No. 852,161. PATENTED APR. 30, 1907.

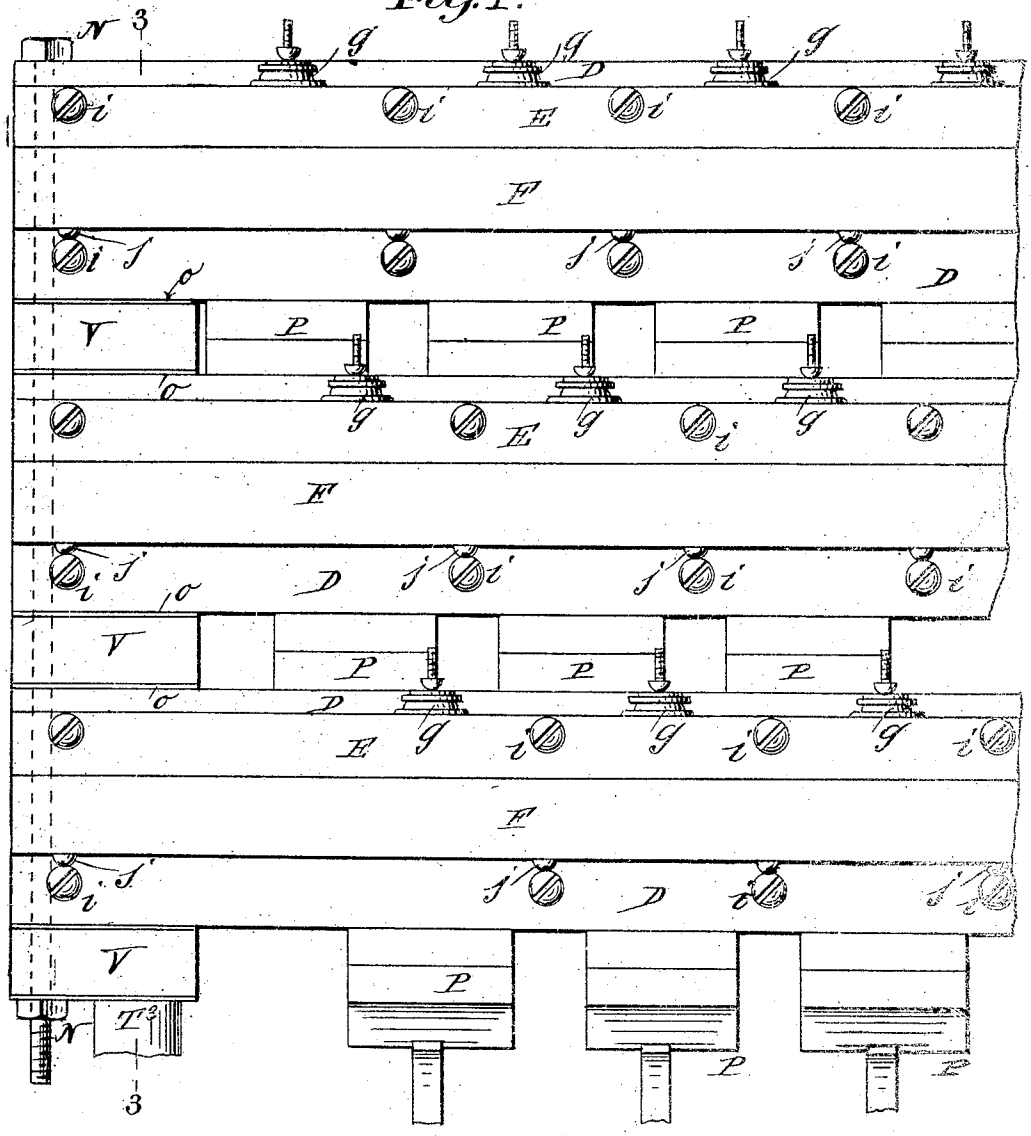
G. P. BRAND

PNEUMATIC PLAYER FOR MUSICAL INSTRUMENTS.

APPLICATION FILED FEB. 23, 1905.

3 SHEETS—SHEET 1.

Fig. 1.



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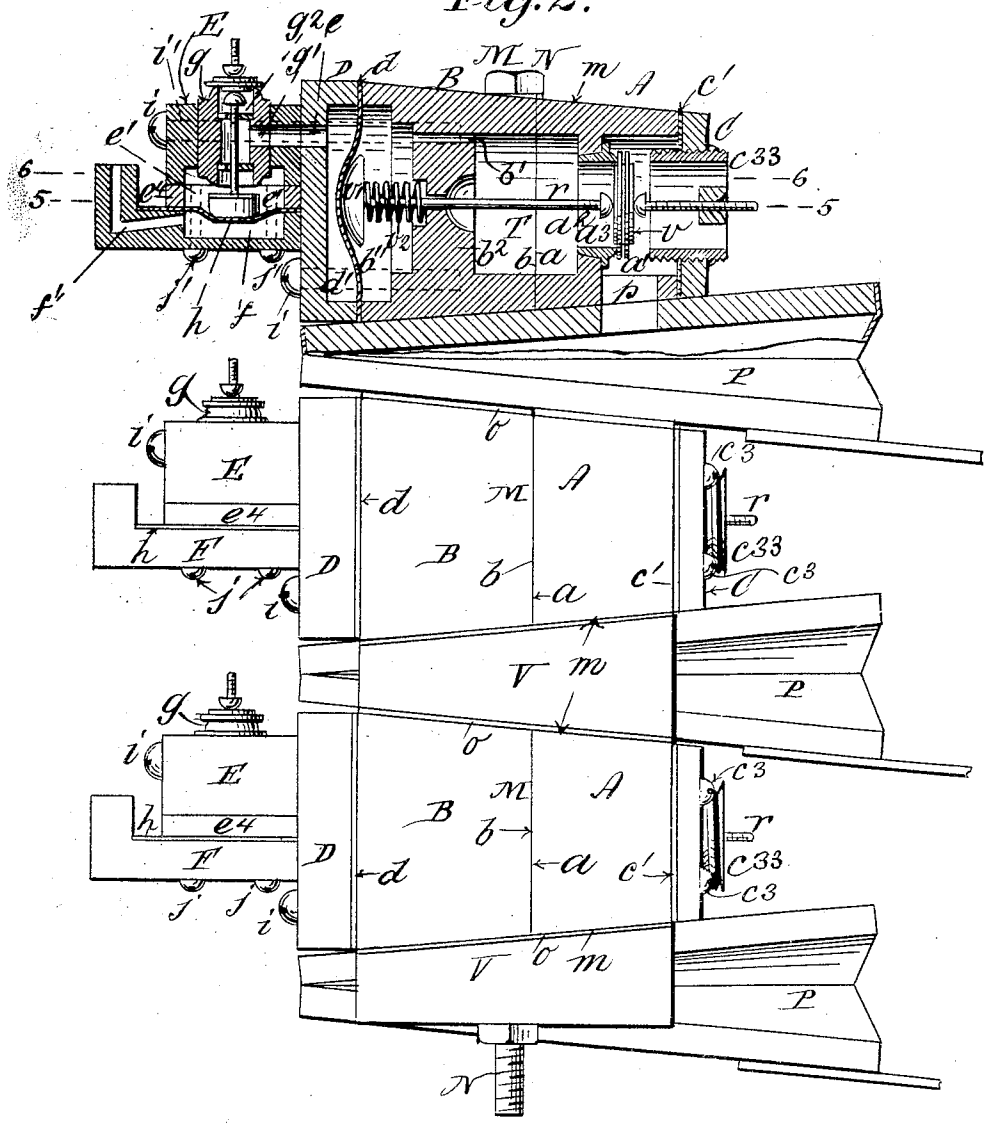
5 SHEETS—SHEET 2.

Fig. 2.



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5 SHEETS—SHEET 3.

Fig. 3.

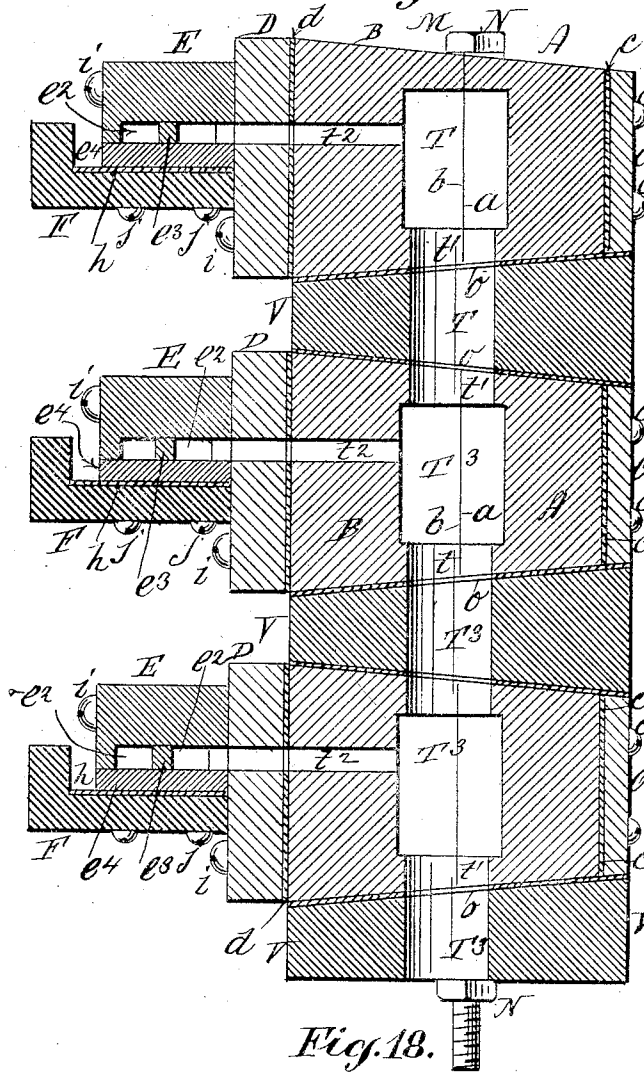


Fig. 4.

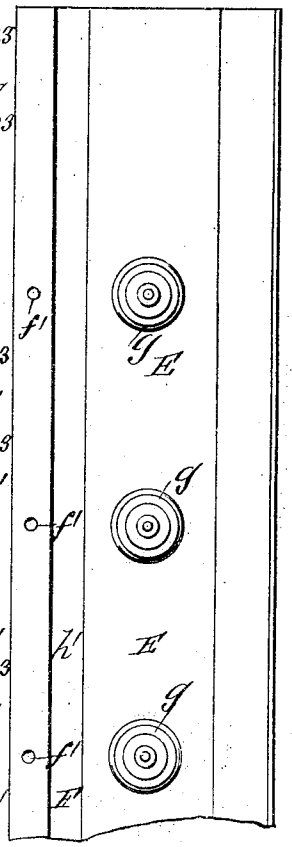
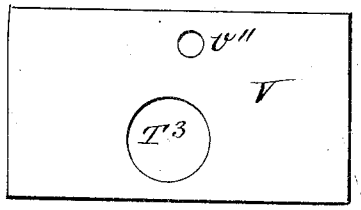


Fig. 18.



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5 SHEETS—SHEET 4.

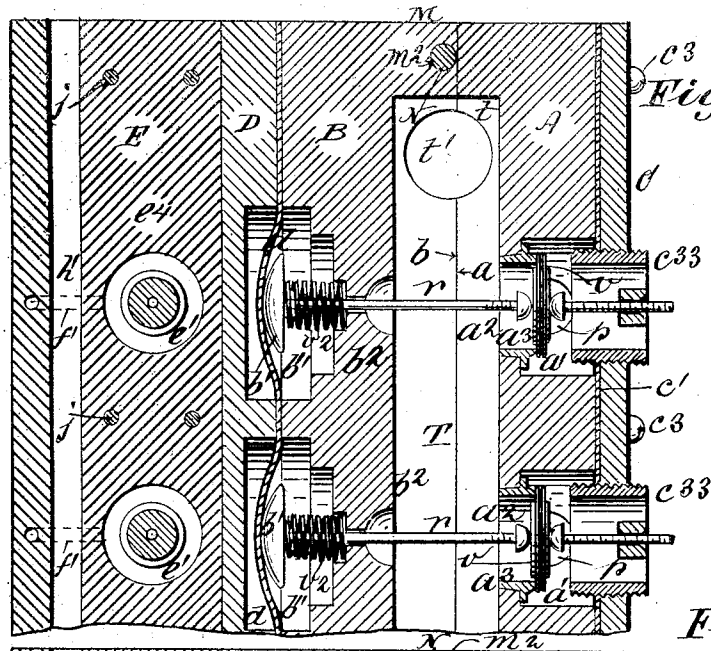

Fig. 5.

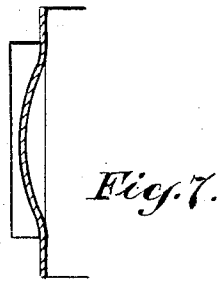

Fig. 7.

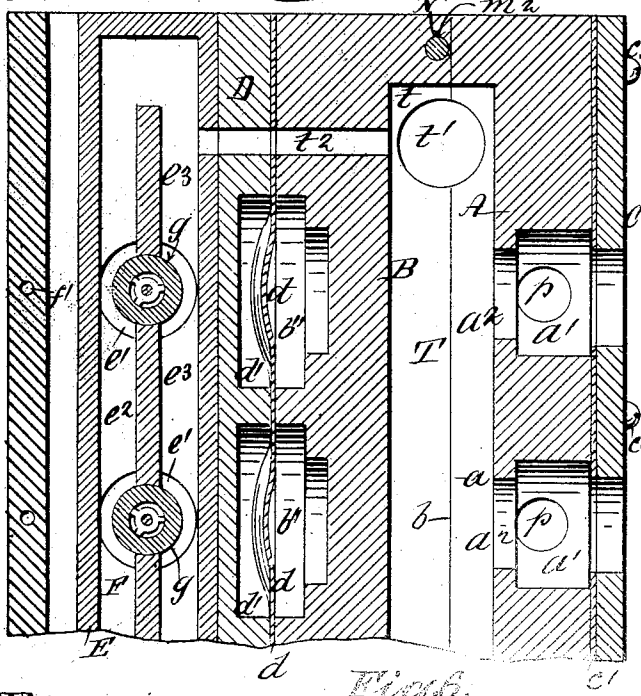

Fig. 6.

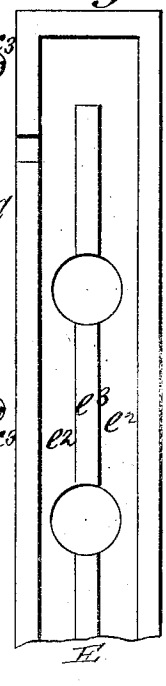

Fig. 8.

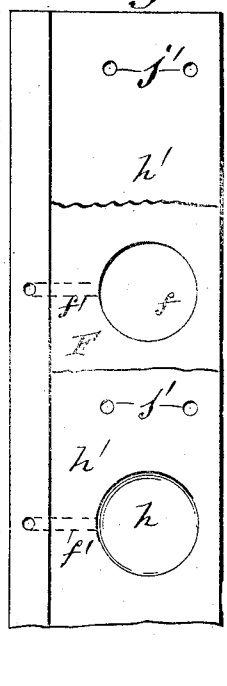

Fig. 9.

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5 SHEETS—SHEET 5.

Fig. 10.

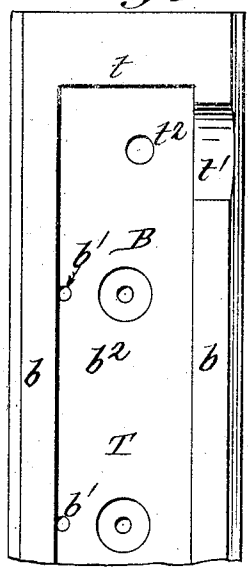


Fig. 11

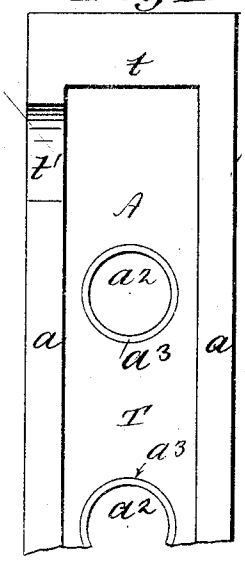


Fig. 12

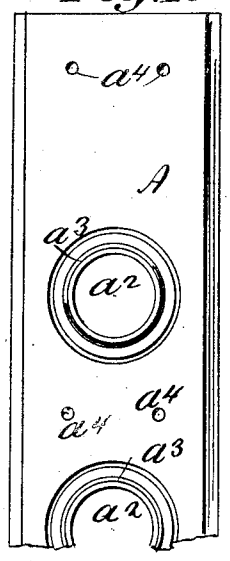


Fig. 13.

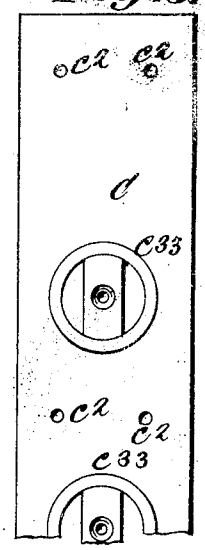


Fig. 14.

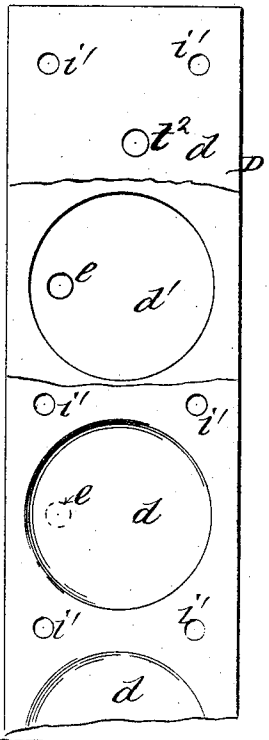


Fig. 15.

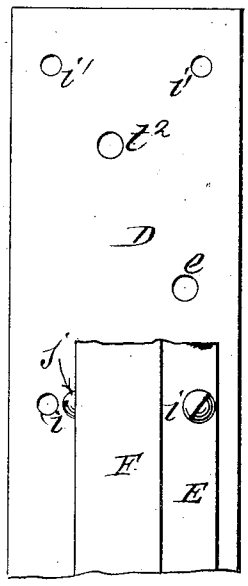


Fig. 16.

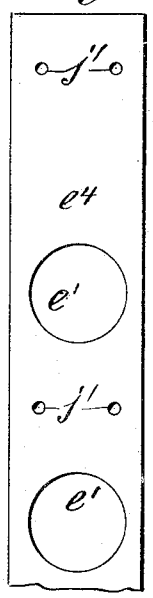
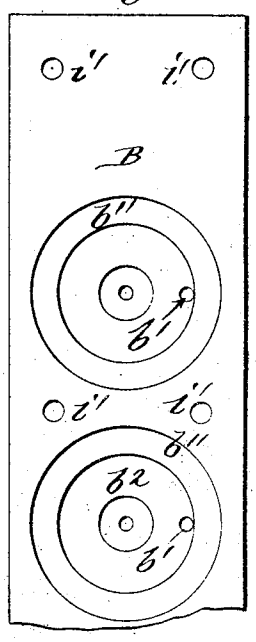


Fig. 17.



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UNITED STATES PATENT OFFICE.

GEORGE P. BRAND, OF NEW YORK, N. Y.

PNEUMATIC PLAYER FOR MUSICAL INSTRUMENTS.

No. 852,161. Specification of Letters Patent. Patented April 30, 1907.

Application filed February 23, 1905. Serial No. 246,864.

To all whom it may concern:

Be it known that I, GEORGE P. BRAND, a citizen of the United States, residing in the city of New York, borough of Manhattan, county and State of New York, have invented certain new and useful Improvements in Pneumatic Players for Musical Instruments, of which the following is a specification.

My improvements relate to what is technically known as the valve chest work in pneumatic apparatus for playing musical instruments by means of perforated sheet music. They are designed mainly to simplify and cheapen construction, to economize space, to obviate the evil effects that might otherwise result from climatic changes or conditions, to render the whole structure as solid and rigid as possible, and to afford convenient access to diaphragm butts, valves &c.

The invention consists in the construction and arrangement of parts herein described and claimed specifically.

In the accompanying drawings, Figure 1, is an elevation taken on the primary side of three superposed tension chests and connections; Fig. 2, is an end elevation partly in section; Fig. 3, is a section taken upon plane of line 3—3—Fig. 1; Fig. 4, is a plan of the primary chest and detachable secondary diaphragm plate; Fig. 5, is a section upon plane of line 5—5—Fig. 2; Fig. 6, is a section upon plane of line 6—6—Fig. 2; Fig. 7, is a diagram illustrating the old method of attaching a diaphragm; Fig. 8, is a view of the under side of a portion of the primary chest; Fig. 9, is a view of a portion of the detachable primary diaphragm plate, showing a portion of the diaphragm strip broken away; Fig. 10, is a view of the inner side of a diaphragm section of the main tension chamber, detached; Fig. 11, is a similar view of the valve section of the main tension chamber, detached; Fig. 12, is a view of the outer face of the valve section of the main tension chamber; Fig. 13, is an elevation of a portion of a detachable valve seat plate; Fig. 14, is a view of the inner side of the secondary diaphragm plate with a portion of the diaphragm strip broken away; Fig. 15, is a front elevation of a portion of the detachable secondary diaphragm plate, showing the primary chest partly broken away; Fig. 16, is a view of a portion of the primary diaphragm chamber plate, constituting the inner side of the primary chest; Fig. 17, is a view of a portion of the outer side of the secondary diaphragm section B, the diaphragm plate being removed; Fig. 18, is a top view of one of the spacings blocks.

Heretofore much difficulty had been experienced in pneumatic apparatus of this class by reason of the evil effects of meteorological changes and conditions, and a distinguishing feature of my present structure is its compactness and solidity, and the absence of cross-binding, as compared with the box chest work in ordinary use. This I accomplish primarily by constructing the body or main portion of the chest preferably in two sections united integrally to form the main tension chamber; in forming the secondary diaphragm chambers, and secondary valve chambers externally upon this body portion, and in using in conjunction therewith a detachable diaphragm plate and a detachable valve seat plate as hereinafter described in detail. Thus, in the drawings what may be designated as the valve section A, is secured rigidly to the diaphragm section B by gluing their abutting surfaces *a*, *b*, together. These sections A and B extend the full length of the chest, their opposed inner sides or faces *a*, *b*, being grooved or cut out to form between them the main tension chamber T which is closed at each end, as at *t*, Fig. 5, and is connected with suitable exhaust mechanism by means of a passage *t'*, shown in Fig. 3. It is obvious that the solid body M, thus formed by the united sections A and B may be built up of more than two pieces or thicknesses of material suitably grooved and seated and then united integrally, but this is not material in so far as the final result is involved,—the essential feature in this respect being the incorporation of the valve section and the diaphragm section integrally to form a solid, rigid body M.

The outer or face side of the valve section A is formed with a series of circular valve chambers *a'*, communicating with the main tension chamber T through ports a^2, which are preferably furnished with driven valve seats a^3 as set forth in my concurrent application No. 243,463 filed January 31, 1905. Each of these valve chambers *a'*, communicates through a port *p* with a power pneumatic P.

The valve plate C is secured by screws c^3, or otherwise applied to the face of the valve section A, in such manner as to be readily detachable therefrom,—a suitable packing c', being interposed between the opposed surfaces. Screw holes are shown in the drawings and lettered c^2, in the plate C, and a^4, in the valve chamber section A (see Figs. 12, 13). In this detachable valve plate C, are preferably mounted adjustable valve seats c^{33}, coinciding in number and position with the valve chambers a', in the valve section A, and described and claimed specifically in my concurrent application No. 243,462 filed January 31, 1905. While the use of this particular form of valve seat is desirable in that I am thereby enabled to dispense with one of the two valves ordinarily employed in the secondary valve chamber and thereby economize space by making the valve chamber correspondingly smaller, still I do not wish to restrict myself in this respect since any desired form of valve and seat may be substituted with practically the same results in so far as the essential features of the present invention are concerned.

The outer face of the diaphragm section B is recessed to form the secondary diaphragm tension chambers b'', communication being established between each of said chambers and the main tension chamber T through an individual passage b', formed in the web or partition b^2, which partition also acts as a guide for each of the valve rods r. The rod carries the secondary valve v, and the diaphragm butt v', between which latter and the partition b^2, is interposed a spring v^2, for the purpose of insuring the return of the valve v, to its normal position upon the seat a^3, of the port a^2, after the deflation of the pneumatic P.

The diaphragms d, are all preferably though not necessarily formed of a single strip of leather or other suitable flexible material, as will be understood by reference to Fig. 14, said material being clamped between the outer face of the diaphragm section B, and the inner face of the secondary diaphragm plate D, which latter is screwed or otherwise secured to the diaphragm section B in such manner as to be detachable therefrom to give access to the diaphragms and their chambers when necessary. Screws i, are shown in the drawings as used for the purpose, the holes therefor being lettered i', in both diaphragm section B, the secondary diaphragm plate D, and the primary valve chest E. By thus forming the secondary diaphragms d, of a single sheet of flexible material I not only save time and labor in placing them in position but I also insure and maintain a perfect seal owing to the relatively large area of the surfaces between which the edges of the diaphragms are clamped. Furthermore this feature of clamping the edges of the diaphragm between the face of the diaphragm section B, and the inner side of the detachable diaphragm plate D is new and not only affords a safer hermetical seal between the parts but also effects an economy in space or area as compared with the method heretofore resorted to of gluing the edges of a diaphragm to the interior of the diaphragm chamber as illustrated in diagram Fig. 7, in which case it will be seen not only that the area of said chamber had to be sufficient to include the edge of the diaphragm, but also that one side only of edge is sealed whereas by a comparative reference to Figs. 5 and 6, it will be seen that by my method of construction the diaphragm chamber need be no longer in area or diameter than the actual diameter of the flexible or operative part of the diaphragm. In other words I effect an economy in space equivalent to the area of the ledge or shoulder heretofore provided, as in Fig. 7, for the attachment of the edge of the diaphragm.

The inner side of the secondary diaphragm plate D, is formed with a recess or chamber d', coinciding with the diaphragm tension chambers b'', in the face of the diaphragm section B so as to admit of the free play of the diaphragms; and the plate D is shown as secured to the section B by means of screws i, i, as before intimated, some of which screws i, also pass through the primary valve chest E, which is by preference integral with said diaphragm plate D. The primary valve chest E, is also provided with a detachable diaphragm plate F similar in structure and function to the secondary diaphragm plate D.

By preference I use in the primary valve chest E the form of duplex valve seat g, described and claimed in my concurrent application No. 243,464 filed January 31, 1905; although I do not restrict myself to the use thereof in this connection since any desired form of primary valve and seat may be substituted therefor. In the arrangement shown in the drawings the lateral port g', in the duplex valve seat g, is brought into coincidence with the passage e, connecting with the diaphragm chamber d'', in the detachable secondary diaphragm plate D, thus establishing communication through the central duct g^2, of the duplex seat g, with the valve chamber e', and tension passage e^2,—the latter being common to all the valve chambers e', in the primary valve chest E. The tension passage e^2, communicates with the main tension chamber T through the medium of transverse ducts t^2, at each end of the chest, one of these being shown in Fig. 3. The longitudinal web or partition e^3, left on the inner face of the primary valve chest E and dividing the tension passage e^2, is to afford a central bearing and contact against the plate e^4, in

which the valve chambers e', are bored, communication between the opposite sides of said longitudinal web or partition e^3, being free through said valve chambers e' as will be seen by reference to Figs. 2, 6, and also through openings in the partition at each end of the passage e^3, as shown in Fig. 6.

The primary diaphragm tension chamber plate e^4, is glued or otherwise incorporated integrally with the primary valve chest E.

As in the case of the secondary diaphragms d, the primary diaphragms h, are preferably formed by the use of a continuous strip of leather h', or other suitable flexible material interposed between the face of the tension diaphragm chamber plate e^4, and the opposed face of the detachable diaphragm plate F, the latter being attached to the primary valve chest E, by screws j, passing through holes j', or by other suitable mechanical expedient that will admit of the removal of said plate F when desired. Diaphragm chambers f are bored in the inner surface of the plate F, each of which chambers has a duct f', communicating by a suitable tube or conduit with a note hole in a tracker bar or equivalent. The ducts f'', are preferably formed directly within the detachable diaphragm plate F as shown in Fig. 2.

In practice several such valve chests are superposed and connected with common exhaust mechanism. My valve chest as a whole is specially formed and designed to accomplish this with the greatest possible economy of space since the main portion or body of the chest consisting of valve chamber section A, and the diaphragm section B united integrally, is formed with convergent external sides m, m, the angle or taper with relation to the central or axial line of the secondary diaphragms and valves being essentially that formed by the sides of a pneumatic P when inflated, so that by the use of tapering spacing and supporting blocks V, corresponding substantially in shape and thickness with the outline of the intervening portions of the adjacent pneumatics P, when inflated as shown in the drawings, provision may be made for the full motion or play of the pneumatics without any waste of space whatever. The compactness of structure and economy in area thus effected is of great practical importance, especially where only a relatively small area is available for chest work, as in slot or other automatic apparatus in which the musical instrument and the pneumatic apparatus are contained in the same case. Any desired number of the chest bodies M may be thus superposed and bound together with these convergent or wedge shaped spacing blocks V between them, the latter being provided at both ends of the chest work, and the ends of the bodies M, and the spacing blocks being rigidly secured together by clamps N, applied externally or in the form of bolts passing through holes v'' and m^2, formed for their reception in the convergent spacing blocks V, and ends of the chest bodies M.

Suitable packing o, is interposed between the spacing blocks and the chest bodies M; and said spacing blocks may be utilized as a convenient means of communication between the several tension chambers T and the exhaust mechanism by forming them with conduits or passages T^2, coinciding with and forming continuations of the ports t' leading into the main tension chambers T as seen by reference to Fig. 3.

It will be seen that by my construction I eliminate all diaphragms, valves and seats from the main-tension T, entirely, which enables me to materially reduce the size of said main tension chamber and at the same time attain a more solid, rigid and compact structure. Furthermore the valves, diaphragms, seats &c. being thus external to the main tension chamber T may be more quickly assembled and adjusted in the first place and are then accessible at all times by reason of the detachable plates provided for the purpose. The parts are also so effectually united and bound together as to be practically exempt form all danger of deterioration by reason of meteorological influences and changes; and to render the parts still further impervious in this respect I treat them all superficially, both internally and externally with paraffin which after they are glued together and finished and ready for reception of the valve seats and valves also insures the sealing hermetically of all joints by the use of paraffin. I am enabled to accomplish this because by my construction I dispense with the use of glue in securing the diaphragms in position. Another feature that enables me to use a main tension chamber T of relatively small area is the use of the individual ducts b', b', in the partition b^2, separating said main tension chamber T from the diaphragm tension chamber b'', since the diaphragms are thereby protected against sudden reaction or back pressure that would otherwise result from the inrush of air into the main tension chamber T from the pneumatics when one or more of the valves v, are opened,—the small area of the ducts b' insuring the neutralization of the pressure before the diaphragm tension chambers b'', are materially affected, a result that could otherwise only be attained by the provision of a main tension chamber of comparatively large area in which the in-rushing air would have ample room, to expand immediately and the pressure equalized before entering the diaphragm chambers.

By incorporating the primary valve chest

E with the detachable secondary diaphragm plate D, I attain shorter ducts and more direct communication with the secondary diaphragms thereby attaining more prompt action of the diaphragms and valves.

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

1. In pneumatic apparatus of the character designated, chest work formed with an internal tension chamber with an external valve chamber formed directly in one side of said chest work and communicating with said internal tension chamber through a valve port in the intervening partition, and a detachable valve plate for said valve chamber secured directly to the chest work and formed with a valve port opening directly into the said valve chamber on one side of said detachable plate and communicating with the atmosphere on the other side thereof, for the purpose described.

2. In pneumatic apparatus of the character designated, chest work formed with an internal tension chamber, with an external diaphragm chamber formed directly in one side of said chest work and communicating with said internal tension chamber through the intervening partition, and a detachable diaphragm plate for said diaphragm chamber secured directly to the chest work and communicating through a port with a source of intermittent air supply, for the purpose described.

3. In pneumatic apparatus of the character designated, a tension chest with an external valve chamber formed directly in one side thereof, said valve chamber communicating directly with the tension chamber in the chest, a detachable valve plate for said valve chamber, secured directly to the chest, an external diaphragm chamber formed directly in another side of said chest, said diaphragm chamber communicating directly with the tension chamber in said chest, and a detachable diaphragm plate formed with a chamber communicating with the said diaphragm chamber in the side of the chest and secured directly to the latter, for the purpose described.

4. In pneumatic apparatus of the character designated, a tension chest with an external valve chamber formed directly in one side thereof, said valve chamber communicating directly with the tension chamber in the chest, a detachable valve plate for said valve chamber, secured directly to the chest, an external diaphragm chamber formed directly in another side of said chest, said diaphragm chamber communicating directly with the tension chamber in said chest, and a detachable diaphragm plate formed with a chamber communicating with the said diaphragm chamber in the side of the chest and secured directly to the latter, a valve rod passing through said tension chamber and into said valve and diaphragm chambers a valve and diaphragm butt on said rod, for the purpose described.

5. In pneumatic apparatus of the character designated a tension chest with external valve chambers formed directly in one side thereof, each of said valve chambers communicating directly with a common tension chamber in the chest, and a detachable valve plate common to all the valve chambers formed with valve seats for each valve chamber, and secured directly to the tension chest, for the purpose described.

6. In pneumatic apparatus of the character designated, a tension chest with external diaphragm chambers formed directly in one side thereof, each of said chambers communicating directly with a common tension chamber in the chest, and a detachable diaphragm plate common to and formed with chambers communicating with each of the individual diaphragm chambers in the chest, for the purpose described.

7. In pneumatic apparatus of the character designated a tension chest with external valve chambers and external diaphragm chambers formed directly in the sides thereof each of said chambers communicating directly with a common tension chamber in the chest, together with a detachable valve plate common to the individual valve chambers, and a detachable diaphragm plate common to, and formed with chambers coinciding with, the individual diaphragm chambers in the chest, for the purpose described.

8. In pneumatic apparatus of the character designated, a tension chest with external valve chambers and diaphragm chambers formed directly in external faces thereof each of said chambers communicating directly with a common tension chamber in the chest, valve rods passing through said tension chamber and into said valve and diaphragm chambers, a valve and a diaphragm butt on each of said rods, a detachable valve plate common to each and all of the individual valve chambers, and a detachable diaphragm plate common to, and formed with chambers coinciding with, the individual diaphragm chambers, for the purpose described.

9. In pneumatic apparatus of the character designated, a tension chest built up of sections formed with a tension chamber between them, said sections being secured rigidly together, and a diaphragm chamber formed directly in an external face of the chest and communicating directly with the tension chamber therein, for the purpose described.

10. In a pneumatic apparatus of the character designated, a tension chest built up of sections formed with a tension chamber between them, said sections being secured rigidly together, and a valve chamber formed directly in an external face of the chest and

communicating directly with the tension chamber therein, for the purpose described.

11. In pneumatic apparatus of the character designated, a tension chest built up of sections formed with a tension chamber between them, said sections being rigidly secured together, a valve chamber formed directly in one external face of the chest and communicating directly with the tension chamber therein, and a diaphragm chamber formed directly in another external face of the chest and communicating directly with the tension chamber therein, for the purpose described.

12. In pneumatic apparatus of the character designated, a tension chamber built up of sections formed with a tension chamber between them said sections being rigidly secured together and a plurality of diaphragm chambers formed directly in an external face of the chest and each communicating directly and independently with the tension chamber therein, for the purpose described.

13. In pneumatic apparatus of the character designated, a tension chamber built up of sections formed with a tension chamber between them, said sections being rigidly secured together, and a plurality of valve chambers formed directly in an external face of the chest and each communicating directly and independently with the tension chamber therein, for the purpose described.

14. In pneumatic apparatus of the character designated, a tension chamber built up in sections formed with a tension chamber between them, said sections being rigidly secured together, a plurality of diaphragm chambers formed directly in an external face of the chest and each communicating directly and individually with the tension chamber therein, and a plurality of valve chambers formed directly in another external face of the chest and each communicating directly and independently with the tension chamber therein, for the purpose described.

15. In pneumatic apparatus of the character designated, a tension chest built up of sections formed with a tension chamber between them, said sections being rigidly secured together, a valve chamber formed directly in one external face of the chest and communicating directly with the tension chamber therein, a diaphragm chamber formed directly in another external face of the chest and communicating directly with the tension chamber therein, a valve rod passing through said tension chamber and into said diaphragm and valve chambers, and a valve and diaphragm butt on said rod, for the purpose described.

16. In pneumatic apparatus of the character designated a tension chest built up in sections formed with a tension chamber between them, said sections being rigidly secured together, a plurality of diaphragm chambers formed directly in an external face of the chest and each communicating directly and individually with the tension chamber therein, and a plurality of valve chambers formed directly in another external face of the chest and each communicating directly and independently with the tension chamber therein, valve rods passing through said tension chamber, and a valve and diaphragm butt on said rod, for the purpose described.

17. In pneumatic apparatus of the character designated a tension chest built up of two parts the opposed faces of which are recessed to form a common internal tension chamber between them and are then united to form a single rigid structure, in one external face of which is formed a series of diaphragm chambers communicating directly with the internal tension chamber, and in another external face of which is formed a series of valve chambers communicating directly with said internal tension chamber for the purpose described.

18. In pneumatic apparatus of the character designated, a tension chest built up of two parts the opposed faces of which are recessed to form a common internal tension chamber between them and are then united integrally to form a single rigid structure, in one external face of which is formed a series of diaphragm chambers communicating directly with the said internal tension chamber, the external face of the opposite side of the chest being formed with a series of valve chambers communicating directly with said internal tension chamber for the purpose described.

19. In pneumatic apparatus of the character designated a tension chest built up of two parts the opposed faces of which are recessed to form a common internal tension chamber between them and are then united integrally to form a single rigid structure, in one external face of which is formed a series of diaphragm chambers communicating directly with the said internal tension chamber, the external face of the opposite side of the chest being formed with a series of valve chambers communicating directly with said internal tension chamber, in combination with a detachable diaphragm plate, and a detachable valve plate secured respectively and directly to the said opposite external sides of the chest for the purpose described.

20. In pneumatic apparatus of the character designated, a tension chest built up of sections formed with a tension chamber between them and secured rigidly together, valve chambers formed externally thereon and communicating directly with said tension chamber, and diaphragm chambers also formed externally on said chest and communicating with the tension chamber therein through ducts which are relatively small in cross section as compared with the valve ports, for the purpose described.

21. In pneumatic apparatus of the character designated, a chest formed with a central tension chamber, a diaphragm chamber formed in said chest on one side of and communicating with, said central tension chamber, a detachable diaphragm plate formed with a coinciding diaphragm chamber, a valve chamber formed in said chest on the other side of said central tension chamber, and communicating therewith, and a valve rod extending through said central tension chamber and abutting against the diaphragm at one extremity and supporting a valve within the valve chamber, for the purpose described.

22. In pneumatic apparatus of the character designated a chest formed with an internal central tension chamber, one external face of said chest being formed with a series of diaphragm chambers communicating directly with the internal tension chamber, and the opposite external face of said chest being formed with a series of valve chambers communicating directly with said internal tension chamber, for the purpose described.

23. In pneumatic apparatus of the character designated a chest formed with an internal central tension chamber, one external face of said chest being formed with a series of diaphragm chambers communicating directly with the said internal tension chamber, the external face on the opposite side of the chest being formed with a series of valve chambers communicating directly with said internal chamber, in combination with a detachable diaphragm plate and a detachable valve plate secured respectively and directly to the said opposite external sides of the chest, for the purpose described.

24. In pneumatic apparatus of the character designated, a chest formed with an internal tension chamber, one external face of said chest being formed with a series of diaphragm chambers communicating directly with the said internal tension chamber, and the external face on the opposite side of the chest being formed with a series of valve chambers communicating directly with said internal valve chamber the individual ducts connecting the diaphragm chambers with the internal tension chamber being relatively small in cross area as compared with the individual valve ports between said internal tension chamber and said valve chambers, for the purpose described.

25. In pneumatic apparatus of the character designated, a chest formed with an internal tension chamber, one external face of said chest being formed with a series of diaphragm chambers communicating directly with the said internal tension chamber, and the external face of the opposite side of the chest being formed with a series of valve chambers communicating directly with said internal valve chambers, the web or partition in the chest between the tension chamber and the diaphragm chambers being formed with a duct for each diaphragm chamber connecting it with the tension chamber and being also formed with a bearing or support for each of the valve rods, in combination with said valve rods and their valves and butts, for the purpose described.

26. In pneumatic apparatus of the character designated a tension chest built up of two parts the opposed faces of which are recessed to form a common internal tension chamber between them and are then united integrally to form a single rigid structure, in one external face of which is formed a series of diaphragm chambers communicating directly with the said internal tension chamber, the external face of the opposite side of the chest being formed with a series of valve chambers communicating directly with said internal tension chamber, the web or partition in the chest between the tension chamber and the diaphragm chambers being formed with a duct for each diaphragm chamber connecting it with the tension chamber and with a bearing or support for each of the valve rods, in combination with said valve rods and their valves and butts, for the purpose described.

27. In pneumatic apparatus of the character designated a tension chest formed with external convergent side walls to one of which a power pneumatic is attached with its larger end adjoining the narrower edge of the said tension chest for the purpose described.

28. In pneumatic apparatus of the character designated a plurality of tension chests formed with external convergent side walls, and a series of spacing blocks also formed with convergent sides and interposed between adjoining tension chests with their broader ends in juxtaposition to the narrower edges of the tension chests, means for binding the tension chests and spacing blocks together and power pneumatics attached at their larger ends to the narrower edges of the tension chests for the purpose described.

29. In pneumatic apparatus of the character designated a plurality of tension chests formed with external convergent side walls, and a series of spacing blocks also formed with convergent side walls and interposed between adjoining tension chests with their broader ends in juxtaposition to the narrower edges of the tension chests, and a bolt passing through both tension chests and spacing blocks and securing the same rigidly together for the purpose set forth.

30. In pneumatic apparatus of the character designated a plurality of tension chests formed with external convergent side walls, and a series of spacing blocks formed with convergent side walls and interposed between adjoining tension chests with their broader ends in proximity to the narrower

edges of the tension chests, said tension chests and spacing blocks being formed with coinciding openings communicating with the tension chambers in the chests and with suitable exhaust mechanism, and means for securing said tension chests and spacing blocks rigidly together for the purpose described.

31. In pneumatic apparatus of the character designated, a tension chest formed with a series of external secondary diaghragm chambers, a detachable secondary diaphragm plate secured directly to said tension chest, and a primary valve chest attached to said detachable secondary diaphragm plate and having ducts connecting its valve chambers directly with the secondary diaphragm chambers on the inner side of said detachable plate for the purpose described.

32. In pneumatic apparatus of the character designated, the combination with the main tension or secondary valve and diaphragm chest, of a primary valve chest formed with a plurality of primary valve seats and passages, with a plurality of diaphragm chambers and with a longitudinal tension chamber common to all the said primary valve passages, and a detachable secondary diaphragm plate having a plurality of diaphragm chambers formed therein communicating with the primary valve passages, said primary valve chest being rigidly attached to the said secondary diaphragm plate opposite the diaphragm chambers therein and being removable with said secondary diaphragm plate, for the purpose described.

33. In pneumatic apparatus of the character designated, the combination with the main tension or secondary valve and diaphragm chest, of a primary valve chest formed with a plurality of primary valve passages and seats, with a plurality of diaphragm chambers and with a longitudinal tension chamber formed entirely within the said primary chest, independent of the secondary diaphragm chest, and common to all the said primary valve passages, and a detachable secondary diaphragm plate having a plurality of diaphragm chambers formed therein communicating with the primary valve passages, said primary valve chest being rigidly attached to the said secondary diaphragm plate opposite the diaphragm chambers therein and being removable with said secondary diaphragm plate, for the purpose described.

34. In pneumatic apparatus of the character designated, the combination with the main tension or secondary valve and diaphragm chest, of a primary valve chest having a plurality of valve passages and seats formed therein, and an independent tension chamber formed entirely within said tension chest and common to all the valve passages, a detachable primary diaphragm plate formed in one piece with a plurality of diaphragm chambers coinciding with the valve chambers in the said primary valve chest, and a single continuous strip of flexible material interposed and secured between the opposed surfaces of the said primary valve chest and the said detachable primary diaphragm plate, and affording a diaphragm for each diaphragm chamber, for the purpose described.

35. In pneumatic apparatus of the character designated, a tension chest having a plurality of diaphragm chambers formed directly in an external surface thereof and each communicating directly and independently with the tension chamber in said chest, a detachable diaphragm plate common to the diaphragm chambers in the external face of the chest and formed with coinciding diaphragm chambers, and a strip of leather or other suitable flexible material interposed and secured between the opposed surfaces of the tension chest and the detachable primary diaphragm plate, for the purpose described.

GEORGE P. BRAND.

Witnesses:
GEO. WM. MIATT,
D. W. GARDNER.