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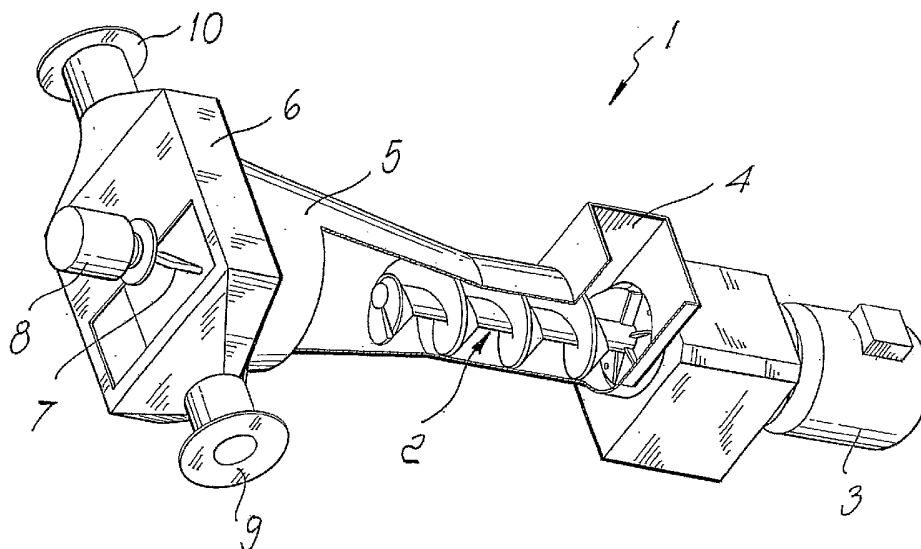
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(54) Title: DEVICE FOR FEEDING REFUSE-DERIVED FUELS (RDF) TO COMBUSTION APPARATUSES



(57) Abstract: A device for feeding continuously a system for the pneumatic conveyance of refuse-derived fuels (RDF) constituted by a motorized screw feeder, into which the RDF is fed through a supply hopper; by a diverging conical sealing tube, in which the RDF transferred by the screw feeder accumulates; a chamber for mixing RDF and compressed air, in which there is a fan driven by an electric motor. The compressed air fed to the mixing chamber exits, conveying the RDF, from the pneumatic conveyance tube. The device is inclined at least 30° to allow to fill the conical sealing tube and the taper of a few degrees of the conical tube allows to form a plug of material by virtue of the pressure of the pneumatic conveyance air, thus avoiding unwanted seepage into the feeder hopper. The device therefore allows the regular remote conveyance of the RDF by pneumatic methods.

DEVICE FOR FEEDING REFUSE-DERIVED FUELS (RDF) TO COMBUSTION APPARATUSES

The present invention relates to a device for feeding refuse-derived fuels (RDF) to combustion apparatuses, such as for example incinerators and cement kilns, where they
5 integrate traditional fossil fuel.

The RFD to which the device can be applied are typically fuels obtained from municipal solid waste (MSW) by milling, mechanical screening, biodrying and refining but also other fuels derived from biomasses or from treatments of animal waste.

More generally, the device can be applied to feed low-density waste with controlled
10 particle size in energy-using systems.

Feeding solid fuels in combustion apparatuses is one of the most important factors in ensuring regular operation of combustion systems.

Among the various techniques that are used, feeding and dosage of the fuel by means of screw feeders and subsequent transfer by pneumatic conveyance with air to
15 the burner or combustion chamber is one of the most widely used techniques if solids suitable for pneumatic conveyance are available and the requirements of the combustion plant demand this.

A typical case is feeding coal to power stations, to cement kilns but also the combustion of unconventional fuels, such as sawdust, finely milled biomasses, animal
20 flours or fuels derived from municipal solid waste (MSW).

These last fuels can be obtained by means of techniques based on biodrying, fine milling and demetallization with procedures such as the one described in EP-A-706839 in the name of this same Applicant.

One obtains a material with a particle size distribution of approximately a few
25 centimeters and with a poured density of approximately 75-200 kg/m³, with a high heat value, which can be easily conveyed pneumatically and therefore can be used in incinerators, in combustion plants and especially in cement kilns as a replacement of, or as a complement to, fossil fuels.

The use of screw feeders combined with the subsequent pneumatic transfer of the
30 fuel to the combustion plant requires a separation between the screw feeder and the

transfer system in order to prevent the seepage of air toward the part of the machine where the RDF enters and to prevent irregular operation of the feeder.

The normally used method, even in the absence of subsequent pneumatic conveyance, consists in forming a plug of compacted material that isolates the screw
5 feeder from the rest of the apparatus.

US-4996930 discloses a system for feeding contaminated soil to an incinerator that is at a different pressure, particularly at a slight vacuum, with respect to the environment.

The goal is therefore to maintain the combustion plant in partial vacuum, reducing the seepage of air from the outside inward.

10 The plug is formed by the agglomeration of the material, which being contaminated soil has a high density and a strong tendency to pack against the final blade of the double-helix screw feeder.

FR-A-2552 206 discloses a device for burning waste in a grill oven, with the aim of a good distribution of the material on the combustion grill.

15 This device is constituted by a barrel with a shaft provided with a screw feeder for conveyance and compression, which discharges onto a rotor that breaks up and propels the waste onto the grill.

It should be noted that the barrel is constituted by a cylindrical chamber, which assumes a converging frustum-like shape in the end part, with the purpose of providing a
20 plug of material.

In EP-A-0967438, in the name of this same Applicant, a similar concept is applied in order to form the plug by using a screw feeder for the dosage of the material and a converging frustum-shaped portion that is not provided with a screw feeder but has a flow breaker or grooves for forming the plug of material before pneumatic conveyance.

25 US-4803836 discloses a system for feeding material that can be extruded to a pressurized combustion chamber, typically powdered coal to the high-pressure combustion plant of a gas turbine.

The material is forced in the output slot between the barrel and the conical part of the shaft. The patented machine is typically an extruder for high pressures, with a
30 frustoconical shaft in the end part, which provides the obstacle for compacting the

powder.

EP0953525 discloses a device which consists of an hopper unit which contains the construction material. A screw conveyor powered by a motor feeds the material to an assembly section. The assembly section is enclosed by a tube which is compressed by a gas or fluid. The device is not adapted to feed RDF and the compacting system is constituted by a flexible membrane rather than a diverging tube. There is no mixing chamber.

US4473327 discloses an apparatus for injecting pulverulent material, such as concrete, into a conveying pipe under a higher pressure by means of a worm mounted in overhead manner in a casing, which conveys against a check valve. Between the worm and check valve is provided a chamber which widens in the conveying direction, which on the one hand prevents any clogging of the conveyed material due to a wedging action in the conveying direction and on the other hand ensures that in the case of a stoppage when an inadequate amount of material is supplied a seal is formed in said area because in the widening chamber the material to be conveyed is compressed and forced back counter to the conveying direction. There is no mixing chamber and no fan for the pneumatic conveyance of the cement.

US-4138162 discloses an apparatus for piped conveyance of material such as a concrete mixture. The material is introduced into a conveyor pipe where it is caused to pass through a blocking section located upstream of a location where compressed air is introduced into the conveyor pipe. In the blocking section, which has an increasing through-flow area in the conveying direction, a material plug is formed by the action of compressed air introduced at the downstream end thereof. The plug seals in a direction upstream and is at its downstream end continuously broken up and blown downstream by means of compressed air. There is no mixing chamber and no fan. The pipe is not inclined.

DE-3228468 discloses a conveying device, for conveying coal dust or the like solid fuel, equipped with a metering device and also with a container containing the fuel. The metering device has a metering screw engaging in the available fuel. The apparatus has an intermediate feed container which has a loosening device for the fuel. The worm

wheels of the metering screw can also be constructed with a pitch which increases upwards. A retaining space for the fuel is provided between the uppermost screw turn of the worm wheel and a mixing channel of a metering housing of the metering device. Space is thus created, for example to make a larger quantity of fuel available for an air pulse.

US-4881862 discloses a screw seal for conveying bulk particulate solids between spaces at differing gas pressures with minimal leakage of gas. A tubular housing encloses a screw conveyor section and a sealing section receiving the solids and forming a sealing plug. The sealing section has a divergent configuration that functions in combination with friction to create sufficient solids pressure with minimal driving torque and wear on the screw conveyor.

The experience gained with the device described in EP-A-0967438, and with the RDF obtained industrially according to EP-A-706839, has shown that the apparatus is capable of operating but it is not free from drawbacks, the main of which is linked to the high abrasive power of the material in the frustum-shaped region where the plug forms, with wear of the parts in contact.

Therefore, the cited prior art devices are not suitable to feed a material such as RDF by pneumatic conveyance or are not free from the same drawbacks mentioned earlier.

The aim of the present invention is to provide a device that overcomes the drawbacks of the cited prior art.

An object of the invention is to provide a device for feeding RDF or similar fuels to combustion apparatuses by using pneumatic conveyance.

A further object of the invention is to provide a device that is capable of ensuring high reliability and durability, at the same time ensuring the uniformity of pneumatic conveyance to combustion.

This aim and these and other objects that will become better apparent hereinafter are achieved by a device for feeding refuse-derived fuels, or RDF, to combustion apparatuses, comprising a motorized screw feeder inserted in a diverging conical seal tube, RDF being fed into said diverging tube through a supply hopper, characterized in that it comprises a mixing chamber associated with one end of said diverging tube, said

mixing chamber being fed with said RDF, said mixing chamber being also fed with compressed air that mixes with said RDF, said device further comprising a pneumatic conveyance outlet from which said compressed air, fed to the mixing chamber, may exit and convey said RDF.

5 Further characteristics and advantages will become better apparent from the description of preferred but not exclusive embodiments of the invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a partially sectional perspective view of the device according to the invention;

10 Figure 2 is a longitudinally sectional side view of the device according to the invention.

With reference to the figures cited above, a device according to the invention, generally designated by the reference numeral 1, includes a screw feeder 2, which is driven by an electric motor 3, which transfers the material fed in a hopper 4.

15 The material accumulates in a conical sealing tube 5, where due to the pressure of the air that is present in a mixing chamber 6 it is compacted so as to reach a density of approximately $0.4\text{-}0.5\text{ kg/m}^3$, so as to ensure a load loss that is sufficient to avoid or reduce air seepage.

The surface of the frustum-shaped sealing tube is mirror-finished because, contrary
20 to what is known from the prior art, it is not necessary to have rough surfaces, grooves or flow breakers in order to contrast the rotation of the plug, but rather it is necessary to facilitate the flow of the material compressed by the air toward the mixing chamber.

The length of the frustum-shaped tube is typically 3-5 diameters and the smooth internal surface is preferably hardened in order to minimize wear.

25 The mixing chamber 6 is coupled by virtue of a flange on the end part of the frustum-shaped tube 5 and is fed with compressed air at pressures of approximately 0.1-0.3 bar.

A fan 7 is installed in the mixing chamber 6 and is driven by an electric motor 8 in order to finely disperse the material in the conveyance air and break up any lumps.

The air enters the chamber in a port 9 and exits from a port 10 connected to the
30 conveyance tube.

Dimensionally, the device according to the invention can be constituted for example as follows.

A device 1 for feeding 2500 kg/h of RDF with an average particle diameter of 2.5 cm, a poured density of 75 kg/m^3 , a humidity content of 17% by weight and a heat value of approximately 4000 kcal/kg is constituted by a screw feeder numeral 2, which is 1000 mm long and has a diameter of 300 mm and is driven by a 15-kW electric motor 3, which turns at 50 rpm and is provided with a loading hopper 4.

The diverging frustum-shaped tube 5 is 1000 mm long and has the same diameter as the screw feeder 2 in the part that is connected to the screw feeder and a taper of 2° .

The mixing chamber 6 is provided with a fan that is driven by a 5-kW motor and with an intake tube 9 and a discharge tube 10 for the air, which has a diameter of 100 mm.

The device is inclined at 30° with respect to the horizontal.

2500 kg/h of RDF are fed and in a few seconds completely fill the conical tube. Air at a pressure of 0.4 bars is fed in a stream of air while the discharge tube 10 is closed.

In this final condition, seepage of the air towards the supply hopper is limited to approximately $2 \text{ m}^3/\text{h}$.

Pneumatic conveyance is started by operating the fan 7 and opening the tube 10, which is connected to a combustion system.

In a typical test performed on a combustion plant for industrial solid waste with a rotating drum, with a pneumatic conveyance tube having an equivalent length of approximately 75 m and a diameter of 100 mm, with an air flow-rate of $1500 \text{ m}^3/\text{h}$, it was possible to feed without problems 2500 kg/h of RDF as auxiliary process fuel.

In practice it has been found that the invention achieves the intended aim and objects, providing a device for feeding RDF or similar fuels to combustion apparatuses by using pneumatic conveyance, with high reliability and durability and at the same time ensuring uniformity of the pneumatic conveyance to combustion.

To do this, the operating principles of the prior art devices described above have been changed completely, entrusting to the compressed conveyance air, and not to the screw feeder, the task of compressing the material.

It has in fact been found, surprisingly, that a duct filled with RDF and subjected to air

pressure on one side is compressed to the point of forming a plug that is scarcely permeable to the air.

If the duct is constituted by an inverted frustum-shaped tube that has a taper of 1-3°, compaction of the material is facilitated and a consistency that is proportional to the air pressure is reached therefore with an operation that is the opposite of the background art.

The frustum-shaped tube must be filled completely, and for this purpose the entire device must be inclined at at least 30°, so that the screw feeder transfers therein the material that will constitute the barrier against the seepage of air in the opposite direction with respect to the stream of material.

The device according to the invention is susceptible of numerous modifications and variations, within the scope of the appended claims. All the details may be replaced with technically equivalent elements.

The materials used, as well as the dimensions, may be any according to requirements and to the state and the art.

CLAIMS

1. A device for feeding refuse-derived fuels, or RDF, to combustion apparatuses, comprising a motorized screw feeder inserted in a diverging conical seal tube, RDF being fed into said diverging tube through a supply hopper, characterized in that it
5 comprises a mixing chamber associated with one end of said diverging tube, said mixing chamber being fed with said RDF, said mixing chamber being also fed with compressed air that mixes with said RDF, said device further comprising a pneumatic conveyance outlet from which said compressed air, fed to the mixing chamber, may exit and convey said RDF.
- 10 2. The device according to claim 1, characterized in that said mixing chamber comprises a fan.
3. The device according to claim 1 or 2, characterized in that said tube is inclined.
4. The device according to one or more of the preceding claims, characterized in that said tube is inclined at approximately 30° with respect to the horizontal.
- 15 5. The device according to one or more of the preceding claims, characterized in that said screw feeder is actuated by an electric motor that transfers the material fed by said hopper.
6. The device according to one or more of the preceding claims, characterized in that said material accumulates in said sealing conical tube, where as a consequence of the
20 pressure of said compressed air that is present in said mixing chamber it is compacted so as to reach a density of approximately 0.4-0.5 kg/m³, so as to ensure a load loss that is sufficient to avoid or reduce air seepage.
7. The device according to one or more of the preceding claims, characterized in that the surface of said frustum-shaped sealing tube is mirror-finished, so as to facilitate the
25 flow of the material compressed by the air toward said mixing chamber.
8. The device according to one or more of the preceding claims, characterized in that the length of said tube is 3 to 5 times the diameter of said tube; said tube having a smooth and hardened internal surface.
9. The device according to one or more of the preceding claims, characterized in that
30 said mixing chamber is coupled on the end part of said tube by means of a flange.

10. The device according to one or more of the preceding claims, characterized in that said mixing chamber is fed with compressed air at pressures of approximately 0.1-0.3 bars.

11. The device according to one or more of the preceding claims, characterized in
5 that in said mixing chamber there is a fan driven by an electric motor, the fan is adapted to finely disperse the material in the conveyance air and to break up any lumps.

12. The device according to one or more of the preceding claims, characterized in that the compressed air enters said chamber from an intake port and exits from a discharge port that is connected to a conveyance tube.

10 13. The device according to one or more of the preceding claims, characterized in that in order to feed 2500 kg/h of RDF having an average particle diameter of 2.5 cm, a poured density of 75 kg/m³, a humidity content of 17% by weight and a heat value of approximately 4000 kcal/kg, it comprises a screw feeder that is 1000 mm long, has a diameter of 300 mm, and is driven by a 15-kW electric motor that turns at 50 rpm.

15 14. The device according to one or more of the preceding claims, characterized in that said diverging frustum-shaped tube is 1000 mm long and has the same diameter as said screw feeder, in the part that is connected to said screw feeder, and a taper of 2°.

15 15. The device according to one or more of the preceding claims, characterized in that said mixing chamber is provided with a fan that is driven by a 5-kW motor and with a
20 tube for the intake and the discharge of the air, which has a diameter of 100 mm.

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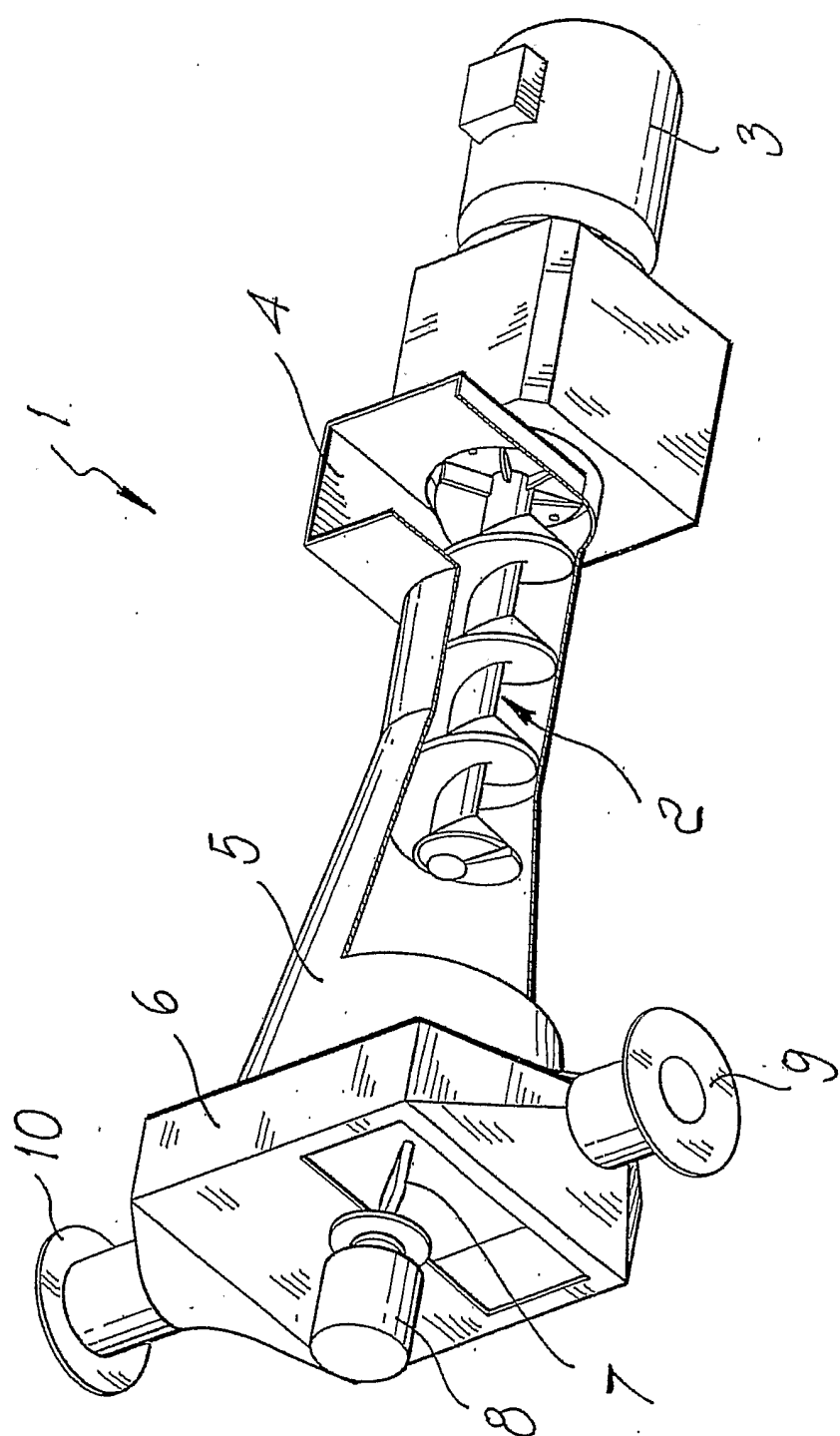
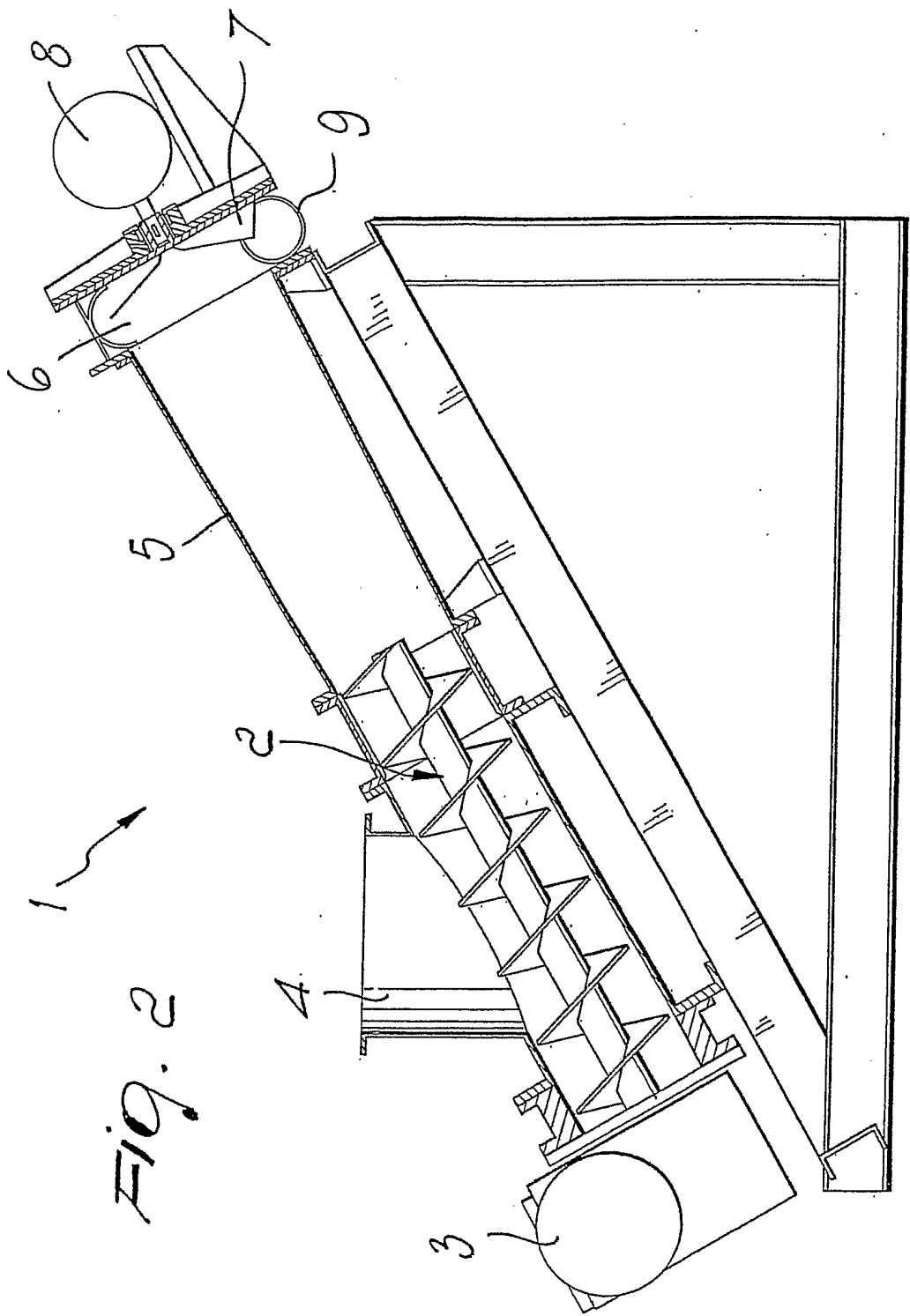


Fig. 1



INTERNATIONAL SEARCH REPORT

International application No

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A. CLASSIFICATION OF SUBJECT MATTER

F23G5/44

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)

F23G F23K B65G B63G

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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* & * document member of the same patent family

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Mougey, M

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International application No

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