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Perrine

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[54] **SILENCER FOR GAS DISCHARGING DEVICES EMPLOYING MEANS FOR REDUCING DRAG**

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[51] **Int. Cl.** **F01n**

[58] **Field of Search** ..... 181/41, 49, 58, 66, 181/70, 47 B, 33 B, 33 C; 55/325, 326, 434, 440, 307, 308; 89/14 D

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Assistant Examiner—Pat Salce
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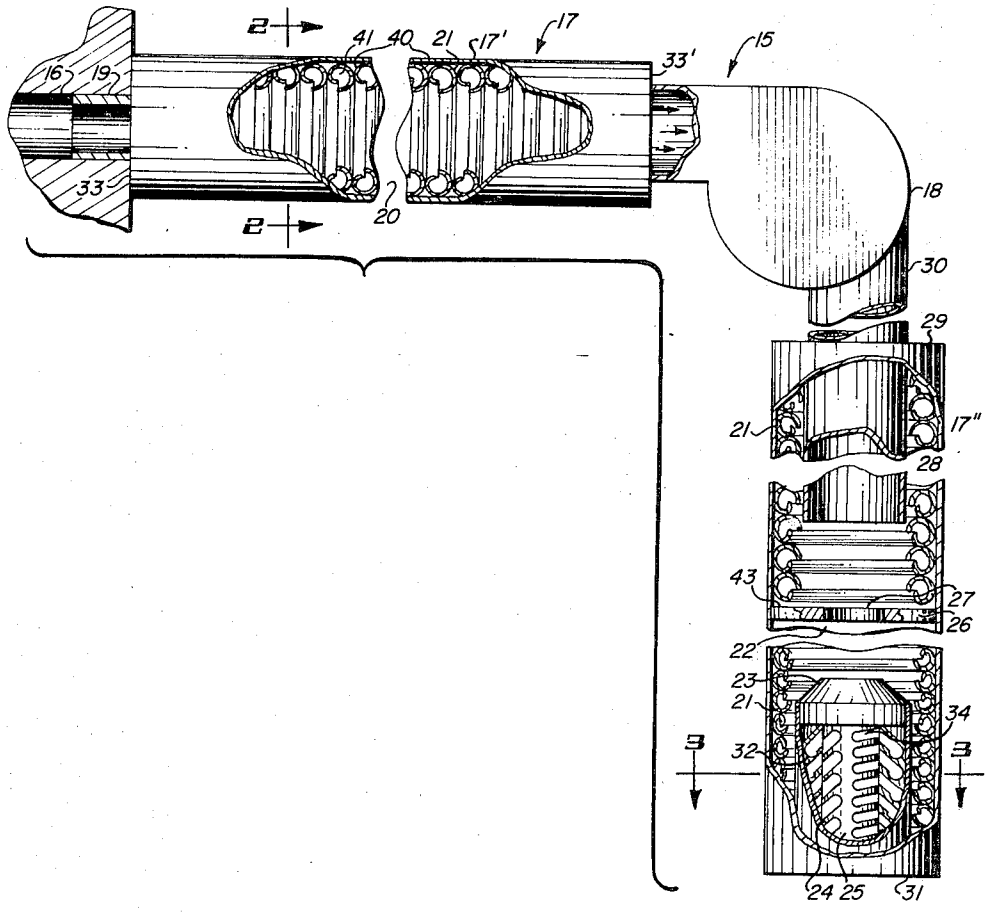
[57] **ABSTRACT**

A silencer for muffling of noises in a gas pressure exhaust system such as the exhaust systems for air operated power cylinders, tools and the like as well as internal combustion engines of the two- and four-cycle type by the utilization of guiding surfaces for directing the gases under pressure into chambers where the gases acquire a rotary or whirling movement about a stationary axis within the silencer and are expelled after such rotary action has dissipated their energy, aided by means for reducing the back pressure or drag of the guiding surfaces on the gases.

16 Claims, 12 Drawing Figures



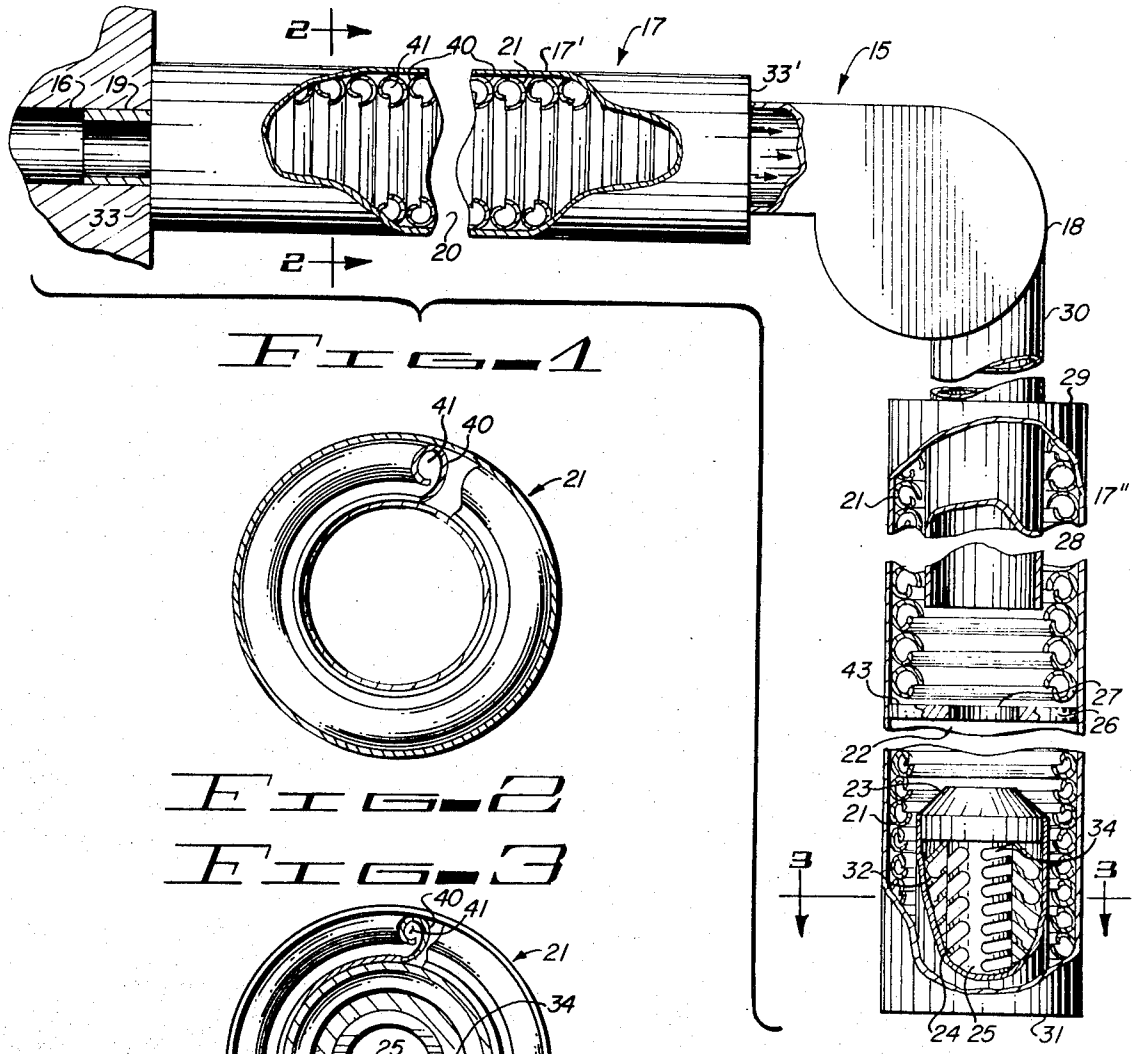


Fig-1

Fig-2

Fig-3

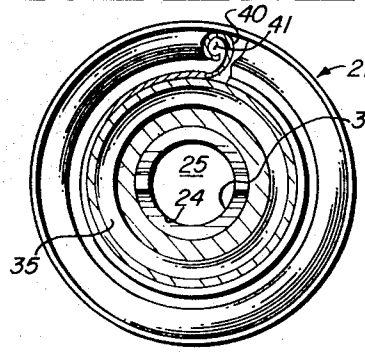
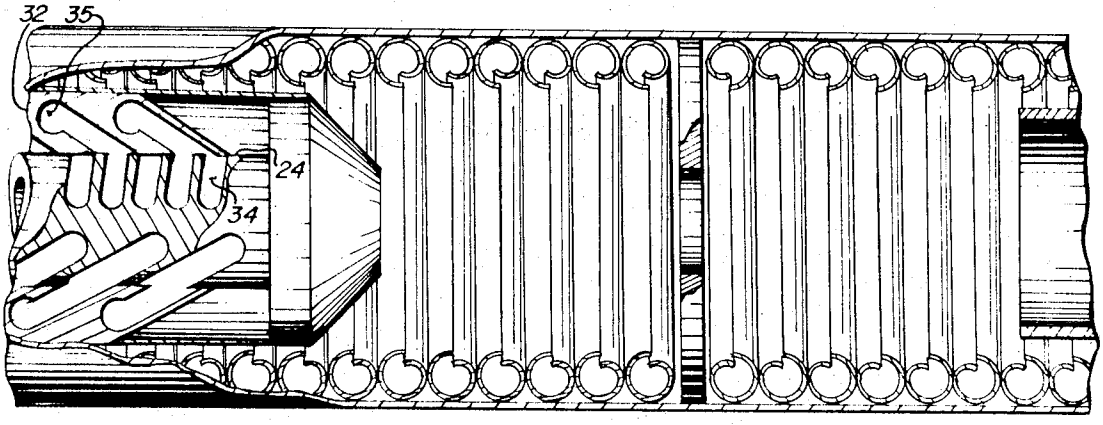


Fig-4



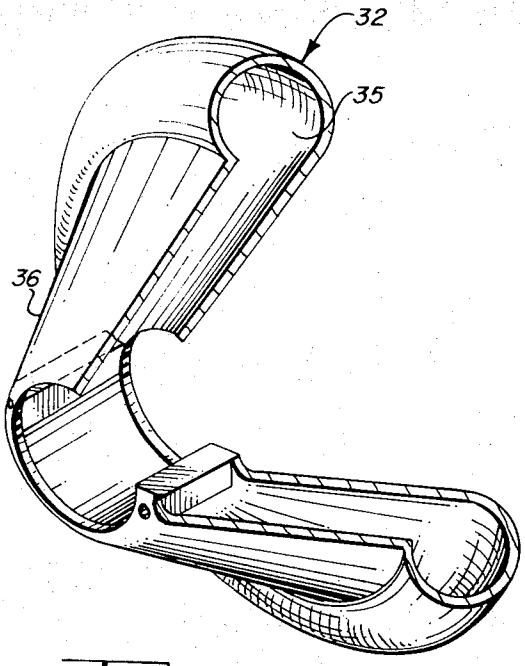


FIG-5

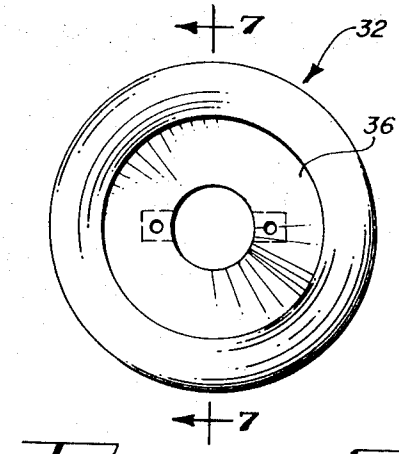


FIG-6

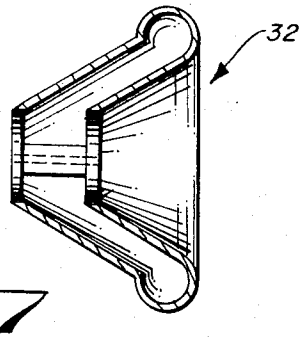


FIG-7

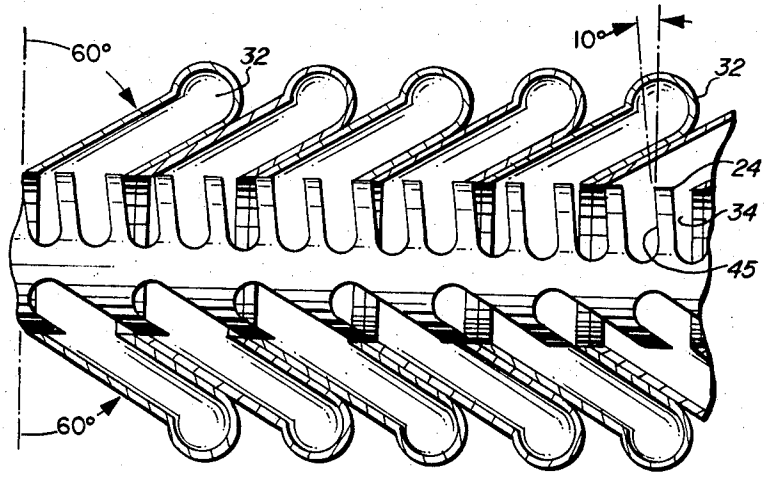


FIG-8

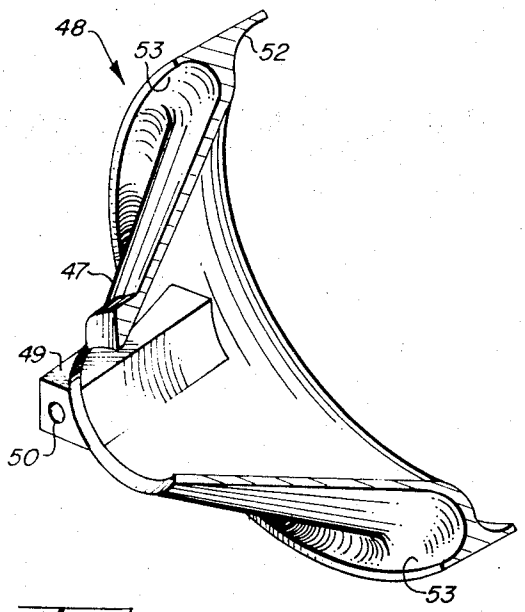


Fig-9

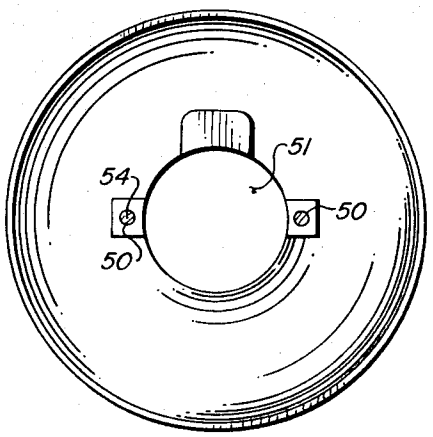


Fig-10

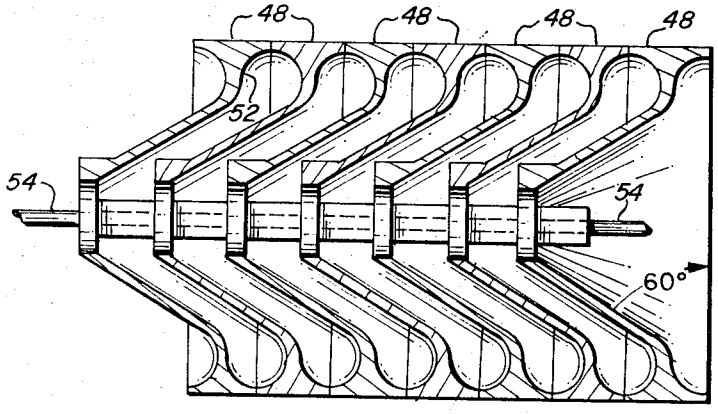


Fig-11

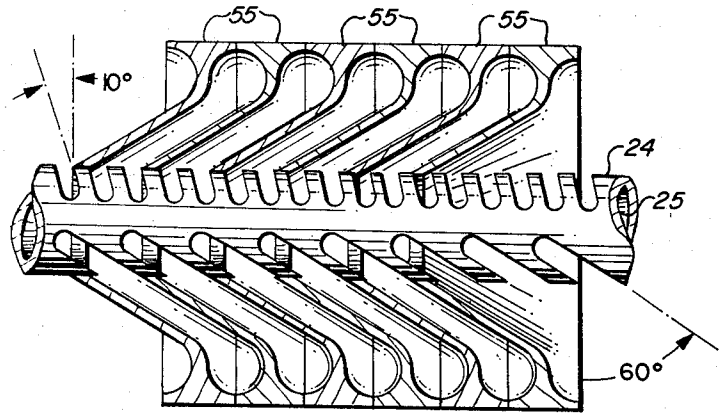


Fig-12

SILENCER FOR GAS DISCHARGING DEVICES EMPLOYING MEANS FOR REDUCING DRAG

BACKGROUND OF THE INVENTION

This invention relates to devices for muffling and silencing of noises in exhaust systems such as the exhausts from compressed air operated power cylinders, tools or the like as well as internal combustion engines of the two- and four-cycle type.

FIELD OF THE INVENTION

This invention is particularly directed to novel and improved muffling devices for silencing exhaust noises by directing exhaust gases under pressure into a chamber where they acquire a rotary or whirling movement about a plurality of stationary axes within the chamber and escape therefrom after their energy is dissipated in such rotary or whirling movements.

DESCRIPTION OF THE PRIOR ART

Heretofore mufflers have been used for the dissipation of exhaust noises wherein the exhaust stream of gases is diverted by fins or ribs of a spider means within the muffler. Other mufflers have reduced the exhaust noises of an exhaust system in a silencing chamber by the utilization of porous walls through which the exhaust fluid is diffused. These porous walls have been formed of cellulose fibre sheet material impregnated with a phenolic resin.

In firearms, attempts were made to dissipate the energy of the powder gases by giving them a rotary or whirling movement in a suitable chamber with the gases gradually escaping from the chamber to atmosphere.

In all cases, the muffling was only partially effective and the muffler devices were not effective when used with a constant source of exhaust gases, since their exhaust to atmosphere after dissipation of their energy was too slow and applied a back pressure to the power generating device such as the power cylinder and internal combustion engine which reduced its efficiency. Therefore, a need exists for a new and improved muffler or silencer which may operate on a continuous stream of exhaust gases to effectively muffle or silence its exhaust gases without destroying the efficiency of the associated power generating device.

SUMMARY OF THE INVENTION

In accordance with the invention claimed, a new and improved muffler or silencer is provided for an intermittent or continuous source of exhaust gases under pressure which dissipates the energy of the exhaust gases by rotary and whirling movements about a plurality of stationary axes progressively positioned in a chamber before the gases are expelled to atmosphere.

It is, therefore, one object of this invention to provide a new and improved muffler or silencer.

Another object of this invention is to provide an improved muffler for silencing the nosies of exhaust gases by giving them new rotary or whirling movements in a suitable chamber.

A further object of this invetnion is to provide an improved muffler for silencing the noises of exhaust fluids by giving them a series of rotary or whirling movements about a series of stationary axes as they pass through a suitable chamber under pressure and/or vacuum supplemental to the pressure of the exhaust gases.

A still further object of this invention is to provide an improved muffler for silencing the noises of exhaust gases by dissipating their energy by giving them a rotary or whirling movement in a suitable chamber about axes coincident with the axis of the dissipated gases being exhausted to atmosphere.

A still further object of this invention is to provide a muffler or silencer for exhaust gases under pressure utilizing gas deflecting means for providing the gases with a rotary or whirling motion which is assembled with a minimum number of interchangeable parts.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize this invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

BRIEF DESCRIPTION OF THE DRAWING

The present invention may be more readily described by reference to the accompanying drawings, in which:

FIG. 1 is a perspective view partially broken away showing a muffler embodying the present invention;

FIG. 2 is a cross-sectional view of FIG. 1 taken along the line 2—2;

FIG. 3 is a cross-sectional view of FIG. 1 taken along the line 3—3;

FIG. 4 is an enlarged partial view of the exhaust end of the muffler shown in FIG. 1;

FIG. 5 is an enlarged partial perspective view of one of the gas guiding means or baffles shown in FIG. 1;

FIG. 6 is a front or end view of the complete guiding means shown in FIG. 5;

FIG. 7 is a cross-sectional view of FIG. 5;

FIG. 8 is an alternate embodiment of the baffle arrangement shown in FIGS. 1–7;

FIG. 9 is a modification of the baffles shown in FIGS. 1–7;

FIG. 10 is an end view of FIG. 9;

FIG. 11 is a cross-sectional view of an assembly of the baffles shown in FIG. 9 mounted on a pin; and

FIG. 12 is a modification of the assembly of the baffles shown in FIG. 11 mounted without the aid of a pin.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring more particularly to the drawing by characters of reference, FIGS. 1-7 disclose an improved muffler 15 for gas discharge devices such as internal combustion engines, air motors or the like. As shown in FIG. 1, for purposes of illustration only, muffler 15 is mounted on the end of an exhaust pipe 16 of a gas discharge device such as a chain saw driven by a gasoline motor.

Muffler 15 comprises a hollow housing 17 comprising, for example, two cylindrical parts 17′ and 17″ interconnected by a fan housing 18. A pipe 19 is attached to one end of part 17′ of the cylindrical housing 17 for insertion into or over the exhaust pipe 16 of the chain saw or other gas exhausting device that it is intended to silence. The hollow cylindrical housing 17 defines a chamber 20 axially aligned with exhaust pipe 16 in part 17′ and having a plurality of deflection devices 21 coaxially arranged along its inner cylindrical wall.

Part 17″ of the cylindrical housing defines an annular chamber 22 which is defined by a funnel-shaped flange 23 fastened to the inboard end of a hollow cylinder 24 with a passageway 25 extending through flange

23 and cylinder 24, as shown in FIG. 3. The opposite end of chamber 22 is defined by an apertured flange 26 which is of substantially the same diameter as the inside diameter of part 17'' with an aperture 27 extending therethrough in alignment with passage 25 and of substantially the same diameter.

An annular chamber 28 is arranged within part 17'' of the cylindrical housing and arranged to receive within its inboard end 29 an exhaust pipe 30 of fan housing 18.

Loosely arranged within part 17'' of the cylindrical housing 17 of muffler 15 between end 29 and flange 26 and between flange 26 and end 31 thereof are a plurality of the deflection devices 21. As noted from FIG. 1, all of the deflection devices 21 in annular chambers 20 are arranged in one direction with regard to the gas under pressure moving through the muffler, and all of the deflection devices in annular chamber 28 including those around the outside periphery of exhaust pipe 30 of fan housing 18 extend in the opposite direction with regard to the flow of gas under pressure through the muffler.

As shown in FIG. 1, cylinder 24 forming within it passageway 25 is slotted along its length to provide vent openings for the gas under pressure passing through passageway 25. These slots 34 are arcuate in configuration and extend less than 180° around the circumference of the outer wall of cylinder 24. Two of the slots 34 on opposite sides of the circumference of cylinder 24 may extend in the same cross-sectional plane or they may be a continuation of a spiral moving longitudinally along the axis of cylinder 24. One requirement of the slots 34 is that they open into the entrance to the deflection devices 32 arranged axially along and around the outer periphery of cylinder 24, as will hereinafter be explained in more detail.

Each deflective device 32, as shown in FIGS. 1, 3 and 4, may be formed or molded separately and then assembled around cylinder 24 to form a part of the annular chamber 22. Each deflection device 32 is formed with a hole or aperture 34 and when a plurality of them are assembled axially in like direction around cylinder 24 they provide a plurality of passages or pockets 35 in which the gases expanding out of slots 34 may dissipate their energy.

Loosely arranged around the outside of the assembly of deflection devices 32 and within part 17'' are a plurality of deflection devices 21 arranged in the same direction as the deflection devices 21 in annular chamber 20.

FIGS. 5, 6 and 7 illustrate enlarged views of deflection device 32 and show that it comprises a funnel-shaped surface 36 which tapers outwardly to a conical opening, passage or pocket 35. The housing forming pocket 35 lies in planes lateral to the axis of the deflection device 32 so that a plurality of the devices may be axially aligned, one fitting into the next as shown in FIGS. 1 and 4. The gases, as they expand out of slots 34 in the cylinder 24, pass into pockets 35 of deflection devices 32 where they expand or diverge and are directed by the guiding surfaces forming pockets 35 to assume a whirling or rotary movement about a substantially circular or annular line or axis in each pocket, whereby under the centrifugal action developed by such rotary movement of the gases and the expansion thereof during such action, the gases are caused to dissipate their energy in friction against the inner walls of these deflection devices forming pockets 35.

It is the intent of this disclosure to disclose a method and means for controlling the gases which escape from the exhaust conduit of an engine such as an internal combustion engine or an air expansion engine, and to compel these gases to acquire within successive cells or chambers formed in the muffler a continuous, expanding rotary or whirling movement about the axis of the muffler. As the gases under pressure from the noise producing device are provided with a rotary or whirling movement, they expand and lose or dissipate their energy.

Usually the blast of a gas under pressure from an internal combustion or gas expansion type of engine passes out of the noise producing device in a pencil-like form or core of gas under pressure. This core of gas, which until this point of expansion has not been made to dissipate its energy in a rotary or whirling movement in a silencing device, therefore occasions some noise of explosion. In the device and method claimed herein, this noise of expansion of the explosive gases under pressure is controlled or substantially eliminated.

In the devices disclosed, the gases of expansion are deflected or turned out of a straight line in a sequence of operations to eliminate or substantially reduce the noise of gas expansion.

Although the method and devices disclosed and claimed herein utilize some principles heretofore known, the claimed configuration is an improvement over the teachings in the following U.S. patents and others that may appear in the art: U.S. Pat. Nos. 916,885, H. P. Maxim; 951,770, J. M. Miller; 958,934, H. P. Maxim; 958,935, H. P. Maxim; 1,066,898, W. R. Gray; 3,399,597, W. E. Perrine.

The silencing effect accomplished only to a limited extent by Maxim in his patents above identified is not enough to silence the exhaust gases of modern internal combustion and gas expansion engines. Therefore, further deflection and expansion of the expanding gases of these noise producing devices must be effected in a new, improved and controlled manner.

As disclosed herein, the expanding gases are first expanded and deflected in a controlled manner in part 17' of the cylindrical housing 17 forming muffler 15, before they are transmitted through fan housing 18 to annular chambers 28 and 22, where they are deflected and expanded further by deflection devices 21 and 32 therein.

As the core or pencil of gas under pressure leaves the noise producing device such as, for example, the exhaust pipe 16 of a gas discharging device, a part of these gases expands in the annular chamber 20 and strikes the open edges of deflection devices 21 as these gases move through the muffler.

Deflection devices 21, as shown in FIGS. 1, 2 and 4, comprise an annular disc having a turned-over, scroll-type outer edge 40 forming a pocket 41 within it for whirling the gases directed into it. A plurality of these deflection devices are mounted in alignment axially along part 17' of the cylindrical housing forming muffler 15 with their scroll opening facing the oncoming stream of gas under pressure to receive the gases. It should be recognized that the opening 42 formed in each deflection device 21, as shown, is slightly larger than the inside diameter of the exhaust pipe 16 so that the opening and deflected gases being controlled may

readily pass rearwardly along the muffler toward end 33' of part 17' of the cylindrical housing and readily pass into the opening leading into fan housing 18. The pockets in the deflection plates cause the gases entering each pocket to assume a whirling or rotary movement about a substantially circular or annular line or axis, whereby under the centrifugal action developed by such rotary movement the gases of expansion are caused to dissipate their energy in friction against the inner walls of these deflection devices forming the pockets 41.

As shown in part 17'' of the cylindrical housing, the deflection devices 21 arranged around the exhaust pipe 30 of fan housing 18 in annular chamber 28 are the same deflection devices 21 arranged in chamber 20. The only difference is this assembly of deflection devices 21 is that the scrolls open in the opposite direction to those in annular chamber 20.

Gases expanding out of exhaust pipe 30 are deflected off of the surface 43 of flange 26 into the openings of the scrolls of deflection devices 21, wherein they dissipate their energy as heretofore explained. Since these deflection devices fit loosely around exhaust pipe 30 and the inside periphery of part 17'' of the cylindrical housing between flange 26 and end 29 of part 17' of muffler 15, many pockets are available for the dissipation of the energy of the expanding gases.

As shown in annular chamber 22, the same deflection devices 21 are arranged axially along the longitudinal axis of part 17'' of the cylindrical housing between flange 26 and the funnel-shaped flange 23. The only difference here from that shown in chamber 28 is that deflection devices 21 are so arranged that their scrolls open in the opposite direction to those shown in annular chamber 28.

Gases expanding out of aperture 27 in flange 26 are deflected off the surfaces of funnel-shaped flange 23 and into the openings of the scrolls of deflection devices 21, wherein they dissipate their energy as heretofore explained. Deflection devices 21, which fit loosely around cylinder 24 within part 17'' of the cylindrical housing, are arranged with their scrolls opening opposite to those just described in annular chamber 22 so that gases escaping outwardly of part 17'' of the cylindrical housing may be further expanded and caused to dissipate their energy.

As noted from FIGS. 1, 3 and 4 of the drawings, the gases under pressure passing through an aperture in funnel-shaped flange 23 pass through passage 25 in cylinder 24 to atmosphere with some of the gas being diverted through slots 34 in cylinder 24 and into pockets 35 of deflection devices 32, where the energy of the gases is still further dissipated before being exhausted to atmosphere.

In order to reduce or overcome the drag or resistance to the exhaust gases discharged from a motor or the like in order to avoid reducing its operating efficiency, a fan, blower or any other form of suction means and/or pressure-generating means may be used for aiding the movement of the gases through the muffler to atmosphere.

As shown in FIG. 1, the fan housing 18 with its fan mechanism is arranged between parts 17' and 17'' of the muffler housing for aiding in driving the exhaust gases through the muffler.

It should be recognized that this fan mechanism also may be placed between the exhaust pipe 16 of the gas discharging device and the muffler or at the discharging end 31 of part 17'' of the muffler, if so desired.

Thus, as the gases of expansion or explosion of a noise producing device are directed into muffler 15, the core of gases first partially expands and is directed in a whirling motion in annular chamber 20 to lose part of its energy of the resulting expansion-generated noise. Next, the core of gas and its trailing portion partly expanded in annular chamber 20 moves into annular chamber 28, where it further expands, and is directed in a whirling motion to reduce further its energy. Thirdly, the gas and its trailing expanded portion moves into annular chamber 22, where it is again expanded and directed to lose or dissipate more of its energy, after which it moves out of end 31 of the muffler through passageway 25, substantially reduced in pressure and substantially noiseless.

FIG. 8 is an alternate arrangement of the slot 34 and associated openings in the deflection devices 32 as assembled in FIGS. 1 and 4. In FIG. 8 the slots 34 are formed in the slotted cylindrical wall 24 such that edge 45 of slots 33 is inclined at an angle of 10° with a line extending perpendicularly to the longitudinal axis of the cylindrical wall 24. As shown also in FIG. 8, the slope of funnel-shaped configurations of deflection devices 32 loosely mounted around the cylindrical wall 24 are substantially 60° to a line extending perpendicularly to the longitudinal axis of the cylindrical wall 24. This particular arrangement of cooperating passages aids in direction of the expanding gases into pockets 35 of the deflection devices for dissipating of the energy of these gases and the resulting noises of gas expansion.

FIGS. 9 and 10 illustrate a modification of the deflection devices 32 wherein the funnel-shaped flange 47 forming the deflection device 48 is provided with shoulders 49 on opposite sides, each of which are provided with apertures 50 extending therethrough longitudinally of aperture 51 formed along the device's longitudinal axis. As noted from FIG. 9, the deflection device opens into an arcuate-shaped, flared end 52. The other side 53 of the flared end 52 is also of an arcuate configuration, curving outwardly in a direction substantially opposite to the flared surface of end 52. When two similarly shaped deflection devices 48 are axially aligned and held together by rods 54, only one of which is shown in FIG. 11, they form an assembly as shown in FIG. 11. This assembly can then be assembled around cylindircal wall 24 to serve as a gas disseminator in the manner of deflection devices 32 shown in FIG. 1.

FIG. 12 shows deflection devices 55 of the same general type shown in FIG. 11 without the shoulder and rod or pin arrangement for holding them together. Each of the deflection devices is axially aligned along and around the cylindrical wall 24, as shown.

Although but a few embodiments of the present invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

I claim:

1. A muffler for receiving gas under pressure from a source comprising:

a housing adapted to communicate with said source,

said housing having a gas discharge opening extending therethrough for the passage of gas under pressure,

a pair of cylindrical chambers in said housing, each defining therethrough sequentially a part of said opening,

a flange having an aperture therethrough forming a part of said opening within said second chamber and extending laterally of said housing,

said flange deflecting upstream gas under pressure expanding outwardly of said opening in said second chamber, and

a plurality of deflecting means mounted along the inside periphery of said first and second chambers,

said deflecting means each comprising a pocket for receiving the deflected gases in the chamber along which they extend for causing the gases to acquire a rotary and whirling movement about an annular axis,

the pockets in said deflection means along said first chamber opening in the upstream direction of movement of gas under pressure through said opening and the pockets in said deflection means downstream of said flange in said second chamber opening in the downstream direction of movement of gas under pressure through said opening, and the pockets in said deflection means upstream of said deflection means along said second chamber opening in the upstream direction of movement of said gases, and

exhaust means for aiding the movement of said gases under pressure through said housing to compensate for the loss of pressure of said gases in said muffler due to friction of the gases on the surfaces of said pockets.

2. The muffler set forth in claim **1** wherein:

said exhaust means comprises a fan for aiding in the movement of the gases under pressure through said housing.

3. The muffler set forth in claim **1** wherein:

said exhaust means comprises a suction-type fan mounted in said housing between said first and second chambers for drawing the gases under pressure through said first chamber and blowing the gases through said second chamber.

4. The muffler set forth in claim **1** wherein:

said exhaust means is mounted at one end of said housing, aiding in moving the gases under pressure through said housing.

5. The muffler set forth in claim **1** wherein:

said first and second chambers divide said housing into two separate parts wherein the only gas communication through said first and second chambers is through said gas discharge opening.

6. The muffler set forth in claim **5** wherein:

said housing defines an annular opening at one end for receiving a discharge of a gas generating device,

said annular opening opening into one end of said first chamber.

7. The muffler set forth in claim **6** wherein:

said deflection means in said first and second chambers extend longitudinally of said chambers around said annular opening.

8. The muffler set forth in claim **1** wherein:

said deflection means each comprise a circular, doughnut-shaped configuration having a turned-over edge forming a scroll-like, arcuate configuration along its outer periphery for forming said pocket.

9. A muffler for a device discharging gas under pressure comprising:

a housing adapted to communicate with the bore of the gas discharging device,

said housing having an opening extending axially therethrough for the passage of gas under pressure from the gas discharging device;

three annular chambers axially aligned in said housing each defining sequentially a part of said opening,

the first and second of said chambers each comprising a plurality of baffles arranged to extend longitudinally of said housing and arranged to define with their adjacent edges a part of the periphery of said opening,

a flange at the downstream end of said second chamber extending laterally of said housing for deflecting downstream in said housing,

a plurality of first deflection means mounted along the inside peripheral surfaces of said first and second chambers for receiving the outwardly deflected gases of the gas discharge stream,

said first deflection means each comprising a pocket for receiving the deflected gases and causing them to acquire a rotary and whirling movement about an annular axis,

the pockets in said first deflection means surrounding said first chamber opening in the upsteam direction of movement of gas under pressure through said opening and the pockets in said deflection mean surrounding said second chamber opening in the downstream direction of movement of gas under pressure through said opening,

the third of said chambers arranged for receiving the discharge gas under pressure from said second chamber and comprising a cylindrical housing surrounding and defining the periphery of a portion of said opening in said muffler,

said cylindrical member provided with a plurality of slots spacedly arranged along the longitudinal axis of said cylindrical housing,

a plurality of second deflection means axially arranged along said cylindrical member and each defining a pocket in communication with at least one of said slots,

each of said pockets of said second deflection means causing said gas deflected through said slots and into them acquiring a rotary and whirling movement about an annular axis to dissipate their energy,

said gases in said muffler after dissipation of a substantial amount of their energy in said first and second deflection means being expelled through said opening to atmosphere, and

exhaust means for aiding the movement of said gases under pressure through said housing to compensate for the loss of pressure of said gases in said muffler due to friction of the gases on the surfaces of said pockets.

10. The muffler set forth in claim **9** wherein:

said second deflection means comprises funnel-shaped devices with one resting within the other when assembled.

11. The muffler set forth in claim **10** wherein:

each of said second deflection means defines an opening axially thereof of a slightly larger diameter than said cylindrical member for slidably fitting thereover.

12. The muffler set forth in claim **11** wherein:

said housing defines an annular opening at one end for receiving a discharge nozzle of a gas generating device,

said annular opening opening into one end of said first chamber.

13. The muffler set forth in claim **12** wherein:

said first deflection means in said first chamber extend longitudinally of said housing around said annular opening and said first deflecting means in said second chamber extend longitudinally of said housing around said second deflection means.

14. The muffler set forth in claim **13** wherein:

said exhaust means comprises a fan for aiding in the movement of the gases under pressure through said housing.

15. The muffler set forth in claim **13** wherein:

said exhaust means comprises a suction-type fan mounted in said housing between said first and second chambers for drawing the gases under pressure through said first chamber and blowing the gases through said second chamber.

16. The muffler set forth in claim **13** wherein:

said exhaust means is mounted at one end of said housing aiding in moving the gases under pressure through said housing.

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