

April 15, 1941.

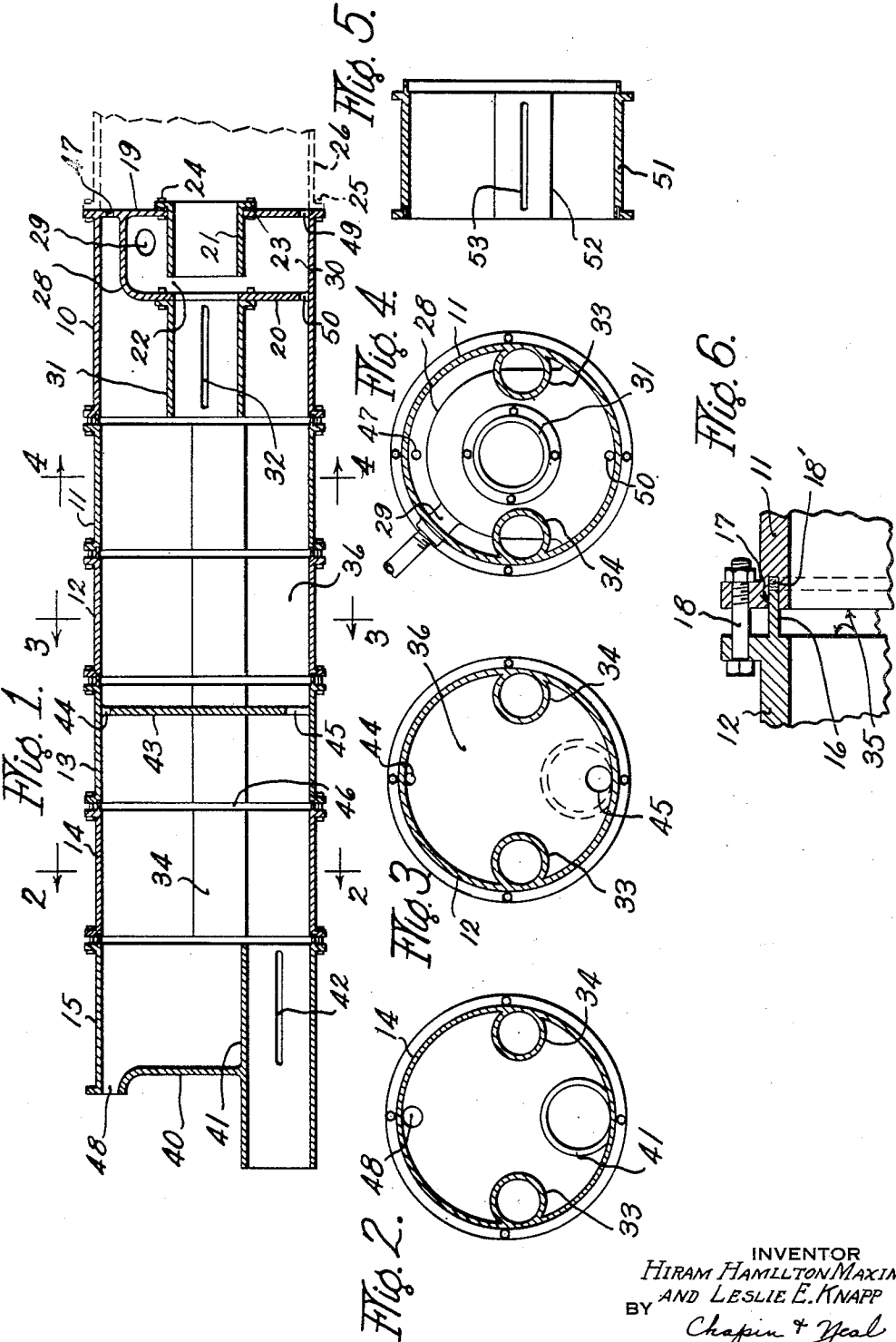
H. H. MAXIM ET AL

2,238,816

SILENCER

Filed Dec. 2, 1939

2 Sheets-Sheet 1



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Fig. 7.

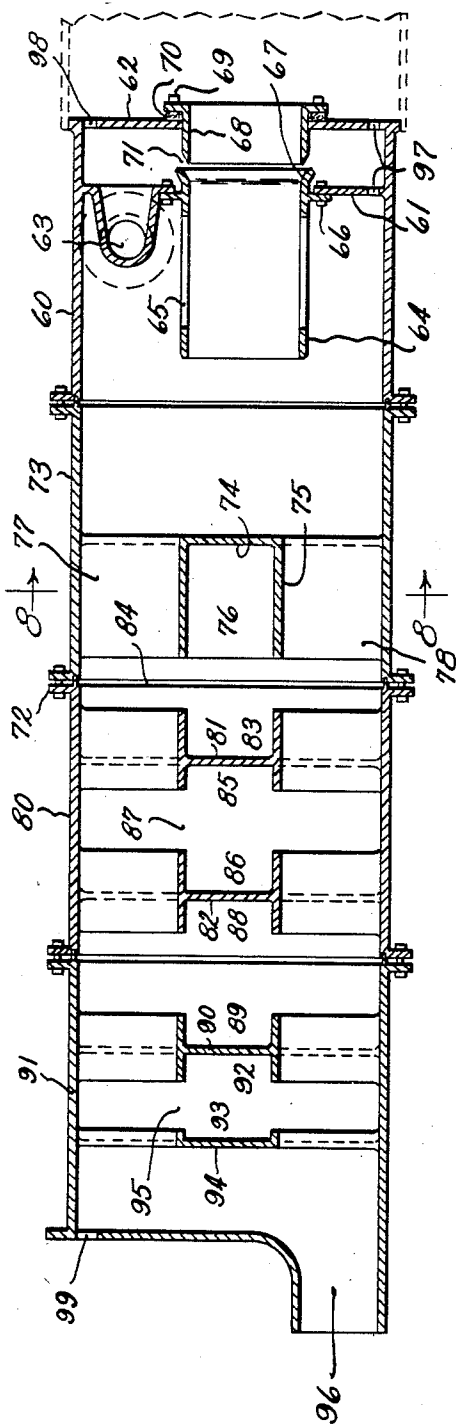
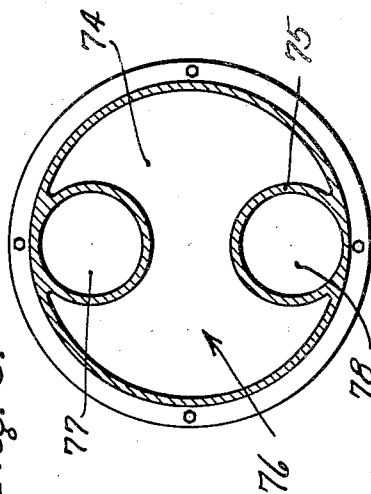


Fig. 8.



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SILENCER

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13 Claims. (Cl. 181—48)

The present invention relates to mufflers particularly designed for internal combustion engines, and has particular reference to installation where cooling water is passed through the exhaust line. A particular application of mufflers of this type is found in silencers designed for submarines, where the use of salt water for cooling makes it necessary to form the silencer from cast iron on account of the resistance of this material to corrosion. By reason of the use of cast iron many of the usual features of construction found in mufflers made of sheet material cannot be employed.

It is one object of the present invention to provide a construction capable of being embodied in a cast iron muffler by which the acoustic principles described in the copending application of R. B. Bourne, Serial No. 290,353, filed August 16, 1939, may be employed. A further object is to provide a novel construction for causing instantaneous mixing of the cooling water with the exhaust gases and for controlling the admission of this water. A further object is to provide a mechanical construction by which a silencer of the type shown in the Maxim Patent 2,093,893, September 21, 1937, may be constructed economically out of cast iron instead of out of sheet steel as shown in that patent. Additional objects will appear from the following description and claims.

Referring to the drawings:

Fig. 1 is a longitudinal cross-section through a muffler embodying the present invention;

Fig. 2 is a section on line 2—2 of Fig. 1;

Fig. 3 is a section on line 3—3 of Fig. 1;

Fig. 4 is a section on line 4—4 of Fig. 1;

Fig. 5 is a longitudinal section through one of the constructional units of the muffler illustrating a modification;

Fig. 6 is an enlarged detail showing a detail of construction;

Fig. 7 is a longitudinal section through a silencer constructed in accordance with the present invention but embodying the acoustical principles set forth in the Maxim Patent 2,093,893; and

Fig. 8 is a section on line 8—8 of Fig. 7.

The muffler is formed of a series of tubular castings connected as will be described below. In detail it comprises an inlet casting 10, intermediate castings 11, 12, 13 and 14 and an outlet casting 15. These are formed as cylindrical shells having their end surfaces preferably machined and provided with projecting annular lugs 16 (Fig. 6) entering into mating annular grooves 17 so that adjacent sections may be held together by bolts 18. Packing material 18' may be located at the bottom of the grooves 17.

The inlet section 10 includes an end header 19

and an intermediate header 20. Extending through the header 19 is a tubular member 21 longitudinally adjustable as will be described to form a variable annular gap 22 between its end and the intermediate header. The width of the annular gap may be varied by inserting gaskets 23 of different thicknesses underneath the flange of the member 21, this flange being held to the header 19 as by bolts 24. The member 21 serves as the inlet connection for the silencer, the end header 19 being connected as by bolts 25 to a portion of the exhaust line indicated at 26. In the case of a submarine silencer this portion of the exhaust line is what is customarily referred to as an evaporator.

The headers 19 and 20 are connected by a bridge piece 28 forming a chamber into which passes a water inlet pipe 29. Water entering through this connection passes first into the chamber 30 within the bridge member 28 and then through the annular slot 22 to mingle with the exhaust gases passing through the tubular member 21. The exhaust gases, together with the water mingled with them, are then passed through a central aperture of the header 20 into a tubular member 31 bolted thereto, this member preferably having a longitudinal slot 32 cast therein for reasons set forth in the Bourne application referred to.

The intermediate sections 11, 12, 13 and 14 each comprise laterally disposed tubular conduits 33 and 34 cast therein and extending from one end of the casing to the other, preferably being machined flush with the ends of the sections. By reason of the packing material 18', however, the machined ends 35 of the sections do not quite touch each other and this causes a similar separation in the adjacent conduit sections 33 and 34. At the line of separation between the sections, therefore, the conduits 33 and 34 open out into the large space 36 occurring within each of the intermediate sections. The purpose of this construction will appear more fully below.

The outlet section 15 is provided with an end header 40 and with a conduit 41 preferably located at the bottom of the muffler to permit draining, but out of line with the two conduits 33 and 34 as appears in Fig. 2. It should be noticed from Figs. 2 and 4 that the size of the sections is made sufficiently greater than the size of the inlet conduit 31 and the outlet conduit 41 so that neither of these will overlap the side conduits 33 and 34. Similarly to the tubular member 31, the outlet conduit 41 is preferably provided with a longitudinal slot 42 and is open at its end adjacent the section 14.

Disregarding for the moment the arrangement of parts to permit the use of water, it will appear that the exhaust gases enter the muffler through the pipe 31 and also through the

slot 32 in the side thereof. The end of the pipe 31 approaches, but is laterally offset from, the ends of the conduits 33 and 34; and, as is fully described in the Bourne application referred to above, the multiplicity of paths thus offered to the exhaust gases and sound waves result in a practically complete silencing action. A similar effect occurs where the section 14 joins onto the section 15. One or more of the sections, here shown as the section 13, is provided with a baffle 43 to break up the direct passage for gas otherwise afforded by the space 36 within the sections. Top and bottom vent and drain holes 44 and 45 in this partition permit some passage of gas and sound, this additional passage resulting in further attenuation due to the fact that sound waves passing through these openings will reunite with the main body in a different phase condition. The gaps 46 between the adjacent section conduits 33 and 34 serve to prevent any occurrence of series resonance and also provide a plurality of possible paths for the gas and the sound waves to still further increase the attenuation.

Since the silencer is intended for use with water and may be flooded during submersion of the submarine it is necessary to provide vent and drain openings at each end. For this reason a vent opening 47 is provided in the end header 19 and a vent hole 48, which may be controlled by a valve if desired, is provided in the end header 40. Drain holes 49 and 50 are provided in the headers 19 and 20 respectively, the conduit 41 furnishing a drain at the opposite end. Fig. 5 shows a modification of one of the sections, here indicated at 51. In this case, the longitudinal conduits 52 corresponding to the conduits 33 and 34 are provided with longitudinal slots 53 which supplement the action of the peripheral slots 46 in bleeding off a portion of the gas into the two chambers 36 on either side of the baffle 43. It will be understood that with either form of construction the gases bled off through the gaps 46 or through the slots 53 are partly led directly to the end section 15 and partly led back through other such slots or gaps and again conducted along the longitudinal conduits. The baffle 43 is preferably located at some point which is not an integral fraction of the length of the muffler in order to avoid series resonance effects.

The silencer shown in Figs. 7 and 8 is constructed in general along the lines indicated above but the details are varied to embody the acoustical principles of the Maxim Patent 2,093,893. This silencer has an inlet shell 60 provided with an intermediate partition 61 between which and the end wall 62 water may be introduced through an inlet 63. A gas inlet tube 64 is longitudinally slotted at 65 and is coupled by bolts 66 to the intermediate partition. The inlet end of this conduit is preferably flared outwardly as at 67 and a tube 68 is secured to the end wall at 69 with intermediate packing 70 so that the width of the annular slot 71 may be varied in the manner described above.

Secured to this inlet section by a flange connection 72 of the type described in connection with Fig. 6 is an intermediate section 73 having a cast partition 74 provided with outstanding walls 75. These walls have the form shown in Fig. 8 so that a generally kidney shaped cup 76 is formed with upper and lower open ended conduits 77 and 78 respectively.

A second intermediate section 80 is provided with partition members 81 and 82 each having

flanges forming cups of a shape similar to that described with relation to the cup 76. The cup 83 is spaced from the cup 76 by a gap 84 which may be formed by the spacing given by the packing material in the joints 72, but which in this instance is generally augmented by a spacing of the partition-carried flanges from the ends of the sections. This is for the reason that in the device being considered the cups form side branches and the gaps 84 form acoustical conductivities, while in the form shown in Fig. 1 the gaps 46 between the conduit sections 33 and 34 are not intended as acoustical conductivities but as leaks for sound waves and gas.

The partition 81 carries a second flange forming a cup 85, and the partition 82 carries a flange defining a cup 86 opposed to the cup 85, both together forming a sidebranch coupled to the channel sections 77 and 78 through a conductivity 87. The partition 82 also carries a flange defining a cup 88 opposing a cup 89 formed by flanges on a partition 90 carried in an end section 91. This partition 90 also forms a cup 92 mating with a cup 93 formed in a partition 94, the two combining to form a sidebranch coupled through a conductivity 95 to the longitudinal channels. The end section 91 also carries an outlet conduit 96 positioned tangent to the lower side of the silencer so as to permit drainage. Drainage is also facilitated by vents 97, 98 and 99 performing a purpose similar to corresponding vents in the form first described.

We claim:

1. A muffler comprising a housing, a partition therein, a plurality of open-ended, aligned, longitudinally spaced intermediate conduit sections on either side of the partition, and inlet and outlet conduit sections at each end of the housing laterally offset from the intermediate conduit sections, said inlet and outlet conduit sections having their portions within the housing longitudinally slotted.

2. A muffler comprising end units, a plurality of open-ended intermediate units each having at least one open-ended conduit section therein, means for coupling the sections together leaving gaps between the aligned conduit sections of adjacent units, a central, longitudinally apertured inlet conduit in one of the end sections, and an eccentric, longitudinally apertured outlet conduit in the other of the end sections.

3. A muffler having end units, a plurality of open-ended intermediate units each having at least one open-ended conduit section therein, means for coupling the units together comprising interfitting annular grooves and lugs, clamping means to hold the sections together, packing within the grooves of sufficient thickness to hold the ends of the aligned conduit sections of adjacent units spaced from each other, a centrally located inlet conduit in one end section laterally offset from the intermediate conduits and longitudinally apertured, and an eccentrically located, longitudinally apertured outlet conduit in the other end section.

4. A muffler having end units, a plurality of open-ended intermediate units each having at least one open-ended conduit section therein, means for coupling the units together comprising interfitting annular grooves and lugs, clamping means to hold the sections together, packing within the grooves of sufficient thickness to hold the ends of the aligned conduit sections of adjacent units spaced from each other, a centrally located inlet conduit in one end section laterally

offset from the intermediate conduits and longitudinally apertured, said inlet conduit also being circumferentially apertured, a housing surrounding the circumferentially apertured part of the inlet conduit, and means for admitting water to said housing.

5. A muffler having end units, a plurality of open-ended intermediate units each having at least one open-ended conduit section therein, means for coupling the units together comprising interfitting annular grooves and lugs, clamping means to hold the sections together, packing within the grooves of sufficient thickness to hold the ends of the aligned conduit sections of adjacent units spaced from each other, a centrally located inlet conduit in one end section laterally offset from the intermediate conduits and longitudinally apertured, said inlet conduit being also circumferentially apertured, means for adjusting the width of said circumferential aperture, a housing surrounding the circumferentially apertured part of the inlet conduit, and means for admitting water to said housing.

6. A muffler comprising end units, a plurality of open-ended intermediate units each having at least one open-ended conduit section therein with its walls spaced from the wall of the unit to provide a chamber between them with its ends flush with the ends of the section, and means for coupling the units together comprising interfitting annular grooves and lugs, clamping means for holding the sections together, and packing within the grooves of sufficient thickness to hold the ends of the aligned conduit sections of adjacent units spaced one from another a distance corresponding to the spaces between the ends of the units to form an acoustic coupling between the aligned conduit sections and said chamber.

7. A muffler comprising end units, one or more intermediate units having a pair of diametrically opposed open-ended conduit sections cast integrally with but spaced from the walls thereof, and means for coupling the units together leaving gaps between the aligned conduit sections of adjacent units.

8. A muffler comprising end units, a plurality of open-ended intermediate units, one or more partitions formed within each of said intermediate sections and having flanges thereon forming at least one open-ended conduit section and a cup-like recess with the open side of the cup disposed adjacent the end of the section, and means for coupling the units together with spaces between the aligned flanges of adjacent units sufficient to form an acoustical conductivity between said conduit section and said cups.

9. A muffler comprising end units, a plurality of open-ended intermediate units, one or more partitions carried by each intermediate section and having flanges thereon defining at least one open-ended conduit section and cup-like recesses, the flanges of adjacent units being aligned, and means for coupling the units together comprising interfitting annular grooves and lugs, clamping means for holding the sections together, and packing within the grooves of sufficient thickness to hold the aligned flanges of adjacent units spaced from each other a distance sufficient to form an acoustical conductivity between the conduit sections and the side branches formed by adjacent recesses.

10. A muffler comprising end units, a plurality of open-ended intermediate units, one or more

partitions carried by each intermediate section and carrying flanges defining a pair of diametrically opposed conduit sections and cup-like recesses, the flanges of adjacent units being aligned, means for coupling the units together comprising interfitting annular grooves and lugs, clamping means for holding the sections together, and packing within the grooves of sufficient thickness to hold the aligned flanges of adjacent units spaced from each other a distance sufficient to form an acoustical conductivity between the conduit sections and the side branches formed by adjacent recesses, a substantially centrally located inlet conduit in one end laterally offset from the intermediate conduits and longitudinally apertured, said inlet conduit being also circumferentially apertured, means for adjusting the width of said circumferential aperture, a housing surrounding the circumferentially apertured part of the inlet conduit, and means for admitting water to said housing.

11. A muffler comprising end units, a plurality of open-ended intermediate units, one or more partitions carried by each intermediate section and carrying flanges defining a pair of diametrically opposed open-ended conduit sections and cup-like recesses, the flanges of adjacent units being aligned, means for coupling the units together comprising interfitting annular grooves and lugs, clamping means for holding the sections together, and packing within the grooves of sufficient thickness to hold the aligned flanges of adjacent units spaced from each other a distance sufficient to form an acoustical conductivity between the conduit sections and the side branches formed by adjacent recesses, a substantially centrally located inlet conduit in one end laterally offset from the intermediate conduits and longitudinally apertured, said inlet conduit being also circumferentially apertured, means for adjusting the width of said circumferential aperture, a housing surrounding the circumferentially apertured part of the inlet conduit, means for admitting water to said housing, and a tangentially disposed outlet conduit in the other end section.

12. A muffler comprising end units, a plurality of open-ended intermediate units, means for coupling the units together, and an open-ended conduit located in each intermediate section, the several conduits being of lengths insufficient to cause them to meet one another and being so positioned within their respective units as to cause them to lie in alignment one with another when the units are coupled together, whereby gaps will be left between the aligned conduit sections of adjacent units.

13. A muffler having end units, a plurality of open-ended intermediate units, means for coupling the sections together including interfitting annular grooves and lugs and clamping means for adjacent sections, an open-ended conduit located in each intermediate unit, the conduit sections being so positioned within their respective units as to cause them to lie in alignment one with another when the units are coupled together, and packing within the grooves, the lengths of the conduit sections being such that their ends will be held separated one from another by a gap determinable by the thickness of the packing in the grooves.

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