May 13, 1941. H. McCURDY 2,241,729

SLICING, ORBIT FUNCTION FLUID STREAM MUFFLER

Filed April 7, 1939 2 Sheets-Sheet 1

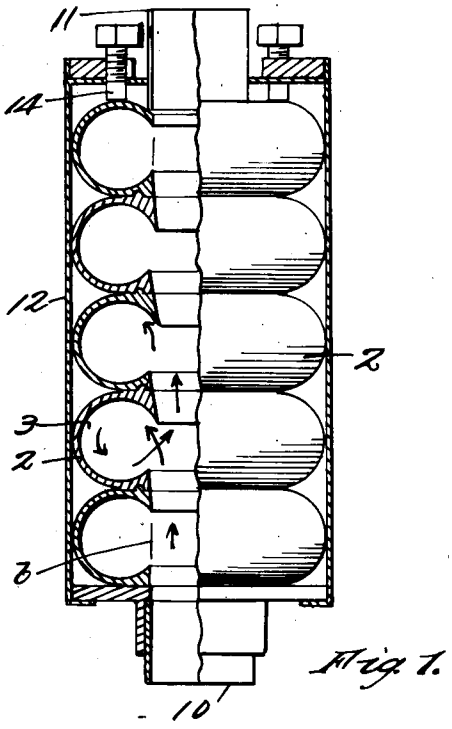

Fig. 1.

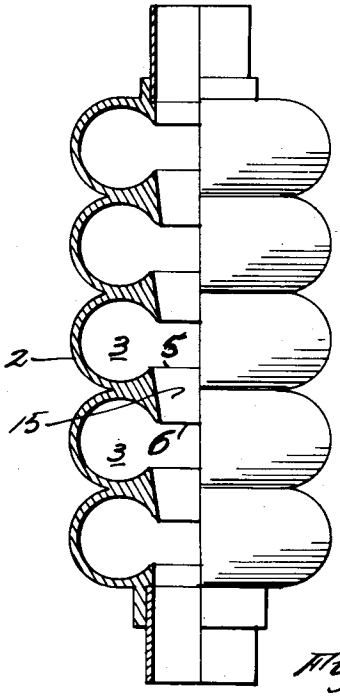

Fig. 2.

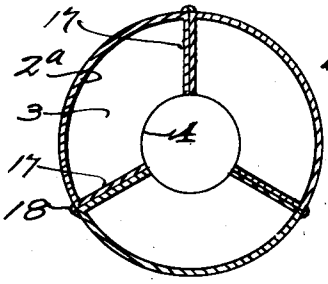

Fig. 4.

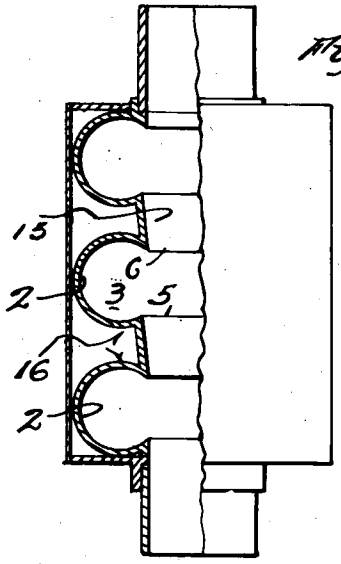

Fig. 3.

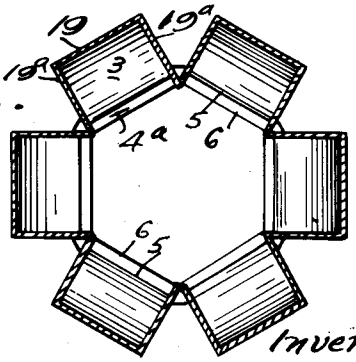

Fig. 5.

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SLICING, ORBIT FUNCTION FLUID STREAM MUFFLER

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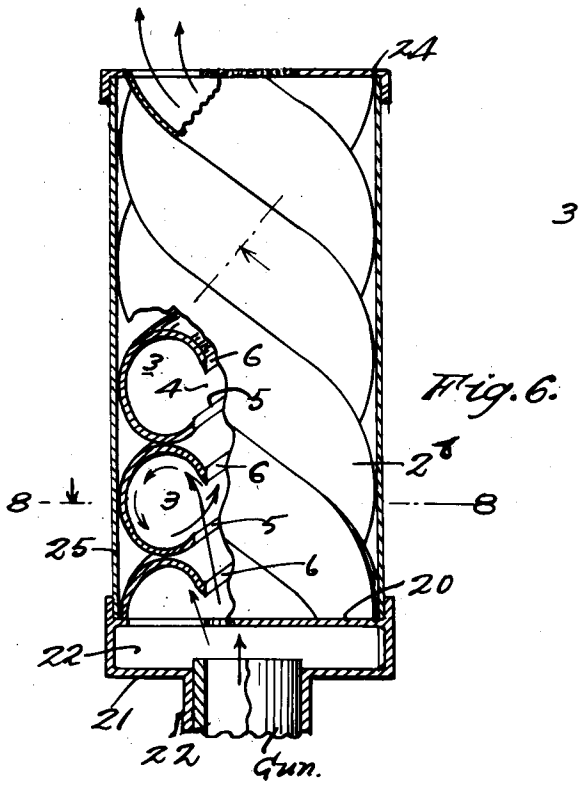

Fig. 6.

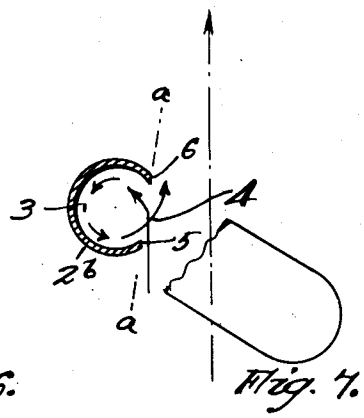

Fig. 7.

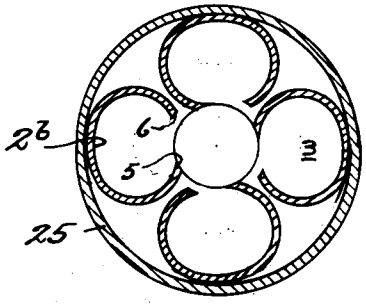

Fig. 8.

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UNITED STATES PATENT OFFICE

2,241,729

SLICING, ORBIT FUNCTION FLUID STREAM MUFFLER

Howard McCurdy, Walnut Park, Calif.

Application April 7, 1939, Serial No. 266,524

19 Claims. (Cl. 181—48)

This invention is a fluid stream muffler for the purpose of reducing noises and also to reduce or eliminate discharge wave pulsations which have the well known effect of stimulating oscillations of more or less remote surfaces which they may impinge.

This application is a continuation, in part, of co-pending applications Ser. No. 218,376, and Ser. No. 228,113. Each of the aforesaid applications discloses, among other variants, one form of muffler including a tube forming a passageway opening outwardly by way of an annular or peripheral mouth into a corresponding expansion chamber element. The mouth is particularly characterized by the fact that its edge nearest the breast of an incoming annular fluid wave is radially more outward from the axis of the tube passage than is the opposite, and parallel, edge of the mouth; that is, the edge of the mouth which is most remote from the inlet of the tube passage. The consequence is that the remote lip or edge of the mouth, it being continuous about the axis of the passage, has a decided interrupting and slicing effect on the annular wave head impinging the said remote edge and positively diverts a complete peripheral slice of the passing slug of fluid, whether this be subjected to a continuous uniform pressure or to intermittent impulses for instance as set up by the discharge of exhaust bodies of fluid from various guns, motors or pumps.

It is a particular feature of this form of wave slicing mouth that it has a noticeable space axially of the passageway between the mouth lip near the intake end of the tube and the remote, and since the two lips lie in different circles on the axis a straight line, from front end to rear end of the passage, will be diagonal to the axis when drawn from lip to lip.

It is an object of the invention to provide a muffler involving an unique means to effect an efficient sectional-rim slice of the fluid stream or plug traversing the muffler passage; to effect a material expansion of the annular slice taken from the fluid body; to effect an orbital whirl of the annular slice of the fluid, not peripherally around the tube axis but in a chamber whose cross-section is substantially circular in planes radial and longitudinal as to the axis of the fluid passage so that centrifugal energy is set up in the annular slice and the friction of the orbitally moving fluid is utilized as a brake on the velocity of the fluid which is finally released from the muffler outlet robbed of stimulating wave power of objectionable degree. It is an object to provide an orbital function chamber having means to effect the slicing of a core mass of fluid in a desired fraction, of annular or ring form, from the mass and to provide for the effective expansion of the slice in the chamber without impact.

To accomplish this the chamber incorporates an annular orifice with lips materially spaced axially, as to the bore or fluid passage, that is the orifice has substantial longitudinal width for centrifugal escape of the expanded slice back into the passage to follow its parent wave or force head—from which the slice has been stripped. An object is to provide an expansion chamber, peripherally about a flow passage, which has means to take off an annular slice of desired thickness and has a mouth with lips spaced longitudinally (axially) of the passage a distance apart which is of greater area than the area of the annular space of a transverse ring defining the radial distance between the opposite lips of the mouth.

This distinctive expansion chamber construction will be at once apparent when compared to the peculiar digit 6 outline seen in the lower portion of Fig. 1, of the patent to Sizer, 956,906, May 3, 1910. In that device the inner and outer lips, 19—20 are not longitudinally spaced but are radially directly opposed and the distance between the lips 19—20 is, radially, greater than the distance longitudinally between the lip 20 and the nearest surface of the radial flange to lip 19. Since the end face area of a slice at lip 19 is greater than the area of the "spiral slot 28" of Sizer the annular slice is choked in front of the lip 19 and must expand centripetally, in part, as a portion does pass into slot 28. Any orbital rotation of the slice part in the circle section space 25 is negated because the fluid motion is killed by the substantially still or static head of the higher pressure fluid body choked in front of the deep flange lip 19. It will be particularly observed that the discharge mouth from the spiral device (a single convolution—as 40, Fig. 9) lies in a radial plane and that the inclination of the flange lip 19 is decidedly back toward the incoming fluid stream. In clear contrast to this, the discharge mouth from the expansion chamber of the instant invention is such as to favor and set up a true and full orbital rotation of the expanded slice for the reason that the slice passes from the cutting lip with a rolling action into the chamber with a motion in the same direction as the travelling wave body or core mass, then reverses on the outermost (inner) surface of the chamber and centrifugally moves

inward along a wall surface which is inclined in the discharge direction of axial flow of the core stream having made a complete, tangential loop in an expansion chamber whose mouth is a chordal line nearly tangent to the cylindrical flow passage.

The invention consists of certain advancements in this art as set forth in the ensuing disclosure and having, 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 embodiments; it being understood that modifications, variations and adaptations may be resorted to within the scope, principle and spirit of the invention as it is more directly claimed hereinbelow.

Figure 1 is an elevational, axial section of a form of the muffler incorporating a stacked series of muffler, expansion units.

Figure 2 is a similar view of a form in which the units are cast en bloc.

Figure 3 is an elevational, axial section illustrating an arrangement of the expansion units in substantially axially spaced relation.

Figure 4 is a transverse section of a unit as made up of segments of an annulus for building heavy or large size mufflers.

Figure 5 is a transverse section of a form of a muffler unit in which the expansion space is of a form to prevent peripheral widening of an annular wave breast passing radially from the muffler bore or passageway into a related, peripheral expansion chamber.

Figure 6 is a partially axially sectioned, side elevation of a helical-form, expansion chamber muffler incorporating the chordal mouth feature and full orbital function.

Figure 7 is a cross-section of one expansion chamber element or unit, of line 7—7 of Fig. 6.

Figure 8 is a trans-axial section of the muffler on line 8—8 of Fig. 6.

The muffler of this invention involves a plurality of units or elements 2 more or less in the form of peripheral shell-forming parts, each unit constituting an individual expansion chamber 3 which is annular in plan or in a plane transverse to an axis of a bore formed by a number of the chamber elements having co-axial arrangement.

As most clearly shown in Fig. 7 the cross-section of one of the annulli chambers, the body of the annulus being hollow, shows the wall of the chamber to be substantially of C-shape, with the mouth 4 of the chamber being either a chordal opening, between the first or entrance-end, as to the muffler, lip 5 and a relative, remote lip 6, or an oblique line *a—a*, as to the axis of the annulus, Fig. 7, or in some cases with the mouth 4 on a chordal line *b*, Fig. 1, parallel to the axis of the ring element 2.

The radially differential arrangement of the first edge lip 5 and the remote lip 6 is to effect a positive annular slicing of a body of fluid passing axially in the bore passage formed in the assembly of elements 2 and extending from the inlet 10, Fig. 1, to the outlet 11, all coaxial in a muffler. The remote or slicing lip 6 cuts off an annular layer of the passing fluid and diverges it into the relatively radially outward expansion chamber 3. Curvature of this chamber from front to rear causes the fluid to rotate a full turn and then escape centrifugally inward through the longitudinally wide mouth 4 and with a co-directional movement with the passing core of the fluid stream in the muffler bore formed by the successive, equi-diameter lips 6.

It will be observed that the radial distance between relative lips 5 and 6 is such as to present a cutting face area of the lip 6 which is materially less than the area of the ring prescribed by the longitudinally disposed mouth 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 positive cutting lip area inward of the ring formed by the peripheral lip 5, and it is especially noticeably observeable that the mouth is on a chord from or of the expansion chamber 3 and lies longitudinally with the flow bore.

This principle of the invention is shown here in several embodiments. In some adaptations the chamber elements 2 are in the form of torus rings 2 any suitable number of which may be coaxially stacked in a cage of jacket 12 joined to the inlet nipple 10 and to the outlet pipe 11 in fixed relation. The stack of rings 2 are shown as rigidly clamped one onto the other as by simple clamp screws 14 in the head of the jacket 12. In some adaptations chamber elements or rings 2 may have their lips 5 and 6 of equal diameter to form a non-slicing mouth as at chord *b*, Fig. 1, so that the relative chamber would function in the main as sound trapping means.

As a modified method of making the side to side ring type of muffler, Fig. 2 discloses the element rings 2 as all cast in block unity. This form eliminates a fastening means and dispenses with the jacket of Fig. 1. A feature of this embodiment is the provision of a smooth-face, bore hub 15 between contiguous remote-side lip 6 to the next remote (discharge end) lip 5 of the next remote mouth 4.

If desired to meet conditions of another environment, the bodies of each ring element 2 may be much axially spaced as at 16, Fig. 3, with successive mouths 3 joined by bore hubs 15.

In the manufacture of these mufflers for heavy duty loads each ring element 2 may be made up in complementary segments 2^a, Fig. 4, of hollow structure providing a C-wall section transverse the body and each end of each segment having a radial, closing, plane wall or web 17 taking both tension strains and compression loads imposed by superstacking a number of the full-ring, chamber elements, arranged as in Fig. 1. In such a segmental-section ring element, Fig. 4, the seam at the abutted faces of the webs 17 may be sealed all around the lap crevice by a joint weld 18.

In any of the stacked element forms of the muffler all meeting surfaces of contiguous elements may be cemented or sealed in any approved manner.

In these several cases where the fluid expands out through the ring mouth into a full annular or ring expansion chamber, around the axis of the flow bore, there is a combined radial expansion and a peripheral expansion for the reason that the ring chamber is of greater annular length than the circular length of the mouth 4. This creates a widening wave front of the fluid expanding out through the ring mouths 4, conversely laterally constricting of the resurge fluid flowing back into the bore passage after the parent wave has sped on. In some cases there may be used an annular series of C-section, right-line expansion boxes 19, Fig. 5, all with open mouths 4^a end to end and tangent to a circle about the axis of the arrangement, and each box 19 having parallel end walls 19^a normal

to the line of the said tangent mouth and having end walls of contiguous sections generally spaced.

In Fig. 6 a muffler is composed of a plurality of C-section tubes 2^b of suitable helical pitch rising from and opening through a foot plate **20** spaced above a bottom plate **21** of an intake space **22** about and at the inner end of the inlet nipple **22**. The helical tubes are of such pitch diameter that their inner cutting lips **6** form a uniform, uninterrupted flow bore from bottom to top at the outlet terminal. The tubes 2^b have freely open discharge ends and may be fixed in the assembly by a head plate **24**. The tubes may or may not be enclosed in a jacket **25**, depending on method of structural embodiment; they may be cast integral, in a manner indicated in Fig. 2. The helices may pitch to right or to the left for adaptation.

It is understood that the number of the chambers **2** may be varied according to adaptations, in some cases one may be sufficient in wave reduction, or many may be used in a set for substantial silencing, or an intermediate number for wave and noise reduction to a satisfactory degree.

This application is, in part, a division of application Ser. No. 218,376, Filed July 9, 1938.

What is claimed is:

1. A muffler including an annular, hollow element the peripheral wall of which is, in planes along the axis of the element, substantially of C-section and the element having a central, rearward flow bore whose edge is a slicing lip and the front wall of the element having a flow bore with an annular edge coaxial with the slicing lip and the edges being axially spaced and forming a mouth at the chordal line between the ends of the C-section wall.

2. In a muffler, a hollow, annular element having coaxial flow ports in its axially opposite sides and the edges of the ports being circular and forming, between their sides of the element, an annular mouth about the axis of the element, the edge of the port of the rear wall, as to flow direction, forming a slicing lip to divert a part of a fluid stream to the annular chamber in the said element for expansion and the lip of the forward port effecting the discharge of the sliced fluid back to the bore at a plane forward of the slicing lip.

3. The muffler of claim 2; the wall of the element being substantially of C-form cross-section.

4. The muffler of claim 2; the lips of the mouth to the element chamber being of relatively differential diameter as to the axis and in non-overlapping relation.

5. The muffler of claim 2; the opposite edges of the mouth being (in cross section) on a chord which is oblique to the axis so that the axially remote edge has a slicing and reducing function on a body of fluid flowing axially in the passageway and both lips are directly exposed to the bore passage for intake and discharge of fluid thereat in the direction of flow to the outlet end of the muffler.

6. In a muffler, an annular, hollow element having an axial bore for fluid flow and the wall of said element being substantially of C-section on planes along the axis of the element and having angularly along its surface nearest the bore an uncongested mouth with opposite lips directly on the bore and spaced on a chord substantially along the direction of fluid flow in the axial bore; whereby to provide a single full orbital whirl of a sliced off fraction of a fluid body from the axial stream and which fraction centrifugally expands through the annular mouth into the element chamber and returns into the bore in the same direction as the passing stream before the kinetic energy of the fraction is dissipated by friction in the said chamber.

7. The muffler of claim 6, and the rearmost of the annular lips of the mouth lying closer to the axis than the other, whereby to effect a positive slicing angularly of the axial stream.

8. A muffler structure including a plurality of co-axial annular, hollow, coaxial elements having coaxial bores and the hollow of each element forming an annular expansion chamber from and having an annular mouth along its innermost surface at the said bores and the mouths having opposed, non-lapping lips spaced co-directionally with the axis of the bores; the rearmost lips forming fluid slicing means and the foremost lips forming discharge edges from the respective chambers.

9. The muffler of claim 8, and the lips, of the mouths, remote from the inlet end of the muffler projecting inward as to the forward relative lips to effect angular slicing from the periphery of an axial, fluid stream in conjunction with the radially expanding fluid passing between the axially spaced lips presented to the bore.

10. The muffler of claim 8, the elements each being operative to set up a single cycle of pocketed gas and then to centrifugally discharge it back into the bore in the original direction of flow.

11. The muffler of claim 8, and the elements being in the form of helices about the bore axis.

12. The muffler of claim 8, the elements being of independent helical body units fixed in assembled relation.

13. In a muffler, an element of annular, hollow-body structure having an axial flow bore and of C-form cross-section on planes along the axis of the element and the open or mouth side of the C-section being arranged at the axis or inner side of the cross-section and constituting an expansion mouth to the chamber of said element for fluid flowing along the bore of the element; the said element including a ring of segments annularly abutted endwise and having end closing webs to tie the axially opposite walls of the mouth of the respective segments.

14. In a muffler, an annular series of hollow, closed-end expansion chamber sections having mouths opening directly toward the axis of the series, and the sections each having end walls; the end walls between contiguous sections being in generally spaced relation.

15. A muffler including a peripherally imperforate generally circular casing having an axial opening therethrough for the passage of a fluid stream and having axially opposite guiding surfaces with axially spaced lips directly on said opening and said surfaces being joined by a peripheral wall and forming a substantially annular-section chamber on radial planes along the casing axis and to which a part of the fluid stream is sliced by the rearmost of the lips, which lips interrupt the said annular section of the chamber to a degree materially less than a circle about an axis in the said cross-section of the chamber and provide for escape for the fluid only from the chamber toward the casing axis in the general direction of stream flow.

16. The muffler of claim 15, and in which the chamber is of helical pitch about the muffler axis.

17. A muffler casing having an axial series of

chambers of the character set out in claim 15, and the spaced lips of chambers of the series forming mouths with differentiated chordal angularity relative to each other, whereby to take off different volumes of slices from the stream.

18. A muffler including a casing for control and outlet of flowing fluid and having a discharge outlet, and provided with a peripherally imperforate chamber having a stream intercepting wall having an axial bore leading to said discharge outlet and which wall deflects a fraction of the bore stream into said chamber and which wall forms, in cross-section an open-sided loop with a discharge lip in advance of the intercepting part of the chamber wall; whereby the kinetic energy of the intercepted part gives said part a cyclic motion of about one rotation and the part is centrifugally expelled only through the loop opening into said bore with the same direction of motion as the bore stream and as when first deflected from the stream.

19. The muffler of claim 1, and the edge of the orifice which faces the incoming stream wave being somewhat indirected to form a cutting or slicing edge for an annular outer layer of the passing stream, to accelerate the processionally expanding function of the muffler.

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