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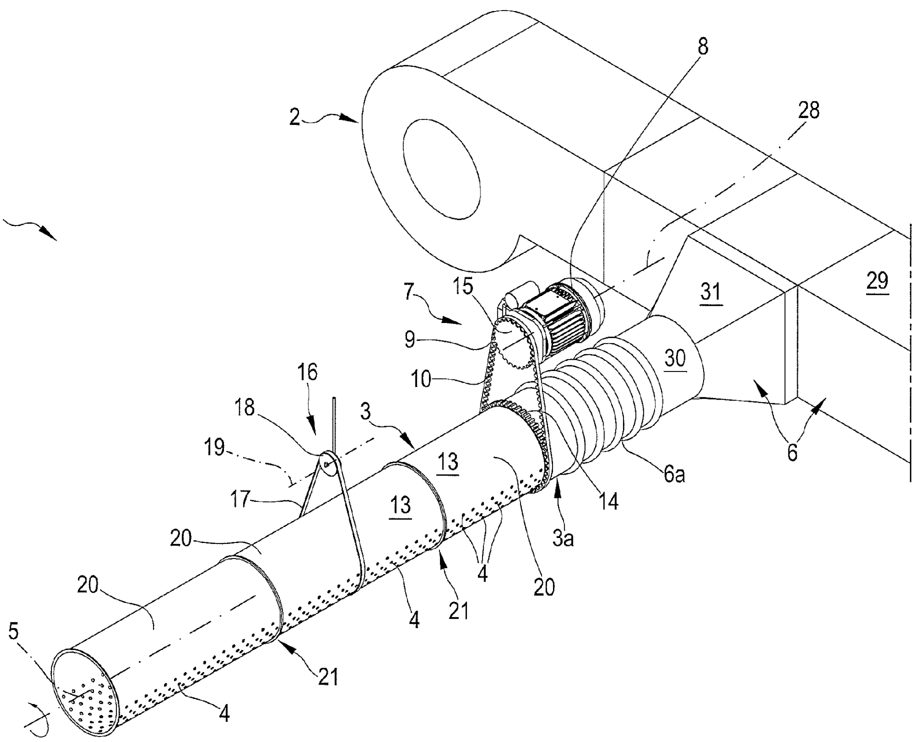
(54) **Apparatus for air treatment, particularly for environment conditioning**

(57) In an air treatment plant at least an air treatment unit (2) sends pressurised treated air to a perforated channel (3) for enabling injection of treated air into the environment, at a predetermined launch angle (α); the perforated channel (3) and the conveyor channelling (6) which conducts thereto air coming from the treatment unit (2) are rotatably coupled such as to enable a relative rotation of the channel (3) with respect to the channelling respect (6) about a longitudinal development direction (5) of the perforated channel (3). The rotation of the channel (3) modifies the launch angle (α) of the air.

FIG.1



EP 2 597 392 A2

Description

[0001] The present invention relates to an apparatus for air treatment and diffusion of air. In particular the present invention is applicable in the conditioning of environments such as swimming pools, offices, large workshops, etc., by means of air treatment plants which exploit perforated channels for diffusing air into environments by an inductive effect, i.e. in order to obtain a pulsion of the environmental air.

BACKGROUND

[0002] As is known, present apparatus for air conditioning use special metal channellings which have the task of transporting the air into the zones of interest and diffusing the air such as to condition the air external of the channel. In particular, one or more devices for generating a flow of delivery air internally of the channels are connected such as to increase the pressure internally thereof.

[0003] High-velocity air flows are generated in specially-perforated metal conduits, or diffusers, which diffusers recall, by inductive effect, the air surrounding the channel, thus creating a mixture of the ambient air with the treated air and extremely efficiently conditioning the room.

[0004] The spatial configuration and arrangement internally of the room of the metal channellings and in particular the positioning and orientation of the diffusers can in general be of any type, such as to optimise the volumes of treated air, as well as the homogenisation of the temperatures.

[0005] Typically the air treatment unit injects a flow at a central zone of the header such that the flow divides on the two branches, left and right, of the header and then arrives at the distribution channels, where it is appropriately shared out.

[0006] As traditional apparatus for air diffusion, which use delivery air diffusion terminals such as vents, diffusers, nozzles, when injecting hot air into environments, generally have the tendency of facilitating stratification, while they generally have the tendency of creating air draughts when they inject colder air, in recent years perforated channels have been developed, which inject air into an environment while obtaining a pulsion of the existing ambient air.

[0007] The basic principle of this type of perforated channel consists in using the delivery air for moving the totality of the ambient air volume in the desired direction and at the desired velocity. For this purpose, the perforated channels create a pressure field along the axis thereof such as to be able to impart a thrust on the totality of the ambient air mass. Since the fluid air layers in delivery have necessarily to exit from the holes with a micro-turbulent flow destined to create a strong depression about the base of the hole such as to recall by induction a quantity of ambient air that is much greater than the delivery air, the dimensioning of the holes and their distribution thereof along the pulsion channel is an extremely delicate matter, especially with the aim of avoiding the generation of annoying draughts at ground level.

[0008] European patent no. EP 2244022, in the name of the present applicant, includes using channelling with ringed arrangement and the use of diffuser channels which branch from the ring by means of an interposing of appropriate shutters or flow choking devices which can enable use of various parts of the apparatus according to needs and operative requirements, for example a summer/winter seasonal setting, closed environments or open environments, start-up transitories and normal operating conditions.

[0009] The ring is in general supplied by one or more pressure increasing stations which can also be used singly or in combination with one another according to the overall needs relating to volume of air to be injected into the environment. Further, air treatment plants are known that exploit metal channels having an inductive effect, i.e. exhibiting a predetermined number of perforations having a small diameter, which lead to generating substantial draughts externally of the channel and for a rather short tract thereof, which substantial draughts can recall the ambient air by induction, leading to a significant mixing of air.

[0010] Also known are channellings designed mainly for injecting rather large volumes of air into environments, which do not however destined create substantial inductive effects, but only transfer energy into the environment.

[0011] Note that induction diffuser channels in general exhibit predetermined development directions along which different-diameter perforations are made. During design and installation an optimal launch angle of the air is established, which can enable effective mixing of the air injected into the environment with the air of the actual ambient, as well as enabling destratification, thus obtaining an air conditioning that is effective and homogeneous internally of the environment.

[0012] While effectively solving the problems they are set to obviate, the plants briefly described above are however not without possible drawbacks caused by some operative limitations.

[0013] Firstly the plants of the prior art have a low operating flexibility.

[0014] In fact, some design or installation errors can be solved at times only with quite expensive structural modifications of the plant.

[0015] Further in the case of wrong launch velocity from the diffuser channel, or even in the case of wrong launch angles, there is a risk of generating ground currents which might be annoying for the user.

[0016] In this situation, the applicant has developed some solutions which enable, though only partially, obviating the above-mentioned drawback.

[0017] See for example European patent no. EP 2244022.

[0018] It is further known that air treatment plants require injection of different volumes of treated air in the environment in an ambient heating situation or conditioning/refrigeration of the environment.

[0019] In this situation the solutions according to the state of the art include turning off part of the plant during the winter season so that it can guarantee correct heating of the ambient; conversely, in the summer season the plant is generally used at its maximum power.

[0020] It is however clear that the insulation and switching-off of part of the plant in general leads to a situation in which in some parts of the ambient to be heated are no longer effectively conditioned.

[0021] The only alternatives are to double the number of plants and configure them such that they reach those unconditioned zones.

[0022] The above however incurs costs that overall are considerable, as they require doubling the lines for transporting and diffusing the air over the zones of interest.

[0023] In the heating condition, only one of the two lines is kept active, while during the summer season in general both the plants are exploited.

[0024] Alternatively, the compensated ring technology of EP no. 2244022 can be used, which, however, once more can lead to the need to isolate a part of the plant and/or turn of some diffuser units.

[0025] It is clear that by checking portions of the plant, i.e. modifying the active length of the pulsion perforated channels, there is the risk of varying the flow rate per linear metre in the channels and therefore generating annoying ground currents, or, conversely, considerably limiting the desired inductive effect. Further, modifying the plant operating conditions sometimes requires also modifying the plant performances. This final operation, when possible, requires the intervention of specialist technicians which, usually, loosen the connecting straps between two successive modules such as to enable small rotations about the longitudinal development axis of the perforated module and slightly varying the launch angle. On completing the regulating operation of a module, the straps are re-tightened, blocking the module itself and, if necessary, the operation is repeated on the successive module. Clearly the operations mentioned above are very complex and expensive, and require the intervention of specialised technicians: even though, regulation of the plant is entirely trial-and-error. In the case of errors or imprecise regulation all the above-described operations have to be repeated.

[0026] Further, in some specific conditions, it might be necessary to create ground draughts for limited times such as, for example, to enable one or more rapid adjustments of the plant. This operation can today be done by closing some air diffuser tracts of the plant, i.e. reducing the active parts of the plants with a same total volume of delivery air such as to increase the launch velocity. In plants where this cannot be done, it is not possible to increase the performance during the adjustment period to normal functioning.

[0027] Further, in situations in which the ambient in which the treated air is to be modified, for example by the addition of articles of furniture or even because of a different distribution of spaces (for example the introduction of separating walls, displacement of doors, windows or the like), traditional plants, which are difficult to modify and customise, in general create a considerable number of problems connected to a no-longer uniform homogenisation of the ambient air with the creation of warmer or cooler areas and possible even ground draughts.

SUMMARY

[0028] An aim of the present invention is therefore substantially to obviate the above-cited drawbacks.

[0029] A first aim of the invention is to notably increase the operating flexibility of known apparatus without however leading to significant increases in costs and plant structures.

[0030] A further auxiliary aim of the invention is to disclose an apparatus for air treatment that is simply configurable in order to be optimised in both winter and summer seasons, but also to be able to vary the operating conditions in a very simple and effective way, for example at start-up transitory stage where it can be necessary to perform a rapid destratification, even in the presence of ground draughts, and a configuration of normal operation in which optimal mixing of the treated air with the ambient air has to be guaranteed, without however leading to ground draughts.

[0031] A possible further objective according to the description of embodiments presented in the following is to enable a simpler regulating of the functioning of the plant which takes account of the situations connected with the seasonal issue, any design errors and/or modifications of the ambient configuration into which the treated air is to be injected, for example following modifications in the distribution of the spaces in the treated environment.

[0032] These and other aims, which will emerge more fully during the course of the following description, are substantially attained by an apparatus for air treatment according to one or more of the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS.

[0033] Further characteristics and advantages will more fully emerge from the detailed description of some embodiments of the invention.

[0034] The description will be made in the following with reference to the accompanying drawings provided by way of non-limiting example, in which:

- figure 1 illustrates a significant portion of an air treatment apparatus, according to a first embodiment;
- figure 2 is a longitudinal section of an attachment portion of a pulsion channel used in the apparatus of figure 1;
- figure 3 is a longitudinal section of an attachment portion between successive modules used in the ap-

paratus of figure 1;

- figure 4 is a longitudinal section of the drive transmission system to the pulsion channel;
- figure 5 is a perspective view of an attachment portion of the treatment plant according to what is described;
- figure 6 is a longitudinal section view of the pulsion channel suspension system used in the described plant;
- figure 7 is a detail of the pulsion channel suspension system illustrated in the preceding figure; and
- figures 8a and 8b are simplified section views of two different operating configurations of the diffusion channellings of figure 1.

DETAILED DESCRIPTION

[0035] With reference to the above figures, reference numeral 1 denotes in its entirety an apparatus for air treatment and in particular for the conditioning of rooms.

[0036] How can be noted from figure 1, the conveyor channelling 6 is constituted by a number of tubular modules (possibly with different sections) suitably joined together such as to transport the treated air coming from the treatment unit 2 (or from treatment units when there is more than one of them) to the environment where, through suitable speakers, air can be introduced into the environment to be conditioned. In particular, the example of figure 1 shows a conveyor channelling 6 which comprises a main channel 29 which receives the air directly from the fan 2 and conveys it to a predetermined number of secondary channellings 30 (only one of which is represented in the accompanying figures) by the use of suitable node modules 31 which deviate air from the main channelling 29 and deflect it towards the secondary channellings 30. By way of example, the main channelling exhibits a square or rectangular section, while the secondary channellings 30 have a circular cross-section. The node module 31 connects the various portions and sections of the channelling 6.

[0037] Still in reference to figure 1, it can be seen how the channelling 6 has at least an end 6a, part of the secondary channelling 30, coupled to a channel 3 having appropriate through-holes 4 for the introduction of the treated air in the environment. Figure 2 shows, in a schematic view and in longitudinal section, a possible coupling system 25 between the end 6a of the channelling 6 and the corresponding end of the third perforated channelling 3. It should first be noted that the coupling system is configured in such a way as to enable a relative rotation of the above-mentioned ends 3a, 6a about a longitudinal axis 5, while substantially preventing axial sliding along the same axis. In detail, one end of the perforated channel 3 is inserted inside the corresponding end 6a of the channel 6. Obviously, the opposite configuration, with the end 3a of the perforated channel external of the channel 6 is alternatively possible.

[0038] In order to achieve the mentioned constraint with a degree of rotational freedom the respective ends 3a, 6a can exhibit a circular cross-section with different diameters, in such a way as to define an annular gap 26 interposed between the inner surface of the external channelling and the outer surface of the inner channelling. Optionally, one or more rolling couplings 27 will be inserted in the annular cavity 26, for example at longitudinally-spaced cross-sections, such as to determine a stable rotation coupling between the conduit 6 and the perforated transport channelling 3. The embodiment illustrated in figure 2 indicates the presence of annular projections 32, 33 defined both at the end 6a of the channel 6 and at both ends 3a of the perforated channel 3. Assuming the coupling illustrated, these projections in longitudinal section define the respective semicircular seatings facing one another and destined to receive the above-mentioned rolling couplings 27, for example ball bearings, rotating bushings or other. In alternative and equally possible solutions, the above-mentioned projections 32, 33 can be facing in the same direction, i.e. both outward-facing or both inward-facing, so as to define substantially complementarily-shaped surfaces intended to couple when the plant is assembled. In this last case, the projections define reciprocally-coupling ribs enabling the above-mentioned relative rotation about the longitudinal axis 5, while preventing a relative translation of the ends 3a, 6a along a same axis. Obviously other and different forms of coupling and coupling systems 25 are possible as long as they allow the above-mentioned degree of rotational freedom and a substantial longitudinal constraint. Small movements along the axis 5 of the respective ends 3a, 6a can be allowed, for example by means of screw couplings or similar. Note that in general the channel 6, constituted by the said modules, are made of rigid material, such as a metal material. The modules defining the channel 6 can be obtained by suitably bent or curved metal sheeting. Although less advantageous from the point of view of simplicity of construction and coupling, the sections of the ends 3a and 6a can also not be circular provided that a relative at least partial rotation by a predetermined angle established *a priori* is allowed.

[0039] Returning to figure 1, it can be observed that the perforated channel 3 is constituted by a predetermined number of tubular modules 20 arranged consecutively to one another and appropriately joined. Figure 1 shows in particular three perforated modules 20 consecutive to one another. Obviously the number of modules 20 can be any according to design requirements and the conditioning needs of the environment. Further, perforated modules 20 can be alternated with non-perforated sections of channelling where treated air is simply to be conveyed and not introduced into the environment in certain sections of the channelling 3. At the external surface thereof the perforated channelling 3 exhibits the above-mentioned through-holes 4 which can exhibit different passage areas suitably arranged to ensure the inductive effects described below. In general, the special perforations applied include two types of holes: induction holes that are smaller and decide the amount of ambient air to be mixed with the air flow; and guide holes that are larger and decide what direction, speed and distance to convey the mass of pre-mixed ambient air from the induction holes. The fluid draughts of the delivery air exit the holes with a micro-turbulent flow that creates a deep depression around the base of the hole by recalling, via induction, a quantity of ambient air which in general terms might reach thirty times higher than the delivery air. In other words, both the induction holes and the guide holes, and in general the holes 4, are such as to define a significant pressure increase localised at the holes themselves. In this way the air coming from the holes, applied in particular to materials having low thickness, causes a micro-turbulent induction flow. In this case, a high-induction diffusion of air is obtained, causing a large-scale mixing of the supply air and the ambient air. Obviously, the higher the induction the shorter the launch, greatly limiting installation heights, particularly in the winter season when the temperature of introduction is higher than ambient temperature. Obviously, the flow direction exiting from the above-mentioned holes define an angle with respect to a reference plane, for example a horizontal plane referred to as the launch angle. The launch angle α is substantially defined by the geometry and positioning of the perforated holes on the module 20 of the perforated channel 3. Observing in particular figure 3, it can be seen that the plurality of consecutive tubular modules 20 exhibit, at respective ends 20a and 20b, a terminal edge 22 emerging radially from the longitudinal lateral surface 23 of the module 21 distancingly from the respective development axis. During assembly of several modules 20, the emerging end edges 22 of opposite ends of adjacent modules 21 are facing and substantially in contact with one another. The coupling of successive modules 21 takes place through the adoption of a rigid constraint device 21 configured such as to join the facing ends of consecutive modules. The rigid constraining device 21 guarantees solidarity in movement to two consecutive modules 20, both in the axial direction along the axis of development 5 and in rotation with respect to the axis thereof. In particular, the rigid constraint device 21 is constituted by a suitable strap, such as a metal clamp, having a sectional shape which is such as to be complementary with and embrace the two emerging end edges 23 of successive modules and to tighten them to one another so as to define a solid coupling thereof. In particular, the strap is wrapped externally around the end edges 21 a, 21 b and straddles the projections 22 before being tightened with an appropriate key or adjusting system.

[0040] Returning to the schematic representation of figure 1, it can be observed that the system also includes a movement device 7 directly or indirectly active on the perforated channel 3 such as to vary a relative angular position with respect to the conveyor channelling 6. The handling device 7 is provided with at least an actuator 8, such as for example a suitable motor, which via a transmission system 9 imparts rotary motion to the perforated channelling 3. The transmission system 9 comprises a suitable revolution-reducing device for the engine and transmits motion to a rotary drive pulley 15 mobile in rotation about a respective axis 28 that will be in general terms parallel to the longitudinal axis 5 of the channel 3. The drive pulley 15 transfers motion by means of a belt 10. In particular, the belt 10 has a respective coupling portion that is at least partially engaged to a corresponding coupling portion 12 present on the external surface 13 of the perforated channel 3 (figure 4). In other words, by means of the above-mentioned elements the movement device 7 can transfer the motion of the actuator 8 to the perforated channel 3 such as to determine at least an angular rotation varying the launch angle α of the air into the ambient. In other words, the movement device 7 is able to configure the channelling 3 in a plurality of different operational configurations with different launch angles α of the air into the environment. In this regard, figures 8A and 8B illustrate two different operating conditions achieved by the channel 3 as a result of a movement via the device 7.

[0041] Observing in particular the detail of figure 4 (a cross-section at the handling device), note that the coupling portion 11 of the belt 10 and the coupling portion 12 of the perforated channel 3 exhibit substantially complementarily-shaped respective surfaces 11 a, 12a, for example cogged surfaces or surfaces with trapezoidal-section projections.

[0042] In this way a precise coupling between the two elements is guaranteed such that relative slippage is prevented. In this way a number of revolutions of the motor or rotary pulley 15 can be singly connected to a corresponding angular variation (positive or negative) of the launch angle α. Therefore, the launch angle α can be varied in any way at all.

[0043] In this way it is also possible to exercise a precise control over the position of the through-holes 4 once the channel 3 has been moved. Still in reference to figure 4, the coupling portion 12 of the perforated channel 3 is defined by a profiled element 14, separate and rigidly connected externally to the channelling, in such a way as to be solid in motion therewith. For example, the profiled element 14 could be defined by a rubber or metal strap wound on the external surface 13 of the respective module 20. The shaped element 14 may completely surround the external circumference of the channel 3 as shown in figure 4 for example and be constrained by a suitable clamping 34 constituted, for example, by a screw or a rivet that couples one and/or another end of the shaped element 14 to the section of channelling 3. Note also how the surface of the profiled element 14 is complementarily shaped 12a, at least at the coupling portion 12 of the channel 3. Note that the profiled, represented as trapezoidal in section, is entirely exemplary. The profiling is illustrated over the whole development of the profiled element 14, i.e. by 360°, but might alternatively only be present at one or more portions of the circular surface of the profiled element 14. The important thing is to ensure a proper coupling with the belt 10 in order to reach the desired angular positions for which the device is intended. Additionally, it can be seen that the profiled element 14 extends, in figure 4, over an angle of approximately 360°. The profiled element might extend only over an arc of a circle with an opening of 15°, or at least 45° or at least 90°.

[0044] In the illustration of figure 4, the belt 10 is defined by a closed loop which externally embraces the perforated channel 3 to which motion is to be imparted. In embodiments that are not illustrated, the belt 10 can be constituted solely by a portion of the loop that goes from the rotating pulley 15 up to the coupling portion 12 of the perforated channel 3. In this situation an end of the belt 10 will be constrained to the rotary pulley 15, while the other end will be constrained to the surface 13 of the channelling 3. Two belts 10 may of course be included, defined by portions that extend between the rotary pulley 15 and a left end of the channel 3 between the pulley 15 and a right end of the channel.

[0045] Two or more movement devices 7 may also be present, according to design requirements, in particular in relation to the dimensions and the length of the channelling 3 to be moved. Obviously, the movement devices 7 can be synchronized such as to move the perforated channel 3 with the same launch angle α variation along the entire longitudinal development 5, or can be independent such as to be able to vary the launch angle α in a different way at different modules of the channel 3. Finally, the belt 10 has been represented in figure 4 as having respective complementarily-shaped surfaces 12a over the entire development of the ring. Obviously the profiled elements 12a will be present only at certain portions of the belt itself.

[0046] Returning to figure 1 note also the presence of a suspension system 16 constrained to the perforated channelling and configured such as to enable the rotary motion of the channel itself about the longitudinal axis 5 thereof. As shown in figures 6 and 7, the suspension system 16 comprises at least an auxiliary belt 17 and at least an idle pulley 18 to which the auxiliary belt 17 is engaged. In use conditions the pulley 18 is located superiorly of the perforated channel 3, and has a rotation axis of 19 substantially parallel to the longitudinal axis 5 of the perforated channel 3. The belt 17 generally has a flat surface with a rectangular section, for example, and is destined simply to enable support of the channel and rotation thereof. The auxiliary belt 17 of the suspension system 16 is also defined by a closed loop and externally embraces the perforated channel 3 so as to support it and enable the degree of rotational freedom.

[0047] The described embodiment of the treatment apparatus attains important advantages.

[0048] In fact, the system is arranged so as to be able to vary at will the launch angle of perforated channels 3 of respective modules 20 according to requirements. The launch angle can be increased when setting the system, for example at start-up thereof in the winter when the air needs to be mixed rapidly and where ground draughts can only be tolerated for short times. In fact in this way the cold air present at the floor level of the ambient is more rapidly mixed and homogenized, thus improving the initial performance of the system.

[0049] Also, the adjustment of the launch angle can be carried out to correct any design errors which may have generated ground draughts, i.e. it can also be used to take account of any variations in the environment to be conditioned, for example related to the realisation of new spaces or the positioning of furniture or the like.

Claims

1. Apparatus for air treatment, comprising:

- at least an air treatment unit (2) for generating an air flow;
- at least a channel (3) exhibiting a plurality of through-holes (4) for enabling injection of treated air into an environment in a predetermined launch angle (α), the channel (3) having a prevalent development direction (5);
- at least a conveyor channelling (6) for transferring air to be diffused by the treatment unit (2) to the perforated channel (3), the perforated channel and the conveyor channelling (6) being rotatably coupled such as to enable a relative rotation of the channel (3) with respect to the channelling (6) about the prevalent development direction (5), the rotation of the channel (3) modifying the air launch angle (α).

2. The apparatus of the preceding claim, further comprising a movement device (7) active, directly or indirectly, on the perforated channel (3) such as to vary a relative angular position with respect to the conveyor channelling (6).

3. The apparatus of the preceding claim, wherein the movement device (7) comprises:

- at least an actuator (8), for example a motor;
- a transmission system (9) having at least a belt (10) configured such as to directly or indirectly receive drive from the actuator (9) and transfer the drive, directly or indirectly, to the perforated channel (3) such as to determine at least an angular rotation thereof which varies the launch angle (α).

4. The apparatus of the preceding claim, wherein the belt (10) exhibits a coupling portion (11) at least partially engaged to a corresponding coupling portion (12) of the external surface (13) of the perforated channel (3), in particular the coupling portion (11) of the belt (10) and the coupling portion (12) of the perforated channel (3), exhibiting respective surfaces (11 a, 12a) substantially complementarily shaped, for example cogged surfaces with a trapezoid section.

5. The apparatus of the preceding claim, wherein the coupling portion (12) of the perforated channel (3) is defined by a profiled element (14) rigidly constrained externally to the perforated channel (3) and solid in motion therewith.

6. The apparatus of the preceding claim, wherein the profiled element (14) develops perimetrally and in an external position about a transversal section of the perforated channel (3) by at least an angle comprised between 15° and 360° and in particular by at least an angle comprised between 45° and 360°, still more in particular by an angle comprised between 90° and 360°.

7. The apparatus of claim 4, 5 or 6, wherein the belt (10) develops about a transversal section of the perforated channel (3) by at least an angle comprised between 15° and 360°, and in particular by at least an angle comprised between 45° and 320°, still more in particular by an angle comprised between 90° and 320°.

8. The apparatus of any one of claims from 3 to 7, wherein the belt (10) is defined by a closed ring externally embracing the perforated channel (3) to which the drive is to be imparted, the belt (10) receiving the drive from an appropriate rotary pulley (15) receiving the drive, in turn, directly or indirectly from the actuator (8).

9. The apparatus of any one of the preceding claims, further comprising a suspension system (16) constrained to the perforated channel and configured such as to enable a rotary motion of the perforated channel (3) about the longitudinal development axis (5) thereof, in particular the suspension system (16) comprising at least an auxiliary belt (17) and at least an idle pulley (18) to which the auxiliary belt (17) is engaged, the pulley (18) being located, in use conditions, above the perforated channel (3) and exhibiting a rotation axis (19) that is substantially parallel to the longitudinal development axis (5) of the perforated channel (3).

10. The apparatus of the previous claim, wherein the auxiliary belt (17) of the suspension system (16) is defined by a closed ring and externally embraces the perforated channel (3) to support and allow the channel (3) a degree of rotational freedom.

11. The apparatus of any one of the preceding claims, wherein the perforated channel (3) comprises a plurality of consecutive tubular modules (20), at least one of which exhibiting the perforations (4), and a rigid constraint device (21) configured to join together respective flanked ends (20a,20b) of consecutive tubular modules (20), the rigid constraint device (21) substantially guaranteeing a solidarity in motion to two consecutive modules.

12. The apparatus of the preceding claim, wherein the modules (20) exhibit, at respective ends (20a, 20b), a terminal edge (22) emerging radially from the lateral longitudinal surface (23) of the module (20), the rigid constraining device (21) comprising a strip (24) located straddling emerging terminal edges (22) of respective flanked ends (20a, 20b) of consecutive tubular modules (20) to constrain the tubular modules (20) solidly by friction coupling.

13. The apparatus of any one of the preceding claims, further comprising a coupling system (25) between the conveyor channelling (6) and the perforated channel (3) configured to enable a constraint with a relative rotational degree of freedom between the conveyor channelling conveyor (6) and the perforated channel (3), the conveyor channelling (6) and the perforated channel (3) exhibiting respective facing ends (3a, 6a) one inserted in another, in particular the ends (3a, 6a) having a circular section with a different diameter defining an annular space (26), one or more revolving couplings (27) being optionally inserted in the annular space (26), for example at longitudinally successive sections to determine a stable rotational coupling between the conveyor channelling (6) and the perforated channel (3).

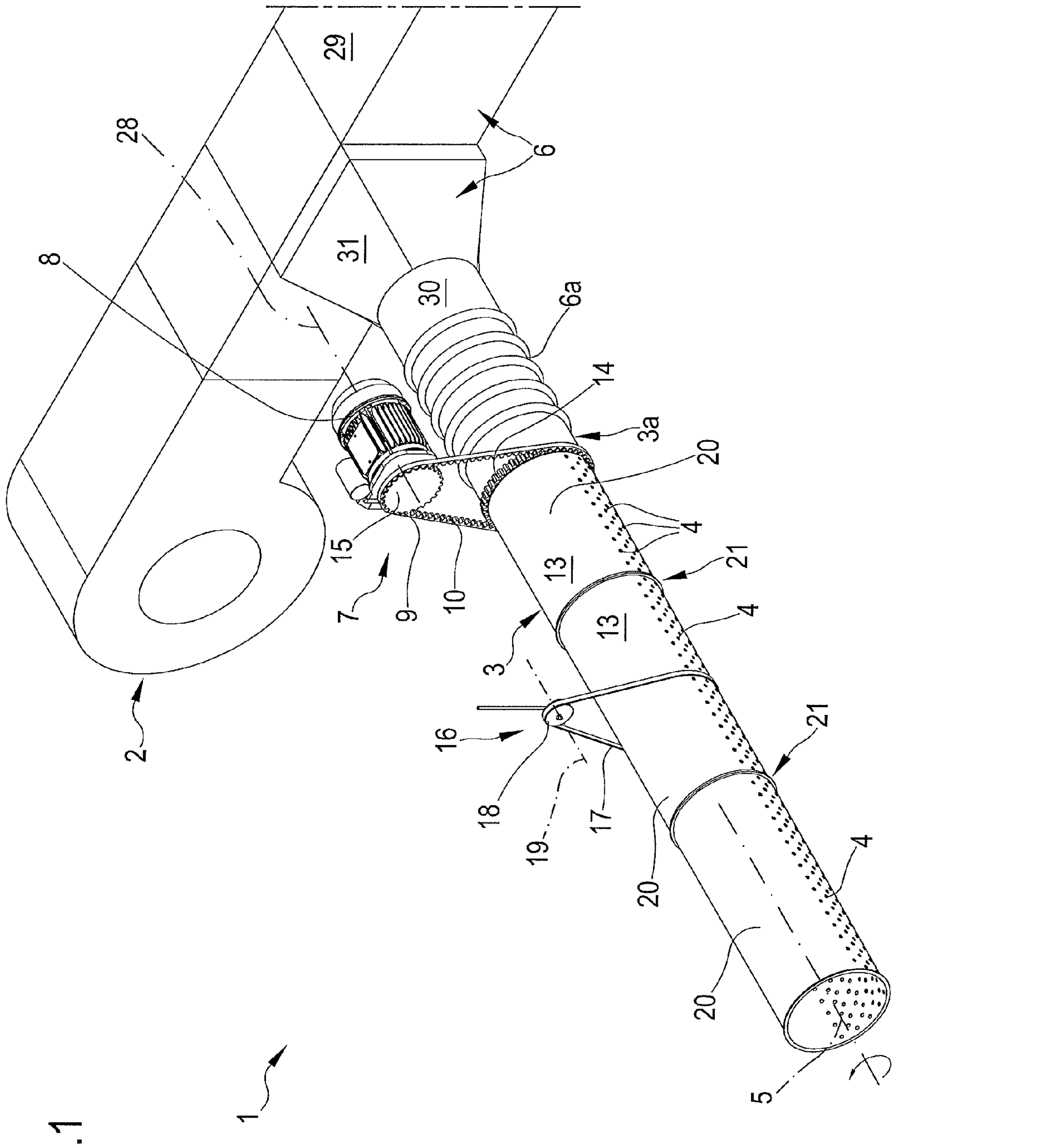

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FIG.1

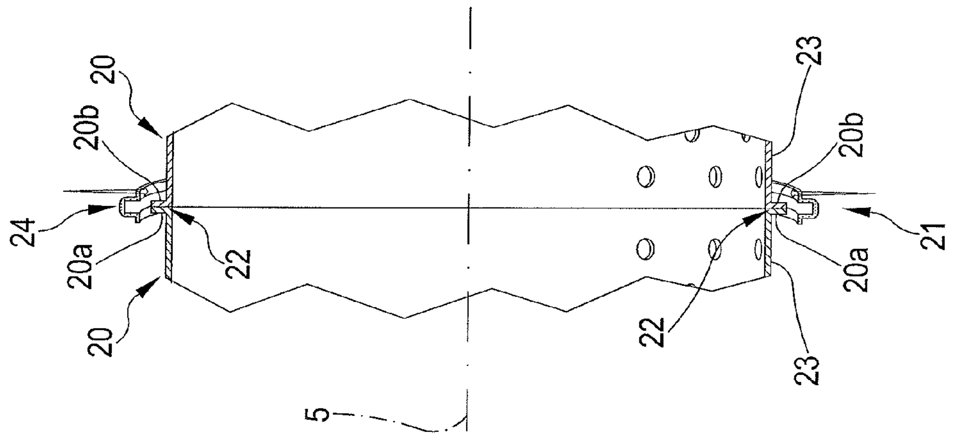
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FIG.3

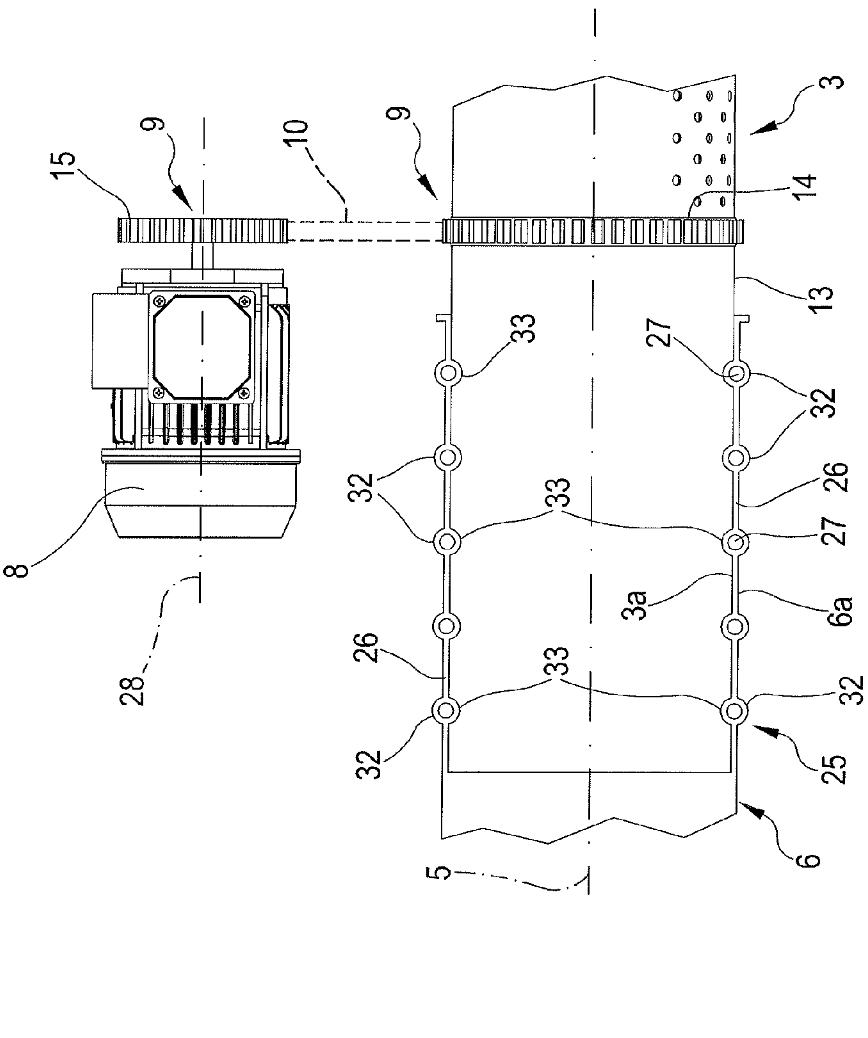
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FIG.2

FIG.4

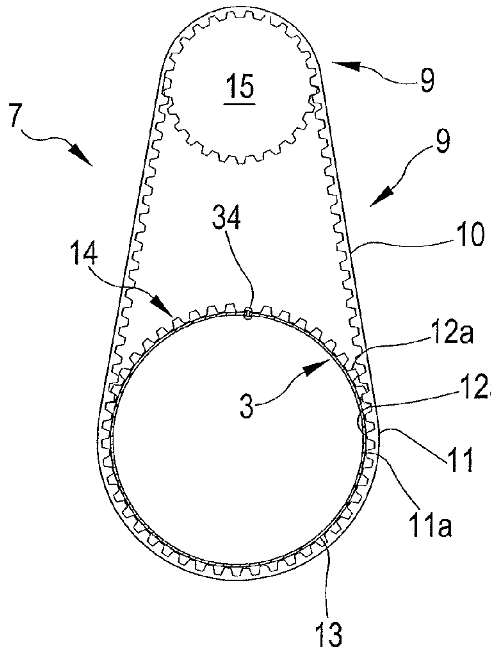
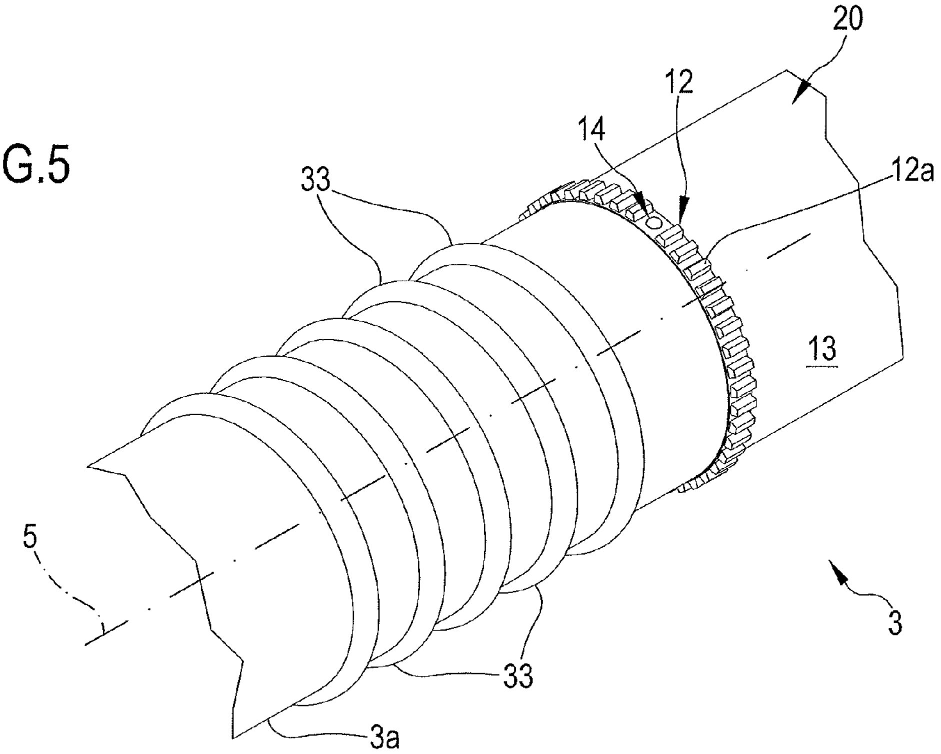


FIG.5



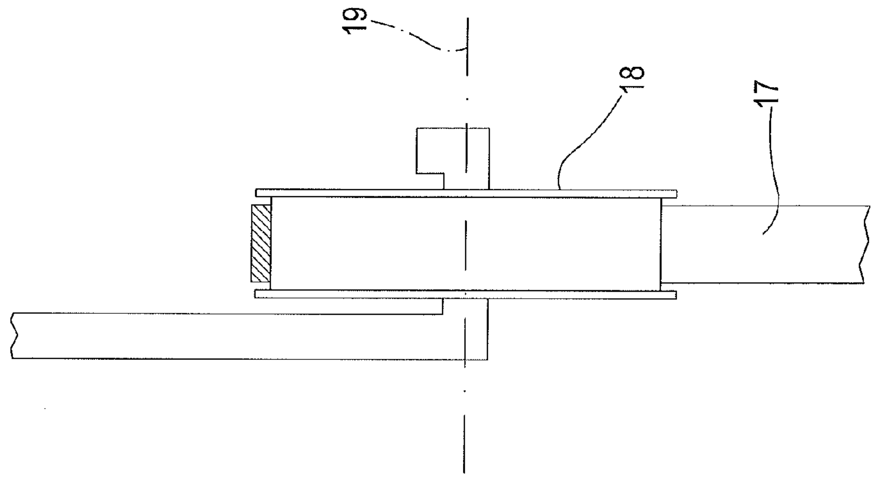


FIG.7

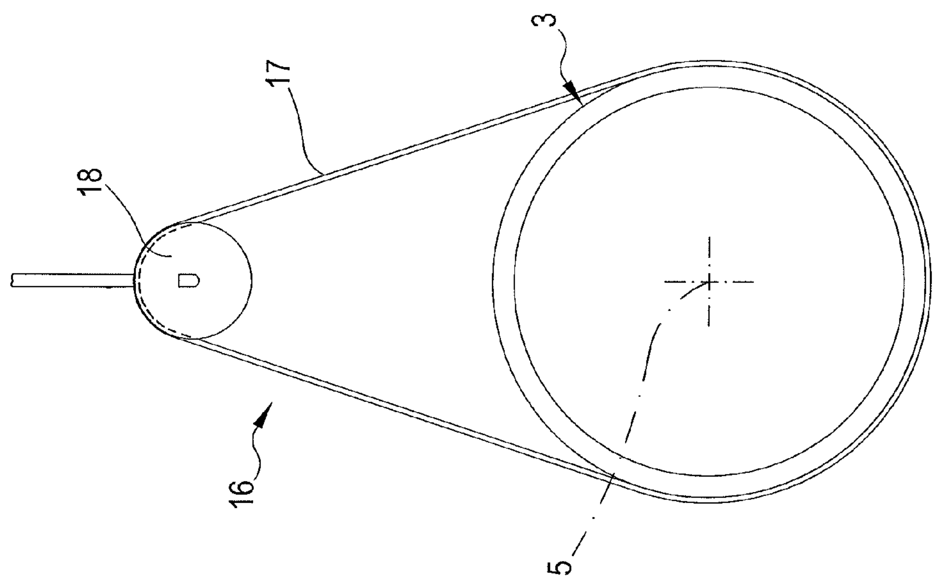


FIG.6

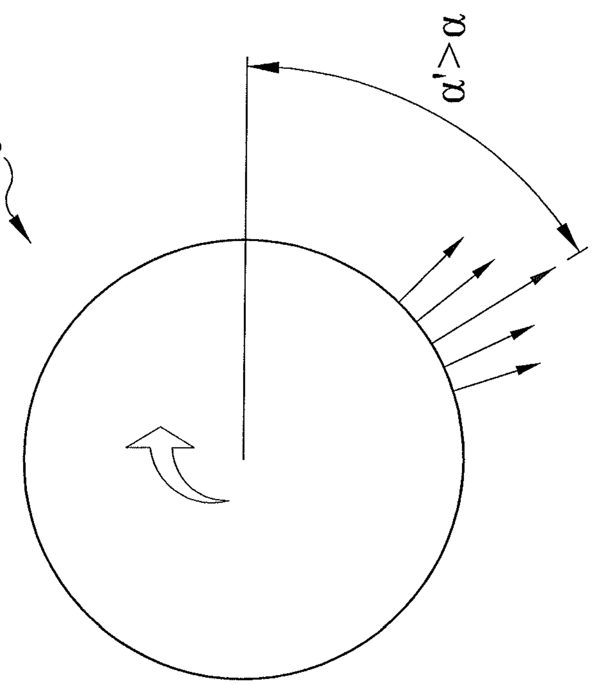


FIG.8B

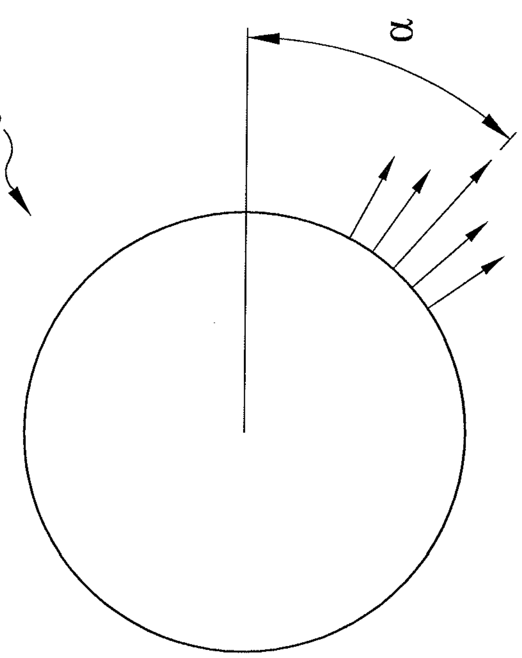


FIG.8A

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 2244022 A **[0008] [0017] [0024]**