A. N. PIERMAN.

SOUND REPRODUCER.

APPLICATION FILED MAR. 22, 1906.

1,148,619.

Patented Aug. 3, 1915.

2 SHEETS—SHEET 1.

Fig. 1

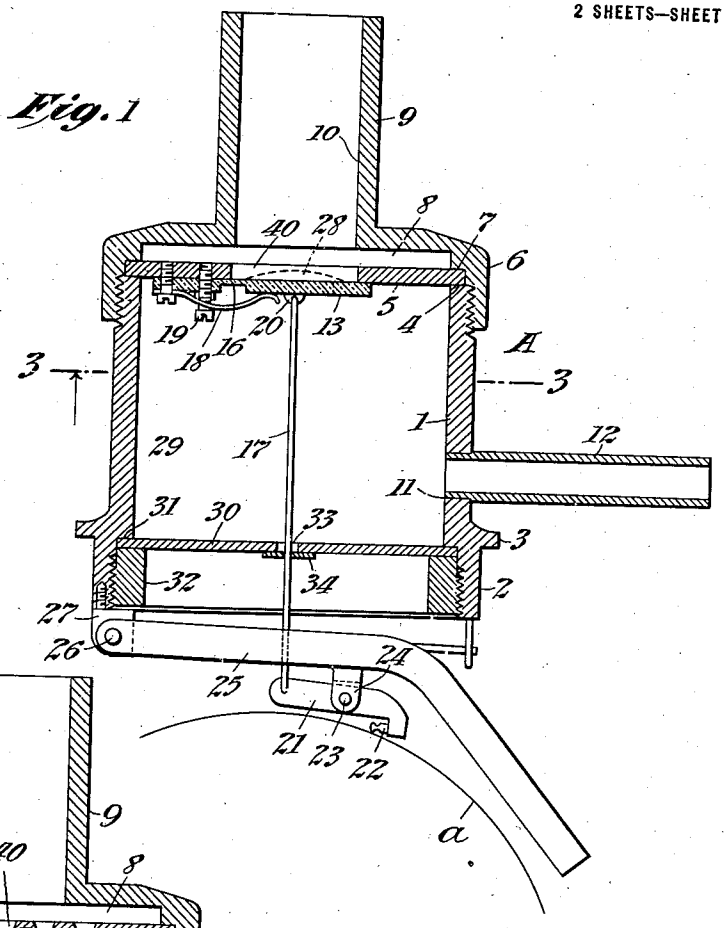


Fig. 2

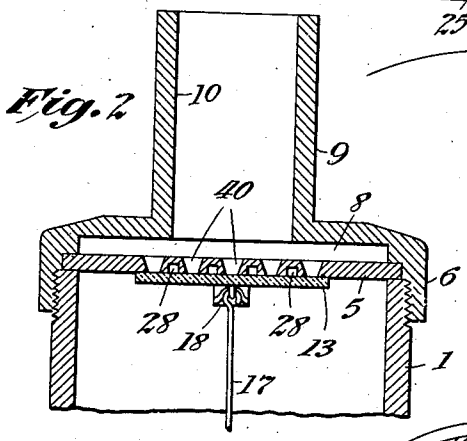


Fig. 4

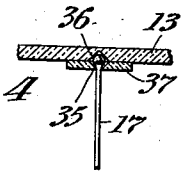
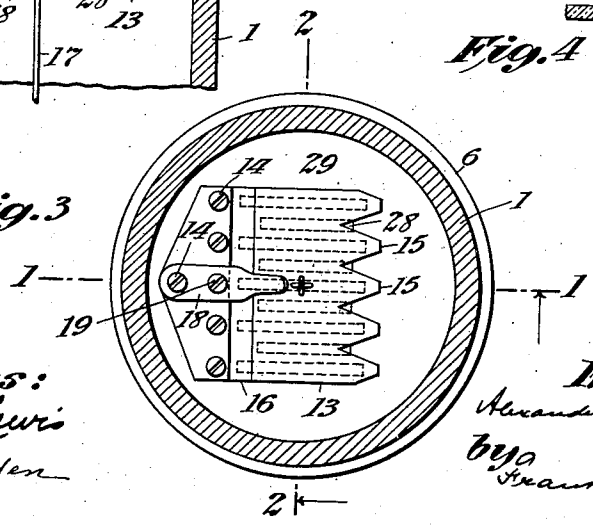


Fig. 3



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Inventor:
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2 SHEETS—SHEET 2.

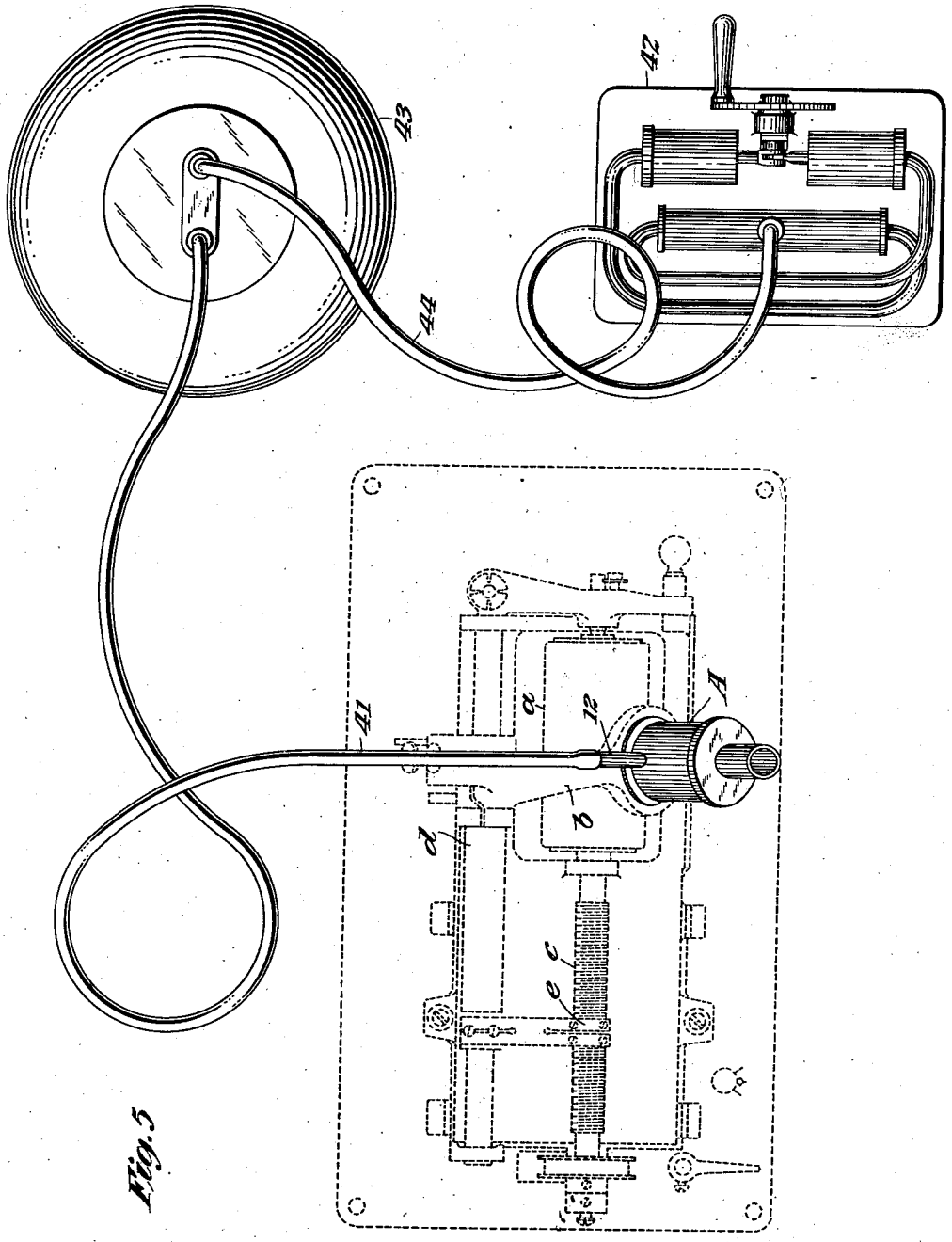


Fig. 5

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UNITED STATES PATENT OFFICE.

ALEXANDER N. PIERMAN, OF NEWARK, NEW JERSEY, ASSIGNOR TO NEW JERSEY PATENT COMPANY, OF WEST ORANGE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

SOUND-REPRODUCER.

1,148,619. Specification of Letters Patent. Patented Aug. 3, 1915.

Application filed March 22, 1906. Serial No. 307,324.

To all whom it may concern:

Be it known that I, ALEXANDER N. PIERMAN, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Sound-Reproducers, of which the following is a description.

My invention relates to sound reproducers of the type described and broadly claimed in my application filed November 24th, 1905, Serial No. 288,837, wherein the sounds are produced by vibrations resulting from varying the extent of opening of ports situated in a sound chamber and adapted to permit the passage of a body of air or other elastic fluid, the valve being elastic and operating by flexure, although the present invention may be applied to reproducers in which the valve is capable of pivotal or reciprocatory movement. In the operation of the apparatus disclosed in said application I have found that while very good reproduction of some phonograph records has been obtained, the reproduction of other records has been more or less imperfect, at least to persons whose hearing is sufficiently refined to enable them to detect the imperfection. Furthermore the said apparatus, while adapted to be operated by very low air pressure, such as that which will sustain a mercury column of about two and a half inches, will give favorable results only when the pressure within the exhaust tube which leads from the reproducer is maintained substantially constant. I have now discovered that it is possible to construct a reproducer of this type wherein the pressure may vary considerably without affecting the quality or very noticeably affecting the volume of the sounds produced by the instrument and which will reproduce all records with a high degree of excellence. The improved results referred to are obtained by greatly increasing the volume of the chamber below the valve so that it will not resonate and will equalize the flow of air through the reproducer, which improvement will be hereinafter more fully set forth and claimed together with certain other improved details of construction. My invention also relates to improved means for producing a flow of air through the reproducer, and to the mounting of the reproducer upon the traveling carrier arm of a phonograph as described but not claimed in said application Serial No. 288,837.

Reference is hereby made to the accompanying drawings of which—

Figure 1 is a vertical section of a sound reproducer constructed in accordance with my invention, the sectional plane being indicated at 1—1, Fig. 3; Fig. 2 is a section on line 2—2 of Fig. 3; Fig. 3 is a section on line 3—3, of Fig. 1; Fig. 4 is a sectional detail of a modified connection between the valve and operating link. Fig. 5 is a plan view showing my invention applied to a phonograph of the Edison type.

In all the views corresponding parts are indicated by the same reference numerals.

The reproducer shown comprises a hollow body A composed of the cylinder 1, plate 5, and cap 6, the former being provided with depending and lateral annular flanges 2 and 3 respectively which are adapted to fit within the reproducer carrier arm *b* of a phonograph which forms a part of the traveling carriage *d*. The upper end of the cylinder 1 forms a seat 4 upon which the circular plate 5 of brass or other suitable material is clamped by the cap 6 threaded upon the cylinder 1 and having a shoulder 7 which bears against the said plate 5 leaving preferably a low space or chamber 8 between the plate 5 and body of the cap 6 parallel thereto. A neck 9 having a cylindrical bore 10 whose diameter is about the same as the length of the ports 40 of the plate 5 extends upward from the body of the cap 6 and is adapted to be connected with an amplifying horn or megaphone in any suitable manner as by a section of rubber tubing; the space 8, bore 10 and horn form a resonating chamber or chambers leading from the atmosphere to the ports 40. The plate 5 is substantially the same as that disclosed in the application referred to and may be one-sixteenth of an inch in thickness and provided with a series of rectangular slots 40 measuring one-half inch in length by three sixty-fourths of an inch in width at the valve seat, forming ports for the passage of the air or other elastic fluid. In the device described in the said application the slots

are formed with parallel walls, but improved results may be obtained by forming the slots so that the walls thereof converge in the direction of the flow of the elastic fluid as clearly shown in Fig. 2. The cylinder 1 is apertured at 11 to receive the tube 12 which is connected by a flexible connection, such as a rubber tube 41, with any suitable apparatus for producing suction, for example—an air pump 42, the flexible connection permitting the carrier arm *b* and body A to be fed across the record by the engagement of the usual feed nut *e* with the feed screw *c*, while a continuous flow of air is maintained through the reproducer. The extent of opening of the ports 40 is varied by any suitable valve, such as the plate 13, which may be of a hard, elastic and flexible material such as the various metals and alloys, but which is preferably of celluloid of the shape shown in the drawings and measuring three-fourths of an inch square by one thirty-second of an inch in thickness. This plate is seated upon and covers the ports 40 as shown, being secured along one edge to the plate 5 by screws 14, the opposite or free edge being serrated to form tongues 15. A groove 16 is formed transversely of the plate 13 so as to weaken the same along the line of flexure produced by the operating link 17. A spring 18 is held at one end by the middle screw 14 and presses at its free end upon the plate 13 at or near its center. An adjusting screw 19 passes through the intermediate portion of the spring 18 and plate 13 and is threaded in the plate 5, whereby any desired degree of pressure of the spring 18 upon the plate 3 may be obtained and the spring 18 will be held against lateral movement so that its free end will always bear upon the medial line of the valve 13. The retractile force due to the resiliency of this spring and of the valve plate 13, balances the downward force due to the air pressure which will be produced upon the valve 13 by the action of the suction device applied to the tube 12. The pressure of the spring increases as the plate is moved downward which movement increases the flow of air so that a substantially perfect balance is maintained in all positions of the plate 13, and by varying the tension of the spring 18 by the adjusting screw 19 proper compensation may be made for variations in the operating air pressure and flexibility of the valve 13. The operating link 17 is connected at one end to the valve 13 in any suitable manner, as by an eye 20 secured to said valve. The link is connected at its other end to the lever 21 which carries the reproducing stylus 22. The lever 21 is pivoted at 23 to a lug or lugs 24 carried by a floating weight 25 which is pivoted at 26 to a block 27 threaded in the flange 2. This weight moves freely up and down to permit the stylus 22 to follow irregularities in the contour of the record surface *a*.

In order to facilitate the escape of air through the ports 40 of the plate 5, grooves or recesses 28 are formed in the lower surface of said plate between and parallel to the said ports. These recesses 28 extend practically the entire length of the ports 40, the ends of the said recesses extending beyond the limiting edge of the plate 13 so as to be in free communication with the equalizing chamber 29. This chamber is formed within the part 1 and is of considerable volume as compared with the flow of air through the apparatus which is preferably small.

I have obtained favorable results with ports and valve of the dimensions specified and an air pressure or suction capable of sustaining two and one-half inches of mercury by constructing the chamber 29 in the form of a cylinder whose diameter is one and one-fourth inches and height one inch, but obviously the volume of this chamber may vary considerably, although it is of course desirable to make it as small as possible without impairing the quality and range of reproduction of the apparatus. The increased size of the chamber 29 not only equalizes the flow of air but eliminates objectionable resonance which sometimes occurs with the device of my prior application as a hissing sound like that of air escaping or exhausting through a small opening. The lower end of the chamber 29 is closed by a plate 30 held against the annular houlder 31 by a clamping ring 32 threaded within the flange 2. The plate 30 is provided with a central aperture 33 through which the link 17 passes and this opening is preferably of sufficient size to allow the link to operate freely, the opening 33 being closed by a small washer 34 of paper or other soft material which surrounds the link 17 and will be held against the plate 30 by atmospheric pressure. By this means friction and wear upon the link 17 and leakage of air around the same are practically eliminated.

In the modification of Fig. 4 the link 17 is connected to the valve plate 13 by a ball and socket joint. The link 17 is preferably a small wire and the ball 35 may be formed by fusing the end thereof. This ball is held in the socket 36 formed in any suitable manner as by cementing to the plate 13 a socketed plate 37 through which the link 17 passes.

As previously stated any air exhausting apparatus may be used, but I prefer, in order to obtain a uniform flow, to use a tank 43 to which the tube 41 is connected, an exhaust pipe 44 leading from said tank to the pump 42 which is shown as a two-cylinder, hand operated suction pump. This

pump may be operated continuously during the reproduction of a sound record, by hand or a suitable motor, in which case the pump and the tank 43 may be of comparatively small dimensions. If desired, however, their size may be increased, and the pump used to produce a high degree of vacuum, (for instance one which will sustain 26 inches of mercury) in the tank 43, prior to the operation of the reproducer. A cylindrical tank measuring twelve inches in diameter by twelve inches in height when exhausted to this degree is of sufficient size to play one entire record of ordinary length.

The operation of the device is as follows: The body A being held in the traveling carrier arm *b* of a phonograph with the stylus 22 in operative position upon the phonogram or sound record *a*, suction is applied to the tube 12 which produces a downward stress upon the plate 13 and slightly opens ports 40. This stress is then balanced by the resiliency of the plate 13 and the upward pressure of the spring 18 so that the ports 40 remain slightly open, allowing the passage of a stream of air. As the reproducer stylus 22 is moved upward by an elevation of the sound record groove, it draws the link 17 downwardly and causes the plate 13 to flex, thereby increasing the extent of opening of the ports 40 and allowing an increased flow of air therethrough. As the stylus 22 passes over the elevation and descends into a depression, the elasticity of the plate 13 and of the spring 18 decreases the extent of opening of the ports 40 thereby diminishing the flow of air. The varying of the extent of opening of the ports 40 is thus effected in exact accordance with the elevations and depressions of the sound record groove and the result is to produce sounds which are representative of said elevations and depressions, and which, as before stated, are of very perfect quality and may be of great volume.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is as follows:

1. In a sound reproducer, the combination of a hollow body, a port plate therein dividing the said hollow body into an equalizing chamber upon the exit side of the said port plate and making up the greater portion of said hollow body, and a relatively small resonating chamber upon the opposite side of said port plate, a plate valve seated upon said port plate and upon the ports therein, means for producing a flow of elastic fluid through the ports and means for operating the plate valve to vary the extent of opening of the ports, substantally as set forth.

2. In a sound reproducer, a hollow body having a comparatively small resonating chamber and an equalizing chamber having several times the volume of said resonating chamber, the said chambers communicating through ports, means for producing a flow of elastic fluid through said ports from said resonating chamber into said equalizing chamber, a valve seated upon said ports and means for operating said valve to vary the extent of opening of the ports, substantially as set forth.

3. In a sound reproducer, the combination of a hollow body having ports, means for producing a flow of elastic fluid therethrough, a valve of elastic material seated upon said ports, an equalizing chamber upon the exit side of said ports the volume of which is sufficient to prevent excessive variation in the operating fluid pressure, and means for flexing said valve to vary the extent of opening of said ports, substantially as set forth.

4. In a sound reproducer, the combination of a hollow body having ports, and a celluloid plate secured at one edge and operating by flexure to vary the extent of opening of the ports, said plate being weakened along the line of flexure, substantially as set forth.

5. In a sound reproducer, the combination of a hollow body provided with a port member having a set of ports therein, a plate for varying the extent of opening of said ports, recesses between adjacent ports, and means for flexing said plate, said recesses being so placed as to communicate with the ports only when the latter are opened by said plate, substantially as set forth.

6. In a sound reproducer, the combination of a hollow body having slots therein and having grooves adjacent said slots, a plate seated on said slots and grooves, the grooves extending beyond the margin of said plate and means for moving said plate, substantially as set forth.

7. In a fluid pressure sound reproducer, the combination of a hollow body having a resonance chamber and an equalizing chamber communicating through ports, said equalizing chamber being located on the exit side of said ports and having sufficient volume to prevent excessive variation in the operating fluid pressure, an apertured plate at the lower end of said body, a valve for varying the extent of opening of said ports, and means extending through said apertured plate for operating said valve, substantially as set forth.

8. In a fluid pressure sound reproducer, the combination of a hollow body having a resonance chamber and an equalizing chamber communicating through ports, said equalizing chamber being located on the exit side of said ports and having sufficient volume to prevent excessive variation in the operating fluid pressure, an apertured plate at the lower end of said body, a valve for varying the extent of opening of said ports,

means extending through said apertured plate for operating said valve, and an outlet tube fixed within the wall of said body and communicating with said equalizing chamber, substantially as set forth.

9. In a sound reproducer, the combination of a hollow body having a set of ports, a plate of elastic material seated upon said ports, a spring pressing on said plate at or near its center, means for varying the pressure of said spring, and means for flexing said plate to vary the extent of opening of said ports, substantially as set forth.

10. In a sound reproducer, the combination of a hollow body having a set of ports, an elastic valve plate adapted to vary the extent of opening of said ports, a spring rigidly secured at one end and pressing at its free end against said valve plate at or near its center, and an adjusting screw passing through the intermediate portion of said spring, substantially as set forth.

11. In a sound reproducer, the combination of a hollow body having ports, a valve for varying the extent of opening of said ports, and means for operating said valve comprising a stylus, a pivoted fulcrum support, a lever pivoted thereon, and a link, said link being connected to said valve by a universal joint, substantially as set forth.

12. In a sound reproducer, the combination of a hollow body having ports, a valve for varying the extent of opening of said ports, and means for operating said valve comprising a stylus, a pivotally supported lever, and a link, said link being connected to said valve by a ball and socket joint, substantially as set forth.

13. In a sound reproducer, a hollow body having a resonating chamber, and an equalizing chamber communicating through ports, said equalizing chamber being located on the exit side of said ports and having a greater volume than said resonating chamber, a valve seated upon said ports, and means for operating said valve to vary the extent of opening of the ports, substantially as set forth.

14. In a sound reproducer, a hollow body having a resonating chamber, and an equalizing chamber communicating through ports, means for producing a flow of elastic fluid through said ports from said resonating chamber into said equalizing chamber, said equalizing chamber having sufficient volume to prevent excessive variation in the operating fluid pressure, a valve seated upon said ports, and means for operating said valve to vary the extent of opening of said ports, substantially as set forth.

15. In a sound reproducer, the combination of a hollow body having ports, means for producing a flow of elastic fluid therethrough, and a valve operating by flexure to vary the extent of opening of the ports, said valve being weakened along the line of flexure, substantially as set forth.

16. In a sound reproducer, the combination of a hollow body having ports, means for producing a flow of elastic fluid therethrough, and a valve plate secured at one edge and operating by flexure to vary the extent of opening of the ports, said plate being weakened along the line of flexure, substantially as set forth.

17. In a fluid pressure sound reproducer, a valve comprising a flexible plate weakened along its line of flexure by a groove, substantially as set forth.

This specification signed and witnessed this 21st day of March 1906.

ALEXANDER N. PIERMAN.

Witnesses:
DELOS HOLDEN,
FRANK L. DYER.