

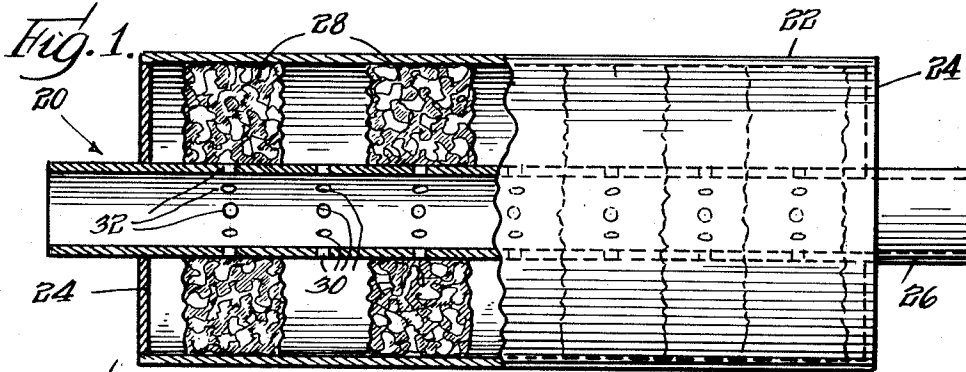
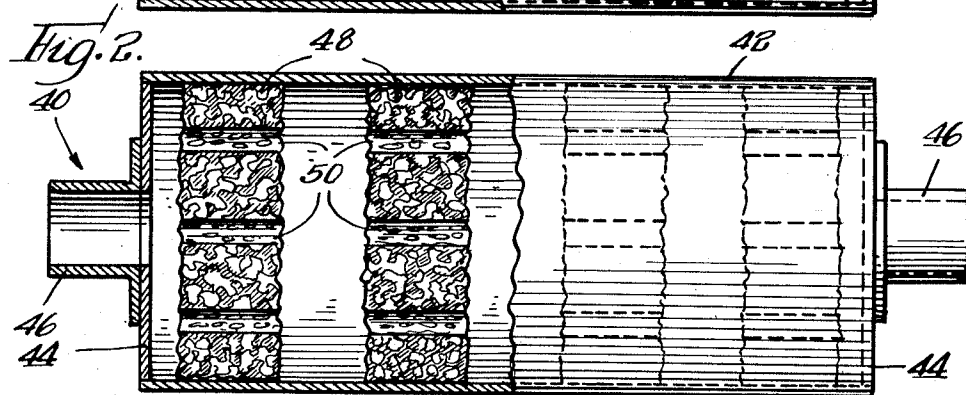
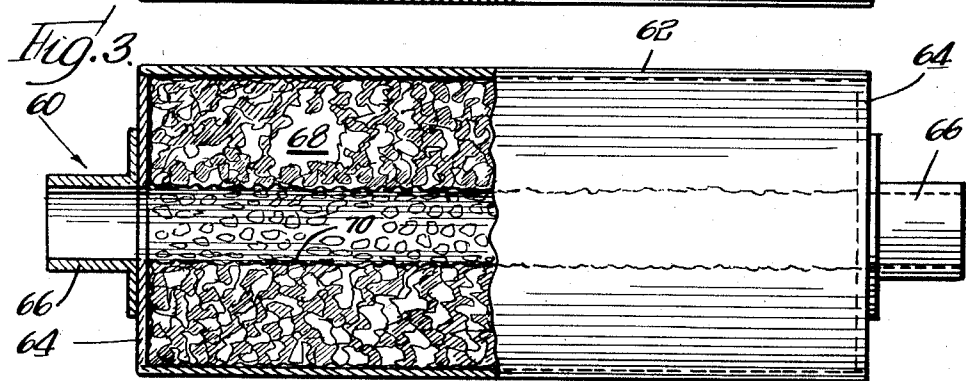
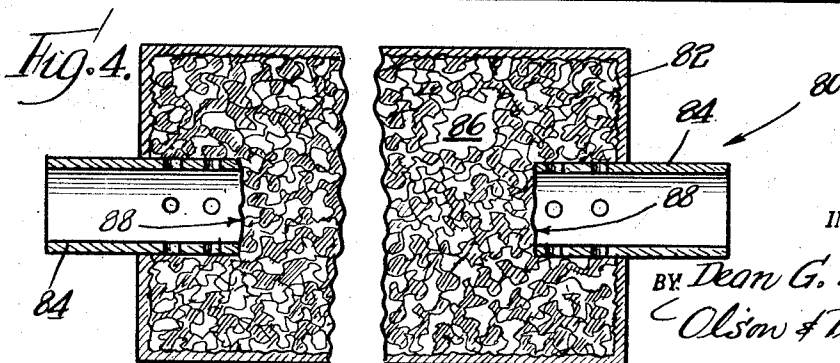
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EXHAUST MUFFLER

3,159,237

Filed Oct. 28, 1959

3 Sheets-Sheet 1



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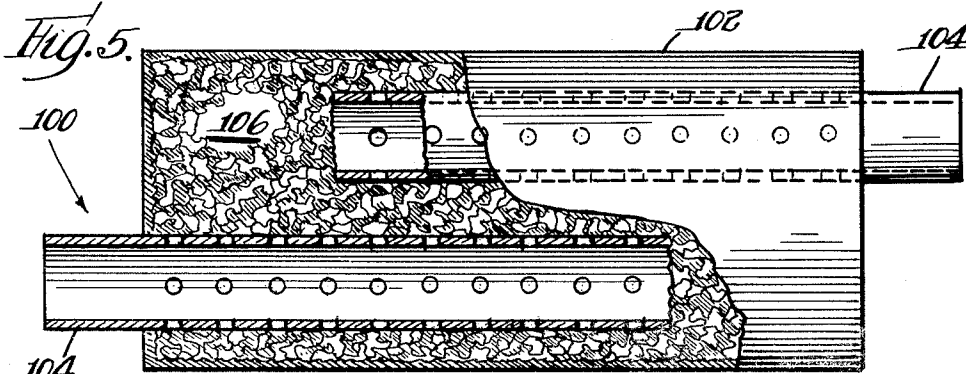
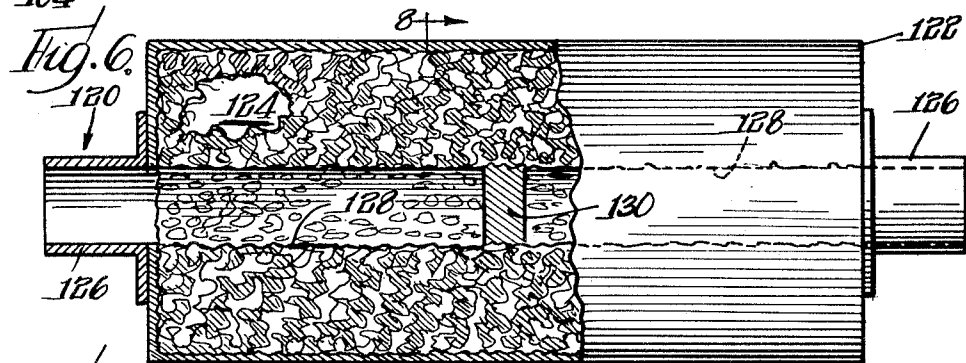
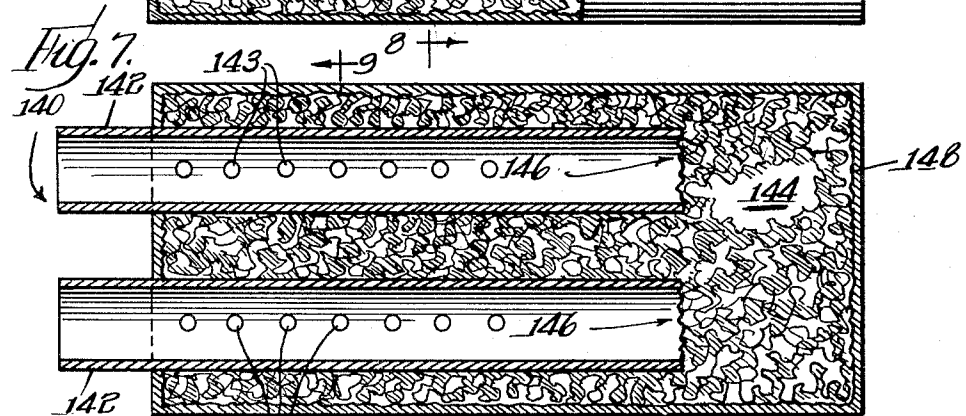
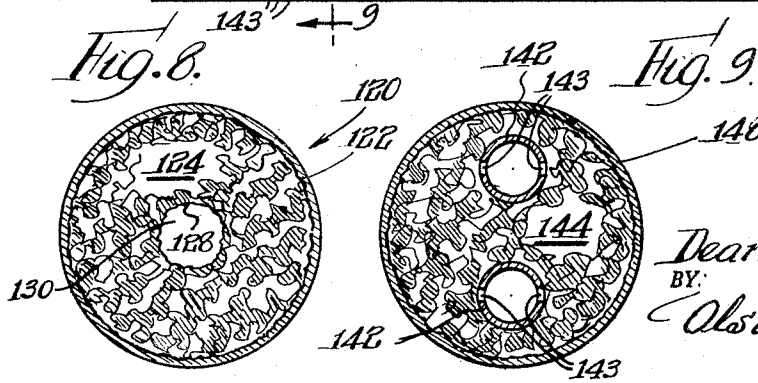
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3 Sheets-Sheet 2



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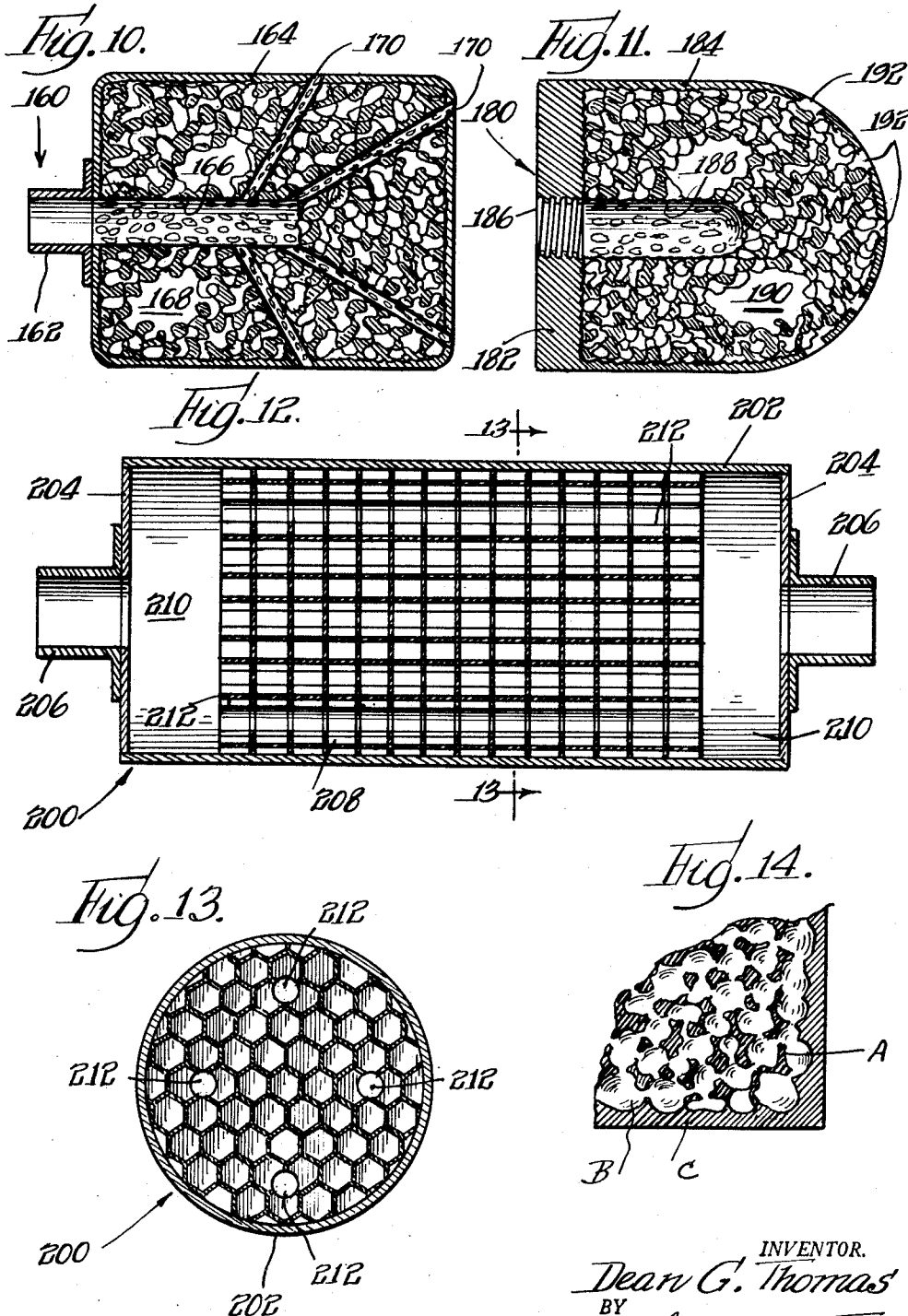
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3 Sheets-Sheet 3



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EXHAUST MUFFLER

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2 Claims. (Cl. 181-42)

This invention relates generally to exhaust mufflers for internal combustion engines.

As is well known, the cyclical manner in which internal combustion engines operate causes the exhaust gases to emanate in a pulsating stream. This pulsating characteristic of the exhaust gas stream gives rise to undesirable sound waves, and numerous schemes have been devised to muffle or attenuate these waves.

One common approach has involved conducting the exhaust gases through a radially apertured tube, the gases being allowed to expand through the apertures into a closed muffler chamber. Introduction of an acoustically absorbent material in the muffler chamber has proved to increase the degree of attenuation, especially with regard to high frequency sound waves; and "acoustical packs" consisting of copper, steel or glass wool have been employed.

However, these acoustical absorbents have a number of disadvantages which tend to diminish their effectiveness upon prolonged use. Glass wool is somewhat fragile and is prone to fail, principally by disintegration, when subjected to engine vibration. Copper and steel wools, on the other hand, while more resistant to fatigue failure, are attacked by corrosive constituents in the exhaust gases. The high temperature of the gases is known to aggravate both of these conditions. Furthermore, all of these wools tend to collapse or become compacted during use; and this reduction in volume of the acoustical absorbent restricts its propensity for attenuation within the muffler chamber.

Therefore, a general object of the present invention is to provide a new and improved muffler construction.

Another object of the invention is to provide a muffler construction having improved sound attenuation characteristics.

Yet another object of the invention is to provide a muffler construction in which the attenuation properties are not degraded during use.

Still another object of the invention is to provide a muffler which is both simple and economical to manufacture.

Additional objects and features of the invention pertain to the particular structures and arrangements whereby the above objects are attained.

The invention will be better understood by reference to the following disclosure and drawings forming a part thereof, wherein:

FIG. 1 is a side elevational view partially in cross-section and partially in broken outline showing a straight-through style muffler constructed in accordance with the invention;

FIG. 2 is a side elevational view partially in cross-section and partially in broken outline showing another straight-through style muffler constructed in accordance with the invention;

FIG. 3 is a side elevational view partially in cross-section and partially in broken outline showing still another modified straight-through style muffler constructed in accordance with the invention;

FIG. 4 is a side elevational view in cross-section of a devious-path style muffler constructed in accordance with the invention;

FIG. 5 is a side elevational view partially in cross-section and partially in broken outline showing a two-

pass style muffler constructed in accordance with the invention;

FIG. 6 is a side elevational view partially in cross-section and partially in broken outline showing a plug style muffler constructed in accordance with the invention;

FIG. 7 is a side elevational view in cross-section of a return-flow style muffler constructed in accordance with the invention;

FIG. 8 is a view through the section 8-8 of FIG. 6;

FIG. 9 is a view through the section 9-9 of FIG. 7;

FIG. 10 is a side elevational view in cross-section of a modified straight-through style muffler constructed in accordance with the invention;

FIG. 11 is a side elevational view in cross-section of a modified plug style muffler constructed in accordance with the invention;

FIG. 12 is a side elevational view in cross-section of still another modified straight-through style muffler constructed in accordance with the invention;

FIG. 13 is a view through the section 13-13 of FIG. 12; and

FIG. 14 is an enlarged, fragmentary, cross-sectional view of one of the sound attenuating materials employed in the invention.

The invention comprehends the use and controlled modification of certain, relatively new materials which have not heretofore been employed in muffler construction and manufacture. The first of these materials is metal foam of the closed cell type as particularly described and claimed in U.S. Patent No. 2,751,289, granted June 19, 1956, to J. C. Elliott. Since this material has a sponge-like appearance and since a major portion of the bubbles or cells are not interconnected, it will be referred to hereinafter as "closed cell vesicular metal."

A second material, the use of which is comprehended in the present invention, is metal foam of foraminous nature, i.e. having intercommunicating cells. To distinguish it from the first described material, this second material will be referred to hereinafter as "open cell vesicular metal."

Whereas closed cell vesicular metal is produced by quenching the foaming, molten mass while each bubble is completely enveloped by the fluid metal, open cell vesicular metal is produced by quenching the mass while the bubbles are at the stage of incipient agglomeration and the vast majority of the bubbles intercommunicate. Open cell vesicular metal is illustrated in FIG. 14 where a metal matrix A defines a network of interconnected voids or cells B.

In the production of either open or closed cell vesicular metal, when the molten mass is poured into a cold mold or otherwise quenched, the metal at the surface coalesces or flows together forming a solid, non-cellular skin or casing C. This skin may be used to advantage as will be brought out hereinafter.

Another material embraced by the present invention is metallic honeycomb which is manufactured by welding specially shaped metal sheets together and subsequently expanding the welded assembly into a structure having an appearance similar to a honeycomb. Since this material can be fabricated to have the individual cells interconnected or imperforate, the two forms will be hereinafter referred to, respectively, as "open cell metal honeycomb" and "closed cell metal honeycomb."

With detailed reference now to the drawings, specifically to FIG. 1, a straight-through style muffler indicated generally at 20 includes a housing or shell 22 of cylindrical or other suitable cross-section. Headers or plates 24 are affixed to shell 22 to close off the ends while a radially apertured tube 26 is located coaxially within the shell

22 extending through plates 24 so as to provide inlet and outlet means. Advantageously, tube 26 is pressed, welded or otherwise suitably secured to plates 24 and is adapted to be coupled to the exhaust pipe of an internal combustion engine, not shown.

In accordance with a feature of the invention, a number of centrally cored, sound attenuating discs 28 are arranged in axially spaced-apart relationship within the housing 22 and fitted about the tube 26. Discs 28 are of either the open or closed cell type of vesicular metal. However, when the closed cell type of material is employed, apertures 30 in tube 26 are appropriately disposed in communication with the spaces between the discs whereas, when the open cell type of material is utilized, apertures 32 are arranged to communicate directly with the discs 28 as shown. In either case, it is advantageous to expose the cells on the outer surface of the discs, as for example by machining away any surface metal closing off the individual pores or cells, so that the energy of the entering sound waves may be absorbed by the cell surfaces.

In FIG. 2, a straight-through style muffler 40 includes a shell 42 closed off by centrally apertured headers 44 to which are welded or other wise suitably affixed flanged, hollow end fittings 46.

A number of sound attenuating discs 48 are fitted within the housing 42; and since muffler 40 does not incorporate a central, longitudinally extending tube, it has proved advantageous to punch or drill the discs 48 with axial bores such as are shown at 50. As will be recognized, bores 50 may be arranged longitudinally aligned or eccentric as is desired.

By means of the extent and arrangement of the bores 50, it is possible to maintain a planned relationship between acoustical attenuation and back pressure, specifically by achieving proper balance of cell volume and passageways.

Discs 48 are of either the open or closed cell type of vesicular metal; and as in the embodiment of FIG. 1, it is advantageous, in any event, to expose the cells at the outer surface of the discs. As will become apparent, only sound waves enter the closed cell vesicular metal discs; but both sound waves and exhaust gases enter the open cell vesicular metal discs.

Turning now to FIG. 3, a modified straight-through style muffler 60 is shown constructed with a housing 62 having plates 64 welded or otherwise suitably secured closing off its ends and having flanged, hollow end fittings 66 providing openings into the interior of housing 62. Before the plates 64 are affixed, a sound attenuating element 68 corresponding in size and shape to the interior of housing 62 is inserted into the housing. The element 68 is fashioned from open cell vesicular metal and is desirably fashioned to have a central bore 70 communicating the opposite end fittings 66. Bore 70 may be provided by drilling the member 68 so as to expose a multiplicity of the individual cells of which member 68 is comprised.

Because of the open cell nature of the member 68, it will become apparent that exhaust gases passing through the muffler 60 expand and follow labyrinthine paths through the member 68 whereby the undesirable sound waves associated with the exhaust gases become attenuated.

The vesicular metal described herein inherently possesses a surface skin of solid metal in its as-cast condition. This skin is employed to advantage as the housing and headers of the devious-path style muffler 80 shown in FIG. 4, the combination housing-headers being designated by the numeral 82. Inlet means and outlet means are provided in the muffler 80 by radially apertured pipe stubs 84 being pressed into blind bores in opposite ends of the structure as shown. As will be recognized, these inlet and outlet means may be positioned axially, eccentrically or in side-entry locations, as is desired.

A vesicular metal element 86 is formed of the open

cell type of material; and accordingly, exhaust gases are allowed to follow devious paths through the cellular structure of element 86 from the exposed pores of two spaced-apart areas 88 located at the ends of the pipe stubs 84.

In FIG. 5, a muffler 100 of the two-pass style employs the as-cast skin for the shell 102, and two lengths of radially apertured pipe or tubing 104 are secured in the vesicular metal element 106 to extend their open ends beyond each other in opposite directions. The cellular element 106 is necessarily of the open cell type in order to provide paths communicating the two pipes 104.

With reference now to FIGS. 6 and 8, a plug style muffler 120 is constructed with a cylindrical shell 122 comprising the cast metal skin referred to hereinabove encompassing an element 124 of open cell vesicular metal. At opposite ends of the muffler 120, flanged, hollow fittings 126 are welded to the shell 122. The fittings 126 are arranged to be coaxial with the blind bores 128 provided in element 124.

Advantageously, the mold which produces element 124 is cored so as to form the bores 128 with a solid plug 130 closing off the common end of the bores. Subsequently, the surface of the bores 128 is etched or machined to expose the pores so as to allow exhaust gases to pass from one fitting 126 through the labyrinthine paths in the element 124 to the other fitting 126.

The embodiment shown in FIGS. 7 and 9 comprises a return-flow style muffler 140 in which two pipes or tubes 142 preferably radially apertured with holes 143, are pressed into parallel blind bores provided in a cylindrical, open cell vesicular metal element 144. The closed end portions 146 of these bores expose the pores of the metal so that the interconnected nature of the pores may provide a path for exhaust gases between the two tubes 142. So as to reduce cost and facilitate manufacture, the as-cast skin of metal is employed for the shell or housing 148 of muffler 140.

Referring now to FIG. 10, a modified straight-through style muffler 160 incorporates a single hollow, flanged fitting 162 affixed to the housing or shell 164 which conveniently takes the form of the as-cast skin referred to previously. Fitting 162 communicates with a bore 166 which is drilled or suitably provided in a vesicular metal element 168. For purposes of this embodiment, element 168 is of the closed cell type; and accordingly, a number of smaller, radiating bores 170 are arranged to communicate bore 166 exteriorly. In muffler 160, the network of unconnected cells primarily serves to isolate the sound waves rather than absorbing them as is the case with networks of interconnected cells.

A muffler 180 of modified plug style and having a solid metal base 182 cast integrally with the case or skin 184 is shown in FIG. 11. Here a tapped hole 186 communicates with a blind bore 188 provided in a vesicular metal element 190 having open cells. In this embodiment, the bore 188 is machined or etched to expose the cells while a number of holes 192 are drilled through the casing 184. The holes 192 provide outlet for the exhaust gases directed through the tapped hole 186 into the labyrinthine passageways in the element 190.

Turning now to FIGS. 12 and 13, a straight-through style muffler 200 is shown to include a housing or shell 202 having headers 204 suitably affixed closing off its opposite ends. A pair of flanged, hollow fittings 206 are secured to the plates 204 in alignment with the central bores provided in the plates. Within the housing 202, a honeycombed metal element 208 is arranged to provide opposite end chambers 210; and the honeycombed metal element 208 is desirably formed with axially extending bores 212 which interconnect the chambers 210. The element 208 is advantageously formed from either the open or closed cell type of material.

Both the vesicular and honeycomb metal elements described hereinabove may be of aluminum metal. However, the invention is not restricted to any specific metal.

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Furthermore, the embodiments hereinabove described represent only a limited number of the constructions possible within the purview of the invention; and as will become apparent, structural features described with particular reference to one of the illustrated embodiments may be exchanged for similar structure found in one or more of the other embodiments. Accordingly, it should be understood that the invention is not to be limited to the specific constructions which have been shown and described, rather, the invention is intended to be limited only by the spirit and scope of the appended claims.

The invention is claimed as follows:

1. An exhaust muffler for internal combustion engines comprising a unitary metal body having an exhaust gas inlet, an exhaust gas outlet and a mass of foamed metal including a network of substantially interconnected cells disposed between said inlet and said outlet in flowpathwise obstructing relationship therewith whereby gases passing from said inlet to said outlet are caused to follow labyrinthine paths through the interconnected cells of said mass of foamed metal for attenuating sound waves carried by said gases.

2. An exhaust muffler for internal combustion engines comprising a unitary metal body having an exhaust gas inlet, an exhaust gas outlet and a mass of foamed metal including a network of substantially interconnected cells disposed between said inlet and said outlet in flowpath-

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wise obstructing relationship therewith whereby gases passing from said inlet to said outlet are caused to follow labyrinthine paths through the interconnected cells of said mass of foamed metal for attenuating sound waves carried by said gases, said metal body further having a substantially imperforate metal skin integrally connected to said network of cells exteriorly thereof whereby to form a housing for said unitary metal body.

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