

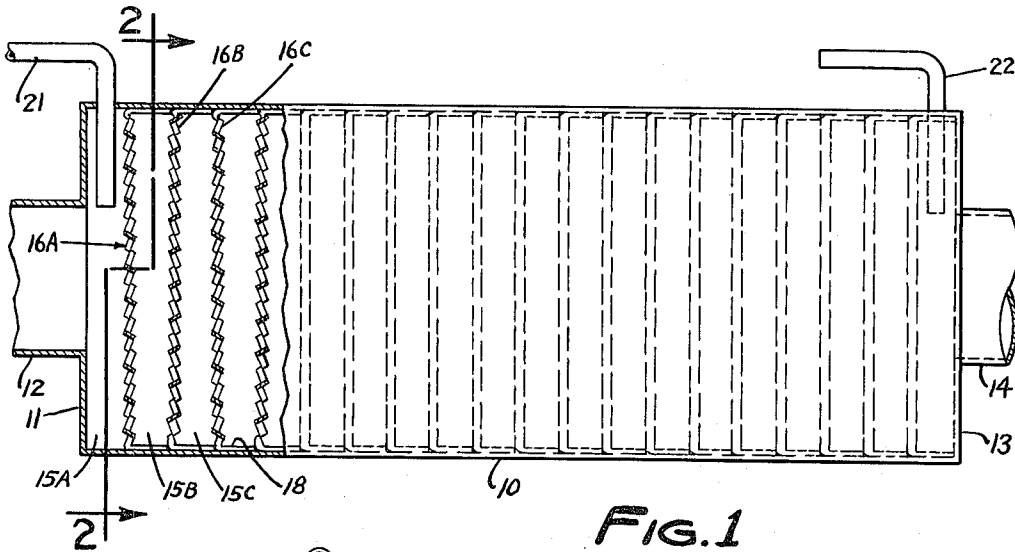
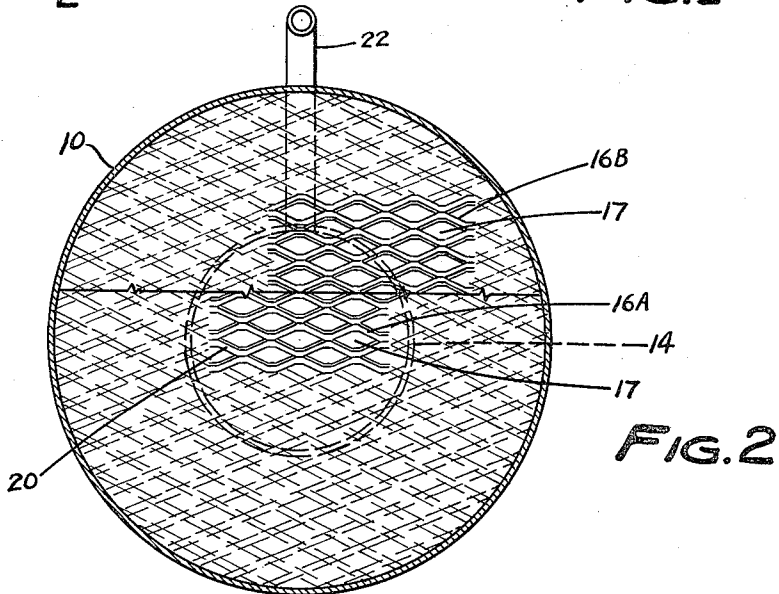
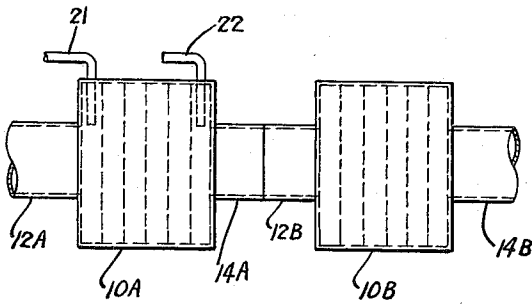
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G. H. BJORK

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MUFFLER WITH TRANSVERSE EXPANDED METAL BAFFLES

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INVENTOR
GUST H. BJORK
BY *Moore, White & Burd*
ATTORNEYS

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MUFFLER WITH TRANSVERSE EXPANDED METAL BAFFLES

Gust H. Bjork, Golden Valley, Minn., assignor to Bjork and Johnson, Inc., Minneapolis, Minn., a corporation of Minnesota

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This invention relates to a system for the reduction of objectionable constituents in exhaust gases from internal combustion engines such as automobile engines. More particularly the invention relates to a muffler device for attachment to the exhaust manifold of an automotive engine for the reduction of quantities of unburned hydrocarbons and carbon monoxide emitted from the exhaust system of the engine. At the same time the system of the present invention reduces noise and reduces back pressure. The system of this invention may be utilized in addition to, or in substitution for, the conventional automobile muffler. When used in conjunction with a conventional muffler, it is installed between the engine exhaust and conventional muffler.

The exhaust gases from the average automobile contain a mixture of carbon monoxide, carbon dioxide, unburned or partially burned hydrocarbons, nitrogen, some of the nitrogen oxides, and under certain conditions, portions of unconsumed air. It is reasonably well established that these automobile exhaust gases and similar exhaust gases from other internal combustion engines contribute to the production of smog. In certain urban areas smog is produced in such quantities as to be considered objectionable and potentially harmful. As a result, states have begun to legislate against the introduction into the atmosphere of gases which contribute to smog production. Exemplary of this is legislation enacted in California which establishes a maximum permissible content of hydrocarbon in escaping exhaust of 275 parts per million and maximum carbon monoxide content of 1.5 percent.

Prior attempts to reduce the unburned hydrocarbon and carbon monoxide content in automobile exhaust have principally been in the form of so-called "after burners" for direct oxidation of the undesired materials with excess air at high temperatures above about 2,000° F. and catalytic converters for catalytically oxidizing the unwanted materials with excess air at lower temperatures of the order of 500° F. However, neither of these systems has proved completely satisfactory under the wide variety of operating conditions which must be met in the course of operation of an automobile in normal use.

The principal object of this invention is to provide a simple muffler system for exhaust gases from internal combustion engines to effectively reduce the content of objectionable gaseous constituents, reduce noise and reduce back pressure.

Other objects of the invention will become apparent as the description proceeds.

To the accomplishment of the foregoing and related ends, this invention then comprises the features herein-after fully described and particularly pointed out in the claims, the following description setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principles of the invention may be employed.

The invention is illustrated by the accompanying drawings in which the same numerals refer to corresponding parts and in which:

FIGURE 1 is a side elevation of a muffler device according to the present invention shown with portions broken away and in section to reveal the internal structure;

FIGURE 2 is a vertical section on the line 2—2 of FIGURE 1 and in the direction of the arrows, drawn to a larger scale than FIGURE 1, shown with one disc partly broken away to reveal the structure behind it; and,

FIGURE 3 is a side elevation of a modified form of muffler system according to the present invention.

Referring now to the drawings, the muffler system according to the present invention includes a tubular housing 10 having an end plate 11 closing one end. End plate 11 has a central opening communicating with an inlet pipe 12 which is adapted to be connected to the exhaust manifold of an internal combustion engine. For best results, inlet pipe 12 should be as short as feasible in the particular environment of the engine in order that the muffler system of the present invention may be located as close to the engine as possible. The opposite end of housing 10 is closed by a further end plate 13 having a central opening connected to a gas discharge pipe 14 which is adapted to be connected to the inlet to a conventional muffler, or simply to a tail pipe for discharge of the purified exhaust gases.

The cylindrical housing 10 is divided into a plurality of transverse chambers 15A, 15B, 15C, etc., by a plurality of transverse foraminous discs 16A, 16B, 16C, etc. Each of the discs is provided with a multitude of closely spaced apertures 17. The axes of the apertures extend at an acute angle less than a right angle with respect to the plane of each disc. Typically each aperture passes through the plane of the disc at an angle between about 30° and 60°, and desirably at about 45°.

Alternate discs are disposed within the cylindrical housing so as to vary the direction of the apertures in the discs so as to define a tortuous path for the gases passing through the muffler system. For example, as shown in FIGURE 1, the apertures in the first disc 16A are directed downwardly. Those in disc 16B are directed upwardly, and those in disc 16C are directed downwardly again. The discs alternate in this manner the entire length of the housing and thus impart to the gas flow alternating downward-upward-downward direction.

In the illustrated embodiment, each disc is rotated 180° with respect to the next adjacent disc. While this is a preferred embodiment, the alternate discs may be rotated to a lesser extent. For example, if each disc is rotated 90° relative to the one immediately preceding it, the gases are directed in a downward-leftward-upward-rightward sequence. If desired, the alternate discs may be rotated with respect to the preceding discs by anywhere from about 90° to 180° although best results are achieved with the latter configuration.

The discs may be spaced apart from about 1/8 inch to 1 inch, but for best results they are spaced apart between about 1/4 inch and 1/2 inch from one another. To facilitate uniform spacing and securing of the discs within the housing, each disc is desirably provided with an annular flange 18.

The apertured discs are conveniently formed from so-called "expanded metal" sheeting which is produced by forming a series of staggered slits in an impervious metal sheet and then stretching the sheets in a direction perpendicular to the slits to open the slits into apertures and expand the metal sheets in the direction while contracting it slightly in the opposite direction. The stretching operation by which the metal sheet is expanded imparts a twist or bend to the ribbon-like portions 20 of the metal sheets separating the apertures. It is this twisting or bending of the metal members 20 between adjacent apertures which imparts the angle or direction to the aperture itself. The expanded metal sheeting is left unflattened to preserve the oblique apertures. The discs may likewise be formed from so-called louver-type screen or the oblique

apertures may be drilled or punched through metal sheeting at an acute angle relative to the plane of the sheet.

All of the metal elements of the muffler system must be constructed from heat resistant materials capable of withstanding temperatures of the order of about 1600 to 2,000° F. An exemplary material is stainless steel, although other heat resistant metallic alloys capable of withstanding these high temperatures, as are known in the art, may be used. Alternatively, less heat resistant metals provided with a refractory ceramic coating may be used to form part or all of the muffler system.

The precise size and shape of the apertures is not critical nor is the relative position of one aperture to another in a given disc. However, the angle or direction of all apertures in a single disc should preferably be the same and sufficient apertures of sufficient size should be present to permit relatively unobstructed flow of exhaust gases through the muffler system, although the path of travel of the gases is deflected as a result of its passage through each apertured disc. In general, the apertures should constitute from about 25% to 75% of the area of each disc to accomplish this. The apertures should be relatively uniform in size and distribution uniformly across the area of the disc. In a typical example, a 4 inch diameter disc formed from unflattened expanded stainless steel had approximately 200 apertures.

A tube 21 extends into the first chamber 15A at the intake end of the muffler system. Tube 21 extends to the breather tube of the crankcase of the internal combustion engine to which the muffler system is connected. The passage of exhaust gases produces an aspirating effect which draws the crankcase fumes from the crankcase and discharges them with the exhaust gases. Although the presence of this tube is optional, the direct withdrawal of the crankcase fumes tends to reduce the production of carbon monoxide to some extent. An air inlet tube 22 extends into the last chamber of the muffler system at the discharge end. The exhaust gases also produce an aspirating effect with respect to this tube to draw air into the system to dilute the purified exhaust gases before discharge into the outlet pipe 14 and tail pipe. The outer end of tube 22 is simply exposed to the atmosphere. Air inlet tube 22 is likewise optional.

In a typical installation in a passenger automobile, the muffler system should be between about 3 inches and 4 inches in diameter and about 8 inches to 12 inches long with about 8 to 40 discs and, preferably, from about 16 to 40 discs. For heavier vehicles such as trucks and buses and the like, the diameter may be increased to about 8 inches and the length to 16 to 20 inches to accommodate the greater volume of exhaust gases produced. While the length of the muffler system may be increased beyond these dimensions, no further beneficial result is obtained except for some slightly greater reduction in noise.

Because it has been determined that the maximum purification of the exhaust gases is achieved in the first 2 to 4 inches at the intake end of the muffler system, and the remainder of the length is necessary primarily for noise reduction, the alternative form of construction shown in FIGURE 3 may be used in some instances. According to this embodiment the muffler system is composed of two separate cylindrical housings or housing compartments 10A and 10B. Housing compartment 10A has an inlet tube or pipe 12A adapted to be connected to the exhaust manifold of an internal combustion engine and a discharge pipe 14A adapted to be connected to the inlet pipe 12B of the second housing compartment 10B. This second housing compartment has a discharge pipe 14B adapted to be connected to a tail pipe or a conventional muffler when such is used. The optional crankcase breather tube pipe 21 and optional air inlet tube 22 may be incorporated into the first unit 10A. In the muffler system according to this embodiment, substantially all of the purification of the exhaust gases occurs within

the first housing unit 10A and the second housing unit 10B is used for noise reduction. Both housing units enclose apertured discs arranged and spaced as heretofore described.

By use of the muffler system according to the present invention the normal 7% to 8% carbon monoxide content of automobile engine exhaust has been reduced to as low as 0.1% in individual tests. Unburned hydrocarbons in the exhaust has been reduced accordingly. Because of the reduced back pressure due to the relatively free passage of exhaust gases through the muffler system according to the present invention, gas mileage has been increased as much as 5 to 7 miles per gallon in a 1961 six-cylinder Ford automobile.

Because of its construction of high grade heat resistant materials, this muffler system is capable of lasting for the lifetime of the automobile on which it is installed, thereby eliminating the need for periodic replacement frequently encountered. Although the muffler system of the present invention may be utilized in connection with the conventional muffler, no advantage is obtained thereby and for this reason in most instances the conventional muffler may be eliminated.

To verify applicant's test results, tests were made by an independent consultant in industrial hygiene and air pollution problems. The tests were performed on a 1959 six-cylinder Ford automobile operating on regular grade Pure Oil Company gasoline. The automobile had been driven about 80,000 miles and was adjudged as being in good running condition. It was fitted with a stainless steel muffler system according to the present invention having a diameter of 4 inches and length of 10 inches. Within the cylindrical housing there were 24 discs of unflattened expanded stainless steel. These discs were arranged with every other disc rotated 180° relative to its neighbors. Each disc contained about 200 apertures uniformly distributed. Determinations were made of carbon monoxide and carbonaceous particulate material being exhausted from the automobile engine into the atmosphere. The tests were performed with the engine idling. The carbon monoxide determinations were made with a Mine Safety Appliances Company Carbon Monoxide Indicator after the exhaust gases had been reduced to $\frac{1}{16}$ of their original concentration. The carbon monoxide concentrations in the diluted gas varied from 400 to 700 parts per million by volume with an average of 480 parts per million by volume, or 0.048% by volume. The concentrated exhaust gases then contained 16 times 0.048 or 0.768% carbon monoxide by volume. The blow-by gases of the engine were passed through the exhaust gas purifying device during the test. The carbonaceous particulate material was determined by filtering the exhaust gases through Gilman AM4 membrane filters. The filters were weighed before and after drawing 335 liters of exhaust gases through them and were then fired in a muffle furnace and the residue weighed. The weight differences indicated 0.0014 and 0.0017 milligram of carbonaceous material in 335 liters of exhaust gases, or an average of 0.0046 milligram of carbonaceous particulate material per 1,000 liters of exhaust gases. This amounts to 4.6 milligrams per million liters of exhaust gases.

It is apparent that many modifications and variations of this invention as hereinbefore set forth may be made without departing from the spirit and scope thereof. The specific embodiments are given by way of example only and the invention is limited only by the terms of the appended claims.

I claim:

1. A muffler system for reducing objectionable constituents in exhaust gases from internal combustion engines, said system comprising a tubular housing, an exhaust gas inlet pipe into one end of said housing and a discharge pipe from the other end of said housing, said inlet pipe being adapted to be connected to the exhaust of an inter-

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nal combustion engine, a plurality of transverse spaced apart foraminous discs in said housing between the inlet and discharge pipes, said discs dividing said housing into a plurality of transverse chambers, each of said discs including a plurality of ribbon-like portions interconnected so as to define a multitude of closely spaced apertures uniformly distributed across the area of each disc, each of said ribbon-like portions in a single disc being disposed obliquely at an acute angle relative to the plane of the disc thus defining apertures extending through the disc obliquely at an acute angle relative to the plane of the disc, adjacent discs of said plurality of discs being disposed with the aperture defining ribbon-like portions of one disc directed in a different angular direction from the aperture defining ribbon-like portions of its immediately neighboring discs, whereby exhaust gases introduced into said muffler system pass through said housing in a relatively unobstructed but tortuous path.

2. A muffler system according to claim 1 further characterized by the provision of a tube extending into one of the chambers of said housing adjacent to the exhaust gas inlet thereof, said tube being adapted to receive blow-by gases from the crankcase of the internal combustion engine with which the muffler system is used.

3. A muffler system according to claim 1 further characterized by the provision of an air inlet tube extending into one of the chambers of said housing adjacent to the discharge end of the housing, the outer end of said air inlet tube being open to the atmosphere.

4. A muffler system according to claim 1 further characterized in that said discs are spaced apart not more than 1 inch from each adjacent disc.

5. A muffler system according to claim 4 further characterized in that said discs are spaced apart between about 1/4 inch and about 1/2 inch from each adjacent disc.

6. A muffler system according to claim 1 further characterized in that said housing includes between about 8 and 40 discs.

7. A muffler system according to claim 1 further characterized in that said aperture defining ribbon-like portions of said discs are disposed in said discs obliquely at an acute angle between about 30° and 60° relative to the plane of each disc.

8. A muffler system according to claim 1 further characterized in that each successive disc in said housing from inlet end to discharge end is disposed at an angle of rotation between about 90° and 180° relative to the immediately preceding apertured disc.

9. A muffler system according to claim 1 further characterized in that said ribbon-like aperture defining portions comprise between about 25% and 75% of the total area of each disc.

10. A muffler system according to claim 1 further characterized in that the component parts of said system are composed of heat resistant material capable of withstanding sustained temperatures of the order of 2,000° F.

11. A muffler system according to claim 10 further

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characterized in that the component parts of said system are composed of stainless steel.

12. A muffler system according to claim 1 further characterized in that said tubular housing is composed of a pair of aligned compartments connected by an intercommunicating pipe of lesser diameter, each of said housing compartments containing a plurality of apertured discs.

13. A muffler system for reducing objectionable constituents in exhaust gases from automobile internal combustion engines, said system comprising a cylindrical tubular housing, an exhaust gas inlet pipe of lesser diameter into one end of said housing and a discharge pipe of lesser diameter from the other end of said housing, said inlet pipe being adapted to be connected to the exhaust of an internal combustion engine, a plurality of from about 8 to 40 transverse spaced apart apertured discs in said housing between the inlet and discharge pipes, said discs being spaced apart between about 1/4 inch and 1/2 inch and dividing said housing into a plurality of transverse chambers, each of said discs including a multitude of closely spaced apertures defined by interconnected ribbon-like portions of said discs uniformly distributed across the area of each disc, said ribbon-like aperture defining portions comprising between about 25% and 75% of the total area of each disc, each of said ribbon-like aperture defining portions in a single disc being disposed upon the disc obliquely at an acute angle between about 30° and 60° relative to the plane of the disc, adjacent discs of said plurality of discs being disposed with the ribbon-like portions apertures of one disc directed in a different angular direction between about 90° and 180° from the ribbon-like portions in its immediately neighboring discs, said housing, pipes and discs being composed of stainless steel, whereby exhaust gases introduced into said muffler system pass through said housing in a relatively unobstructed but tortuous path to reduce the objectionable constituents therein.

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LEO SMILOW, *Primary Examiner.*