Dec. 14, 1948. G. WOHLBERG 2,455,965

WET-TYPE, WATER-SEPARATING, STEAM-INHIBITING, EXHAUST MUFFLER

Filed March 25, 1943 2 Sheets-Sheet 1

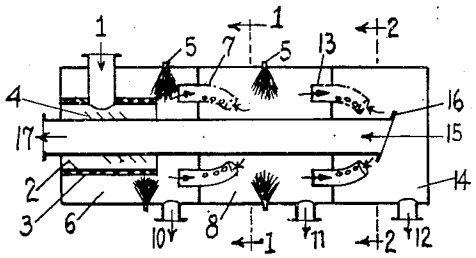


Fig. 1

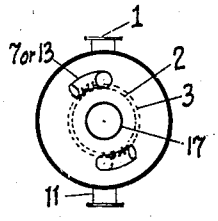


Fig. 2

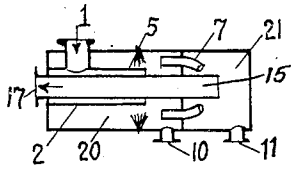


Fig. 3

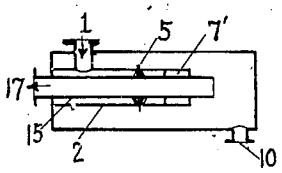


Fig. 4

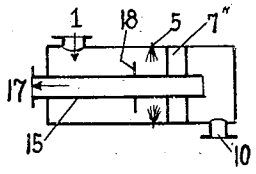


Fig. 5

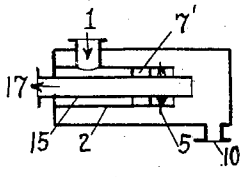


Fig. 6

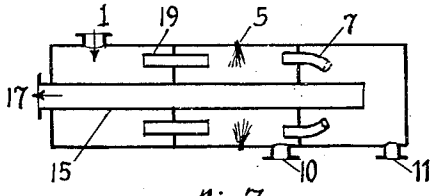


Fig. 7

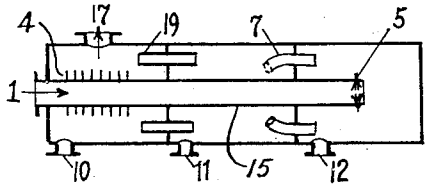


Fig. 8

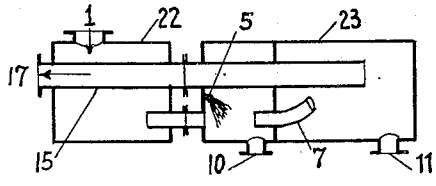


Fig. 9

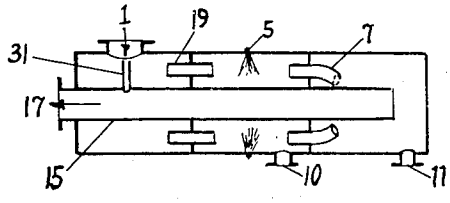


Fig. 10

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WET-TYPE, WATER-SEPARATING, STEAM-INHIBITING, EXHAUST MUFFLER

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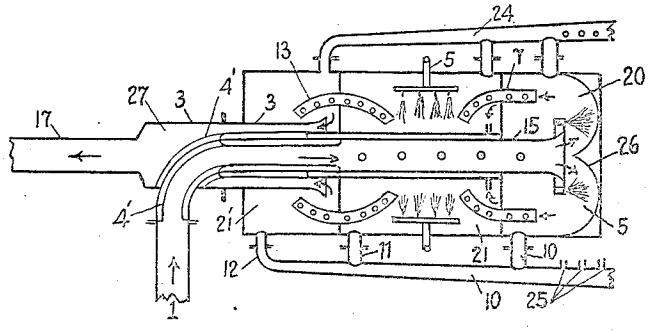


Fig. 11

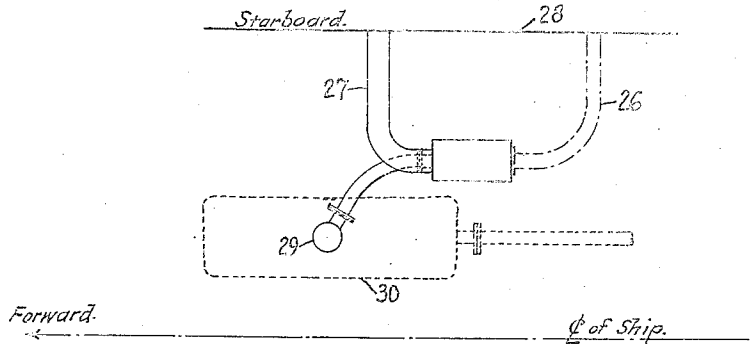


Fig. 12

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WET-TYPE WATER-SEPARATING STEAM-INHIBITING EXHAUST MUFFLER

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Application March 25, 1943, Serial No. 480,554

12 Claims. (Cl. 181—52)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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This invention deals with wet-type, water-separating, steam-inhibiting exhaust mufflers which may be adapted for use on watercraft engines to avoid detection of the craft by the enemy in time of war. In operations within possible range of enemy observation, or detection by sound, it is necessary not only to muffle the noise of the exhaust but also to render it invisible in the daytime or at night. It is therefore very desirable to inhibit the discharging of sparks, flame, steam plumes and even water spray, which may interfere with activities on deck and other operations.

The object of the present invention is to construct a muffler which will serve the above purpose in a simple yet efficient manner.

A further object is to make a muffler of the above type adaptable for either original installations or to replace mufflers on existing installations which may not be as efficient for the purposes outlined.

A further object is to build a muffler which will eliminate sparks by introducing one or more water spray curtains into the path of the exhaust gases, will then separate the water particles out by centrifugal action and will then conduct the comparatively dry gases through a heat exchanger to raise their temperature well above the ambient point before releasing them into the atmosphere, so as to enable their sufficient dispersion in the air before any visible condensation can occur.

Further and more specific objects will become apparent as this description proceeds, with reference to the accompanying drawings of some illustrative examples of construction, in which:

Fig. 1 is a diagrammatical sectional view of a preferred form of my muffler;

Fig. 2 is a sectional view thereof taken at either 1—1 or 2—2 in Fig. 1;

Fig. 3 is a sectional view of another form of my muffler, which has only one spray chamber and one centrifuging chamber;

Fig. 4 is a sectional view of still another form, having means for passing the gases through the water spray and whirling them in a more restricted passage;

Fig. 5 is a sectional view of still another form, using a shield for directing the gases into more intimate contact with the spray curtain prior to whirling the gases;

Fig. 6 is another form similar to that of Fig. 4 but having the whirling means placed before the spray means;

Fig. 7 is another form of muffler, having restricted conduits for directing the gases toward the water spray nozzles;

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Fig. 8 is another form similar to that of Fig. 7 but with the inlet and outlet in reversed positions and the spray nozzles transposed to cover the end of the inlet duct;

Fig. 9 is another form, in which the heat exchanger unit is separated from the spray chamber and centrifuging means, for better insulation;

Fig. 10 is another form, in which a portion of the hot exhaust gases is bled into the outlet to assist in raising the temperature of the outgoing gases;

Fig. 11 is another form, showing the use of heat conducting fins on one portion of the inlet conduit and a cooling jacket around another, and

Fig. 12 shows another and final form adapted for replacement of a conventional muffler used in a submarine installation.

Similar parts in the several forms and figures of the drawings are designated by like numerals.

Referring to Fig. 1, the exhaust gases from the engine enter the muffler through a suitably located inlet connection 1 which leads into jacket 2, covered by insulation 3. Thence, the gases flow into chamber 6 where they are mixed with water supplied through any suitable means 5. The wetted gases then flow through conduits 7, which are curved, bent or otherwise so disposed as to induce a whirling motion of the medium in chamber 8. Additional water is supplied in chamber 8 in order to cool the gases further and to condense the steam formed in chamber 6. Excess water in chambers 6 and 8 is removed through drains 10 and 11, respectively. The whirling action in chamber 8 facilitates the water-removal process. The gases pass from chamber 8 to the next chamber 14 through conduits 13 which are similar to conduits 7. In chamber 14 the entrained water is separated from the exhaust gases by centrifugal force and gravity. Any water remaining in the gases at this stage is largely water-vapor which cannot be removed by mechanical means, but is treated by a subsequent process. Water is removed from chamber 14 through drain 12. The gases then flow into conduit 15. Before leaving the muffler they must traverse that section of conduit 15 which has heat transfer fins 4 and is surrounded by jacket 2, and which is heated to a relatively high temperature by the incoming, hot gases from the engine. In this region, the temperature of the outgoing gases is raised, and by this process the formation of visible steam at the outlet terminus 17 of the muffler is inhibited.

The objects of the invention which relate to the wetting of the exhaust gases, the separation of entrained water and the inhibition of steam formation may be accomplished by various devices, different in design, arrangement, form and number of chambers employed, but similar in principle to that shown in Figure 1. Diagrammatic examples of some of the many possible variants of the basic idea are shown in Figures 3 to 12, inclusive. Figure 3 shows a device consisting of only two chambers 20 and 21. All of the water is introduced in the first chamber 20; water separation takes place in the second chamber 21. Figures 4, 5 and 6 depict single chamber mufflers in which the introduction and separation of water and the reheating of the outgoing gases all occur in the same chamber. Figures 7 and 9 show devices in which the reheating jacket is formed by the shell of the muffler. Figure 8 illustrates an arrangement which is the inverse of that in Figure 1. In Figure 8 the cool, outgoing gases surround the conduit bearing the hot, incoming gases, whereas in Figure 1 the opposite arrangement is used. Figure 9 shows one of the many possible ways in which the muffler constituting this invention may be built in sections 22 and 23. The sections may be separated, if necessary.

In Fig. 11, the incoming gases are passed through the central conduit 15, through a water spray against a reverse baffle 26 at the end of the muffler into chamber 20, then through centrifugal ducts 7 into chamber 21, where they pass through another water spray, then through ducts 13 into chamber 21' whence they enter the heat exchanger portion by way of the restricted angular passage 27, and after being reheated, they are discharged through the outlet 17.

Fig. 12 shows a form of muffler built in accordance with the present principles and adapted to replace a specific installation in a submarine. The conventional location of the old tail pipe is shown in dot and dash lines at 26. The discharge in the new installation is at 17 into the tail pipe 27. The inlet 1 is coupled to the exhaust manifold 29 of engine 30 which passes down through the wall of the engine compartment.

By suitable location of the component parts, any of the devices involving the principles of this invention may be adapted for operation in either horizontal, vertical or in any intermediate position. The horizontal position shown in the figures is used only for convenience in representation.

The arrangement of component parts does not necessarily need to be concentric, circular, or symmetrical.

The principles of operation outlined above and their adaptation to practice are not limited to any particular number, shape, size or arrangement of the conduits, external shells, external connections or other component parts employed, nor by the directions of gas-flow occuring within the muffler.

To conserve the heat available for raising the temperature of the outgoing gases, jacket 2 in Figure 1 is preferably covered on either or both sides by a suitable heat-insulating material 3, or it may be made entirely of such material. The purposes of jacket 2 may also be served by structures having multiple, or cellular walls.

To improve heat transfer between the incoming and outgoing gases, conduit 15 in any of the forms shown may be equipped with fins 4 (Figs. 1 and 8) or other devices 4' (Fig. 11) used for extending heat-transferring surfaces.

Conduits, such as 7 and 13 in Figure 1, which are curved or bent may be perforated in any suitable maner to make them act as acoustical filters with side-branches. When so perforated, the perforations should be placed on that side of the conduit which is opposite to the direction in which the medium flowing through the conduit is impelled by the centrifugal force developed by curvature or bending of flow-path. By so doing, unwanted leakage of the medium is minimized without impairing the acoustical filtering function of the side-branches.

Water drains such as 10, 11 and 12 in Figure 1 should be connected to conduits which either terminate below the water-line of the vessel or else are so constructed as to have appropriate acoustical filtering properties for minimizing noise leakage through the drainage path. Such filters may be constructed by suitably perforating drain conduits as shown, e. g., at 25 in Fig. 11, to form acoustical filter side-branches, by combining perforations with tubes, by enclosing the drain conduits with a cover to form spaces which are acoustically connected to the conduit for filtering purposes, or by filtering devices inserted into the conduit.

Wet mufflers, in which a portion of the hot gases coming into the muffler are directly admitted into and mixed with the cooler outgoing gases and serve to reheat the latter, are one of the variant forms of this invention. An example of such construction is shown in Figure 10, by the bleeder 31 for admitting a portion of the hot exhaust gases from the inlet 1 directly into the heater portion of duct 15.

Centrifuging action by whirling the mixture of gases and water particles on their journey through the muffler may be obtained in any one of a number of different ways, only some examples of which are shown diagrammatically in the drawings. In Figs. 4 and 6 inclined vanes 7' are used in the outlet end of the jacket 2. In Fig. 5, similar vanes 7'' are used around the end of the duct 15.

Where space permits, it may be advisable in some installations to make the heat exchanger portion of the muffler as a separate unit 22 coupled to the rest of the muffler 23, as shown in Fig. 9. The specific design for any particular installation will obviously depend on many factors and considerations to suit requirements.

The scope of the present invention is therefore not limited to the particular modifications of the device disclosed in the drawings, but is defined by the appended claims.

This invention may be used by or for the Government of the United States for governmental purposes without the payment to me of any royalties thereon or therefor.

What is claimed is:

1. A wet type exhaust muffler comprising a casing having inlet and outlet sections in heat exchanging relation concentrically arranged, the outlet section being a pipe extending through one end of said casing and nearly to the other, the inlet section being an insulated cylindrical baffle formed in the casing around the outer end of the outlet section and having an annular opening at its inner end in communication with a wetting and cooling chamber, water spray means in said chamber, an annular wall around said outlet section in said casing having helically shaped conduits passing therethrough from said chamber

to a water separating chamber, and drainage means for carrying away the excess and separated water from said chamber.

2. A wet type exhaust muffler comprising a casing having inlet and outlet sections in heat exchanging relation concentrically arranged, the outlet section being a pipe extending through one end of said casing and nearly to the other, the inlet section being an insulated cylindrical baffle formed in the casing around the outer end of the outlet section and having an annular opening in its inner end in communication with a wetting and cooling chamber, water spray means in said chamber, an annular wall around said outlet section in said casing having helically shaped conduits passing therethrough from said chamber to a separating chamber, and drainage means for carrying away the excess and separated water from said chamber, said conduits having perforations therein for assisting in the attenuation of the noise level.

3. A wet type exhaust muffler comprising a casing, inlet and outlet means passing concentrically through one end of said casing, the inlet being inside the outlet means and extending nearly to the other end of the casing where it flares and is provided with water sprays, an annularly grooved deflecting baffle at said end of the casing for smoothly reversing the flow from said inlet means into the annular space around it, a pair of axially spaced annular walls in said casing around said inlet means forming a middle annular wetting and cooling chamber having water sprays therein and a drying annular chamber in communication with the annular opening between the inlet means and the inner end of the concentrical outlet means, helically shaped conduits passing through said walls for imparting a whirling motion to the gases for mixing them with the sprays in the middle chamber and for centrifugally separating the particles of water out of the gases as they pass through the drying chamber before entering the outlet means, axial fins on said inlet means for increased heat transfer to the dry gases as they pass through the outlet means, and drains in said drying and wetting chambers and in said end space for collecting the excess and separated water connected to a common manifold.

4. A wet type exhaust muffler as defined in claim 3 wherein the casing has vent passages at the top of said chambers and space connected to a common manifold, there being a series of perforations in said conduits and said manifolds for aiding in the attenuation of the noise level.

5. A wet-type exhaust muffler comprising an outlet conduit, means having an outlet end for passing the hot gases entering the muffler in heat-exchanging relation with said outlet conduit, water spray means positioned in the muffler in the vicinity of said outlet end for spraying the said gases after they pass through said heat-exchanging means, deflecting means positioned in the muffler in the vicinity of the side of the spray means remote from said outlet end for imparting a whirling motion to the gases after they leave the water spray means to separate the water particles therefrom before passing the resulting comparatively cool and dry gases through said outlet conduit.

6. A wet-type exhaust muffler comprising an outlet conduit, an inlet conduit in heat exchanging relation with said outlet conduit, water spray means in said muffler beyond said inlet conduit for quenching any incandescent particles in the exhaust gases, and helical conduits in the vicinity

of the side of the spray means remote from said inlet conduit provided with noise attenuating perforations for centrifugally separating the water from said gases after they pass the water spray means and before they reach the outlet conduit.

7. A counter-flow wet-type exhaust muffler comprising an inlet conduit positioned near one end of the muffler adapted to conduct exhaust gases thereinto, a tail pipe extending through the one end to its inlet and near the other end of the muffler provided with a longitudinal passage in juxtaposition to said inlet conduit near the one end of the muffler for maximum heat transfer from said inlet conduit to said tail pipe passage whereby the flow of the exhaust gas is from the inlet conduit around and along the tail pipe to the said inlet end near the other end of the muffler where it enters the said longitudinal passage and flows in a direction counter to the flow from said inlet conduit, water spray means for the gases flowing from said inlet conduit, a partition in said muffler between said water spray means and the inlet end of said tail pipe provided with helically formed conduits passing therethrough for imparting a whirling movement to the gases to assist in separation of the water particles therefrom and drainage means for the water from both sides of the partition.

8. A counter-flow wet-type exhaust muffler comprising an inlet conduit positioned near one end of the muffler adapted to conduct exhaust gases thereinto, a tail pipe extending through the one end to its inlet end near the other end of the muffler provided with a longitudinal passage in juxtaposition to said inlet conduit near the one end of the muffler for maximum heat transfer from said inlet conduit to said tail pipe passage whereby the flow of the exhaust gas is from the inlet conduit around and along the tail pipe to the said inlet end near the other end of the muffler where it enters the said longitudinal passage and flows in a direction counter to the flow from said inlet conduit, water spray means for the gases flowing from said inlet conduit, a partition in said muffler between said water spray means and the inlet end of said tail pipe provided with helically formed conduits passing therethrough for imparting a whirling movement to the gases to assist in separation of the water particles therefrom and drainage means for the water from both sides of the partition, said helical conduits also provided with perforations therealong for attenuating the noise level.

9. A wet-type exhaust muffler for internal combustion engines comprising inlet and outlet means, a section provided with passages or spaces arranged in heat-transferring relation to one another so that the hot gases flowing through the inlet means can impart heat to the cooled gases leaving the muffler through the outlet means, a second section provided with water sprays for the gases coming from the inlet means to cool them and to quench sparks, a drain for the excess water in this section, a third section connected to the outlet means provided with means for imparting a whirling motion to the gases coming from the second section for centrifugally separating the water particles from the wet gases and draining means in said third section for the separated water.

10. A wet-type exhaust muffler comprising an outlet portion, an inlet conduit having heat-exchanging relation with said outlet portion and a second portion connected with said inlet conduit

and outlet portion provided with continuous water spray means in said muffler at the inner end of said inlet conduit for quenching sparks and cooling the exhaust gases, helically curved conduits in said second portion between the spray means and the outlet portion provided with noise attenuating properties imparted to them by openings of suitable size and spacing along their lengths, said conduits serving to separate the entrained water by whirling the gases prior to their reaching said outlet portion, and drain means in said second portion for carrying away the excess separated water.

11. A wet-type exhaust muffler comprising a casing divided into transverse sections, inlet and outlet ducts telescopically arranged in the first section to transfer heat from the inlet duct to the outlet gases, the said inlet duct extending along and exteriorly of the said outlet duct and terminating in the first section at its inner end in an annular opening, the said outlet duct extending through the other sections to its inner end at a point near the end of the casing, water spraying means at the inner end of the inlet duct in the first section for quenching and cooling the gases, means for imparting a whirling motion to these cooled wet gases as they flow on through the sections to separate the water particles out of the gases, drainage means in each section to carry away this sprayed water and passage means in the last section to the inner end of the outlet duct.

12. A wet-type exhaust muffler comprising a casing divided into transverse sections, the first section adapted to function as an exhaust gas inlet, a gas outlet conduit arranged in heat exchanging relationship with the first section extending in the casing through the sections to its terminus at a point near the end wall of the casing, a baffle adapted to form the inner end wall of the inlet section provided with passages from said section to a second section adapted to wet and cool the gases flowing therethrough, water spray means in the said second section, a baffle wall provided with helical conduits passing therethrough from said second to a third, separating section, drainage means for carrying away the excess water in the second and third sections of the casing and direct leakage means between said first gas inlet section and gas outlet conduit.

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