# United States Patent

**Gordon**

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## [54] MUFFLER FOR INTERNAL COMBUSTION ENGINES


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[52] **U.S. Cl.**.....**181/40,** 181/53, 181/56, 181/57, 181/61, 181/69, 181/72

[51] **Int. Cl.**.....**F01n 1/08,** F01n 7/10, F01n 7/20

[58] **Field of Search**.....181/35 C, 36 D, 40, 53, 56, 181/57, 61, 72, 68–70



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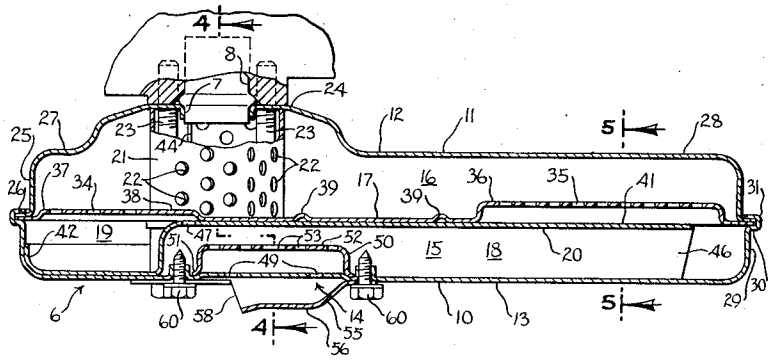
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[57] **ABSTRACT**

A muffler for a single cylinder engine comprises a shallow, elongated shell having a rear wall with an inlet port near one end of the shell and a front wall with an outlet port. A baffle plate clamped between the shell members divides the shell interior into front and rear compartments, communicated through spaced apart openings in the baffle plate. A front baffle member subdivides the front compartment into two communicated chambers, from one of which the outlet port opens and the other of which surrounds said one.


**9 Claims, 6 Drawing Figures**



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3 Sheets-Sheet 1

FIG. 1.

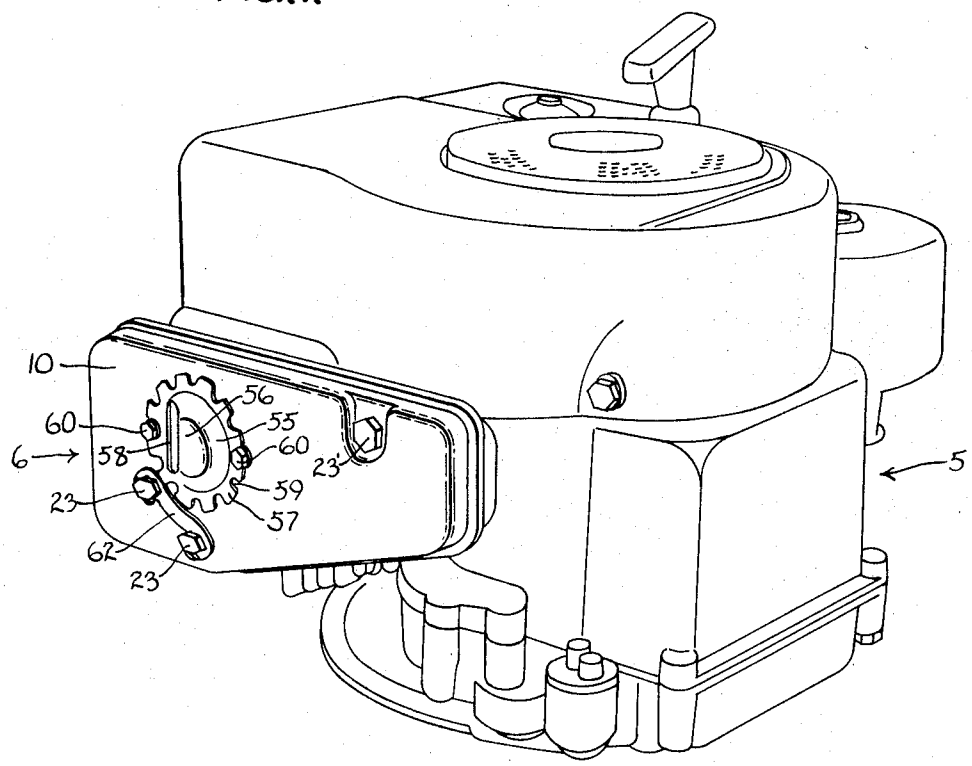
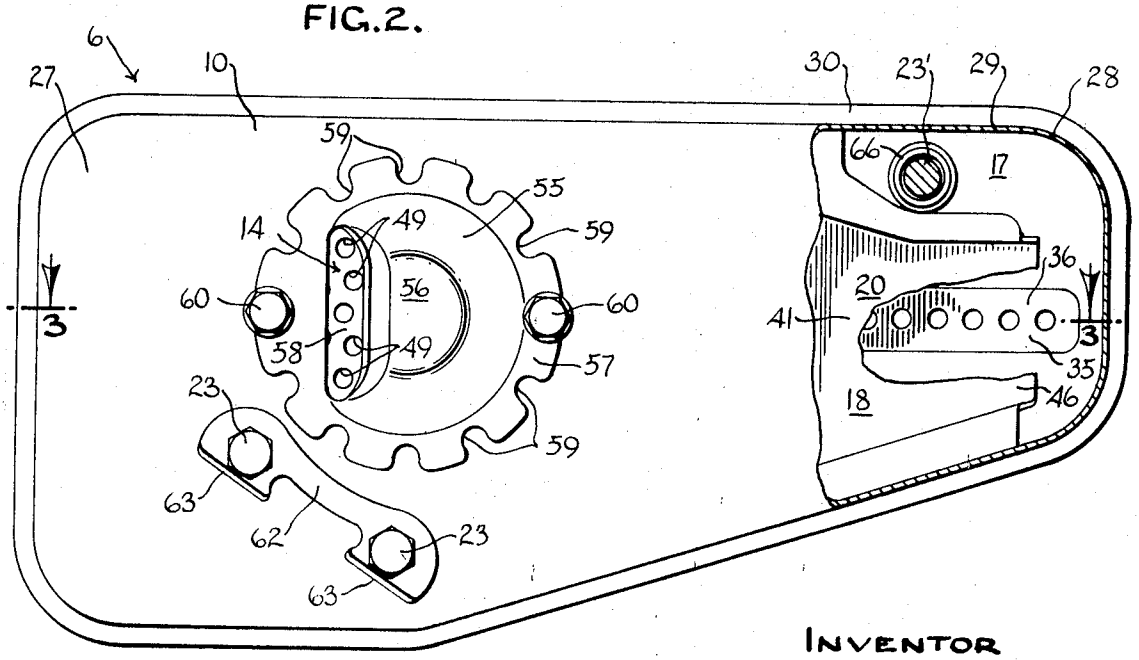



FIG. 2.




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3 Sheets-Sheet 2

FIG.3.

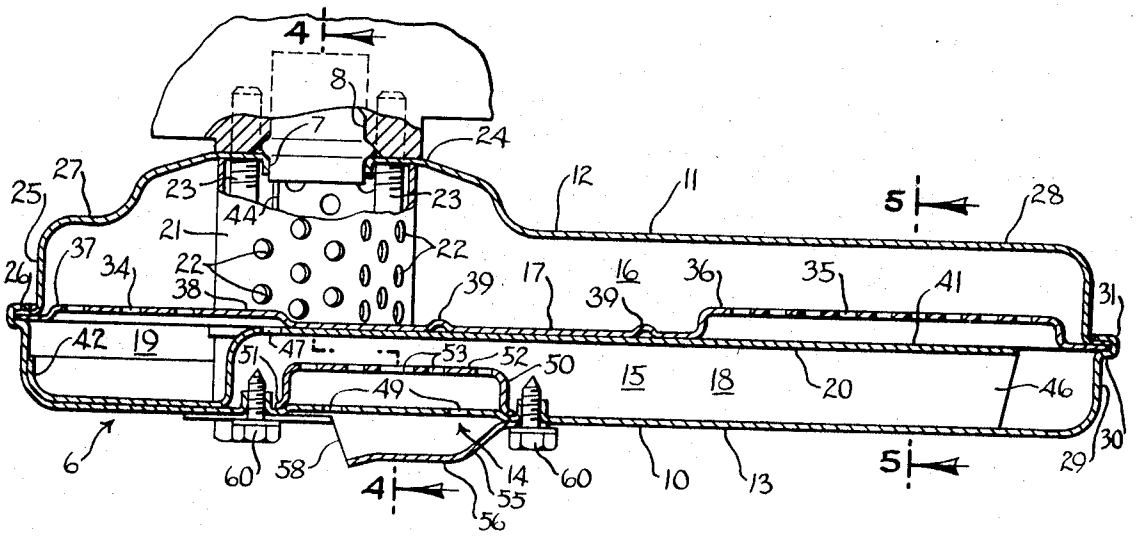



FIG.4.

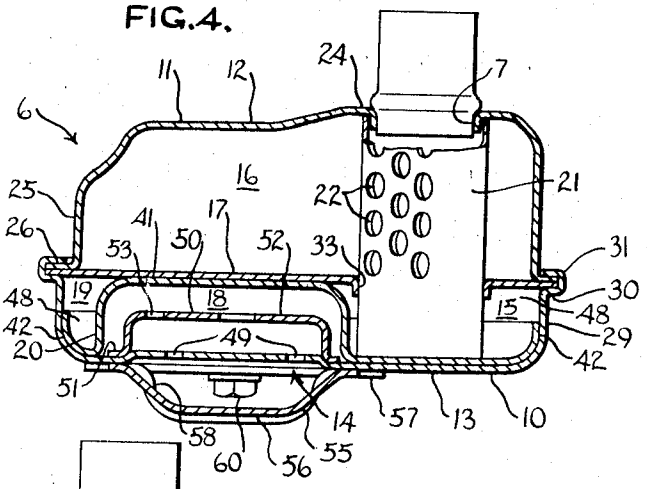
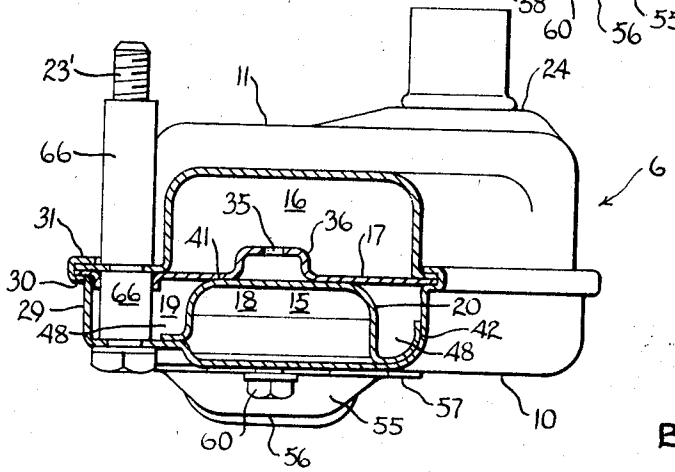
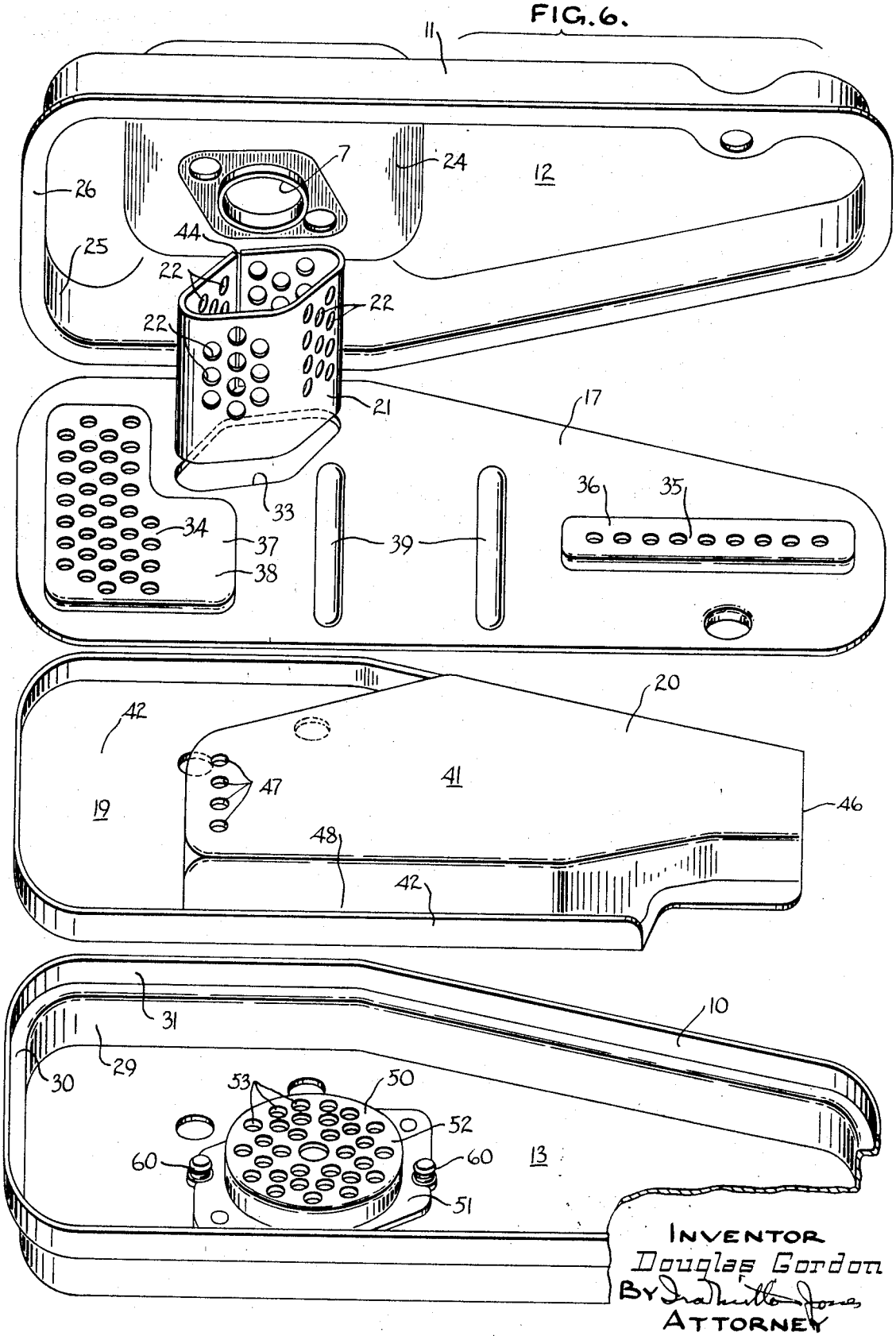



FIG.5.




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FIG. 6.




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# MUFFLER FOR INTERNAL COMBUSTION ENGINES

This invention relates to mufflers for internal combustion engines and refers more particularly to a muffler which is especially well suited for installation on single cylinder engines.

Heretofore the mufflers ordinarily installed on small engines have left something to be desired in their quieting of exhaust noise, as is well known to those who have had experience with gasoline engine powered lawn mowers, garden tractors and the like. Engine manufacturers are at least as much aware of this problem as is the general public, but reduction of the noise output of small engines is by no means easy to accomplish.

Any muffler that is at all effective tends to reduce the horsepower of the engine to some extent by creating a so-called back pressure in the exhaust system. Heretofore improved exhaust noise suppression has usually been achieved at the expense of decreased engine efficiency.

Prior muffler designs have also embodied compromises with respect to one or more of the desirable attributes of low cost, compactness and attractive appearance. The price of small engines is such that the cost of the muffler must be kept very low. Installation requirements and limitations for such engines dictate that their mufflers be as small and compact as possible. And the appearance of a muffler for a small engine is important because the muffler is fully visible in most installations, and the overall esthetics of the machine of which it forms a part have often been the subject of intensive design effort.

With the foregoing considerations in mind, it is the general object of this invention to provide a muffler for small internal combustion engines that achieves to an unprecedented degree the desirable characteristics of effective noise reduction and attractive appearance, and does so with disproportionately small sacrifice of engine horsepower, cost and compactness.

It is also a specific object of this invention to provide a very compact muffler that has a relatively large number of chambers or compartments through which exhaust gas must flow successively in passing from the inlet to the outlet of the muffler, and in which the gas is compelled to undergo a substantially large change in flow direction in passing from each such compartment to the next successive one, and which, further, produces a succession of divisions and recombinations of the flow of gas therethrough, the divided gas streams being in each case caused to traverse paths of different lengths so that pulsations in the gas flow tend to be canceled upon their recombination.

The extent to which the muffler of this invention achieves these objectives can be appreciated from the fact that a prior muffler reduced engine power by about 12 percent, as compared with the unmuffled engine, while the muffler of this invention produces a substantially lower noise level on the same engine but reduces its power by only about 7 percent.

With these observations and objectives in mind, the manner in which the invention achieves its purpose will be appreciated from the following description and the accompanying drawings, which exemplify the invention, it being understood that changes may be made in the specific apparatus disclosed herein without departing from the essentials of the invention set forth in the appended claims.

The accompanying drawings illustrate one complete example of an embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

FIG. 1 is a perspective view of a single-cylinder gasoline engine on which there is installed a muffler embodying the principles of this invention;

FIG. 2 is a front plan view of the muffler of this invention, with portions shown broken away to illustrate interior details;

FIG. 3 is a sectional view taken on the plane of the line 3—3 in FIG. 2;

FIG. 4 is a sectional view taken on the plane of the line 4—4 in FIG. 3;

FIG. 5 is a sectional view taken on the plane of the line 5—5 in FIG. 3; and



FIG. 6 is an exploded perspective view of the muffler.

Referring now to the accompanying drawings, the numeral 5 designates generally the body of a single-cylinder gasoline engine of the type used for powering rotary lawn mowers, to which is secured an exhaust muffler 6 embodying the principles of this invention.

In general, the muffler 6 comprises a hollow, elongated and relatively shallow shell defined by complementary dished or bowl-shaped front and rear shell members 10 and 11, respectively, both of which can be formed as unitary stampings. The rear shell member 11 comprises a rear wall 12 in which an inlet port 7 is located, while the front shell member 10 provides a front wall 13 in which there is an outlet port 14. The muffler is mounted on the engine with its inlet port 7 registering with an exhaust outlet 8 in the engine body.

The interior of the shell is divided into front and rear compartments 15 and 16, respectively, by a platelike baffle or wall member 17 that extends generally parallel to the front and rear walls and is clamped between the shell members 10 and 11. The front compartment 15 is in turn subdivided into a pair of chambers 18 and 19 by a stamped or drawn front baffle member 20. A baffle tube 21 of more or less diamond-shaped cross section extends through the baffle wall member 17 in bridging relationship to the walls 12 and 13. The baffle tube is substantially coaxial with the inlet port 17, so that gas entering the shell first passes into the baffle tube. Rearwardly of the baffle wall member 17 the baffle tube has numerous perforations 22, all around its periphery, through which gas flows radially out of it into the rear compartment 16.

The shell is secured to the engine body by means of a pair of bolts 23 which extend through the shell, generally parallel to the axis of the inlet port and at opposite sides thereof, and which are received in threaded holes in the engine body 5. The diamond-section baffle tube 21 embraces these screws, which extend along its opposite corners, and supports the compressive forces that they impose upon the shell. A third bolt 23', spaced lengthwise of the shell from the bolts 23 and parallel to them, also extends through the shell and is threaded into the engine body.

The shell of the muffler is elongated so as to lie along one side of the cylinder of the engine on which it is installed and extend part way over its crankcase portion. However, the shell is no wider than the cylinder; and because it is relatively shallow from front to back, the overall dimensions of an engine are not materially increased by its installation thereon.

The rear wall 12, which comprises a part of the rear shell member 11, has a rearwardly offset portion 24 around the inlet port 7, by which the remainder of the rear wall is held in spaced relation to the body of the engine on which the muffler is installed, to provide for flow of cooling air between the engine body and the muffler. The inlet port 7 is near one end 27 of the rear shell member, and from the rearwardly offset portion 24 the shell tapers in width towards its other end 28. Hence gas issuing from the perforations 22 in the baffle tube is rather rapidly decelerated by entering the widest and deepest part of the rear compartment 16.

A side wall portion 25 of the rear shell member projects forwardly from the rear wall all around the same and has its front edge portion turned outwardly to form a flange 26. The uniplanar forwardly facing rim or shoulder defined by the flange 26 flatwise engages the marginal edge portion of the baffle wall member 17.

The front wall 13 of the shell, which comprises a part of the front shell member 10, is substantially flat and parallel to the rear wall 12 and to the baffle wall member 17. The outlet port 14 in the front wall is spaced to one side of the axis of the inlet port 7, but like the latter it is nearer to the wide end 27 of the shell. A side wall 29 on the front shell member projects rearwardly from the front wall, all around the same, and its rear edge portion provides a shouldered rim, with a rearwardly facing peripheral shoulder surface 30 and a flange 31 that projects rearwardly beyond the shoulder surface to closely embrace the flange 26 on the rear shell member and the edge of the baffle wall member 17. Preferably the flange 31 is clinched

around the flange 26 to hold the shell members assembled. The shoulder surface 30 on the front shell member opposes the flange 26 and cooperates therewith in clamping the marginal portion of the baffle wall member 17.

The baffle wall member has a substantially diamond-shaped hole 33 therein in which the tubular baffle member 21 is received with a fairly close fit. In addition, the baffle wall member has two groups of perforations. One of these, designated by 34, extends across a major portion of the width of the baffle wall member, in a zone between its wide end and the tubular baffle member, and contains numerous perforations. The other, designated 35, comprises only a single row of perforations extending lengthwise of the shell in a zone near the narrow end of the baffle wall member.

The tubular baffle member 21 is so oriented that the portion thereof which is nearest the larger group of perforations 34 is an imperforate corner; hence gas issuing from the perforations 22 in the tubular baffle member must generally make a turn in a plane parallel to the baffle wall member 17, as well as turning in a plane transverse thereto, in order to pass through the perforations 34 and into the front compartment 15. It will also be observed that the portion of the gas flow that passes out of the rear compartment 16 through the perforations 34 follows a substantially shorter flow path than that which passes through the smaller group of perforations 35.

The perforations 35 are formed in a shallow rearwardly offset depression or embossment 36 that is slightly longer and wider than the row of perforations. The larger group of perforations is formed in a rearwardly offset embossment 37 that extends beyond the perforations a substantial distance, as at 38, in the direction toward the narrow end of the shell. The purpose of these embossments will appear as the description proceeds. The baffle wall member can also have stiffening ribs formed therein, as at 39.

The front baffle member 20, which divides the front compartment of the shell into the two chambers 18 and 19, is a stamping that has a rearwardly offset recess portion 41 and rim portions 42 that extend laterally from the recess portion and flatwise overlie inner surface portions of the front shell member. The rear wall of the recess portion 41 is substantially flat and is spaced far enough rearward to flatwise engage the front surface of the baffle wall member 17. Thus each of the chambers 18 and 19 defined by the front baffle member has a depth substantially equal to the full depth of the front compartment 15, and the chamber 19 is in more or less surrounding or embracing relation to the chamber 18.

The rim portions 42 of the front baffle member extend all the way to, and part way rearwardly along, the side wall 29 of the front shell member, so that the front baffle member is receivable in the front shell member with a fit that is easy enough for manual assembly but just snug enough to retain those parts in their assembled relationship during normal handling. Since the front baffle member conforms to the shape of the front shell member, it can only be installed therein in the correct position and orientation, thus assuring quick and easy assembly. It will be observed that the front wall of chamber 19 is of double thickness for good noise suppression.

The front end of the tubular baffle member 21 engages a flat portion of the rim 42 of the front baffle member, where the latter overlies the front wall 13. The tubular baffle member is formed with an open seam 44 that extends along its full length, so that even though its front end portion is otherwise imperforate, a small amount of gas can pass from it directly into the chamber 19.

The length of the front baffle member 20 is such that it terminates a distance short of the narrow end 28 of the shell, and this terminal edge of said baffle member has no rim, so as to provide an inlet 46 into the chamber 18 from the chamber 19. Note that the inlet 46 which is thus defined by the open end of the recess portion 41 of the front baffle member is close to the small group of perforations 35 in the baffle wall member 17, and that the embossment 36 around those perforations cooperates with the recess portion 41 to define a narrow passage along which gas that has passed through the perforations can flow to the inlet 46. Also note that such gas undergoes about a 90° change of direction in passing out of the perforations 35 and along the passage just mentioned, and then undergoes about a 180° change of direction in flowing into the chamber 18.

The chambers 18 and 19 are also communicated with one another by way of a small group of perforations 47 in the rear wall of the recess portion 41, near the wide end 27 of the shell. Somewhat restricted communication between these perforations 47 and the perforations 34 in the baffle wall member 17 is provided by the portion 38 of the embossment 37, which cooperates with the rear wall of the recess portion 41 to define another narrow passage. Again note the repeated changes of direction which gas undergoes in flowing successively through the perforations 34, along the last mentioned passage and through the perforations 47.

Most of the gas passing through the large group of perforations 34 in the baffle wall member of course passes into the chamber 19, at the wide end of the shell, whence it must change direction and flow around the recess portion 41, along narrow passages 48 adjacent to the side wall 29, and then it must undergo another marked change of direction to pass into the inlet 46 to the chamber 18.

Gas must traverse most of the length of the chamber 18 in flowing from the inlet 46 to the outlet port 14 in the front wall of the shell, since that outlet port is spaced a substantial distance along said front wall from the inlet 46, as well as being spaced (by a lesser distance) from the perforations 47. To issue from the outlet port 14, gas flowing through the chamber 18 must again undergo a change of direction of about 90°.

The outlet port 14 is the front wall of the shell comprises a group of perforations 49 in that wall, arranged in concentric circles. Before the gas can finally issue from those perforations, however, it must traverse a small outlet baffle 50 that is dished to provide a coplanar rim portion 51 and a rearwardly offset circular boss or recess 52 in which there are numerous small apertures 53. The rim portion 51 is flatwise secured (as by spot welding) to the inner surface of the front wall. None of the apertures 53 in the outlet baffle is coaxial with any of the perforations 49 comprising the outlet port 14, hence the gas must again undergo changes in flow direction in passing out of the muffler shell.

As shown, a deflector 55 is mounted over the exhaust port. It comprises a stamping having a dome-like central portion 56 surrounded by a uniplanar flange 57 that flatwise overlies the front wall 13 of the shell. A cutout 58 at one side of the dome 56 provides the outlet through which gas finally leaves the muffler. The deflector 55 serves mainly to direct the outgoing gases in a predetermined direction, away from the operator, and therefore it is arranged to be secured to the shell in any of a number of different angular positions. To this end its flange or rim 57 has circumferentially spaced pairs of notches 59 that open radially outwardly, the notches of each pair being located diametrically opposite one another. The deflector is secured to the shell by means of a pair of sheet metal screws 60 passing through a selected pair of diametrically opposite notches and received in holes in the front wall of the shell, at opposite sides of the outlet port.

The bolts 23 that anchor the muffler to the engine body can be confined against rotation under engine vibration by means of a clip 62 underlying the hexagonal heads of both of them and having lugs 63 bent forward to lie flat against side surfaces of their heads. The third mounting bolt 23', near the narrow end of the muffler, can be secured by a lock washer and can be surrounded by spacer sleeves 66 that prevent it from compressively deforming the shell as it is tightened.

From the foregoing description taken with the accompanying drawings it will be apparent that this invention provides a muffler which is especially well suited for single-cylinder internal combustion engines, and which provides good silencing of exhaust noise at low sacrifice of engine power, and is compact, low in cost, and attractive in appearance.

Those skilled in the art will appreciate that the invention can be embodied in forms other than as herein disclosed for purposes of illustration.

The invention is defined by the following claims:

1. A muffler for an internal combustion engine comprising:
A. a pair of oppositely concave complementary shell members having rim portions which oppose one another, and which shell members cooperate to define a hollow shell having a pair of opposite walls, there being an inlet in one of said shell members through which exhaust gas can pass into the interior of the shell from an exhaust outlet in an engine body, and the other of said shell members having an outlet therein through which gas can leave the shell;
B. means holding the shell members assembled with one another; one
C. a baffle plate extending across the interior of the shell generally parallel to said walls, in spaced relation to both of them, and having edge portions clampingly confined between the rim portions of the shell members, said baffle plate cooperating with the shell members to define a pair of compartments, to open of which the inlet opens, and having spaced apart holes therethrough by which gases can pass from said one to the other of said compartments;
D. a baffle member in the other shell member dividing said other compartment into a pair of communicated chambers, to one of which the holes in the baffle plate open and from the other of which said outlet opens, said one chamber being in embracing relation to said other, said baffle member having
1. a rim portion which flatwise overlies the inner surface of said other wall of the shell, and
2. an offset medial wall portion which flatwise overlies a portion of the baffle plate and which terminates at an edge of the baffle member to provide for communication between said chambers around said edge.

2. The muffler of claim 1 further characterized by:
a tube extending across the shell, through a closely fitting hole in the baffle plate, with its opposite ends respectively engaging said walls of the shell, said tube being aligned with the inlet to receive gas flowing thereinto and having perforations through which gas can flow into said one compartment.

3. The muffler of claim 2, wherein a pair of bolts extend through said walls and the baffle plate, at opposite sides of the inlet and substantially parallel to its axis, for securing the muffler to an engine body, further characterized by:
said tube embracing said bolts to support inward compressive forces which they exert upon said opposite walls.

4. A muffler for an internal combustion engine, comprising:
A. a pair of complementary shell members secured together to define a hollow shell, each shell member having
1. an end wall in which there is a port through which exhaust gas can flow between the interior and the exterior of the shell,
2. a side wall projecting inwardly from the end wall, all around the same, and
3. a rim portion at the inner edge of the side wall, opposing the rim portion on the other shell member;
B. a baffle wall member having marginal edge portions clampingly confined between the rim portions of the shell members and extending across the interior of the shell to divide the same into first and second compartments which communicate with one another by way of port means that are spaced along the baffle wall member from the axes of said ports in the end walls and are located near a pair of opposite edges of the baffle wall member; and
C. a divider member in said second compartment, dividing the same into two communicated chambers, one of which is in embracing relation to the other, said divider member having
1. a marginal portion which flatwise overlies an inner wall surface of the second compartment, and
2. a recessed medial portion that cooperates with another portion of said wall surface to define said other chamber,
said chambers being communicated at zones spaced from said port means and from the axes of said ports.

5. A muffler for an internal combustion engine comprising:
A. an elongated rear shell member having
1. a rear wall in which there is an inlet port, near one end thereof, and
2. a side wall projecting forwardly from said rear wall all around the same and terminating in a rim that defines a uniplanar forwardly facing peripheral shoulder;
B. a complementary elongated front shell member having
1. a front wall in which there is an outlet port, and
2. a side wall projecting rearwardly from said front wall all around the same and terminating in a rim that defines a uniplanar rearwardly facing peripheral shoulder;
C. means securing said front and rear shell members together, with their said shoulders opposing one another, so that the shell members cooperate to define an elongated hollow shell;
D. a tubular baffle member extending across the interior of the shell from said front to said rear wall and in register with the inlet port so that gas entering the inlet port passes into the interior of the tubular baffle member, said tubular baffle member having perforations in a zone rearwardly of the plane of the opposing shoulders, through which gas can flow radially outwardly in all directions;
E. a baffle plate clampingly confined between the opposing shoulders of the shell members and through which the tubular baffle member extends, said baffle plate cooperating with the rear shell member to define a first expansion chamber into which gas can flow from said tubular baffle member, said baffle plate having a large group of perforations near the first mentioned end of the rear shell member and a small group of perforations near the opposite end thereof, all of said perforations providing for flow of gas forwardly out of the first expansion chamber; and
F. a baffle stamping dividing the interior of the shell forward of the baffle plate into second and third expansion chambers, said baffle stamping
1. having a rearwardly recessed medial portion which extends lengthwise of the shell and is spaced inwardly of the side walls thereof, said medial portion cooperating with the portion of said front wall that has the outlet port therein to define the third expansion chamber, and
2. having marginal portions flatwise overlying the inner surface of the front wall and cooperating with said medial portion, the baffle plate and the side wall of the front shell member to define the second expansion chamber, which is in embracing relation to the third expansion chamber,
said baffle stamping providing a first and more restricted communication between said second and third chambers that is near the first mentioned end of the shell and a second and less restricted communication between said second and third chambers that is near said opposite end of the shell.

6. A muffler for an internal combustion engine, comprising:
A. means defining a hollow shell having a pair of opposite walls,
1. in one of which there is a gas inlet port and
2. in the other of which there is a gas outlet port;
B. a baffle wall member extending across the interior of the shell generally parallel to said opposite walls to divide the interior of the shell into an inlet compartment to which the inlet port opens and another compartment, said baffle wall member providing for communication between said compartments at zones that are spaced along the baffle wall member from one another and from the axis of the inlet port; and
C. means in the shell dividing said other compartment into two communicated chambers,
1. one of said chambers being in at least partially surrounding relationship to the other and being commu-

nicated with the outlet port substantially only through said other chamber, and

2. said other chamber being communicated with the inlet compartment substantially only through the first mentioned chamber,

3. communication between said chambers being at a zone spaced in a direction edgewise of the baffle wall member from the axis of the outlet port and from said zones of communication between the compartments.

7. The muffler of claim 6, further characterized by:

A. said means defining a hollow shell comprising a pair of complementary dished members, each of which has one of said walls and has a rim portion formed to provide a peripheral surface which opposes the corresponding surface on the other dished member;

B. said baffle wall member being platelike and having its marginal edge portions clampingly confined between said opposed peripheral surfaces on the dished members; and

C. the rim portion of one of said dished members being clinched around the rim portion of the other and around the marginal edge portion of the baffle wall member to secure said members in assembled relationship.

8. The muffler of claim 7, further characterized by:

D. a pair of screws extending through said walls and the baffle member, at opposite sides of the inlet port and substantially parallel to the axis thereof, for securing the muffler to an engine body; and

E. a tubular baffle member extending through the baffle wall member and endwise confined between said walls, said tubular baffle member embracing said screws and reinforcing the shell against inward deforming forces exerted by the same, and said tubular baffle member having numerous apertures distributed around its periphery in a zone thereof which is at the side of the partition wall member nearer the inlet port, said apertures providing for entry into the inlet compartment of gas that enters the tubular baffle member from the inlet port.

9. The muffler of claim 7, further characterized by:

F. the means dividing said other compartment into two communicated chambers comprising a stamping having a recessed portion which defines one of said chambers and a rim portion that extends laterally from said recessed portion, said stamping being confined between said baffle wall member and said wall of the shell that has the outlet port therein.

* * * * *