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(12) # EUROPEAN PATENT APPLICATION

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(71) Applicant: **GILMAN (PTY) LTD.**
15 Hagart Road
Pinetown(ZA)

(72) Inventor: **Schultz, Richard Dehane**
8A Woodlands Avenue
Westville Natal(ZA)

(74) Representative: **Brown, John David et al,**
FORRESTER & BOEHMERT Widenmayerstrasse 4/I
D-8000 München 22(DE)

(54) **Exhaust system.**

(57) An reverse type silencer (10) is combined with a resonance type silencer (20). The resonance type section has a core (22) housed in a shell (26) and filled with a sound absorbing material. Open notches (24) are spirally arranged in the core (22) and include downwardly depending lips (28) forming openings to incoming wave forms. Second waves passing the silencer are reflected and attenuated to dampen noise.

Croydon Printing Company Ltd.

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"Exhaust System"

FIELD OF THE INVENTION

This invention relates to an exhaust system and in particular to an absorbtion type silencer for an exhaust system.

BACKGROUND OF THE INVENTION

Absorbtion type silencers are known which comprise a cylindrical body having a plurality of holes, the space between the outside of the body and the inside of the cover containing sound absorption material such as a glass or ceramic fibres.

It is an object of the present invention to provide an arrangement which is more effective in absorbing exhaust noise.

THE INVENTION

According to the invention a silencer includes a cylindrical body including a plurality of open notches in its surface.

The notches may be of any shape, but are preferably cut transversely and a curved portion pressed into the surface to constitute a downwardly-depending lip. The curved portion may be directed forwardly or rearwardly.

In a preferred form of the invention the notches constitute less than 30 percent of the surface area and are arranged in the form of a number of spirals longitudinally of the body. They are grouped together so that longitudinally adjacent notches are of the order of 10 mm apart. This arrangement ensures that portions of wavelengths or groups of wavelengths of sound are collected by at least one or a group of notches, whence the waves pass into the sound absorbing material to be absorbed in part and, in some and often most cases, become out of phase when reflected back into the body, thereby attenuating or altering the wave pattern of incoming waves. Attenuation also results from the inertia of the gas in the notches. The spiral formation also causes a reduction in turburlence at high gas velocities.

The silencer of the invention may be used as such but it is preferred, particularly for high volumes of exhaust to provide a secondary silencer compartment, which is preferably located on the downstream side of the silencer as described above.

According further to the invention this secondary silencer includes a core located centrally in a cover, the cover terminating in a curved formation, the core having two portions, the first portion including openings flanking the second portion, and the second portion having rearwardly (having regard to the flow of exhaust gas) facing openings flanking the first portion.

The end of the second portion may be fixed in the curved termination of the cover. In this manner, the gases issuing from the first portion pass the second portion and are reflected by the curved termination, and then enter the rearwardly facing openings of the second portion for passage to atmosphere.

In a preferred form of the invention, the openings are formed by pinching (without altering the effective cross-sectional area) the ends of adjacent cylindrical bodies and then joining the bodies with the resulting openings located in opposite directions and at right angles to each other.

A plate may separate the first absorbtion type silencer compartment with the second.

Sound waves entering the second compartment will be diverted by the first openings and will be reflected by the curved termination (which may be convex or concave). The reflected waves will serve to attenuate forward

moving waves both as regards angle and phase. Further loss of wave intensity occurs by viscosity and friction loss, and still further attenuation occurs by reason of transfer of wave energy through the diaphragm or plate separating the compartments.

In a preferred form of the invention, the second portion of the core of the second compartment includes a plurality of holes which serve to bleed off excess pressure in the plenum section of the silencer and also to assist in the attenuation of sound waves.

EMBODIMENT OF THE INVENTION

An embodiment of the invention is described below with reference to the accompanying drawing which is an exploded perspective view of a silencer according to the invention.

In the drawing the absorbtion type silencer is combined with a reverse type silencer, the latter being indicated by the reference 10 while the resonance type silencer is indicated by the reference 20.

Dealing firstly with the resonance type section of the combined silencer, it comprises a core 22 which is housed in a shell 26, the space between the core and the shell being filled with suitable sound absorbing material such as glass or ceramic fibres.

The essence of the invention is the provision of open notches 24 in the wall of the core 22, the notches being formed by making a transverse cut 27 and pressing out downwardly depending lips 28, thereby forming a series of openings to the incoming wave forms. It will be appreciated that the physical laws governing sound waves apply and the similarity to wind musical instruments is apparent. Thus, certain wave forms will pass through one or more of the notches depending on the distance of the particular notch or group of notches from the opening of the core. These waves are then attenuated in the sound absorbing material, and the wave form returning to the core will be out of phase when the distance between notches is an appreciable fraction of the wavelength, thus serving to attenutate other wave forms having common characteristics.

As an alternative arrangement the downwardly depending lips may be pressed down on the downstream side of the transverse cut.

Holes placed at small fractions of a wavelength behave as a single hole at a single point but more efficiently. The notches also behave as side branches, not only orifices, as due to the forming action they have an effective depth. The presence of this depth causes the acoustic impedance at the junction to differ from the characteristic for plane waves in a pipe, and consequently a reflected wave is produced. A portion of

the incident acoustic energy is also transmitted into and dissipated in this branch. Both these factors contribute to a reduction in acoustic energy transmitted through the portion of the pipe lying behind the branch or branches.

The notches are preferably arranged spirally as described above.

In the embodiment of the invention the absorbtion type silencer section is followed by a reverse type section 10 which comprises a pair of cylindrical portions 12,14 the meeting ends of which are pinched as shown and overlap as shown, slots having been provided for this purpose. A plurality of holes (not shown) may be provided in the cylindrical portions 12,14.

The shell 30 (which may be integral with shell 26) of the reverse type silencer section has curved termination 32, formed by pinching the end of the cylinder forming it. The end of portion 14 extending through the orifice 34 in the shell 30.

The pinching of the portions 12,14 results in the formation of openings 16 in portion 12 and 18 on portion 14, these openings flanking the respective portions. The exhaust gases and sound waves entering this section of the combined silencer have two routes - a first route through the centre of the two portions where the

pinching causes the formation of a restriction in the form of a cross and a second route through the flanking openings from where the gases and the sound waves impinge on the curved termiation 32. It will be appreciated that shapes other than a cross may be formed depending on the alteration of the cross-section. The restriction also causes a reduction in sound energy by altering the impedance of the system.

The reflected gases and sound waves then move rearwardly from a number of different points on the curved termination, some of the gases finding their way through the openings 18 and thence to atmosphere. The reflected sound waves attenuate some of the incoming sound waves, and others impinge on the diaphragm 40 between the two sections of the combined silencer, and are transmitted through the diaphragm to this section in which they are damped by the absorbtion medium.

The features disclosed in the foregoing description, in the following claims and/or in the accompanying drawings may, both separately and in any combination thereof, be material for realising the invention in diverse forms thereof.

1.

A silencer characterised in including a cylindrical body having a plurality of open notches in its surface.

2.

A silencer according to claim 1 characterised in that the notches are formed transversely into the cylindrical body and a curved portion thereof extends into the surface to constitute a downwardly depending lip.

3.

A silencer according to claim 1 or claim 2 characterised in that the notches constitute less than 30 percent of the surface area and are arranged in the form of a number of spirals longitudinally of the body.

4.

A silencer according to any one of claims 1 to 3 characterised in having a secondary silencer including a core located centrally in a cover terminating in a

curved formation, the core having two portions, the first portion including openings flanking the second portion and the second portion having rearwardly (having regard to the flow of exhaust gases) facing openings flanking the first portion.

5.

A silencer according to claim 4 characterised in that the openings are formed by pinching the ends of adjacent cylindrical bodies and then joining the bodies with the resulting openings located in opposite directions and at right angles to each other.

6.

A silencer according to claim 4 or claim 5 characterised in that the core of the second compartment includes a plurality of holes to bleed off excess pressure in the plenum section of the silencer.

7.

A silencer according to any one of claims 4 to 6 characterised in that the first and second sections are separated by a plate.

8. A silencer substantially as herein described with reference to the accompanying drawing.

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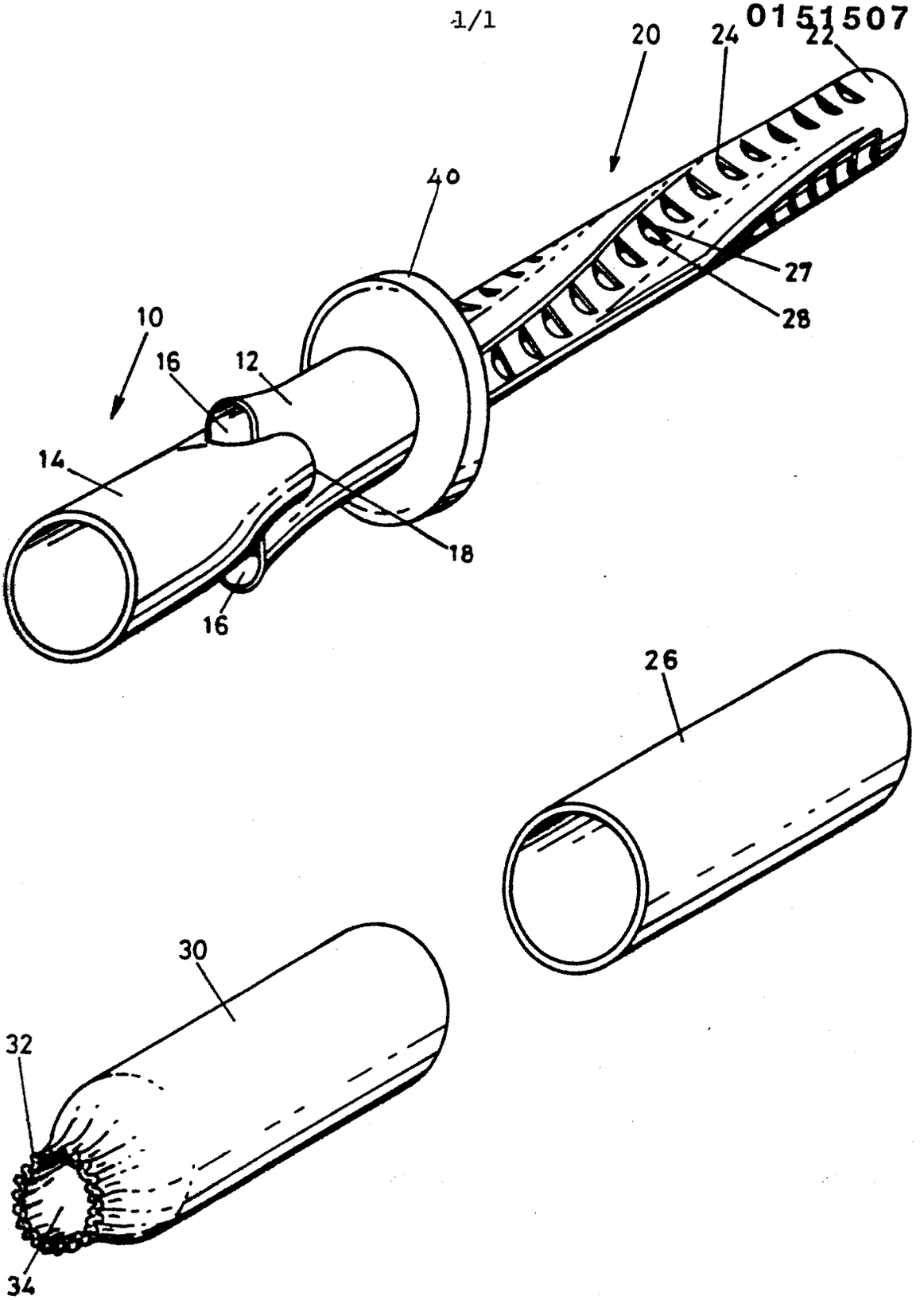

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EUROPEAN SEARCH REPORT

0151507
Application number

EP 85 30 0041

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-4 184 565 (PRICE) * Column 2, line 55 - column 3, line 64; figures 1-3,5 *	1,2	F 01 N 1/10 F 01 N 7/18
A		3	
A	US-A-4 140 204 (WILSON) * Column 3, line 30 - column 5, line 12; figures 1-4 *	1-4,6	
A	US-A-4 278 147 (WATANABE) * Column 4, line 50 - column 5, line 11, figure 3 *	4,7	
A	FR-E- 49 204 (WILMAN) * Page 1, line 46 - page 2, line 23; page 3, lines 22-64; figures 1,8-11 *	4	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

F 01 N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15-04-1985	HAKHVERDI M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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