No. 872,453. PATENTED DEC. 3, 1907.

D. REID.

MUFFLER.

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Fig. 1.

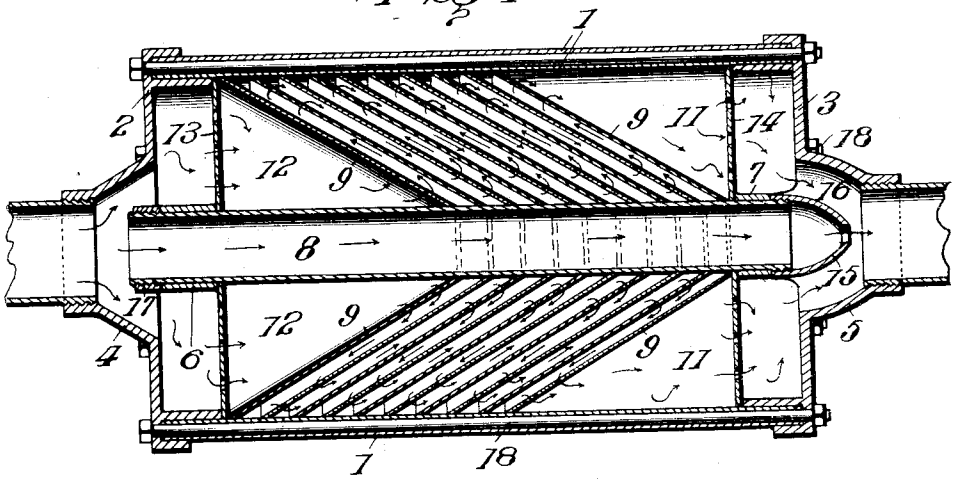


Fig. 2.

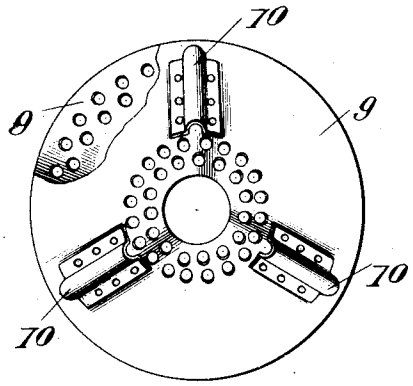


Fig. 3.

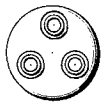


Fig. 4.



Witnesses

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MUFFLER.

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To all whom it may concern:

Be it known that I, DAVID REID, a subject of the King of Great Britain, residing at Ithaca, in the county of Tompkins and State of New York, have invented a new and useful Muffler, of which the following is a specification.

My invention relates to muffling devices such as are used to silence the exhaust of heat engines.

Heretofore two general methods of muffling the exhaust from heat engines have been used. In one method the surplus heat is abstracted from the exhaust fluid by bringing it in contact with a cooling medium before it has an opportunity to expand freely. For successful operation of such a system there must be a comparatively large body of the cooling medium, or some effective means for keeping the medium at a sufficiently low temperature, and both of these necessary features are objectionable, especially in the case of portable motors. In the second method of muffling referred to, means are provided to cause the gradual expansion of the exhaust fluid, thus preventing the concussion and noise that attends free expansion in the open air. This gradual expansion has been attended in all cases, so far as I am aware, with a considerable back pressure that materially reduces the power of the engine.

The object of the present invention is the production of a muffler that effectively uses the atmosphere as a cooling medium, that causes a gradual expansion of the exhaust fluids without the production of any effective back pressure, that is of simple construction and that is light, strong and compact.

To this end the invention consists in certain combinations and features of construction which are fully set forth in the following description in connection with the accompanying drawings which illustrate the preferred form of my invention.

In the following description and appended claims I shall use the term "gas" in referring to the exhaust fluid for the sake of convenience and for the further reason that my muffler is especially adapted for use in connection with internal combustion motors. At the same time I would have it understood that I do not intend by so doing to restrict the scope of my invention.

Referring to the drawings, Figure 1 is a central, longitudinal section through the body of the muffler which is cylindrical in form; Fig. 2 is a detached view of two of the baffling cones showing certain details of construction; Fig. 3 is an end view, and Fig. 4 a sectional view of a modified form of nozzle.

The muffler as illustrated is cylindrical in form, the side wall 1 being preferably formed of two thicknesses of sheet metal spaced apart so as to form an annular chamber adapted to receive asbestos fiber or any other suitable non-conductor. The ends of the muffler are closed by heads 2 and 3. The head 2 opens centrally through a hollow boss 4 to receive the exhaust pipe from the engine, while a similar boss 5 on the head 3 forms the outlet of the muffler. The boss 5 may open directly to the atmosphere or receive a pipe that opens to the atmosphere at a distance from the muffler. Rings 6 and 7 are formed integral with the heads 2 and 3, respectively, the rings being borne by radial ribs that project from the inner faces of the heads. These rings receive a tube 8 and upon this axial tube are arranged a series of sheet metal baffling cones 9. Each cone is formed with a series of perforations and these perforations occur alternately at the inner and outer edges of the cones, as shown in Fig. 1, also in Fig. 2 where a portion of the nearer cone is broken away to show the perforations of the one back of it. Furthermore, in the preferred form of my muffler, the perforations progressively increase in capacity from the inlet to the outlet end of the muffler, and at no place is the capacity of the muffler passages less than that of the engine exhaust pipe which the muffler is adapted to receive.

The baffling cones are spaced by means of sheet metal ribs 10 which, after being bent to form, are secured to the cones by riveting as shown in Fig. 2. While I prefer this method of spacing the cones other means can be employed; for example, the cones may be made alternately plane and corrugated. The use of conical baffle plates in a cylindrical casing forms chambers 11 and 12 at the ends of the muffler. These chambers are of considerable volume and, especially in the case of chamber 11, perform an important function in the operation of the muffler. In addition to the cones, plane perforated baffle plates 13 and 14 are interposed between the cones and the two heads of the muffler.

On the outlet end of the tube 8 is screwed a nozzle 15 that projects well into the outlet boss 5 of the muffler, thus forming an annular passage 16 that communicates with the chamber 11. The inlet end of the tube 8 is provided with a nut 17 and, as the nozzle also acts as a nut, the tube is adapted to serve as a tie rod and binds the parts of the structure securely together. I prefer, however, to supplement this means of securing the parts by providing a series of tie rods 18 that pass between the inner and outer members of the wall 1. The holes that are drilled in the heads 2 and 3 to receive these rods, are so disposed that when the rods are placed under tension they are drawn against the inner member of the wall 1 and aid materially in strengthening the structure so that a muffler explosion is sustained without injury.

In operation the gas issuing from the engine exhaust pipe enters the muffler through the boss 4, a portion passing directly through the tube 8 and nozzle 15 to the muffler outlet, while the remainder passes through the baffle plate 13 into the chamber 12 and thence enters the tortuous passage formed by the conical baffle plates. This passage leads to the chamber 11 which in turn communicates through the annular passage 16 with the muffler outlet. The flow of the gas through the two passages (direct and tortuous) is indicated by arrows in Fig. 1 of the drawing.

The results secured with the structure that has been described will be best understood by following the action within the muffler during the exhaust of the engine, the interior of the muffler being at atmospheric pressure at the start. As the exhaust gas first enters the pressure within the muffler rises momentarily on account of the resistance offered the gas by the nozzle and the baffle plates. But a jet is at once established at the nozzle, and as the gas forming this jet passes at a high velocity through the muffler outlet it has an ejector-like action that produces a partial vacuum in the chamber 11. This reduction of pressure in the chamber 11 due to the suction of the nozzle is communicated to the tortuous passage formed by the baffle plates so that the gas that had been retarded is set in more rapid motion through the passage and this, of course, has the effect of drawing the entering gas forward into the chamber 12. This suction effect due to the partial vacuum in chamber 11 is great enough to more than offset the resistance offered the gas by the baffle plates, so that the pressure at once falls below that of the atmosphere and there remains to the end of the exhaust stroke. Thus, while the pressure rises above that of the atmosphere during the first part of the exhaust of the engine, on the other hand, it falls below atmospheric pressure during the latter part of the exhaust, so that the mean effective back pressure during the exhaust stroke is practically *nil*.

Considering further the action within the muffler, it is clear that as the gas is drawn through the tortuous passage it will pass through the perforations of the baffle plates in the form of jets. As these jets impinge against the adjacent plates a considerable portion of the energy of the gas is transferred to the plates in the form of heat. This process is repeated again and again throughout the passage, the gas meanwhile gradually expanding. As the gas passes through the last baffle plate it expands rapidly in the chamber 11 and, thus losing most of its remaining surplus heat, passes out of the muffler into the atmosphere without noise. At the end of the exhaust stroke of the engine the gas left in the muffler passages moves forward to fill the partial vacuum in the chamber 11 but, before the pressure in said chamber can be raised to that of the atmosphere by this forward movement of the exhaust gas, atmospheric air is drawn back into the muffler through the casing outlet, the jet at the nozzle having been broken at the closure of the engine exhaust valve, if not before. The entrance of the comparatively cold outer air cools the muffler plates and, with the added cooling effect of the rapid expansion in the chambers and passages, the muffler is maintained at a comparatively low temperature; indeed it is found that the cooling effect extends back some distance in the engine exhaust pipe.

To review the operation briefly for the sake of clearness, as the gas enters the muffler at the beginning of the exhaust, first a jet is established and a partial vacuum created in the chamber 11. This partial vacuum is sufficient to more than offset the retarding effect of the baffle plates so that the pressure in the muffler falls and the gas is drawn rapidly through the tortuous passage, a portion of its heat being given up to the baffle plates and by gradual expansion in the manner described and its remaining surplus heat being lost in the rapid expansion that takes place as the gas enters the chamber 11. The surplus heat having been removed from the gas it passes quietly from the chamber 11 into the atmosphere. Finally, the cool outer air is drawn back into the muffler and assists the cooling effect of the expansion to maintain the muffler at a low temperature.

In mufflers of large capacity a single jet becomes too large to work silently and I then use a multiple nozzle such as is shown in Figs. 3 and 4.

What I claim as my invention and desire to secure by Letters Patent, is—

1. In a muffler, the combination of an expansion chamber, a passage for the flow of gas opening into said chamber, means disposed in said passage for retarding the flow of

gas therethrough, and means for creating a partial vacuum in said chamber.

2. In a muffler, the combination of an expansion chamber with means for utilizing a portion of the heat energy of the exhaust gas to create a partial vacuum in said chamber.

3. In a muffler, the combination of an expansion chamber, a passage opening into said chamber, means for retarding the flow of gas through said passage, and means for utilizing a portion of the heat energy of the exhaust gas to create a partial vacuum in said expansion chamber.

4. In a muffler, the combination of means for retarding the flow of the exhaust gas with means for accelerating the flow against the resistance of the said retarding means.

5. In a muffler, the combination of means for retarding the flow of the exhaust gas, with means for utilizing the heat energy of a portion of the exhaust gas to accelerate the flow of the remainder of the exhaust gas against the resistance of said retarding means.

6. In a muffler, the combination of a passage for the flow of exhaust gas, means for retarding the flow in said passage, a second passage for the flow of gas, and means whereby the heat energy of the gas flowing through said second passage is utilized to accelerate the flow of gas through said first named passage against the resistance of said retarding means.

7. In a muffler, the combination of an expansion chamber, a passage for the flow of gas opening into said chamber, means for retarding the flow of gas through said passage, a second passage for the flow of gas, and means whereby the heat energy of the gas flowing through said second passage is utilized to reduce the pressure in said expansion chamber.

8. In a muffler, the combination of a casing, an inlet and an outlet for the casing, a circuitous passage leading from the inlet to the outlet, and a direct passage leading from the inlet and opening into the circuitous passage in a manner such that gas flowing through the direct passage has a suction effect on gas in the circuitous passage.

9. In a muffler, the combination of a casing, an inlet and an outlet for the casing, a passage for the flow of gas leading from the inlet to the outlet, means for retarding the flow of gas through said passage, and a second passage for the flow of gas leading from said inlet and opening into said first named passage.

10. In a muffler, the combination of a casing, an inlet and an outlet for the casing, an expansion chamber, a circuitous passage leading from the casing inlet to said chamber, a discharge passage leading from the chamber to the casing outlet, and a direct passage leading from the casing inlet and opening into said discharge passage.

11. In a muffler, the combination of a casing, an inlet and an outlet for the casing, an expansion chamber, a passage leading from the casing inlet to said chamber, means for retarding the flow of gas through said passage, a discharge passage leading from said chamber to the casing outlet, and a direct passage leading from the casing inlet and opening into said discharge passage.

12. The combination in a muffler of a casing, an inlet for the casing, a discharge passage leading from the casing, an intermediate passage leading from the inlet to the discharge passage, means for retarding the flow of gas through said intermediate passage, an ejector nozzle disposed in said discharge passage, and means for directing a flow of gas through said nozzle.

13. In a muffler, the combination of a casing, an inlet and an outlet for the casing, an expansion chamber, a passage leading from the casing inlet to said chamber, means for retarding the flow of gas through said passage, a discharge passage leading from the chamber to the casing outlet, an ejector nozzle disposed in the discharge passage, and means for directing a flow of gas through said nozzle.

14. In a muffler, the combination of a casing, an inlet for the casing, a discharge passage leading from the casing, an intermediate passage leading from the casing inlet to the discharge passage, means for retarding the flow of gas through said intermediate passage, an ejector nozzle disposed in the discharge passage, and a passage adapted to conduct a portion of the exhaust gas to said nozzle with comparatively slight retardation.

15. In a muffler, the combination of a casing, an inlet and an outlet for the casing, an expansion chamber, a passage leading from said inlet to said chamber, means for retarding the flow of gas through said passage, a discharge passage leading from the expansion chamber to the casing outlet, an ejector nozzle disposed in said discharge passage, and a passage adapted to conduct a portion of the exhaust gas to said nozzle with comparatively slight retardation.

16. In a muffler, the combination of a casing, an inlet and an outlet for the casing, a passage leading from the inlet to the outlet, a series of baffle plates in said passage, an ejector nozzle disposed at the junction of said passage and the casing outlet, and a passage leading directly from the casing inlet to said nozzle.

17. In a muffler, the combination of a casing, an inlet and an outlet for the casing, an expansion chamber within the casing, a passage leading from the casing inlet to said chamber, baffle plates in said passage, a discharge passage leading from the expansion chamber to the casing outlet, an ejector noz-

zle disposed in said discharge passage, and a passage leading directly from the casing inlet to said nozzle.

18. In a muffler, the combination of a chamber to receive exhaust gas with means for utilizing the energy of a portion of the exhaust gas to eject gas from said chamber.

19. In a muffler, the combination of a casing, a plurality of expansion chambers within said casing that communicate with each other in series relation, and means for utilizing the energy of part of the exhaust gas to lower the pressure in one of said chambers.

20. In a muffler, the combination of a cylindrical casing, an inlet passage in one head of the casing and an outlet passage in the other head thereof, a straight, axially disposed passage leading from the casing inlet passage and terminating in a nozzle arranged to discharge into the casing outlet passage, and a plurality of conical baffle plates surrounding the axially disposed passage and forming a circuitous passage from the inlet passage to the outlet passage.

21. In a muffler, the combination of a cylindrical casing, an inlet passage in one head of said casing and an outlet passage in the other head thereof, a straight, axially disposed passage leading from the inlet passage and terminating in a nozzle arranged to discharge into the outlet passage, an expansion chamber in the casing and in communication with the outlet passage thereof, and a plurality of conical baffle plates surrounding said axially disposed passage and forming a circuitous passage between the inlet passage and said expansion chamber.

22. In a muffler, the combination with a cylindrical casing having an inlet port in one end and an outlet port in the other end thereof, of a straight, open ended tube disposed axially in said casing and secured at its ends to the respective casing heads, a nozzle on one end of said tube having its outlet in line with the outlet port of the casing, an expansion chamber in the casing, a discharge passage surrounding the said nozzle and leading from the expansion chamber to the outlet port of the casing, a plurality of conical baffle plates arranged symmetrically on said tube and extending to the side wall of the casing, each baffle plate being provided with perforations that are staggered with respect to the perforations in the adjacent plates, and means for spacing said plates whereby a circuitous passage is formed leading from the casing inlet port to the expansion chamber.

23. In a muffler, the combination of a casing, means in said casing for absorbing heat from the exhaust gas passing therethrough, and means whereby a current of air is intermittently drawn into said casing in alternating sequence with the passage of exhaust gas therethrough.

24. In a muffler, the combination of an expansion chamber comprising a plurality of compartments that communicate with each other in series relation, an ejector nozzle disposed so as to exhaust the gas from one of the compartments, and means for directing a portion of the exhaust gas through said nozzle.

25. In a muffler, the combination of a casing, an inlet and an outlet for the casing, a plurality of expansion chambers communicating with each other in series relation and constituting a passage leading from the inlet to the outlet, an ejector nozzle disposed at the junction of said passage and the casing outlet, and a passage leading from the casing inlet to the nozzle.

In testimony whereof I affix my signature in presence of two subscribing witnesses.

DAVID REID.

Witnesses:

S. E. BANKS,

FLORENCE L. SMITH.