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(54) Title: A MOBILE APPARATUS AND METHOD FOR FILLING AN ELONGATED BAG WITH PARTICULATE MATERIAL

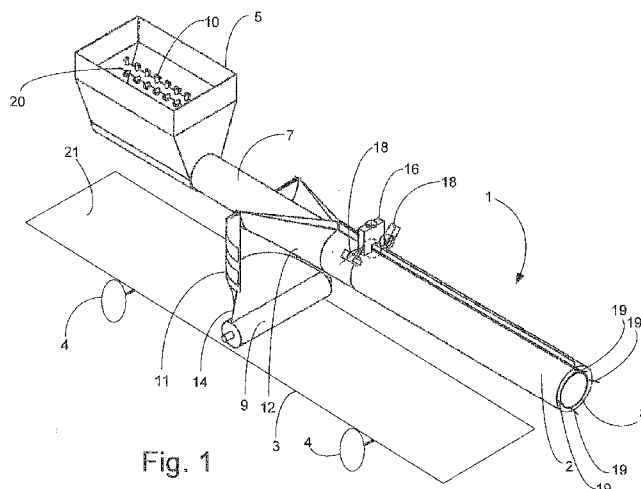


Fig. 1

(57) Abstract: There is described a mobile apparatus (1) for filling an elongated bag (2) with particulate material. The mobile apparatus (1) is adapted for moving along a surface at a controlled velocity, and comprises a receiving means (5) for receiving the particulate material to be filled into the elongated bag (2). The mobile apparatus (1) comprises a tubular member (7) adapted to extend essentially horizontally into said elongated bag (2) during filling, and a rotary auger (6) extending at least partially into said tubular member (7) from said receiving means (5).

A mobile apparatus and method for filling an elongated bag with particulate material

The present invention relates to a mobile apparatus for filling an elongated bag with particulate material, more specifically, a mobile apparatus for filling an elongated bag with particulate material, where said mobile apparatus is adapted for moving along a surface at a controlled velocity, where said mobile apparatus comprises a receiving means for receiving the particulate material to be filled into the elongated bag, and where the mobile apparatus comprises a tubular member adapted to extend essentially horizontally into said elongated bag during filling, and a rotary auger extending at least partially into said tubular member from said receiving means. The present invention also relates to a method for filling an elongated bag with particulate material comprising the providing of the particulate material to a receiving means, conveying the particulate material through an essentially horizontal tubular member into the elongated bag using an auger.

It is an old and well-tested technique to use bags filled with particulate material, such as sand, for creating temporary barriers against water intrusion from high water levels in costal and fluvial regions.

Traditionally, the sand is filled into relatively short bags having a length and width ratio allowing them to be handled by persons, e.g. allowing the bags to be manually stacked to form a barrier against the water. Such bags may have a length to width ratio of in the interval of e.g. 2:1 to 5:1. Stacking such bags to form a barrier involves individual handling of each bag, which is very labour intensive. Apart from the costs deriving from the labour performed by the personnel, there is also a safety consideration, because situations where flooding is threatening, the personnel involved may be endangered not only by the flood itself, but also from the weather conditions such as hurricanes. Moreover the faster a barrier can be established, the more the risk of flooding and danger for the personnel is reduced.

There is therefore an interest in a quick method with low labour-intensity for creating such barriers.

In this respect, US-A-5425403 and US-A-5901762 both disclose apparatuses using augers for filling particulate material into bags. However, both of these apparatuses only suggest the filling of – and are only suitable for filling short bags, such as the ones mentioned above having  
5 a length to width ratio of e.g. 2:1 to 5:1. Moreover, these apparatuses also rely on gravitation to fill these short bags and the chute therefore must be vertical. The auger only conveys the particulate material into the vertical chute, where it, as in US-A-6085810, falls down under the influence of gravitation. No compacting of the particulate material or any  
10 control of the filling degree of the bags in the sense of the present invention takes place.

Also, US-A-6085810 discloses a prior art mobile apparatus for filling an elongated bag with particulate material, where the mobile apparatus is adapted for moving along a surface at a controlled velocity,  
15 and said mobile apparatus comprises a receiving means for receiving the particulate material to be filled into the elongated bag. More specifically, this document suggests to use a sand filled cement truck, to fill an elongated bag via an open chute.

Though this apparatus allows for filling an elongated bag, it suffers from some drawbacks. The main drawback is that it relies on gravitation, when the sand slides down the chute and into the elongated bag. This makes it very difficult to control the filling rate and the filling degree, and thus a uniform compactness and height of the filled elongated bag, and the resulting barrier. Furthermore, it will be very difficult to re-  
20 fill the cement truck with sand without having to dismantle the chute arrangement first.

US-A-2006/0151057 and DE-A-102004009662 both suggest the use of augers to fill elongated bags using augers, for the use as barriers. Though longer than the bags described above these bags still have a limited length.  
30

Based on this prior art, it is the object of the invention to overcome the above drawbacks.

According to a first aspect of the invention this object is overcome with a mobile apparatus according to the opening paragraph,

characterized in that it comprises means adapted to continuously form said elongated bag from at least one continuous sheet of material around the outside of said tubular member by joining the edges of said at least one continuous sheet.

5           By using an auger in an essentially horizontal tubular member it becomes possible to compress the particulate material, e.g. sand, while the mobile apparatus moves along the surface and deploys the elongated bag as a barrier. This, in turn, ensures a completely filled bag with a controlled degree of filling and compactness of the particulate material,  
10 and thus an essentially uniform thickness of the barrier. In terms of deploying the elongated bag it should be noted that elongated bag in the context of the present invention means a bag having a length to width ratio longer than the short bags mentioned above, i.e. ratios of several tenths, or preferably hundreds or thousands to one. In particular, this al-  
15 lows elongate bags of in principle any desired length to be formed in-situ.

          According to a second aspect of the invention the object is achieved by a method according to the opening paragraph, in which said elongated bag is continuously formed around said tubular member by  
20 joining the edges of at least one sheet member, and in which said auger fills said elongated bag to a predetermined degree, so as to achieve a predetermined compactness of the particulate material in elongate bags of in principle any desired length formed in-situ.

          In a preferred embodiment according to the first aspect of the  
25 invention, the distal end of the tubular member is located at a predetermined distance from the distal end of the rotary auger. Preferably said predetermined distance is in the interval of 0.5 to 5 times the internal diameter of the tubular member, preferably in the interval of 1 to 3 times the internal diameter of the tubular member. This prevents or lim-  
30 its any rotary motion from the rotary auger to be transmitted via the particulate material to the elongated bag.

          In another preferred embodiment according to the first aspect of the invention, the mobile apparatus comprises control means for controlling the controlled velocity and the speed of rotation of said rotary

auger with respect to each other. Thereby it becomes possible to better control and to ensure a desired degree of filling and compactness of the elongated bag.

Thus, in a further preferred embodiment according to the first aspect of the present invention, the mobile apparatus comprises at least one sensor for monitoring the degree of filling of said elongated bag with the particulate material. Using such a sensor, allows direct monitoring of the degree of filling and compactness of the particulate material in the elongated bag, and thus aids in achieving a desired degree of filling of the elongated bag and compactness of the particulate material in said elongated bag.

According to an especially preferred embodiment according to the first aspect of the invention, said at least one sensor is located in connection with said tubular member. Locating said at least one sensor in connection with said tubular member, and in particular in connection with the distal end thereof, gives immediate response to the actual degree of filling of the elongated bag and the compactness of the particulate material in said elongated bag.

In yet another preferred embodiment according to the first aspect of the invention, the mobile apparatus comprises conveying means adapted to transport the elongated bag along the outside of said tubular member at a speed adapted to the speed with which the edges are joined, and the controlled velocity of the mobile apparatus. Thereby it becomes possible to continuously form the elongated bag without tension building up due to the rate with which the elongated bag is filled and/or deployed, which could possibly damage the seam or even the joining means.

According to another preferred embodiment according to the first aspect of the invention, the mobile apparatus comprises a sewing apparatus for joining the edges of said at least one continuous sheet. Sewing the edges together is an efficient method, which is moreover not difficult to perform even under harsh weather conditions.

According to a preferred embodiment of the second aspect of the invention, said method comprises monitoring said filling degree us-

ing at least one sensor in connection with the tubular member. Thereby the degree of filling of the elongated bag and the compactness of the particulate material in said elongated bag may continuously be monitored and the filling rate adapted to the deployment rate of the elongated bag.

According to yet another preferred embodiment the elongated bag is formed as an endless tube, which is pinched off at one end before filling. Simply pinching off an endless tube, e.g. by means of a zip-strip provides an efficient way of providing an elongated bag.

The two latter embodiments are in particular interesting in conjunction with the third aspect of the invention, i.e. the use of an elongated bag provided using a mobile apparatus according to any one of claims 1 to 7 as a barrier against water. In such cases long stretches of temporary barriers may continuously be provided rapidly along the top of existing dykes or levees.

The invention will now be explained in greater detail using non-limiting exemplary embodiments and referring to the schematic drawings, on which:

Fig. 1 is a perspective view of a mobile apparatus according to a first embodiment of the present invention adapted for continuously forming an elongated bag,

fig. 2 is a top plan view of the mobile apparatus of fig. 1,

fig. 3 is a side view of the mobile apparatus of fig. 1,

fig. 4 is a partially cut away perspective view of a mobile apparatus according to a second embodiment of the present invention adapted for continuously forming an elongated bag,

fig. 5 is a top plan view of the mobile apparatus of fig. 4,

fig. 6 is a side view of the mobile apparatus of fig. 4,

fig. 7 is a perspective view of the mobile apparatus of fig. 4 where an elongated bag is being formed,

fig. 8 is a top plan view of the mobile apparatus according to fig. 4 where an elongated bag is being formed.

Referring first to figs. 1-3 there is shown a first embodiment of mobile apparatus 1 according to the invention for filling and deploying

elongated bag 2 with particulate material. The particulate material will typically be sand, in particular when the mobile apparatus 1 is used for deploying a temporary barrier against water.

The mobile apparatus comprises an undercarriage 3 with wheels  
5 4 in order to achieve the desired mobility. The undercarriage 3 is only illustrated schematically, as it may take numerous forms depending on preferences and intended use. It may be adapted to be towed by a tractor or a lorry or be self-propelled, e.g. as a self-contained unit or using a lorry or the like as the undercarriage. In case of a self-contained unit the  
10 mobile apparatus 1 preferably comprises a main engine in the form of a Diesel or Otto engine, providing propulsion and driving generators and/or hydraulic pumps for auxiliary devices. Also, it may comprise caterpillar tracks instead of or in combination with the wheels 4. The mobile device 1 preferably comprises a computer or similar control means (not  
15 shown) in order to control the various functionalities of the mobile device 1, as will be explained later.

The mobile apparatus 1 comprises a receiving means 5 for receiving the particulate material. Preferably, the receiving means is a hopper as illustrated. As best seen in fig. 2 a rotary auger 6 extends essentially along the bottom of the hopper. The rotary auger 6 extends  
20 into a tubular member 7, inside which the distal end 13 of the rotary auger is located. The tubular member 7 extends essentially horizontally away from the receiving means 5 ending in an open distal end 8, which, as can be seen, is located inside the elongated bag 2 during filling. Slight  
25 deviations from horizontal may be possible, as long as the inclination does not lead to the material sliding by itself under the influence of gravitation, in which control over the compactness and the degree of filling of the elongated bag 2 may be lost. Preferably, as can best be seen from Figs. 4-6, the rotary auger 6 does not extend all the way from the  
30 receiving means 5 to the distal end 8 of the tubular member 7. This is of major importance when filling and forming the elongated bag 2. If the auger 6 extends all the way to the distal end 8 of the tubular member 7, the rotary motion of the rotary auger will be transmitted to the elongated bag 2 via the particulate material. This, in turn, will result in unde-

sired warping and twisting of the elongated bag 2 in the rotational direction of the rotary auger 6. The distal end 13 of the rotary auger 6 is therefore located inside the tubular member 7 at a predetermined distance from the distal end 8 thereof. Experiments have shown that if this  
5 predetermined distance is selected in the interval of 0.5 to 5 times the internal diameter of the tubular member 7, preferably in the interval of 1 to 3 times the internal diameter of the tubular member 7, any rotary motion from the rotary auger 6 transmitted via the particulate material to the elongated bag 2 is effectively prevented or limited to insignifi-  
10 cance.

In order to ensure a continuous supply of particulate material to the rotary auger 6, the receiving means is open upwardly, so that it can be replenished with particulate material as the rotary auger 6 removes particulate material from the bottom, pushing it into the tubular member  
15 and into the elongated bag 2 via the opening at the distal end 8 of the tubular member 7. Moreover, to ensure that the particular material does not pack and get stuck in the receiving means 5, the receiving means 5 preferably comprises fluidising means to keep the particulate material in motion. In the preferred embodiment, the fluidising means comprises  
20 two rotary shafts 20 with a number of radial protrusions 10. Other fluidising means could be used instead, e.g. means for vibrating the receiving means 5. In some embodiments the fluidising means may even be omitted, depending e.g. on the nature of the particulate material. The rotary shafts 20 and the rotary auger 6 are preferably driven by electric and/or  
25 hydraulic motors, not shown. Likewise, it should be realized that the mobile apparatus may comprise its own means for supplying the receiving means 5 with particulate material, rather than having to rely on an external digger or the like. That is to say means for gathering sand directly from e.g. a beach, and filling it into the hopper, or even supplying  
30 it directly to the tubular member 7 and rotary auger 6.

Figs. 4-6 show an alternative embodiment of a second embodiment of mobile apparatus 1 according to the invention for filling and deploying elongated bag 2 with particulate material. For illustration purposes, however, external parts have been cut away for better view of



the rotary auger 6. The rotary auger 6 and many other parts do not differ substantially from those depicted and already explained in conjunction with figs. 1-3. To facilitate the understanding of the similarities and differences, corresponding parts in different embodiments, such as the rotary auger 6, bear the same reference numerals throughout the figures. Moreover, in order to avoid unnecessary repetition of the description of similar parts and parts fulfilling the same function will not generally be repeated. In respect of points where the embodiments differ, it should be noted that features may be interchangeable between embodiments. That is to say, even though the mobile apparatuses of figs. 4-8 do not visibly present any fluidising means in conjunction with the receiving means, the fluidising means described above comprising two rotary shafts 20 with a number of radial protrusions 10 or means for vibrating the receiving means 5 could be used.

15           The mobile apparatuses of figs. 1-3 and figs. 4-8 are both adapted to continuously form the elongated bag 2, as the mobile apparatus 1 moves along deploying it. Continuously forming an elongated bag as such is nothing new and *inter alia* disclosed in WO-A-2006/072233.

20           More specifically, the mobile apparatus 1 comprises means for forming an elongated bag 2 from a supply of sheet material 9. In the embodiment illustrated in figs. 4-8, the supply of sheet material 9 is stored in stack of fan-fold layers of sheet material 9 on the upper surface 21 of the undercarriage 3. Alternatively, as illustrated in figs. 1-3, the supply of sheet material 9 could be stored as a roll, e.g. in a suitable suspension means, not shown. Fan-fold sheet material 9, however, is currently preferred because it allows access to both ends, thus allowing several lengths (in principle an infinite number of lengths) of material 9, to be joined as the material is used up forming the elongated bag 2.

30           In both embodiments, the sheet material 9 is drawn through a vertical semi-cylindrical guide means 11, which extends into an open cone shaped guide means 12 ending in an essentially circular opening surrounding the tubular member 7, where the edges 14, 15 are joined to form the elongated bag 2. The edges 14, 15 may be joined by any suitable joining means known by the person skilled in the art, such as sew-

ing, welding or gluing, depending *inter alia* of the specific properties of the sheet material 9.

For the use as sand-filled barriers against water, a sheet material 9 in the form of a textile sheet is made of polypropylene, e.g. in a width of 100 cm or more and of a fabric quality of  $100 \text{ gr/m}^2 + 2 \times 25 \text{ gr/m}^2$  (double pp coated) and being UV stable is currently preferred.

The currently preferred joining method for this textile sheet is sewing using sewing machine 16, as illustrated in figs 1-3, more specifically a Seiko DN-8E-AP high speed, double chainstich binding edge sewing machine, manufactured by Seiko Sewing Machines Co., Ltd, 2-13-6, Sakaecho, Funabashi-shi, Chiba Prefecture, 273-0018, Japan.

Alternatively, the elongated bag 2 could be formed by joining the edges 14, 15 of a plastic sheet by heating overlapping opposite edges 14, 15 using a heat-sealing device 17, as illustrated in figs. 4-7.

As will be understood, what is manufactured is in fact not fully an elongated bag, but rather an endless tube. Thus, in order to start up the process, the endless tube has first to be closed at one end. The currently preferred method for this is simply to use a zip-strip to pinch off the endless tube.

The typical velocity of the mobile apparatus 1 during deployment of an elongated bag 2 is about 1 km/h, but evidently variations and even stops will occur, e.g. if the supply of particulate material to the receiving means 5 is insufficient. Because the elongated bag 2 is formed as the mobile device 1 moves along, fills and deploys the now sand-filled elongated bag 2, care has to be taken that the velocity with which the mobile apparatus 1 moves, is in a predetermined relationship with the speed of rotation of the rotary auger, as well as matches the overall speed with which the edges 14, 15 are joined.

If the velocity of the mobile device 1 is higher than the speed with which the edges 14, 15 are joined, strain will occur at the position where they are being joined, and the joint may not have sufficient quality. If sewing is used, the strain may even lead to damage to the sewing machine 16 such as the needles thereof (not shown). Similar damage could occur if, as explained above the elongated bag 2 is twisted under

the influence of the rotary auger 6, because this twisting motion would propagate backward from the distal end 8 of the tubular member 7 to the sewing machine 16.

The mobile apparatus 1 therefore comprises conveying means  
5 18 controlling the rate with which the sheet material 9 is drawn from the supply and joined. However, as the sheet material 9, in particular if it is a textile sheet, may alter its dimensions during filling, it is also necessary to control the filling rate, i.e. the rotational speed of the rotary auger 6. If the rotational speed is too high, the auger will force a lot of particulate material into the elongated bag 2, which will then expand to  
10 form a thicker elongated bag 2 than desired. The thicker elongated bag 2, which would then have to be deployed at different speed.

In order to control the rotational speed of the rotary auger 6 with respect to the velocity of the mobile apparatus 1, at least one sensor, such as a sensor probe 19, is located in connection with the tubular  
15 member 7, in particular on the outside and in the vicinity of the distal end 8 of the tubular member 7. The sensor probes 19 are outwardly biased rods, which will be in contact with the inner surface of the elongated bag and giving off an output signal corresponding to e.g. the deflection angle with respect to the tubular member 7. Using the output of  
20 a sensor probe 19 allows the computer control to detect whether the elongated bag 2 is filled sufficiently to achieve the desired degree of radial expansion, and control the rotational speed of the auger 6, with respect to the velocity of the mobile apparatus 1, or vice versa. That is to  
25 say, if detected pressure falls, the speed with which the elongated bag 2 is formed is reduced, or the rotational speed of the auger 6 is increased. In this respect it should be noted that ideally, the speed with which the elongated bag 2 is formed and deployed, as well as the velocity of the mobile device 1 will essentially be the same, and are also controlled to  
30 match each other by the computer control or the like.

As to the sensors, the skilled person will realize that numerous alternatives to the sensor probes 19 exist, e.g. pressure sensors arranged on the inside or the outside of the tubular member 7 could be used. Also, inwardly biased sensor probes in contact with outer surface

of the elongated bag could be used. Such sensor probes could conveniently be arranged in connection with additional means for conveying the filled elongated bag 2 away from the mobile apparatus 1, as described below.

5                Similarly, the speed of the conveying means 18 is adapted by the computer control to avoid any tension at the joining site.

              Though the present invention has been described with reference to specific embodiments above, the skilled person will know that many variations and modifications are possible without departing from the scope of the invention as set out in the claims.

10              In particular, additional means could be used for conveying the filled elongated bag 2 away from the mobile apparatus 1 at a slight angle allowing several elongated bags 2 to be laid out during several passes of the same path. Such further means may also be used to place several  
15              elongated bags 2.

              Also, means for swiftly adapting the apparatus for deploying barriers of different dimensions could be provided. In this case the proximal end of the tubular member 7 could be welded to a flange (not shown) bolted onto the hopper 5. This allows the tubular member 7, the  
20              auger 6 and the means for forming the elongated bag to be easily removed and replaced by another set of tubular member, auger and means for forming the elongated bag, all having different dimensions.

## P A T E N T C L A I M S

1. A mobile apparatus for filling an elongated bag with particulate material,  
said mobile apparatus being adapted for moving along a surface  
5 at a controlled velocity, and  
said mobile apparatus comprising a receiving means for receiving the particulate material to be filled into the elongated bag,  
a tubular member adapted to extend essentially horizontally into said elongated bag during filling, and  
10 a rotary auger extending at least partially into said tubular member from said receiving means, characterized in that it comprises means adapted to continuously form said elongated bag from at least one continuous sheet of material around the outside of said tubular member by joining the edges of said at least one continuous sheet.
- 15 2. A mobile apparatus according to claim 1, characterized in that the distal end of the tubular member is located at a predetermined distance from the distal end of the rotary auger.
3. A mobile apparatus according to claim 2, characterized in that said predetermined distance is in the interval of 0.5 to 5  
20 times the internal diameter of the tubular member, preferably in the interval of 1 to 3 times the internal diameter of the tubular member.
4. A mobile apparatus according to any one of the preceding claims, characterized in that it comprises control means for controlling the controlled velocity and the speed of rotation of said rotary  
25 auger with respect to each other.
5. A mobile apparatus according to any one of the preceding claims, characterized in that it comprises at least one sensor for monitoring the degree of filling of said elongated bag with the particulate material.
- 30 6. A mobile apparatus according to claim 5, characterized in that said at least one sensor is located in connection with said tubular member.
7. A mobile apparatus according to claim 1, characterized in that it comprises conveying means adapted to transport the

elongated bag along the outside of said tubular member at a speed adapted to the speed with which the edges are joined, and the controlled velocity of the mobile apparatus.

8. A mobile apparatus according to any one of claims 1 or 7,  
5 c h a r a c t e r i z e d in that it comprises a sewing apparatus for joining the edges of said at least one continuous sheet.

9. Method for filling an elongated bag with particulate material comprising the providing of the particulate material to a receiving means, conveying the particulate material through an essentially horizontal tubular member into the elongated bag using an auger c h a r -  
10 a c t e r i z e d in that said elongated bag is continuously formed around said tubular member by joining the edges of at least one sheet member, and in that

said auger fills said tubular member to a predetermined degree,  
15 so as to achieve a predetermined compactness of the particulate material.

10. Method according to claim 9, c h a r a c t e r i z e d in monitoring said filling degree using at least one sensor in connection with the tubular member.

20 11. Method according to claim 10, c h a r a c t e r i z e d in that the elongated bag is formed as an endless tube, which is pinched off at one end before filling.

12. The use of an elongated bag provided using a mobile apparatus according to any one of claims 1 to 9 as a barrier against water.

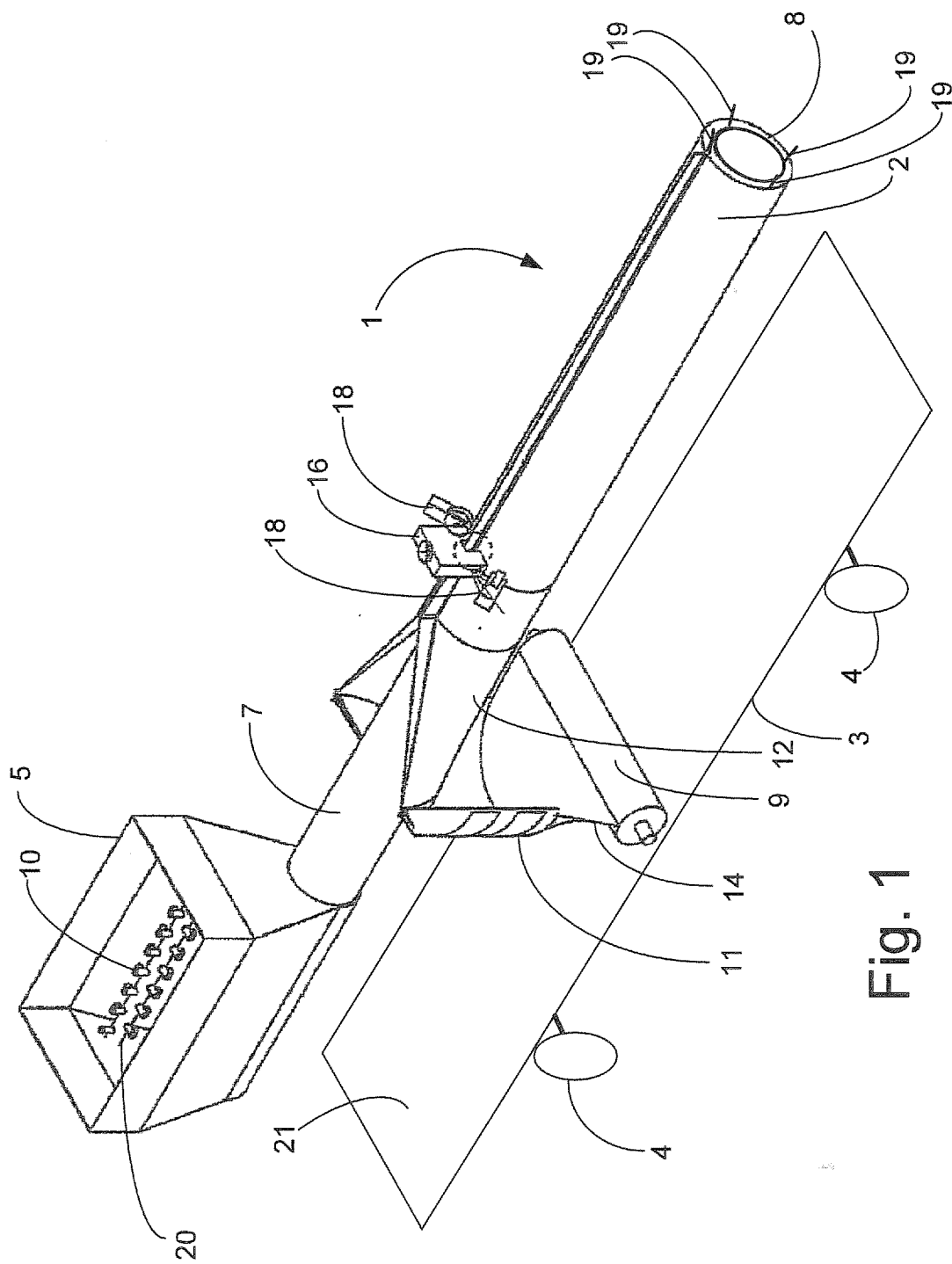


Fig. 1

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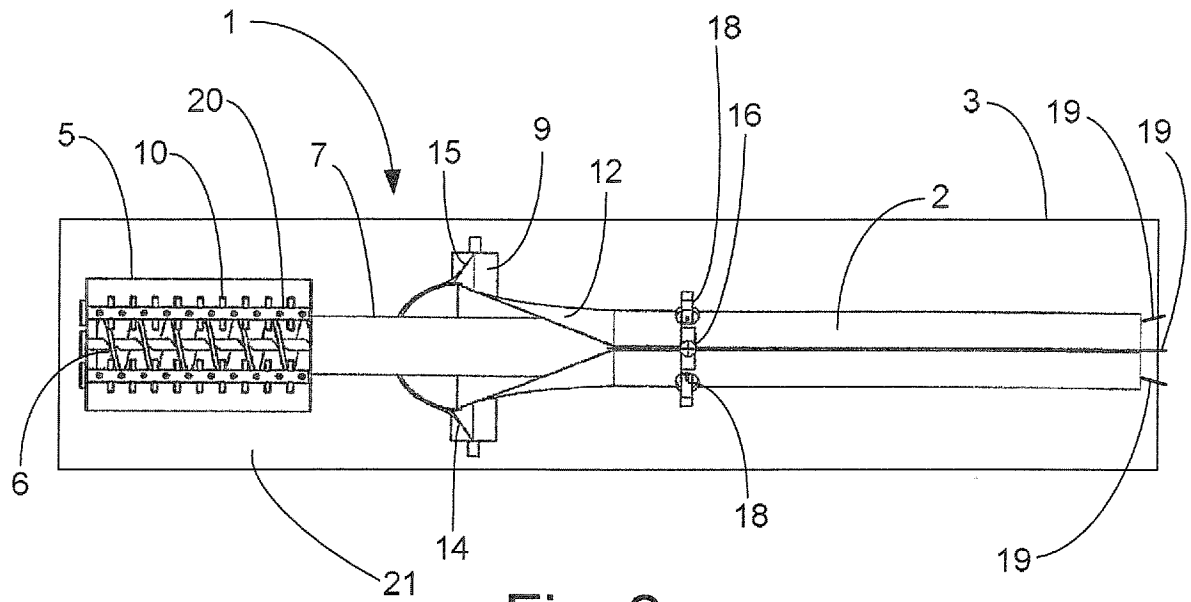


Fig. 2

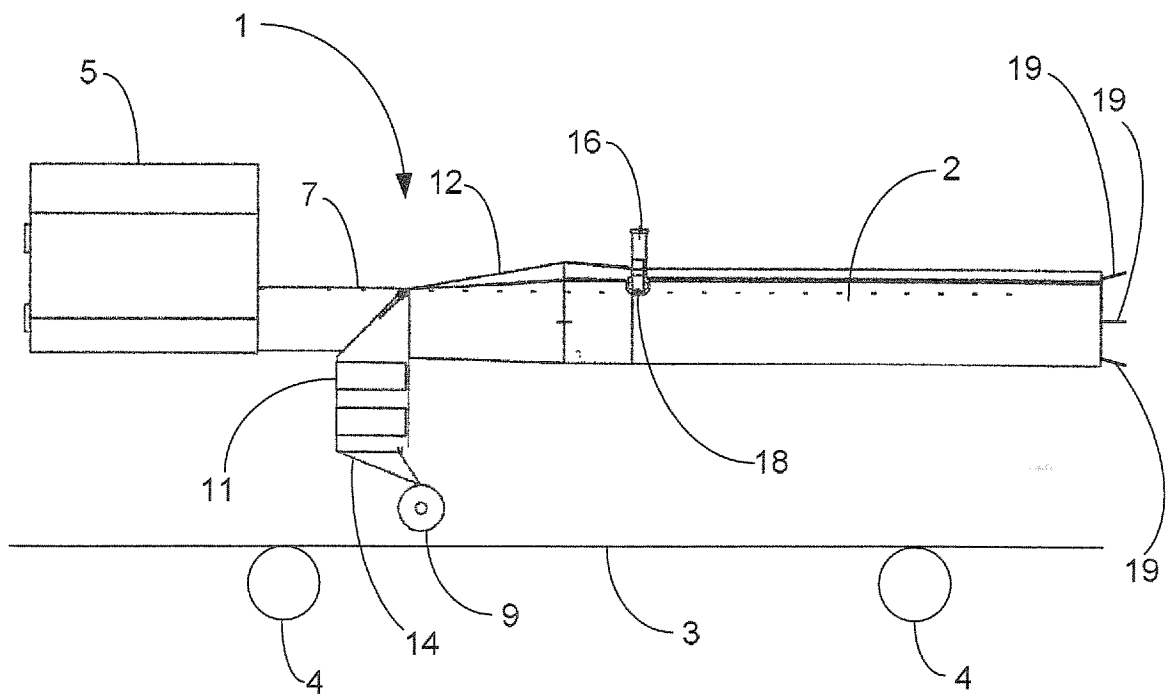


Fig. 3



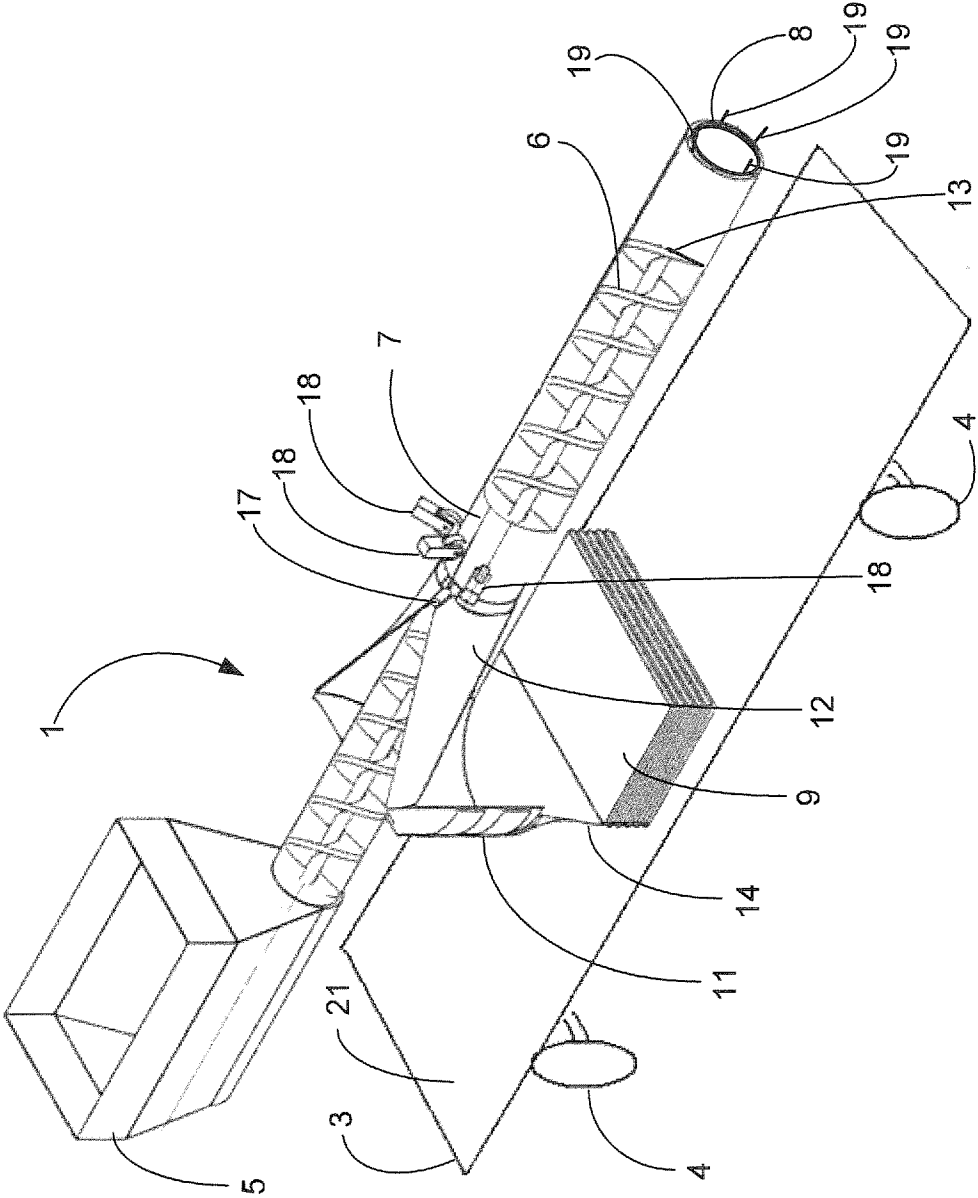


Fig. 4



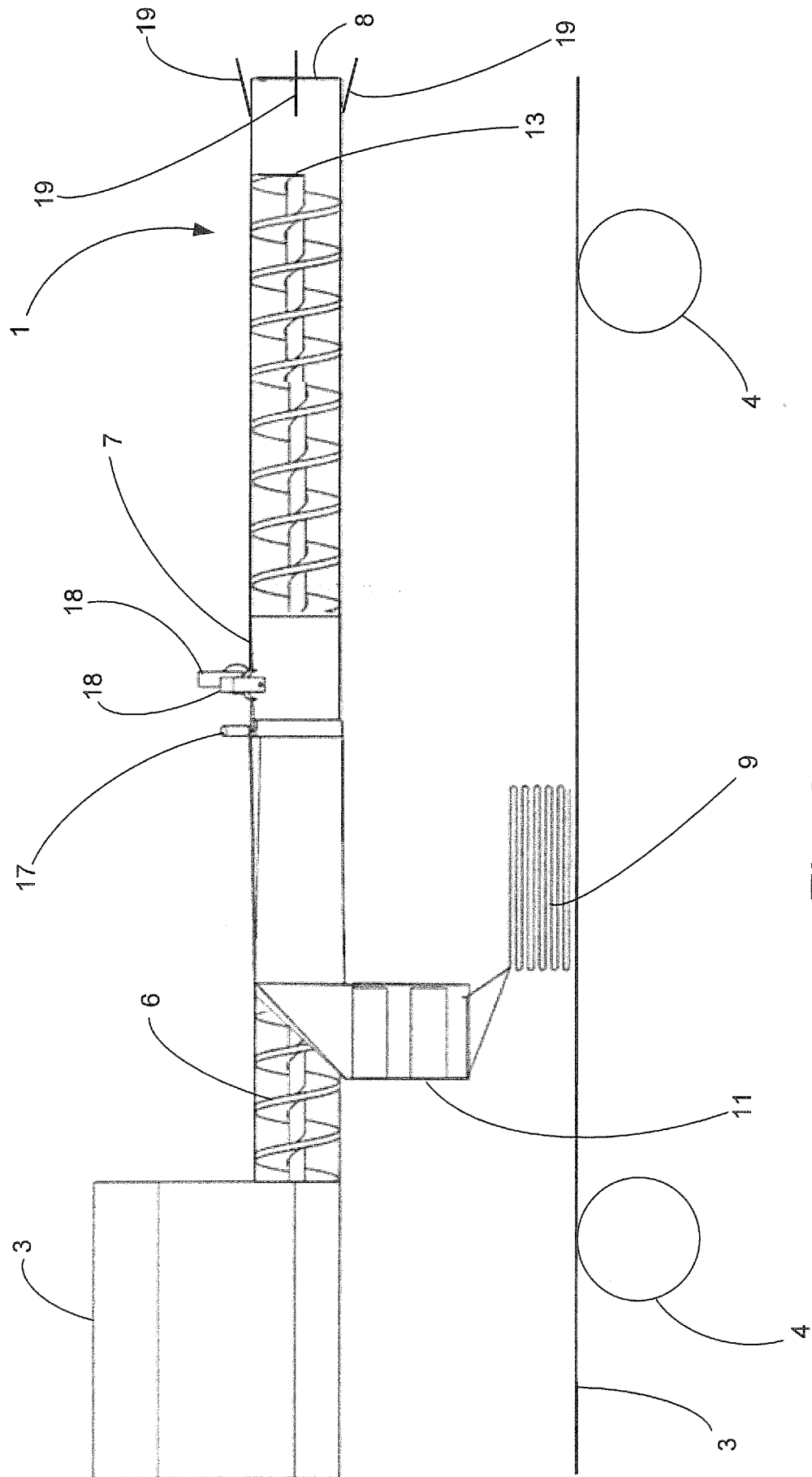


Fig. 6

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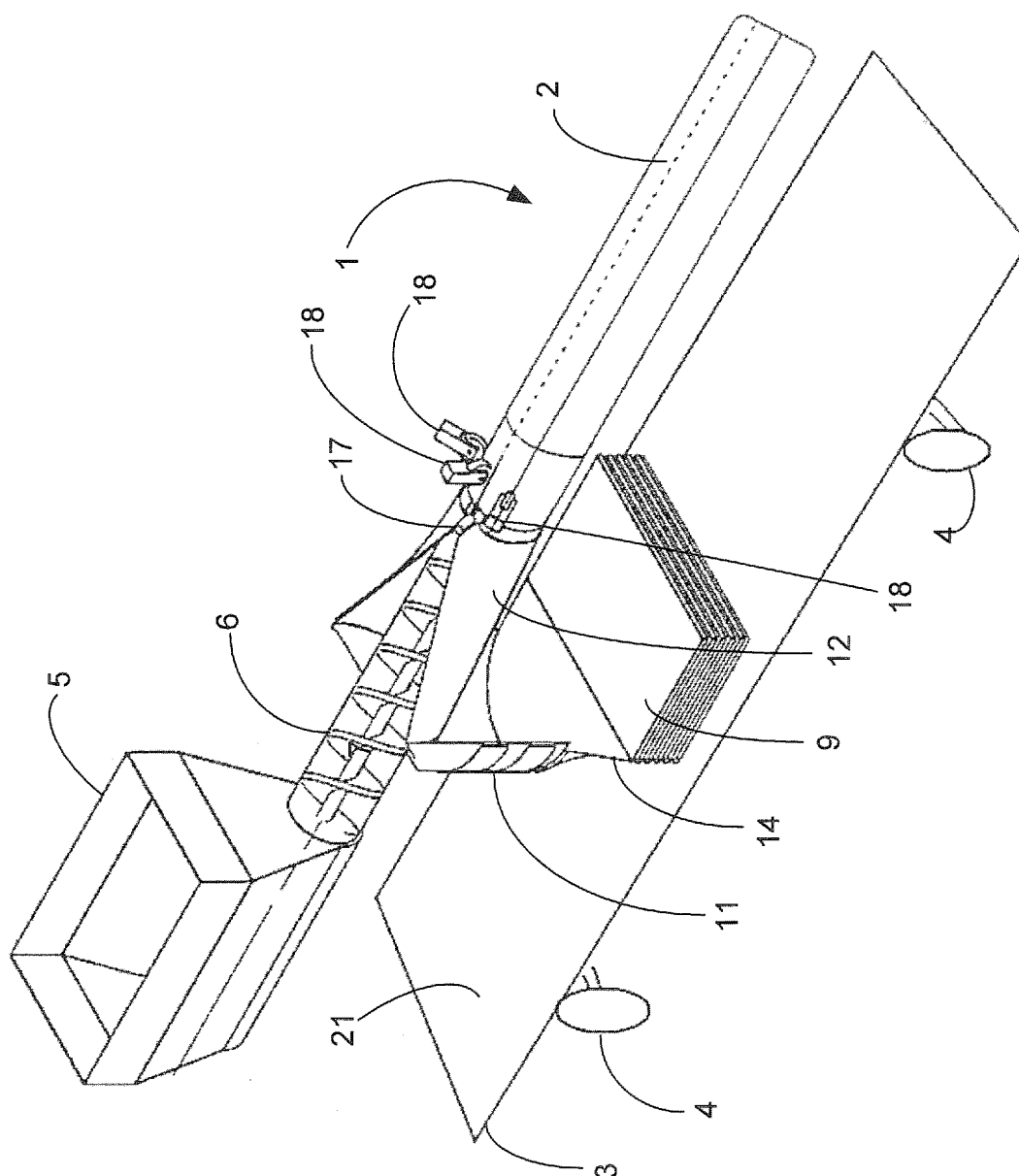


Fig. 7

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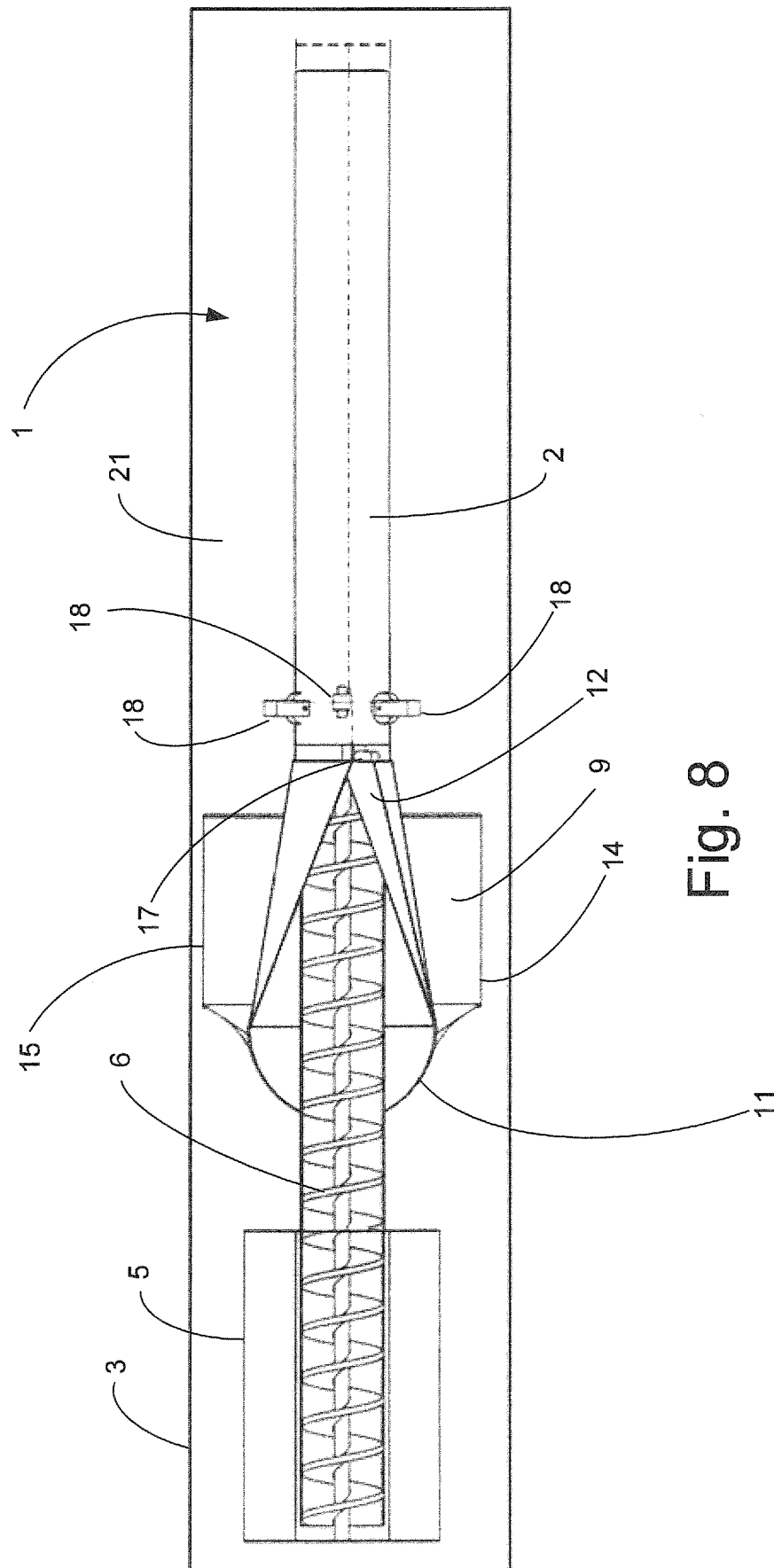


Fig. 8

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/DK2010/050134

A. CLASSIFICATION OF SUBJECT MATTER  
INV. B65B1/12 B65B9/10  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
B65B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages           | Relevant to claim No. |
|-----------|--|-----------------------|
| A         | US 5 893 260 A (MCKENNA MARK [US])<br>13 April 1999 (1999-04-13)<br>the whole document       | 1,9,12                |
| A         | US 2004/128953 A1 (CULLEN STEVEN R [US])<br>8 July 2004 (2004-07-08)<br>the whole document   | 1,9                   |
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|           | -----<br>-/-   |                       |



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

3 September 2010

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## INTERNATIONAL SEARCH REPORT

International application No

PCT/DK2010/050134

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