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(54) Air-conveying and distributing channel

(57) The invention relates to an air-conveying and distributing channel comprising an elongated body (2) of tubular conformation and flexible structure having at least one end (2a) for air delivery, as well as support means (3) operatively associated with the elongated body. Air-delivery means (9) is operatively associated with at least one wall of the elongated body (2) to carry out air distribution towards an external environment. The elongated body has a transverse section of a decreasing area away from said one end.

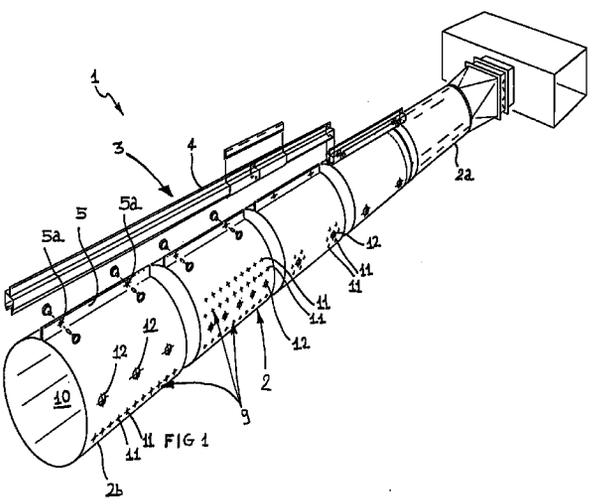

FIG 1

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Description

[0001] The present invention relates to an air-conveying and distributing channel.

[0002] It is known that, for the purpose of ensuring an appropriate conditioning and ventilation in environments intended for civil use, industrial use or still other applications, thermal-ventilation plants are presently employed which are comprised of channels or ducts capable of distributing predetermined amounts of air optionally previously processed from a thermal point of view, following a given logic.

[0003] More specifically, according to a first type of thermal-ventilation plants presently in use, employment of rigid channels usually made of metal material which are disposed at the ceiling of the environment to be conditioned is provided, which channels extend along predetermined paths in order to ensure the best operating efficiency.

[0004] Metal ducts at a side surface thereof are provided with openings for discharge of the air they convey and along their longitudinal extension they have a substantially constant section over pieces of predetermined length suitably connected with each other.

[0005] While metal channels briefly described above are widely employed in many applications, they however have many drawbacks both from an operating point of view and from a manufacturing and installation point of view.

[0006] It is actually to note that metal-made distributing ducts or channels are very expensive and of great weight so that employment of very strong support means is required, which will contribute to increase weight of same and the setting-up costs for the overall structure.

[0007] From an operating point of view it is also to point out that metal ducts must necessarily process air at relatively low velocities in order to avoid problems connected with high losses of head and also, in particular at the air discharge openings, problems of the acoustic type because if air passes through said openings at a very high exit velocity, a maddening noise would occur as a result of vibrations of the metal sheet at said discharge openings.

[0008] It is also to note, still from an operating point of view, that while channels of metal material, if conveniently sized, succeed in ensuring distribution of the desired air amounts to an environment, they hardly succeed in avoiding thermal-stratification phenomena that, in conclusion, greatly limit the operating efficiency of the whole conditioning plant.

[0009] In order to solve the above mentioned drawbacks at least partly, air-conveying and distributing ducts made of a flexible material, a material of a textile nature for example, have been widely spread on the market in the past, which ducts were capable of combining a reduced production cost and a great lightness with a good operating liability.

[0010] In particular, channels of deformable material can ensure a greater amount of processed air per unit time, their section being the same, because the materials used to make them are intrinsically capable of absorbing vibrations, due in particular to the deformable character characterizing them, thereby solving problems of the acoustic type at the air-distribution holes provided in the channel wall.

[0011] From a construction point of view, the above described channels are usually of cylindrical conformation and have one open end or delivery end which is put into fluid communication with the conditioning plant with which the channel is associated, and a second end which is terminally closed.

[0012] In a first typology of flexible channels, employment of flexible porous materials contemplating the presence or not of random openings is provided, as far as conditioning with cold air is concerned. As a matter of fact, since these channels are unable to direct the outgoing flow, they cannot solve stratification problems. They apply in the agroindustrial and pharmaceutical fields (where the bacterial-proliferation problem is felt), due to the fact that they can be easily washed and disinfected.

[0013] There is a second typology of channels made of textile material or other flexible material and consisting of channels provided with perforations. These channels have proved to be efficient in reducing stratification phenomena.

[0014] In fact, since a perforated deformable channel can work with greatly higher air flow rates, the air jets at high speed coming out of the perforations in this case succeed in creating the so-called "induction phenomena" that, in conclusion, have the effect of making mixing between the air present in an environment and the air coming out of the channel in question much more efficient. It is in fact to note that by arranging holes of appropriate size it is possible to cause air discharge at high speed, which, close to the hole itself, gives rise to a strong vacuum condition capable of calling back a great amount of the surrounding air. This phenomenon that, as said, is defined as an induction phenomenon, clearly causes movement and mixing of important air masses that, even in environments of great sizes or in particular of great bulkiness in height, greatly contribute to reduce and practically cancel thermal-stratification problems.

[0015] Substantially, for the above reasons, channels of deformable material are taking an increasingly more important role within the field of thermal-ventilation plants.

[0016] While the above described ducts have important qualities and a very efficient operating behaviour, they however also have some drawbacks.

[0017] In particular, it is to point out that the operating efficiency of the channels of known type is not constant over their longitudinal extension. This is due to the fact that the flow rate entering the delivery end decreases as

it moves on along the channel, due to the distribution perforations present in the side wall of said channel. It is therefore apparent that the fluid-movement conditions existing within the channel, in particular in terms of flow velocity, are adversely affected to a great extent by this factor so that there is a varying air distribution through the delivery holes along the longitudinal extension of the channel.

[0018] It is also important to note that, as already said, the second end of the last-mentioned deformable channels is terminally closed. Obviously this gives rise to a strong static-pressure condition at the end region of the channel, which will undoubtedly contribute to increase the behavioural differences along the channel itself.

[0019] With reference then to the channel-installation and starting steps, it is to point out that the presence of a second closed end obliges workers assigned to this task to inflate the channel in a progressive manner during relatively long execution times, in order to avoid excessive waving or oscillations of the channel capable of impairing the structural integrity of said channel or of its support means.

[0020] Under this situation, the present invention aims at substantially solving all the above mentioned drawbacks.

[0021] In particular, it is a fundamental object of the invention to make an air-conveying and distributing channel that is capable of ensuring an operating efficiency never reached until now and in particular capable of automatically adapting itself to the progressive flow-rate modifications along the channel length, due to the discharge of air from the side holes, thereby ensuring a fluid-movement condition, in terms of speed, which is as much as possible uniform along the longitudinal extension of the channel itself.

[0022] It is a further object of the invention to make a channel of greater structural strength, less bulkiness in space and easier installation.

[0023] The foregoing and further objects that will become more apparent in the progress of the present description are substantially achieved by an air-conveying and distributing channel as disclosed in the appended claims.

[0024] Further features and advantages will be best understood from the detailed description of some preferred but nonexclusive embodiments of an air-conveying and distributing channel in accordance with the present description. This description will be given hereinafter with reference to the accompanying drawings, taken by way of non-limiting example, in which:

- Fig. 1 is a partly exploded perspective view of a channel in accordance with the present invention;
- Fig. 1a shows the support means operatively associated with the channel seen in Fig. 1, to an enlarged scale;
- Figs. 2, 3 and 4 show some alternative embodiments of a channel in accordance with the invention, still in a perspective view similar to Fig. 1;
- Figs. 2a, 3a and 4a show the support means relating to Figs. 2, 3 and 4 respectively, to an enlarged scale;
- Figs. 5 to 9 show different types of shapes in transverse section that a channel in accordance with the invention can take, depending on requirements, and the corresponding different types of support means;
- Fig. 10 is a diagrammatic side view of a channel in accordance with the invention, provided with condensate-collecting means;
- Fig. 11 is a front view relating to the channel in Fig. 10;
- Fig. 12 is a front view similar to Fig. 11, relating to an alternative embodiment of the condensate-collecting means.

[0025] With reference to the accompanying drawings, an air-conveying and distributing channel in accordance with the present invention has been generally identified by reference numeral 1.

[0026] The conveying channel 1 comprises an elongated body 2 of tubular conformation and flexible structure. The elongated body 2 has at least one end 2a for air delivery as well as a second end 2b opposite to the first end which is generally closed. Associated with the elongated body 2 is support means, generally denoted by 3, which is arranged to enable engagement of the elongated body with a wall or a ceiling, for example.

[0027] In particular, depending on the transverse sectional shape of the elongated body, support means 3 of different conformation may be provided, as specifically shown in Figs. 1 to 9.

[0028] Actually, it is to point out that the elongated body 2 can have a transverse section either of circular conformation (Figs. 5 and 6), semicircular conformation (Fig. 8), in the form of a quarter of a circumference (Fig. 9), in the form of an arc of a circumference connected to a straight line (Fig. 3), in the form of an arc of a circumference connected to a curved line (Fig. 7), or of any other conformation, depending on the operating requirements that may occur each time.

[0029] The support means advantageously comprises at least one guide rail or steel cable 4, at least one engagement portion 5 emerging from the elongated body and having a predetermined number of elongated engagement holes 5a, and a plurality of carriages 6 which are each in engagement with at least a corresponding one of said elongated holes 5a and also slidably associated with said rail 4. More specifically, rail 4 normally consists of at least one section member defining slide tracks 7 in which the rolling elements 8 of each carriage 6 engage. It is to note that, depending on the conformations in transverse section of the elongated body 2, employment either of a single rail 4 or of a pair of rails set in place at symmetrically opposite positions, or even of three rails as shown in Fig. 9, may be pro-

vided.

[0030] As viewed from the accompanying drawings 1, 2, 3 and 4, the elongated body 2 is also provided with air-delivery means generally identified by 9, which is operatively associated with at least one side wall of the elongated body to create a fluid communication between chamber 10 at the inside of duct 2 and the external environment, for the purpose of carrying out the desired air distribution.

[0031] In more detail, the delivery means 9 advantageously comprises a first and a second series of holes 11 and 12 homogeneously distributed along the side wall of the elongated body 2.

[0032] Holes 11 of the first series have an air-passage section of a lower area than the air-passage section of the holes of the second series. In this way, the holes of the first series are passed through by an air flow of high speed and great turbulence.

[0033] These flows of high speed and turbulence create a vacuum effect capable of calling back a great amount of air from the regions surrounding holes 11. In other words, the air coming out of holes 11 of the first series creates a strong return effect of the surrounding air, known as induction effect, causing a great amount of air present in the external environment to be involved, which air is therefore mixed in a very efficient manner. Holes 12 of the second series, since they have a section of greater area, are passed through by flows of greater flow rate but at a greatly lower velocity, as compared with that of flows passing through holes 11. The holes of the second series are normally disposed close to those of the first series, according to a varying arrangement and geometry, depending on requirements. More generally, the holes of the second series are used to direct and establish a throw for the flow coming out of the elongated body 2.

[0034] According to a preferential solution shown in the accompanying drawings, the holes of the first and second series are distributed in respective rectilinear lines disposed mutually in side by side relationship.

[0035] It is to note that as an alternative solution to the above description, provision may be made for delivery means which, in place of the above described holes, comprises porosities homogeneously distributed at least on said side surface of the elongated body 2 or distributed in a non-homogeneous manner depending on the intended effect. These porosities can be easily obtained by the use of an appropriate material having a good transpiration capability in respect of air. In combination with, or in place of one of the above described solutions, the delivery means may also be provided to comprise a plurality of through openings disposed mutually in side by side relationship and defining at least one longitudinal grating that can extend along the side wall of the elongated body 2. In some cases, two or more longitudinal gratings conveniently disposed along the side surface of the elongated body 2 may be also provided.

[0036] It is apparent that all these solutions can operate individually or in combination with each other depending on the operating requirements occurring each time from a practical point of view.

[0037] In an original manner, in accordance with a fundamental aspect of the invention, it is to note that the elongated body 2 preferably has a transverse section of decreasing area away from the first end 2a. This type of solution makes it possible to carry out that which is defined by those skilled in the art as a "dynamic recovery", i.e. the duct capability to substantially keep the flow velocity constant along the longitudinal extension of body 2, in spite of the fluid mass gradually coming out of holes 11 and 12. Preferably, the transverse section will be linearly decreasing so that the elongated body will have a substantially frusto-conical conformation.

[0038] However, depending on the shape and distribution of holes 11 and 12, the transverse section may be provided to decrease in a different manner from the one described above.

[0039] From a construction point of view, it is to note that the elongated body is made of a sheet material comprising an inner layer, made of a fabric material for example, and an outer covering layer, of an impermeable material for example. More specifically, for making the inner fabric layer synthetic fibres can be utilized such as glass fibres and polyester yarns, while the covering layer may be made of PVC, silicone, polyurethane or still other materials.

[0040] In general, merely as regards production, the fabric layer will be covered with a covering layer preferably by coating.

[0041] As an alternative solution to the above, the sheet may be also completely made of a plastic material such sized as to ensure an appropriate strength and good flexibility, and provided or not with porosities distributed in a more or less homogeneous manner, depending on requirements.

[0042] Finally, from the point of view of installation, the elongated body 2 will be arranged so that it extends substantially horizontally or substantially vertically, depending on the operating requirements and the available spaces, without any modification to the overall structure of channel 1 being needed because, due to the conformation of the elongated body and support means 3, this channel adapts itself to any type of disposition very well.

[0043] It is to note that for particular applications where work is carried out in an environment conditioned to a high degree of humidity, which often happens in the textile field in sheds housing spinning machines and the like for example, the elongated body 2 can be provided with a condensate-collecting element 13 which is disposed below the elongated body itself (see Fig. 10). In this case the elongated body will have one side 14 facing the collecting element that will slope from bottom to top away from the first end 2a, whereas the opposite side 15 is maintained in a horizontal position to enable

an appropriate engagement with a ceiling, for example.

[0044] The collecting element 13 preferably extends along the elongated body parallelly to said side 14 so that it slopes from bottom to top as well, away from the first end of the elongated body.

[0045] From a construction point of view, the collecting element may be a section member of metal or plastic material for example, coupled by fitting with a corresponding projection 16 integral with the side wall of the elongated body 2 or linked to one or more rails 4 by a predetermined number of supporting belts 17.

[0046] Operation of a channel in accordance with the invention described above mainly as regards structure, is as follows.

[0047] Under operating conditions, after channel 1 has been set up, air is sent into the elongated body 2 through the first end 2a so that the channel passes from a deflated condition shown in chain line in the illustrative figures 5, 6, 7 and 8, to an inflated condition shown in solid line.

[0048] It is to note that during this step, admission of progressively increasing air deliveries is advisable in order to avoid too many waving phenomena that could impair the structural integrity of body 2.

[0049] Once a steady state has been reached, the air passing through the body 2 is partly and progressively discharged through holes 11 and 12 of the first and second series. In particular, as already mentioned, holes of the first series cause a strong induction effect so that a great air mass is involved, whereas holes 12 of the second series serve to direct the air collected from holes 11 and establish the distance said air is to be sent.

[0050] It is to note that, due to tapering or more generally to the progressive section reduction of body 2 away from the first end 2a, in spite of the air discharge from holes 11 and 12, velocity at the inside of body 2 is substantially constant, thereby ensuring a uniform behaviour along the whole duct.

[0051] The invention achieves important advantages.

[0052] First of all, it is to point out that, due to its structure, channel 1 substantially solves all drawbacks typical of the prior art and, as already said, succeeds in ensuring an excellent operating efficiency and behavioural uniformity along the whole extension of body 2, while at the same time, due to the presence of the first and second holes, solving all thermal-stratification problems. In addition, it substantially ensures the absence of problems connected with condensate formation due to the presence of humidity in the air, since a very intense dynamic condition exists around the side surface of the elongated body 2.

[0053] In particular, with reference to humidity, it is to note that the above is substantially true for any operating situation, except those cases involving operation in humidity-saturated environments where obviously a channel 1 provided with the condensate-collecting element as illustrated in Figs. 10, 11 and 12 will be advantageously used.

[0054] It is also important to note that the particular conformation of the channel in reference is advantageous in the starting step before normal working conditions have been reached because the progressive section reduction ensures an important stiffness, the materials being the same, and therefore practically minimum waving problems, which will result in easier setting up. It is to point out that if the transverse section at the second end 2b is reduced to such a point that a body 2 of conical conformation is defined, the waving effects due to creation of a condition of overpressure at the end 2b will be reduced to a minimum.

[0055] It is also important to highlight that, due to the particular channel conformation, there is a great saving (even up to 50%) in the materials used for making it as well as a better adaptability of the channel itself even to relatively narrow spaces, given the reduced bulkiness relative to channels of the traditional type, the processed air mass being the same.

[0056] It is then important to point out that the channel in reference is advantageous also in its most specific aspects.

[0057] Actually, the particular conformation of the support means 3 provided with rails 4 and carriages 6 is economical from a construction point of view and very efficient as regards operation so that the overall costs are reduced and a strong structure, reliable in time, is ensured.

[0058] In particular, it is to note that rails create a better support and ensure a correct expansion of the channel body relative to supports using a steel cable.

[0059] It is also to note that, if two or more rails 4 are used, as shown in Figs. 6 to 9, the channel bulkiness is very contained also under inflated conditions of the elongated body 2.

[0060] In addition, if the elongated body is made of two layers, a great strength and at the same time an appropriate flexibility is ensured to the structure which, obviously, is advantageous for a correct operation of the channel.

[0061] With reference then to the above-mentioned condensate-collecting element 13, it is to note that by adopting an elongated body 2 of conical conformation disposed as shown in Fig. 10, the obtained structure while being very efficient from an operating point of view, is still capable of operating in very reduced spaces.

[0062] Finally, other aspects too are not to be forgotten, such as the great lightness of the channel in reference which is surely reduced to a minimum, the capacity of acoustic insulation of body 2 made of a fabric material, the possibility of washing and repairing the channel in question and the capability of same to be applied to any type of already existing apparatus.

[0063] Obviously, many modifications and variations can be made to the invention as conceived, all of them falling within the scope of the inventive idea characterizing it.

Claims

1. An air-conveying and distributing channel comprising:

   - an elongated body (2) of tubular conformation and flexible structure having at least one end (2a) for air delivery;
   - support means (3) operatively associated with said elongated body;
   - air-delivery means (9) operatively associated with at least one wall of said elongated body to carry out distribution of said air towards an external environment, characterized in that said elongated body (2) has a transverse section of a decreasing area away from said one end.

2. A channel as claimed in claim 1, characterized in that said elongated body (2) has a transverse section linearly decreasing away from said one end, and preferably has a substantially frusto-conical conformation.

3. A channel as claimed in claim 1, characterized in that said elongated body (2) is made of a sheet of plastic material or, alternatively, of at least one inner layer of fabric material and at least one covering layer of an impermeable material externally applied to said inner layer.

4. A channel as claimed in claim 1, characterized in that said air-delivery means (9) comprises at least one first series of holes (11) distributed along a wall of said elongated body 82).

5. A channel as claimed in claim 1, characterized in that said air-delivery means (9) comprises at least one second series of holes (12) distributed along a wall of the elongated body (2), in that the holes of said first series have an air-passage section of a lower area than the holes of said second series, and in that preferably the holes of said first and said second series are distributed following respective rectilinear lines disposed mutually in side by side relationship.

6. A channel as claimed in claim 1, characterized in that said delivery means (9) comprises porosities distributed at least over one side surface of said elongated body.

7. A channel as claimed in claim 1, characterized in that said delivery means (9) comprises a plurality of through openings disposed mutually in side by side relationship and defining at least one longitudinal grating extending along at least one wall of said elongated body.

8. A channel as claimed in claim 1, characterized in that said support means (3) comprises:

   - at least one guide rail or one steel guide cable (4);
   - at least one engagement portion (5) radially emerging from a side wall of said elongated body and defining a predetermined number of elongated engagement holes (5a); and
   - a plurality of carriages (6) each engaged with at least one of said corresponding elongated holes and slidably associated with said rail.

9. A channel as claimed in claim 1, characterized in that operatively associated with said elongated body (2) is a condensate-collecting element (13) disposed under the elongated body itself.

10. A channel as claimed in claim 1, characterized in that, under operating conditions, the elongated body (2) extends substantially horizontally or substantially vertically.

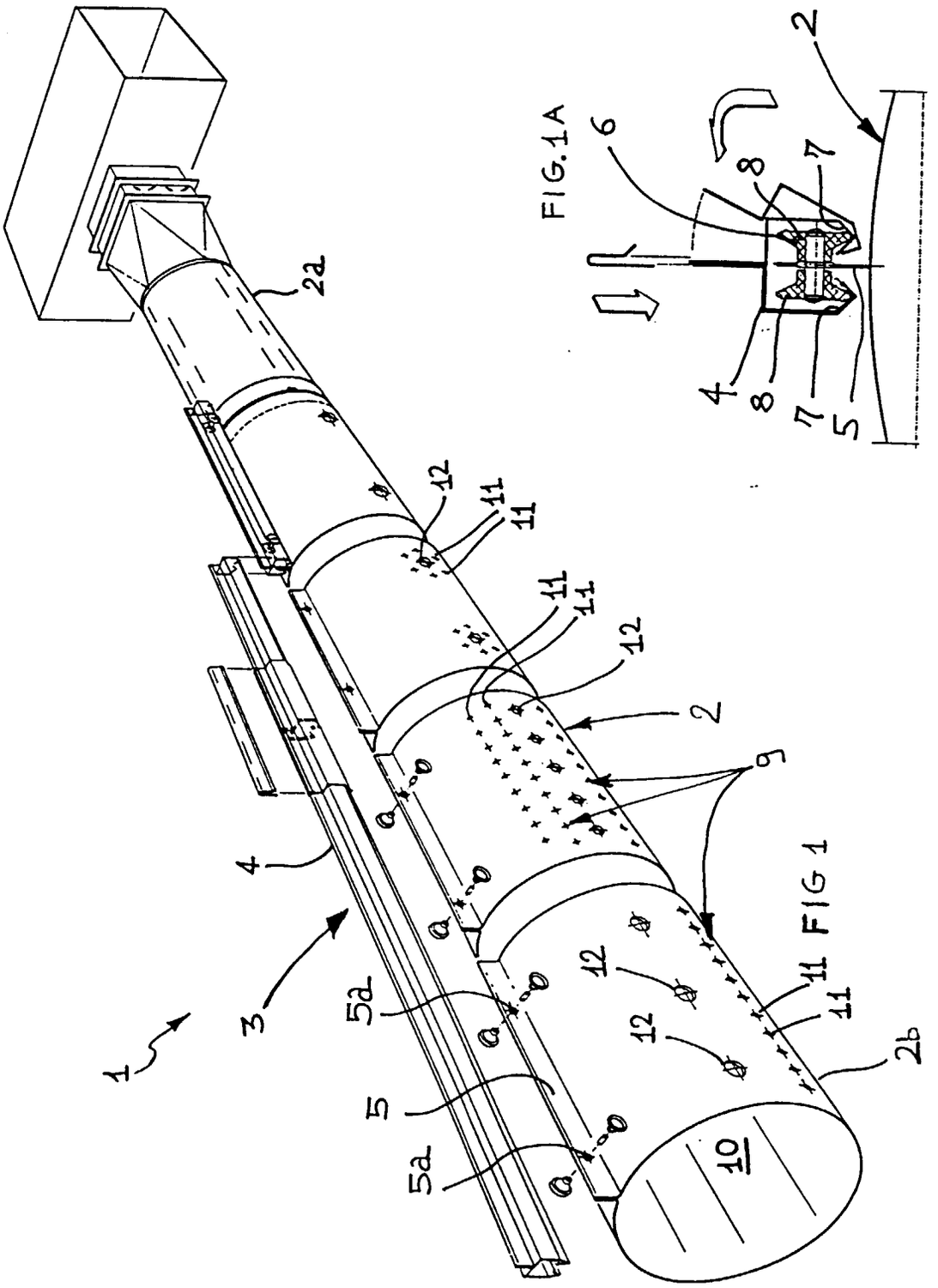

FIG 1

FIG.1A

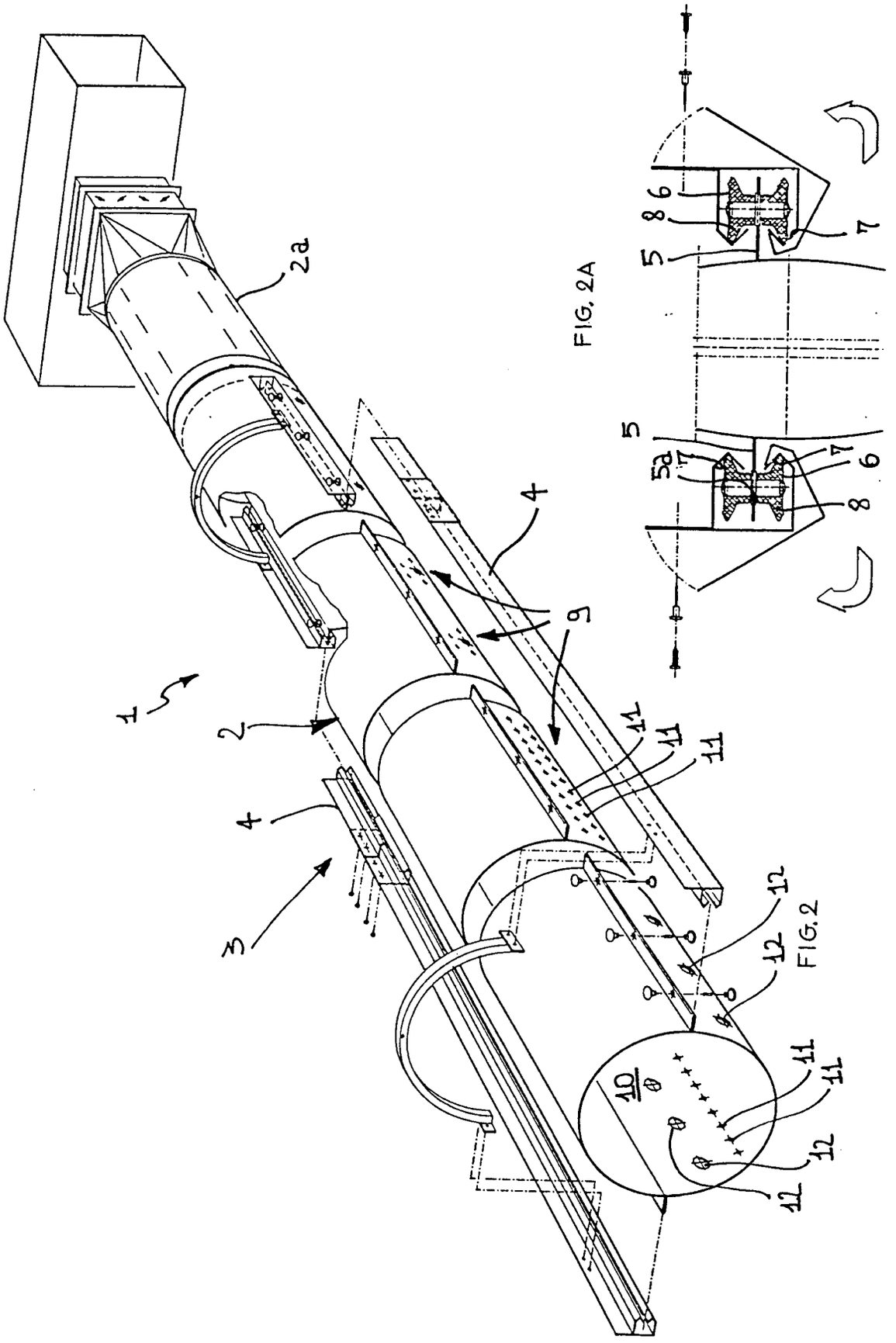

FIG. 2

FIG. 2A

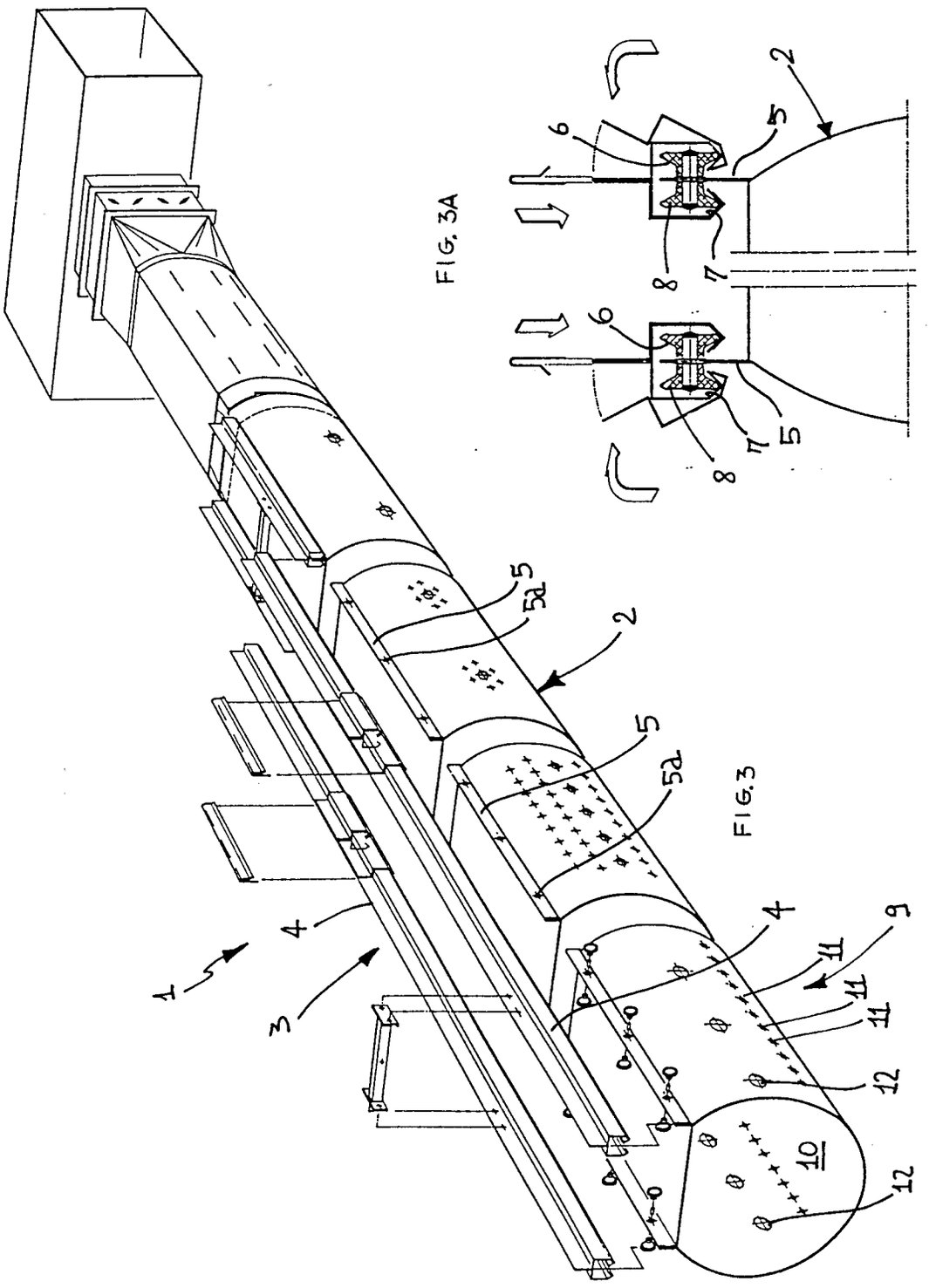

FIG. 3

FIG. 3A

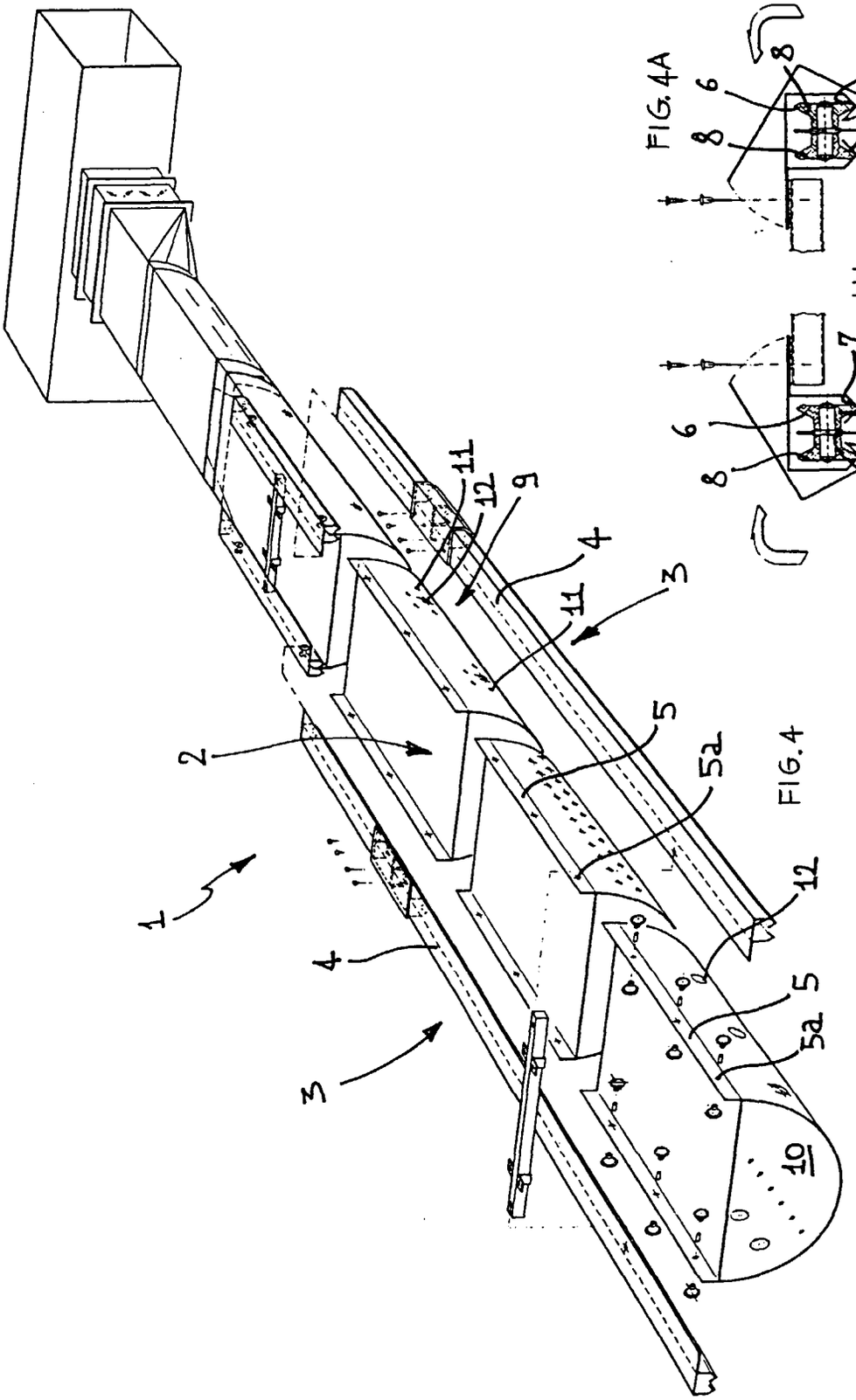

FIG.4

FIG.4A

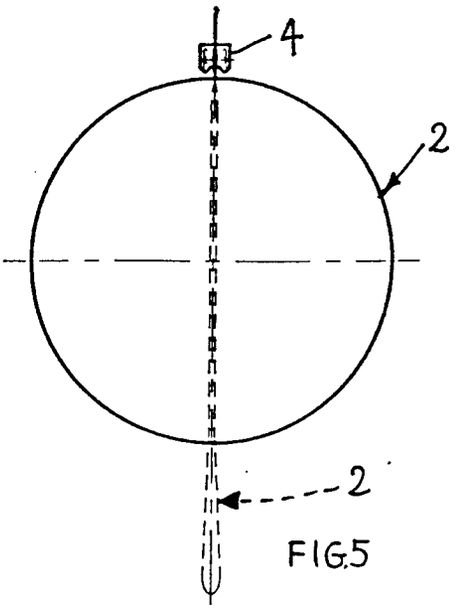

FIG.5

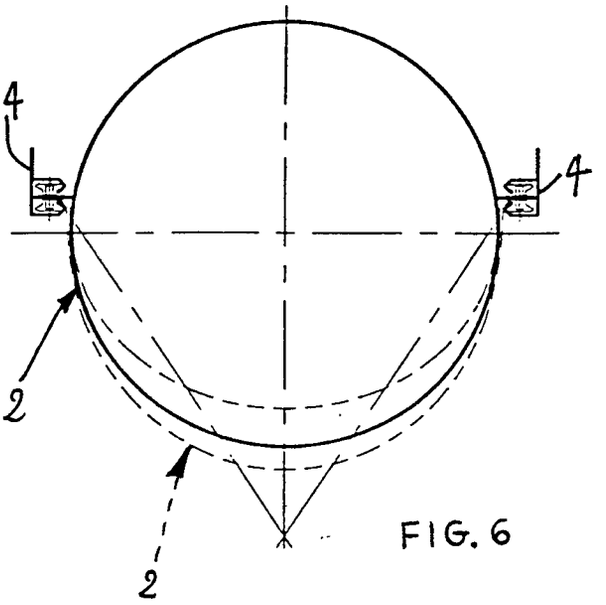

FIG. 6

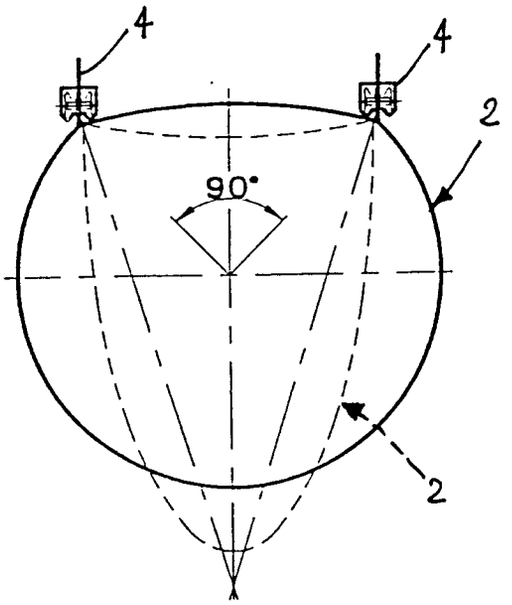

FIG. 7

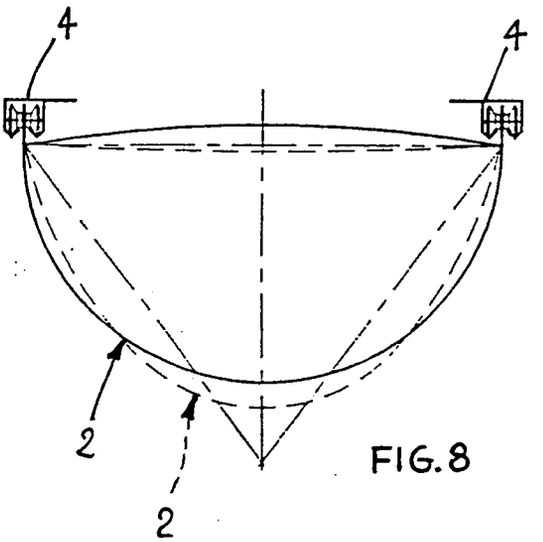

FIG.8

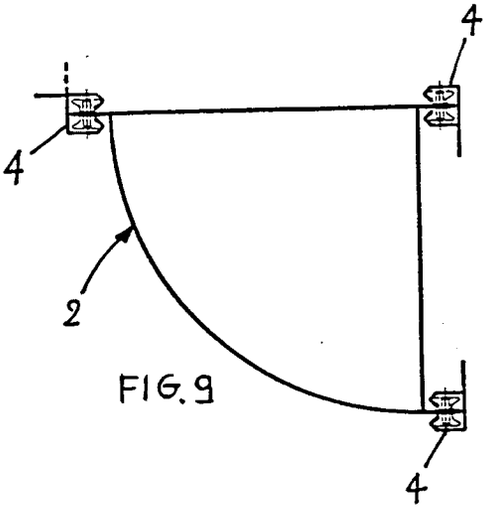

FIG. 9

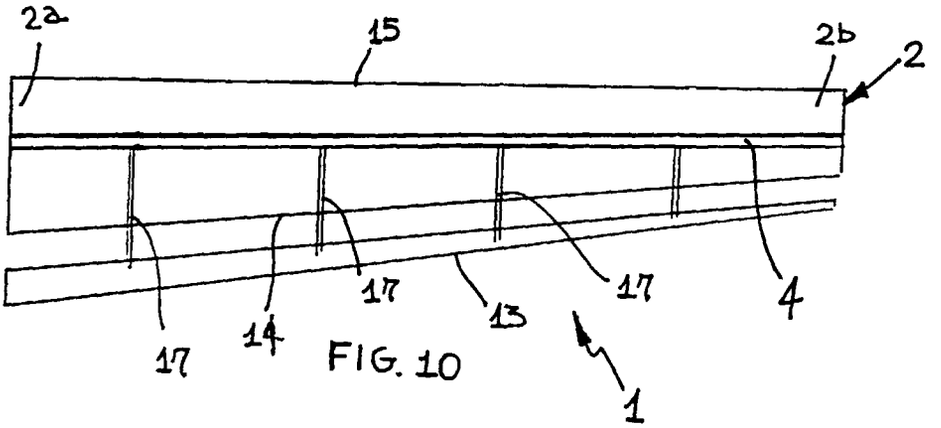

FIG. 10

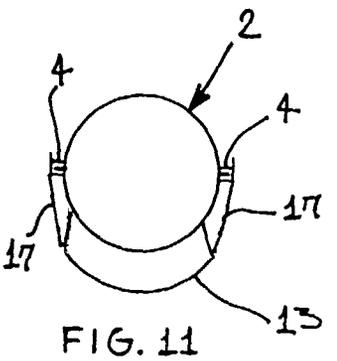

FIG. 11

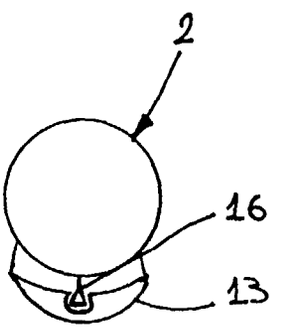

FIG. 12

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 83 0388

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.6)
Y	US 2 857 108 A (JAMES O. WALLACE) * the whole document *	1-4,6,7, 10	F24F13/068
Y	FR 2 124 780 A (HOWORTH & CO LTD JAMES) * page 4, line 7 - line 18; figures 2,4 *	1-4,6,7, 10	
A	US 5 137 057 A (HUMMERT III AUGUST H) * the whole document *	1,8	
A	GB 2 135 442 A (HOWORTH AIR ENG LTD) * abstract; figures *	1,5	
A	WO 93 15366 A (KE BURGMAN A S) * abstract; figures *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

F24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	5 December 1997	GONZALEZ-GRANDA, C

CATEGORY OF CITED DOCUMENTS

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05-12-1997

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2857108 A	21-10-1958	NONE	
FR 2124780 A	22-09-1972	AU 461810 B	05-06-1975
		AU 3800172 A	19-07-1973
		CA 943317 A	12-03-1974
		CH 541329 A	31-10-1973
		DE 2202481 A	10-08-1972
		GB 1317833 A	23-05-1973
		IE 36681 B	02-02-1977
		SE 384731 B	17-05-1976
		US 3824987 A	23-07-1974
		ZA 7200248 A	29-11-1972
		BE 771396 A	31-12-1971
		LU 63728 A	04-01-1972
		NL 7113936 A	22-11-1972
		CH 494035 A	31-07-1970
		DE 1921890 A	29-01-1970
		FR 2007652 A	09-01-1970
		GB 1191386 A	13-05-1970
		US 3602212 A	31-08-1971
US 5137057 A	11-08-1992	CA 2017420 A	26-11-1990
		US 5285818 A	15-02-1994
GB 2135442 A	30-08-1984	NONE	
WO 9315366 A	05-08-1993	AT 131275 T	15-12-1995
		AU 3626493 A	01-09-1993
		DE 9390009 U	13-10-1994
		DE 69300970 D	18-01-1996
		DE 69300970 T	08-08-1996
		DK 9400295 U	01-08-1994
		DK 624236 T	08-01-1996
		EP 0624236 A	17-11-1994
		ES 2085150 T	16-05-1996
		US 5490813 A	13-02-1996

EPO FORM P0459

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