Aug. 6, 1957 J. K. BRIXIUS ET AL 2,801,705

SILENCER

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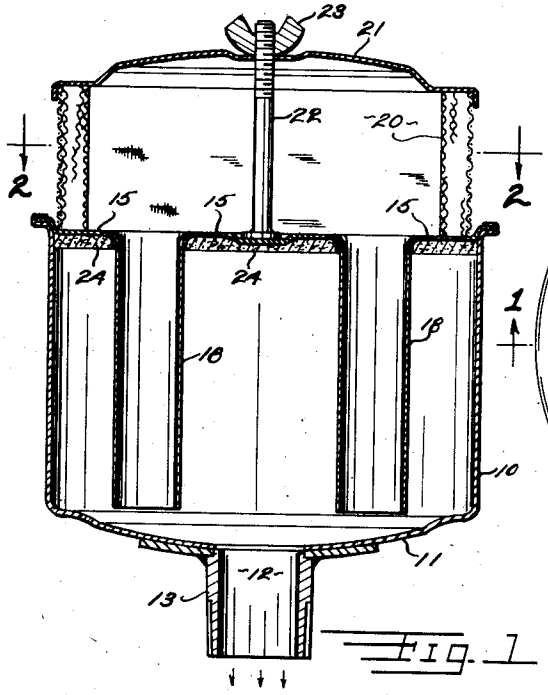

Fig. 1

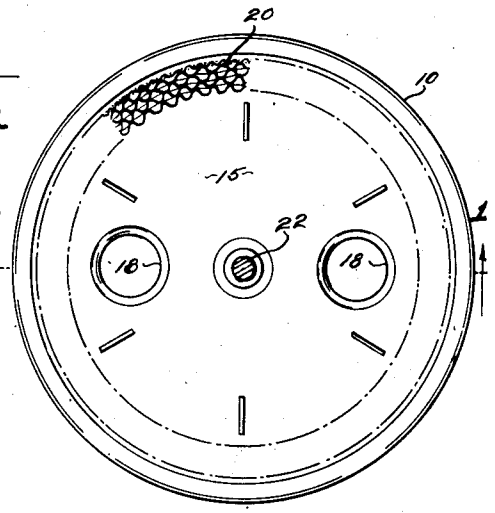

Fig. 2

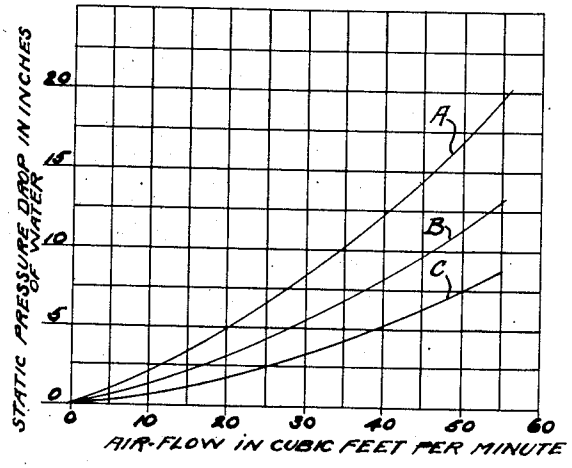

Fig. 3

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SILENCER

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This invention relates to improvements in an air intake silencer for use with a stream of air or other gas flowing through a compressor or the like.

An object of this invention is to provide a silencing device adapted to silence sound waves having a frequency of the order of 800 cycles per second or less.

Another object of this invention is to provide a silencing device adapted to eliminate hissing and whistling caused by harmonics set up in the silencer itself.

Another object of this invention is to provide a smaller ratio between the inlet and outlet areas of a silencing device which produces a drop in the static pressure in the device and has a silencing effect.

A further object is to provide a silencing device composed of parts which need not be constructed to extremely close tolerances and one which does not require precision assembly.

Another object of the present invention is to provide a silencing device characterized by its structural simplicity, the ease of assembly of its parts, its strong and sturdy nature and its low manufacturing cost. Other features of this invention reside in the arrangement and design of the parts for carrying out their appropriate functions.

Other objects and advantages of this invention will be apparent from the accompanying drawings and the following description and the essential features will be set forth in the appended claims.

In the drawings,

Fig. 1 is a central sectional view of our improved silencing device, taken along the line 1—1 of Fig. 2.

Fig. 2 is a cross sectional view taken along the plane of line 2—2 of Fig. 1.

Fig. 3 shows a graph which illustrates an increase in pressure drop as the volume of air flow becomes greater, for several different types of silencer construction.

The present device is adapted to be connected to the air intake manifold of a compresser or other noise-producing mechanism. While my device may take a number of forms, I have chosen to disclose an embodiment comprising a cylindrical casing **10** having an outwardly convex rounded bottom portion **11** which contains an orifice **12** whose axis is concentric with the axis of the cylindrical casing **10**. Attached to the periphery of the orifice **12** and projecting through the bottom of the casing is a collar for outlet pipe **13**, used to secure or attach the device to the intake manifold of the noise-producing mechanism, air flow being in the direction of the arrow in Fig. 1. The upper periphery of the cylindrical casing **10** is connected in any suitable manner to a top member **15**. The connection shown is constructed by extending the upper edge of the cylindrical casing outwardly and then inwardly in substantially U-shape to engage and retain the outer peripheral edge of the top member **15**. This joint may be brazed, soldered or welded for securing the members together.

Air flow into the interior of the casing **10** is by means of a pair of spaced inlet openings through the top member **15**. A hollow cylindrical tube **18** is secured into each of the openings and extends downwardly to a point near the bottom of the housing **10**. The tubes are of such length as to cause entering air to be directed in a vertically downward stream. As viewed in Fig. 1, the tubes **18** are substantially equally spaced from the axis of the cylindrical casing and have axes which are out of alignment or eccentric to the axis of the casing **10** and orifice **12**. An annular filter element **20** preferably formed of a large number of layers of wire mesh screen, is provided above top member **15**. The bottom of the filter element **20** is seated just inside the peripheral edge of the casing and extends circumferentially all around the top of the casing. A cover **21** secures the filter element to the casing **10** by means of wing nut **23** threaded on bolt **22**, which in turn is fastened to the top member **15** by welding or other suitable means. All air entering the casing **10** must first pass through and be filtered by the filter element **20**.

The present device is known as a low frequency silencer or one which is designed to silence sound waves in the range of 10 to 800 cycles per second. The size here illustrated supplies air at approximately 40 cubic feet per minute. Previous silencers of this general type employed a single inlet tube whose position within the silencer had to be located with extreme precision. The axis of the single tube had to be exactly concentric with that of the outlet orifice. The spacing between the end of the tube and the outlet orifice was extremely critical and had to be very accurately adjusted. Great care had to be employed in the manufacture of the tube itself since any burrs or rough spots present on the tube would cause annoying sounds. The one-tube construction was limited to a cross sectional area which was approximately 40% of the cross sectional area of the outlet orifice. It was found that if the area of the single inlet tube was greater than 40% of the outlet orifice, there was a substantial loss in silencing efficiency.

In the present invention, the total flow area or cross sectional area of the inlet tubes **18** is approximately 70% of the cross sectional area of the outlet orifice **12**. It has been found that a total inlet tube area of between 60% and 80% of the outlet orifice will work efficiently. In a practical sense, this means that the present invention will supply the same amount of air with less pressure drop across the silencer, thus increasing the efficiency of the air moving device connected at **13**. These results are readily illustrated in the graph of Fig. 3, wherein the abscissa of the graph illustrates the air flow in cubic feet per minute and the ordinate represents the static pressure drop in inches of water. Curve A represents a single tube silencer having a cross sectional inlet tube area equal to approximately 40% of the outlet orifice area. Curve B represents the present invention wherein the total cross sectional area of the inlet tubes **18** is equal to approximately 70% of the cross sectional area of the outlet orifice **12**. Curve C represents the present invention wherein the total cross sectional area of the inlet tubes was increased to equal approximately 100% of the cross sectional area of the outlet orifice.

For an air flow of approximately 50 cubic feet per minute, the single tube silencer, as illustrated by curve A, had a static pressure drop of approximately 16 inches of water; as compared to approximately 11 inches of water for curve B; and 7½ inches of water for curve C. The static pressure drop indicated by curve A was substantially 100% greater than that indicated by curve C, and approximately 50% greater than that of curve B. Under the conditions of the test, as illustrated by the graph in Fig. 3, a constant background noise of 56 decibels was maintained. A noise-making mechanism comprising a compressor was then operated without the benefit of a

silencer and raised the total noise level to 77 decibels. The compressor was then equipped with a single tube silencer as illustrated by curve A, and when operating at a capacity of 40 cubic feet reduced the total noise to 70 decibels. The single tube silencer was then removed and the compressor was provided with the silencer as herein described and at an air flow of 40 cubic feet per minute, the total noise was reduced to 65 decibels. Providing the compressor with a silencer as herein described having a total inlet area of 100% of the outlet orifice, as illustrated by curve C, reduced the total noise to 66 decibels, thus indicating that a more efficient silencer is provided when the total cross sectional area of the inlet tubes is equal to approximately 70% of the total cross sectional area of the outlet orifice than when 100% of the area of the outlet orifice is used.

It is interesting to note that the two tube silencer of the present invention, as illustrated by curve B, reduced the total noise as compared with the single tube silencer illustrated by curve A, by five decibels. As a practical matter, the noise produced by the single tube silencer was approximately four times greater than that of the silencer of the present invention illustrated by curve C, since it is a well-known scientific fact that the intensity of a sound doubles with each change of three decibels. Thus, a sound which is six decibels higher than another is perceived by the human ear as being four times as loud as the other. It follows, then that in the present test a difference of five decibels indicates the noise of the compressor, when operating with the single tube silencer, as being not quite four times as loud as the compressor operating under the same conditions but provided with our present invention having a total cross sectional inlet tube area equal to approximately 70% of the cross sectional outlet area of the orifice **12**. And this is accomplished with a lower pressure drop through our improved silencer.

It was found that if the total cross sectional inlet area of the tubes in the present device was increased beyond 80% of the total cross sectional area of the outlet orifice, there was a loss in silencing efficiency.

The inner surface of the top member **15** is preferably lined with a sound-proofing material **24** of felt, cotton or the like, which has a tendency to reduce the high-pitched sounds which are at times transmitted back along the air stream through the interior of the casing **10**.

Fourteen different arrangements of the old single tube silencer showed a whistle at one or two points in the range of 800 to 2000 cycles per second. This new two-tube silencer eliminates any whistle in this range.

Although I have shown a preferred construction of the present invention, I do not wish to limit myself to this specific construction. We have found that the number and location of tubes **18** is not critical, nor is the spacing between the lower end of the tubes and the bottom of the casing **10**.

The exact theory under which the present phenomena occurs is not fully understood; it may be because of the elimination of a certain resonant frequency characteristic of the specific type of enclosure or for some other reason which is not herein necessary to explain. It appears that the prior art silencer with a single tube in the center of the chamber sets up harmonics, while the present two-tube silencer eliminates such harmonics. The fact remains that the present invention does produce the results heretofore described most efficiently and effectively.

In view of the foregoing description, taken in conjunction with the accompanying drawings, it is believed that a clear understanding of the construction, operation, and advantages of the device will be quite apparent to those skilled in this art.

It is to be understood, however, that even though there is herein shown and described a preferred embodiment of the invention the same is susceptible to certain changes fully comprehended by the spirit of the invention.

What we claim is:

1. A silencer consisting of a hollow housing having in a closed end thereof an outlet orifice, said housing having a plurality of spaced inlet tubes entering said housing through a wall opposite said closed end, said inlet tubes terminating in a zone spaced from said outlet orifice and having their tubular outlet openings completely out of axial registration with said outlet orifice, said inlet tubes being of sufficient extent to cause entering fluid to be directed toward said closed end, said housing having imperforate walls save for said outlet orifice and said inlet tubes, said housing forming a resonance chamber communicating with the inner end of said tubes, the total cross sectional area of said inlet tubes being approximately sixty to eighty percent of the area of said outlet orifice.

2. A silencer consisting of a hollow cylindrical housing having in a closed end thereof an outlet orifice concentric with the axis of said cylindrical housing, an opposite wall of said housing having a pair of spaced cylindrical inlet tubes entering said housing through said opposite end, said inlet tubes terminating short of said orifice and having their tubular outlet openings completely out of axial registration with said orifice, said inlet tubes being of sufficent extent to cause entering fluid to be directed in streams toward said closed end, said housing having imperforate walls save for said outlet orifice and said inlet tubes, said housing forming a resonance chamber communicating with the inner end of said tubes, the total cross sectional area of said inlet tubes being approximately sixty to eighty percent of the cross sectional area of said orifice, the inner surface of said opposite end being lined with a sound absorbing material.

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