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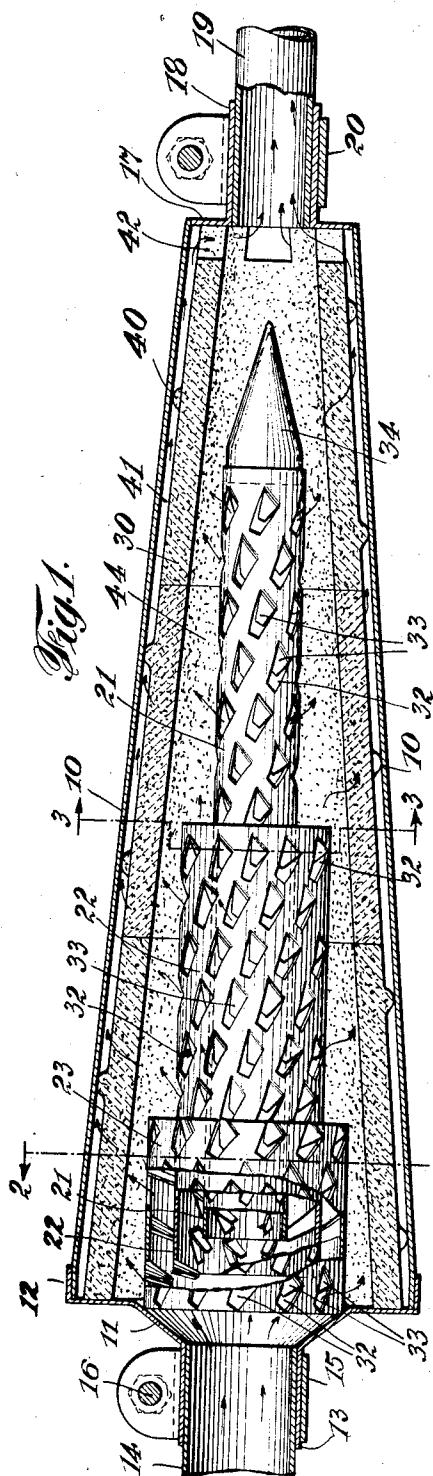
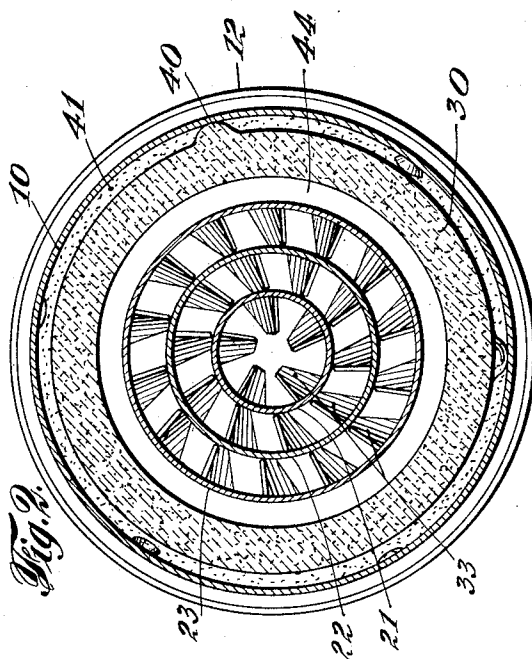
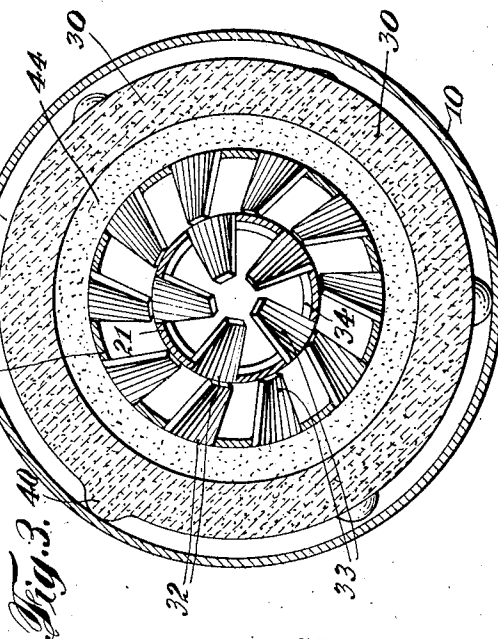
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EXHAUST MUFFLER

Filed Nov. 13, 1930

2 Sheets-Sheet 1



INVENTOR
Robert A. Moore
John Mitchell
BY
Meyers & Jones
ATTORNEY

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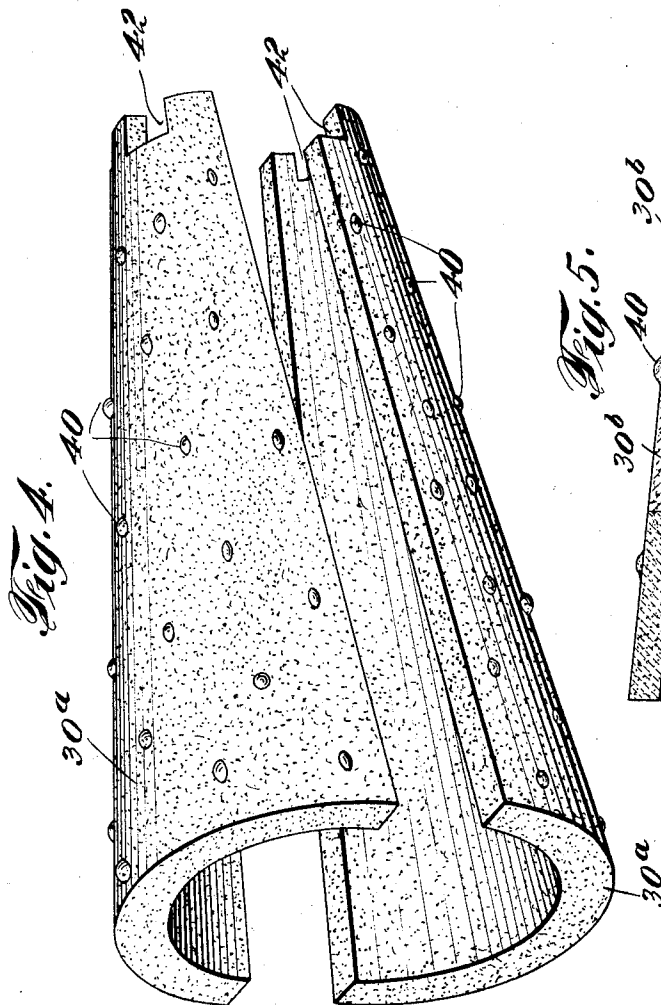
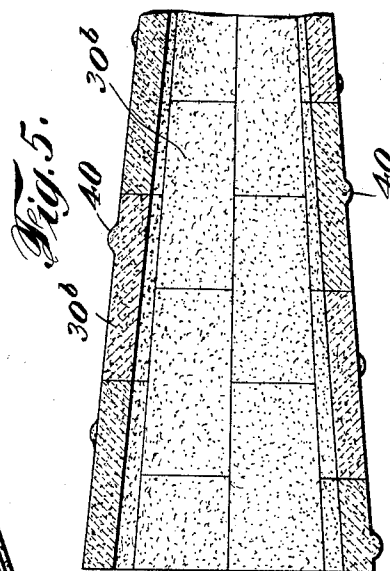
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INVENTOR
Robert A. Moore
John Mitchell,
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Meyers & Jones
ATTORNEY

UNITED STATES PATENT OFFICE

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EXHAUST MUFFLER

Robert A. Moore and John Mitchell, New York,
N. Y., assignors to M. & M. Engineering Cor-
poration, a corporation of New York

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10 Claims. (Cl. 181—50)

Our invention relates to exhaust mufflers for internal combustion engines, and has two principal objects:

To greatly reduce or eliminate back pressure, and at the same time to greatly reduce audible sound produced by the exhaust.

The sound reducing effect is obtained largely by providing in the muffler casing a liner of non-resonant material or composition, which may also be of porous character, having a high sound absorbing or deadening effect and being also of such character or composition that it has adequate mechanical strength and especially is refractory and resistant to hot gases to a high degree, thus providing the necessary durability at high temperature; and by so controlling or directing the entering gases that they are caused to impinge upon or flow directly in contact with the inner surface of the liner without appreciably retarding the gas flow, so as not to create any appreciable back pressure.

The gas controlling means may vary considerably. It has the principal characteristics of directing, dividing, or otherwise controlling flow of gas in such manner that exhaust explosion sounds are largely reduced without producing appreciable back pressure; and when such gas controlling or directing means is employed in conjunction with a liner of the character also here disclosed, the liner so further absorbs or reduces the explosion noise that in the complete structure the reduction of exhaust noise is equal to or greater than that secured with the best mufflers heretofore known, and with the added important and economic advantage of practical or complete elimination of back-pressure upon the engine.

In mufflers heretofore proposed or used, noise reduction has been accomplished by various means and sometimes to a practically satisfactory extent, but this desired result has been obtained with the concurrent disadvantage of producing very substantial back pressure, which, especially at the higher speeds or throttle openings, imposes a very substantial back pressure, amounting to a parasitic load upon the engine, adversely affecting cinder scavenging, proper carbureter adjustment for maximum efficiency, increasing fuel consumption, etc., as well understood by automotive engineers. This is principally because mufflers which have desired silencing effect usually or always depend upon the use of successive chambers, baffles or equivalent or other means which more or less positively impede the gas

flow and produce the undesired back pressure effect.

The present invention provides gas flow controlling or directing means which in itself has substantial silencing effect, without appreciable back pressure, and additionally provides a casing liner having further silencing effect, so that the combined result or effect is silencing the exhaust to a satisfactory or increased degree with practical elimination of back pressure.

While the two principal features, namely, the gas directing means and the silencing liner, are preferably employed in combination for optimum results, in some cases either principal feature may be employed alone; thus, the gas controlling or directing means as here disclosed, or its equivalent, may be employed to produce substantial silencing effect without any back pressure, or the silencing liner may be employed with any of a wide variety of gas flow directing means to produce improved silencing effect, with or without back pressure in a range considered permissible in approved automotive practice up to the present time.

While, as above stated, the gas flow directing means and the silencing liner may both vary substantially, in the present specific embodiment, as briefly described, the desired results are produced by providing a muffler casing or chamber, which in a preferred case is of a generally conical form, and a series of telescoped or nested and gas-directing tubes extending toward the discharge end of the casing, the tubes having spaced walls and being provided also with apertures and angular fins or baffles which provide for progressive outward radial movement and expansion of the gas in the forward part of the casing, and also a spiral or whirling movement, and also provide for progressively diminishing volume substantially proportionally to the reduction in pressure and volume of the gases as they cool and move toward the discharge aperture at the rear end. The controlling tube, aperture and deflecting fin arrangement is such that the explosion impact effect of gases entering at the front of the casing is effectively damped or broken up with substantial reduction in externally audible sound and without producing any substantial or measurable retardation of the gas flow, or in other words, without producing measurable back pressure, even at high engine speeds or with full throttle opening.

We also provide in preferred cases, in conjunction with the other features referred to, a lining in the casing, which is preferably of coherent,

self-supporting form, such as a molded porous composition of a generally non-resonant character, having a sound deadening effect, and which is refractory and highly resistant to heat. Preferably this lining has its inward surface directly exposed to the gases. Aside from the porous characteristic, the lining material may be of a character generally similar to fire-brick as used in high temperature furnaces, or may be composed principally of such material as broken or pulverized pumice, furnace slag, cinders or a mixture of such materials, with a suitable binder, such as fire-clay, rutilite, aluminum, cement, pulverized calcined gypsum or any other material having sufficient refractory or heat resisting capacity to withstand high temperatures and flame. Also when the broken or comminuted material is of porous character, the binder is of a character which will not fill the pores or interstices of the completed body, but will preserve its generally porous character. When a refractory lining material having substantial porosity is employed, there is an important sound-deadening effect produced by the absorption of sound waves in the interstices of the material; and whether porous or not, suitable refractory material such as pumice, cinders, fire-brick, etc., is of generally non-resonant character as compared with metal, and materially reduces externally audible sound by absence of any resonant response to the explosive impacts.

Preferably also the liner is spaced moderately but substantially from the outer wall of the casing, providing a dead gas space into which when the material is porous, a substantial part of the exhaust gases pass through the wall of the liner still further reducing the audible noise. This gas may be discharged at the rear end of the dead space, to pass out with the other gases at the discharge opening of the casing.

The characteristics and advantages of the invention are further sufficiently explained in connection with the following detailed description of the accompanying drawings, which show a representative embodiment. After considering this example, skilled persons will understand that many variations may be made without departing from the principles disclosed, and we contemplate the employment of any structures that are properly within the scope of the appended claims.

Fig. 1 is a longitudinal section of a muffler embodying the invention in one form.

Fig. 2 is an enlarged section at 2—2, Fig. 1.

Fig. 3 is a section at 3—3, Fig. 1, on a still larger scale.

Fig. 4 is a perspective view of two liner sections constituting a complete liner in one form.

Fig. 5 is a longitudinal section of another form or type of liner.

In Figs. 1 to 3 the muffler has an outer shell or casing 10 of sheet metal which is preferably, though not necessarily, of rearward tapering or conical form. At the front end is a front plate or header 11 connected to the shell in any suitable way as by a flange 12 into which the front end of the shell telescopes and is secured as by riveting, brazing, etc. The front plate has a tubular extension 13 to fit over the rear end of the exhaust pipe 14 on which it is secured by any suitable means such as the split or band clamp 15 and bolt 16. The rear end of the casing is closed by an end plate 17, having a central tubular extension 18 to receive the forward end of a

discharge pipe 19, to which the tubular member 18 is secured as by a clamp 20.

Extending from the front plate or header, rearwardly within the casing is a series of partially nested or telescoped gas flow controlling tubes, the number of which and also the particular arrangement relative to each other and to other parts of the muffler, may vary considerably. In the example shown there are three gas controlling pipes or tubes, namely, an inner tube 21 of moderate diameter, a next outward or intermediate tube 22 of large diameter, and an outer tube 23 of still larger diameter, all the tube walls being substantially spaced apart, and the tube diameters being usually graduated uniformly from smallest to largest diameters, with regard to the cross sectional area of the casing, and with allowance for a casing liner, when the liner is employed.

The tubes are of different lengths, the inner tube being longest and extending a substantial distance from the front of the casing, and usually terminating as shown, at a point or in a transverse plane relatively near the rear end of the casing, but substantially forward therefrom; and this tube is of a length and diameter in relation to casing dimensions such that its rear end is spaced substantially from the inner surface of a liner, such as 30, when a liner is employed, or in the absence of a liner, the relative casing and tube dimensions will be so adjusted that the rear end of the tube is spaced substantially from the casing wall. In a similar way the progressively outward tubes 22 and 23 are shorter, terminating at points or in planes such that the tube ends will be spaced substantially from the surface of the liner or casing. The forward ends of all the tubes may be located close to the header or front plate 11, and may be supported thereon and in spaced relation to each other in any suitable way, as by a spider structure and the rearward ends of the tubes may be supported and relatively spaced by similar means. When deflecting blades or fins are employed, as later referred to, these provide for relative tube support, and spacing throughout their lengths, as will appear.

In the particular arrangement shown, the forward end of the outer tube 23 is secured to the inner face of the front plate or header 11, as by brazing or otherwise. The front ends of the other tubes are located progressively slightly rearwardly from the front end of the outer tube, and may be supported by the fins of the relatively outward tubes, and may also be secured to the forward fins of such tubes, as by brazing, to prevent relative longitudinal movement.

Preferably each tube is provided with a multiplicity of apertures such as 32, these being preferably arranged in spiral rows or series, and preferably also at each or all of these holes is a deflecting blade or fin 33 which conveniently consists of the metal partially excised from the tube in forming the hole, this metal tongue being usually of truncated triangular form and bent inward substantially radially, and also being so located by the cutting operation, or bent, that it is angularly inclined to the transverse plane of the muffler, thus providing for angular deflection of the spiral flow of gas discharged through the various tube apertures.

It will now be evident that when the tubes are provided with apertures and fins, the ends of the fins of each outward tube may be located against the surface of the next inward tube and

so properly support and space the tubes apart. The fins of the inner tube terminate, as shown in Figs. 2 and 3, at suitable points relatively near the tube center.

5 Preferably, although not necessarily in all cases, the rear end of the inner tube is closed, and preferably this closure consists of an elongated or conical sheet metal cap 34 providing for substantially stream-line flow of gases between the
10 tube end and the liner or casing wall, as the case may be.

As so far described, in operation, hot gases entering the front end of the muffler at high velocity and with impact effect, due to the quick release of the burning gases under high pressure
15 from the engine cylinders, pass into the forward ends of the directing tubes, the total gas stream being divided to flow through the center tube and through the cylindrical chambers
20 between the tube walls, to the rear ends of the tubes, where the total volume of gases are recombined and flow past the conical end of the inner tube to the discharge aperture. At the same time when the tubes are perforated, the
25 expansive gas passing through each tube passes out through the tube aperture into the next outer tube and so on, the gases discharged through the apertures at the outer tube of course being discharged into the space between that tube and
30 the liner or casing shell, as the case may be. In this way the velocity and impact effect of the entering gas is broken up and dissipated into a multiplicity of outwardly and rearwardly directed annular columns and radial streams with
35 marked reduction of audible sound and gradual reduction of gas volume rearwardly to a discharge point.

At the same time, when the angular deflecting fins are employed, as shown, the relatively small
40 jets of gas issuing through each tube orifice are deflected tangentially and rearwardly, producing a spiral centrifugal flow of all the gases and still further tending to reduce externally audible sounds, cool and reduce the volume of gases, and
45 avoid any or any appreciable back pressure.

It has been found in actual test in comparison with other or standard types of mufflers, usually of the successive chamber type, and under identical conditions, that with the ordinary muffler
50 applied to a vehicle running at medium or high speeds, there is a very substantial gauge pressure in the exhaust pipe ahead of the muffler; whereas under the same conditions the present muffler when subjected to similar gauge test shows
55 no pressure in the exhaust pipe, thus indicating practically complete absence of back pressure with corresponding avoidance of unnecessary load imposed upon the motor, increase in efficiency, fuel saving, etc., as well understood by automotive experts without further explanation.

Desirably, although not necessarily in all cases, to additionally reduce back pressure and noise, and for other purposes, as sufficiently referred to above and hereafter, a casing liner is provided of which the liner 30 of Figs. 1 to 3, is one
60 preferred example. Preferably, this liner extends throughout the length of the casing, and is of a general non-resonant, non-metallic, refractory character, and of substantial thickness, for the sake of mechanical strength, durability, and also to provide a sufficient body of non-resonant sound absorbing and heat resisting material. The liner may be of the general nature of a fire
70 brick as used in high temperature furnaces, or may be of comminuted or pulverized material,

mixed with a suitable binder, molded and heat treated.

The binder may be of any suitable material having requisite refractory capacity and adapted to retain the component materials in molded or
5 block form, and also when the liner is of porous character, the binder is also porous or of such nature that it does not interfere with the porosity of the complete line or wall. Among suitable binders, are those above referred to including
10 fire-clay, rutile, aluminum, cement, Portland cement, pulverized calcined gypsum.

Desirably, although not necessarily, the liner is of porous character, admitting a substantial amount of gas flow through its body with in-
15 creased sound absorbing and a pressure reducing effect. Suitable mixtures of pumice, slag, cinders and analogous materials provide desired porosity.

Preferably, the liner is spaced substantially from the casing, as by flanges, lugs or knobs 40,
20 provided in conveniently spaced relation on the outer face of the unitary liner or of its component parts, thus providing a substantial annular or conical dead gas space 41 of moderate but substantial volume, between the liner and
25 the casing or shell 10, this gas chamber extending substantially throughout the length of the casing. When the liner is of a porous character, a substantial amount of the gases impinging directly on its inner surface, pass through and into
30 the dead gas space and so to the rear thereof, where the rear end of the liner or of its rearward section or members may be provided with lug formations or slotted, as at 42, to permit the gases to pass into the main gas stream and be
35 discharged through the discharge fitting 18.

The liner may be in one continuous piece, or as shown in Fig. 1, may consist of a plurality of sleeves or tubular sections of frusto-conical form with their ends abutting, and tightly held in
40 place by engagement with the casing 10 and by engagement of the front end of the forward section with header 11 and engagement of the lugged or slotted rear end of the rearward section with the rear end of the plate 17.
45

Otherwise, as shown in Fig. 4, the liner may consist of two sections 30a, each of semi-frusto conical form, and these sections will be properly held in place by engagement with the casing; or, as shown in Fig. 5, the liner may consist of a plurality of relatively small or moderate
50 sized blocks 30b cemented together, or held in place by engagement with the casing parts, in a manner generally similar to the placement of a fire brick liner in a furnace.
55

While the muffler casing and liner as shown and as described in detail, are of conical form, in a broader aspect of the invention it is not limited to this specific form of casing or liner. Thus, and as provided for in the scope of certain
60 of the claims, the casing may be of generally cylindrical form and the liner of substantially corresponding form or shape.

The non-metallic, non-resonant lining material herein referred to, may consist of a baked or
65 otherwise formed clay, or similar material, which has pores or interstices formed therein in any approved way so as to render the material sufficiently porous to accomplish the results stated.

It is understood that we do not wish to limit
70 ourselves to any specific non-metallic materials, nor to any specific way of forming the pores or interstices therein.

The broad idea of this invention resides in providing an exhaust muffler or silencer with a
75

non-resonant and non-metallic liner for the purposes set forth, and this, irrespective of the particular construction of the muffler itself, and whether provided with the herein-described spaced tubes or not.

We claim:—

1. An exhaust muffler comprising a casing and a plurality of concentric spaced gas controlling tubes therein extending substantially from the inlet end of the casing toward the outlet, the rear ends of the tubes being located with respect to the successively outward tubes, at progressively greater distances from the inlet end of the casing, the inner tube terminating at a point relatively near the rear end of the casing but substantially forward thereof, and means on said tubes for imparting a whirling motion to the gas.

2. An exhaust muffler comprising a substantially conical casing and a plurality of concentric spaced gas controlling tubes therein extending from near the forward end of the casing to progressively rearward points therein, the tubes having each a plurality of gas apertures, the tubes also having at the apertures substantially radial gas deflecting fins in angular relation to transverse planes, providing for spiral gas flow.

3. An exhaust muffler comprising a casing and a liner therein of generally non-metallic, non-resonant, refractory material, the liner being spaced from the casing wall to provide a dead gas chamber, the liner having at its rearward end formations providing communication between said gas chamber and the rear discharge tube of the muffler.

4. The structure defined in claim 2 with the addition of a liner in the casing, exposed to gas-contact, and composed of generally non-metallic, non-resonant, refractory material.

5. An exhaust muffler comprising a casing, a plurality of concentric spaced gas controlling tubes therein extending from near the forward end of the casing to progressively rearward points therein, said tubes having different diameters, decreasing from the inlet end to the outlet end of the muffler, the innermost tube terminating adjacent the outlet end of the casing, said inner tube having a rear end closure, and each tube having a plurality of apertures arranged in spiral rows.

6. A muffler for the exhaust gases of internal combustion engines comprising an infusible and incompressible cellular fired clay body having relatively large intercommunicating cells as distinguished from the pores of ordinary fired clay

bodies and having a waste gas passage extending therethrough, and means for connecting said body to an exhaust manifold at one end and an exhaust pipe at its other end.

7. A composite muffler for the exhaust gases of internal combustion engines comprising a housing having end passages for the exhaust gases and having a core of self-sustaining cellular fired clay body, said core being preformed to fit into the housing and having a gas passage extending there- through communicating with the end passages of said housing, the cell structure of said core consisting of relatively large intercommunicating cells as distinguished from the pores of ordinary fired clay bodies.

8. An exhaust muffler comprising a casing, a plurality of concentric spaced gas controlling tubes therein extending from near the forward end of the casing to progressively rearward points therein, the innermost tube terminating adjacent the outlet end of the casing, said inner tube having a rear end closure, and each tube having a plurality of apertures arranged in spiral rows, the tubes being provided adjacent said apertures with means to deflect the gases and impart a spiral motion thereto.

9. An exhaust muffler comprising a casing, a plurality of concentric spaced gas controlling tubes therein extending from near the forward end of the casing to progressively rearward points therein, the innermost tube terminating adjacent the outlet end of the casing, said inner tube having a rear end closure, and each tube having a plurality of apertures arranged in spiral rows, and a liner of porous, non-resonant, refractory, sound absorbing material surrounding the tubes and disposed in spaced relation thereto within the casing.

10. In a muffler for the exhaust gases of an internal combustion engine, said muffler having an inlet and an outlet, a block of refractory, cellular, ceramic material having relatively large intercommunicating cells as distinguished from the pores of ordinary fired clay bodies and formed with a gas escapement passage extending therethrough, the wall surface of said passage being formed entirely by said cellular ceramic material for direct contact by the exhaust gases and the cross sectional area of said passage being at least as great as the cross sectional area of the inlet and outlet passages.

ROBERT A. MOORE.
JOHN MITCHELL.