March 19, 1935. R. J. MacKENZIE ET AL 1,995,071

SILENCER

Filed Dec. 2, 1929

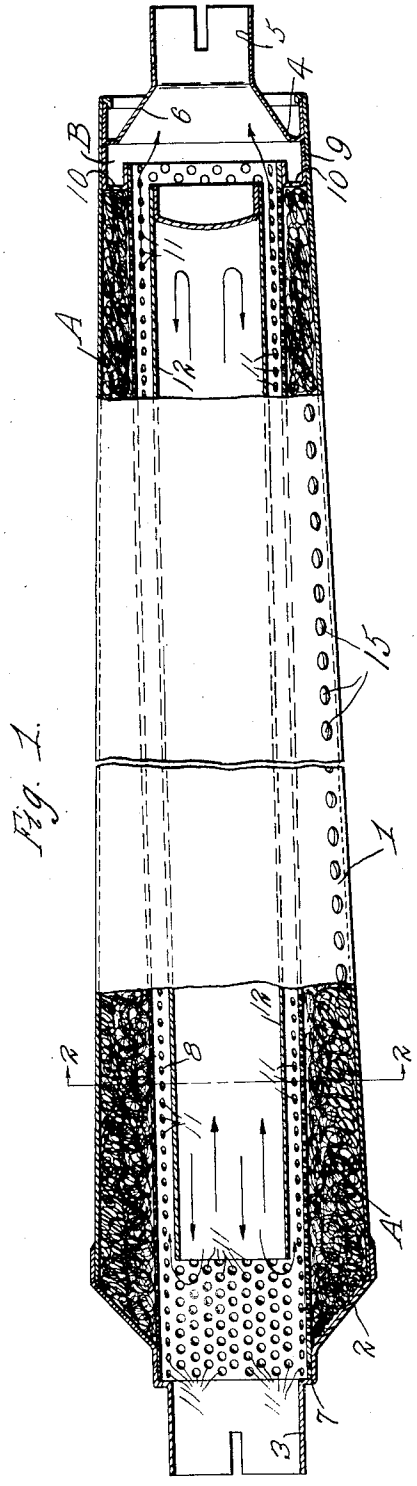

Fig. 1.

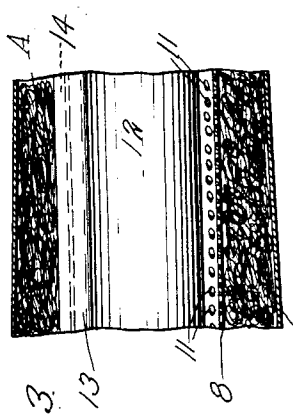

Fig. 3.

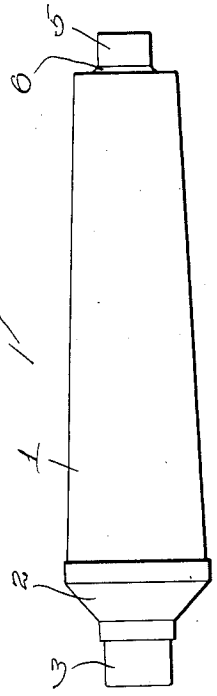

Fig. 4.

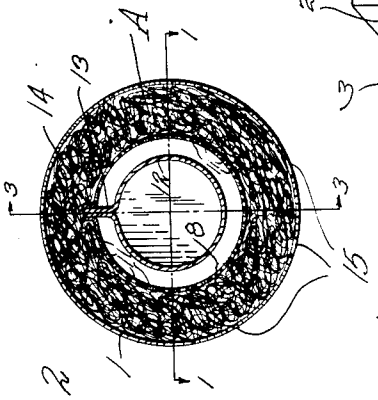

Fig. 2.

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1,995,071

## SILENCER

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10 Claims. (Cl. 137—160)

This invention relates to silencers for moving gases, and particularly to the silencing of the gases discharged from internal combustion or explosion engines as a succession of puffs.

An object of this invention is to provide an improved simple, compact, and effective silencer for moving gases.

Another object of the invention is to provide an improved silencer for moving gases, which will effectively silence the gases with a minimum back pressure; which will not be injured by internal explosions or excessive internal pressures; which will both cool and silence the gases; which may be made of any desired size depending upon the quantity of gases to be silenced or the degree of silencing required; which will be exceptionally efficient, durable and inexpensive.

A further object of the invention is to provide an improved silencer for moving gases which may be made largely of sheet metal by simple machine operations, and which will not release the gases in silencing them until desired.

Further objects and advantages will be apparent from the following description of an embodiment of the invention, and the novel features will be particularly pointed out hereinafter in connection with the appended claims.

In the accompanying drawing:

Fig. 1 is a plan, partly in section approximately along the line 1—1 of Fig. 2, of a silencer constructed in accordance with the invention and illustrating one embodiment thereof;

Fig. 2 is a transverse sectional elevation of the same, the section being taken approximately along the line 2—2 of Fig. 1;

Fig. 3 is a longitudinal, sectional elevation of a portion of the same, the section being taken approximately along the line 3—3 of Fig. 2; and

Fig. 4 is an elevation of another embodiment of the invention and illustrating the imperforate outer shell.

In the illustrated embodiment of the invention, the improved silencer includes a tubular closed casing 1, which may conveniently be of cylindrical or frusto-conical shape. This casing, which in the example is tapered, is closed at one end, such as the larger end, by an end wall 2 having a tubular boss 3 extending outwardly therefrom and forming an inlet passage for the gases to be silenced. The other, and preferably smaller, end of the tubular casing 1 may be closed by an end wall 4, which also may have an outwardly extending boss or extension 5 that forms an outlet passage for the gases after treatment.

The end wall 4 may be provided with a funnel shaped portion 6 leading to the tubular outlet extension 5 to facilitate the collection and discharge of the treated gases. The bore of the inlet passage 3 is provided adjacent its inner end with a slight shoulder or enlargement 7 forming an annular seat, and a pipe or conduit 8 is fitted at one end in said seat and supported thereby, so as to form an extension or continuation of the inlet passage or extension 3. The pipe or conduit 8 extends through the interior of the casing shell 1 in spaced relation to the peripheral wall of the casing shell, so as to provide a chamber A between the conduit and the casing shell. The pipe or conduit 8 terminates a short distance before it reaches the end wall 4, so as to provide a chamber B at the outlet end of the casing.

An annular ring or channel 9 surrounds and supports the free end of the pipe or conduit 8, and in turn is fitted within the casing shell 1, as shown clearly in Fig. 1. This channel or ring 9 is provided with any desired number of apertures 10 which provide direct communication between the chambers A and B of the casing. The conduit or pipe 8 is provided along its length, within the casing shell 1, with a plurality of apertures 11 which provide free communication between the passage of the conduit and the chamber A. The gases passing along the conduit from the inlet extension 3 may spread and enter the chamber A through apertures 11 and then either return to the passage through other apertures 11 farther along the conduit, or pass from the chamber A into the chamber B and thence into the outlet passage provided by the extension 5 of the end wall 4.

The chamber A is filled with suitable silencing means, and I have found that some filter-like material which permits of the passage of gases, yet considerably baffles and cools the same, is very satisfactory for this purpose. Inasmuch as the cooling of the gases is an important aid in their silencing, this silencing material is preferably formed of good heat conducting material such as metal wool or fibers for example. One form of such metal fibers or wool is commonly known as steel wool. The gases passing through this filter-like material are cooled and baffled, so that they reach the chamber B at a very much lower temperature with fluctuations in pressure.

The conduit or pipe 8 is preferably made at least as large as the inlet passage, and a suitable device 12 is disposed in this conduit for somewhat restricting it and for confining the gases moving along the conduit to an approximately annular or tubular layer along the periphery of

the pipe or conduit 8. This restricting device 12 thus serves to divert some of the gases through the chamber A and keeps the remaining gases in close proximity to the wall of the conduit 8 where they can be cooled thereby. The apertures 11 may extend along the entire length of the conduit 8, and the device 12 aids materially in diverting a considerable quantity of the gases through the chamber A from different sections along the length of the same.

The restricting device 12 does not entirely obstruct the conduit except as a central core therefor, and therefore there is at all times a direct passage from end to end of the silencer through which some of the gases may move. In the event of an internal explosion or excessive internal pressure, the gases can move along this direct passage to a greater extent and thus injury to the silencer will be largely avoided.

The restricting device 12 is preferably constructed to act like the pneumatic dome of a liquid pump in smoothing out or equalizing pressure fluctuations, and for that purpose, the device 12 is preferably formed of a closed tube, open only at one end and into the conduit 8, so as to have a dead air or gas chamber which acts as a pneumatic chamber in smoothing out the fluctuations of the pressure of the gases moving through the silencer. This restricting device therefor can be an elongated hollow tube-like core, somewhat smaller than the pipe 8, closed at one end, and opening at the other end into the conduit 8, this tube or core extending in a direction lengthwise of the conduit 8, as shown in Fig. 1.

Preferably the open end of the tube of the device 12 is towards the inlet end of the conduit 8, so that the inrushing gases directly compress the dead air or gases in the closed end of the tube, and such dead gases or air pneumatically smooth out or equalize the pressures of the entering gases. The tube 12 may be supported in spaced relation to the conduit 8 in any desired manner, such as by a longitudinally extending rib 13, which suspends the tube 12 from the conduit 8.

All of the parts of this silencer may be made of stamped and die drawn sheet metal, such as sheet steel. The tube 12 may be formed by rolling a strip of sheet metal into cylindrical shape, with adjacent edges flanged outwardly and abutting one another to form the rib 13. The closed end may be a plug secured in the rolled sheet. The pipe or conduit 8 may be similarly formed, with the rib 13 received between the abutting flanged edges 14, the abutting edges or flanges of both pipes or tubes 8 and 12 all being secured together in any suitable manner such as by welding or by bolts.

The operation of the silencer is believed to be obvious from the foregoing description, but briefly the action is as follows:—The gases to be silenced, such as those coming from an explosion or internal combustion engine, are conducted into the casing through the inlet extension 3. The entering gases immediately start along the conduit 8 and the pressure fluctuations are smoothed out or equalized by the tube 12 which acts as a pneumatic dome. The tube 12 preferably does not extend entirely to the inlet end, and therefore some of the entering gases can pass through the apertures 11 into the chamber A adjacent the inlet end portion of the conduit 8, and the remaining gases will start along the annular or tubular space between the device 12 and the conduit 8.

As the gases travel along the chamber between the tube 12 and conduit 8, more of the gases may pass into the chamber A and work along through the silencing material contained therein, and either return into the conduit 8 at a point farther along or else pass through the channel ring 9 into the chamber B and thence into the outlet passage of the silencer. The other of the gases of the conduit 8 will pass directly along the approximately annular space in the conduit into the chamber B, mix with the other gases which have passed through the silencing material in the chamber A, and together the gases will all pass out through the extension 5.

The gases in passing through the silencer are materially cooled and the pressure fluctuations reduced or smoothed out, so that there will be a relatively steady discharge of cooled gases from the extension 5, and such a steady discharge of cooled gases is relatively silent. When the gases are cooled the volume occupied thereby is reduced, and therefore the pressure is greatly reduced.

It will be noted that none of the gases passing through the silencer are released exteriorly of the silencer, when the outer shell or casing 1 is imperforate, as shown in Fig. 4 but are all conducted through the outlet extension 5 so that they may be conducted away to a distant point for final discharge. In this manner the discharge of gases immediately beneath the floor boards of an automobile is avoided.

In some instances, as for example in mufflers for aircraft, it may be desirable to decrease further the back pressure caused by the muffler and therefore, if desired, the casing shell 1 may be provided with apertures 15, such as in a row along the bottom of the shell, as shown in Fig. 1, for example. In those instances, some of the gases entering the chamber A may escape through the holes 15 instead of passing through the discharge end wall 4.

Silencers constructed in accordance with this invention may be adapted to motors having quite a wide range of piston displacement, merely by decreasing or increasing the diameter of the member 12, without extensive or expensive changes in tools, or large increase in the cost, even where only a small quantity of a selected size are to be produced.

It will be obvious that various changes in the details, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

What is claimed is,

1. A silencer for moving gases comprising a closed casing having a passage from an inlet end to an outlet end, and a chamber arranged along said passage and communicating therewith at a section adjacent the outlet end and also at another section materially nearer the inlet end, filter-like material filling said chamber for silencing gases passing therethrough from said passage, and a fluid pressure equalizer of the gaseous dome type disposed in said passage with its open end facing the inlet end of said passage, for smoothing out pressure variations in gases traveling in said passage and for also restricting said passage in a manner to divert some of said gases through said chamber.

2. A silencer for moving gases, comprising a

closed casing having a passage for said gases from an inlet end to an outlet end, a closed chamber arranged along said passage and communicating therewith at different sections along the passage, a dome-shaped fluid pressure equalizer disposed in said passage entirely between said sections and with its open end facing the inlet end of said passage, for smoothing out pressure variations in said moving gases and for diverting some of the gases through said chamber.

3. A silencer for moving gases, comprising a closed tubular casing having an inlet at one end and an outlet at the other end, a conduit communicating with said inlet and outlet, extending through said casing to form a chamber between it and the casing, and having a perforate wall adjacent the inlet and the outlet ends and providing communication between said conduit and the chamber between the conduit and the casing, a wall of said chamber having openings affording communication between the outlet and the rear end of said chamber, whereby gases may pass through said conduit into said chamber, and thence pass into the outlet from said chamber, and means disposed in said conduit and spaced from the walls thereof for diverting some of the gases from said conduit through said chamber and the remaining gases as a thin layer along the wall of said conduit, and means in said chamber for silencing the gases passing therethrough.

4. A silencer for moving gases, comprising a closed casing having a conduit extending therethrough and of a size smaller than the interior of the casing, so as to form a chamber around said conduit, said chamber communicating directly with the outlet end of said conduit, said conduit being apertured at points along its length to provide openings into said chamber, an imperforate tube smaller than the said conduit and disposed therein in spaced relation to the walls of the conduit, said tube having the end adjacent the outlet end of said conduit closed and disposed approximately between the point of communication of said chamber with said outlet end of the conduit and the inlet end of said conduit, said tube extending and opening toward the inlet end of the conduit, and means in said chamber for silencing the gases passing therethrough.

5. A silencer for moving gases, comprising a closed casing having a conduit extending therethrough and of a size smaller than the interior of the casing, so as to form a chamber around said conduit, said chamber communicating directly with the outlet end of said conduit, said conduit being apertured at points along its length to provide openings into said chamber, an imperforate tube smaller than the said conduit and disposed therein in spaced relation to the walls of the conduit, said tube having the end adjacent the outlet end of said conduit closed and disposed approximately between the point of communication of said chamber with said outlet end of the conduit and the inlet end of said conduit, said tube extending and opening toward the inlet end of the conduit, and metal wool in said chamber for silencing the gases passing therethrough.

6. A silencer for moving gases comprising a closed casing having a conduit extending therethrough and of a size smaller than the interior of the casing so as to form a chamber between the conduit and casing, said conduit having apertures at different points along its length opening into said chamber, and said chamber having free communication with said conduit at the outlet end thereof, means in said chamber for silencing the gases passing therethrough, and means disposed in said conduit and terminating in advance of said free communication with the outlet end of the conduit, for confining the gases moving directly through said conduit to a peripheral layer along the inner wall of the conduit.

7. A silencer for moving gases, comprising a tubular, closed shell with end walls, one end wall having an inlet passage and the other end wall having an outlet passage, a conduit connected at one end to the end wall having the inlet passage so as to form a continuation of the inlet passage of at least equal size and extending toward but spaced from the opposite end wall of the casing, means for supporting the other end of said conduit in said casing and permitting free communication of the chamber provided between the conduit and casing wall, with a chamber of the casing between the outlet wall and the free end of said conduit, said conduit being apertured along its length to provide communication between the same and said chamber, means in said chamber for silencing gases passing therethrough, and means in said conduit and extending from but in advance of said other end of the conduit for the major portion of the length of the conduit, for confining the gases passing directly along said conduit to a relatively thin layer along the periphery of said conduit, whereby some of the gases will be diverted through said chamber.

8. A silencer for moving gases comprising a closed casing having a conduit extending therethrough from end to end, and of a size smaller than the interior of said casing, so as to form a chamber surrounding said conduit within said casing, a wall of said chamber being apertured to afford communication between the chamber at the inlet and outlet end sections of said conduit, so as to provide communication between the conduit and the chamber adjacent the ends of the chamber, and means formed of imperforate walls, disposed in said conduit, spaced largely from the wall thereof, and also spaced from the ends of said conduit for diverting the gases entering the said conduit into a thin layer along the wall of said conduit, said means having a fluid chamber open at one end into said conduit and closed otherwise, whereby some of said gases may pass directly along the space between said means and the conduit wall, another portion of the gases may pass into said surrounding chamber at one part and out at another part, and the pressure fluctuations in said conduit will be evened out by said fluid chamber.

9. A silencer for moving gases, comprising a closed casing having a conduit extending therethrough from end to end, and of a size smaller than the interior of the casing, so as to form a chamber running along said conduit, a wall of said chamber having an opening into the inlet and outlet ends of said conduit, a porous mass of good heat conducting material disposed in said chamber across the path of gas flow between the openings into the inlet and outlet ends of said conduit, and a cup of imperforate metal open solely at one end disposed in said conduit and spaced largely from the wall thereof and disposed between the openings from said chamber into the ends of said conduit for diverting the gases passing along the conduit into a thin layer along the wall of said conduit, whereby

some of the gases entering the conduit may pass as a thin layer along the wall of the conduit and directly from end to end thereof, and another part of the gases may enter said chamber at the inlet end and pass through the interstices of the mass and reenter said conduit at another point nearer the outlet end.

10. A silencer for exhaust gases, comprising a closed casing converging in size from end to end, and having a conduit extending therethrough from end to end, to form a chamber surrounding the conduit and within the casing and converging in transverse area endwise, said conduit having apertures for some distance from each end, so as to provide communication between said chamber and the end sections of said conduit, a quantity of metal wool disposed in said chamber, through the interstices of which gases entering the chamber from the apertures may pass, and a core disposed in the central part of said conduit between the apertures into said chamber and spaced largely from the walls of said conduit for diverting the entering gases as a thin layer along the wall of said conduit, said core being hollow and open at one end and otherwise imperforate, whereby some of said gases may pass into and through said chamber and through the interstices in said wool, and the pressure fluctuations of the gases will be evened out by said core.

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