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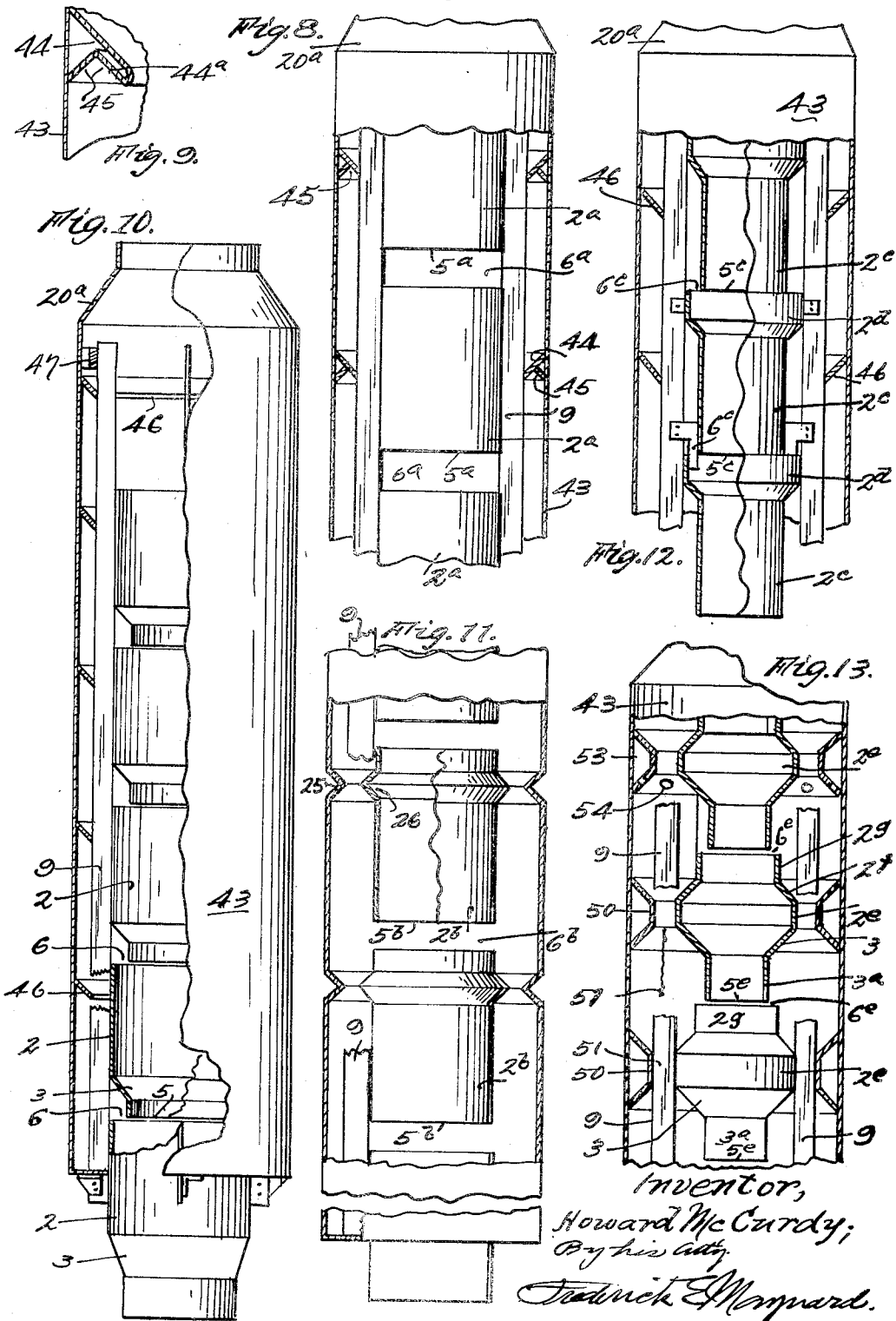
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Filed Sept. 20, 1938

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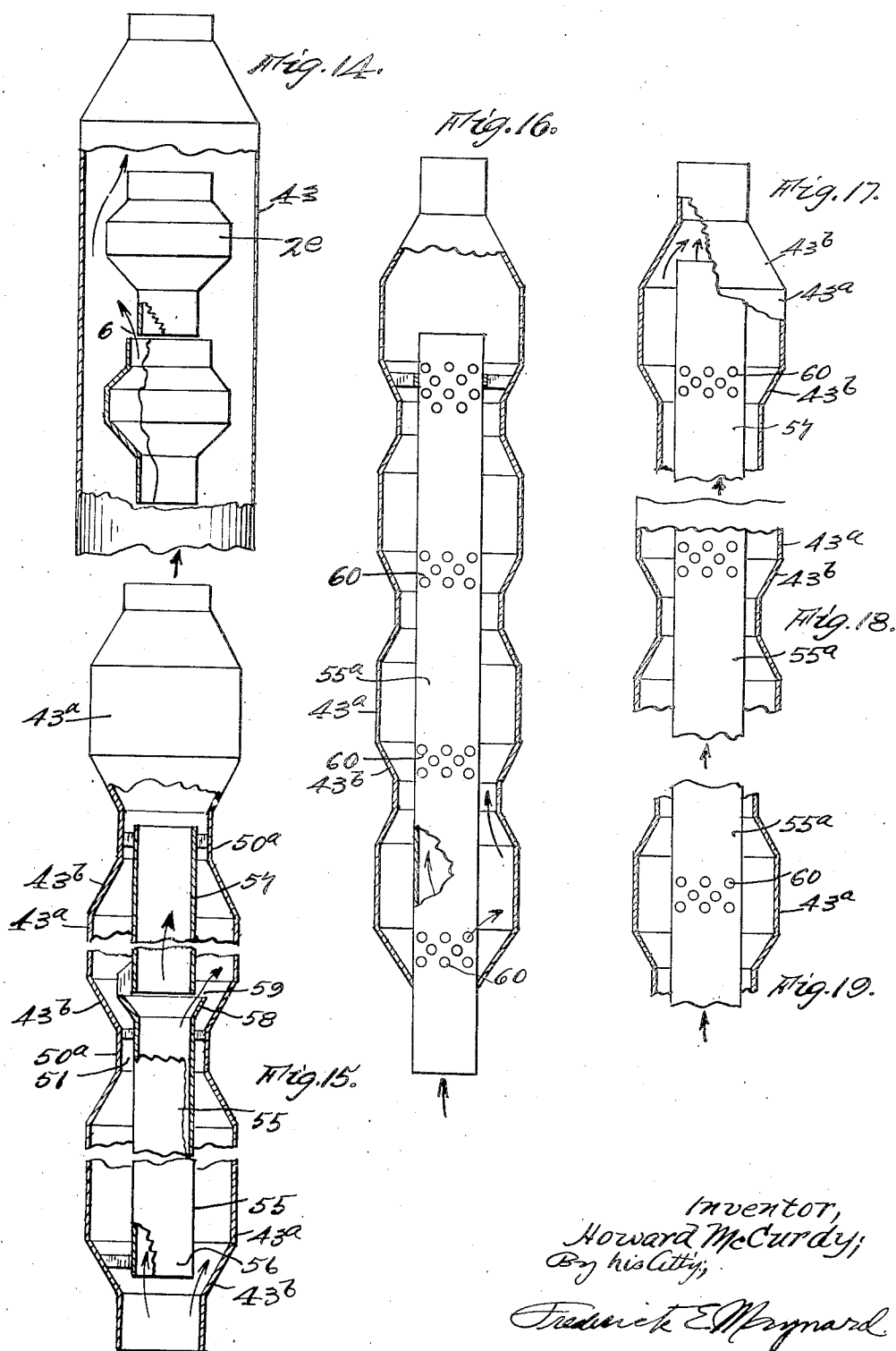
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## UNITED STATES PATENT OFFICE

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## PULSATION BLEEDING CONTROL MUFFLER

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7 Claims. (Cl. 181-46)

This invention is a pulsation bleeding, control muffler and is, in a manner, related to the type of muffler shown in U. S. Patent No. 2,113,055. The said patent shows a fluid control conduit involving a series of coaxial expansion chambers laterally bleeding outward the pulsating waves of fluid from a motor chamber.

In that patent the successive expansion chambers or stages were of gradually reducing size and of gradually reduced bore, that is minimum entrance of each, and each stage had its wall perforate for diffusion of the trapped portion of the fluid expanding in the relative stage.

It is an object of the present invention to provide a muffler structure involving an axial series of substantially similar chambers or stages in the form of successive tubes of substantially like proportions, preferably with imperforate walls and such chambers having contiguous ends of such form and in such relation as to have an annular slicing efficiency on the ball or breast rim of each successive, incoming pressure impulse or vibration stimulating media; whereby the pulsation is fractionally peeled during its axial transit of the muffler.

Where the annular slices of the rim peeled wave of pressure is vented in a circle about the axis of the muffler and in a common plane or close parallel planes transverse to the axis there may be unduly high pulsation factor still in the bleed off part and an object is to provide an annular wave interceptor and muffler about in the path plane of the outlet between each of the chambers; the interceptors having, in some designs, provision for arrest of sound.

Again, a purpose of the invention is to provide a muffler having the successive chambers of such form as to provide an inlet throat of somewhat lesser or herein called "bore" diameter than the body of the chamber proper so that that portion of a fluid stream, from which the rim of the breast has been sliced off, entering the chamber proper as a core of the stream may expand in the chamber and pass on at a speed exceeding that of the sliced off rim of the stimulating head.

While it is an object to provide a pulsation bleeding muffler in which a passing head of pressure may be broken down by successive slicing as just above set forth by the action of successive slicing means, with or without expansion within each of said means, another object is to provide for the diffusion of the expanding slices laterally directly to atmospheric space, with or without a quenching muffler at each vent annulus of the train of chambers, and further, an object is to

provide a closed type of structure incorporating the desirable features and advantages incident to the structures above alluded to.

The invention consists of certain advancements in this art as will be set forth in the ensuing disclosures and having with the above, additional objects and advantages as hereinafter developed and whose construction, combinations and details of means, and the method 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 herein below.

Fig. 1 is a partial axial section of a diffusion form of the muffler, and Fig. 2 is a top plan thereof. Fig. 3 is a sectional elevation of a bowl part. Fig. 4 is a bottom plan of Fig. 1.

Fig. 5 is a sectional elevation of a form including a modified vent part, and Fig. 6 is a cross-section through a louver outlet thereof. Fig. 7 is a fragmentary section axially of a ring louver.

Fig. 8 is a partial axial section of a closed type, tandem chamber modification.

Fig. 9 is a cross-section of a ring barrier.

Fig. 10 is a sectional side elevation of a modified closed type of the muffler.

Fig. 11 is a broken axial section of a modification showing a Venturi constriction.

Fig. 12 is a section showing flared, rear end bore members.

Fig. 13 is a section showing a two-step expansion adaptation.

Fig. 14 is a detail showing a semi-Venturi passageway.

Fig. 15 is a sectional elevation of a form having a shell of tandem, reduced wall portions.

Fig. 16 is a sectional elevation showing a perforated bore member of the muffler, and Figs. 17, 18 and 19 are sections showing variations of arrangement of the perforated member.

Figure 1 is a broken-away, longitudinal elevation of an open, lateral diffusion type of the fluid control conduit, or muffler, as the invention will be called herein. This embodies axially successive expansion chambers 2 somewhat in the form of bottomless bowls having, here, convergently constricted, uniform bore throats 3 the leader or foremost of which has connection by nipple 4 to any given apparatus to or from which the fluid may pass to spaces of different volume; it being understood these mufflers have capacity for use when the fluid flows in either direction, though,

perhaps with different efficiency. The rims or larger ends of the bowls 2 are shown as in about the transverse plane of the near and smaller throat end of the next bowl in series so that there is provided about the intake end of each throat 3, except the leader, a sharp, annular slicing lip 5 which functions to annularly cut off the outer layer of a breast or head of a stimulated fluid impulse entering each bowl 2 whose enlarged space constitutes an expansion stage for that core part of the stream of fluid not sliced off and which proceeds axially of the muffler. It will be noticed that the slicing lips are here of about uniform diameter and form the minimum bore cylinder of the train of bowls.

Therefore, as each pressure head is sliced off at any lip 5 the annular body of the fluid is at once laterally diverted by the inwardly tapered throat 3 for relatively free expansion into lateral space about the axial bowls. In some cases the lateral expansion may be entirely into atmospheric space without other muffling, as in instances where atmospheric impulses stimulated by the discharged waves raise no complaint or do no injury. However in order that the muffler may be efficiently used and still destroy objectionable impulses to the atmosphere as many of the outlets 6, from the rims of the bowls 2, as desired, may be shrouded with appropriate external, annular muffler means, spaced from one another axially. At the first outlet 6, where the sliced off pressure fluid may have the greatest stimulation there is provided an annular shrouding jacket 7 having an intumed bottom flange 8 radially slotted to receive a longitudinal series of elongate ribs or ties 9 which rigidly connect the bowls 2 in train and form a support for the jacket means 7. This first jacket is closed at its upper end by a preferably inwardly and downwardly converged collar 10 presenting a hook to such part of the annular slice of expanding fluid as does not follow along the angularly spaced ties 9; the bottom 8 and the collar 10 cooperating to form a longitudinally closed, supplemental expansion stage and muffling that part of the sliced cylinder of fluid. If desired, the jacket 7 may have a suitable number of inwardly directed baffles 11, for further muffling reaction.

At the next outlet 6 of the muffler bowls there is a jacket 12 whose rim collar 13 is in annular opposition to an outwardly and downwardly flared hood band 14 fixed about the near bowl 2 and leaving at its outer edge an annular vent 15 over the upper face of the collar 13. This jacket will effect a muffling of the fluid escaping at the relative bowl throat. Above the jacket 13 there is provided a third jacket 16 in the form of a narrow cylinder with an intumed bottom 17 fitting the ties 9 and the near bowl 2 and being freely open at its top edge to vent out its portion of the wave slice vented from the contiguous throat outlet 6. A less restrictive muffler jacket 18 is arranged, on the ties 9, next above the jacket 16, and is in the form of a narrow cylinder open freely at its top and bottom, and the remaining outlet 6 may be laterally unobstructed if desired, as shown.

It will be seen from the above that this form of muffler is designed to keep down the cost of construction and at the same time to control diffusion of the expanding, annular slices of the pressure head of fluid as each head successively reaches the stages of the bowls.

Figure 2 is a top plan of the device of Fig. 1, and

Figure 3 is a broken, side elevation of one of the bowls 2.

Figure 4 is a bottom plan of the device of Fig. 1.

Figure 5 is a broken-away, longitudinal elevation of an open lateral discharge muffler also including an axial series of the stages or bowls 2. In this muffler the first outlet 6 is shrouded by a jacket 24 which, with the near bowl or stage 2, gives an exterior Venturi throttle to the passing fluid slice. The closed bottom jacket 24 has its upper part constricted by an indented, annular corrugation 25 arranged laterally opposite a cooperative, salient, annular shoulder 26 here in the form of a corrugation out-set from the interior surface of the relative stage 2; this corrugation form of venturi being an economical expedient. It will be seen that this construction and arrangement of the bowl or stage 2 and the near jacket 24 effect a triple expansion of the immediate part of a fluid body in transit; first in the bowl space at throat, next in the jacket space from the annular port 6, and then in passing the Venturi constriction 26—25. Moreover, the corrugation 26 in the inner surface of the relative bowl 6 has a reaction of the outer element of the passing fluid. Above the jacket 24 there is at the next vent 6, a simpler jacket 28 intumed at the bottom and top. Above jacket 28 and below the next vent 6 there is provided an annular series of tangential louvers 29 which have the elongate inner edges 30 spaced out from the near bowl 2, and have the outer edges 31 of the louvers at least in the radial plane on which the edges 30 are disposed.

Figure 6 is a cross-section through the muffling louvers 29 of Fig. 5, showing the preferred arrangement and proportions of the set of louvers. A variation of lateral, annular, shrouding muffler includes a jacket 32, Fig. 5, in the form of a cylinder with closing bottom and top flanges 33—34; the latter spaced from the relative bowl 2 to provide an annular outlet 35. Fluid issuing to this jacket space from outlet 6 is expanded but its longitudinal flight is checked by a helical arresting ribbon 36 of about one and one-quarter turns, and shown as beginning at 37, Fig. 5. This helical ribbon preferably inclines inwardly and downwardly as shown at 38, from the wall of its jacket 32.

It will be seen that type, Fig. 5, also involves the utilization of exterior shrouding muffler jackets of different details of construction for given apparatus. It is understood that one or more of the louver type jacket may be employed in the series of stages 2 and that the axially successive louver sets may be of reverse tangentiality of the blades thereof.

Figure 7 is a sectional detail, showing, in section a louver form of jacket 40 formed by the axial spacing of a series of conoidal rings 41, flared from the intake direction.

If there are no outside, secondary mufflers jackets such as above described used at the several annular vents 6, the main muffler would be of free outside diffusing function; and where such outside jackets are employed the muffler becomes a partially closed type. Where the first few shrouding jackets operate to sufficiently reduce expansion noises thereabove the simpler forms of jackets may be used to sufficiently stop the issue of wave stimulating impulses.

Figure 8 is a broken, longitudinal elevation of a closed type of muffler involving the principle, above set out, of a series of axially spaced expansion chambers or stages 2a with contiguous

ends in such relation as to provide axially spaced or successive, annular vents 6a about respective slicing end edges 5a; in this case the chambers 2a being of uniform bore and without any constricting throat 3 as above set forth. The train of chambers 2a are fixed together by the ribs or ties 9 and these are enclosed by a continuous, outwardly spaced shell 43 into which the fluids expanding through vents 6a pass. Rearward flight of the expanded part of the flowing fluid stream is partially arrested by provided inner wall barriers 44 the frontal faces 45 of which present annular concavities to the arrested pressure and noise waves; that is, the ring-like barriers are of such a cross-section as to present annular grooves to the stream with the bottom of the groove between the inner and the outer edges of the barrier 44 in a manner to converge the impacting waves of pressure or of sound.

Figure 9 is a detail section across a form of ring barrier 44 having converging, opposite conical faces.

Figure 10 is a broken-away, longitudinal elevation of a variant showing the throat bowls 2 of Fig. 1, and this is a closed form having a shell 43 spaced about the set of longitudinal ties 9 by intermediate, annular, inwardly and downwardly converged conoidal barriers 45 in suitably spaced relation above the next forward annular vent 6 between bowls. The upper ends of the ties 9 are here slidably mounted in a fixed bearing ring 47. The closed forms of muffler have the top ends of the shells 43 converged to any suitable discharge tube 28a.

Figure 11 is a longitudinally broken sectional elevation of a closed form of the muffler in which cylindric chambers or stages 2b are axially spaced to form annular vents 6b in front of their leading or slicing edges 5b. These stages 2b are of uniform inside diameter except for grooves 26 resulting from outwardly corrugating the wall to form in combination with an opposite arresting ring or shoulder 25 a Venturi constriction, as in Fig. 5.

Fig. 12 is a longitudinally broken, sectional elevation of the muffler in which the inner expansion chambers or stages include elongate, cylindric members 2c having flared rear ends 2d concentric with the near, succeeding stage to provide an annular vent 6c about the front slicing edge 5c of the next stage, a closed shell 43 being provided with suitable internal arrestors, as 45, about the fixing ties 9.

Figure 13 is a longitudinally broken, sectional elevation of a further Venturi principle muffler. Here there is an axial series of inner chambers 2e with parts 3 converging to relative intake throats 3a having slicing end edges 5e. The chambers 2e converge rearwardly at 2f to straight outlet muzzles 2g. In this embodiment the intake 3a is smaller than the outlet muzzle of its own element, and between contiguous elements 2e of the train there is formed annular vents 6e. This vent, at each element, provides a second step for the expansion of a sliced annulus of the stream. The closing shell 43 of this muffler is provided with axially spaced, secondary Venturi chokes or bands 50 of about the length of the concentrically adjacent swelled part 2e of the relative inner element and any expansive fluid passing out of a vent 6e expands between two successive bands 50 and then flows on to the constricting passage 51 toward the final outlet of the muffler. The shell bore is thus formed internally as an axial series of commu-

nicating Venturi passages and a contiguous pair of elements 2c cooperate to form an axial inner series of related Venturi passages which are axially offset with respect to the passages of the shell 43, so that the expansion spaces at 2e of the inner series are opposite to the constrictions 50 of the shell.

When the intruded bands 50 effect a hollow construction as at 53, with the shell wall, the frontal face of the band may be perforated as at 54 for the inflow of the sound waves.

Throughout the several forms there is employed the principle of axially successive, inner chambers having contiguous ends so formed or spaced as to provide lateral vents at each of which there is an effective slicing edge to cut the passing core of fluid, there is shown provision for either a free lateral diffusion of the vented slice, at the top of Fig. 1, or for the partial interruption of the flow to the atmosphere, as by short mufflers, Figs. 1 and 2, or for the full closed, lateral control as in the forms having elongate shells 43, with divers interrupters.

Figure 14 is a longitudinally broken, sectional elevation of a form of the inner Venturi series of chambers 2e, as in Fig. 13, where each chamber has constricted ends, but which, when two are placed end to end form a medially constricted passage which is open at 6 for lateral vent of the fluid. In Fig. 14 shell 43 is of uniform flow bore diameter and only the surface of the series of chambers 2e opposed to the wall of the shell serves to form a series expanding or semi-Venturi stages.

Figure 15 is a longitudinally broken, sectional elevation of a muffler having a shell with axially spaced expansion stages 43a with upper and lower converging walls 43b joined by spaced throats 50a forming constricted passages 51. Disposed concentrically in the shell 43a and axially along its continuous flow passage from stage to stage, there is a central conduit formed by a train of conduit sections 55 having intake ends 56 disposed in the flaring wall 43b of the relative stage 43a. The rearmost section 57 of the train is here shown as ending in the adjacent throat 50a of the shell. The leading or frontal ends of each of the conduit sections 55 and of the terminal section 57 constitutes a concentric slicing edge in the train of sections and the rear ends of the sections, except section 57, has a flared rim 58 arranged concentrically in the contiguous shell passage preferably in the rearwardly flaring wall from the relative throat 50a. Contiguous ends of the several sections of the conduit are about in a common transverse plane as at annular opening 59. Thus a part of the flowing fluid is sliced and expanded at each front end of each conduit section 55-57 and a core part of the stream passes on into the next section.

Figure 16 is a longitudinally broken, sectional elevation of a muffler having a shell as in Fig. 15 with axially successive expansion stages 43a along its wall face in the shell. In this case the muffler includes a substantially continuous conduit 55a having communication with the expansion chambers of stages 43a by way of axially spaced, annular groups of vent holes 60, which in this Fig. 16, are disposed opposite the rearwardly flaring wall part 43b.

Figure 17 is a fragmentary section of a muffler having a staged shell 43a, as above, and in the embodiment the groups of vent holes 60 are opposite a rearwardly flaring wall part 43b and the conduit part 57 projects to and ends in an

adjacent, converging wall part 43b of the shell to act with a pulling effect on fluid passing from the last stage of the shell.

Figure 18 is a fragmentary section of a muffler having shell 43a as above with a central conduit 55a. In this case the groups of vent holes 60 are arranged about in the plane of juncture between a flaring wall part 43b and the expanded or enlarged shell body.

Fig. 19 is a fragmentary section of a shell 43a and shows a group of the vent holes 60 of the conduit 55a arranged medially in the length of the relative shell enlargement.

While reference is made herein to shells and inner conduits of cylindric form, it is understood that various cross-sections are within the concept. Also the diameters of the slicing ends of the various inner conduit forming means may be of differential dimensions in a given muffler structure.

It will be seen that mufflers of the types herein exhibited may be used for control of fluid flowing in either direction therein, though with a difference in the efficiency of the device according to direction.

Referring to Fig. 9 it will be seen that the wall device 44 is of hollow form and has a front wall 44a spaced somewhat from the rear wall to form with the shell 43 a dead air space as a barrier to sound waves impacting the front, concave face wall 44a.

What is claimed is:

1. A lateral diffusion muffler including an axial series of hollow cylindric elements whose ends are juxtaposed in relation to form lateral diffusion vents spaced along the series for partial exhaust of fluid flowing in the bore of the series, and an elongate, outermost, cylindric shell structure concentric to the hollow, bore forming elements and forming therewith an axially and radially unobstructed longitudinal passageway which is unconstrictedly, annularly open at and around the far end of the cylindric element series for unobstructed flow of fluid from the passageway longitudinally and inwardly as to the end of the bore of the far element of the series.

2. A muffler including an axial series of hollow, cylindric elements whose ends are juxtaposed in spaced relation so as to form lateral,

annular diffusion vents spaced along the series for partial exhaust of fluid flowing in the bore of the series, said elements being open ended for continuous flow and each element forming a chamber in the series, and an outermost, elongate, cylindric shell structure concentric to the chamber elements and forming thereabout an axially and radially uninterrupted longitudinal flow space along the shell bore adjacent to the said elements; the said space being annularly open at its far end for discharge of the partial exhaust, and the shell having inwardly directed, annular, axially spaced restrictions with inner edges spaced from the elements and leaving said space clear along said elements for unobstructed exhaust of part of the fluid.

3. A muffler as in claim 1, and having flat, radial longitudinal ribs arranged in the flow space.

4. A lateral diffusion muffler including an axial, uniform flow bore series of cylindric elements forming chambers with spaced, open contiguous ends to form annular vents for radial expansion therefrom, and a continuous, end exhaust shell spaced about the series to form directly thereabout a longitudinal, cylindrical conduit axially unobstructed to the discharge end of the muffler.

5. A muffler as in claim 4, each of said chambers having an enlarged portion for expansion of incoming fluid not sliced off at the intake end of the chambers; the intake end of each chamber element being of less diameter than its discharge end whereby to effect a material, annular slicing function at the intake ends of the elements, and a series of angularly spaced plane blades disposed radially and longitudinally in and inwardly spaced from the shell and whose inner edges are contiguous to and axially aline the said members in the shell.

6. A muffler as in claim 4, the contiguous edges of the ends of the said elements being of differential diameter with the largest at the outlet ends of the elements and about in the same transverse plane.

7. A muffler as in claim 4, said shell and said elements having opposed deflector parts cooperating to form restricted passages along the shell bore conduit.

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