

Aug. 28, 1934.

Q. G. NOBLITT

1,972,065

MUFFLER

Filed March 2, 1931

2 Sheets-Sheet 1

Fig. 1.

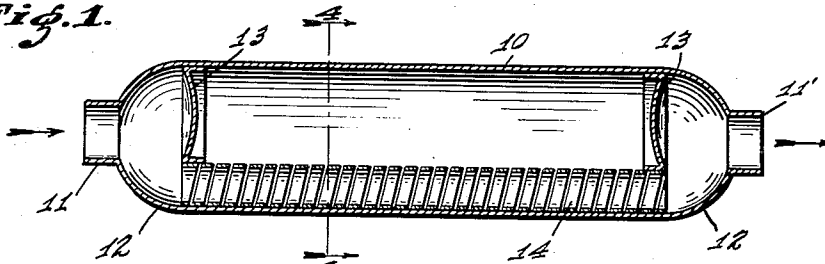


Fig. 2.

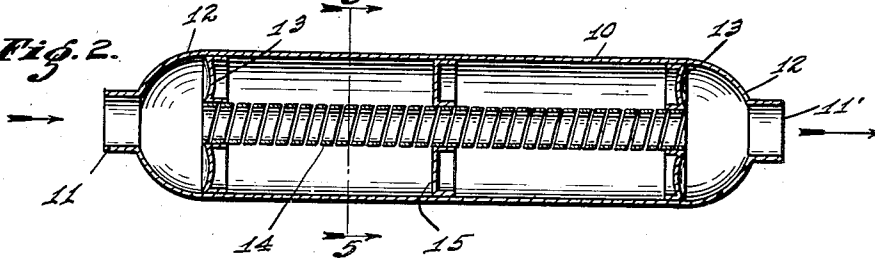


Fig. 3.

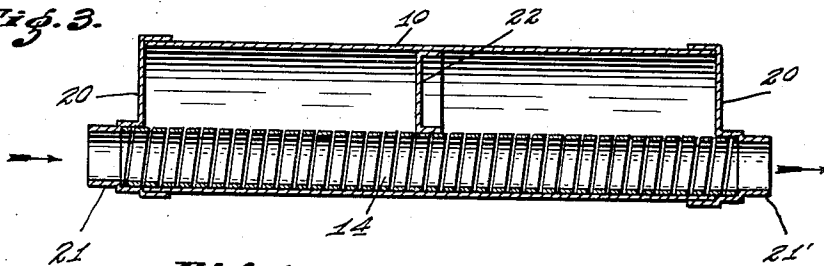


Fig. 4.

Fig. 5.

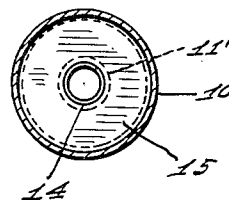
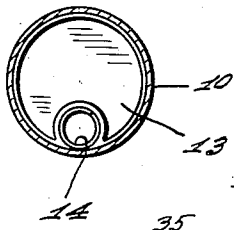


Fig. 13.

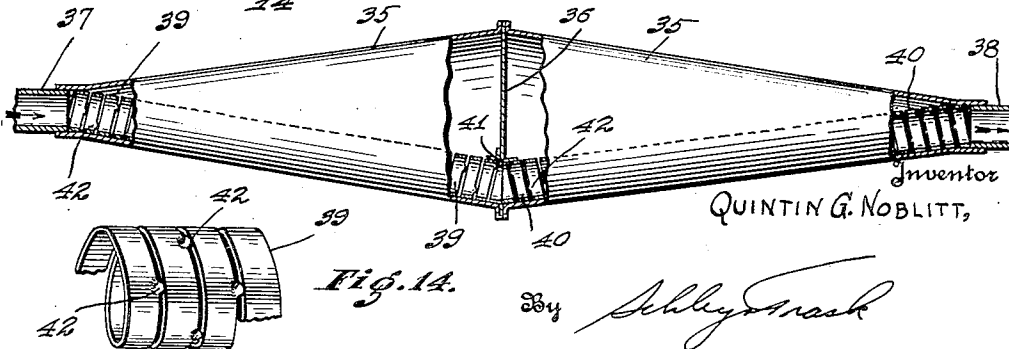


Fig. 14.

INVENTOR
QUINTIN G. NOBLITT,

BY

Schley & Nash

Attorneys

Aug. 28, 1934.

Q. G. NOBLITT

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MUFFLER

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Fig. 6.

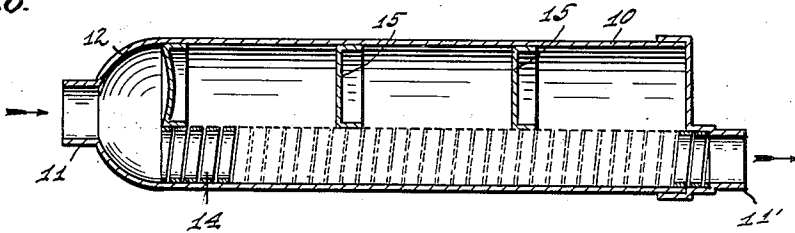


Fig. 7.

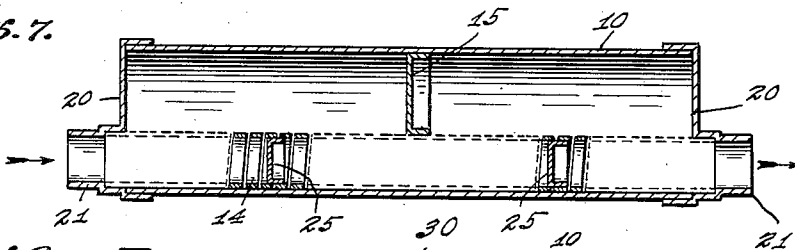


Fig. 8.

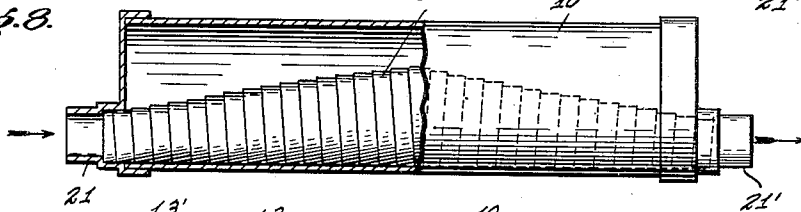


Fig. 9.

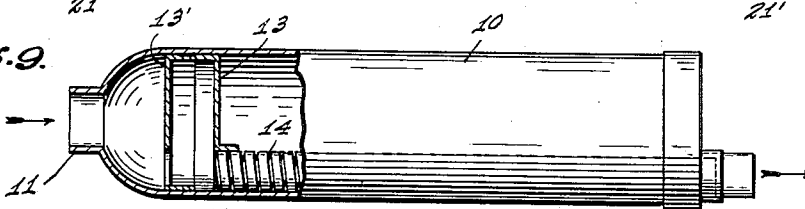


Fig. 10.

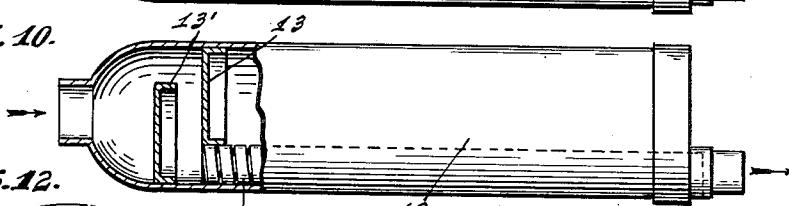


Fig. 12.

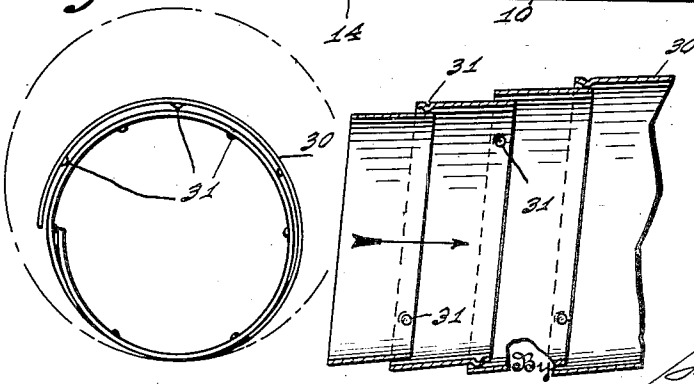


Fig. 11.

Inventor
QUINTIN G. NOBLITT,

Atty.
Attorneys

UNITED STATES PATENT OFFICE

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MUFFLER

Quintin G. Noblitt, Indianapolis, Ind., assignor
to Noblitt-Sparks Industries, Inc., Indianapolis,
Ind., a corporation of Indiana

Application March 2, 1931, Serial No. 519,380

9 Claims. (Cl. 137—160)

It is the object of my invention to produce an internal-combustion engine muffler which will effectively silence the sound of the exhaust, which will be of simple and economical construction, and which will not interfere with engine-efficiency by developing excessive back-pressure.

In carrying out my invention, I provide a hollow shell having within it a tube of smaller diameter through which the exhaust gases from the engine pass. This tube is preferably although not necessarily completely free from any interior obstructions and has in its wall a plurality of openings or the equivalent thereof providing restricted communication between the interior of the tube and the enclosed annular space surrounding it. Preferably, the tube is so located transversely of the surrounding shell that the distance between the tube and shell at angularly spaced points varies. Conveniently, the tube and shell are both circular in cross-section, and the tube is located eccentrically of the shell to secure this variation between the tube and the shell-wall.

The accompanying drawings illustrate my invention: Figs. 1, 2, and 3 are longitudinal sections through differently constructed mufflers all embodying my invention; Fig. 4 is a transverse section on the line 4—4 of Fig. 1; Fig. 5 is a transverse section on the line 5—5 of Fig. 2; Figs. 6 to 10 inclusive are longitudinal sections illustrating further modifications of my invention; Fig. 11 is a fragmental longitudinal section of the tube illustrated in Fig. 8; Fig. 12 is a cross-section of such tube; Fig. 13 is a longitudinal section showing another modification; and Fig. 14 is a fragmental elevation of a tube illustrating a preferred form of construction.

The muffler illustrated in Fig. 1 comprises a cylindrical shell 10 of circular cross-section, the ends of the shell being reduced in diameter to provide necks 11 and 11' for attachment to the exhaust pipe of an engine and to a tail pipe respectively. Preferably, the tapering portion 12 at each end of the muffler between the central portion of the shell and the neck is smoothly curved and of gradually increasing diameter from the neck to the shell-body.

Within the shell, and conveniently at the points where the intermediate curved portions 12 join the body portion 10, I provide partitions 13 provided with eccentric openings for the reception of a tube 14. Preferably, the tube-receiving openings in the partitions 13 are aligned and the tube 14 is straight, but this is not essential.

To prevent the partitions 13 from vibrating unduly, they may be dished to increase their rigidity.

Each partition is conveniently mounted within the shell by providing it with a peripheral flange which lies against the inner surface of the shell and which may be secured thereto as by spot-welding. In addition, each partition may be provided around each tube-receiving hole with a flange which lies against the outer surface of the tube 14.

The tube 14 is preferably formed by an open-wound helical ribbon, as indicated in the drawings. By reason of its open-wound character, the ribbon which forms the tube 14 provides substantially continuous but somewhat restricted communication between the interior of the tube and the surrounding annular space. The spacing of the turns and the winding of the strip which is used to form the tube 14 may vary considerably, but I have found a strip-width of one-half inch to one inch with a space of 0.015 inch to 0.050 inch between turns to give excellent results. The most effective strip-width and turn-spacing will depend to a large extent upon the engine with which the muffler is to be used, and these dimensions may therefore be departed from in some instances.

In the muffler illustrated in Fig. 1, the tube 14 is shown in eccentric position and as in contact with the inner surface of the shell 10 to which it may be secured at intervals by spot-welding.

The two partitions 13 are imperforate except for the holes which receive the ends of the tube 14; and as a result, all the gases which pass through the muffler must pass through the ends of the tube 14. In other words, it is desirable that the annular space surrounding the tube 14 have no communication with the inlet or outlet openings of the muffler except by way of the tube.

The gases entering the muffler through the neck 11 are discharged into the enlargement provided by the tapering portion 12 of the muffler shell, I believe that this enlargement acts as an expansion chamber permitting a certain equalization of pressures. From this expansion chamber, the gases enter the interior of the muffler through the end of the tube 14, and pass through the interior of the muffler emerging into the intermediate portion 12 at the opposite end thereof and thence outwardly through the neck 11'.

As the gases pass through the muffler, they flow in general toward the discharge end thereof but may pass, in response to local and temporary pressure conditions, back and forth between the tube 14 and the annular space surrounding it through the spaces between the turns of the strip that forms the tube 14. By this action, pressure

variations in the gases are smoothed out so that the gases emerge through the neck 11' at substantially constant pressure and without noise.

The muffler illustrated in Fig. 2 is substantially the same as that illustrated in Fig. 1 except that the tube 14 is located centrally of the shell 12 instead of eccentrically thereof. In addition, the muffler is shown as provided with an intermediate transverse partition 15 which divides the annular space surrounding the tube into two portions and compels all the exhaust gases flowing from one portion to the other to enter and pass through the tube 14.

The muffler illustrated in Fig. 2 operates satisfactorily in the main, but I have found that at certain engine speeds the muffler is less effective in silencing exhaust gases than at other engine speeds. I believe this may be due to the central location of the tube, which permits gases emerging at angularly spaced points from the tube 14 to strike the inner surface of the shell 10 simultaneously, thus setting up a condition favorable to resonance.

In the muffler illustrated in Fig. 3, the expansion chambers provided by the tapering portions 13 of the shell are eliminated, the shell being provided at its ends with heads 20 having necks 21 and 21' for connection to the exhaust pipe of the engine and to a tail pipe respectively. The tube 14 lies within the shell 10 and communicates at its end with the necks 21 and 21'. I have shown the muffler of Fig. 3 as embodying an intermediate partition 22 which has the same function as the partition 15 included in the muffler illustrated in Fig. 2.

Except for the effect produced by the provision of the expansion chamber within the intermediate portion 12 of the muffler illustrated in Figs. 1 and 2, a muffler constructed in accordance with Fig. 3 will operate in substantially the same manner and will effectively silence the exhaust. In Fig. 3, the tube 14 is shown as located eccentrically, as that is the preferred location when the shell 10 is of circular cross-section; but this eccentric location of the tube 14 is not essential.

The muffler illustrated in Fig. 6 is generally similar to that illustrated in Fig. 1 except that the expansion chamber 12 at the discharge end is eliminated. The muffler illustrated in Fig. 6 is also shown as provided at intermediate points with two partitions 15 which divide the annular space surrounding the tube 14 into three sections and prevent gases from flowing from one section to the other except by way of the tube.

In most cases, the elimination of the expansion chamber at the discharge end of the muffler has very little, if any, effect on the silencing of the exhaust gases. By eliminating this expansion chamber I remove from the gas passage one enlargement, one contraction, and a double bend, thus decreasing the back pressure.

The muffler shown in Fig. 7 is identical with that illustrated in Fig. 3 except that the tube 14 at points intermediate the partition 15 and the heads 20 is provided with dams 25. These dams divide the tube 14 into three sections and prevent direct flow of gas through the tube 14 from one end toward the other.

The muffler illustrated in Fig. 8 has the casing 10, heads 20, and necks 21 of the mufflers shown in Figs. 3 and 7. The muffler of Fig. 8, however, embodies a materially different form of interior tube. Like the tube 14, the tube 30 shown in Fig. 8 is formed of a wound metal strip or ribbon, but it differs from the tube 14 in that the succes-

sive turns of the ribbon overlap, being spaced apart radially to provide spaces for the passage of exhaust gases to and from the annular space surrounding the tube. The radial spacing of the turns of the tube 30 is conveniently secured by forming projections 31 at intervals along the strip from which the tube is formed.

Conveniently, the tube 30 is formed in two halves, each half being constructed by winding a ribbon spirally and then by expanding the spiral axially.

Like the tube 14, the form of the tube 30 provides restricted communication between the interior of the tube and an annular space surrounding it at substantially all points along the tube. By varying the extent to which successive turns of the strip forming the tube 30 overlap, the effective length of the restricted passages providing communication between the interior of the tube and the annular space surrounding it may be varied. I believe that this amount of overlapping has a very material effect in the silencing of the exhaust gases, probably by reason of the friction imposed on the gases escaping between the successive turns which form the tube 30. I have found excellent results to be obtained by forming each half of the tube 30 of metal ribbon one and one-quarter inches in width, and by so winding this ribbon that successive turns overlap by approximately one-quarter inch with a radial spacing of one sixty-fourth of an inch between turns.

The two mufflers illustrated in Figs. 9 and 10 resemble the muffler shown in Fig. 6 except that each of them is provided at its inlet end with two expansion chambers instead of the single expansion chamber possessed by the muffler of Fig. 6. These two expansion chambers are conveniently formed by means of an intermediate partition 13' which is located between the partition 13 and the neck 11. The location of the opening in the partition 13' may vary. This opening is shown as eccentric in both Figs. 10 and 11, in Fig. 10 it being shown as in line with the opening in the partition 13, while in Fig. 11 it is diametrically opposite the opening in the partition 13.

While I have shown the inner tube in each muffler as formed of a helically wound strip, such construction is not essential to my invention although it is preferred because it is less expensive.

In Figs. 13 and 14 I have illustrated a modification of my invention which has been found to give excellent results in respect to both low back-pressure and effective silencing. In this structure, the outer casing of the muffler is formed of two conical halves 35, the bases of which are placed together. The interior of the casing is divided longitudinally into two parts by means of a transverse partition 36 which extends across the casing at the bases of the two casing-halves. The apex of each conical casing-half is truncated to provide openings respectively for the exhaust pipe 37, through which exhaust gases are conveyed to the muffler, and a tail pipe 38, through which gases are conveyed from the muffler. In the two halves of the muffler I provide tubes 39 and 40 formed by helically wound strips. The two tubes 39 and 40 are connected together through an opening 41 in the partition 36.

In Fig. 14 I have shown a preferred form for the tubes 39 and 40, although this form of tube may be used in any of the mufflers illustrated in Figs. 1 to 7, 9 and 10. The tube illustrated is formed of a strip which at intervals along one edge has projections 42 formed as by swaging the metal of the strip locally to displace a small por-

tion laterally. The projections 42 extend laterally from the strip a distance equal to the desired spacing between the turns of the helix. With the helix wound so that the projections 42 on each helix-turn engage the adjacent helix-turn, the tube is mounted in the casing as shown in Fig. 13. Conveniently, each of the tubes is held in place by spot-welding it to the casing.

I have found that in order to secure the best results in any muffler of the various forms shown and described herein it is advisable to so wind the helix forming the inner tube that the distance between its turns is less than the thickness of the material of which the tube is formed, and desirably is less than one-half the thickness of the tube-wall. Experiments also indicate that particularly in mufflers in which the space surrounding the inner tube is divided by a transverse partition an advantage will be derived from spacing the coils near the discharge end of the tube somewhat closer together than those near the inlet end, as indicated somewhat exaggeratedly in Fig. 13.

Excellent results with the engine of the present Ford automobile have been found to be obtained by a muffler of the type illustrated in Figs. 13 and 14 having a length of about thirty-six inches and a maximum diameter of five and one-half inches, the tubes 39 and 40 being approximately one and five-eighths inches in diameter and wound from material one-half inch in width. The preferred thickness of the material from which the tubes are formed is one-sixteenth inch, and the preferred spacing of turns is approximately 0.025 inch for the tube 39 and 0.018 inch for the tube 40. If the tubes are formed of material one-eighth inch in thickness, the turns of the tube 39 may be spaced 0.040 inch apart and those of the tube 40 may be spaced 0.020 inch. If the strips from which the tubes are formed are of widths other than that specified, the spacing between adjacent turns should in general be changed in order to maintain approximately constant the total effective area of the opening or openings which provide communication between the interior of the tube and the space surrounding it.

Although the tubes 14, 39, and 40 are shown in the drawings as of uniform diameter this is not essential. To reduce back-pressure, the ends of each tube should be of substantially the same internal diameter as the passages with which they are respectively connected, and the tube should be free from any abrupt changes in internal diameter intermediate its ends.

All the mufflers described are very effective in silencing the exhaust and have the very desirable feature that they do not create excessive back pressure. Further, they lend themselves to sheet-metal construction and may therefore be manufactured at a low price.

My muffler is not to be confused with a muffler such as is shown in the Mason Patent No. 1,874,326 and which demands for maximum silencing efficiency that the openings in the metal tube be arranged in spaced groups with a section of unperforated tubes separating adjacent groups. To distinguish from such a muffler, I refer in the claims to my central tubes as being provided with "a continuous series of openings".

I claim as my invention:

1. A muffler, comprising an elongated circular casing having inlet and discharge openings near opposite ends, a substantially rigid tube located within said casing and connecting said inlet and discharge openings, said tube being smaller in diameter than said casing and being free of

internal obstructions between said openings, said tube having a substantially continuous narrow helical slot through its wall to provide restricted communication between the interior of said tube and the space surrounding it.

2. A muffler, comprising a tube to which exhaust gases are to be supplied, a casing surrounding said tube, said casing at a point intermediate its length being of larger diameter than said tube and decreasing in diameter toward its ends, a transverse partition located at an intermediate point in said casing to divide the space within the casing and surrounding the tube, said tube extending generally longitudinally through said casing and being secured adjacent the side walls thereof, said tube being free of internal flow-preventing obstruction and being formed of one or more helically wound strips of material the turns of which are spaced apart a distance less than one-half the thickness of the material from which the tube is wound, and the turns of the tube on the discharge side of said partition being spaced more closely than are the turns on the inlet side of said partition.

3. A muffler, comprising a tube to which exhaust gases are to be supplied, a casing surrounding said tube, said casing at a point intermediate its length being of larger diameter than said tube and decreasing in diameter toward its ends, a transverse partition located at an intermediate point in said casing to divide the space within the casing and surrounding the tube, said tube extending generally longitudinally through said casing and being secured adjacent the side walls thereof, said tube being free of internal flow-preventing obstructions and being formed of one or more helically wound strips of material the turns of which are spaced apart a distance less than one-half the thickness of the material from which the tube is wound.

4. A muffler, comprising a tube to which exhaust gases are to be supplied, a casing surrounding said tube, said casing at a point intermediate its length being of larger diameter than said tube and decreasing in diameter toward its ends, a transverse partition located at an intermediate point in said casing to divide the space within the casing and surrounding the tube, said tube being free of internal flow-preventing obstructions and being formed of one or more helically wound strips of material the turns of which are spaced apart a distance less than the thickness of the material from which the tube is wound, and the turns of the tube on the discharge side of said partition being spaced more closely than are the turns of the inlet side of said partition.

5. A muffler, comprising a tube to which exhaust gases are to be supplied, a casing surrounding said tube, said casing at a point intermediate its length being of larger diameter than said tube and decreasing in diameter toward its ends, a transverse partition located at an intermediate point in said casing to divide the space within the casing and surrounding the tube, said tube extending generally longitudinally through said casing and being secured adjacent the side walls thereof, said tube being free of internal flow-preventing obstructions and being formed of one or more helically wound strips of material the turns of which are spaced apart a distance less than the thickness of the material from which the tube is wound, and the turns of the tube on the discharge side of said partition being spaced more closely than are the turns on the inlet side of said partition.

6. A muffler, comprising a tube to which exhaust gases are to be supplied, a casing surrounding said tube, said casing at a point intermediate its length being of larger diameter than said tube and decreasing in diameter toward its ends, a transverse partition located at an intermediate point in said casing to divide the space within the casing and surrounding the tube, said tube extending generally longitudinally through said casing and being secured adjacent the side walls thereof, said tube being free of internal flow-preventing obstructions and being formed of one or more helically wound strips of material the turns of which are spaced apart a distance less than the thickness of the material from which the tube is wound.

7. A muffler, comprising a tube to which exhaust gases are to be supplied, a casing surrounding said tube, said casing at a point intermediate its length being of larger diameter than said tube and decreasing in diameter toward its ends, said tube being free of internal flow-preventing obstructions and being formed of one or more helically wound strips of material the turns of which are spaced apart a distance less than the thick-

ness of the material from which the tube is wound, and the turns of the tube near the discharge end being spaced more closely than are the turns near the inlet end.

8. A muffler, comprising a substantially rigid tube to which exhaust gases are to be supplied, a casing surrounding said tube, said casing being of larger diameter than said tube to provide a space between the tube and casing, said tube being formed of a helically wound strip of material, the turns of the helix being spaced apart a distance less than one-half the thickness of such material, said tube being free of internal obstructions throughout its length.

9. A muffler, comprising a substantially rigid tube to which exhaust gases are to be supplied, a casing surrounding said tube, said casing being of larger diameter than said tube to provide a space between the tube and casing, said tube being formed of a helically wound strip of material, the turns of the helix being spaced apart a distance less than the thickness of such material, said tube being free of internal obstructions throughout its length.

QUINTIN G. NOBLITT.

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