April 4, 1950 H. A. DORMAN 2,502,709

EXHAUST MUFFLER INCLUDING PLURAL VENTURI ELEMENTS

Filed Nov. 1, 1940 3 Sheets-Sheet 1

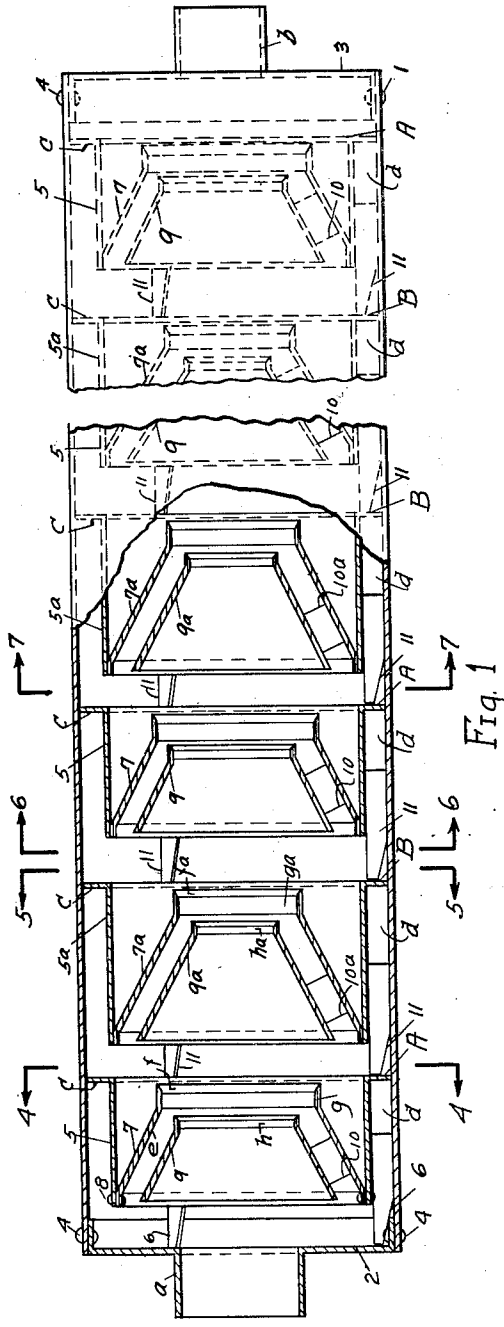


Fig. 1

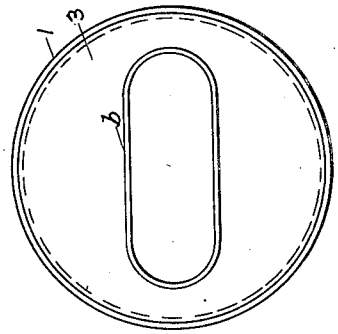


Fig. 3

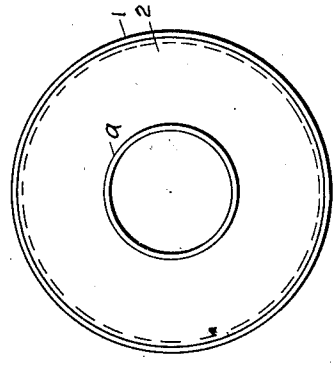


Fig. 2

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Filed Nov. 1, 1940 3 Sheets-Sheet 2

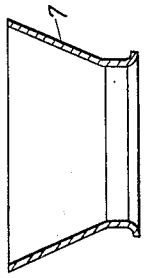


Fig. 8

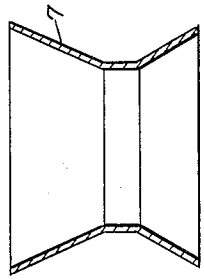


Fig. 9

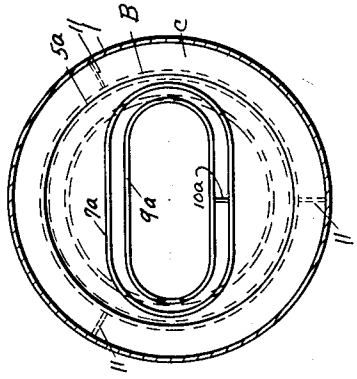


Fig. 5

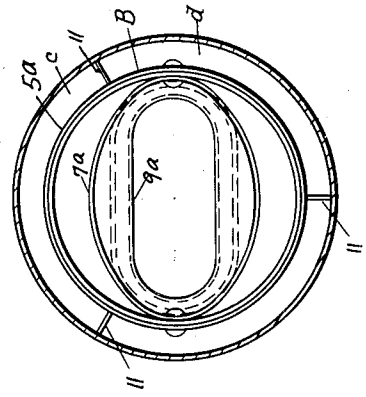


Fig. 7

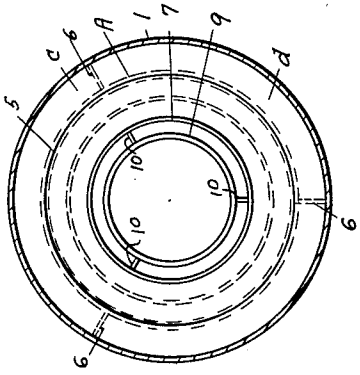


Fig. 4.

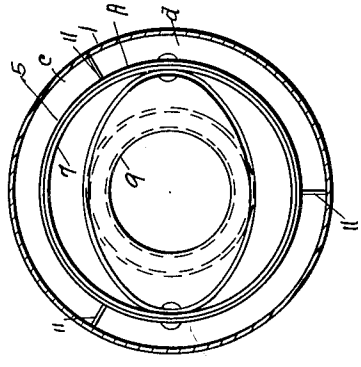


Fig. 6

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EXHAUST MUFFLER INCLUDING PLURAL VENTURI ELEMENTS

Filed Nov. 1, 1940 3 Sheets-Sheet 3

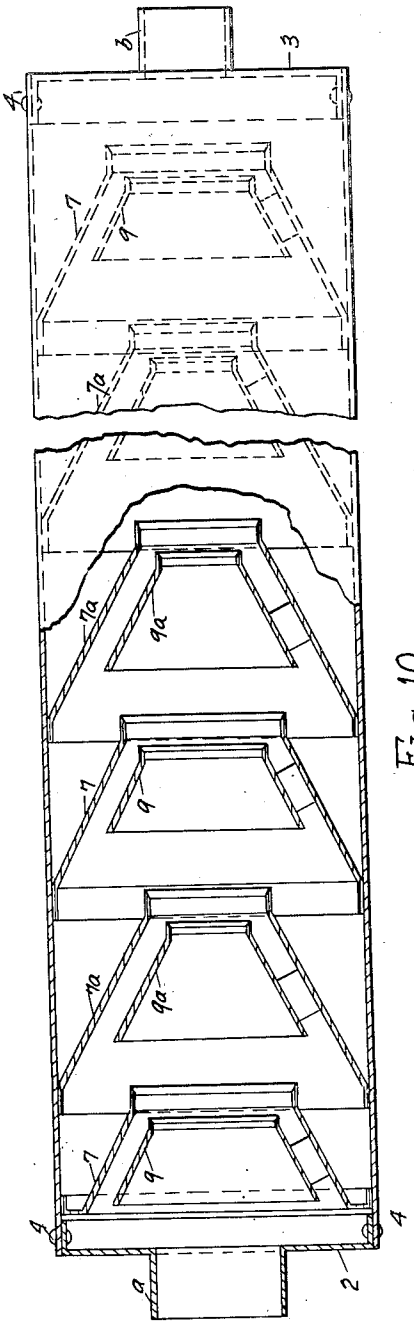


Fig. 10

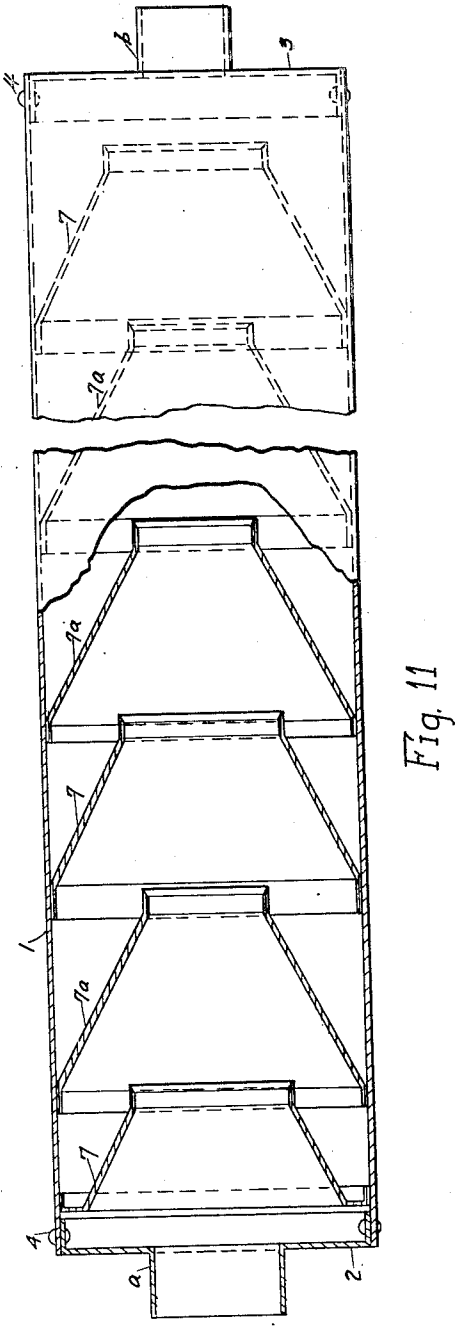


Fig. 11

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UNITED STATES PATENT OFFICE

2,502,709

EXHAUST MUFFLER INCLUDING PLURAL VENTURI ELEMENTS

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Application November 1, 1940, Serial No. 363,861

11 Claims. (Cl. 181—41)

1

The object of my invention is to provide a special muffler for deadening the sound from an internal combustion engine exhaust, and at the same time greatly reduce the engine back pressure to a minimum.

Another object is to construct a muffler that is simple in construction, easily and efficiently installed on any engine unit and that can be manufactured at a very low cost.

These objects are secured in the preferred form by the construction and arrangement of parts more fully hereinafter set forth.

Similar parts on all drawings are marked by similar numerals or letters.

Fig. 1 is a longitudinal sectional view through the assembled muffler, along the centerline thereon, showing its general construction and arrangement of the various units mounted therein.

Fig. 2 is an end view of the assembled muffler showing the tubular intake port for connecting with the engine exhaust.

Fig. 3 is the opposite end view of the muffler, showing the restricted exhaust port walls leading therefrom.

Fig. 4 is a cross-sectional view taken on the line 4—4 of the Fig. 1, showing the formation and the relative position of one set of muffler units as used therein.

Fig. 5 is also a cross-sectional view taken on the line 5—5 of the Fig. 1, showing the formation and position of the alternate set of units utilized therein.

Fig. 6 is a modified cross-sectional view taken on the line 4—4 of the Fig. 1, showing a slight distortion of the inner units to facilitate manufacturing and assembly requirements, over that shown in the Fig. 4.

Fig. 7 is also a modified cross-sectional view as taken on the line 5—5 of the Fig. 1, illustrating a similar distortion of the corresponding inner units over those shown in the Fig. 5.

Fig. 8 is a vertical sectional view through one of the Venturi tubes illustrating a slight modification of the expanding or defusing chamber.

Fig. 9 is also a vertical sectional view through a modified Venturi tube for a more controlled defusion of the passing gases.

Fig. 10 is a longitudinal sectional view as taken along the muffler centerline and similar to that shown in the Fig. 1, but with the external air dome and chamber omitted.

Fig. 11 is a similar longitudinal sectional view, but further modified by the omission of the central nozzle section also.

In accomplishing my object I have applied the

2

combination of several well known principles affecting sound waves, especially for gases controlled by Venturi and ejector tubes, and at the same time utilized the kinetic energy and expansion of gases for lowering the back pressure within the connected unit.

It is a well known principle that sound waves will not pass through a vacuum, and are likewise affected or diminished as a vacuum condition is approached, and further sound waves travel in straight lines. It is therefore logical that if the carrying medium, gas in this case, can be subjected to varying densities by successive contractions and expansions, the sound waves themselves may likewise be affected and diminished or possibly destroyed by successive low pressure areas created therein, and further affected by the diffusion of lines of travel through the intermingling gases.

I will now describe more fully the detailed construction of my device referring to the drawings and the marks thereon, illustrating my invention by the preferred form of construction shown in Figs. 1 to 9 of the drawings.

The casing 1 is made of suitable sheet metal, cylindrical in design, and is provided with head members 2 and 3 securely mounted therein at opposite ends of the casing. The head section 2 is provided with a tubular intake port *a* designed for receiving the end of the engine exhaust pipe thereon. The head section 3 is preferably formed with a flattened aperture *b* providing an exhaust outlet port for the unit, although it may be made cylindrical, or other shapes, if desired. Both heads 2 and 3 are securely attached to the casing preferably by the rivets 4, or other suitable means such as welding, etc. Within the casing 1, adjacent the inlet head 2, is mounted a flanged cylindrical air dome 5 of some pre-determined length, and preferably sealed with the casing wall by the fitted flange *c*, but open at the opposite end thereof nearest the intake port, forming an outer compression chamber *d*. The air-dome 5 is retained in position separated from the casing head 2, by the attached spacers 6 engaging the head walls. Within the open end of the cylindrical air-dome 5, adjacent the exhaust inlet port *a*, is mounted the enlarged end of a Venturi tube 7, fitted and attached thereto preferably by rivets 8, or by a welding process. The Venturi tube 7 is formed of two conical surfaces *e* and *f*, of uneven lengths, joined at their smaller ends by a short cylindrical throat section *g*. The cone section *e* acts somewhat as a compression chamber, while the shorter outlet section acts as a diffuser

for the gases, and the intervening throat *g* creates the low pressure area. Within the mouth of the Venturi tube 7, above the throat section *g*, is mounted a smaller conical nozzle section 9, positioned concentric with the Venturi tube section *e* and separated therefrom by the interposed separators 10, providing a clear passage therebetween, and as illustrated in the Figs. 1 and 4 of the drawings. However, if desired to cheapen construction costs, the nozzle 9 may be somewhat distorted as illustrated in Fig. 6. It is preferred that the nozzle 9 also be made of the Venturi construction, although a straight conical nozzle section will produce very good results. The short throat *h* as herein illustrated, with its flaring outlet wall is sufficiently separated from the adjoining Venturi section so as not to obstruct the passage space therebetween, and allow the nozzle to react on the ejector principle, producing pulsations between the respective units, modified by the connected air-dome chamber *d*, as the exhaust gases are forced therethrough, creating the successive high and low pressure sections within the unit A. Adjacent the air dome 5 within the casing 1, is mounted a modified air-dome 5*a* of different sectional length and spacing from its previous unit, and is separated therefrom by attached spacers 11 extended to engage the flange *c*. A modified venturi 7*a*, similar to 7, is fitted and securely mounted within the open end of the air-dome 5*a*, as in the former case. The venturi 7*a* is also correspondingly greater in length than the previous venturi 7 and is provided with a modified throat and defusion sections *ga* and *fa* as illustrated in Fig. 5 of the drawings. Likewise, the inner receiving nozzle 9*a* is modified in like form and proportions, and is provided with flat outlet throat *ha*, to aid in the defusion of sound waves. The nozzle 9*a* is positioned concentric with its inclosing Venturi section 7*a* and is separated therefrom by spacers 10*a* as in the former case, and this combined section forms the secondary muffler unit B. The nozzle 9*a* and venturi 7*a* may also be combined by distortion of the inner unit as in the former case, and as illustrated in the Fig. 7 of the drawings. The remaining muffler units are installed alternate A and B sections, and to include any number desired within the chosen length casing 1. It is preferable to vary the lengths of the respective unit sections A and B throughout the extended muffler section, thus producing a greater variation of densities and a slightly more effective muffler, although it may somewhat increase the manufacturing cost.

In all cases the throat openings *h* and *ha* of the nozzles 9 and 9*a* must be not less than that of the intake port *a*, and with the respective Venturi openings somewhat larger, in order to secure the lower back pressures within the muffler. These openings may however, be varied to meet the allowable back pressures permitted, depending on the use and application of the muffler.

With each pulsation from the engine exhaust into the intake port *a*, the gases are discharged directly into the receiving nozzle 9 utilizing a small portion of kinetic energy of the high velocity gas, causing a slight entrainment of gases outside the nozzle walls, by ejector reaction, thus preventing equalization of pressure throughout the compartment preceding the Venturi tube, and at the same time creating a low pressure area within the nozzle throat *h*. The flowing gases likewise create a low pressure area on passing through the Venturi throat *g*. By adding the air dome chamber *d* of such length that each will emit sound waves of very low pitch, a space is created which reacts as a cushion to the highly pulsating gas from the engine exhaust, and thereby maintain a more even low pressure within that area. Further, experiments have shown that sound velocities decrease with tube diameters. It would therefore follow that continued successive low pressure areas alternating with high pressure sections, the flow of gases through decreasing tube diameters, and the defusion of sound waves by variations of the Venturi openings, would ultimately destroy, or greatly diminish their intensity as they pass through the successive muffler units, and without creating appreciably the back pressure, due to the unrestricted orifices of the nozzle and Venturi tubes. Extensive experiments have fully verified these facts.

It has been found that by alternating the muffler units A and B the best results are attained, and where more variations in the air dome lengths are used, tone beats can be completely eliminated for all engine speeds and without any increase of back pressure.

Fig. 10 illustrates a modification of the preferred form of muffler, by omitting the air dome 5 and chamber *d*. Its operation is similar to the former case except less effective.

Fig. 11 illustrates a further modification of my preferred form of muffler by a further omission of both the air dome 5 and the receiving nozzle 9, resulting in a still less effective muffler unit, although very serviceable for certain types of engines.

It is apparent my muffler is subject to various modifications without departing from the spirit of my invention, and I not only claim the design herein shown, but any modification thereof that is substantially a substitution of parts or sections herein illustrated.

Having fully described my exhaust muffler for internal combustion engines, what I claim as my invention and desire to secure by Letters Patent is:

1. An exhaust muffler for internal combustion engines, comprising an elongated cylindrical casing formed with a closing head mounted within opposite ends thereof, an intake port formed through one casing head and an exhaust port provided in the opposite head wall, a series of sound deadening units mounted within said cylindrical casing for the full length thereof, each of said sound deadening units being formed of symmetrically positioned Venturi sections of different sizes and lengths arranged so one opens into another, a sound deadening chamber surrounding said assembled Venturi sections, and each alternate sound deadening unit being formed of different length and with flattened central exhaust aperture walls therethrough positioned symmetrically with the casing axis.

2. An exhaust muffler for internal combustion engines, comprising a cylindrical casing closed at both ends thereof and provided with an intake and exhaust at opposite ends, a series of sound deadening units mounted consecutively within the cylindrical casing for the full length thereof, each of said sound deadening units comprising an outer compression chamber positioned concentric with the casing axis, an enlarged Venturi tube mounted within the casing walls and sealed therewith also positioned concentric with the casing axis, a conical nozzle mounted within the intake end of said Venturi tube, positioned concentric therewith and separated therefrom,

means mounted between the nozzle and Venturi tube for retaining same in fixed predetermined positions, and means mounted on said unit for separating same from the next adjacent sound deadening unit.

3. An exhaust muffler for internal combustion engines, comprising an elongated cylindrical casing closed at both ends and provided with intake and exhaust ports at opposite ends thereof, a series of sound deadening units mounted consecutively within the said casing for the full length thereof, each of said sound deadening units comprising an outer circular compression chamber positioned adjacent to the casing walls, a Venturi tube with an enlarged central opening mounted within the casing walls and sealed therewith, positioned concentric with the axis thereof and having its exhaust port projected within the next adjacent sound deadening unit, alternate sound deadening units having their respective Venturi tubes formed at different lengths and formed with flattened exhaust aperture walls therein.

4. An exhaust muffler for internal combustion engines, comprising an elongated cylindrical casing closed and both ends and provided with intake and exhaust ports formed at opposite ends thereof, a series of sound deadening units mounted consecutively within said casing for the full length thereof, each of said sound deadening units comprising a flanged cylindrical air-dome ring fitted and mounted within the casing, an enlarged Venturi tube fitted and mounted within the air-dome ring open end, positioned concentric therewith, a conical shaped nozzle mounted within the intake end of the Venturi tube, concentric therewith and separated therefrom by suitable means, and means for separating the different sound deadening units providing intervening spaces therebetween.

5. An exhaust muffler for internal combustion engines, comprising an elongated cylindrical casing having an intake and exhaust end head fitted therein, a series of sound deadening units mounted consecutively within said casing for the full length thereof, each of said sound deadening units comprising a flanged cylindrical air-dome ring fitted within the casing walls and open at one end nearest the muffler intake port, an enlarged Venturi tube fitted and mounted within the open end of the air-dome ring positioned concentric therewith, a Venturi nozzle section mounted within the open end of the Venturi tube concentric therewith and separated therefrom by suitable means, and means for separating the different sound deadening units from each other providing predetermined spaces therebetween, alternate sound deadening units being formed of different lengths and provided with flattened exhaust aperture walls in their respective Venturi tubes.

6. A muffler for an internal combustion engine exhaust, comprising an elongated cylindrical casing closed at both ends and provided with intake and exhaust ports at opposite casing ends, a series of sound deadening units mounted consecutively within the casing for the full length thereof, each of said sound deadening units comprising a flanged cylindrical air-dome ring fitted and mounted within the casing walls and provided with an open chamber end nearest the muffler intake port, an enlarged Venturi tube fitted and mounted within the air-dome ring open end positioned concentric with the casing axis, and

means for separating the assembled units providing predetermined intervening spacings therebetween, alternate sound deadening units being formed with flattened exhaust aperture walls on their respective Venturi tubes.

7. An exhaust muffler for internal combustion engines, comprising an elongated cylindrical casing closed at both ends and provided with intake and exhaust ports in opposite ends thereof, a series of sound deadening units fitted and mounted consecutively within the casing for the full length thereof, each of said sound deadening units comprising a flanged cylindrical air-dome ring fitted and mounted within the casing walls, said air-dome ring being formed with an open end positioned nearest the muffler intake port, an enlarged Venturi tube fitted and mounted within the said air-dome ring open end, concentric therewith, a diminished Venturi nozzle section mounted within the intake end of said Venturi tube, concentric therewith and separated therefrom by suitable means, and means for separating the different sound deadening units one from another providing predetermined intervening spacings therebetween, alternate sound deadening units being formed of different lengths and provided with flattened exhaust outlet aperture walls on their respective Venturi and nozzle sections.

8. A muffler for exhaust gases comprising an outer casing provided with inlet and discharge openings and a plurality of sets of parallely-arranged Venturi tube elements mounted in spaced relation within said casing for breaking up said exhaust gases into a plurality of streams having different speeds of flow.

9. A muffler for exhaust gases comprising an outer casing provided with inlet and discharge openings and a plurality of sets of Venturi tube elements mounted in spaced relation within said casing, said Venturi tube elements of each set having nonapertured continuous walls and arranged in parallel for breaking up the exhaust gases into a plurality of streams having different speeds of flow.

10. A muffler for exhaust gases comprising an outer casing provided with inlet and discharge openings, and a plurality of sets of Venturi tube elements mounted in spaced relation within said casing, said Venturi tube elements of said sets having a different cross-sectional area and parallelly arranged for breaking up said exhaust gases into a plurality of streams having different speeds of flow.

11. A single unit for use in mufflers of exhaust gases comprising an outer Venturi tube element, an arm extending from said outer Venturi tube element, and an inner Venturi tube element formed on said arm.

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