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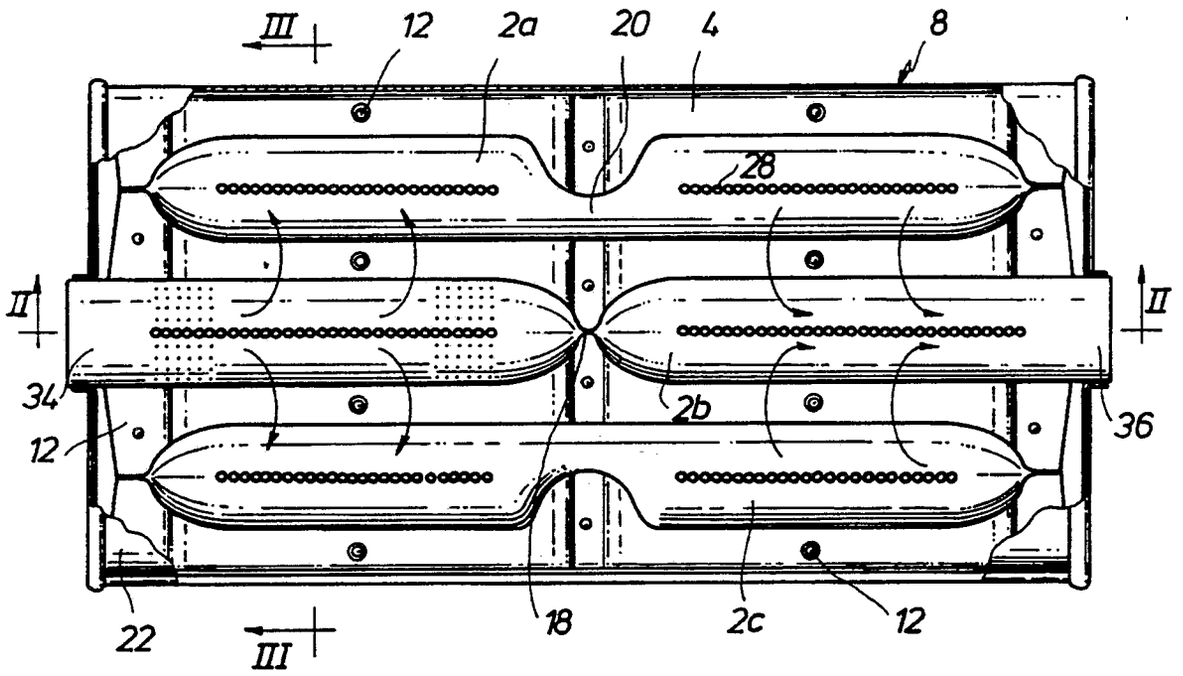
(54) Silencer for automobile exhaust systems.

(57) The silencer comprises two or more adjacent parallel tubular passages (2a, 2b, 2c) in which there is at least one flow restriction (18, 20) in the longitudinal direction; each tubular passage (2a, 2b, 2c) is in communication with one or more adjacent tubular passage by means of a longitudinally elongate slot (14).

FIG. 1



EP 0 389 401 A1

SILENCER FOR AUTOMOBILE EXHAUST SYSTEMS

The invention relates to a silencer for automobile exhaust systems comprising at least two adjacent tubular passages defining mutually parallel longitudinal orientations, there being at least one at least partial flow restriction in said passages.

An automobile engine exhaust system basically comprises a tube conveying the exhaust gases from the engine exhaust manifold to the rear of the vehicle for release to the atmosphere. Along the tube there are placed one or more silencers having the mission of damping the sound pressure wave to achieve attenuation of the noise due to the explosions in the engine down to the maximum levels allowed by current regulations.

Automobile silencers are based on several more or less efficaceous systems, one of the most usual being the so-called absorption system consisting of a container completely or partly full of mineral wool through which one or more perforated tubes conveying the engine exhaust gases pass, such that the sound waves contact said wool through the perforations and the waves, mainly the high frequency ones, are absorbed.

Another widely used system is the so-called reflection system which manages to brake the speed of the gases and, therefore, damp the sound waves by subjecting the gases to successive restrictions and expansions by way of chambers connected together by tubes, perforations, channels, etc. This system has the advantage of not requiring absorbent wool, which suffers from the drawbacks of cost and duration, but is less effective acoustically and is more complex to manufacture in view of the larger number of parts required to form the successive expansion chambers. This system also offers a greater resistence to the exhaust gas flow, whereby there is a higher backpressure representing a loss of engine power.

There is another mixed type system which is a combina tion of the previous two, i.e. absorption and reflection in which there is a series of expansion chambers and absorption areas. This system is usually the most effective as far as the acoustic performance is concerned, although it is more expensive and complicated.

The invention seeks to provide a gas flow system allowing absorption, reflection or mixed silencers to be built with a simpler structure in comparison with the known systems and which, therefore, allows a considerable cost reduction to be obtained.

The above object is achieved with a silencer of the type first mentioned above characterized in that each tubular passage is in communication with at least one other adjacent tubular passage by way of at least one longitudinally elongate slot.

Further features of the invention will be appreciated from the following description in which, without any limiting intention, there are described preferred embodiments of the invention, with the reference to the accompanying drawings in which:

Figure 1 is a plan view of one embodiment of the silencer of the invention, the shell having been shown partly broken away and without showing either the absorbent material or the layer of metal filaments.

Figure 2 is a cross section view on the line II-II of Figure 1, schematically showing the shell, the absorbent material and the layer of metal filaments.

Figure 3 is a cross section view on the line III-III of Figure 1, showing the same items as Figure 2.

Figure 4 is a schematic plan view of a silencer with three tubular passages, showing different possibilities of gas flow routes.

Figure 5 is a similar view to the previous one but of a silencer with two tubular passages.

Figures 6 to 10 are similar cross section views to that of Figure 3, of other embodiments.

Figure 11 is a cross section view of two tubular passages in communication through a slot.

The automobile vehicle exhaust system silencer described comprises, in a known way, two or more adjacent tubular passages 2a, 2b, 2c defining respective longitudinal orientations determined by the ideal axis of the passage (or, as the case may be, centre line) and said orientations are mutually parallel. Preferably these longitudinal orientations are straight and in this case the respective axes are parallel lines. Nevertheless the invention also relates to cases in which said tubular passages may have an elbow or curved portion. In the latter cases the respective centre lines are generally parallel over the straight portions thereof and are generally concentric over the curved portions thereof.

The silencer preferably comprises a first sheet-like structure 4 (which is the only one seen in Figure 1) and a second sheet-like structure 6, which may be formed by swaging and die stamping, which are superimposed and connected generally symmetrically, forming a unit 8. Both structures 4, 6 are preferably identical and the two structures when connected together are practically completely symmetrical.

Each structure 4, 6 is provided with concave portions 10, shown in Figure 3, such that when the said concave portions 10 of both structures are placed face to face they form the tubular passages

2a, 2b and 2c of the unit 8. Each structure is furthermore provided with contact areas 12, such that when the contact areas 12 of both sheet-like structures 4, 6 are superimposed and fastened together, the structures are united, forming the unit 8. The fastening may effected by welding, by pins, bolts or the like and may also be effected or terminated by crimping (Figures 7 and 9).

Also in a known way the silencer comprises at least one flow restriction for the gas flow in the longitudinal direction. Such restrictions may be partial or complete and hinder or prevent the longitudinal flow, causing the gases to flow laterally, due to the existence of communication arrangements adjacent tubular passages.

These communication arrangements are longitudinally elongate slots 14 formed by narrow spaces between facing portions 16 of both sheet-like structures. The portions 16 extend between two adjacent concave portions 10. The facing portions are preferably curved in cross section, the convex section of which is directed towards the corresponding facing portion, i.e. so that the convex side of the curve is close to the facing portion, forming a limit for the slot 14. This configuration of the slot 14 as a space limited by two convex surfaces improves the aerodynamic behaviour of the gas flow.

In turn the flow restrictions which, as stated above, may be total restrictions 18 or partial restrictions 20 (Figure 1) are preferably formed by flattening the portions of the concave portions 10 against each other. These flow restrictions 18, 20 obviously also aid in the connection between the sheet-like structures 4, 6.

In the arrangement described above the gases are caused to flow crosswise to the natural direction, whereby said gases are subjected to substantial lamination since they have to flow through a long relatively narrow slot 14. This lamination of the gases has a good acoustic effect of itself and at the same time has a better behaviour relative to the back-pressure than other flow restriction systems.

Thus, according to such principle, two or more tubular passages 2a, 2b, 2c, communicated together at the sides by slots 14 having dimensions appropriate to the engine cubic capacity form one stage of the sound damping process, since the gases flow easily through the slots 14 but the sound waves are damped. Once through the slot 14, the gases enter an adjacent tubular passage and undergo expansion, whereby one reduction-expansion cycle typical of a reflection system is completed. This reduction-expansion cycle is repeated several times by the system to achieve the desired damping.

The width of the slots 14, i.e. the distance between the portions 16 defining them, preferably lies between 1 and 6 mm. They may be substantially as long as the element 2 itself, although there may be interruptions formed by the contact areas 12 of the facing portions 16; all of this further to the restriction implied by the necessary existence of a total flow restriction 18.

The results obtained with the silencer of the invention improve with the use of a sheet-like shell 22, in the form of a circular, oval or generally elliptical section tube, which may be formed from a tube or by bending a flat metal sheet and subsequently joining the edges, for example, by crimping 24.

To attach the unit 8 inside the shell, it is contemplated that each longitudinal edge of the unit 8 is provided with a pair of diverging fins 26, which are press-fitted against the inner surface of the sheet-like shell 22, the connection being completed, for example, by spot welding.

The walls of the tubular passages 2a, 2b, 2c of a unit 8 contained within a sheet-like shell 22 are preferably provided with a large number of closely spaced aport perforations 28. Figure 1 shows only a few rows of perforations in each tubular passage wall for greater clarity of the drawing, but they extend over practically all the surface of the concave portions 10 forming the tubular passages 2a, 2b, 2c.

The silencer is improved, in certain cases, by the use of an absorbent material 30 filling the space between the unit 8 and the sheet-like shell 22. The space may be completely filled, as shown in Figures 2, 3, 6 and 7 or partially filled, as shown in Figures 9 and 10. In the latter case the absorbent material completely fills half the space between the shell 22 and the unit 8.

The absorbent material has notable soundproofing properties and is formed by mineral wool fiber, metal swarf, porcelain or ceramic granules or other appropriate materials. With the said perforations and the absorbent material, a mixed reflection-absorption system is obtained in the silencer.

Since the absorbent material suffers serious aggression from the exhaust gases, there is contemplated the use of a layer of metal filaments 32 adapted to the outer surface of the unit 8, between the latter and the absorbent material 30. As stated above, the invention also comprises a silencer as shown schematically in Figure 8, that is without absorbent material between the unit 8 and the shell 22. The gas flow from one tubular passage to another through the respective perforations also notably damps the effects of the exhaust noise.

A particularly preferred embodiment of the invention is shown in Figures 1 to 3. Therein there is a central tubular member 2b having a straight orientation, provided with perforations 28 and hav-

ing the end 34 thereof in communication with the engine from which it receives the gases, which are blown out through the opposite end 36. Intermediate the central tubular member 2b there is a complete flow restriction 28, forming two semipassages.

Each of said semipassages is provided with elongate slots 14 placing each semipassage in communication with two lateral tubular passages 2a, 2c, also having a straight orientation and also provided with perforations 28. The lateral tubular passages are closed at both ends and are preferably provided with respective partial flow restrictions 20, situated adjacent the complete flow restriction 18.

The unit 8 is connected to a corresponding shell 22 by way of the edge fins 26, there being within the shell an absorbent material 30 protected by a layer of metal filaments 32. As shown by the arrows of Figure 1, the gases flowing from the engine enter through the end 34, flow along the leading semipassage 2b and, on finding the passage blocked by the flow restriction 18, the flow through the slots 14 into the lateral tubular passages 2a and 2c. Through the latter again through the slots 14, they attain the trailing semipassage 2b from where they flow to the outside.

Other possible gas flow routes between adjacent tubular passages are shown as a guidance in Figures 4 and 5.

Figure 4 shows a set of three tubular passages 2a, 2b and 2c with a gas inlet 34 through the first and exit 36 through the third, with all the remaining combinations both for the inlet and for the outlet of gases being possible.

In Figure 5 the set comprises two tubular passages 2a and 2b with inlet 34 and outlet 36 in the former.

In the Figure 4 embodiment the tubular passage 2b has a complete flow restriction 18, whereas the other two tubular passages 2a and 2c have a partial flow restriction 20, with other combinations also being possible. In the Figure 5 example there is only one flow restriction 18 in passage 2a, closing it completely.

Other possible embodiments, to some of which reference has already been made, are shown in Figures 6 to 10. Thus, Figure 6 shows a silencer in which the unit 8 is formed by a first sheet-like structure 4 and a second sheet-like structure 6 which are shaped in such away that the communication slot between the tubes causes a turbulence in the gases which, in certain cases, may improve the absorption of the sound waves.

Figure 7 shows a unit 8 in which the tubular passages are different, with the lateral passages 2a and 2c being rectangular and the centre passage 2b circular. These last two embodiments have absorbent material between the unit and the shell, with edge fins 26 to be seen in Figure 6 and not in Figure 7.

Figure 8 shows a silencer with tubular passages and shell like the one shown in Figure 3, but without absorbent material.

In turn, Figures 9 and 10 show silencers in which the absorbent material is only in centre spaces (Figure 9) or in an upper half of the space (Figure 10), it being appreciated in Figure 9 that the lateral tubular passages are different from the centre one.

The invention contemplates other embodiments not shown, including among them combinations of the embodiments shown in Figures 3 and 6 to 10.

Figure 11 schematically shows a very simple embodiment, formed by two tubes 2a, 2b along which respective elongate apertures 40 forming a slot 14 have been made. These apertures are closed by corresponding peripheral weld beads 42.

Claims

1.- Silencer for automobile exhaust systems comprising at least two adjacent tubular passages (2a, 2b, 2c) defining mutually parallel longitudinal orientations, there being in said tubular passages (2a, 2b, 2c) at least one at least partial flow restriction (18, 20), characterized in that each tubular passage (2a, 2b, 2c) is in communication with at least one other adjacent tubular passage by way of at least one longitudinally elongate slot (14).

2.- The silencer of claim 1, characterized in that said tubular passages (2a, 2b, 2c) are formed by the opposition of concave portions (10) formed in first (4) and second (6) sheet-like structures which are mutually superimposed and generally symmetrically connected forming a unit (8), and said slots (14) are formed by narrow spaces between face to face portions (16) of said sheet-like structures (4, 6).

3.- The silencer of claim 2, characterized in that each of said portions (16) is of curved cross section with the convex section thereof facing the opposite portion (16).

4.- The silencer of any one of claims 2 or 3, characterized in that the minimum spacing between two opposite portions (16) lies between 1 and 6 mm.

5.- The silencer of any one of claims 2 to 4, characterized in that said elongate slots (14) are provided with interruptions formed by contact areas (12) between both sheet-like structures (4, 6).

6.- The silencer of any one of claims 2 to 5, characterized in that said unit (8) is contained in an oval or circular section sheet-like shell (22).

7.- The silencer of claim 6, characterized in

that each extreme longitudinal edge of said unit (8) is provided with two divergent edge fins (26) and in that the unit (8) is connected to the sheet-like shell (22) by pressure fitting of said tabs (26) against the inner surface of the sheet-like shell (22)

8.- The silencer of any one of claims 6 or 7, characterized in that said tubular passages (2a, 2b, 2c) are provided with perforations (28).

9.- The silencer of any one of claims 6 to 8, characterized in that the space between the unit (8) and the sheet-like shell (22) is occupied at least in part by an absorbent material (30).

10.- The silencer of claim 9, characterized in that said absorbent material (30) is formed by mineral wool fibre, metal swarf, porcelain granules and/or ceramic granules.

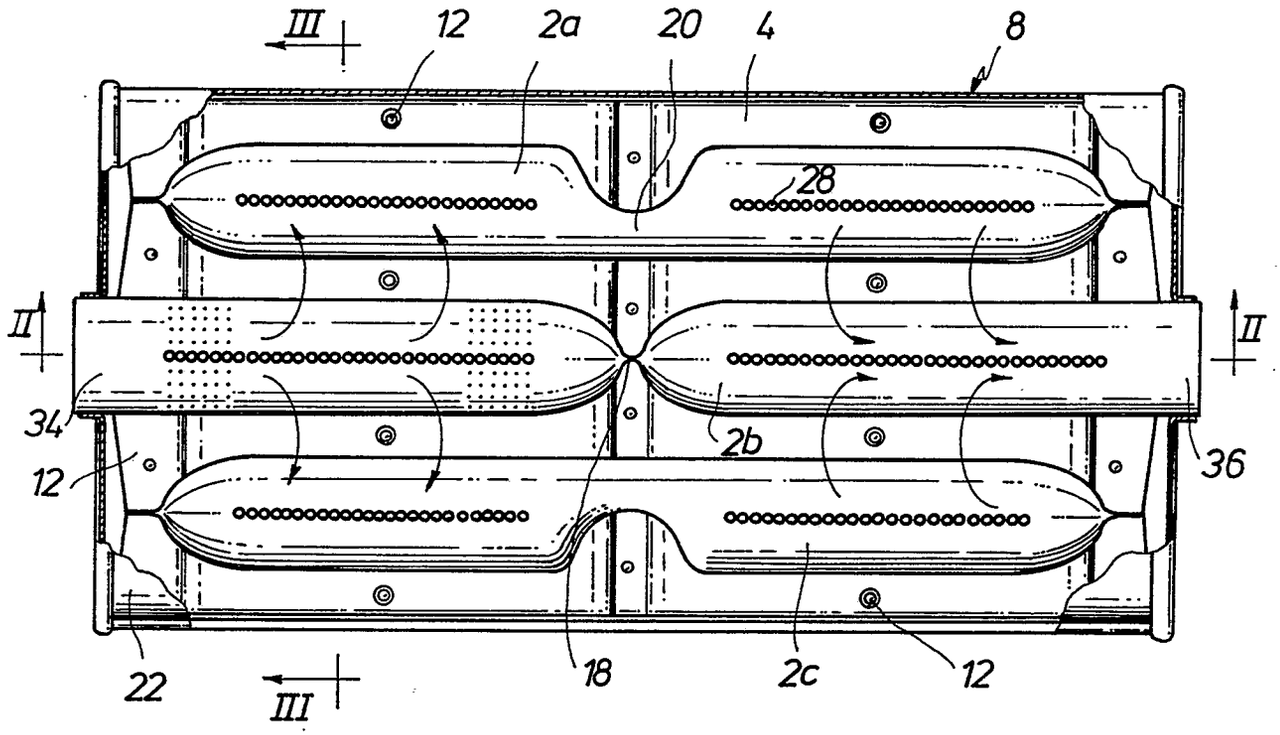
11.- The silencer of any one of claims 9 or 10, characterized in that a layer of metal filaments (32) is applied to the outer surface of the unit (8) between the latter and the absorbent material (30).

12.- The silencer of any one of claims 2 to 11, characterized in that said flow restrictions (18, 20) are formed by the mutual engagement by flattening of portions of said concave portions (10).

13.- The silencer of any one of claims 2 to 12, characterized in that it comprises: a) two sheet-like structures (4, 6) forming a unit (8) in which there is: a central tubular passage (2b) of straight orientation, provided with perforations (28) with one end (34) receiving gases from the engine and one end (36) emitting said gases, said central tubular passage passage (2b) having in an intermediate zone thereof a complete flow restriction (18) forming two semipassages ; and two lateral tubular passages (2a, 2c), of straight orientation, provided with perforations (28) and being parallel with the central passage (2b), each of which is closed at both ends and communicates with both semipassages through elongate longitudinal slots (14); b) an oval section shell (22) connected to said unit (8) by means of divergent edge fins (26) of the unit (8); c) a layer (32) of metal filaments surrounding the outer surface of the unit (8); and d) a filling of absorbent material (30) between said layer (32) and the shell (22).

14.- The silencer of claim 13, characterized in that each of said lateral tubular passages (2a, 2c) has a partial flow restriction (20) situated adjacent the complete flow restrictions (18) of the central tubular passage (2b).

FIG. 1



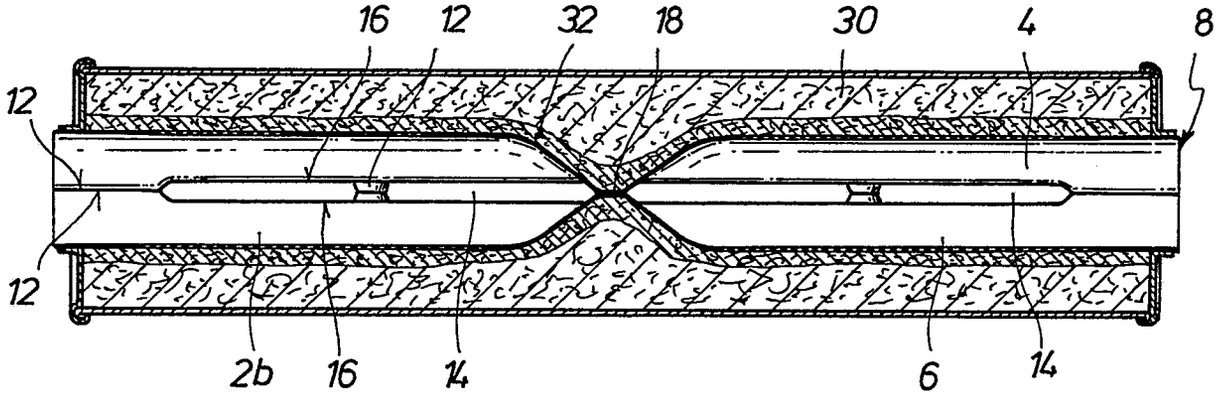


FIG. 2

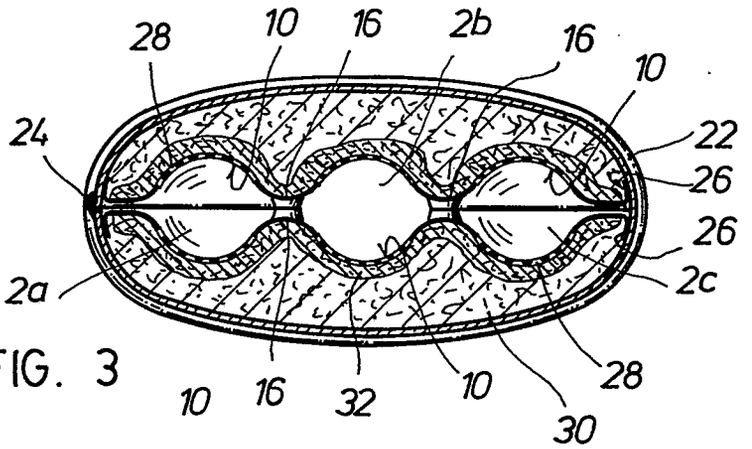


FIG. 3

FIG. 4

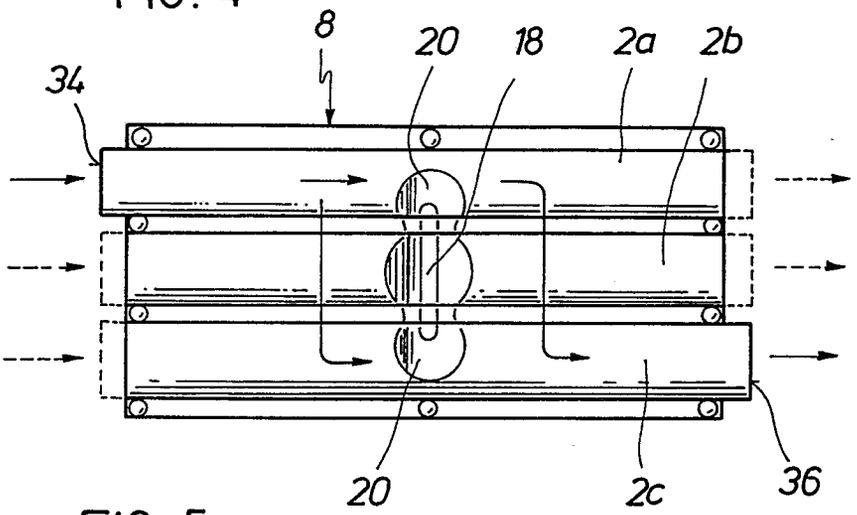
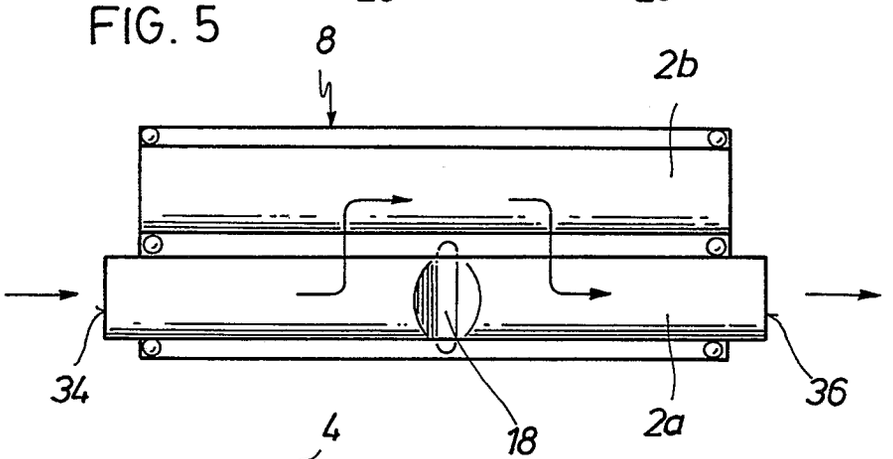


FIG. 5



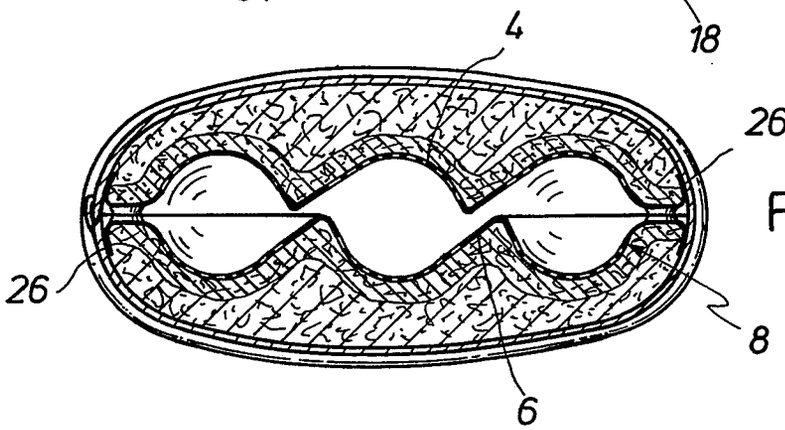


FIG. 6

FIG. 7

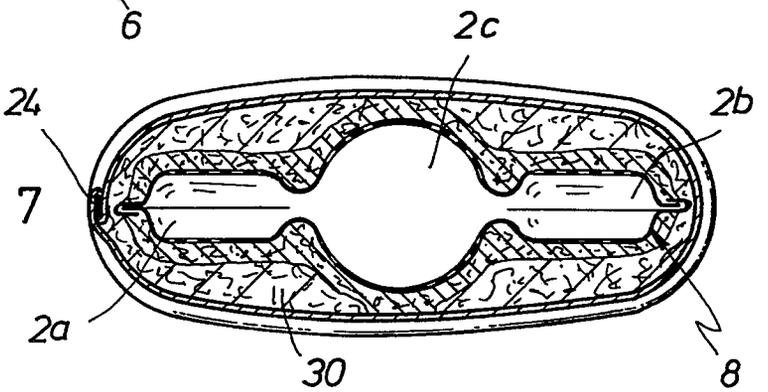


FIG. 8

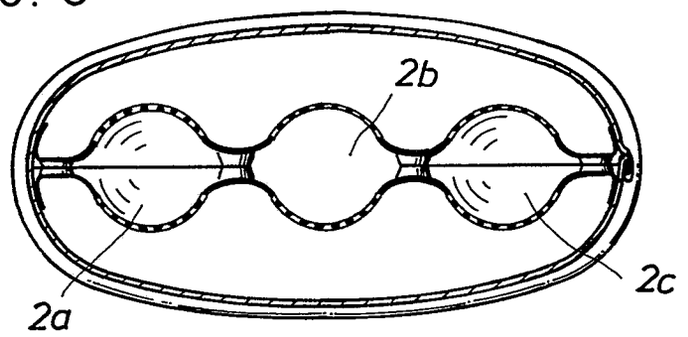


FIG. 9

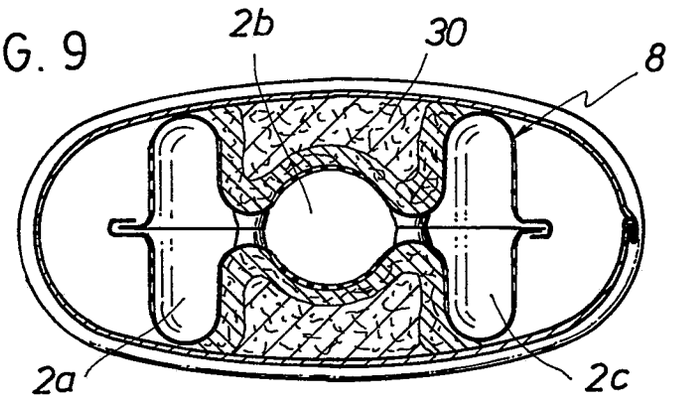


FIG. 10

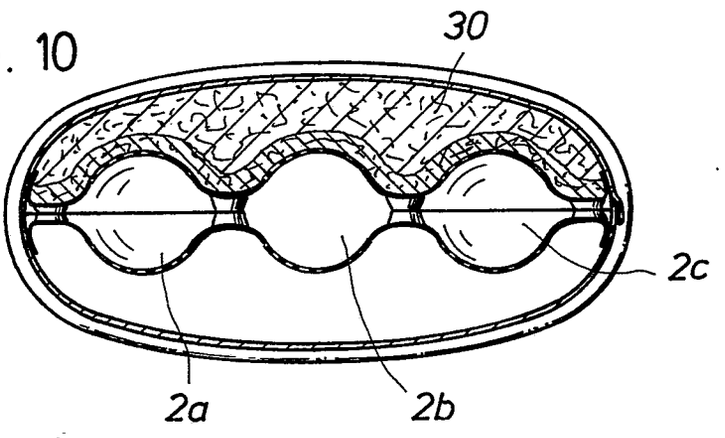
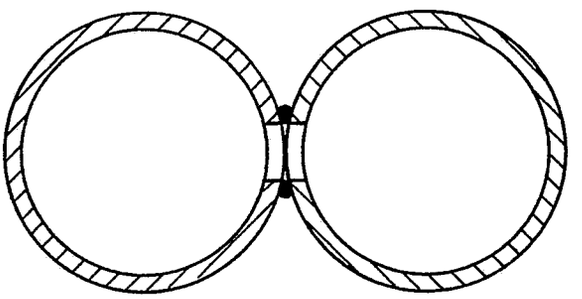


FIG. 11



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EUROPEAN SEARCH REPORT

Application Number

EP 90 50 0025

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.5)
X	DE-A-3035332 (FA J. EBERSPÄCHER) * page 5, paragraph 4 - page 6, paragraph 3; figures 1-3 *	1-3, 5, 6, 8, 9	F01N1/08 F01N1/10
Y		10, 11	
X	DE-A-3149622 (FA J. EBERSPÄCHER) * page 5, paragraph 3 - page 8, paragraph 1; figures 1-3 *	1-3, 5, 6, 8, 9	
Y		10, 11	
Y	US-A-2583366 (ENGELS) * column 2, line 2 - column 2, line 29; figure 1 *	10, 11	
Y	GB-A-923611 (KYFFIN) * page 1, line 64 - page 2, line 74; figures 1, 2 *	10	
A		6, 8, 9	
Y	GB-A-250399 (WOLFF) * page 1, lines 67 - 83; figure 1 *	10	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	DE-C-358083 (LEHMANN)		F01N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 MAY 1990	SIDERIS M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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