G. S. WILLIAMS.

VACUUM PUMP.

APPLICATION FILED MAR. 2, 1909.

960,609.

Patented June 7, 1910.

2 SHEETS—SHEET 1.

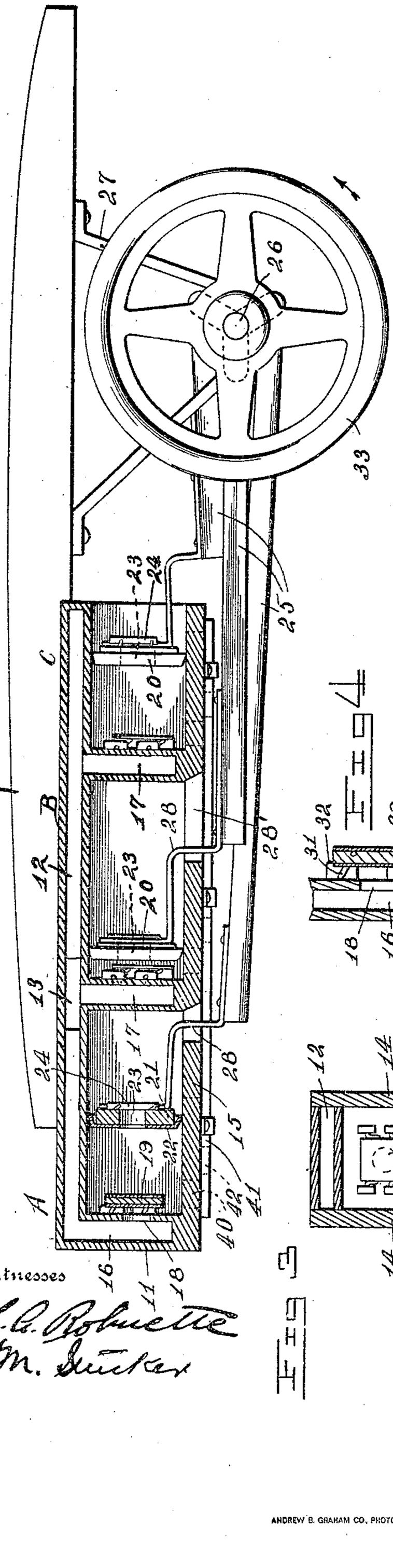

FIG. 1.

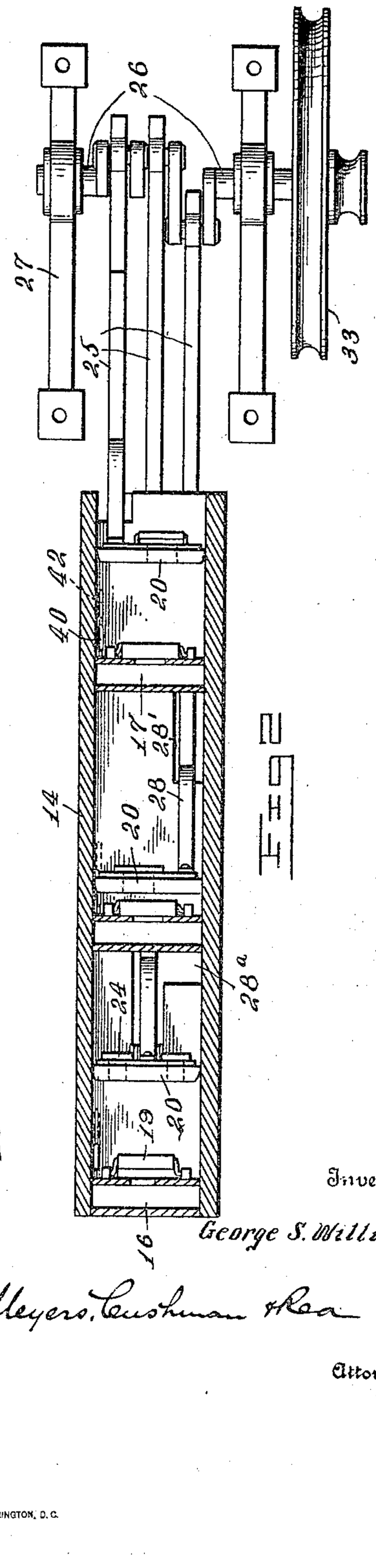

FIG. 2.

FIG. 4.

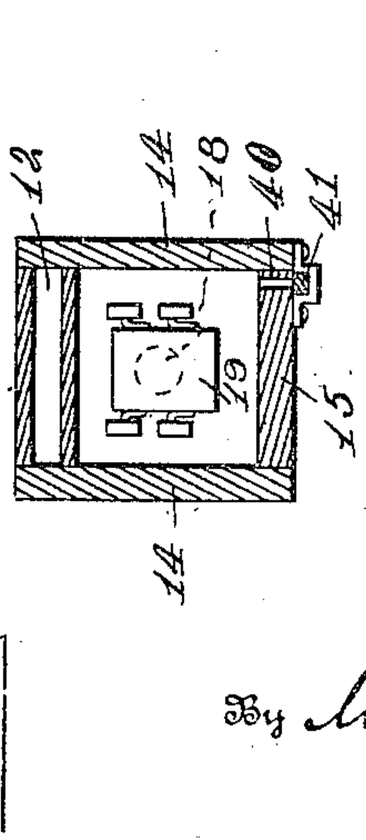

FIG. 5.

FIG. 3.

Witnesses

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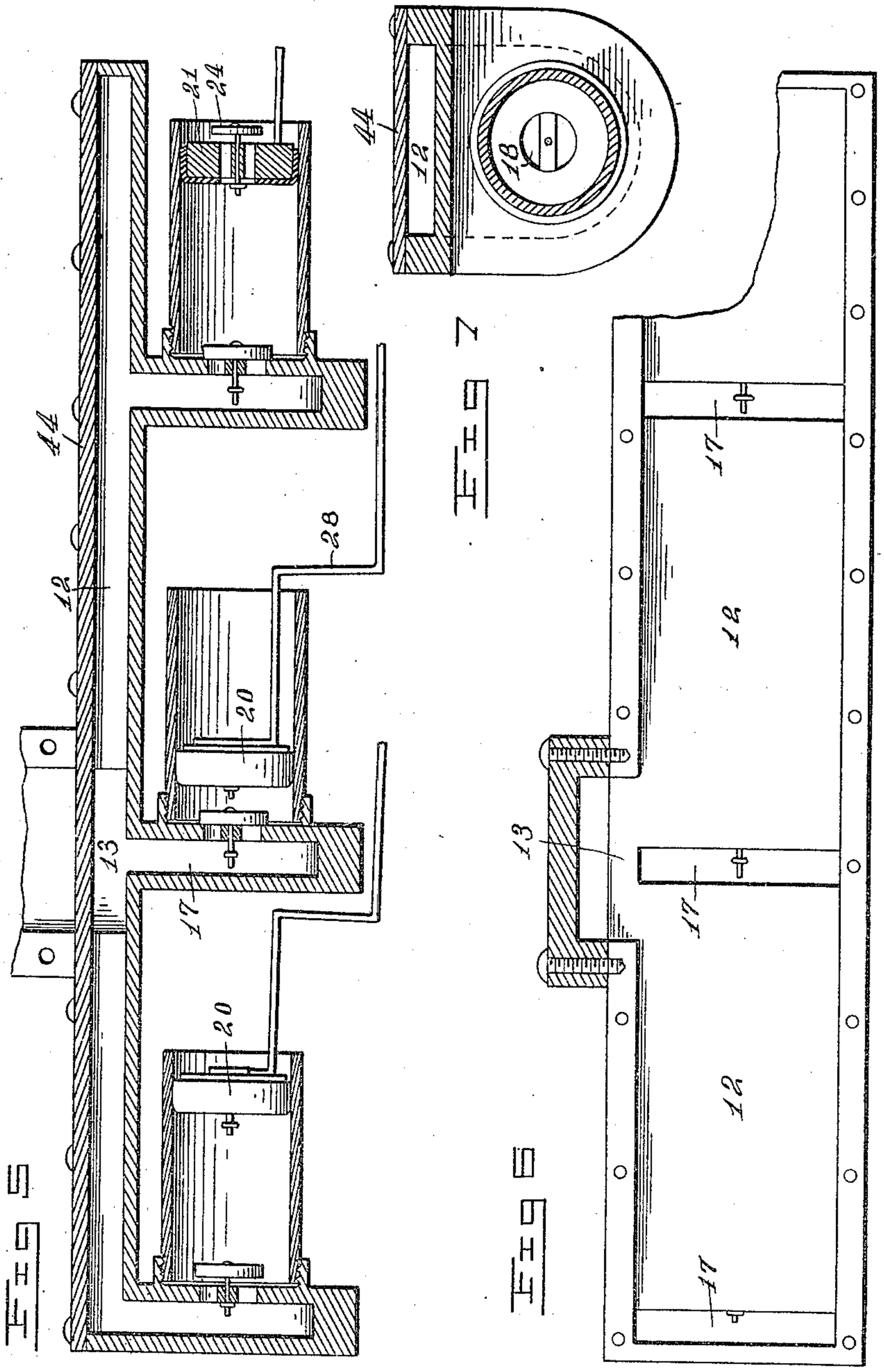

FIG 5

FIG 6

Witnesses

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UNITED STATES PATENT OFFICE.

GEORGE S. WILLIAMS, OF NORFOLK, VIRGINIA, ASSIGNOR TO AMERICAN PIANO PLAYER COMPANY, OF NORFOLK, VIRGINIA, A CORPORATION OF VIRGINIA.

VACUUM-PUMP.

960,609. Specification of Letters Patent. **Patented June 7, 1910.**

Application filed March 2, 1909. Serial No. 480,885.

To all whom it may concern:

Be it known that I, GEORGE S. WILLIAMS, a citizen of the United States, residing at Norfolk, in the county of Norfolk and State of Virginia, have invented new and useful Improvements in Vacuum-Pumps, of which the following is a specification.

My invention relates to improvements in exhaust pump apparatus, and is especially adapted for use in pneumatic players.

In pneumatic playing mechanism it is desirable that the vacuum chamber that is subjected to the venting effect to provide movements of the pneumatic mechanism, be subjected to the action of a second or auxiliary vacuum chamber which acts to immediately overcome the changed conditions in the first chamber produced by the venting action, the auxiliary chamber thereby serving as a vacuum controlling device for the first chamber, and having its vacuum in turn produced by an exhaust mechanism such as a pump or bellows mechanism. Owing to the requirements, the auxiliary chamber is relatively large and therefore requires the use of an exhaust mechanism of sufficient power to maintain the desired vacuum therein. To obtain this result without producing variations in the degree of vacuum in such chamber, and at the same time provide an apparatus which can be readily positioned and inclosed within the case of a piano or other player, is the aim of the present invention.

The main object of my invention is to provide an exhaust mechanism which will provide a constant exhausting relation to the auxiliary chamber.

A further object is to provide an apparatus by means of which a vacuum may be quickly produced in a relatively large chamber and maintained therein by the use of a relatively small and compact apparatus, requiring a minimum amount of power.

A further object is to provide an exhaust pump apparatus having a plurality of pistons arranged in tandem and each operating to affect the condition of a chamber subjected to the action of all of the pistons.

A further object is the provision of a plurality of piston cylinders arranged in tandem, said cylinders having walls forming conduits, the conduits having valved connection with the cylinders.

To these and other ends, the nature of which will be readily understood as the invention is hereinafter disclosed, my invention consists in the improved construction and combination of parts hereinafter fully described, illustrated in the accompanying drawings, and particularly pointed out in the appended claims.

In the accompanying drawings, in which similar reference characters indicate similar parts in each of the views,—Figure 1 is a vertical sectional view of an exhaust pump mechanism illustrating one form of my invention, some of the parts being shown in elevation. Fig. 2 is a horizontal sectional view of the construction shown in Fig. 1. Fig. 3 is a vertical cross-sectional view. Fig. 4 is a detail view of one of the valves shown in Fig. 1. Fig. 5 is a view similar to Fig. 1, but showing a modified form of construction. Fig. 6 is a view similar to Fig. 2, but showing the construction illustrated in Fig. 5. Fig. 7 is a vertical cross-sectional view of the mechanism shown in Fig. 5.

10 designates a support for the exhaust pump mechanism, which support may be of any desired form or type, or may form a portion of the structure of the chamber being exhausted, as desired. I have shown the pump mechanism as secured to the underside of the support, but it is to be understood that this may be varied to provide the supporting connection at points other than the top, the latter construction being shown as it indicates one manner in which the mechanism may be mounted within the casing without liability of disarrangement of parts or affecting the operation of the mechanism.

11 designates a casing of any desired cross-sectional configuration, that shown in Figs. 1 and 3 being wholly angular, while that shown in Figs. 5 to 7 provides a semi-cylindrical construction. It will be obvious that still further changes in the cross-sectional configuration may be made without materially varying the operation of the mechanism.

Referring first to the construction shown in Figs. 1 and 4 of the drawings, the casing 11, which is long and relatively narrow, has its upper wall in the form of a conduit 12 extending substantially the length of the casing, and having an opening or port 13 in communication with the chamber to be ex-

hausted, the latter and the particular connections leading thereto not being shown. In this form of construction the cylinders have their bores angular (square or rectangular, as desired), in cross-section, and hence the side walls 14, which are solid, extend in the same plane throughout their vertical length, the inner face of the upper and side walls forming the corresponding surfaces of the cylinders. The bottom 15, which completes the cross-sectional configuration of the casing, is of particular form and will be hereinafter described in detail.

The casing 11 has its outer end closed by a hollow head 16 which is in open communication with the conduit 12, and at suitable points in the length of the casing partitions 17 are provided, each of said partitions also being hollow and each being in open communication with said conduit 12. In the drawings, two partitions 17 are shown, providing, with the end 16 three cylinders, the inner one of which has its inner end open, said latter cylinder being of less length than the remaining cylinders. By this construction, it will be seen that one wall (the upper) of all of the cylinders is hollow, and that the outer end of each cylinder is also hollow, these walls each forming conduits. It will also be understood that while the end 16 and partitions 17 are shown and described as independent structures, they are, in effect, equivalent structures with respect to the cylinders, since they form a hollow head for the cylinder located in rear of the head.

The conduit in the end 16 is in communication with the outer cylinder through an opening 18, normally closed by a valve 19, said valve being movable, under the action of the piston mounted within the cylinder, to provide open communication between the end conduit and the cylinder. The rear walls of the conduits of the partitions 17 are each formed with openings 18 and valves 19 operating in the same manner in each cylinder.

20 designates the pistons, one of which is located in each cylinder. Each piston is in the form of a block 21 having a facial area less than the cross-sectional area of the cylinder, the block having peripheral packing 22 of less thickness than the space between the edges of the piston and the opposing wall of the cylinder. The packing 22 may be of any desired character, that shown in the drawing being in the form of a facing of leather secured to the front face of the block and having projecting edges extending rearwardly into the space between the edges of the block and the cylinder wall, the leather being sufficiently stiff to cause its free edges to ride in contact with the walls of the cylinder and prevent misplacing of such edges under the pressures of air; it will be understood that such packing may, instead of being of a single piece of leather, be in the form of strips secured to the front face of the piston. Each piston is provided with one or more openings 23 extending therethrough and through the leather facing (if the latter is coextensive with the face of the piston) each opening being controlled by a valve 24 located on the rear side of the piston. The valves 24 may be of any desired type, those shown in the drawings being similar in construction to the valves 19.

The pistons 20 are operated by means of arms 25 mounted on the cranks of a crank shaft 26 supported in suitable manner, as by brackets 27, in rear of the casing 11, the front ends of the arms 25 being connected by suitable angular connections 28, with the rear of the pistons. Each piston has a separate arm 25, and as the cranks are arranged angular with respect to each other on the crank-shaft, the movements of the shaft will cause simultaneous movements of the pistons. These movements, however, while of the same length within the cylinders, are timed so as to prevent any two pistons from reaching the same extreme of its movement at the same time, this result being obtained by the angularity of the cranks. To permit the pistons to be connected to their operating arms by the brackets 27, the bottom 15 is slotted in each cylinder as at 28′, the length of the slots being sufficient to permit of the full length of movement of the piston and its bracket. The length of the slot in the rear cylinder is less than that in the remaining cylinders, but the distance between the forward end of the cylinders and the forward end of the slots is the same in all of the cylinders; as the slots 28′ open to the outside of the cylinder, the movement of the pistons rearwardly is limited to a point forward of such forward end of the slot, the length of movement of the pistons being therefore the same.

Owing to the arrangement of the valves 19 and 24, it will be understood that when a piston is moving toward the left in Fig. 1, the pressure ahead of the piston will seat the valve 19 and open the valve 24 of the piston, thereby permitting the air to escape to the rear of the piston; when, however, the piston reaches the end of its forward stroke and begins its return movement, the valve 24 immediately closes, whereupon the movement of the piston opens valve 19 by reason of the reduction of pressure of the rear side of said valve, thereby placing the cylinder in communication with the exhaust chamber through conduit 12.

The valve structure shown in Fig. 4 comprises a block 29 having a facing 30 of suitable material, and provided with one or

more bails 31, said bails being adapted to be supported to permit a swinging movement of the valve, in ears 32 carried by the cylinder head and the piston. This form of valve is one type which may be used in the apparatus, its cheapness, the simplicity of operation, and the elimination of springs, making it desirable where a relatively low cost apparatus is employed. It will be understood, however, that any other form of valve may be employed for this purpose. The crank-shaft is operated from a suitable motor (not shown), said shaft having a pulley 33 by means of which connection may be made with the motor.

As heretofore pointed out, one of the principal objects of the present invention is to provide a constant exhausting relation with the vacuum chamber, and this is provided by the particular arrangement of the parts heretofore described, as will be understood from the following: Designating the three cylinders shown, as A, B, and C, for the purposes of illustration, and with the parts in the position shown in Figs. 1 and 2, and the crank-shaft revolving in the direction of the arrow shown in Fig. 1, the piston in cylinder B is on the point of changing from its forward to its return stroke; piston in cylinder A is on its return stroke and acting as the exhausting piston, while the piston in cylinder C is on its forward stroke. As the shaft revolves, the piston in cylinder B will begin its return stroke thereby opening communication with the vacuum chamber, the length of movement of this piston prior to opening such communication being approximately that required to complete the exhausting stroke of the piston in cylinder A, so that as the latter piston is about becoming inoperative for exhausting purpose, its work is taken up by the piston in cylinder B. The latter continues as the sole exhausting piston until it reaches the position in which the piston in cylinder A is shown, at which time the piston in cylinder C has reached the end of the forward stroke, and begins the movement to place it in position to act as the active exhausting piston. From this it will be understood that at least one of the cylinders is in active communication with the vacuum chamber at all times; and that such exhausting action is placed not only on the vacuum chamber, but also on the conduits in the heads of the other cylinders so that the valves of the inactive cylinders are positively held to their seats by difference in pressure until the pressure in an inactive cylinder is reduced to a point below that within the conduits, so that a surety is had that the vacuum pressure in a cylinder is at least that in the conduits before the cylinder is brought into activity. This feature permits of a regulation of vacuum pressure, by placing in the bottom of each cylinder a port 40 normally closed by a member 41 having ports 42, said member having a reciprocating movement to open or close the port 40, the movement of the member being controlled by any suitable regulator connected with the vacuum chamber, it being obvious that if the ports 40 and 42 are brought into alinement, the movement of the piston will not sufficiently affect the pressure in the cylinder to cause the valve 19 to open, the length of time such alinement is had determining the length of activity of the piston as an exhausting means; and by reason of the movements of the member 41, variations in pressure within the cylinder can be had during the period of movement of a single piston, sufficient to balance the greater or less venting of the first chamber in cases where a greater or less number of notes are sounded at the same time, the varying of the size of the vent produced by the ports 40 and 42 producing corresponding variations in pressure in the cylinder.

As shown, in Fig. 2 the arms 25 are spaced apart horizontally, thereby requiring that the slots 28′ in the cylinders be out of longitudinal alinement. In order that the mechanism may be positioned within the case of the piano without liability of obstructing the exhaust from the cylinders, through the slots 28′, the arm 25 for the open ended cylinder C is located on the side of the mechanism closest to the interior mechanism of the piano, since the exhaust from this cylinder may pass out through its open end; to permit the remaining cylinders to exhaust on the same longitudinal plane, the slot 28′ for the intermediate bracket 27 is extended laterally, as at 28ª, as shown in Fig. 2.

While I have shown the number of cylinders as three, it is to be understood that the number may be varied; but whatever the number of cylinders and pistons used, the cranks will be angular with respect to each other and spaced apart distances sufficient to cause the piston movements to provide a continuous exhausting relation to the vacuum normally uniform in pressure degree, variations being provided by the controlling mechanism such, for instance, as that provided by ports 40 and 42.

The structure shown in Figs. 1 to 4 is especially adapted to be made from different materials, such as metal or wood; when made from the latter material the cost is greatly reduced without affecting the operation and durability of construction.

The construction shown in Figs. 5 to 7 differs from that shown in Figs. 1 to 4, mainly in the fact that the sides and bottom of the casing are eliminated, the piston cylinders being tubular in form and screw-threaded to the hollow heads, as shown, the material in this form being metallic. To

permit the parts to be readily cast, the upper wall of the conduit 12 is in the form of a plate 44 bolted to the remaining portions of the casing, the heads of the cylinders, as shown in Fig. 7, being semi-cylindrical. In this form, the cylinders are of equal length, and the pistons are provided with a slightly different form of packing; and the valves are shown as of a different type, but these changes are simply in details of construction without changing the mode of operation which is the same as in the form previously described.

Having now described my invention, pointing out one or more forms in which the same may be provided, but without showing in detail all of the various changes and modifications therein which may be used to produce the desired result, what I claim as new is:

1. The combination with a vacuum chamber, of exhausting mechanism therefor, said mechanism comprising a plurality of cylinders arranged in tandem, said cylinders each having a head formed with a conduit in open communication with said chamber, each head having an opening leading to its cylinder, valves carried by said heads for controlling said openings, and valved reciprocating pistons mounted within the cylinders, the reciprocations of the pistons providing intermediate periods of exhaust pressure producing activity within its cylinder, said pistons having relative movements to combinedly provide a constant exhaust-pressure on the chamber of substantially uniform degree.

2. The combination with a vacuum chamber, of exhausting mechanism therefor, said mechanism comprising a plurality of cylinders arranged in tandem, said cylinders each having a head formed with a conduit in open communication with said chamber, each head having an opening leading to its cylinder, valves carried by said heads for controlling said openings, and valved reciprocating pistons mounted within the cylinders, the reciprocations of the pistons providing intermediate periods of exhaust-pressure producing activity within its cylinder, said pistons having movements of uniform length and timed to combinedly provide a constant exhaust-pressure on the chamber of substantially uniform degree.

3. In combination, a casing having a conduit, cylinder heads each having a conduit in open communication with the casing conduit, a cylinder for each head and in controlled communication with the conduit in the head, said cylinders being arranged in tandem, and a piston mounted in each cylinder, said pistons providing intermittent periods of exhaust-pressure producing activity in the casing conduit, the combined periods of activity of the pistons providing a constant exhaust pressure on said conduit of substantially uniform degree.

4. An exhaust pump apparatus comprising a casing having a conduit, cylinder heads in said casing and each having a conduit in open communication with the casing conduit, a cylinder for each head, said cylinders being arranged in tandem, said cylinders being free from inter-communication, each cylinder having valve-controlled communication with its head-conduit, and a motor-driven piston for each cylinder, each piston having valve mechanism to provide vacuum pressure within its cylinder, said pistons having movements of equal length and timed to provide substantially non-concurrent intermittent periods of exhaust-pressure producing activity on said casing-conduit.

5. An exhaust pump apparatus comprising a casing having a conduit, cylinder heads in said casing and each having a conduit in open communication with the casing conduit, a cylinder for each head, said cylinders being arranged in tandem, said cylinders being free from inter-communication, each cylinder having valve-controlled communication with its head conduit, and a motor driven piston for each cylinder, each piston having valve mechanism to provide vacuum pressure within its cylinder, said pistons having movements of equal length and timed to provide substantially non-concurrent intermittent periods of exhaust-pressure producing activity on said casing-conduit, the combined periods of activity providing a constant exhaust-pressure on said conduit of substantially uniform degree.

6. In combination, a chamber, a plurality of cylinders arranged in tandem, said cylinders each having a head formed with a conduit in open communication with said chamber, each head having an opening leading to its cylinder, valves carried by said heads for controlling said openings, and a reciprocating piston mounted within each cylinder, the reciprocations of the pistons severally providing intermittent periods of action on its head conduit, said pistons having relative movements to combinedly provide a constant action on the chamber of substantially uniform degree.

7. In combination, a chamber, a plurality of cylinders arranged in tandem, said cylinders each having a head formed with a conduit in open communication with said chamber, each head having an opening leading to its cylinder, valves carried by said heads for controlling said openings, and a reciprocating piston mounted within each cylinder, the reciprocations of the pistons severally providing intermittent periods of action on its head conduit, said pistons having movements of uniform length and timed to combinedly provide a constant action on

the chamber of substantially uniform degree.

8. In combination, a casing having a conduit, cylinder heads each having a conduit in open communication with the casing conduit, a cylinder for each head and in controlled communication with the conduit in the head, said cylinders being arranged in tandem, and a piston mounted in each cylinder, said pistons providing intermittent periods of activity in the casing conduit, the combined periods of activity of the pistons providing a constant action on said conduit of substantially uniform degree.

9. A pump apparatus comprising a casing having a conduit, cylinder heads in said casing and each having a conduit in open communication with the casing conduit, a cylinder for each head, said cylinders being arranged in tandem, said cylinders being free from inter-communication, each cylinder having valve-controlled communication with its head-conduit, and a motor-driven piston for each cylinder, each piston having valve mechanism to provide action within its cylinder, said pistons having movements of equal length and timed to provide substantially non-concurrent intermittent periods of activity on said casing-conduit.

10. A pump apparatus comprising a casing having a conduit, cylinder heads in said casing and each having a conduit in open communication with the casing conduit, a cylinder for each head, said cylinders being arranged in tandem, said cylinders being free from inter-communication, each cylinder having valve-controlled communication with its head-conduit, and a motor-driven piston for each cylinder, each piston having valve mechanism to provide action within its cylinder, said pistons having movements of equal length and timed to provide substantially non-concurrent intermittent periods of activity on said casing-conduit, the combined periods of activity providing a constant action in said conduit of substantially uniform degree.

11. A pump comprising a plurality of hollow heads spaced one from another and arranged in tandem, a cylinder for each head, said cylinders being non-communicating, a valved port connecting each cylinder with its head, a valved piston within each cylinder, a rotatable shaft, and independent connections between the shaft and each piston, each head having a passageway leading to a chamber adapted to be affected by movements of all of the pistons.

12. A pump comprising a plurality of cylinders in axial alinement and arranged in tandem, each cylinder having a hollow head, a valved port connecting each cylinder with its hollow head, a piston within each cylinder, a rotatable shaft, independent connections between said shaft and each piston, a port in each cylinder and open to the atmosphere, and a controlling valve common to all of said ports.

13. A pump comprising a plurality of cylinders in axial alinement and arranged in tandem, each cylinder having a hollow head, a valved port connecting each cylinder with its hollow head, a piston within each cylinder, a rotatable shaft, independent connections between said shaft and each piston, and a conduit open to and connecting the spaces of said hollow heads.

14. A pump comprising a hollow casing having a plurality of hollow heads in communication therewith and arranged in axial alinement, a tubular casing for each head, said latter casings each forming a cylinder, said cylinders being of less length than the distance between the adjacent heads, a valved port connecting each head with its cylinder, said cylinders being free from inter-communication, a piston for each cylinder, a driven shaft, and independent connections between said shaft and each piston.

15. A pump comprising a hollow casing having a plurality of hollow heads in communication therewith and arranged in axial alinement, a tubular casing for each head, said latter casings each forming a cylinder, each cylinder having an open end, said cylinders being of less length than the distance between adjacent heads, a valved port connecting each head with its cylinder, said cylinders being free from inter-communication, a piston for each cylinder, a driven shaft, and independent connections between said shaft and each piston, said connections extending through the open end of the cylinders.

16. A pump comprising a hollow casing having a plurality of hollow heads in communication therewith and arranged in axial alinement, each head having a port and also having a screw-threaded boss, a tubular casing screw-threaded on each of said bosses and adapted to form a cylinder on each head, said cylinders being of a length less than the distance between adjacent heads and each having an open end, a valve for controlling each head port, a piston in each cylinder, said cylinders being free from inter-communication, a driven shaft, and independent connections between said shaft and said pistons.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

GEORGE S. WILLIAMS.

Witnesses:

J. GRANVILLE MEYERS,

T. L. VAUGHAN.