June 16, 1942. H. McCURDY 2,286,683

DIFFERENTIAL CELL ORBITAL FLOW FLUID SILENCER

Filed Nov. 13, 1940 2 Sheets-Sheet 1

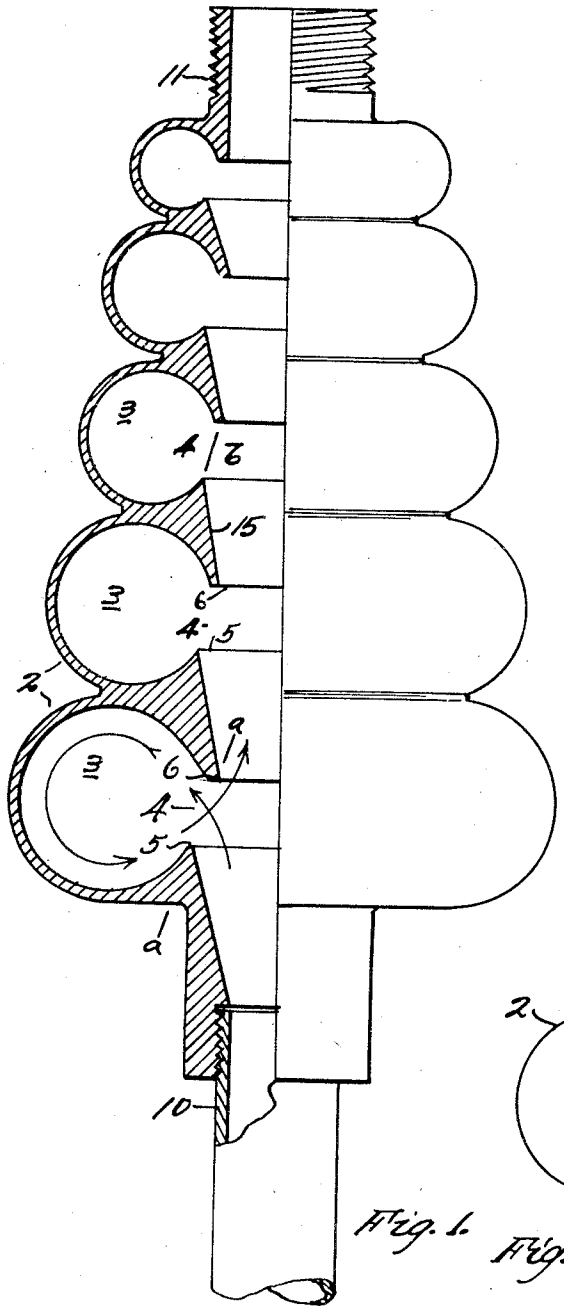

Fig. 1.

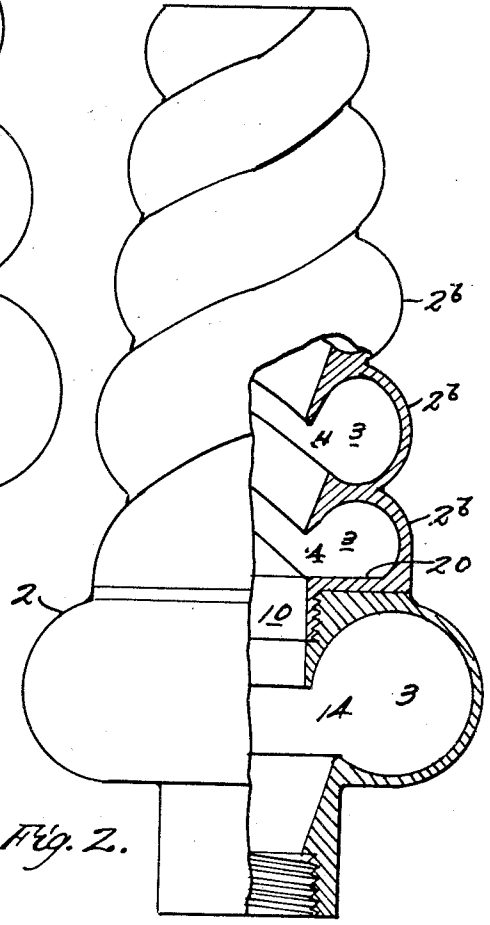

Fig. 2.

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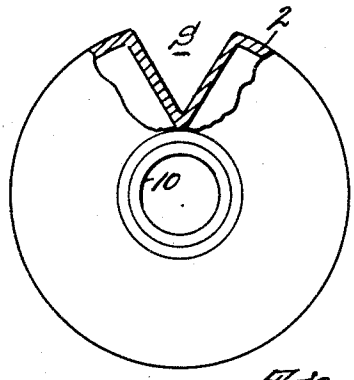


Fig. 3.

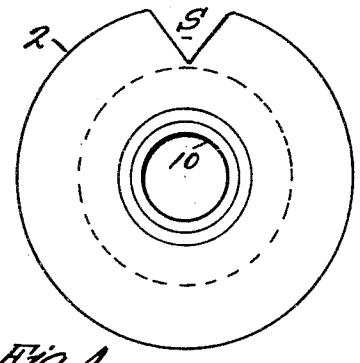
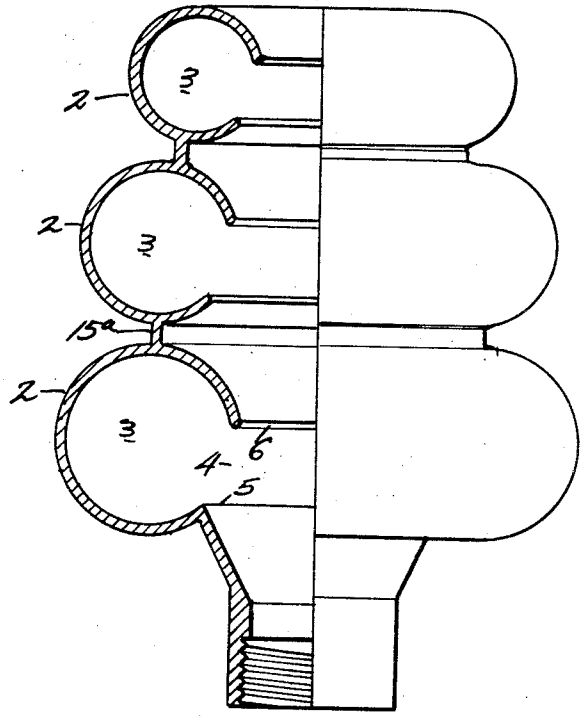


Fig. 4.

Fig. 5.



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2,286,683

DIFFERENTIAL CELL ORBITAL FLOW FLUID SILENCER

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Application November 13, 1940, Serial No. 365,496

9 Claims. (Cl. 181—48)

This invention is a fluid stream silencer, more particularly for use on gaseous fluids.

The present invention has for an object to quickly and effectively so act on a gaseous pressure wave flowing in a muzzle or other tubular passageway as to bring about complete suppression of noise incident to the discharge of the stream from the passageway.

This effective noise reduction is in the present invention effected by the provision of a means involving a succession of peculiar, axially alined expansion cells which combine to form a continuous axial bore for stream flow which is, itself, unobstructed from end to end of the device which will hereinafter be called the silencer, and each cell has an annular space about the axis and opens at its innermost side directly into the bore in such a manner that the fraction of an axially flowing stream which has expanded outwardly and radially into the cell space can return to the bore without need of making one or more full orbital turns in a plane across the cell and which is radial to and along the axis of the bore: a full rotation effect shell and cell device being shown in Maxim Patent No. 916,885. But the silencer of this invention is very materially further distinguished from that Maxim patent by reason that the series of expansion cells here are distinctly differentiated in volume, in succession along the bore of the silencer, the gas head entering the silencer will be partly, annularly sliced from the bore stream and diverted outwardly into the first and largest volume cell of the series and the continuing stream will have successive annular fractions sliced off and out into the next cells in train and which are each of gradually decreasing volume. The direct objective of this peculiar processional volume decrease of the series of the cells is to bring about the substantially instantaneous slicing and expanding of a number of fragments from a pressure head in cells which are larger at the high pressure end of the bore of the silencer and smaller at the lower pressure stream end in the bore and in such expansion capacity relation that all of the fractions will have been expanded to such a degree that they will uniformly resurge from their respective cells at about one and the same degree of pressure and therefore eliminate any effect of a resurge of gas from the highest pressure (incoming end) of the stream, at the first cell, back-flowing to the bore and then being choked at or near the outlet end of the bore by a lagging low-pressure bore stream. Therefore by effecting the complete expansion of a highly compressed volume of flowing gas into a medium which allows for step by step slicing of the wave in axial flow the energy of the wave will have been destroyed by the time it can leave the bore and the ultimate discharge will be at such low pressure at the outlet as to be noiseless when unloaded to the atmosphere.

The invention consists of certain advancements in this art as will be made clear in the ensuing disclosure and has, with the above, additional objects and advantages as hereinafter developed, and whose constructions, combinations and details of means, and the manner of operation will be made manifest in the description of the herewith illustrative apparatus; it being understood that modifications, variations and adaptations may be resorted to within the spirit, scope and principle of the invention as it is more particularly claimed presently.

Figure 1 is an elevational, axial section of the silencer showing an axial series of shell cells normal to the axis and of differential, serially decreasing capacity. Figure 2 is a broken-away elevation of a modification of the silencer combining a first and annular shell cell with a helical structure cell device. Figure 3 is an end view showing provision of a gun-sight valley on a silencer adapted for use on a fire-arm. Figure 4 is an end view showing a gun-sight valley on the form of silencer of Fig. 2. Figure 5 is a detail section of a modified embodiment of wall for the silencer.

The muffler or silencer of this invention involves a plurality of cell units **2** more or less in the form of peripheral shell-forming parts, each unit constituting an individual expansion cell **3**, Fig. 1, which is annular in plan or in a plane normal to an axis of a bore formed by a number of the cell units having co-axial arrangement. The cross-section of the cell units, the body of the annulus being hollow, shows the wall of the cell **3** to be substantially of C-shape with the mouth **4** of the cell or chamber preferably being on an oblique line *a—a* from the first or entrance-end (as to the silencer) lip **5** and a relative, remote lip **6**; the obliquity being as to the axis of the series of the cell units **2**, but it is to be understood that the direction of the chordal line *a—a* may vary as to the plane of its cell unit.

The radially differential arrangement of the first lip **5**, of each cell unit, and the remote lip **6** is to effect a positive, annular slicing of a body of fluid passing axially in and along the bore passageway formed in the series of elements **2** and extending from the attached muzzle or tube

10, Fig. 1, to the outlet 11; all coaxial in a given combination. The remote or slicing lip 6 cuts off an annular layer of the passing fluid stream and diverges it into the relatively radially outward expansion cell 3. The inner surface curvature of a cell from front to rear causes the entrapped fluid to rotate about a full turn (about the center of the C-section cell) and then escape centrifugally inward through the longitudinally wide mouth 4 and then in a co-directional movement with the fluid stream in the bore of the series formed by the successive, axially spaced and preferably equi-diameter lips 6.

It will be observed that the radial distance between the relative lips 5 and 6 is such as to present a cutting face area or band at the lip 6 which is materially less than the area of the ring prescribed by the longitudinally disposed mouth 4 at *b* between the lips 5 and 6. In other words the centrifugal, centripetal discharge capacity of the mouth 4 is materially greater than the slicing capacity of the band formed by the peripheral lip 6 inward as to lip 5, and it is especially noticeable that the mouth 4 is on a chord *b* from or of the expansion cell 3 and lies longitudinally with the flow bore.

Fig. 2 illustrates a silencer including a plurality of C-section tubes 2*b* of suitable helical pitch rising from a foot or end wall 20 which in the present adaptation has a central inlet tube 10 joined coaxially to a torus cell unit 2 which has its plane normal to the axis of the series helically interlapped cell tubes 2*b* and which unit 2 is coaxially joined onto any desired conduit whose fluid is to be discharged into this silencer.

Fig. 5 shows an axial series of torus ring cell units 2 as in Fig. 1 which are normal to the bore axis but in which each ring unit is somewhat axially spaced from the next adjacent and rigidly united in the series by an intervening tie web 15*a* so that the lip 6 of one cell 3 is in clear spaced relation as to the lip 5 of the next cell 3 in train, whilst in Fig. 1 these same lips are tied by a longitudinal wall 15, of right-line character.

If either the type of cell unit structure of Fig. 2 or of Fig. 1 is to be adapted for use on a selected fire-arm then there will be provided longitudinally thereof an exterior valley or sight channel S of a size not to materially affect the expansion cell value.

A particular feature of the present silencer is clearly shown in Figs. 1, 2 and 5 wherein the cell units of each are, in their series, of gradually decreasing volume starting at the intake or first cell. They are not only of differential volume in the series but this difference is preferably accompanied by a distinction in that the first cell of each series is of the greatest diameter so that the first slice taken from an incoming pressure wave and at its highest pressure peak is diverted into an expansion cell of greatest capacity and can there make a full orbital whirl in the C-section space and then, if having any energy left may resurge back into the bore in a direction harmonious with the bore stream. In a like manner successive slices of the wave head are taken off and diverted individually into the successive cells 3 which are of gradually reduced diameter from the first cell. It will be seen that the several slices are substantially being instantly expanded in cells proportioned to the amount of work they have to do in destroying the velocity of the whole wave head and to effect its ultimate resurge into the bore robbed of noise and material velocity: the first cell 3 takes the slice having the highest pressure and the others take slices of gradually reduced pressure and needing less expansion space.

The diameter of the muzzle bore which discharges into the silencer bore may be different from the bore of the silencer, or may be the same as it.

That quadrant of each cell wall which faces the incoming gas stream becomes a sound deflecting hood for each cell to prevent noise from passing outwardly in the silencer bore.

What is claimed is:

1. A muffler or silencer including an annular, hollow wall structure which has along its axis a plurality of substantially C-section portions each having a flow bore at its rear whose edge is a slicing lip and the front wall of each said portion having a flow bore with an annular edge coaxial with the said slicing lip and the said edges being axially spaced and forming a mouth at the chordal line between the ends of the relative C-section portion; and the C-section portions being distinguished in that the first as to the inlet end is of the greatest volume in the series.

2. The silencer of claim 1, and the first said portion being of the greatest wall diameter in the series.

3. The silencer of claim 1, and the remaining C-section portions forming cells of gradually decreasing volume as to the cell of the first portion.

4. The silencer of claim 1, and the several said portions each forming an expansion cell and said cells being of gradually reduced wall diameter, from the intake end, along the axis of the silencer.

5. The silencer of claim 1, the largest of the C-section portions being of torus form and normal to the axis of the series and the others extending as helices beginning at the torus portion.

6. A silencer of the class described and including an elongate wall structure having expansion cells of C-cross-section opening inwardly to its bore, the wall being provided with an exterior, longitudinal sighting channel.

7. A silencer of the class described and including a series of coaxial, annular shell portions which are each of C-cross-section opening inwardly and forming a central bore; the cells of the said portions being relatively of different maximum wall diameters.

8. A silencer of the class described and including a series of coaxial, annular shell portions which are each of C-cross-section forming a central bore to which the mouths of said sections open and are on lines along the direction of the axis; the cells of the shell portions being relatively of differential volumes in the series.

9. A silencer including a shell with coaxial expansion cells having mouths opening onto a flow bore centrally along the cells, and relatively differential length for expansion throats to the cells.

HOWARD McCURDY.