

June 10, 1952

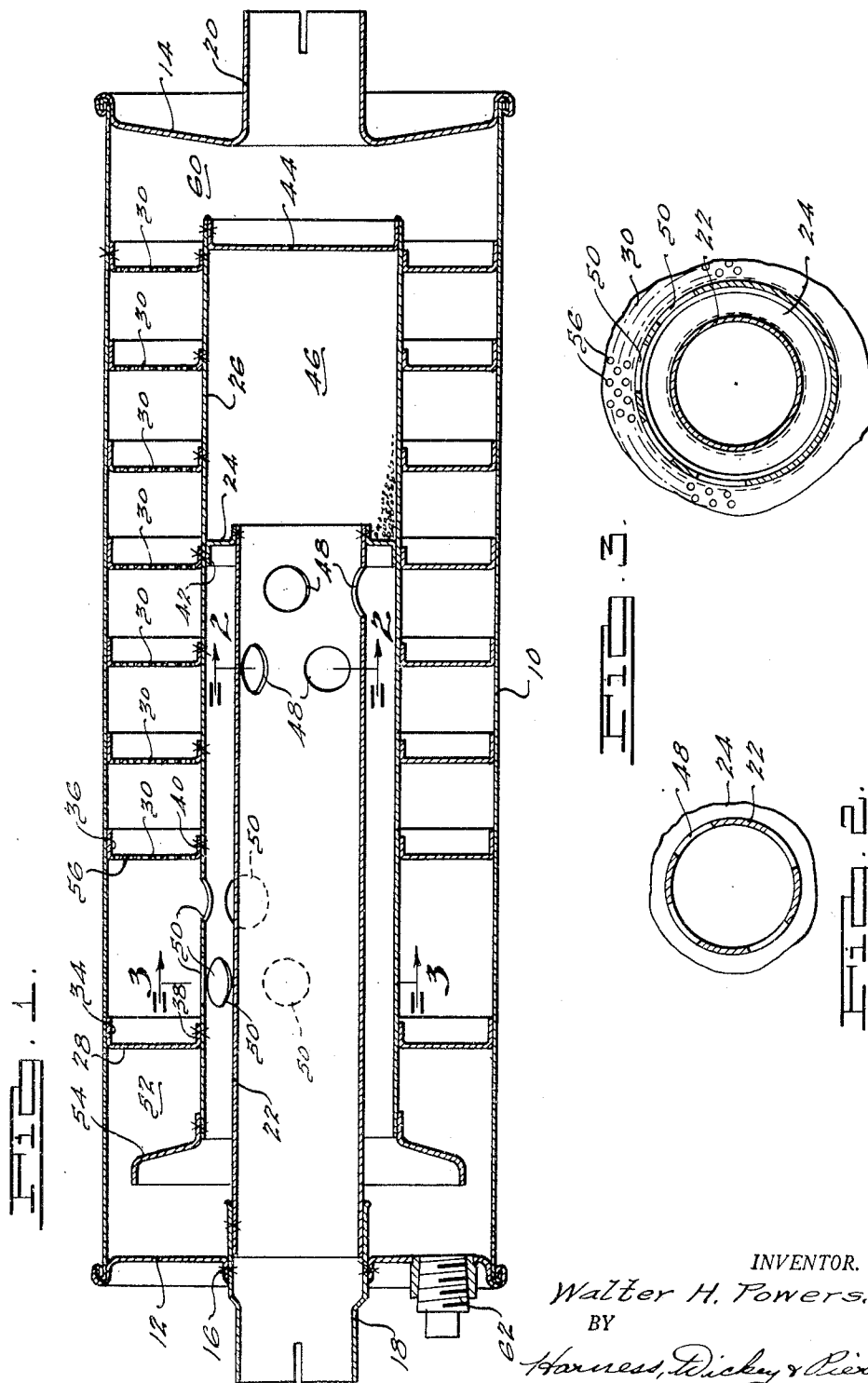
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2,600,262

SPARK ARRESTER MECHANISM

Filed March 19, 1951

3 Sheets-Sheet 1



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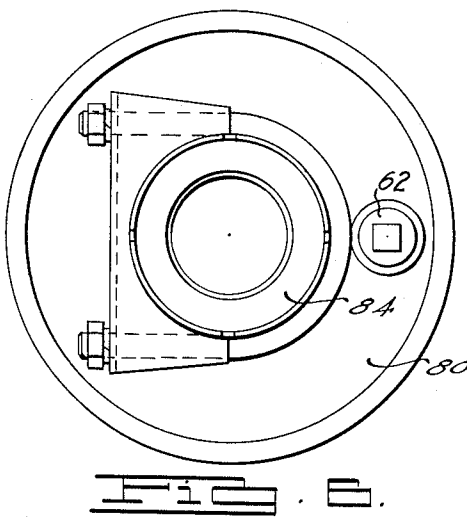
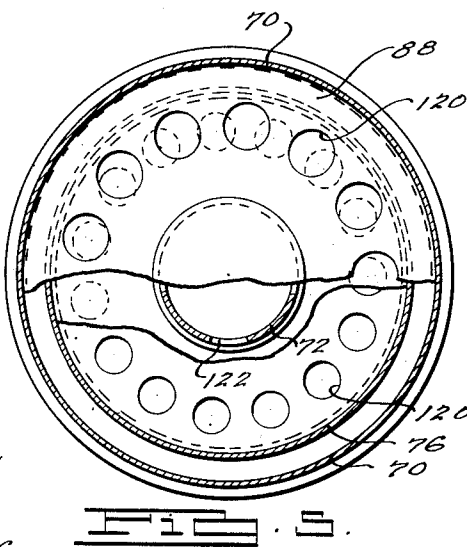
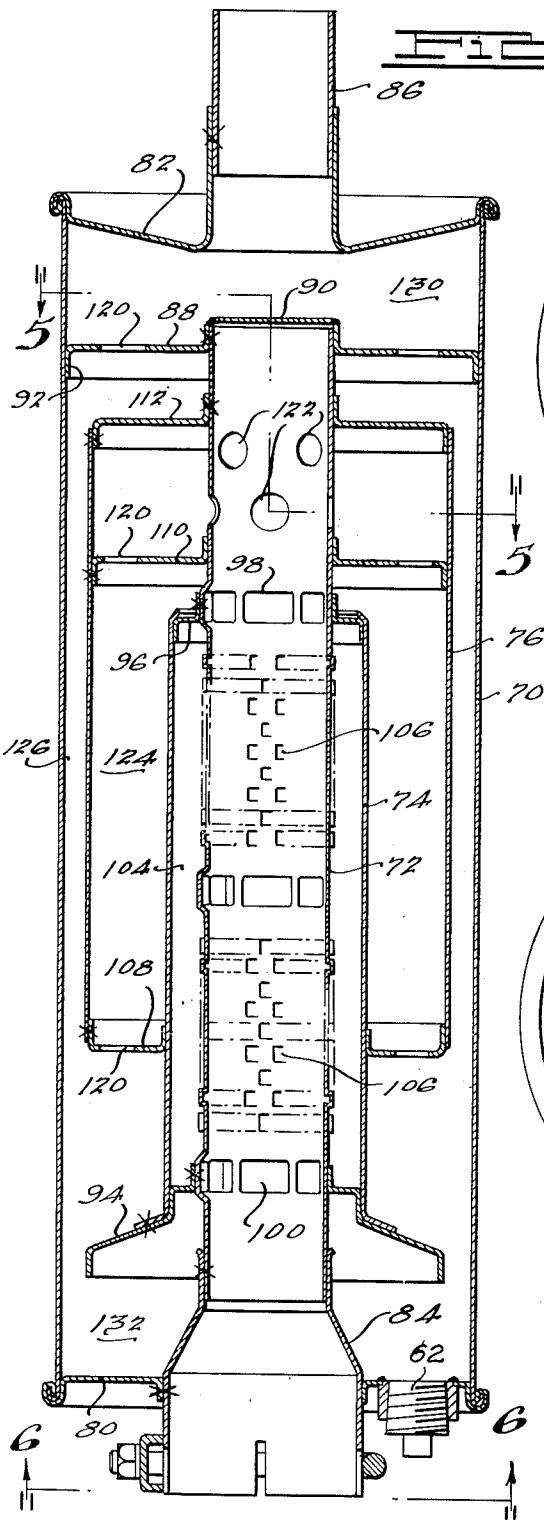
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SPARK ARRESTER MECHANISM

Filed March 19, 1951

3 Sheets-Sheet 2



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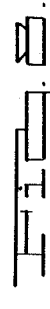
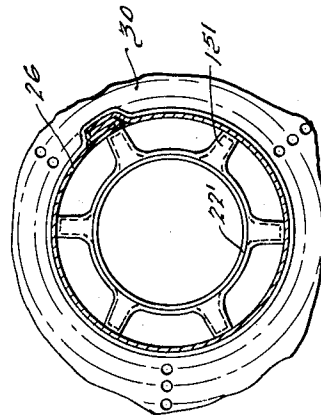
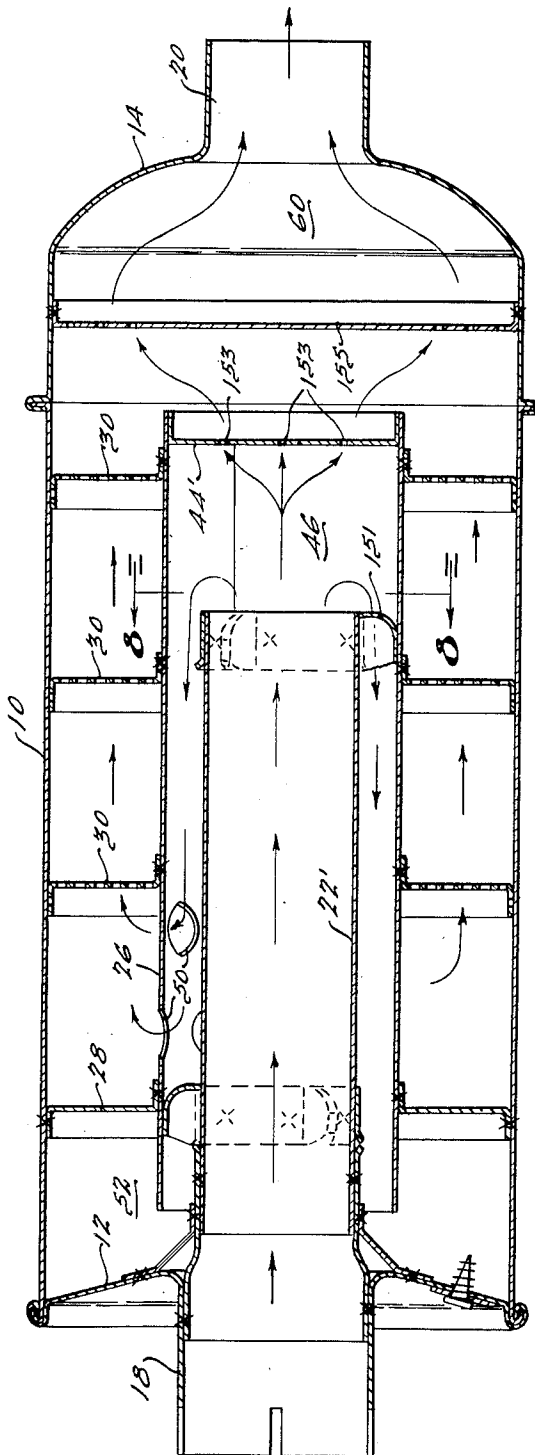
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SPARK ARRESTER MECHANISM

Filed March 19, 1951

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UNITED STATES PATENT OFFICE

2,600,262

SPARK ARRESTER MECHANISM

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Application March 19, 1951, Serial No. 216,333

12 Claims. (Cl. 183—96)

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The present invention relates to apparatus for separating entrained particles from, and cooling, gas streams, and more particularly, provides improved such structures which, when associated with sources of a pulsating gas flow, such as internal combustion engines, also serve to silence such flow to a desired degree. This application is a continuation-in-part of application, Serial No. 503,353, filed September 22, 1943, entitled "Spark Arrester Mechanism," and now abandoned.

The principal objects of the invention are to provide structures of the above type, which are simple in construction, economical to manufacture and assemble, and which are efficient and reliable in service; to provide such structures comprising a shell through which the gas stream to be acted upon is passed, and which shell houses separating and cooling elements; to provide structures of the last-mentioned type, wherein the structure within the shell also includes silencing elements; to provide such structures, wherein the gas stream to be acted upon is caused to follow a tortuous path involving at least one directional change, which change causes entrained solid particles to be separated from the gas, in which the particles and the gas are brought into contact with cooling surfaces whereby heat is extracted therefrom and wherein the gas path also includes silencing elements; to provide such structures wherein the gas path is defined by a plurality of telescopically related conduits which cooperate to define a retroverted circuit; and to generally improve the arrangement and operation of structures of the above generally indicated type.

With the above as well as other and more detailed objects in view, which appear in the following description and in the appended claims, preferred but illustrative embodiments of the invention are shown in the accompanying drawings throughout the several views of which corresponding reference characters are used to designate corresponding parts and in which:

Figure 1 is a view in longitudinal central section of a structure embodying the invention;

Fig. 2 is a view in vertical transverse section, taken along the line 2—2 of Fig. 1;

Fig. 3 is a view in vertical transverse section, taken along the line 3—3 of Fig. 1;

Fig. 4 is a view in longitudinal central section of another embodiment of the invention;

Fig. 5 is a view in transverse section, taken along the line 5—5 of Fig. 4;

Fig. 6 is a view in end elevation taken along the line 6—6 of Fig. 4;

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Fig. 7 is an axial section through another form of the invention; and

Fig. 8 is a section taken on line 8—8 of Fig. 7.

It will be appreciated from a complete understanding of the present invention that the improvements thereof may be embodied in structures intended for widely differing specific purposes and partaking of widely differing individual constructions. Illustrative but practical uses of the invention are in connection with the removal of sparks, cooling and, to a desired degree, silencing the exhaust streams of internal combustion engines associated, for example, with tractors and similar vehicles. As will be appreciated, such vehicles are frequently used in the immediate region of combustible material, making it essential that the gas stream as discharged from the exhaust system be relatively free of heated solid particles and be cooled to a point well below incandescence. The silencing feature of the present structures may be used to supplement other and more conventional silencing structures associated with such vehicles and, in many cases, may be used instead of such conventional silencing arrangements.

Referring first to Figs. 1, 2 and 3, the entire structure may be and preferably is made up of relatively light-weight metal stampings, ranging in thickness, for example, from 14 to 24 gauge, and composed of the same grades of material as are conventionally used in the automobile muffler field. Preferably, but not necessarily, these elements may be subjected to the same corrosion resisting treatment found suitable in the muffler field, and a further advantage of the present arrangement resides in the fact that the individual elements may be initially formed and assembled together by the pass production methods which characterize the automotive muffler field.

More particularly, the illustrated structure comprises an outer enclosure or shell 10, herein illustrated as being of cylindrical form, the ends whereof are closed by apertured headers 12 and 14. The inlet header is provided with a central neck or flange 16, within which the inlet 18 is secured, as by spot welding. It will be understood that the inlet 18 may be connected to the exhaust pipe of the associated source of gas flow, such as an internal combustion engine. The header 14 is provided with a neck 20, which, when the structure is associated with an internal combustion engine, may be connected to the exhaust pipe of the associated exhaust system. In those cases in which the illustrated structure supplements a usual muffler arrangement, it may be connected into the exhaust system either ahead

of or behind such muffler arrangement, although usually it would be connected behind the muffler arrangement.

An inlet conduit 22 is received within the shell 10, the left-hand end thereof being secured, as by welding, within the inlet 18 and the right-hand end thereof being similarly secured to the inner flange of a centrally apertured but otherwise imperforate partition 24. The shell 10 also receives an intermediate conduit 26, which is supported in substantially concentric relation to the shell 10 by means of a partition 28 and a plurality of cooperating partitions 30. The outer flanges 34 and 36 of the partitions 28 and 30 are slidably associated with the inner surface of the shell 10, with the exception that the outer flange of the right-hand partition 30 is spot welded to shell 10. The inner flanges 38 and 40 of partitions 28 and 30 are rigidly secured, as by spot welding, to the outer surface of the intermediate shell 26. The outer flange 42 of the previously mentioned partition 24 is slidably received within the intermediate shell 26, which latter shell thus affords radial support for the right-hand end of the central conduit 22.

The right-hand end of the intermediate conduit 26 is closed by an imperforate partition 44, which, with the partition 24 and the portions of conduit 26 therebetween, defines a collecting and silencing chamber 46, into which access is afforded through the open end of conduit 22.

Adjacent the partition 24, the central conduit 22 is provided with a substantially non-restrictive side outlet, constituted in this instance by two series of circumferentially distributed openings 48. The number and size of the individual holes may, of course, be varied, but assuming that the conduit 22 has a diameter of approximately 2", a series of 8 holes each approximately $\frac{3}{4}$ " in diameter has been found satisfactory, as affording a substantially non-restrictive outlet, i. e., an outlet which does not materially restrict the flow of the gas stream which is introduced through the conduit 22.

In the space between the partition 28 and the left-hand one of the partitions 30, the intermediate conduit is also provided with a substantially non-restrictive side outlet constituted, in the present arrangement, by two rows of holes 50. The illustrated structure is primarily intended to be used in a horizontal position and preferably, but not necessarily, the holes 50 are distributed throughout the upper half of the surface of the conduit 26. Assuming that the conduit 26 is approximately 3" in diameter, a series of 8 holes 50, each approximately $\frac{3}{4}$ " in diameter, has been found to be satisfactory.

The space between the header 12 and the partition 30 affords an annular chamber 52 into which the left-hand end of the conduit 26 projects. At its left-hand end, the conduit 26 is provided with a baffle 54, herein shown as being of generally conical form and secured in place as by spot welding.

In the present arrangement, the partitions 30 are interposed directly in the path of the gas stream and function primarily to extract heat from the gas stream after the larger solid particles have been in large part separated from such stream. The partitions 30 are each provided with a relatively large number of relatively small apertures 56, which break the gas stream into a plurality of small jets, each of which jets is brought into contact with the material of which the partitions are formed. Various numbers and

sizes of holes 56 may, of course, be utilized, but assuming the shell 10 is approximately 6" in diameter, each partition 30 may be provided with a series of holes $\frac{1}{8}$ " in diameter, located on centers spaced $\frac{3}{16}$ " x $\frac{3}{16}$ " from each other.

It will be appreciated that the foregoing recitals as to numbers and sizes of holes, conduit and shell sizes, etc., are illustrative only. In addition, also in an illustrative way, it may be noted that a shell length of approximately 18" is consistent with the above given figures, and that the drawing as a whole is made to scale.

Considering now the operation of the structure of Figs. 1, 2 and 3, insofar as concerns its action in separating and collecting entrained solid particles, such as sparks, and its action in cooling the gas stream as a whole to a point well below incandescence, it will be understood that the gas stream is introduced to the shell 10 through the inlet 18, and may be of either a more or less continuous or decidedly pulsating character, depending upon the nature of the source of the gas stream. The thus introduced gas stream flows to the right through the central conduit 22 under the influence of a velocity head imparted to it by the source. The heavier solid particles continue, under the influence of this velocity head, into the first collecting chamber 46 and impinge against the imperforate partition 44, from whence they fall to the bottom of the chamber. The chamber 46 may be expected to contain exhaust gas at a pressure determined by the pressure conditions in the conduit 22. In case the last-mentioned pressure is of a continuous character, substantially the entire gas stream may be expected to be diverted through the outlet afforded by the openings 48, into the annular space between the conduits 22 and 26. In case the gas stream is of a pulsating type, such as is produced by an internal combustion engine, it will be understood that a part of the gas stream may be expected to initially enter the chamber 46 and thereafter be discharged from conduit 22 through the openings 48.

The entire gas stream, partially freed of solid particles by the separating action afforded by the chamber 46, continues to the left through the above-mentioned annular passage. Under the influence of a velocity head developed in this part of the circuit, any remaining entrained solid particles may be expected to continue past the openings 50 into the chamber 52. Such particles impinge against the header 12 and fall to the bottom of the chamber 52. Turbulence within chamber 52 is reduced by the baffle 54 and these collected particles normally tend to collect in the bottom of the chamber 52 between the baffle 54 and the partition 34. As in the case of the chamber 46, the entire gas stream passes outwardly through the openings 50, either directly or after a partial excursion into the chamber 52. After such passage, the gas passes through the openings 56 along the annular passage defined between the shell 10 and the conduit 26. After passing the last partition 30, the gas stream enters a final expansion chamber 60, defined between the header 14 and such partition 30, and passes therefrom through the outlet 20. As previously mentioned, in passing through the relatively small openings 56, the gas stream is broken into fine jets, which jets recombine in the space between adjacent partitions 30. This breaking up of the gas stream brings the gas particles into contact with the partitions 30 and with the walls of the shell 10 and the conduit 26, which engagement affords an efficient means of extracting

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heat from the gas stream. It will be noticed that the separating chambers 46 and 52 receive the major proportion of entrained solid particles and that the gas stream which passes through the openings 50 contains only very fine particles. The excursion of the stream from the inlet to the openings 50 thus affords both a cooling and a separating action, whereas the excursion of the stream from the openings 50 to the outlet 20, serves primarily to cool the gas particles.

Considering now the silencing action of the present structure, the conduit 22, chamber 46 and openings 48 are acoustically related in accordance with the invention disclosed and claimed in the present applicant's Patent 2,357,791, granted September 5, 1944, which was co-pending with the parent application hereof. More particularly, the gas stream which is introduced at the inlet 18 from a pulsating source, such as an internal combustion engine, may, for purposes of description, be regarded as made of a succession of pressure peaks alternating with valleys. This pulsating stream, under the influence of the velocity head under which it flows through the conduit 22, is directed in part at least past the openings 48 into the chamber 46, which functions as a resonator. Each pressure peak entering the chamber 46 builds up a pressure therein and, under the influence of this increased pressure, the inflow to the chamber 46 is followed by an outflow of gas therefrom through the open end of the conduit 20. As will be understood, the return or outflow from the chamber 46 joins a valley in the oncoming gas stream, which rejoinder produces the silencing action which is characteristic of resonator structures. Similar comments apply to the acoustic relation between the annular passage between conduits 22 and 26, openings 50 and chamber 52, which elements cooperate to further attenuate the pulsations of the gas stream. Additional silencing of the stream is afforded by the flow therethrough through the relatively small openings 56, as will be understood.

As will be appreciated, accumulated cinders and other solid matter may be removed from the structure by agitating it while in a vertical position. Each agitation enables the particles collected in chamber 46 to fall through the conduit 22. Removal of these particles from the chamber 52 may be effected by removing the plug 62.

The embodiment of the invention shown in Figs. 4, 5, and 6 is designed for use in a vertical position. This embodiment comprises an outer shell 70, which receives a central conduit 72 and intermediate conduits 74 and 76. Shell 70 is provided with headers 80 and 82, which may correspond to the previously described headers 12 and 14 and which are similarly provided with inlet and outlet nipples 84 and 86. The lower end of the central conduit 72 is supported by the inlet nipple 84 and the upper end thereof is supported by a partition 88. The cuplike central portion 90 of the partition 88 affords a closure for the end of conduit 72 and the outer flange 92 thereof is slidably received within the shell 70.

The intermediate shell 74 is telescopically fitted over the central conduit 72, the lower end thereof being secured, as by spot welding, to a baffle 94, which may correspond to the previously described baffle 54, and the upper end thereof being similarly secured to the inner flange of a small partition 96. The partition 96 is secured to an annular embossment or ridge 98 formed in the conduit 72. The baffle 94 is similarly secured

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to an embossment 100, also formed in the conduit 22. The annular space between conduits 72 and 74 affords a silencing chamber 104, which is coupled to the interior of the conduit 72 through a distributed series of louver openings 106 provided in the wall of the conduit 72. These louver openings 106 may be variously arranged, but preferably embody the construction described and claimed in Gunn Patent No. 1,949,074.

The intermediate shell 76 is supported in concentric relation to members 70 and 72 by partitions 108, 110 and 112. The inner flange of partition 108 is slidably associated with the surface of conduit 74 and the inner flange of partition 110 is similarly associated with conduit 72. The inner flange of the remaining partition 112 is secured to the conduit 72 as by spot welding. The partitions 108, 110 and 88 are provided with openings 120, sufficient in number and size to enable a substantially unrestricted flow of gas therethrough.

As in the case of the previously mentioned central conduit 22, the conduit 72 is provided adjacent its upper end with a substantially non-restrictive side outlet defined by a plurality of openings 122. These openings are arranged in the space between partitions 110 and 112 and afford communication between the conduit 72 and the intermediate pass 124 of the structure which is defined by the annular space between shells 72 and 74, on the one hand, and shell 76, on the other hand. It will be recognized that the third pass 126 of the structure is defined by the annular space between the shell 70, on the one hand, and shells 72, 74, and 76, on the other hand.

Considering now the operation in respect to the separation of solid particles and cooling of the gas stream, it will be understood that the gas stream enters the inlet 84 and flows along the conduit 72. Under the influence of their velocity head, the solid particles carry past the openings 122 and impinge against the imperforate wall 90. By virtue of the relatively small volume to the right of the openings 122 and the consequent turbulence therein, these particles, though cooled by the just-mentioned impingement, may be expected to remain entrained in the gas stream and pass therewith outwardly through the openings 122 into the second pass 124. Further cooling of the gas stream is afforded by the engagement of the gas stream with the walls of this pass. Under the influence of the velocity head developed in the pass 124, the solid particles may be expected to in large part pass from the openings 120 in partition 108 into the space below the baffle 94 and be collected on the upper surface of the lower head 80. As before, the baffle 94 serves to reduce turbulence in the region below it, so that the just collected particles are not, by turbulence, again blown into the gas stream. The gas stream, however, substantially freed of solid particles by the just mentioned separation, reverses its direction and flows through the third and final pass 126, through the openings 120 in the final partition 88, through the expansion chamber 130, and thence to exhaust through the outlet 86. It will be noticed that the baffle 94 deflects the gas stream and produces the just-mentioned reversal of flow into the pass 126. The space 132 below the baffle 94 may thus be regarded as a collecting chamber, which is displaced from the primary path of the gas stream.

With respect to the silencing action of the present structure, it will be recognized that the

arrangement is generically analogous to familiar triflow-silencing structures in that it affords a retroverted flow of the gases, which retroverted flow is found in practice to produce an efficient silencing action. Further silencing is afforded by the previously mentioned silencing chamber 104 into and out of which a portion of the gas stream is enabled to flow through the lower openings 106.

The simplified structure of Figs. 7 and 8 also embodies features of the invention. Here the side openings 48 in the tube 22 and the imperforate partition 24 are replaced by openings between the legs of a radial spider 151 that is welded to the outside of the tube 22' and the inside of tube 26 and serves to support the end of the tube 22'. In this embodiment, the radial wall 44' is provided with a few small perforations 153 so that some of the gas can by-pass the tortuous passage through the muffler and therefore reduce back pressure. The gas flowing through openings 153 is mixed with gas flowing through partitions 30 by the perforated partition 155 which is similar to partitions 30 except that it has no large center opening, though small perforations may in some cases be used in the central portion. The perforations 153 in wall 44' are preferably made so small individually that large carbon particles can not go through the wall. A second radial spider 157 interconnects the left-hand ends of tubes 22' and 26 and, like spider 151, has large unrestrictive openings therein so that solid particles may flow into chamber 52. In this embodiment, the baffle 54 is eliminated but the wall 28 still serves to separate the chamber 52 from the gas passage through partitions 30.

Although only three specific embodiments of the invention have been described in detail, it will be appreciated that various further modifications in the form, number and arrangement of the parts may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. In an arrester structure for a gas stream having entrained solid particles, the combination of a shell having an inlet and an outlet, a conduit telescoped within said shell having one end in communication with said inlet, means defining an enlarged chamber in communication with the other end of said conduit, said chamber being closed except for said communication, said conduit being formed to provide a substantially non-restrictive side outlet adjacent said other end through which the entire said gas stream passes, solid particles being enabled to pass under the influence of momentum into, and be collected in, said chamber, said gas stream passing through said side outlet to said shell outlet, and means defining a series of relatively small openings through which said stream passes in travelling from said side outlet to said shell outlet.

2. In an arrester structure for a gas stream having entrained solid particles, the combination of a shell having an inlet and an outlet, a conduit telescoped within said shell having one end in communication with said inlet, means defining a chamber of a cross section larger than that of said conduit in communication with the other end of said conduit, said chamber being closed except for said communication, said conduit being formed to provide substantially non-restrictive relatively large area side outlets adjacent said other end through which the entire said gas stream passes, solid particles being enabled to pass under the influence of momentum into, and

be collected in, said chamber, said gas stream passing through said side outlets to said shell outlet, means in said shell for causing a reversal of direction of flow of said gas stream in passing from said side outlets to said shell outlet, and an additional collecting chamber for receiving solid particles separated from said stream by said reversal of flow.

3. In an arrester structure for a gas stream having entrained solid particles, the combination of a shell having an inlet and an outlet, a conduit telescoped within said shell, one end of said conduit being in communication with said inlet, means defining substantially non-restrictive relatively large area side outlets in the wall of said conduit adjacent the other end thereof through which the entire said gas stream passes, means cooperating with said conduit for so closing said other end thereof as to cause the entire gas stream to pass through said side outlets, an intermediate conduit telescoped over said first-mentioned conduit and forming therewith an annular passage for the flow of the gas stream after leaving said side outlets, an enlarged collecting chamber in line with said passage into which solid particles are carried by momentum developed in said passage, and means for conducting the gas stream from said passage to the shell outlet.

4. In an arrester structure for a gas stream having entrained solid particles, the combination of a shell having an inlet and an outlet, a conduit telescoped within said shell, one end of said conduit being in communication with said inlet, means defining a substantially non-restrictive relatively large area side outlet in the wall of said conduit adjacent the other end thereof, means cooperating with said conduit for closing said other end thereof and for causing the entire gas stream to pass through said side outlet, an intermediate conduit telescoped over said first-mentioned conduit and forming therewith an annular passage for the flow of the gas stream after leaving said side outlet, an enlarged collecting chamber in line with said passage into which solid particles are carried by momentum developed in said passage, and means for conducting the gas stream from said passage to the shell outlet, said closing means including means defining a chamber of a cross section larger than that of said conduit which cooperates to attenuate pressure pulsations of said stream.

5. In an arrester structure for a gas stream having entrained solid particles, the combination of a shell having an inlet and an outlet, a conduit telescoped within said shell, one end of said conduit being in communication with said inlet, means defining a substantially non-restrictive side outlet in the wall of said conduit adjacent the other end thereof, means cooperating with said conduit for closing said other end thereof and for causing the entire gas stream to pass through said side outlet, an intermediate conduit telescoped over said first-mentioned conduit and forming therewith an annular passage for the flow of the gas stream after leaving said side outlet, an enlarged collecting chamber in line with said passage into which solid particles are carried by momentum developed in said passage, said chamber being completely closed except for said communication with said passage, and means for conducting the gas stream from said passage to the shell outlet, said collecting chamber being defined in part by a baffle surface which causes said stream to reverse its di-

rection of flow and enter said last-mentioned means.

6. In an arrester structure for a gas stream having entrained solid particles, the combination of a shell having an inlet and an outlet, a conduit telescoped within said shell, one end of said conduit being in communication with said inlet, means defining a substantially non-restrictive side outlet in the wall of said conduit adjacent the other end thereof, means cooperating with said conduit for closing said other end thereof and for causing the entire gas stream to pass through said side outlet, an intermediate conduit telescoped over said first-mentioned conduit and forming therewith an annular passage for the flow of the gas stream after leaving said side outlet, an enlarged collecting chamber in line with said passage into which solid particles are carried by momentum developed in said passage, said chamber being completely closed except for said communication with said passage, means for conducting the gas stream from said passage to the shell outlet, said last-mentioned means including the annular space between said shell and said intermediate conduit, and said annular space including a plurality of partitions having relatively small openings therein.

7. The structure of claim 3 wherein said closing means is constituted by an imperforate partition in said conduit, said conduit having an imperforate wall portion between said side outlet and said partition.

8. In an arrester structure for a gas stream having entrained solid particles, a casing having end walls, a first and a second of said end walls being provided with an inlet and an outlet respectively, a first tubular member positioned within said casing, one end of said member being sealed to said inlet and connecting said inlet with the interior of said casing, said member terminating inwardly of said second end wall, a second tubular member arranged within said casing and surrounding at least a portion of said first member and providing a chamber therebetween, means providing a first radial wall extending between said members adjacent an end portion of one of said members whereby the adjacent portions of said members are held in fixed relation with respect to each other, said first radial wall acting to define an end of said chamber, said first member being open to provide a fluid flow passageway communicatively connecting the interior of said first member with said chamber, one of said tubular members extending beyond the other in the direction of said outlet, a second radial wall in said one tubular member spaced beyond the end of the other, the chamber defined by said second radial wall and the portion of said tubular member adjacent said second radial wall being in open communication with the interior of said first tubular member, said second tubular member extending from said first radial wall toward but terminating inwardly of said first end wall, said first end wall, said casing and said first tubular member cooperating to define a chamber for capturing the solid particles entrained in the gas, a radial baffle member positioned inwardly of said first end wall for defining the inner end of said second-named chamber, said last named chamber being in communication with said outlet through a space between said casing and said second member and in open communication with the interior of said second member and serving to change the direction of gas through said casing.

9. In an arrester structure for a gas stream having entrained solid particles, a casing having end walls, a first and a second of said end walls being provided with an inlet and an outlet respectively, a first tubular member positioned within said casing, one end of said member being sealed to said inlet and connecting said inlet with the interior of said casing, said member having an inner end portion terminating inwardly of said second end wall, a second tubular member arranged within said casing and surrounding at least a portion of said first member and having an end portion extending outwardly of said first member end portion toward said second end wall, means providing a radial wall extending between said members adjacent said one member end portion and serving to support said one member end portion in fixed relation with respect to said second member, a radial wall for said second member extending portion to define an end chamber in open communication and aligned with said first tubular member, said first member being open adjacent said radial wall to provide a fluid flow passageway communicatively connecting the interior of said first member with a passageway formed between said first and said second members, said second tubular member having a second end portion terminating inwardly of said first end wall, an imperforate radial member sealed between said second tubular member and said casing to define with said first end wall an end chamber in alignment with said passageway to receive and capture solid particles entrained in the gases, and to define an end wall for a second passageway between said second member and said casing, said second passageway being in communication with said outlet, said end chamber being entirely closed except for its communication with said passageway, said second member being apertured adjacent said last-named radial member to communicatively connect said passageways.

10. In an arrester structure for a gas stream having entrained solid particles, a casing having end walls, a first and a second of said end walls being provided with an inlet and an outlet respectively, a first and a second tubular member positioned within said casing one within the other, said first member being sealed to said inlet and connecting said inlet with the interior of said casing and having an inner end portion terminating inwardly of said second end wall, said second tubular member having first and second end portions terminating inwardly of said first and said second end walls respectively, said second member second end portion terminating intermediate said first member end portion and said second end wall, means providing a radial wall connecting said first member end portion to an intermediate section of said second member, an end member for said second member second end portion, the portion of said second member intermediate said intermediate section and said second member second end portion and said end member and said radial wall acting to provide a chamber in open communication with said first member, a radial closure member closing the space between said casing and said second member adjacent said second member first end portion to define a second chamber intermediate said first end wall and said closure member closed except for its open communication with a passageway formed between said tubular members, said first tubular member being opened adjacent its said end por-

tion for communicatively connecting the interior of said first member with said last-named passageway, said second member being apertured intermediate said first member opening and said closure member for communicatively connecting said last-named passageway with said space, and a plurality of spaced perforated radial members arranged in spaced relation to each other within said space intermediate said closure member and said second end wall through which the gas flows to said outlet.

11. A spark arrester for gas flow comprising a hollow elongated casing having an inlet at one end and an outlet at the other, a first tube located in said casing and connected to said inlet to receive gases entering said casing, said tube extending longitudinally of said casing toward the outlet end of the casing and having substantially unrestricted outlet opening means therein adjacent the end thereof remote from said inlet, means including a second tube surrounding the first tube and forming a first chamber about the first tube, a radial wall in said first tube and positioned between said outlet means and said casing outlet and in alignment with the path of gases flowing through the first tube, said radial wall and a portion of said first tube defining a second chamber for separating solid particles from the gases, said second chamber being in gas flow communication with said outlet means, said first chamber being in gas flow communication with said outlet means and providing a substantially unrestricted first passage for the flow of gases away from said second chamber in a longitudinal direction opposite to the direction of flow in said first tube, said first passage terminating inwardly of the inlet end of the casing and said second tube having substantially unrestricted outlet means for said first passage

whereby solid particles in the gas may flow longitudinally out of said passage toward said inlet end, the space between said casing and second tube providing a second passage for the flow of gases in a longitudinal direction toward said outlet and being in gas flow communication with said first passage, the space in said casing surrounding said first tube and adjacent the inlet end of the casing comprising a third chamber for separating solid particles from the gas and being in gas flow communication with said outlet means, said means including a radial baffle wall to interfere with flow from the third chamber into the second passage.

12. The invention set forth in claim 8 wherein said second radial wall has a plurality of small holes therein, said holes serving to reduce back pressure in said one tubular member but being too small for passage of at least the larger solid particles.

WALTER H. POWERS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,044,397	Knopp	Nov. 12, 1912
1,084,290	Pelletier	Jan. 13, 1914
1,514,441	Culp	Nov. 4, 1924
1,881,051	Haas	Oct. 4, 1932
2,125,449	Kingsley	Aug. 2, 1938
2,138,477	Ludlow	Nov. 29, 1938
2,147,015	Deremer	Feb. 14, 1939
2,182,204	Hector	Dec. 5, 1939
2,182,945	Gunn	Dec. 12, 1939
2,196,920	Hoyle	Apr. 9, 1940