No. 787,984. PATENTED APR. 25, 1905.

R. HOPE-JONES.

SOUND PRODUCING DEVICE.

APPLICATION FILED NOV. 6, 1903.

2 SHEETS—SHEET 1.

Fig. 2.

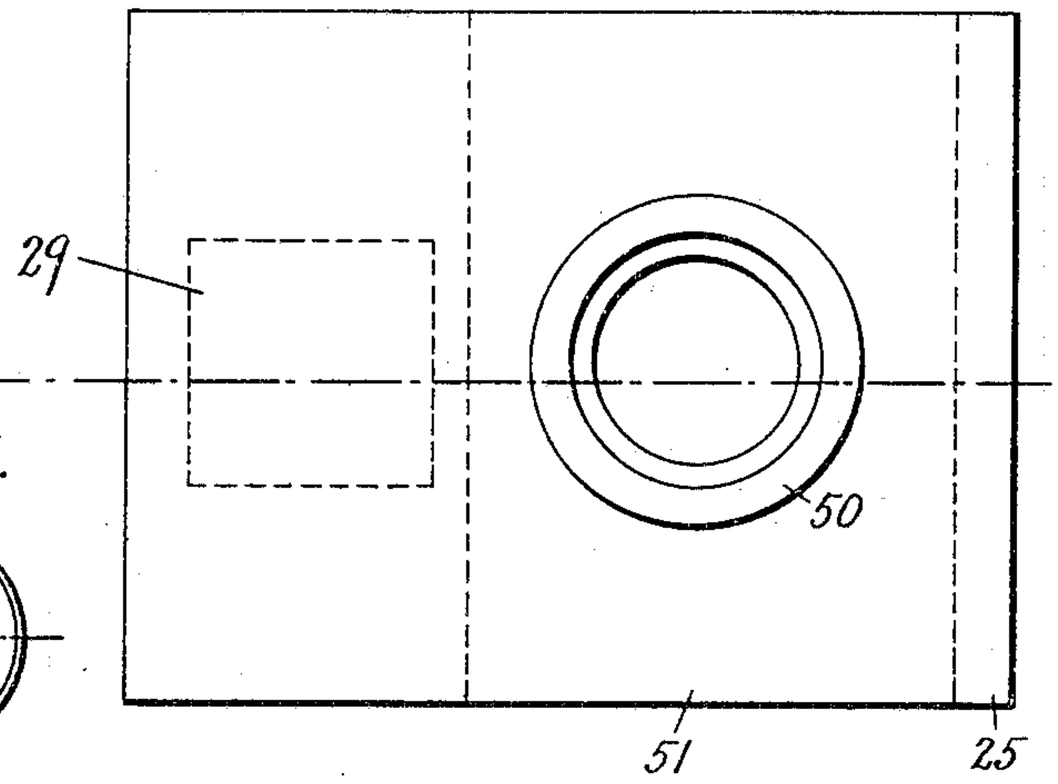


Fig. 5.

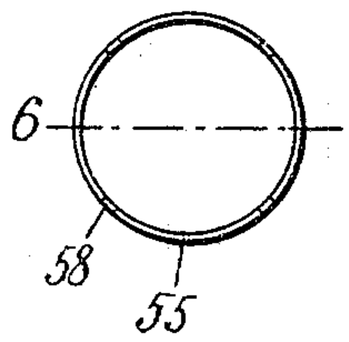


Fig. 7.

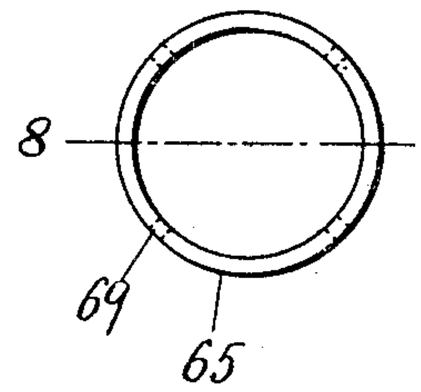
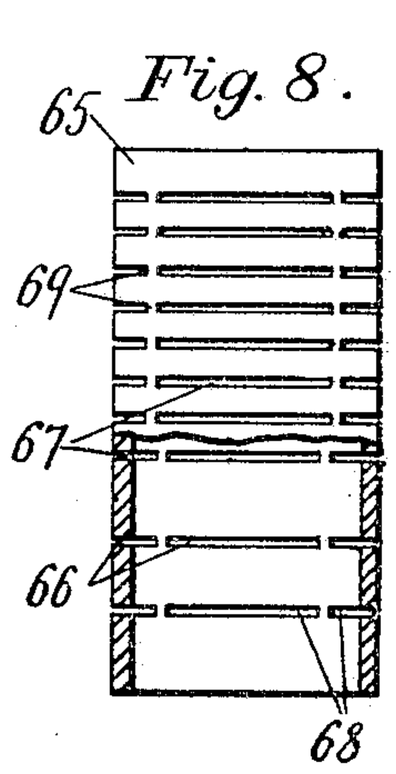


Fig. 1.

Fig. 6.

Fig. 8.



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2 SHEETS—SHEET 2.

Fig. 4.

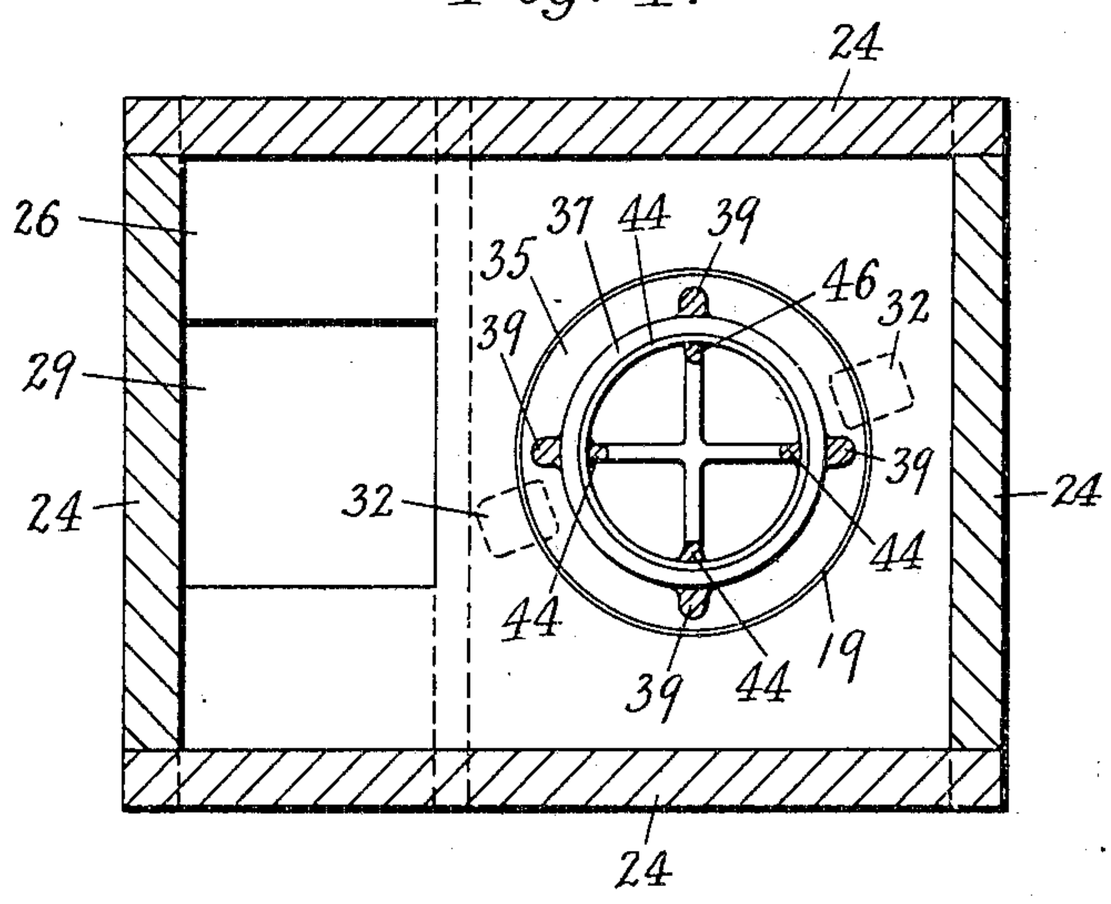
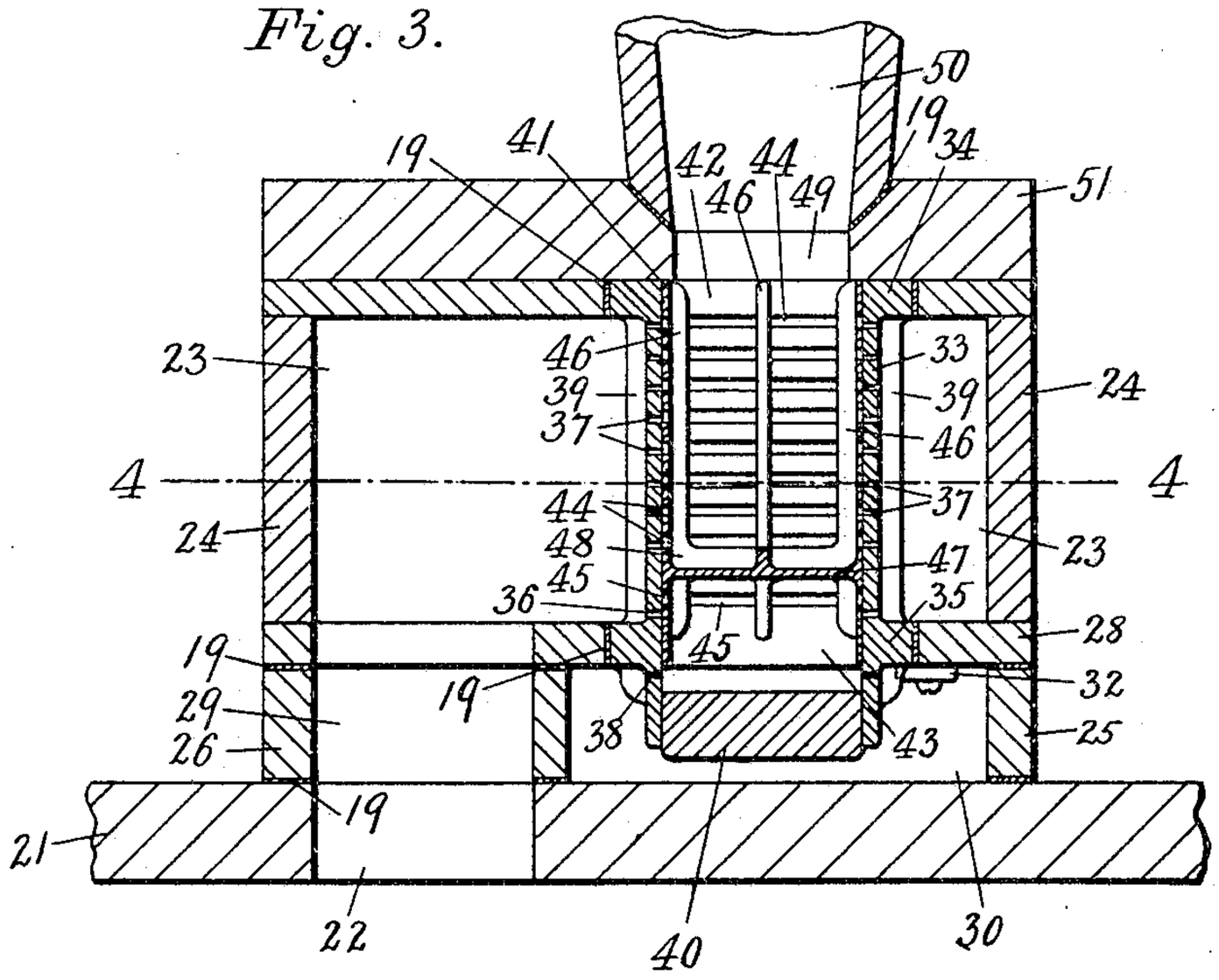


Fig. 3.



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No. 787,984. Patented April 25, 1905.

UNITED STATES PATENT OFFICE.

ROBERT HOPE-JONES, OF HARTFORD, CONNECTICUT.

SOUND-PRODUCING DEVICE.

SPECIFICATION forming part of Letters Patent No. 787,984, dated April 25, 1905.

Application filed November 6, 1903. Serial No. 180,090.

To all whom it may concern:

Be it known that I, ROBERT HOPE-JONES, a subject of the King of Great Britain, and a resident of Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Sound-Producing Devices, of which the following is a full, clear, and exact specification.

This invention relates to improvements in fluid-pressure devices for producing rapid vibrations for various purposes, including the production of sound in connection with organs, sirens, and other sound instruments.

The vibrating apparatus comprises a chambered piston and its coöperating cylinder, the meeting walls of which are provided with perforations or ports for the admission of the pressure fluid from the pressure-chamber to the receiving-chamber. There are two or more sets of these perforations which by the vibrations of the cylinder are carried alternately into and out of coincidence, and thus successively and rapidly interrupt the flow of the pressure fluid to the receiving-chamber. In the embodiment of this invention shown and described herein it is employed with a resonating chamber or trumpet connected with the receiving-chamber into which the air or other fluid admitted through one of the said sets of perforations, herein designated the "speaking-ports," is directed by a succession of puffs in approximate coincidence with the vibrations of the piston. In my United States Patent No. 702,557 is described a device of this general class combined with an adjunctive or supplemental vibrating engine, the piston of which is reciprocated in both directions by a volume of air which is diverted from the sound-producing device. In the present invention the supplemental engine is dispensed with, and a portion of the same volume of air which is admitted to the receiving-chamber is also utilized to drive the piston in one direction instead of opposing the piston for a portion of the time, as in the former device, thus avoiding the necessity for the employment of a separate supply of air of higher pressure or the employment of a separate or enlarged cylinder and piston for performing what are purely the driving or motive functions of the device. The invention also comprises improvements in the form and arrangement of the parts, whereby greater simplicity, lightness, compactness, and inexpensiveness of construction are secured.

While this invention may be adapted for use in connection with many sound-producing instruments, it is here shown in connection with the pipe of an organ using compressed air as motive power.

Figure 1 of the drawings is a side view in section of this improved device and shows the piston approximately at the lower end of its stroke, the section being taken through the line 1 to 3 of Fig. 2. Fig. 2 is a plan view of the device, the sound-board or top of the air-chest being omitted. Fig. 3 is a side view in section, similar to Fig. 1, but with the piston shown in its uppermost position. Fig. 4 is a plan view in section on the line 4 4 of Fig. 3. Figs. 5, 6, 7, and 8 show modified forms of the cylinder and piston constructed from tubing. Fig. 5 is a plan view of the piston; and Fig. 6 is a side view partly in section, the section being taken through the line 6 of Fig. 5. Figs. 7 and 8 are similar plan and side views of the cylinder, the section of the latter view being taken through the line 8 of Fig. 7.

The sound-board 21, upon which this device rests and which is usually adapted to receive a number of these devices of the different pitches required, forms the top wall of an air-reservoir or wind-chest, in which a pressure of air is maintained. The pressure-chamber 23 is inclosed by the walls 24 and supported by the feet 25 and 26, the space between the feet being open to the atmosphere. Communication between the pressure-chamber 23 and the wind-chest below the sounding-board 21 is had by means of the opening 22 in the sound-board and the opening 29 in the foot or base 26 of the pressure-chamber. The cylinder 33 is provided with flanges 34 and 35, which fit corresponding openings formed in the upper and lower walls of the chamber, the cylinder being supported by means of the straps or buttons 32. The joints, which have to be made air-tight, are

provided with packing 19 in the customary way.

In this device the speaking function and the engine function are both performed by a cylinder 33 of uniform bore throughout in cooperation with a simple piston 41 of uniform diameter throughout fitting the bore of the cylinder. The wall of the cylinder 33 is perforated by a number of circumferential ports comprising the speaking-ports 37, the engine-port 36, and the exhaust-port 38, the cylinder being, in effect, composed of a series of rings connected together by the longitudinal ribs 39 on the outside of the rings. The speaking-ports 37, which also serve as engine-ports for the downward movement of the piston, and the port 36, which serves as the engine-port for the upward movement of the piston, all open into the pressure-chamber 23, while the exhaust-port 38 opens into the space 30, being therefore in direct communication with the outer atmosphere. The bottom of the cylinder is shown to be closed by a plug 40; but it may obviously be closed by a screw-cap or by any other well-known form of closure.

The piston 41 is fitted to slide easily in the bore of the cylinder 33, and its interior is divided by a diaphragm or partition 47 into two open-ended tubular chambers 42 and 43. The peripheral wall of the piston is perforated similar to that of the cylinder by a corresponding number of circumferential ports, the form of the piston being therefore, in effect, made up of a series of rings united by the vertical ribs 46 on the inside of the rings. The open upper end of the cylinder forms an outlet for the pressure admitted from the supply-chamber 23 through the speaking ports or passages 37 and 44. That outlet may lead directly to the open air or to or through any desired apparatus with which this device may be employed. In the arrangement herein shown the outlet communicates with a resonator or trumpet 50 through the throat 49.

Secured to the upper wall 27 of the pressure-chamber is the base 51, which supports the resonator 50, the opening in the bottom of the latter being directly over the open end of the piston-chamber 42 and practically forming a continuation thereof. The combined area of the openings through the speaking-ports is usually made somewhat greater than the area of the throat 49, leading to the resonator, so that the act of opening the speaking-ports admits a volume of air to the receiving-chamber in excess of that required for the resonator, this excess being utilized for moving the piston downwardly.

The engine-port 45 for communicating with the port 36 opens into the lower chamber 43 below the partition 47, while the speaking-ports 44 open into the upper chamber 42, which in this construction forms the larger portion of the receiving-chamber. The relative position of these ports is such that when the piston is in its lower position, as shown in Fig. 1, the lower or exhaust port 38 of the cylinder is closed by the wall of the piston, while the port 36 communicates with the port 45, leading to the chamber 43. The upper or speaking ports 37 and 44 of the cylinder and piston, respectively, are closed, the ports of each member being closed by the adjacent wall of the other member. While in this position the air entering the ports 36 and 45 moves the piston toward its upper position of Fig. 3.

When the piston 41 is in its upper position, the speaking-ports 37 and 44 are in coincidence, while the piston-chamber 42 is in communication with the pressure-chamber 23. The piston-chamber 43 is at the same time in direct communication with the atmosphere through the uncovering of the exhaust-port 38, the port 36 being meanwhile closed by the wall of the piston 41. In this position of the piston the air entering through the coinciding speaking-ports 37 and 44 causes a compression to take place in the air in the lower end of the resonator and reacts downwardly to carry the piston 41 to its lower position of Fig. 1.

The normal stroke of the piston 41 is seen by comparison of Figs. 1 and 3, which respectively represent the piston approximately at the lower and upper ends of its stroke. The ports of one member are in practice preferably made somewhat wider than the corresponding ports of the other member, in the present case the ports of the piston being shown somewhat wider than the ports of the cylinder, so as to afford latitude for slight overrunning of the stroke after the ports reach full opening without reducing the opening again, so as to throttle the flow of the air, which should have free ingress until it has cushioned, stopped, and reversed the movement of the piston. The extent to which the ports of one member are widened should be sufficient to allow for all such variations in the stroke of the piston; but in order to positively prevent accidental overrun of the upward movement the base 51 is made to overlie the piston and prevent it going above the position shown in Fig. 3. The plug 40 at the lower end of the piston similarly serves to prevent overrun of the piston at the lower end of its stroke. In normal operation, however, there will be a clearance at both ends of the stroke similar to that shown in Fig. 1 between the plug 40 and the piston, the stops being provided merely to prevent the piston passing by and closing the port-openings. The plug 40 serves also to support the piston when the device is not in operation with the ports 36 and 45 in open position, so as to start automatically upon admitting the pressure to the pressure-chamber 23.

In the operation of this mechanism the air

under pressure enters the chamber 23 through the passages 22 and 29 and passing through the ports 36 and 45 enters the chamber 43, where by means of the pressure exerted on the under side of the partition 47 it raises the piston 41 until its wall closes the port 36. The continued expansion of the air and the momentum of the piston carries it upward until the speaking-ports 37 and 44 are in communication, at which time pressure will be exerted on the upper side of the partition 47, as the lower portion of the column of air in the resonator 50 will be momentarily compressed when these speaking-ports are opened. Thus the speaking-ports, which admit the air to the resonator, serve also as engine-ports for the downstroke of the piston. As the piston moves downward the air in the chamber 45 passes to the outer atmosphere through the exhaust-port 38, which has been uncovered by the lifting of the piston, the ports 37 and 38 are once more closed, the port 36 is reopened, and the cycle of movement repeats itself, thus keeping the piston in a state of rapid vibration. These vibrations of the piston will produce musical sounds without any further adjuncts; but I prefer to confine it with a tone producing or regulating device or resonator, as is shown herein. The length and size of the resonator will within certain limits determine the periodicity of the vibrations, as it is evident that the column of air therein will regulate the motion of the piston and will tend to bring its periodicity of movement into substantial accordance with the natural periodicity of the resonator. If the length of the column of air in the resonator be slightly increased, the action of the piston will be slightly retarded, while if the length be reduced the action of the piston will be accelerated. This construction of the device enables the respective parts to be made of the material best suited to them. The cylinder and piston are preferably made of metal. The tubular construction of one diameter throughout permits the parts to be both light and strong. This simple form of these parts also greatly facilitates the proportioning and adjusting of the dimensions and weight of the piston to suit the desired pitch of the sound to be produced. The weight of the piston may be further modified by making it of lighter metal—as, for example, aluminium—where a light weight is desired.

Any desired number of these devices may be arranged side by side in rows, as in the case of an organ-stop, controlled by valves or slides, which enables the entire row or any individual member of the row to be thrown into or out of operation, according to well-known methods of organ construction and arrangement.

In Figs. 5 and 6 a modified form of piston 55 is shown made from tubing of suitable material. The ports 56 and 57 in this case are not entirely circumferential, but are made by a number of saw-cuts, leaving the vertical strips 58, which serve to hold the remaining segments 59 together. A partition 60 divides the piston into the upper and lower chambers 61 and 62, respectively, as before.

The modified form of cylinder 65 (shown in Figs. 7 and 8) may also be constructed of tubing and is designed to coöperate with the piston 55, (shown in Figs. 5 and 6,) the circumferential ports 66, 67, and 68 being made similar to those of the piston by a series of saw-cuts separated by the joining-strips 69. The cylinder 65 may be secured within the pressure-chamber 23 by making the holes in the top 27 and the bottom 28 of a suitable diameter and forming the plug 40 so that it will be long enough to rest on the sound-board 21 and at the same time engage the lower edge of the cylinder 65, so as to prevent any possible end movement in that direction, the resonator-base 51 serving, as before, a similar purpose at the upper end.

I claim as my invention—

1. In a sound-producing device, the combination with a resonator and a chamber for a supply of fluid under pressure, of a cylinder provided with a series of speaking-ports, and an engine-port, a tubular piston working in the cylinder, and having a partition dividing its interior space into two chambers, one of which is provided with a series of speaking-ports corresponding with those of the cylinder, the other chamber being provided with an engine-port, corresponding to that of the cylinder.

2. In a sound-producing device, the combination with a resonator and a chamber for a supply of fluid under pressure, of a cylinder having a bore of uniform diameter throughout, a tubular piston mounted to slide in said bore and having its interior space divided into two chambers opening at opposite ends of the piston, one of the said chambers being provided with speaking-ports, and the other chamber with an engine-port, and the cylinder being provided with a corresponding series of speaking and engine ports.

3. In a sound-producing device, the combination with a resonator and a chamber for a supply of fluid under pressure, a cylinder provided with a series of speaking-ports and with an engine-port, a tubular piston of uniform diameter fitting the bore of the cylinder and having its interior space divided by a partition into two chambers opening at the opposite end of the piston, one of the chambers being provided with a series of speaking-ports corresponding with those of the cylinder, and the other chamber being provided with an engine-port communicating with that of the cylinder when the speaking-ports are out of communication.

4. In a sound-producing device, the combination with a chamber for a supply of fluid under pressure, of a cylinder provided with a series of speaking-ports and an engine-port communicating with the said chamber, a tubular piston provided with separated chambers, a series of speaking-ports, and an engine-port corresponding with those of the cylinder, and, opening into the separate chambers of the piston, the engine-ports being arranged to communicate when the piston is at the lower end of the stroke, and the speaking-ports to communicate at the upper end of the stroke.

5. In a sound-producing device, the combination with a resonator, and a chamber for a supply of fluid under pressure, of a cylinder provided with a series of ports, a piston working in the said cylinder, and provided with a corresponding series of ports, the cylinder and the piston constituting a fluid-pressure engine, the ports of one series being wider than those of the other series to permit slight overrun of the piston-stroke, without reducing the area of the passage through.

6. In a sound-producing device, the combination with a resonator, and a chamber for a supply of fluid under pressure, of a cylinder provided with a series of ports, a piston working in the said cylinder, and provided with a corresponding series of ports, the cylinder and the piston constituting a fluid-pressure engine, the ports of one series being wider than those of the other series to permit slight overrun of the piston-stroke, without reducing the area of the passage through, and stops at the ends of the piston for preventing it from exceeding the predetermined amount of overrun of its stroke.

7. In a sound-producing device, the combination with a resonator, and with a chamber for a supply of fluid under pressure, of a cylinder provided with a series of speaking-ports and with an engine-port communictiang between the said chamber and the interior of the cylinder, a tubular piston of uniform diameter mounted to slide in the said cylinder and provided with a series of speaking-ports, and an engine-port corresponding with those of the cylinder, but separated by an interior partition of the piston, the ports of one series being wider than those of the other series, to permit slight overrun of the stroke without reducing the area of the passage through.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ROBT. HOPE-JONES.

Witnesses:

B. G. AUSTIN,

WM. H. HONISS.