May 24, 1960 J. ERNST 2,937,707

MUFFLER FOR SILENCING GASES

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FIG. 1

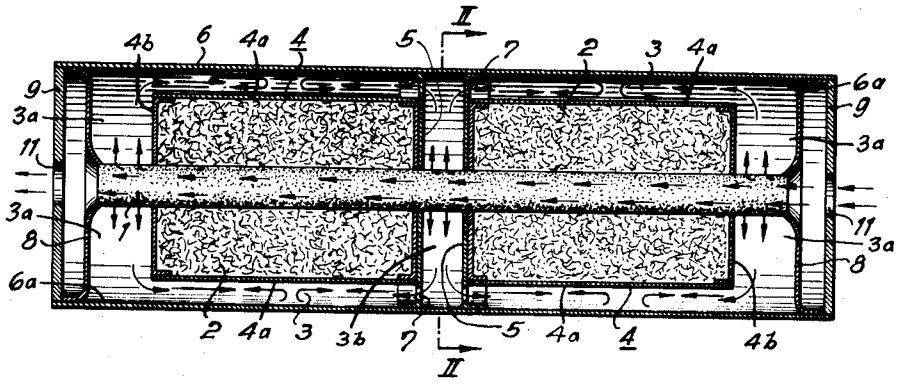
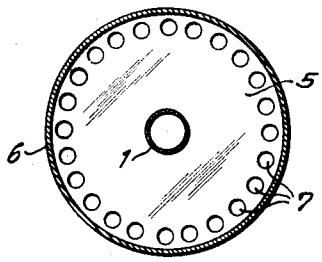


FIG. 2



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FIG. 3

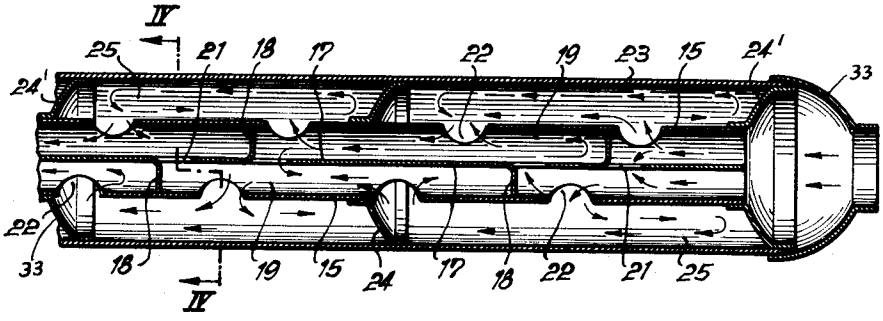


FIG. 4

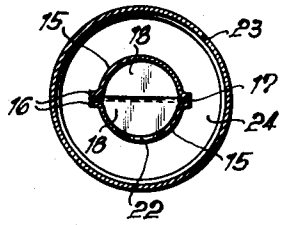


FIG. 5

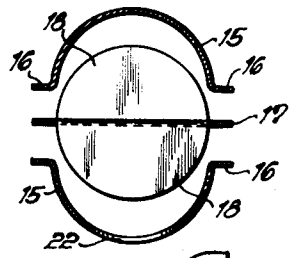
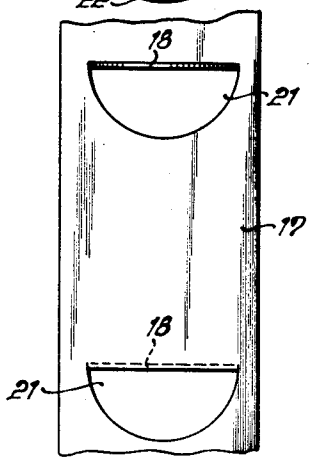


FIG. 6



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FIG. 7

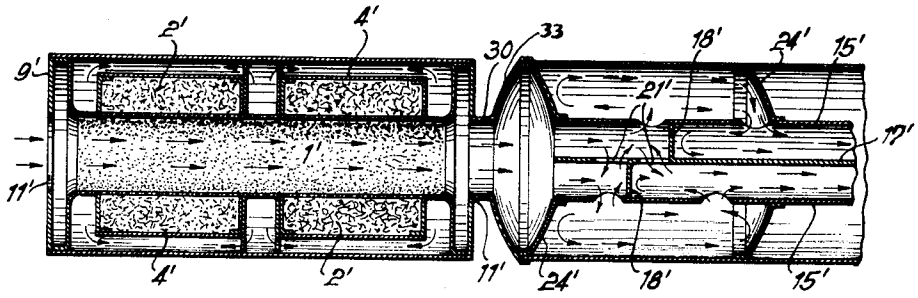


FIG. 8

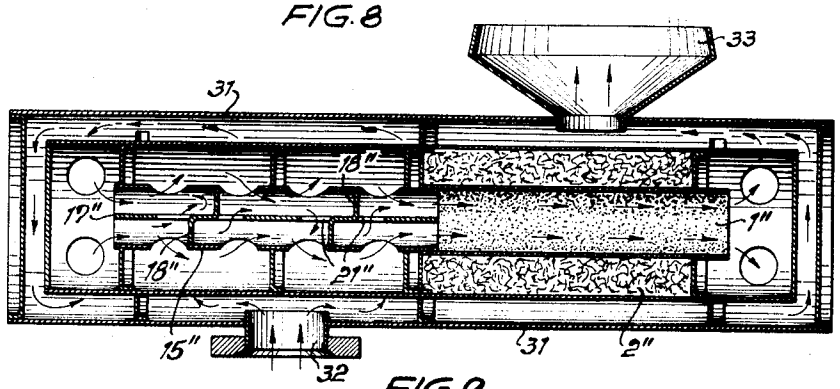
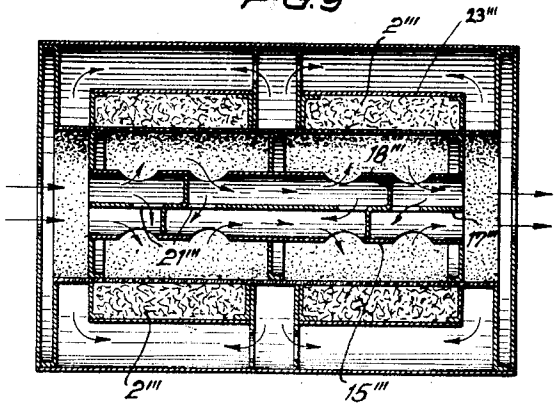


FIG. 9



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MUFFLER FOR SILENCING GASES

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5 Claims. (Cl. 181—42)

This invention relates to mufflers adapted to be connected to pipes for silencing noises of all kinds of flowing gases.

Various designs of mufflers, especially for internal combustion engines, have been known. For example, in internal combustion engines, housings lined with sound-absorbing material, such as basalt wool, have been generally used for conducting the exhaust gases of these engines. When passing through these housings, the gases are inhibited to a greater or lesser degree by the change of the passage opening, for example, as the gases are diverted through screens, funnels, staggered plates and baffles. The back pressures of the gases are harmful to four cycle engines and cause rough running and over-heating of the engines while their power is reduced. In case of two cycle engines, a certain amount of back pressure is advantageous which, however, cannot be adjusted sufficiently accurately when the presently known mufflers are used. In very few cases, the back pressure present in the muffler is suited for the engine. Mufflers have already been known in which a pipe with a cylindrical passage opening is mounted in a muffler housing. These mufflers, which generally are lined with glass wool, have to be approximately 20 inches long inorder to obtain a sufficient muffling action. As a result of this, the muffler becomes rather expensive and requires a large space in the car. Even in such mufflers, a gas back pressure is produced and the engine overheats and operates roughly. Furthermore, in all of the known mufflers the sound is insufficiently suppressed and unpleasant metallic noises are caused during driving of the car. Mufflers have also been known in which a perforated inner pipe is provided which is partly surrounded by sound-absorbing material, and an outer housing encloses this structure in spaced relation. In these mufflers, chambers are provided between sections of said-absorbing material, said chambers being separated from each other by partitions, and adapted to serve as air or gas cushions. In these mufflers, the gas flow is forced exclusively through the inner pipe, so that the action of these chambers is rather insignificant and the sound-absorbing material, as is the case in other mufflers, causes a substantial, though insufficient, damping. Furthermore, mufflers have been known in which the gas flow is divided within the muffler and the divided currents are conducted between sound-absorbing padding to be united at the outlet. In such mufflers, it is also only the sound-abosrbing material which causes the damping of the noises by absorbing the high frequencies, while the dividing of the gas flow does practically not influence the damping action. The division of the gas flow causes back pressure resulting in overheating of the muffler and disadvantageous operation of the engine.

Furthermore, it has been known to divide the inner pipe into parts of smaller cross-section by means of axial plates or partitions and to provide recessed chambers in the passages to conduct the gases in different directions. In such mufflers these recessed chambers conduct the

gases along serpentine paths from the inner pipe to the outer housing and back. This results in an insufficient silencing action, because no sound-absorbing materials are used in such mufflers and the silencing action takes place solely as a result of this baffling of the gases. Another known muffler operates according to the same principle, the pipes of said muffler being composed of semi-circular shells and plates or baffles being fitted to the inner pipe. Also in these mufflers, the gases are conducted through the pipes along a serpentine path, whereby an insufficient damping is obtained.

It is an object of the present invention to provide a muffler adapted to be inserted into a pipe line for silencing noises of all kinds of gases, said muffler having a perforated inner pipe, which may be surrounded by layers of sound-absorbing material, and having an outer housing spaced from the inner pipe and the sound-absorbing envelope, if any. Such design results in a superior muffling action, requires little space, at the same time avoids undesirable back pressure and over-heating of the engine, while increasing its efficiency.

It is a further object of this invention to provide chambers formed by the layers of sound-absorbing material, by plates, baffles and partitions in the inner pipe and between the inner pipe and the outer housing, so that the gases are circulated in opposite directions, whereby a free passage for the expanding gases is provided in these chambers.

It is a still further object of the present invention to provide a muffler, in which the layers of sound-absorbing material and the separating plates are provided only between the inner pipe and outer housing, while the inner pipe has a free passage.

It is another object of the invention to place in a muffler insulating layers, such as of basalt wool, around a sieve-like perforated inner pipe, whereby portions at the pipe ends and at the center of the pipe are left free from these basalt wool layers so that empty chambers are formed at these interruptions of the basalt wool covering.

It is a further object of this invention to insert the basalt wool into sheet metal bodies andto place the latter around a sieve-like perforated pipe which is held spaced from an outer housing surrounding the sheet metal bodies by means of plate members serving as supports and spacers for this outer housing. These supports or spacer members are provided with a plurality of holes at their rim areas to permit circulation of the gases.

It is a still further object of the invention, to design the ends of the muffler symmetrically and to insert double walls in spaced relation in the housing at each end, said walls having openings, and the openings of the inner of these walls connecting to the ends of the perforated pipe, while the openings of the outer walls are adatped to be connected to the gas supply and discharge pipes, respectively.

It is another object of this invention to provide the same cross section for the passage from the gas inlet to the gas exit, in case of four-cycle engines, or to enlarge this cross section. In order to use such mufflers for two-cycle engines, the cross section of the passage is reduced by one third between the gas inlet to the exit in order to provide the back pressure necessary for these two-cycle engines. A muffler of the type described, for example, filled with sound-absorbing, elastic, shock-proof, form retaining and heat-resisting basalt wool, and in which the gases are circulated in plural directions, avoids the deficiencies of the known mufflers. The new muffler renders the exhaust gases virtually noiseless, because the high frequencies of the exhaust gases are absorbed by the sound-absorbing material, while the amplitudes of the low frequencies are reduced by the circulation and the eddy currents. In view of this great efficiency of the

muffler, according to the invention, it is possible to design it considerably smaller than the mufflers heretofore known. By avoiding the back pressure or by adapting the same to the requirements of the engine, such as a two-cycle engine, the efficiency of the latter is increased and a substantially faster acceleration obtained without overheating the engine.

It is a further object of the invention, to provide in a muffler, which is especially advantageous for two-cycle engines, an inner pipe made of two perforated semi-cylindrical shells, between which a perforated wall serving as partition and carrying plates or baffles is inserted in axial direction. These plates or baffles are stamped out from the partition and bent 90° from its plane alternately to both sides of this partition. In this embodiment of the invention, the perforated shells are welded together with the partition at flanges provided therealong. In order to obtain gas circulation, the perforations through the two shells are staggered with respect to each other and the bent plates or baffles of the partition are arranged in the direction of the gas flow behind every second perforation through the shells.

It is a still further object of the invention to provide separating members between the inner pipe and the outer housing and to place them on the inner pipe, so that they serve to space the outer housing from the inner pipe. These spacers, which can be made in the form of caps, divide the space between the inner pipe and the outer housing longitudinally into individual chambers. The free passage in the inner pipe is inhibited by the bent plates or baffles longitudinally dividing the interior of the inner pipe into a plurality of chambers, from which the gases are conducted into the chambers between the inner pipe and outer housing and from there back into the inner pipe. A serpentine gas circulation is obtained in this manner, which can be repeated as often as desired by suitably designing the muffler. The sound waves are totally cancelled or damped by the forced diversion and the presence of eddy currents. The sheet metal parts have no inner stresses like the pipes made of a single piece, and no oscillation and resonance phenomena are produced therein. The inner pipe according to the invention can be manufactured in any lengths and can be inserted into any kind of housing, including the conventional casings. The manufacture of mufflers of this design is simple and inexpensive, as all of the inner parts can be made as simple punched-metal parts.

It is another object of the invention to combine two mufflers, of which the one is provided with a perforated inner pipe having sections surrounded with sound-absorbing material, while the other is equipped with an inner pipe comprising two perforated semi-cylindrical shells and being longitudinally divided by a partition carrying plates or baffles which divide the space between the inner pipe and the outer housing into a plurality of chambers. In an embodiment of the invention of this kind, these two mufflers are arranged in series and at least, the inner pipes of the two mufflers are connected in series with each other and sealed.

It is a further object of the invention to arrange these two mufflers in series inside a common housing. It is a still further object of this invention to combine these two mufflers in such a manner that the muffler with the inner pipe comprising the two perforated semi-cylindrical shells is placed within the muffler having pipe sections lined with layers of sound-absorbing material.

A superior damping or silencing action of the noises of the gases is obtained by these combinations of two mufflers. The sequence of the mufflers arranged in series can be selected according to the specific purpose for which they are used.

These and other important objects and advantageous features of the invention will be apparent from the following detailed description and drawings, appended thereto, wherein merely for the purposes of disclosure non-limitative embodiments of the invention are set forth.

In the drawings:

Fig. 1 shows a longitudinal section through the center of a muffler according to this invention.

Fig. 2 is a cross section through the muffler, shown in Fig. 1, along the line II—II and looking in the direction of the arrows.

Fig. 3 shows a longitudinal cross section through the center of another embodiment of this invention.

Fig. 4 is a cross section of the muffler, shown in Fig. 3, along the line IV—IV and looking in the direction of the arrows.

Fig. 5 is an enlarged exploded view of the central portion of the cross section of Fig. 4, showing the individual parts of the inner pipe of the new muffler prior to their assembling.

Fig. 6 shows a top view of the inner construction of the muffler, shown in Figs. 3 to 5, i.e. of a longitudinal partition in the inner pipe of the muffler.

Figs. 7 to 9 illustrate longitudinal sections through several combinations of the muffler constructions according to Figs. 1 to 6.

In the muffler of Figs. 1 and 2, a perforated pipe **1** is centrally arranged. Larger portions of this pipe **1** are surrounded with layers **2** of basalt wool, not provided around the pipe ends which are left free, nor at the center of the pipt **1**. Passage ways or chamber means **3** are left between the outer wall or circumference **4***a* including lateral end walls **4***b* of casings **4** housing the basalt wool layers and being symmetrically arranged on both sides of the longitudinal center of the muffler. The casings **4** are centered and spaced from an outer muffler housing **6** by means of plates **5** supporting this outer housing **6** and simultaneously providing the desired clearance around the casings **4**. The plates **5** are provided with holes **7** near their outer peripheries to permit circulation of the gases. The ends of the outer housing **6** having an inner wall **6***a* are closed by double end walls **8** and **9** having central openings, whereby the inner end walls **8** with their openings are placed over the ends of the pipe **1**, while the openings **11** of the outer walls **9** are to be connected to inlet and discharge pipes, respectively, not shown. The portion of the chamber means or space between the end walls **4***b* of the casing **4** and the end wall **8** of the housing **6** define radially extending openings **3***a* communicating with the perforated pipe **1**. A similar opening **3***b* is provided intermediate the pipe **1** between the spaced casings **4**.

In the embodiment of Figs. 3 to 6, the inner pipe comprises two semi-cylindrical shells **15** having outwardly bent edges or flanges **16** which are welded to a partition **17** inserted between these shells **15**. This partition **17** divides the inner pipe formed by the shells **15** into two parts of a semi-circular cross section. From the plane of the partition **17** stamped out sectors **18** of semi-circular cross section are bent 90° alternately to both sides, said sectors dividing the interior of the semi-circular pipe parts into a plurality of chambers **19**. At those places where the sectors **18** are bent from the plane of the partition **17** openings **21** are obtained therethrough connecting adjacent chambers **19** in the two semi-cylindrical shells **15** to one another. The outer walls of these shells **15** are provided with openings **22** to connect the chambers **19** with a chamber **25** between the shells **15** and an outer housing **23** surrounding the inner pipe. This chamber **25** is divided longitudinally into two parts by means of an inserted arched disc **24** having a central opening. This arched disc **24** is placed over the shells **15** inside the housing **23**. Similar arched cap members **24'** with central openings are mounted on the two outer ends of the inner pipe. The outer housing **23** is spaced from the inner pipe and supported by means of these cap members **24** and **24'**. The front and rear ends of the muffler are closed in the usual manner

by means of caps 33 having openings to be connected to inlet and discharge pipes. A larger portion of the partition 17 in front of the discharge opening may be left without bent sectors 18. The arrows shown in Fig. 3, indicating the approximate course of the gas flow, illustrate how the gases are conducted in labyrinth-like counter currents, whereby the sound waves tend to cancel one another. Primarily as a result of the provision of the openings 21 in the partition 17 a gas circulation is obtained, whereby the gases from opposite sides of the partition are fed into each other and are caused to flow in counter currents to obtain a superior interference damping.

In the embodiment of Fig. 7, a muffler as shown in Fig. 1 is combined with a muffler of Fig. 3, i.e. these two kinds of mufflers are connected in series. The inner muffler pipes 1' and 15' are joined and sealed by inserting the end of a tubular flange 30 of the inlet cap 33 of the muffler according to Fig. 3 into the outlet opening 11' of the muffler shown in Fig. 1. Like parts of the mufflers are indicated by primes.

According to the embodiment of Fig. 8, the inner pipes 1'' and 15'' of the two mufflers of Figs. 1 and 3 are directly conected with each other and the two mufflers are arranged in a common casing 31 having a lateral inlet flange 32 and a lateral exit 33 for the gases. Like parts of the mufflers are indicated by double primes.

In the embodiment of Fig. 9, an outer pipe 23''' of a muffler as that shown in Fig. 3 is perforated like a sieve and together with the elements housed therein inserted as an inner pipe into a muffler as shown in Fig. 1. Like parts of these mufflers are indicated by triple primes.

The invention provides a muffler of the multi-chamber type having an increased gas circulation with eddy currents, whereby heat is sufficiently conducted to the outside, so that the pipes are cooled in a superior manner.

Although in accordance with the provisions of the patent statutes this invention is described as embodied in concrete forms and the principle of the invention has been explained together with the best modes in which it is now contemplated applying that principle, it will be understood that the elements and combinations shown and described are merely illustrative and that the invention is not limited thereto, since alterations and modifications will readily suggested themselves to persons skilled in the art without departing from the true spirit of the invention or from the scope of the annexed claims.

I claim:

1. A muffler for the exhaust gases of an internal combustion engine and the like comprising, a muffler housing having an inner wall including end walls and provided with inlet and outlet ports for said exhaust gases, an inner perforated pipe spaced from and disposed within said muffler housing and communicating with said inlet and outlet ports, first means provided with an outer wall including lateral end walls surrounding said inner perforated pipe, said first means being of a length less than the length of said inner perforated pipe and spaced from said inner wall of said muffler housing to define chamber means between said inner wall of said muffler housing and said outer wall of said first means, the space between the lateral end walls of said first means and the end walls of said muffler housing defining radially extending openings spaced from one another in the axial direction of flow of said exhaust gases and in registry with said inner perforated pipe, thereby permitting movement of said exhaust gases from said inner perforated pipe into said chamber means in opposite directions of flow to form counter-currents, said oppositely directed exhaust gases colliding within said chamber means and producing eddy currents to thereby increase the sound wave cancellation effect of said muffler.

2. A muffler according to claim 1, wherein said first means include separate casings spaced from one another substantially intermediate said inner perforated pipe to define an additional radially extending opening for movement of said exhaust gases from said inner perforated pipe into said chamber means.

3. A muffler according to claim 1, wherein said first means include layers of sound absorbing material surrounding said inner perforated pipe.

4. A muffler according to claim 3, wherein said layers are made of basalt wool.

5. A muffler according to claim 2, wherein perforated plate means are provided for said separate casings adjacent the respective lateral end walls which are oppositely opposed substantially intermediate said inner perforated pipe.

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