Jan. 14, 1964 R. E. SWANSON 3,117,552

PNEUMATIC SOUND PRODUCING DEVICES

Filed Oct. 5, 1961

Fig. 1

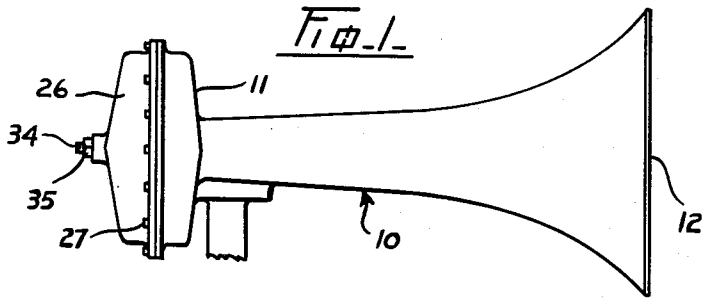


Fig. 4

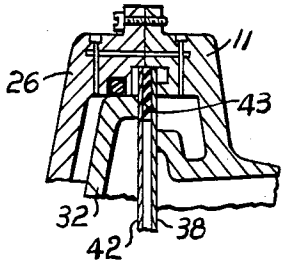


Fig. 2

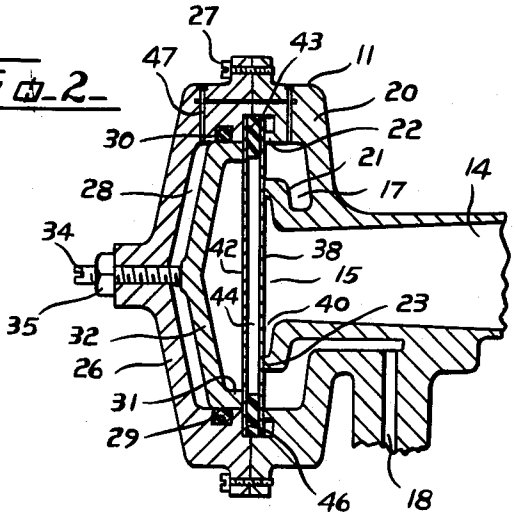


Fig. 3

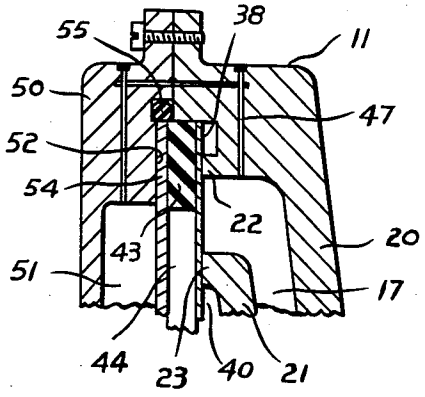
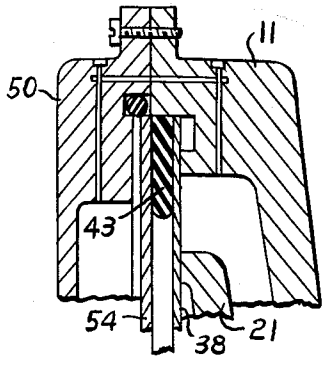


Fig. 5



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PNEUMATIC SOUND PRODUCING DEVICES

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My invention relates to improvements in sound producing devices and more particularly to pneumatically operated horns.

A pneumatic horn is usually fitted with a diaphragm which vibrates so as to produce sound in response to compressed air or other fluid being fed through the device. Such a diaphragm is adjusted to initially vibrate or "speak" at a low pressure of say 5 pounds per square inch and to vibrate at a frequency proportionate to the air pressure, up to the maximum operating pressure of the horn which may be between, say, 200 to 250 lbs./p.s.i. However, it has hitherto been found that at the higher frequency ranges, distortion of the diaphragm occurs which seriously impairs the tonal qualities of the horn.

Therefore, an object of the present invention is to provide means whereby the diaphragm tension is automatically increased as the operating pressure is increased, thus eliminating distortion.

Further objects are to provide means whereby the initial speaking pressure on the diaphragm may conveniently be adjusted according to the requirements of each particular horn.

Referring to the drawing:

FIGURE 1 is a side elevation of the invention.

FIGURE 2 is an enlarged vertical section taken through the centre of the head portion and showing the diaphragms and their supporting parts.

FIGURE 3 is a further enlarged vertical sectional view of a modified form of the invention, taken through a part of the head portion and showing diaphragms of varying thickness.

FIGURE 4 is a fragmentary vertical section of the structure of FIGURE 2 showing the slidably mounted diaphragm moved towards the fixed diaphragm.

FIGURE 5 is a similar view of the structure of FIGURE 3.

In the drawings like characters of reference indicate corresponding parts in each figure.

The air pressure operated sound producing device consists of a horn 10 having an integral head portion 11 and a flared end 12. Within the horn a column 14 is formed which tapers down from the flared end 12 to a relatively narrow throat 15 within the portion 11.

The head portion 11 is provided with an annular chamber 17 which has an inlet duct 18 connected to a suitable source of fluid under pressure. The annular chamber defines an outer flange 20 and an inner flange 21 and formed on said flanges are a clamping ring 22 and a seating ring 23, respectively.

Fitted to the head portion 11 is a slightly conical cover plate 26 which is secured in position by means of screws or other fastening devices 27. An air space 28 is defined within the cover plate and said plate is provided with an annular groove 29. An O ring 30 is seated in the groove 29 to form a seal for the annular rim 31 of a pressure plate 32. The pressure plate has slight longitudinal movement in the air space 28 and is adapted to be moved towards the head portion 11 by an adjustment screw 34 which is fitted with a locknut 35.

Mounted between the portion 11 and the cover 26 are the vibrating elements of the device. These elements include a diaphragm 38 which bears against the rings 22 and 23. In this position the diaphragm closes off the

annular chamber 17 and, with the inner flange 21, defines a wedge shaped (in cross section) nozzle 40 which communicates with the throat 15.

A backing diaphragm 42 is disposed parallel to the diaphragm 38 and is spaced therefrom by a relatively soft resilient washer 43 thus forming a closed compartment 44. The diaphragm 42 is housed within a rebate 46 formed on the inner face of the cover plate 26 and is slidably mounted therein so that it may be moved towards and away from the diaphragm 38 as shown in FIGURE 4. The combined thickness of the diaphragms and the washer 43 is such that when the cover plate 26 is drawn tightly against the head portion 11, said washer is only very slightly compressed and the vibrating elements are suitably supported around their peripheries. In the vicinity of the peripheries of the diaphragms, the portion 11 and the cover plate 26 are drilled to provide a relatively small diameter passage 47 which provides communication between the chamber 17 and the air space 28. It will be noted that the passage 47 has two right angle bends which serve to restrict fluid flow therethrough.

The adjustment screw 34 is adapted to be tightened to thrust the pressure plate 32 against the diaphragm 42 to compress the washer 43 and apply pressure to the diaphragm 38. Since the last mentioned diaphragm is buttressed by the rings 22 and 23, this pressure forms a slight crimp in the vibrating element near its periphery. At the same time a slight crown is formed in the diaphragm 38 within the seating ring 23. Thus, the diaphragm is flexed so that a pre-determined air pressure must be applied thereto before the element will start to vibrate or speak. As air pressure is admitted to the chamber 17 to sound the horn, said pressure reaches the air space 28 through the restricted passage 47 and exerts an additional force upon the pressure plate 32. The pressure plate in turn, moves the diaphragm 42 in a longitudinal direction or to the right as shown in FIGURE 4 so as to further compress the washer 43, thereby reducing the volume of air trapped within the compartment 44 and in so doing reinforces the diaphragm 38. Since the working pressure on the diaphragm 38 is now compensated for, to some extent, by the automatic increase in speaking pressure, said diaphragm is not excessively distorted and the horn sounds with an extremely loud and clear tone.

In the modification shown in FIGURE 3, the device is fitted with a cover plate 50 which forms an air space 51. A rebate 52 is provided on the inner face of the plate 50 and mounted for limited movement longitudinally of said rebate, see FIGURE 5, is a backing diaphragm 54 which is somewhat thicker than the diaphragm 38. An O ring 55 is carried by the cover plate so as to seal against the peripheral edge of the backing diaphragm within the rebate 52.

The chamber 17 and the air space 51 are connected by the restricted passage 47 which as before, has two right angle bends. I have found the passage to be most satisfactory when given a diameter of substantially $\frac{3}{64}$ of an inch, as this provides a time lag between the pressurizing of the chamber 17 and the air space 51. This time lag improves the operation of the horn, particularly during short sudden blasts, since the horn speaks or sounds immediately the chamber 17 is pressurized. When the air space 51 is subsequently pressurized through the passage 47, the diaphragm 54 is moved to the right as shown in FIGURE 5 and when so moved serves to reinforce the diaphragm 38 and compensate for the increased working pressure as has been previously described.

The horn is sounded by admitting fluid under pressure to the chamber 17 so that the diaphragm 38 is deflected to the left of FIGURES 2 and 3. Upon deflection

of the diaphragm, a puff of air escapes over the seating ring 23 and enters the nozzle 40 where it expands and increases in velocity. The inwardly moving particles of air collide at a central point or node in the throat 15. Succeeding nodes are then formed as the compression waves travel outward along the column 14 to the outer end 12 and when the wave slaps against the atmosphere, amplified sound waves are set in motion.

As the diaphragm 38 is forced off its seat to the left, compression waves set up in the compartment 44 force the backing diaphragm to deflect to the left also, whereupon the elastic forces in the diaphragms overcome the compression waves and permit the diaphragms to return rapidly to the right and reseat on the rings 22 and 23. Thus, a cycle of vibration is completed and this is rapidly repeated to set up a resonant sound frequency in the column 14.

It has been found that the present sound producing device will ensure satisfactory results over a frequency range of from 80 cycles per second up to 800 cycles per second. Furthermore, it has been found that a low speaking pressure of 2 lbs./p.s.i. may be used and the operating pressure may be varied up to approximately 300 lbs./p.s.i. with an extremely loud and musical signal. The intensity of the signal increases with the operating pressure and without loss of tonal quality and a factor contributing to the stability of the horn is the action of bypassing a limited amount of the operating air so as to apply a pressure to the opposite sides of the diaphragms. As previously stated, this pressure moves the backing diaphragms so as to compress the resilient washers and reinforce the diaphragms 38 by reducing the volume and thereby increasing the pressure of the air within the compartments 44.

What I claim is:

1. In a sound producing device having a horn forming a sound resonant column open at one end and having a seating ring at the other end, said device including an annular chamber surrounding the seating ring and having a duct for supplying fluid under pressure to said chamber, a clamping ring carried by the device and located concentrically outside the seating ring, the combination comprising a first diaphragm abutting the clamping ring and the seating, a second diaphragm movable towards and away from the first diaphragm, a resilient washer spacing the first and second diaphragms apart in substantially parallel relation and forming a closed compartment therebetween, a cover plate secured to the device, said cover plate enclosing the diaphragms and forming a closed and sealed air space, said device having

means for conducting annular chamber fluid pressure to the air space.

2. In a sound producing device having a horn forming a sound resonant column open at one end and having a seating ring at the other end, said device including an annular chamber surrounding the seating ring and having a duct for supplying fluid under pressure to said chamber, a clamping ring carried by the device and located concentrically outside the seating ring; the combination comprising a first diaphragm abutting the clamping ring and the seating ring, a second diaphragm of greater thickness than the first diaphragm, a relatively soft resilient washer spacing the diaphragms apart in substantially parallel relation and forming a closed and sealed compartment therebetween, a cover plate secured to the device and forming with the second diaphragm, a closed and sealed air space, said second diaphragm being mounted for sliding movement towards and away from the first diaphragm and means connecting the annular chamber to the air space.

3. In a sound producing device having a horn forming a sound resonant column open at one end and having a seating ring at the other end, said device including an annular chamber surrounding the seating ring and having a duct for supplying fluid under pressure to said chamber, a clamping ring carried by the device and located concentrically outside the seating ring, the combination comprising a first diaphragm abutting the clamping and seating rings, a second diaphragm movable towards and away from the first diaphragm, a resilient washer spacing the diaphragms apart in substantially parallel relation and forming a closed and sealed compartment therebetween, a cover plate secured to the device, said cover plate enclosing the diaphragms and forming a closed and sealed air space, a pressure plate slidably mounted in the air space within the cover plate, said pressure plate having an annular rim normally engaging the second diaphragm, said device having a passage communicating between the annular chamber and the air space.

4. In a sound producing device as claimed in claim 3, and an adjustment screw carried by the cover plate and engaging the pressure plate.

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