

July 26, 1938.

G. C. STARKWEATHER
MUFFLER

2,124,933

Filed June 14, 1937

2 Sheets-Sheet 1

Fig. 1.

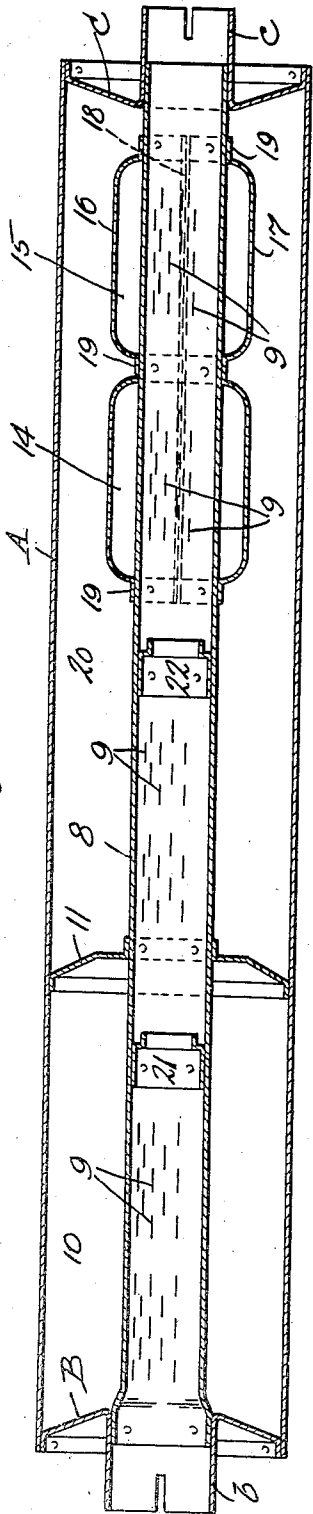
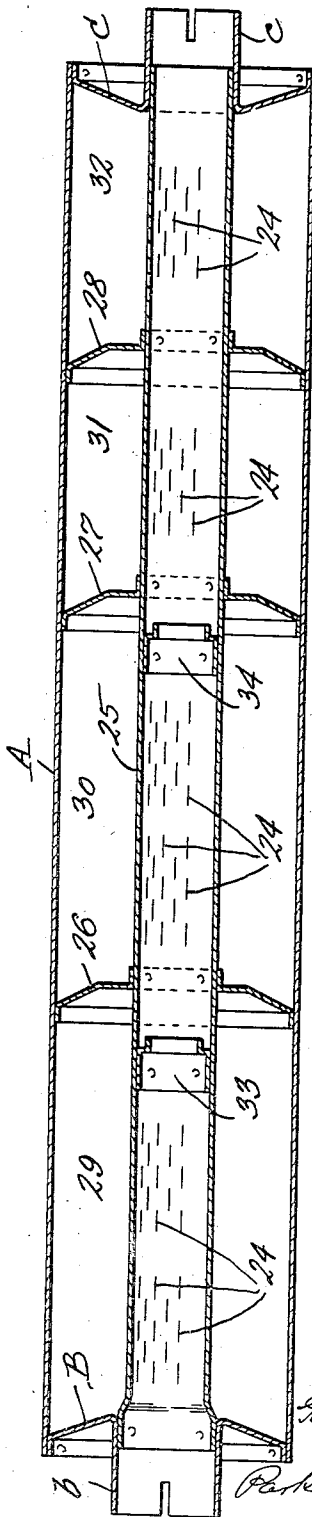


Fig. 2.



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Fig. 3.

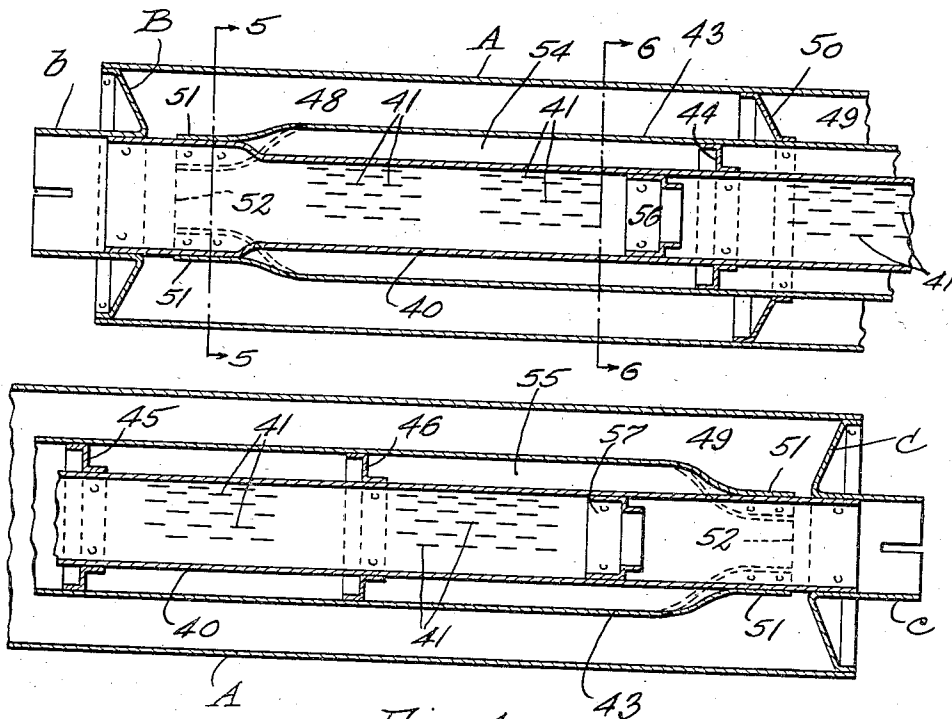
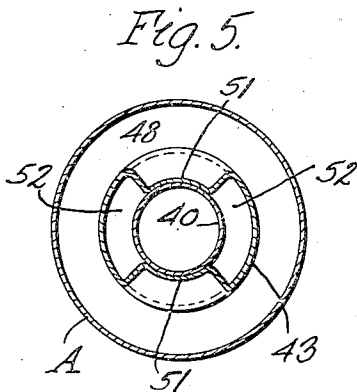
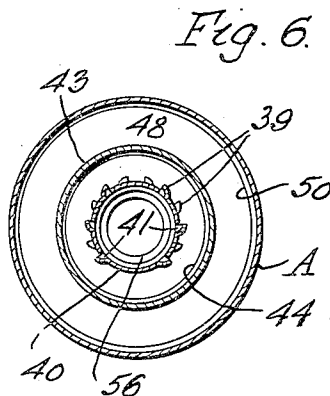


Fig. 4.



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UNITED STATES PATENT OFFICE

2,124,933

MUFFLER

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8 Claims. (Cl. 181—48)

This invention relates to improvements in mufflers or silencers of the kind which are usable for reducing the noise of the exhaust of internal combustion engines.

5 In the Starkweather and Haas Patent Nos. 2,047,442 and 2,047,443 are shown mufflers in which restrictions in the inner perforate conduit are provided between groups of perforations communicating with a chamber in such a manner
10 that the restriction in the conduit causes a portion of the gases to by-pass the restriction by passing into the chamber through apertures located in front of the restriction and returning from the chamber through the conduit through
15 apertures located in rear of the restriction. I have found that by locating the restriction in rear of all of or most of the openings or apertures communicating with a chamber, a different operation of the chamber is produced in that
20 substantially no by-passing of gases or sound waves around the restriction results. Consequently, by locating the restriction in this manner, the gases which are forced into the chamber because of the slight increase in pressure created
25 in advance of the restriction must reverse their direction of flow and then re-enter the chamber through the same openings or apertures in advance of the restriction. While the arrangement
30 of the restriction in the conduit as herein described produces a somewhat increased back pressure in the muffler than that described in said patents, yet the modified action of the silencing chambers arranged about the conduit
35 makes the use of this arrangement of the restriction desirable for certain purposes.

One of the objects of this invention, therefore, is to provide a muffler of the type having a main gas passage and chamber communicating there-
40 with with a restriction arranged in the gas passage in rear of the connection or opening communicating with the chamber in such a manner as to provide for a backing up of the gases into such chamber and a consequent return of the
45 gases through the apertures into the conduit in advance of the restriction. Another object of this invention is to provide a muffler in which the effectiveness of chambers arranged about a perforate conduit is increased or modified by
50 means of restrictions located in the conduit in rear of all of the apertures or openings leading to such chamber. Other objects of this invention will appear from the following description and claims.

In the accompanying drawings:

Figs. 1 and 2 are longitudinal central sections of two different forms of mufflers embodying this invention.

Fig. 3 is a longitudinal central sectional view 5 of the front portion of a muffler of modified construction.

Fig. 4 is a similar longitudinal central section of the remainder or rear portion of the muffler shown in Fig. 3. 10

Figs. 5 and 6 are respectively transverse sectional views, taken respectively on lines 5—5 and 6—6, Fig. 3.

In all of the mufflers shown, the outer casing or housing of the muffler may be of any suitable 15 or desired construction, such for example as an outer shell A provided at one end with an inlet head B having an inlet formed therein, for example, by means of an integral tubular duct b to which the exhaust pipe of an engine may be 20 secured in any suitable or usual manner. At their other ends these outer shells A are provided with exhaust or discharge heads C having suitable discharge openings formed by means of integral ducts c through which the gases are dis- 25 charged from the mufflers and to which the usual tail pipes may be connected, if desired.

In Fig. 1, I have illustrated my invention as applied to a comparatively simple form of muffler, in which the passage for gases through the 30 muffler consists of an inner perforate conduit 8 in which openings for the flow of gases out of and into the conduit are in the form of perforations 9, which may, for example, be produced by forming in the conduit 8 longitudinally extending 35 slits and by bending the metal at one side of each slit outwardly to form louvers. Any other form of aperture or opening may, however, be provided if desired, and preferably these apertures or openings are arranged in groups, the groups 40 being in turn arranged at intervals lengthwise of the conduit 8. About the exterior of the conduit 8, suitable sound deadening chambers may be provided in any suitable or desired manner. For example, a chamber 10 may be formed be- 45 tween the inner conduit and the outer shell A by means of a transversely extending wall or baffle 11 extending from the conduit to the outer shell. At the rear end of the muffler, high frequency resonator chambers 14 and 15 may be 50 provided about the conduit 8 by means of an intermediate shell of any suitable or desired form, that shown being formed by two half shells 16 and 17, the longitudinal edges of which are suitably secured together as indicated in broken 55

lines at 18 and these two shell sections are provided with inwardly extending shoulders or parts 19 which engage the conduit 8 and thus enclose perforate portions or groups of perforations of the conduit and form chambers which react upon high frequency sound waves in such a manner as to render them inaudible.

The construction described also results in the formation of another chamber 20 within the muffler which includes a portion which is arranged between the conduit and the outer shell A and another part which extends into the space between the intermediate shell 16, 17 and the outer shell 18.

In order to provide for a more pronounced and modified action of the chambers 10 and 20 upon gas pulsations and sound waves in the muffler, I have provided restrictions in the interior of the conduit, which are located in rear of all or substantially all of the openings or apertures in the conduit communicating with the respective chambers. The restrictions employed may be of any suitable or desired form and may be formed integrally with the conduit or they may be in the form of sleeves inserted in the conduit, both of which forms of restrictions are disclosed in the aforementioned Starkweather and Haas patents. In the particular muffler shown in Fig. 1, I have illustrated by way of example, a pair of restricting sleeves 21 and 22 each of which has a cylindrical portion fitting snugly within the interior of the conduit 8 and rigidly secured thereto, for example by welding, and also a portion of reduced diameter. Any other form of restriction may, however, be employed if desired. In accordance with my invention, I locate the restriction 21 in rear of all openings or apertures leading into the chamber 10 and similarly the restriction 22 is located in rear of all apertures or openings leading into the chamber 20.

By means of the construction described, gases entering the inlet of the muffler housing pass into the conduit 8 and are held back to a limited extent by means of the restriction 21 in the conduit, so that substantial portions of the peaks of pressure pulsations enter into the chamber 10 through the perforations or apertures 9 of the conduit, and the gas flowing through these apertures into the conduit probably also carries sound waves with it. The remainder of the pressure pulsations continue through the restriction 21 into the portion of the conduit 8 in rear thereof and are again held back to a limited extent by the restriction 22, so that further portions of the peaks of pressure pulsations, probably accompanied by sound waves, will enter into the chamber 20.

In the case of gases flowing into the chambers 10 and 20 through the apertures 9 in the conduit, these gases will be forced in general to reverse their direction of movement, and thus return through the same apertures through which these gases entered the chambers 10 and 20, and will pass back into the conduit 8, during the troughs or intervals between the peaks of the pressure pulsations, thus equalizing to a material extent the flow of gases in the conduit. Because of the fact that the location of the restrictions 21 and 22 is in rear of the apertures leading to the chambers 10 and 20 respectively, it will be impossible for gases entering the apertures to by-pass around the restrictions 21 and 22 as in the before mentioned patents, and consequently, a complete reversal of the flow of gases entering the chambers 10 and 20 is necessary. This action, con-

sequently, results in a different action of the chambers 10 and 20 upon the gases and sound waves in the muffler, than takes place in the before mentioned patents, in which the restrictions effect a bypassing of the gases.

After passing through the restriction 22, the gases flow through the portion of the conduit which is enclosed by the high frequency resonator chambers 14 and 15 where a further effective silencing of sound waves results in a well known manner.

In the muffler shown in Fig. 2, the space between a perforate inner conduit 25 and the outer shell A is divided into a plurality of chambers by means of transversely extending walls or baffles 26, 27 and 28, thus forming chambers 29, 30, 31 and 32, all of which communicate with the interior of the conduit 25 by means of suitable apertures or openings 24 in the conduit 25. In the conduit 25 are arranged a pair of restrictions 33 and 34, which are located in rear of those perforations which communicate with the chambers 29 and 30 respectively. It will be readily understood from the description of the operation of the muffler shown in Fig. 1, that a similar operation will take place in connection with the muffler shown in Fig. 2, namely, that gases flowing lengthwise of the conduit will encounter an increased resistance at the restriction 33, and thus build up in advance of the restriction a slightly increased pressure which causes gases to flow into the chamber 29 to a materially greater extent than would be the case, if the restriction 33 were not present. The gases entering the chamber 29 must be reversed in their direction of flow and pass back into the conduit 25 through the same group of apertures through which they entered. A similar action results in the chamber 30, and the gases which finally pass through the restriction 34 will, consequently, be of relatively uniform flow and this flow will be still more equalized by means of the chambers 31 and 32 which also communicate with the interior of the conduit 25 through apertures 24. It will be obvious that any desired number of restrictions may be employed, if desired, and consequently, restrictions could also be employed in connection with the chambers 31 and 32, and in some cases, only a single restriction may be necessary to produce the desired silencing effect.

In Figs. 3 to 6 inclusive, I have shown my invention applied to a muffler having an intermediate shell. In this muffler, 40 represents the inner conduit having suitable openings or perforations 41 therein, which may be produced by forming a series of longitudinal slits in the conduit 40 and pressing the metal at one side of each slit outwardly to form louvers 39, as shown in Fig. 6. The conduit shown connects at one end with the inlet b and at the other end with the outlet or discharge c. 43 represents an intermediate shell of any suitable or desired form which may be supported in the muffler in any suitable manner. In the construction illustrated, the intermediate shell 43 is shorter than the conduit 40 and is supported from the conduit intermediate of its ends by means of a series of transverse partitions or baffles 44, 45 and 46, and the ends of the intermediate shell are provided with suitable openings communicating with outer or low frequency resonator chambers 48 and 49, these chambers being separated from each other by means of a transverse partition or baffle 50 connecting the outer shell A with the intermediate shell 43. The openings in the intermediate shell may be formed

in any suitable or desired manner, and in the construction illustrated by way of example, I leave at least portions of the ends of the intermediate shell open, other portions 51 being pressed inwardly into engagement with the conduit 40, these pressed-in portions being spaced between open portions of the intermediate shell which are spaced from the conduit 40 and form therewith channels or passages 52, which act as bottle necks in connection with the resonator chambers 48 and 49. Any other means for establishing communication between the interior of the end portions of the inner shell and the chambers 48 and 49 may be provided, if desired.

It will be noted that the transverse baffles 44, 45 and 46 form in the space between the conduit and intermediate shell, high frequency resonator chambers, while the portions of the intermediate shell between the ends of this shell and the transverse baffles 44 and 46 form chambers 54 and 55 which connect with the outer resonator chambers 48 and 49.

In order to increase the effectiveness of the outer chambers 48 and 49, I provide in the inner conduit 40 restrictions 56 and 57, which are located in rear of those perforations which open into the end chambers 54 and 55 of the intermediate shell.

In the operation of the muffler described, gas pulsations entering into the inner conduit 40 will be slightly checked by the restriction 56 so that a substantial portion of each pressure pulsation will flow outwardly through the apertures 41 into the chamber 54 and then through the openings or channels 52 into the outer low frequency resonator chamber 48. Since the gases cannot by-pass the restriction 56 as is the case in the mufflers shown in the patents hereinbefore referred to, a higher pressure will accumulate in the end chamber 54, thus forcing a larger proportion of gases to flow into the outer chamber 48 than would be the case, if the restriction 56 were not employed. The reversing of the flow of gases in the end chamber of the intermediate shell and the outer chamber 48 also requires a slightly longer time interval than the by-passing of gases, so that the gases will return to the interior of the conduit 40 after a greater time interval than would be the case with a corresponding gas pressure pulsation in the mufflers described in the aforementioned patents. The increased delay in the return of gases into the conduit may be utilized advantageously in connection with the design of mufflers for certain types of engines.

The gases, after passing through the restriction 56, pass the high frequency chambers formed between the baffles 44, 45 and 46, and then reach the restriction 57 in which a similar action takes place, as has already been described in connection with the restriction 56. The gases passing out of the apertures in the conduit in advance of the restriction 57 find their way through the chamber 55 and the passages 52 into the outer chamber 49.

While the accompanying drawings illustrate only three forms of mufflers embodying my improvements, it will be obvious that restrictions positioned in accordance with this invention may be employed in mufflers of many different forms and constructions and may be used in any type of muffler conduit through which all or a greater portion of the gases entering the muffler pass.

The restrictions herein described are inexpensive to produce and may be easily provided in any

muffler conduit having communication in advance of the restriction with a chamber, and while the restrictions increase to some extent the back pressure of the muffler, such increase in back pressure is more than compensated for by the materially increased silencing obtained. The restrictions may, of course, vary in the extent to which they restrict the passage of gas through the conduits in which they are located by varying the internal diameters of the reduced portions thereof, and also the silencing effect may be varied to some extent by varying the sizes of the restrictions.

I claim as my invention:

1. A muffler having a housing provided with an inlet and an outlet, a perforate conduit of substantially uniform diameter connecting said inlet and said outlet and arranged within said housing, a partition arranged in the space between said housing and said conduit and forming a chamber which communicates with the interior of said conduit through perforations therein, and a restriction in said conduit arranged in rear of all of those perforations communicating with said chamber.

2. A muffler having a housing provided with an inlet and an outlet, a perforate conduit of substantially uniform diameter within said housing through which gases flow, means arranged between said conduit and said housing and forming therewith a chamber into which gases may enter only through perforations of said conduit, and a restriction in said conduit located in rear of all of the perforations communicating with said chamber.

3. A muffler having a housing provided with an inlet and an outlet, a passage within said housing through which gases flow from said inlet to said outlet and including a conduit of substantially uniform diameter, partition means arranged between said housing and said conduit and forming a substantially closed chamber having a connection with said passage through which gases may flow into and out of said chamber, a restriction in said conduit for restricting the flow of gas pulsations through the same and located rearwardly of said connection between said conduit and said chamber, whereby an increase in gas pressure in advance of said restriction produces an increased passage of gas into said chamber.

4. A muffler having a housing provided with an inlet and an outlet, a passage in said housing leading from said inlet to said outlet and including a conduit of substantially uniform diameter, partition means arranged between said housing and said conduit and forming a chamber having a connection with said passage through which gases may flow into and out of said chamber from said passage, and a restriction in said conduit for restricting the flow of gas pulsations through the same and located in rear of any connection between said passage and said chamber, whereby an increase in pressure in advance of said restriction results in increased flow of gases into said chamber.

5. A muffler having a housing provided with an inlet and an outlet, a perforate conduit of substantially uniform diameter arranged within said housing and connecting said inlet and outlet, a partition between said housing and said conduit and forming a substantially closed chamber which communicates with the interior of said conduit through perforations therein, and a restriction in said conduit arranged in rear of all

those perforations communicating with said chamber, whereby increased pressure of gases in advance of said restriction results in an increased flow of gases into said chamber, and

5. whereby the gases in said chamber reverse their direction of movement and return through said perforations and re-enter said conduit through said perforations in advance of said restriction.

6. A muffler having a housing provided with an inlet and an outlet, a perforate conduit of substantially uniform diameter within said housing through which gases flow, an intermediate shell between said conduit and said housing and forming with said conduit an inner chamber arranged about a perforate part of said conduit and an outer chamber communicating with said inner chamber, and a restriction in said conduit located in rear of all of the perforations in said conduit communicating with said inner chamber, said restriction producing an increased gas pressure in said conduit in advance of said restriction, which produces an increased passage of gases and sound waves into both said inner and said outer chambers.

7. A muffler having a housing provided with an inlet and an outlet, a passage in said housing leading from said inlet to said outlet and including a conduit of substantially uniform diameter, partition means arranged between said housing and said conduit and including a shell extending about said conduit and a transversely extending

part forming an end wall in the space between said shell and said conduit, said partition means forming with said conduit an inner chamber having a connection with said passage and an outer chamber having a connection with said inner chamber, and a restriction in said conduit located in rear of any connection between said passage and said inner chamber, whereby an increase in pressure results in advance of said restriction, which produces an increased flow of gases and sound waves into said inner and outer chambers.

8. A muffler having a housing provided with an inlet and an outlet, a perforate conduit of substantially uniform diameter within said housing through which gases flow, an intermediate shell between said conduit and said housing, a transverse baffle connecting said shell and said conduit to form with said shell an inner chamber about a perforate portion of said conduit, a transverse baffle connecting said intermediate shell with said housing to form therewith an outer chamber communicating with said inner chamber, and a restriction in said conduit located in rear of all of the perforations in said conduit communicating with said inner chamber, said restriction producing an increased gas pressure in said conduit in advance of said restriction, which produces an increased passage of gases and sound waves into said inner chamber and from said inner chamber to said outer chamber.

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