Nov. 27, 1945. R. L. LEADBETTER 2,389,988

SILENCER AND SOLID PARTICLE SEPARATOR

Filed Nov. 21, 1943 2 Sheets-Sheet 1

Fig. 1.

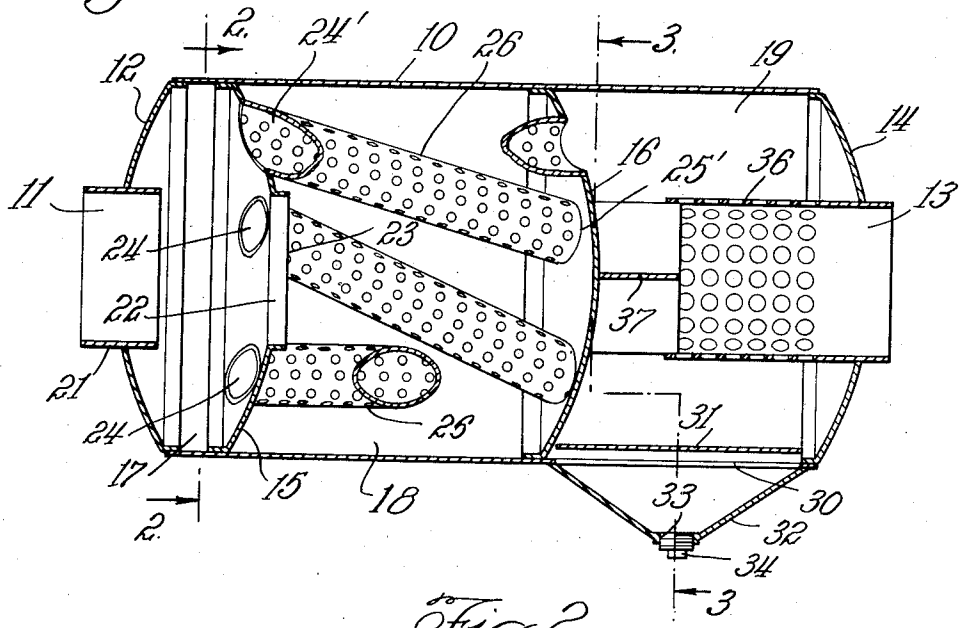


Fig. 2.

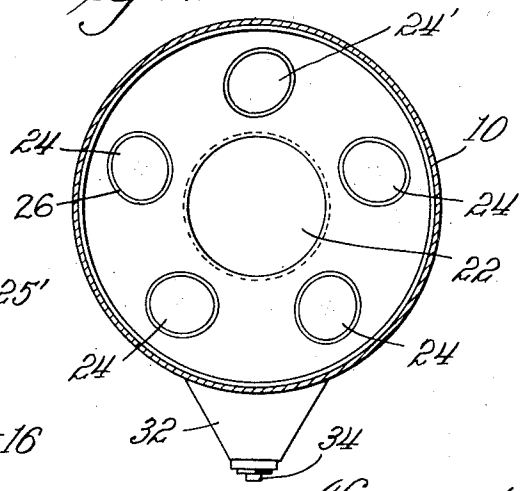
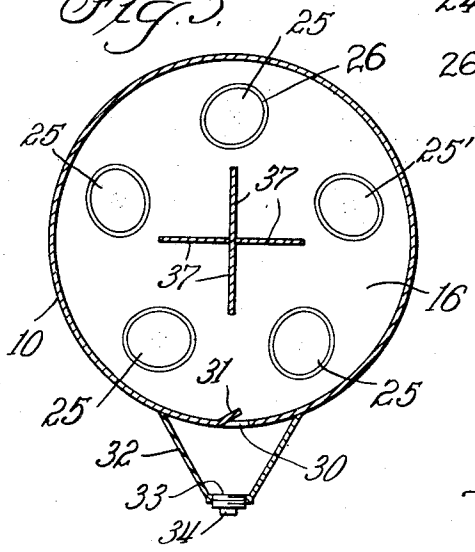


Fig. 3.



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Fig. 4.

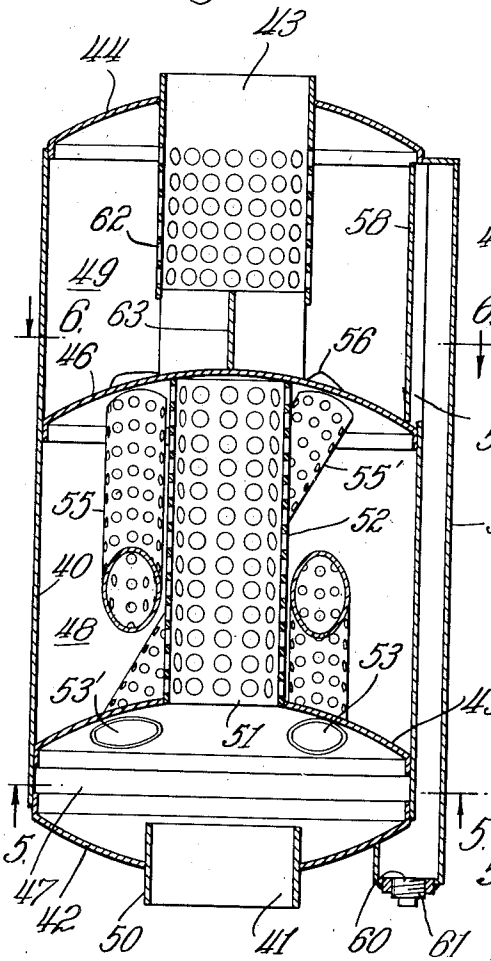


Fig. 5.

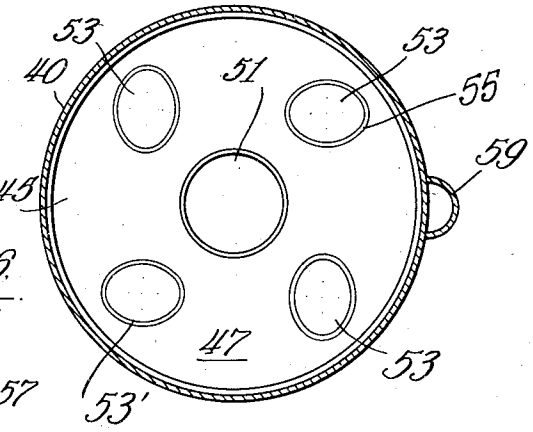


Fig. 6.

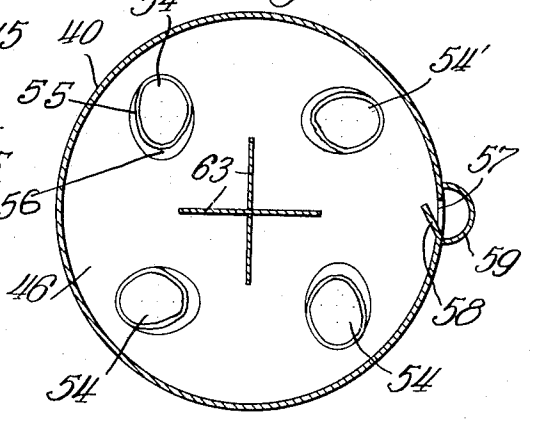
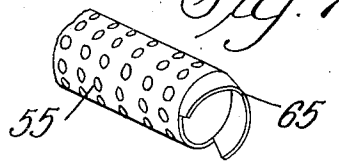


Fig. 7.



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UNITED STATES PATENT OFFICE

2,389,988

SILENCER AND SOLID PARTICLE SEPARATOR

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Application May 21, 1943, Serial No. 487,889

17 Claims. (Cl. 181—36)

This invention relates to improvements in devices for acting upon streams of pulsating gases, such as the exhaust gases of internal combustion engines, to prevent the formation of noise thereby. In particular, it relates to that form of device in which the velocity peaks of the gas pulses, or slugs, are snubbed by being allowed to expand in a chamber and then pass out of the chamber by filtering through the openings in the walls of apertured walled conduits which lead out of the chamber. A device of such character is described in Chipley U. S. Patent 2,205,899, granted June 25, 1940. The improvement of the present invention resides in the arrangement of the conduits with their axes oblique to the axis of the chamber whereby the length of the conduits within the chamber, and the effectiveness of the action of the device upon the gas slugs, are increased. In addition, as a result of the oblique arrangement of the conduits, the gases emerging therefrom are given a whirling motion which may be utilized for causing a separation of sparks, or other solid particles, from the gases.

It is, accordingly, the object of the invention to provide a device of the character described which exhibits increased effectiveness in the snubbing of the gas slugs and which inherently accomplishes the separation of solid particles from the gas stream, whereby the simple provision of a receptacle for such particles causes the device to operate as a solid particle separator as well as a silencer. The device may be referred to herein as a silencer, but it is understood that this is done for convenience and brevity, and that the device operates to snub the pressure-velocity peaks, or slugs, and thus removes the primary cause of noise rather than silences the noise after it has been created.

In the accompanying drawings:

Fig. 1 is a longitudinal sectional view of one embodiment of the invention;

Figs. 2 and 3 are transverse sectional views along lines 2—2 and 3—3 of Fig. 1;

Fig. 4 is a longitudinal sectional view of a different embodiment of the invention;

Figs. 5 and 6 are transverse sectional views along lines 5—5 and 6—6 of Fig. 4; and

Fig. 7 is a fractional perspective view of a portion of the device of Fig. 4.

The embodiment shown in Figs. 1, 2 and 3 is adapted for arrangement with its axis extending horizontally and consists of a shell 10 of cylindrical shape, which has an inlet opening 11 in inlet end wall 12 and an outlet opening 13 in outlet end wall 14, and has two spaced-apart transverse partitions 15 and 16 dividing the interior of the shell into an inlet chamber 17, a snubber chamber 18 and a separating chamber 19, arranged in succession proceeding from the inlet end wall. The end walls and partitions may be dished, as shown, for increased strength, and may be joined to the cylindrical wall of shell 10 by welding. The remainder of the parts of the structure are joined together in a similar manner.

An inlet conduit 21 passes through inlet opening 11 in a direction axially of the shell 10 and leads into the inlet chamber 17. The partition 15 has a central opening 22 therein, which is in alignment with inlet conduit 21 and has an area at least substantially as large as the cross sectional area of inlet conduit 21. To facilitate the flow of gases through opening 22, a lip 23 is provided at the edge of the opening, said lip extending into the snubber chamber 18.

Partition 15 has a plurality of openings 24 spaced from the central opening 22, and preferably adjacent the cylindrical wall of shell 10, as shown in Fig. 2. The openings 24 are spaced apart uniformly angularly with respect to the axis of the shell. Partition 16 has an equal number of openings 25 spaced from the center thereof and preferably adjacent the cylindrical wall of the shell, as shown in Fig. 3. Openings 25 are also spaced apart a uniform angular distance with respect to the axis of the shell. Apertured walled conduits 26 pass through the snubber chamber 18 and are connected at their opposite ends to openings 24 and 25 respectively. The individual openings of each pair of connected openings are arranged in non-alignment with each other, whereby the axes of conduits 26 extend in a direction oblique to the axis of the shell. In the particular device shown in Figs. 1, 2 and 3 there are five openings in each of partitions 15 and 16 and five conduits 26. One of the conduits 26 extends between the specific opening 24' in partition 15 and opening 25' in partition 16. The individual openings of each connected pair of openings are uniformly displaced an angular distance of 72° with respect to each other, the effect being as though the openings 25 were initially aligned with openings 24 and connected by conduits 26 extending in a direction parallel to the axis of the shell, and one of the partitions was then rotated through an angle of 72°. That is, looking at the device from the outlet end (as viewed in Fig. 3), partition 16 has been rotated 72° in a clockwise direction with respect to partition 15.

The effect of the arrangement is that conduits of substantially increased length can be accom-

modated within a snubber chamber of a given length. In the specific device shown in Figs. 1, 2 and 3, the conduits 26 are approximately 20% longer than they would be if they were arranged parallel to the axis of the shell. The increased length of the conduits is an important factor in obtaining improved snubbing action, as will be explained hereinafter.

A second effect of the oblique arrangement of conduits 26 is that the gases emerging therefrom are given a whirling motion in the separating chamber 19, which may be utilized for effecting a separation of solid particles from the gases. The separating chamber 19 has a slot 30 in its side wall, extending generally longitudinally of the shell. The slot 30 is formed by making a longitudinal cut in the wall and pushing the material of the wall inwardly to form a lip 31 which extends in an oblique direction toward the interior of the chamber, as shown in Fig. 3. The arrangement is such that the slot 30 is on the near side of the lip 31 in the path of the oncoming whirling gases. A receptacle 32 for solid particles is provided exteriorly of the shell 10 and in communication with the slot 30, the receptacle having bottom walls tapering downwardly to a clean-out opening 33 which may be closed by a removable plug 34. Plug 34 may be removed periodically and the receptacle emptied of accumulated particles.

An open ended outlet conduit 36 passes through outlet opening 13 and extends into the separating chamber 19 to a point adjacent the partition 16. The walls of outlet conduit 36 are preferably imperforate for a portion of their length within the separating chamber adjacent the outlet wall 14, and apertured for the remainder of their length within the separating chamber. Between the end of outlet conduit 36 and partition 16 a plurality of vanes 37 are arranged to extend radially of the conduit 36, that is, with their broad surfaces in a plane extending substantially parallel to and passing through the axis of the outlet conduit.

In operation, the exhaust system of the engine is connected to inlet conduit 21 and the pulsating exhaust gases are discharged from said inlet conduit into inlet chamber 17. The gases consist of a succession of slugs, each slug being under high pressure and traveling at high velocity and, therefore, possessing much inertia. The slug is projected from the end of inlet conduit 21 directly across the inlet chamber 17 and through opening 22 in partition 15 and into snubber chamber 18. It displaces the air or gas standing in inlet chamber 17, and this gas moves transversely in said chamber and into the ends of conduits 26 and through said conduits and into the separating chamber 19. In snubber chamber 18, the traveling slug also displaces the gases present, which filter through the apertures in the walls of conduits 26 and into said conduits and through said conduits and into the separating chamber. The slug itself expands in the snubber chamber whereby its pressure is reduced and its kinetic energy dissipated. As it expands it filters through the apertures in the walls of conduits 26 and passes into the conduits and through the conduits and into the separating chamber. Each slug has a trailing portion which is under less pressure and travels at a lower velocity than the leading portion, and this trailing portion expands transversely in the inlet chamber 17 and passes directly from inlet conduit 11 into the open ends of conduits 26 and through said conduits into the separating chamber. As a result of this action, the slugs are effectively snubbed and the gases pass into the separating chamber in a relatively steady stream, whereby the creation of noise is prevented. The action of the gases filtering through the apertured walls of conduits 26 is an important factor in producing the snubbing action. The pressure and velocity conditions at the outlet of each conduit are the resultant effect of the pressure and velocity conditions of the gases passing into the conduit through each aperture throughout the length of the conduit. There is a leveling-off action within the conduit, by which an entering high pressure pulsation is suppressed. This leveling-off action is increased with increasing length of conduit and the present invention provides a substantially increased length of conduit without any increase in the length of the apparatus.

The gases emerge from conduits 26 traveling in a direction parallel to the axes of said conduits, and because of the oblique arrangement of the conduits the gases have a component of force in a direction transversely of the axis of the separating chamber, and when the gases strike the cylindrical wall of the chamber, this component produces a whirling motion of the gases within the chamber. As a result of this whirling action, solid particles which may be present in the gases are thrown to the exterior of the vortex. The lip 31 is turned in such a direction as to intercept the particles and direct them through the slot 30 and into the receptacle 32. The gases filter through the apertures in outlet conduit 36 and also pass into the open end of said conduit. It has been found that improved separation of particles from the gases is obtained if the portion of the conduit wall adjacent the shell outlet wall 14 is imperforate as described heretofore, and that less restriction to the flow of gases through the device is offered if vanes 37 are present. Such vanes arrest the whirling motion of the gases entering the end of the conduit and the passage of the gases through the conduit is facilitated as a result.

For satisfactory operation, the area of the apertures in conduits 26 should not be so great that the slugs pass through the conduit walls so readily that they do not undergo the desired snubbing action, nor should the area be so small that the device offers excessive restriction to the passage of gas therethrough. It is preferred that the apertures in said conduits occupy an aggregate area of from approximately 0.75 to approximately 2 times the aggregate cross sectional area of said conduits. The apertures in the outlet tube 36 preferably also occupy an area equal to approximately 0.75 to 2.0 times the cross sectional area of said conduit 36. Partition 15 should be spaced from the end of inlet conduit 21 a distance such that the area of the gap between them is at least equal to the cross sectional area of the inlet conduit, that is, the area of the path which must be followed by the gas in escaping transversely from conduit 21 and passing into the ends of conduits 26 should be at least substantially as great as the cross sectional area of inlet conduit 21. In the same way, the end of outlet conduit 36 preferably is spaced from partition 16 a distance sufficient that the area of the space between such parts is at least substantially equal to the cross sectional area of the outlet conduit. The gases undergo cooling and contraction in the device, and, as a result,

the outlet conduit may be somewhat smaller in cross sectional area than the inlet conduit. From the standpoints of silencing, particle separation and structure, the individual openings of each connected pair of openings are preferably displaced angularly from each other from approximately 45° to approximately 135°.

In a specific application of a device of the construction shown in Figs. 1, 2 and 3 for use with a 2 cycle Diesel engine having 9 cylinders and a piston displacement per cylinder of 1037 cubic inches, and capable of developing a maximum brake horse power of 1600 at 800 R. P. M., the shell 10 had a length of 89 inches (between the centers of the dished end walls) and a diameter of 42 inches; the chambers were of the following length, the inlet chamber 17 inches, the snubber chamber 40 inches and the separating chamber 32 inches; the inlet and outlet conduits and opening 23 were of a diameter of 18 inches; the outlet end of the inlet conduit was spaced 14 inches from the partition 15; the inlet end of the outlet conduit was spaced 9 inches from partition 16; the apertures in the walls of conduits 26 and 36 were 1 inch diameter openings spaced approximately 4 inches apart between centers, and the individual openings of each connected pair of openings in partitions 15 and 16 were displaced from each other 72° angularly with respect to the axis of the shell.

The device shown in Figs. 4, 5 and 6 is adapted for use with the axis thereof extending vertically. The device consists of a generally cylindrical shell 40 having an inlet opening 41 in inlet end wall 42 and an outlet opening 43 in outlet end wall 44, and having spaced apart transverse partitions 45 and 46 dividing the shell into inlet chamber 47, snubber chamber 48 and separating chamber 49 arranged in succession proceeding from inlet end wall 42. An inlet conduit 50 leads into inlet chamber 47, and an opening 51 is provided in partition 45 in substantial alignment with inlet conduit 50. An apertured snubber receptacle 52 has its open mouth connected to opening 51, and extends into the snubber chamber 48. The partition 46 forms a closed end for said receptacle, opposite the open mouth thereof. Openings 53 and 54 are provided in partitions 45 and 46 respectively, said openings being spaced from the centers of said partitions and being connected by apertured conduits 55 which pass obliquely through snubber chamber 48 and provide direct communication between inlet chamber 47 and separating chamber 49 in an arrangement similar to that of conduits 26 of the device shown in Figs. 1, 2 and 3. The conduit 55′ which is seen in Fig. 4 extends between the particular opening 53′ in partition 45 (see Fig. 5) and opening 54′ in partition 46 (see Fig. 6). The openings 53′ and 54′ are angularly displaced 90° with respect to each other. Lips 56 are provided at the outlet ends of conduits 55 within separating chamber 49, said lips being formed by cutting off the end of the conduit diagonally and bending inwardly the projecting portion of the conduit wall. The lip is arranged so as to impart to the emerging gases a directional component such that the obliqueness of the path of said gases is increased.

In the side portion of the wall of separating chamber 49, a slot 57 and an inwardly projecting lip 58 are provided, similar to slot 30 and lip 31 of the device of Figs. 1, 2 and 3. Exteriorly of the slot is arranged a particle receptacle 59 extending the length of the shell and having a clean-out opening 60 at the bottom thereof which may be closed by a removable plug 61.

An outlet conduit 62 passes through outlet opening 43 and extends into separating chamber 49. Straightening vanes 63 are arranged between conduit 62 and partition 46. The details of conduit 62 and vanes 63 are similar to the corresponding features of the device of Figs. 1, 2 and 3.

The operation of the device of Fig. 4 is substantially the same as that of the device in Figs. 1, 2 and 3. The gases enter by way of inlet conduit 50 and the slugs are projected directly across the inlet chamber 47 and into the snubber receptacle 52. The apertured walls of such receptacle permit the expansion of the slugs within the snubber chamber 48, while exerting a slight restraining action upon such expansion so that the desired snubbing effect is obtained. After expanding within the snubber chamber, the gases filter through the apertured walls of conduits 55 and into said conduits and through said conduits into separating chamber 49. The lips 56 increase the obliqueness of the path of the gases as they emerge from the conduits 55 and, as a result, the whirling action and the effectiveness of particle separation are increased. The action in chamber 49 is similar to that described heretofore in connection with separating chamber 19 of the device of Figs. 1, 2 and 3.

The invention is not limited to the specific embodiments which are shown and described, and various modifications thereof may be made. For example, the separation of particles from the gases may not be required, in which case the third chamber, corresponding to chamber 19 of Fig. 1, is simply an outlet chamber, rather than a separating chamber, and the side wall thereof does not contain a slot and lip for trapping particles, and the particle receptacle may be dispensed with. In such case, also, the length of the outlet chamber may be substantially less than that of chamber 19.

Lips 56 at the ends of conduits 55 (see Fig. 4) may be of the construction shown in Fig. 7. A separate lip member 65 is mounted upon the end portion of conduit 55 projecting into chamber 49 by welding or other suitable means, and is arranged at an angle to the axis of the conduit so as to impart the desired directional component to the emerging gases. It encircles the greater portion of the periphery of the conduit and its length gradually increases from one end to the other. The end portion of greatest length is arranged upon that side of the gas stream which is to receive the deflecting force.

The number of oblique conduits passing through the snubber chamber may be varied as desired. However, if the separation of particles is required, it has been found that the use of a single oblique conduit does not impart sufficient of a whirling motion to effect the substantially complete separation of the particles. The use of two oblique conduits provides satisfactory results, but better results are obtained from the standpoint of both silencing and particle separation, if more than two conduits are provided, and excellent results have been obtained with four or five conduits. Also, while the dished shape of the ends walls and partitions shown is preferred, such parts may be flat. In the same way, the lip 23 upon partition 15 may be omitted if desired. While the conduits within the device are shown as having a large number of round apertures in the walls thereof, the apertures may

be of a shape other than round, and may be elongated slots extending longitudinally of the conduits.

I claim:

1. A device of the character described, comprising a shell, means forming an inlet chamber, a snubber chamber and an outlet chamber in longitudinal succession in said shell, gas inlet conduit means leading into said inlet chamber, said snubber chamber having an inlet opening in direct communication and alignment with and spaced from said inlet conduit means, a plurality of apertured walled conduits passing through said snubber chamber and providing communication between said inlet chamber and said outlet chamber, the axes of said conduits being oblique to the longitudinal axis of said snubber chamber, the inlet ends of said conduits being in non-alignment with said inlet conduit means, and gas outlet means leading out of said outlet chamber.

2. A device of the character described, comprising a shell, means forming an inlet chamber, a snubber chamber and an outlet chamber in longitudinal succession in said shell, gas inlet conduit means leading into said inlet chamber, said snubber chamber having an inlet opening in direct communication and alignment with and spaced from said inlet conduit means, a plurality of apertured walled conduits passing through said snubber chamber and providing communication between said inlet chamber and said outlet chamber, the interior of said snubber chamber being substantially free of obstructions whereby gases therein are substantially free to expand and pass into said conduits through the apertured walls thereof, the axes of said conduits being uniformly oblique to the longitudinal axis of said snubber chamber, the inlet ends of said conduits being in non-alignment with said inlet conduit means, said inlet chamber providing a transverse gas path between said inlet conduit means and said apertured conduits at least substantially as large as the cross sectional area of said inlet conduit means, and gas outlet means leading out of said outlet chamber.

3. A device of the character described, comprising a shell, first and second spaced-apart transverse partitions dividing said shell into an inlet chamber, a snubber chamber and an outlet chamber, a gas inlet conduit leading into said inlet chamber and having the outlet end thereof spaced from said first partition, said first partition having a primary opening therein in direct communication and substantial alignment with said inlet conduit and a plurality of secondary openings therein in non-alignment with said inlet conduit, said second partition having openings therein spaced from the center thereof and equal in number to said secondary openings, open-ended, apertured walled conduits passing through said snubber chamber and connecting each of said secondary openings to one of said openings in said second partition and providing communication between said inlet chamber and said outlet chamber, the axes of said apertured walled conduits being oblique with respect to the axis of said snubber chamber, and gas outlet means leading out of said outlet chamber.

4. A construction in accordance with claim 3, in which an open mouthed apertured walled receptacle is arranged within said snubber chamber in substantial alignment with said inlet conduit, the open mouth of said receptacle being in direct communication with the inlet chamber through the primary opening in the first partition and being spaced from the outlet end of said inlet conduit.

5. A device of the class described, comprising a generally cylindrical shell, first and second spaced-apart transverse partitions dividing said shell into an inlet chamber, a snubber chamber and an outlet chamber, a gas inlet conduit leading into said inlet chamber, said first partition having a primary opening therein at least substantially as large as the cross sectional area of said inlet conduit and in direct communication and substantial alignment with said inlet conduit, said first partition having a plurality of secondary openings therein in non-alignment with said inlet conduit, said secondary openings being in unrestricted communication with the outlet end of said inlet conduit, said second partition having openings therein spaced from the center thereof and equal in number to said secondary openings, open-ended, apertured walled conduits passing through said snubber chamber and connecting each of said secondary openings to one of said openings in said second partition and providing communication between said inlet chamber and said outlet chamber, the individual openings of each of said connected pairs of openings being angularly displaced one from the other with respect to the axis of said cylindrical shell, whereby the axes of said apertured walled conduits extend uniformly obliquely with respect to said axis of said shell, and an outlet conduit extending into said outlet chamber from the wall thereof opposite said second partition.

6. A construction in accordance with claim 5, in which the mutual angular displacement of the individual openings of each connected pair of openings is from approximately 45 degrees to approximately 135 degrees.

7. A construction in accordance with claim 5, in which the apertures in the walls of each of the conduits traversing the snubber chamber occupy an aggregate area of from approximately ¾ to approximately 2 times the cross sectional area of said conduit.

8. A construction in accordance with claim 5, in which the distance between the outlet end of the inlet conduit and the first partition is sufficient to provide a transverse escape path for the gases leaving said inlet conduit having an area at least substantially equal to the cross sectional area of said inlet conduit.

9. A construction in accordance with claim 5, in which means are provided in the outlet chamber adjacent the inlet end of the outlet conduit for arresting whirling motion of gases.

10. A construction in accordance with claim 5, in which a plurality of vanes are arranged within the outlet chamber adjacent the inlet end of the outlet conduit, said vanes being arranged generally radially with respect to the axis of said conduit and having their broad surfaces in planes substantially parallel to and passing through the axis of said outlet conduit.

11. A construction in accordance with claim 5, in which the outlet conduit extends into the outlet chamber to a point adjacent the second partition and the walls thereof are imperforate for a substantial distance from the chamber wall and are apertured for the remainder of the length of the conduit.

12. A device of the character described, comprising a shell, means forming an inlet chamber, a snubber chamber and a separating chamber in longitudinal succession in said shell, said separating chamber longitudinal wall being gen-

erally cylindrical, gas inlet conduit means leading into said inlet chamber, said snubber chamber having an inlet opening in direct communication and alignment with and spaced from said inlet conduit means, a plurality of apertured walled conduits passing through said snubber chamber and providing communication between said inlet chamber and said separating chamber, the axes of said conduits being uniformly oblique to the longitudinal axis of said separating chamber, the inlet ends of said conduits being in non-alignment with said inlet conduit means and the outlet ends of said conduits being adjacent the longitudinal wall of said separating chamber, and means at said longitudinal wall of said separating chamber for trapping solid particles whirling about the axis of said separating chamber, and gas outlet means leading out of said separating chamber.

13. A construction in accordance with claim 12, in which the obliquely arranged conduits have lips at the ends thereof opening into the separating chamber, said lips being arranged to deflect the emerging gases in such direction that the said obliqueness of their path is increased over that of the gases within the said conduits.

14. A device of the character described, comprising a shell, means forming an inlet chamber, a snubber chamber and a separating chamber in longitudinal succession in said shell, said separating chamber longitudinal wall being generally cylindrical, gas inlet conduit means leading into said inlet chamber, said snubber chamber having an inlet opening in direct communication and alignment with and spaced from said inlet conduit means, a plurality of apertured walled conduits passing through said snubber chamber and providing communication between said inlet chamber and said separating chamber, the interior of said snubber chamber being substantially free of obstruction whereby gases therein are substantially free to expand and pass into said conduits through the apertured walls thereof, the axes of said conduits being uniformly oblique to the longitudinal axis of said separating chamber, the inlet ends of said conduits being in non-alignment with said inlet conduit means and the outlet ends of said conduits being adjacent the longitudinal wall of said separating chamber, said inlet chamber providing a transverse gas path between said inlet conduit means and said apertured conduits at least substantially as large as the cross sectional area of said inlet conduit means, and means at said longitudinal wall of said separating chamber for trapping solid particles whirling about the axis of said separating chamber, and gas outlet means leading out of said separating chamber.

15. A device of the character described, comprising a shell, first and second spaced-apart transverse partitions dividing said shell into an inlet chamber, a snubber chamber and a separating chamber, the longitudinal wall of said separating chamber being generally cylindrical, a gas inlet conduit leading into said inlet chamber and having the outlet end thereof spaced from said first partition, said first partition having a primary opening therein in direct communication and substantial alignment with said inlet conduit and a plurality of secondary openings therein in direct communication and non-alignment with said inlet conduit, said second partition having openings therein spaced from the center thereof and equal in number to said secondary openings, open-ended, apertured walled conduits passing through said snubber chamber and connecting each of said secondary openings to one of said openings in said second partition and providing communication between said inlet chamber and said separating chamber, the axes of said apertured walled conduits being uniformly oblique with respect to the axis of said snubber chamber, whereby gases emerging from said conduits into said separating chamber are given a whirling motion about the axis of said separating chamber, and means at said longitudinal wall of said separating chamber for trapping solid particles whirling about the axis of said separating chamber, and gas outlet means leading out of said separating chamber.

16. A device of the class described, comprising a generally cylindrical shell, first and second spaced-apart transverse partitions dividing said shell into an inlet chamber, a snubber chamber and a separating chamber, a gas inlet conduit leading into said inlet chamber, said first partition having a primary opening therein at least substantially as large as the cross sectional area of said inlet conduit and in direct communication and substantial alignment with said inlet conduit, said first partition having a plurality of secondary openings therein in non-alignment with said inlet conduit and adjacent the cylindrical wall of said shell, said secondary openings being in unrestricted communication with the outlet end of said inlet conduit, said second partition having openings therein equal in number to said secondary openings and adjacent the cylindrical wall of said shell, open-ended, apertured walled conduits passing through said snubber chamber and connecting each of said secondary openings to one of said openings in said second partition and providing communication between said inlet chamber and said separating chamber, the individual openings of each said connected pair of openings being uniformly angularly displaced one from the other with respect to the axis of said cylindrical shell, whereby said apertured walled conduits extend through said snubber chamber uniformly obliquely with respect to the said axis, the cylindrical wall of said separating chamber having an opening therein, means forming a particle collecting chamber exteriorly of said opening, and an outlet conduit extending into said separating chamber from the wall thereof opposite said second partition, said outlet conduit walls being substantially imperforate for a substantial distance into said separating chamber from the wall thereof.

17. A device of the class described, comprising a generally cylindrical shell, first and second spaced-apart transverse partitions dividing said shell into an inlet chamber, a snubber chamber and a separating chamber, a gas inlet conduit leading into said inlet chamber and having the outlet end thereof spaced from said first partition, said first partition having a primary opening therein in direct communication and substantial alignment with said inlet conduit and a plurality of secondary openings therein in non-alignment with said inlet conduit, said second partition having openings therein spaced from the center thereof and equal in number to said secondary openings, a plurality of open-ended apertured walled conduits passing through said snubber chamber and connecting each of said secondary openings to one of said openings in said second partition and providing communication between

said inlet chamber and said separating chamber, the individual openings of each said connected pair of openings being angularly displaced one from the other with respect to the axis of said shell, whereby the axes of said apertured walled conduits are oblique with respect to the axis of said shell, the cylindrical wall of said separating chamber having a slot extending longitudinally thereof, and means forming a solid particle collecting chamber exteriorly of said slot, said separating chamber having a gas outlet opening in a wall thereof opposite said second partition.

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