this pocket is of a length less than a length which would cover the three ports in the guide block. The slide block has such a length, so that when in one of its limiting positions covering one of the end ports, the other end port is opened to the outside air, so as to permit the pneumatics alternately to exhaust to the outside air. The slide block is actuated by a depending valve rod 56 pivotally mounted between lugs 57 constituting an extension at the lower ends of the block. The lower ends of each of the valve rods are bent laterally to form pivoting pins 58 designed to engage in an aperture 59 in a plate 60 constituting a wide part of the link rod 38 and pivoted thereto off-centered from the connection between this plate and the crank-shaft.

In operation, it will be understood that this motor works substantially in the same manner as devices of this character usually operate, the pneumatic tension in the tension box acting through the valvular mechanism to distend or collapse one of each pair of pneumatics, while the other pneumatic of each pair is opened to the outside air or corresponding exhaust. With the reversal of the position of the valvular mechanism, the previously operated pneumatic is opened

to the outside air and this operation is repeated, the pneumatics being alternately distended and then collapsed. The levers connected to the movable elements of the pneumatics are rocked on their fulcrum and the motion therefrom transmitted to the driven shaft and utilized to actuate the valvular mechanism in their proper sequence.

10 It is noted, however, that the full effective pneumatic force directed into the wind space of the several pneumatics is transferred directly to the entire face of the diaphragm and obviously the pneumatic pressure is constant over the entire movable face of the diaphragm irrespective of its position. In this manner, the whole effective force of the pneumatic tension is utilized and there is not the variable counteracting force of the external air pressure with its resulting loss of energy, characterizing the accordion types of pneumatics. The full effective force of the air tension passing in the motor is transmitted onto the diaphragm and from the diaphragm transmitted with a straight line thrust onto the lever, so that by means of a device of this character the pneumatic thrust on the diaphragm is transmitted almost directly to the mechanism actuated by the motor. A pneumatic of the type disclosed is peculiarly adaptable for the high speed work required of devices of this character, and the wear and tear on the diaphragm is practically eliminated as there is no tendency to form creases and any irregular load on the actuating shaft is taken up easily by these diaphragms without shock to the system. Further as the diaphragms are not pivoted at one side, usual in pneumatics of the accordion type, all hinge constructions with their resulting wear at the hinge are eliminated and the part of the movable member which has the greatest extent of movement and which is the center of application of force thereto is the part which is connected to the levers actuated thereby.

Having thus described my invention, I claim:

50 1. A pneumatic motor for player pianos comprising a support provided with a wind passageway, a driven shaft, a pair of flexible circular diaphragms fixed to the support and having their centers free to vibrate, a lever extending substantially at right angles to the lines of movement of the diaphragms pivoted intermediate its length and operatively connected to said shaft to rotate the same, a connection with each of said diaphragms adjacent its center and with said lever attached thereto on opposite sides of its fulcrum, said connection including means for adjusting the lever relative to each diaphragm, and valvular mechanism 65 designed to open the diaphragms alter-

nately to the wind passageway whereby the air tension in said passageway will act promptly against the circular diaphragms thereby to cause the diaphragms to actuate the driven shaft through the levers.

70 2. A pneumatic motor for player pianos comprising a board containing a wind passageway, a pair of flexible diaphragms fastened to said board on one side thereof and positioned relatively close to each other whereby relatively large diaphragms may be mounted within a limited space, another diaphragm overlapping said pair of diaphragms whereby two banks of diaphragms may be disposed relatively close to each other and one back of the other, a single shaft operatively connected to be driven by said diaphragms and valvular means for connecting said wind passageway with the diaphragms to actuate the same.

85 3. A pneumatic motor for player pianos, comprising a support provided with a wind passageway, a plurality of diaphragms arranged substantially in one plane to constitute a bank of diaphragms, a second bank of diaphragms disposed in a plane substantially parallel and close to the first named plane, valvular means operatively connecting said wind passageway with all of said diaphragms whereby the tension in said wind passageway may be caused to vibrate the diaphragms and a single shaft operatively connected to be actuated by the vibrating movement of said diaphragms.

100 4. A pneumatic motor for player pianos including a supporting member provided with a passageway for pneumatic power, a bank of pneumatics supported from said member, a second bank of pneumatics disposed substantially parallel to the first named bank of pneumatics and positioned relatively close thereto, a bank of valvular elements mounted on the opposite face of the supporting member, each element designed to control the passage of power from the passageway to a pair of said pneumatics, a single driven shaft and driving mechanism operatively connected to said pneumatics and said driven shaft and designed to actuate the same by the movement of said pneumatics.

115 5. A pneumatic motor for player pianos including a supporting member provided with a passageway for pneumatic power, a bank of pneumatics supported from said member, certain of said pneumatics overlapping others and arranged in pairs, diaphragms constituting the movable sides of said pneumatics, a bank of valvular elements, each element designed to control the passage of power from the passageway to a pair of said pneumatics, and common means for taking power alternately from each member of said pairs of pneumatics.

130 6. A pneumatic motor including a sup-



port provided with a passageway for pneumatic power, a pair of pneumatics positioned one on one side of the support, a second pair of pneumatics, means for supporting said second pair of pneumatics in spaced relationship to the side of the support carrying the first named pair of pneumatics, said second pair of pneumatics lapping the first named pair, valvular means for opening the pneumatics to said passageway and a single shaft operatively connected to said two pairs of pneumatics to be actuated thereby.

7. A pneumatic motor for player pianos forming a unitary structure and comprising a frame containing therein a passageway for pneumatic power, said frame provided with a pocket within its outlines and a diaphragm covering said pocket to form a pneumatic at one face of the frame and a pneumatic controlling valvular element mounted on the opposite face thereof, transverse passageways in said frame designed to open communication between the valvular element and said pneumatic and between the valvular element and said reservoir, a driven shaft and operating mechanism mounted for rocking movement about a fixed axis of rotation connected to said shaft and actuated by the vibratory movement of said pneumatic, said operating mechanism including an adjustable connection with the diaphragm.

8. A pneumatic motor for player pianos forming a unitary structure and comprising a frame containing a passageway for pneumatic power, a plurality of vibratory pneumatics on one face of the frame arranged compactly in parallel planes and close together, and pneumatic controlling valvular elements, transverse passageways in said frame designed to open communication between the valvular elements and said pneumatics and between the valvular elements and said passageway.

9. In a device of the class described, the combination of two banks of pneumatics, the pneumatics in one bank lapping those in the other bank, a single crank-shaft driven from the pneumatics, a plurality of levers connected to said crank-shaft to rotate the same and connecting means between each of said pneumatics and one of said levers whereby the actuation of the pneumatics in the two banks will cause the crank-shaft to rotate.

10. A pneumatic motor for player pianos including a flat board with pair of pneumatics disposed side by side, substantially confined within the outlines of the board, diaphragms constituting the movable sides of each of said pneumatics and substantially coextensive with the adjacent face of the board, the active part of each of said diaphragms constituting the sector of a sphere, a lever and connections including adjustable

pivots between the parts of said diaphragms having the greatest travel and said lever, said active part and the connection of the lever therewith being readily accessible whereby the active part may be readily replaced, and said connection including a readily removable pivotal joint with the lever whereby the separation of the connection at the joint will permit the ready removal of the diaphragm and connection as a unit, a shaft, a crank connection between said shaft and lever whereby the pulsation of the pair of diaphragms will assist to rotate the shaft.

11. In a motor, the combination with a pneumatic extending flatwise in one plane, a second pneumatic extending flatwise in a plane parallel and close to the first named plane, valvular means for controlling the actuation of said pneumatics and a single shaft operatively connected to be actuated simultaneously by both pneumatics.

12. A pneumatic motor including a support, a plurality of actuating elements carried by said support and arranged in banks with the banks positioned relatively close together, a single shaft and a connection between each of said elements and said shaft for driving the shaft by the actuation of the elements.

13. A pneumatic motor including a support, a plurality of actuating elements carried by said support and arranged in two banks, each of said banks including a plurality of parallel rows of the elements and the banks extending in parallel planes relatively close together, and a single means connected to each of said elements to be actuated by the actuation of said elements.

14. A pneumatic motor including a support, a plurality of actuating elements carried by said support and arranged in two banks, each of said banks including a plurality of parallel rows of the elements and the banks extending in parallel planes relatively close together, means connected to each of said elements to be actuated by the actuation of said elements, said support including a main passageway for pneumatic power and other passageways leading from said main passageway to each of said elements.

15. A pneumatic motor for player pianos including a vertically disposed flat board relatively thin from front to rear, said board provided with a longitudinally extending passageway therein adapted to be connected to a source of pneumatic power, one face of said board being drilled to provide a pair of vertically disposed pneumatic recesses, three parallel passageways extending transversely of the board, one of said passageways opening into the longitudinal passageway and the other transverse passageways opening directly into the recesses,



flexible diaphragms having their edges fixed to said face and covering said recesses to complete the pneumatics, a vertically disposed lever, adjustable connections between  
5 each arm of the lever and one of the diaphragms whereby the distentions of the diaphragm will alternately act on each arm of the lever to rock the same, a single crank shaft operatively connected to the lever to  
10 be rotated by the rocking of the lever and valvular mechanisms for alternately opening each pneumatic to said longitudinally extending passageway.

16. A pneumatic motor for player pianos including a board containing a passageway adapted to be connected to a source of pneumatic power, one face of said board provided with a number of recesses drilled therein, diaphragms covering each of said  
20 recesses to provide pneumatics substantially contained within the outlines of the board, said pneumatics arranged in pairs, said board provided with a pair of transverse passageways opening from one side of the  
25 board directly into said recesses, valvular means carried by the board for alternately opening each pneumatic of a pair to the passageway through said transverse passageways, a single driven power member, a  
30 plurality of power transmitting members mounted on a common support operatively connected to said pneumatics to be actuated by the combined power from all of the pneumatics and having crank connections  
35 with said power members.

17. A pneumatic motor for player pianos, including a supporting board containing a passageway adapted to be connected to a

source of pneumatic power, a plurality of pneumatics disposed in one face of the support and arranged in pairs, a single lever  
40 support carried by the supporting board on the side thereof having the pneumatics, a plurality of levers, one for each pair of pneumatics and connected with said  
45 pneumatics to be actuated thereby, said levers being all fulcrumed to said single lever support whereby the removal of the support will carry with it all the levers, a crankshaft, driving connections between said levers and said shaft and valvular means actuated by said shaft for alternately opening  
50 the pneumatics of each set to said passageway.

18. In a pneumatic motor for player pianos, a shaft driving mechanism including a lever pivoted intermediate its ends, a pair of diaphragms mounted on opposite sides of the fulcrum of said lever, each of said diaphragms being circular with their peripheral portions fixed in position and their  
60 centers free to move toward and from the lever, and adjustable connections between said movable centers and said lever on opposite sides of the fulcrum whereby the  
65 throw of one of the diaphragms may be adjusted relative to the throw of the diaphragm on the other side of the lever fulcrum.

Signed at Newark, in the county of Essex and State of New Jersey this thirteenth day of June A. D. 1916.

FRANK G. LYNDE.

Witnesses:

S. R. CAIRNS,  
H. R. BANES.