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Publication number:

0 097 011
A2

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EUROPEAN PATENT APPLICATION

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Application number: 83303220.4

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Int. Cl.³: **B 05 D 1/14, B 05 B 7/14**

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Date of filing: 03.06.83

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Priority: 14.06.82 CH 3614/82
11.11.82 GB 8232267

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Date of publication of application: 28.12.83
Bulletin 83/52

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Designated Contracting States: **AT BE CH DE FR GB IT
LI LU NL SE**

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Fluid entrainment of fibrous material.

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The invention relates to a method of entraining a fibrous material in a fluid stream by forming a plug of the fibrous material, progressively removing particulate portions from said plug, e.g. by shredding, and admixing said particulate portions with a fluid stream for entrainment thereby. The fibrous material is preferably compacted to form a substantially fluid type plug. Means may be provided for introducing additives and/or binders into said fluid stream either before or after entrainment of said fibrous material.

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FLUID ENTRAINMENT OF FIBROUS MATERIAL

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DESCRIPTION

The present invention relates to a fluid entrainment of fibrous material, and particularly to entrainment of fibrous material in air.

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It is often desirable to entrain fibrous material in air, for example, so that it may be sprayed as an insulative layer over a desired surface, or in the textile industry during fibre production.

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Because fibrous materials are generally light, entrainment thereof in an air line presents problems since positive pressures are difficult to apply to the air line without risking blow-backs into the fibre hopper, and negative pressures, while more usually applied, tend to cause blockages if the flow is momentarily interrupted for any reason. Further, where negative pressures are utilized and fibrous material particles are introduced to an inlet,

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comparatively large volumes of air must be shifted

relative to a given weight of fibrous material in
order to prevent blockages, and to satisfactorily
entrain the particles in a satisfactory manner. This
requires fairly large energy consumption, most of
5 which is unnecessary for entrainment alone.

The present invention addresses these difficulties by
compaction of the fibrous material to form a fluid
tight plug immediately adjacent a fluid stream, means
10 being provided to shred the compacted fibrous material
into the entraining fluid.

There is, thus, no pressure connection between a
hopper containing compacted fibrous material and the
15 shredder.

According to the present invention, there is provided
a method of entraining a fibrous material in a
fluid stream which method comprises
20 compacting the fibrous material to form a plug
progressively removing particulate portions from
said plug
and admixing said particulate portions with a
fluid stream for entrainment thereby.

The invention also includes

apparatus for the entrainment of a fibrous material in a fluid stream characterised by

a container for fibrous material

5 compaction means for compacting said fibrous material into a plug

means for removing particulate portions from said plug and

10 high pressure fluid conduit means for said fluid stream

the arrangement being such that the compaction means compacts the fibrous material to a plug of sufficient density of prevent substantial flow back from the high pressure fluid conduit means to said container and advances said plug to said removing means whereby particulate portions are all trained by said fluid stream.

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The container may be a hopper provided with a drive means to move the fibrous material to a hopper exit. Said drive means may constitute a driven shaft having a plurality of inclined blades thereupon to move said material to said hopper exit or, alternatively, a worm drive may be provided.

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Having reached the hopper exit the particulate material may be supplied to a primary compression means, said primary compression means being optionally constituted by a pair of parallel drive shafts, each
5 being provided with a plurality of plates, disposed substantially perpendicular to said shafts, and in an interlocking relationship. The drive shafts may be disposed substantially vertically, and the upper of said shafts may be driven at a slower speed,
10 preferably 10 to 50% lower than the lower shaft. The plate may be continuous and at least substantially circular in cross section, or may be bladed but subsist in a single plane.

15 The primary compression means is adapted to remove fibrous material from the hopper exit and supplying it as a uniform constant volume supply of semi-compacted fibrous material to a main plug-forming compression unit.

20 Preferably, the fibrous material leaves the primary compression means as a coherent mass which is sufficiently dense that it does not slump significantly, and which tends to cohere if removed

from the primary compression means, into free falling aggregates.

5 The primary compression means, the hopper drive means and the main compression unit are all, preferably, operatively interconnected such that the relative RPM ratios are fixed to achieve a desired compression of the fibrous material throughout the various compression stages.

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Thus, any change in driving speed would automatically result in the necessary relative changes in the ratios provided.

15 The main compression unit is preferably a worm conveyor, although, of course, its mechanical equivalents are also suitable. Such a worm conveyor takes up the coherent fibrous material mass from the primary compression means, and moves it to the fluid, usually air, entrainment point. The main compression unit is preferably formed with a first area wherein the fibrous material has its density increased, and a second area wherein the material is maintained at its maximum density, thereby forming a plug. This plug prevents blow-back through the compression unit.

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In the embodiment of the invention in which the first area of the main compression unit comprises a worm drive, portions thereof may have different pitches so that differing degrees of compression can be applied

5 in different areas. Preferably, the pitch of the worm drive adjacent the primary compression means is finer than the pitch adjacent the plug forming area. The intermediate portion therebetween, often constituting the portion of the worm drive from $\frac{1}{3}$ to $\frac{2}{3}$

10 of its length, can be arranged to be of progressively coarser pitch, in a direction towards the fibrous plug in order to provide a gradually increasing pressure. The worm drive is preferably accommodated in a tube, the worm extending from 75 - 95% of the length of the

15 compression unit, thereby leaving 5 to 25% for the plug forming area. In the plug forming area fibrous material is moved progressively to the entrainment point.

20 Further, if desired, the diameter of the worm drive can be progressively or instantaneously reduced by from 5 to 50% at the point where the pitch begins to coarsen, thereby to increase the efficiency of plug

formation. The plug zone, therefore, extends from the end of the worm drive to the point of entrainment.

5 The plug not only forms a seal against blow-back, but also forms a structure from which suitably sized particles can be removed and entrained in the air flow.

10 Adjacent the end of the plug zone is a knife head which acts upon fibrous material in the plug to remove suitably sized particles. The knife head may form part of a fluid conduit through which entrainment fluid, usually air, flows at a constant speed.

15 A venturi can, if desired, be positioned adjacent the entrainment point to raise this speed at the entrainment point to assist in entrainment.

20 The knife is preferably rotated so as to contact the plug with suitable blades or pins as the plug progressively obtrudes into the air stream. By adjusting the speed and form of the knife, and the entrainment air speed, a desirable entrainment can be produced and varied at will. The knife head is
25 preferably arranged in a housing which can be readily

detached so that the knife blades can be changed as desired.

5 In a further feature of the invention, there is provided at the end of the fluid conduit an applicator means. This is adapted to apply to the entrained fibrous material debouching from a nozzle of the fluid conduit any suitable system for reaction with, or addition to, the entrained fibrous material.

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Accordingly, there is provided in a further feature of the invention, a fluid conduit for the passage of entrained fibrous material, terminating in a delivery nozzle, characterised in the provision of a plurality of dispensing jets, disposed in a generally regular spaced array about said nozzle, and inclined inwardly at an angle of 10 to 30° toward the axis of the nozzle. The angle is most preferably 15 to 20°.

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The spray angle of the nozzle may be between 30 and 50° (i.e. from 15 to 25° from the longitudinal axis of the nozzle) and in which case, in ordinary applications, the substance to be applied from the

jets and the fibrous material will intermix some 25 to 200 cm, (preferably 50 to 150 cm) from the nozzle.

5 This aerial admixing of the components prevents clogging of the system with the substances to be applied to the fibrous material (e.g. binder) and, of course, allows a much wider range of component systems to be utilized. Such may include, for example, binder systems, solvents and other miscellaneous reactants.

10 Further, the ratio of the fibrous material to the binder material maybe readily varied.

If desired, the jets may also be angularly displaced in a circumferential direction to impart swirl to the aerial system; the angular displacement may be 0 to 15 20°. Further, each or each group of jets may be adapted to dispense a binder component so as to allow aerial admixture of a plurality of components such as dyestuffs, pigments, flameproof agents, fillers, 20 hydrophobic agents, etc.

The term "fibrous material" used herein denotes a material present in the form of fibres of any usable size, or collections of fibres such as paper, textile

webs etc., which are mostly disintegrated. Thus,
suitable fibrous materials may be rockwool, ground
papers, irregularly shaped particulates. Further
powdered materials can be admixed with the fibrous
5 material in the hopper if desired, although they
cannot, of course, constitute a major proportion of
the admixture.

The invention will now be described, by way of
10 illustration only, with reference to the accompanying
drawings wherein:

Figure 1 shows a diagrammatic vertical cross section
through one embodiment of the invention.

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Figure 2 shows a transverse cross section along a line
A : A of Figure 1, and

Figure 3 shows in diagrammatic cross section an
20 applicator means for positioning at the end of the
fluid conduit of the device shown in Figures 1 and 2.

With reference, particularly to Figure 1, there is
provided a hopper 1 of a generally rectangular cross
25 section, the lower walls of which are inwardly

inclined to form a channel, positioned generally below the shaft 1A. The shaft 1A which extends throughout the effective length of the hopper 1 is provided with a plurality of paddles 23 which are inclined so as to force material toward a hopper exit 10.

Positioned below the hopper exit 10 is the primary compressor unit formed by a pair of horizontally disposed shafts 2, each bearing blades 2A and 2B which intermesh. The blades 2A are of a generally semi-circular configuration in cross-section, whereas the blades 2B are formed of a plurality of petal shaped elements disposed in a perpendicular plane.

Disposed below the primary compression means 2 is the main compression unit 3A which is formed of a cylindrical body disposed about the screw conveyor 3. The portion of the screw conveyor 3 immediately below the primary compression means is provided with comparatively fine pitched screw threads which coarsen over an intermediate portion to terminate in the maximum compression zone 4 of the most coarse thread to impart the maximum compression.

Further, the diameter of the screw conveyor 3 is at its maximum toward the left-hand side of Figure 1 reducing by up to 50% as the screw thread coarsens toward the maximum compression zone 4.

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The compression unit 3A terminates toward its right-hand side in a plug forming section 5 which constitutes between 5 and 25% of the length of the compression unit 3A.

10

As may be seen in Figure 1 the plug forming portion 5 terminates toward its right-hand end in an entrainment portion 8 extending generally perpendicular and horizontally to the compression unit 3A. Entrainment point is provided with a knife head 6 rotating about substantially a common axis with the worm conveyor 3 and driven by a motor 7.

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In operation, fibrous material is fed into the hopper 1 and shafts 1A, 2A, 2B and worm conveyor 3, are set in motion by virtue of an operative connection via gear train 9. The fibrous material is driven by the paddles 23 toward the exit 10. The fibrous material is then fed under gravity into the primary compression zone, and cited upon by plates 2A and 2B for partial

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compression. The partially compressed material which is now a coherent mass is fed to the screw conveyor 3 and gradually compressed within the compression unit 3A reaching its maximum compression at the compression zone 4 and forming plug 5 which is gradually expressed into the entrainment point 8.

It will be appreciated that an increase in speed of the gear train 9 automatically adjusts the relative rotational ratios of the shafts 1A, 2A and 2B and screw conveyor 3 so that the relative degrees of compaction are achieved at each stage.

With reference now to Figure 2, a rotor housing 11 is provided with inspection means (not shown) whereby a knife head 6 can be readily inspected. The knife head 6 is provided at its out ends with blades 13 which are readily interchangeable by removal of the housing. Adjacent the upper portion of the knife head 6 is a venturi 16 which acts to increase the speed of the entrainment air 12 at the entrainment point 8. It will be appreciated that with motor 7 engaged, the knife rotates about its axis shredding fibrous material from the plug 5. The plug 5 is thereby converted into fibrous particles entrained in air

stream 12 to form a mixed air entrained material 15.

The entrained mixture 15 exits to a nozzle 18 via conduit 17. Entrainment essentially takes place at mixing zone 14, the degree of entrainment being

5 dependent upon the rotational speed of the knife blades 13, the speed of air stream and the rate of introduction of the fibrous plug material 5. All these parameters can be controlled in order to provide the desired air entrainment ratio at the nozzle 18.

10 Obviously the length of the conduit 17 will be limited by its size, and the volume of air 12 available etc.

Turning now to Figure 3, it will be noted that the conduit 17 terminates in a nozzle 18 which, in this
15 particular instance, forms a spray of fibrous particles at an angle of 30° from the nozzle (15° from the axis of the nozzle). The spray is designated 21 for reference purposes.

20 Spaced at 180° intervals about the end of the nozzle 18 are dispensing jets 19 and 20 dispensing a binder system in sprays 22A and 22B. The two-component binder system is thereby provided; components A and B thereof admixing with each other and the fibrous

material within the zone 21 to provide a final fibrous material with binder admixed. Optionally, the dispensing jets 19 can be inclined at an angle of 20° in an arcuate direction thereby to impart a swirl to the exiting fibrous material, and to thereby increase the degree of admixture therewith.

It will be appreciated that by means of this aerial admixture, clogging occasioned by the interaction of component particles within the nozzle line which has previously occurred, is avoided.

The present invention, therefore, relates to a method and apparatus for the entrainment of fibrous material in a dispensing fluid, and to fibrous sprays so formed. It also relates, separately, to a method of aerially admixing components with a fibrous material, and to an apparatus for effecting the same.

CLAIMS

1. A method of entraining a fibrous material in a fluid stream which method comprises
 - 5 compacting the fibrous material to form a plug
 - progressively removing particulate portions from said plug
 - and admixing said particulate portions with a fluid stream for entrainment thereby.
- 10 2. A method as claimed in claim 1 wherein the fibrous material is compacted to form a substantially fluid tight plug which is advanced progressively to a cutting station.
- 15 3. A method as claimed in claim 2 wherein the plug is shredded at said cutting station for entrainment by said air stream.
- 20 4. A method as claimed in any preceding claim wherein a further additive is entrained with said admixture for delivery therewith.

5. Apparatus for the entrainment of a fibrous material in a fluid stream characterised by
a container for fibrous material
compaction means for compacting said fibrous material into a plug
means for removing particulate portions from said plug and
high pressure fluid conduit means for said fluid stream
the arrangement being such that the compaction means compacts the fibrous material to a plug of sufficient density of prevent substantial flow back from the high pressure fluid conduit means to said container and advances said plug to said removing means whereby particulate portions are all trained by said fluid stream.

6. Apparatus as claimed in claim 5 characterised in that said container comprises a hopper having a primary compression means comprising one or more driven shafts each having one or more plates disposed in a plane substantially perpendicular to said each shaft whereby rotation of said shaft results in compaction of said fibrous material towards said compaction means.

7. Apparatus as claimed in claim 5 or claim 6 characterised in that said main compaction means comprises a worm conveyor.

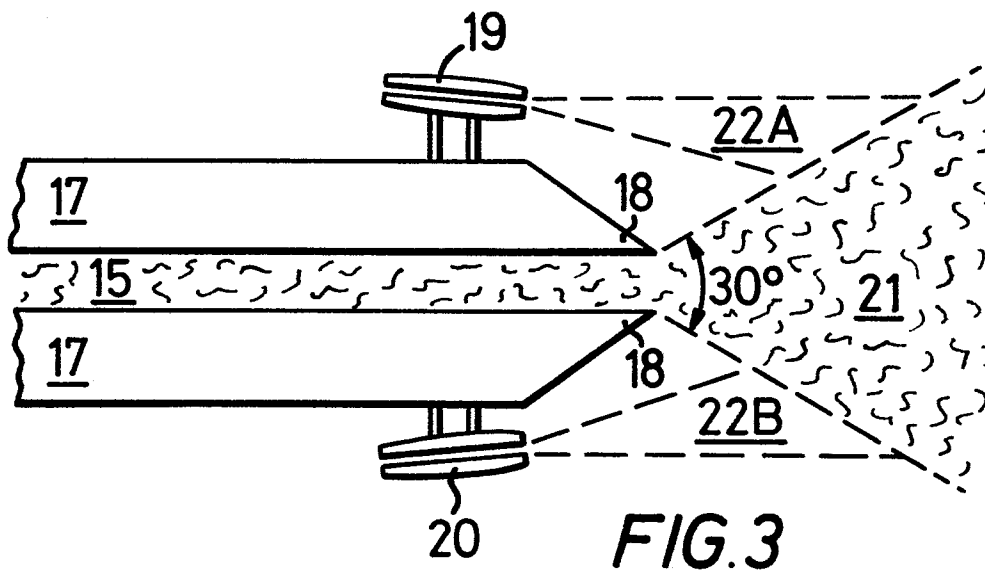
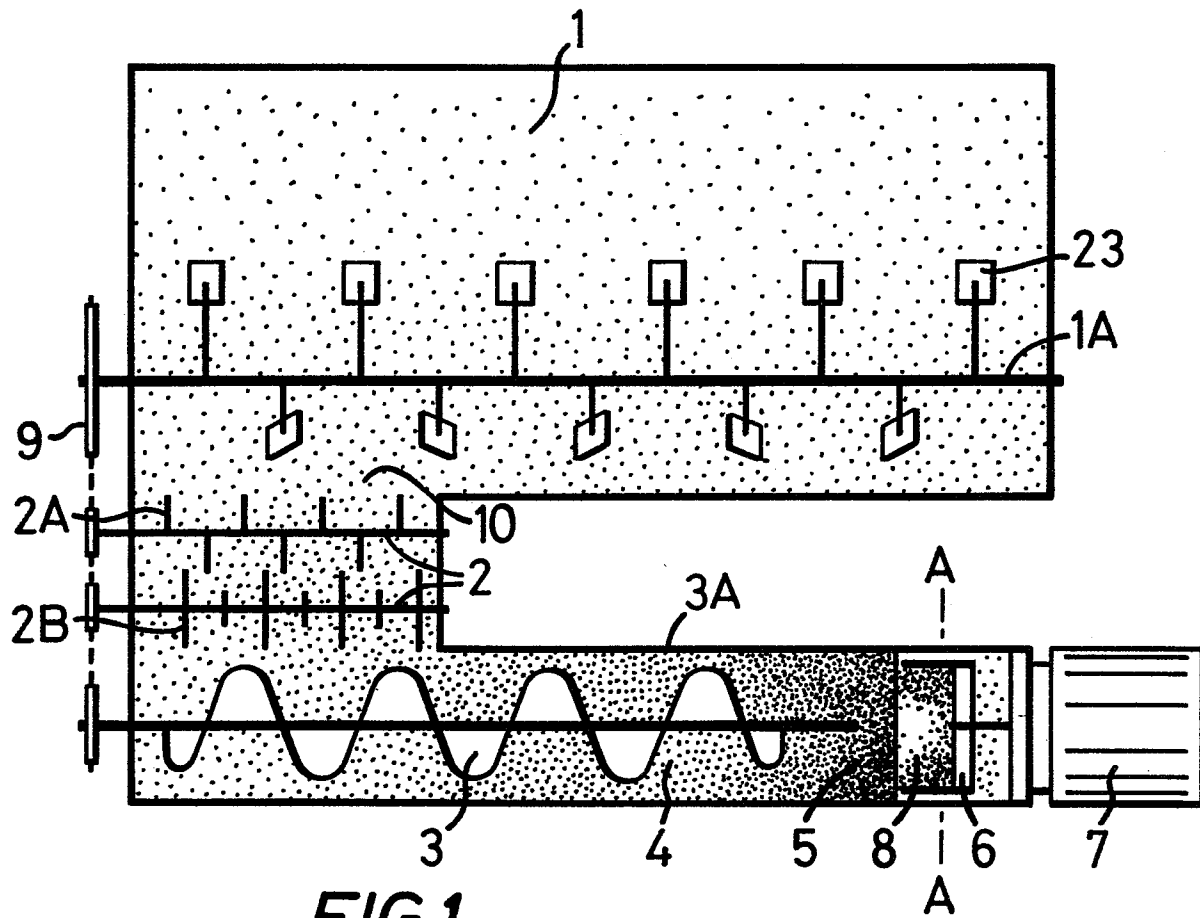
5 8. Apparatus as claimed in claim 7 wherein said worm conveyor has a varying pitch along its length in order to increase the compaction of the fibrous material as it is transported to form said plug.

10 9. Apparatus as claimed in claim 8 wherein said removing means is a driven knife head which acts on said advancing plug to remove suitably sized particles therefrom into said conduit.

15 10. Apparatus as claimed in claim 9 wherein the fluid conduit includes venture means juxtaposed said removing means in order to increase the fluid stream velocity in the vicinity of the entrainment point for the fibrous material.

20 11. Apparatus as claimed in any one of claims 5 to 10 wherein the said conduit terminates in a delivery nozzle and wherein one or more dispensing jets is disposed in juxtaposition to said nozzle for the

introduction of one or more additives to the fluid
stream admixture.



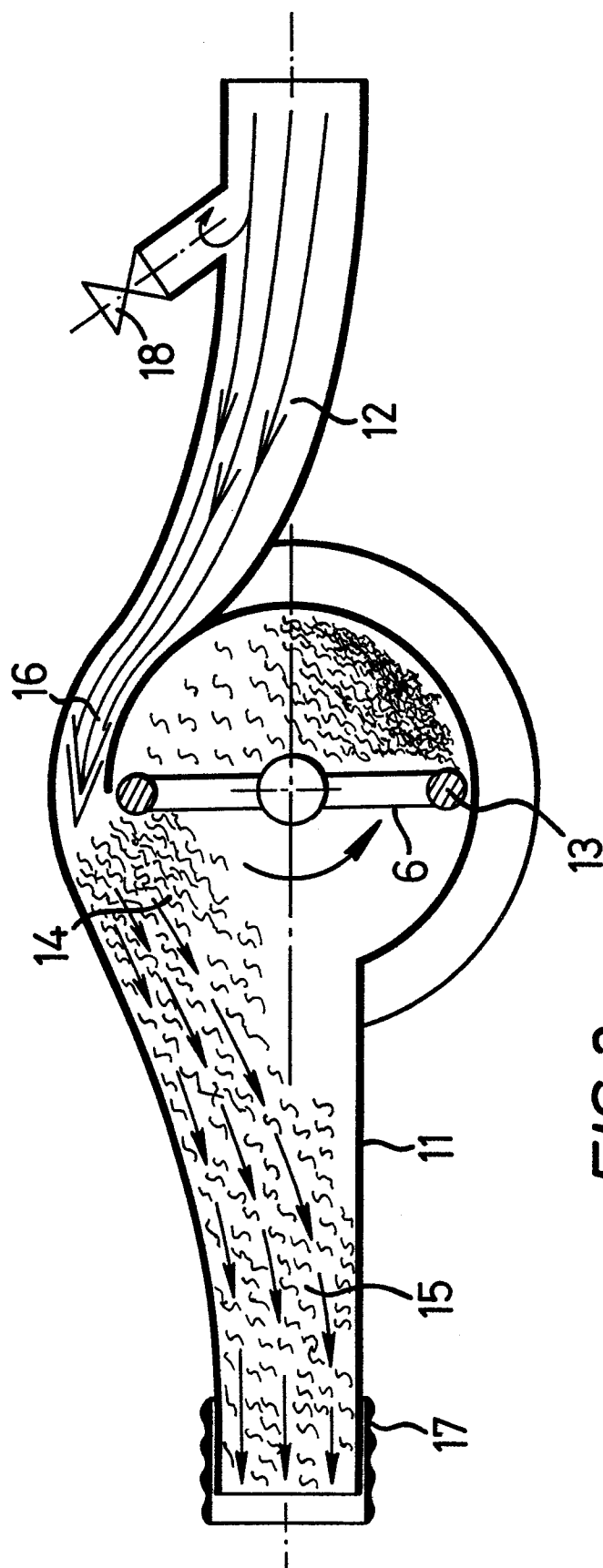


FIG. 2