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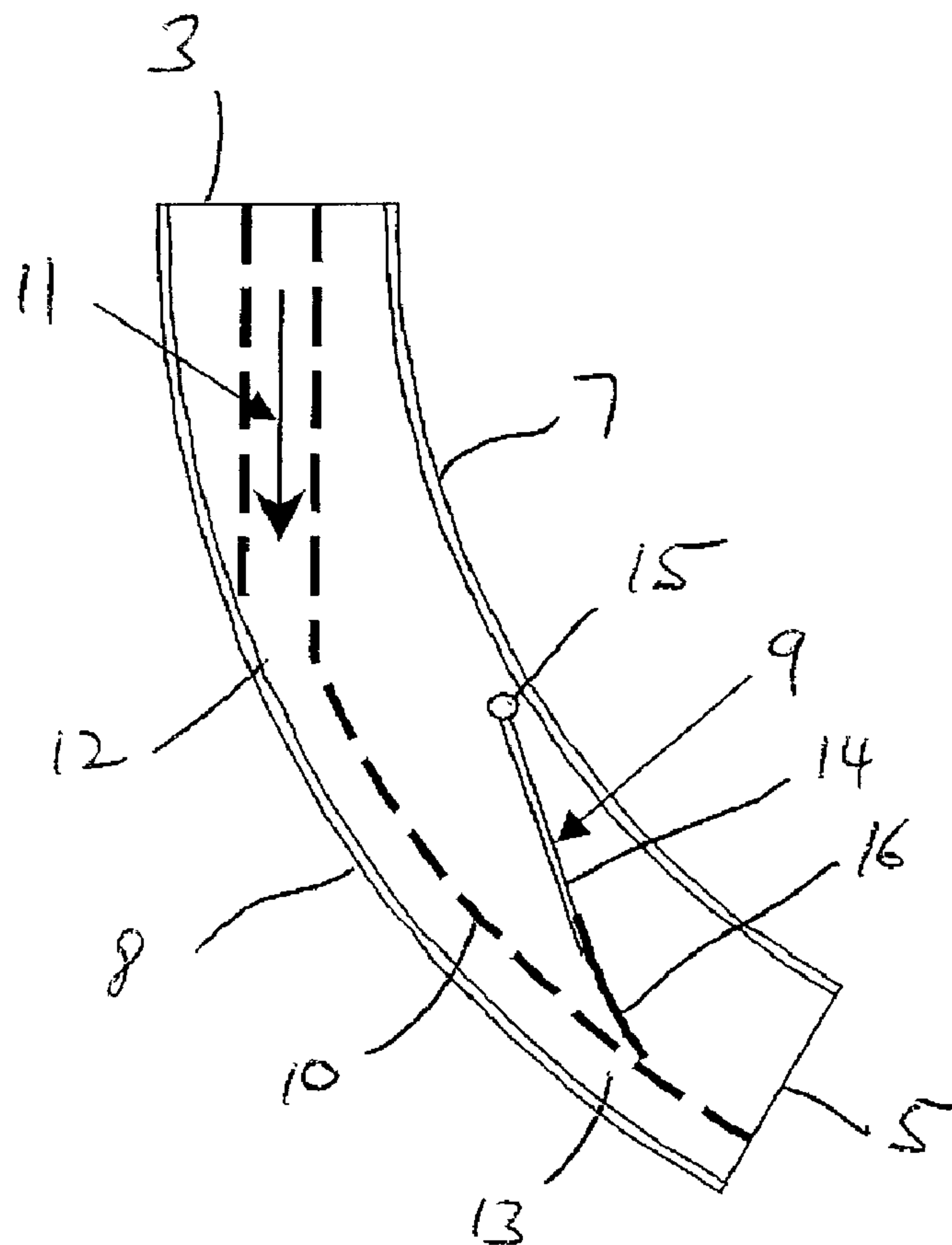
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(54) Titre : REDUCTION DE LA POUSSIERE DANS LA DISTRIBUTION DES PRODUITS PARTICULAIRES

(54) Title: DUST REDUCTION IN DELIVERY OF PARTICULATE COMMODITIES



(57) **Abrégé/Abstract:**

Apparatus (1) for reducing dust emissions from particulate commodities during discharge from an outlet (5); including a curved duct (4) having an inlet (3) and said outlet (5), and delivery means (2) arranged to deliver particulate commodities to the inlet (3) at

(57) **Abrégé(suite)/Abstract(continued):**

or above a predetermined delivery velocity, the curvature of said duct (4) being determined in combination with said delivery velocity to cause dust arising from the particulate commodities to be re-entrained within the commodities as the commodities are diverted from a straight path by the curvature of the duct (4).

Abstract

Apparatus (1) for reducing dust emissions from particulate commodities during discharge from an outlet (5), including a curved duct (4) having an inlet (3) and said outlet (5), and delivery means (2) arranged to deliver particulate commodities to the inlet (3) at or above a predetermined delivery velocity, the curvature of said duct (4) being determined in combination with said delivery velocity to cause dust arising from the particulate commodities to be re-entrained within the commodities as the commodities are diverted from a straight path by the curvature of the duct (4).

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DUST REDUCTION IN DELIVERY OF PARTICULATE COMMODITIES

FIELD OF THE INVENTION

This invention relates to dust reduction in delivery of particulate commodities and has been devised particularly though not solely for reducing the amount of dust issuing
5 into the atmosphere from the discharge nozzles of grain loaders such as those used for loading wheat into ships or other vessels.

BACKGROUND OF THE INVENTION

There are many applications where particulate materials are delivered through chutes or other discharge devices to various destinations, where dust is released from the
10 particulate commodities causing an environmental hazard or a nuisance from pollution or contamination. Such instances may include the delivery of grains such as wheat or corn from silos or other holding vessels into the holds of ships or railway cars, or the transfer of other particulate commodities such as coal from one conveyor to another or to a required delivery point or stockpile.

15 It has been recognised that the fines or dust typically entrained with such particulate commodities are prone to be emitted from the product stream as dust during handling, which at the least can be a nuisance due to cleanliness requirements, or at the worst can form an environmental hazard. One recognised way of controlling dust in these situations is to reduce the velocity of the product stream to keep the relative
20 velocity of the air stream over the product below the minimum pick up velocity of the dust, but such an approach has the disadvantage of limiting the rate at which particulate product can be delivered to the destination, and hence is a limitation on the efficiency of the process.

By way of contrast, the present invention seeks to restrict the emission of dust
25 from particulate commodities during delivery, by utilising the velocity of the product stream to re-entrain the dust within the product.

SUMMARY OF THE INVENTION

Accordingly, the present invention provides an apparatus for reducing dust emissions from particulate commodities during discharge from an outlet, including a
30 curved duct having an inlet and said outlet, and delivery means arranged to deliver particulate commodities to the inlet at or above a predetermined delivery velocity, the curvature of said duct being determined in combination with said delivery velocity to cause dust arising from the particulate commodities to be re-entrained within the

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commodities as the commodities are diverted from a straight path by the curvature of the duct.

In one form of the invention the curved duct forms a delivery spoon for the discharge of particulate commodities into a stockpile which could, for example, be in the
5 hold of a ship.

Preferably the curved duct is substantially rectangular in cross-section with substantially flat side walls and curved inner and outer walls.

In one form of the invention the radius of curvature of the inner and outer walls is substantially constant throughout the curve.

10 In another form of the invention the radius of curvature of the inner and outer walls varies over the curve such that the duct is curved in a parabolic manner.

Preferably the tighter radius portion of the parabolic curve is positioned adjacent the inlet.

As an optional feature the delivery means may include a converging duct located
15 adjacent the inlet to the curved duct, arranged to deliver the particulate commodities into the curved duct at a location adjacent the curved outer wall.

The curved duct may also be provided with an air-restrictive flap extending inwardly into the duct from the curved inner wall adjacent the outlet, the flap having a trailing edge arranged to rest in use just above the stream of particulate commodities
20 issuing from the outlet.

In one embodiment the flap is hingedly connected to the curved inner wall such that the trailing edge can move toward or away from the curved outer wall depending on the volume of particulate commodities passing therebeneath at any point in time.

Preferably the trailing edge portion of the flap is flexible to automatically allow for
25 changes in the mass flow rate of particulate commodities passing therebeneath.

BRIEF DESCRIPTION OF THE DRAWINGS

Notwithstanding any other forms that may fall within its scope, one preferred form of the invention will now be described by way of example only with reference to the accompanying drawings in which:

30 Fig. 1 is a side view of a grain discharge spoon according to the invention, having a substantially constant radius;

Fig. 2 is a similar view to Fig. 1 showing a parabolic spoon;

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Fig. 3 is a diagrammatic cross-section of a constant radius grain delivery spoon with an air restriction flap; and

Fig. 4 is a similar view to Fig. 3 showing the addition of a converging duct located adjacent the inlet to the grain delivery spoon.

5 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

In the preferred form of the invention the apparatus for reducing dust emissions from particulate commodities during discharge from an outlet will be described in the embodiment of a grain handling ship loader where wheat is delivered down an inclined
10 or substantially vertical duct or pipe to a discharge spoon from where it is emitted as a product stream into the hold of a ship.

In this situation particulate commodities such as grain in the form of wheat are fed through known conveyor mechanisms into a loading spout which is typically an inclined or vertically extending tube or duct which drops the wheat from an overhead gantry into
15 the hold of a ship. It is known to provide the discharge end of the loading spout with a discharge spoon, otherwise known as a loading spoon, which may have an angled portion at the end in order to direct the grain being discharged at an angle from the loading spout and enable grain to be directed under the coamings of the hold of a ship. It is also common to provide existing loading spoons with top impact plates and
20 sometimes spring loaded gates in an attempt to control the flow rate of grain through the loading spoon in the belief that this would reduce dust emissions.

On the contrary, the inventors of the present invention have discovered that the velocity of the grain passing down the loading spout can be utilised to re-entrain airborne dust into the body of the product stream. This is achieved by connecting a
25 curved loading spoon 1 to the discharge from the loading spout 2 such that product enters through an inlet 3 into a curved duct 4 before being discharged from an outlet 5.

The curved duct 4 may be of any convenient cross-section but is typically rectangular in cross-section having substantially flat side walls 6 and a curved inner wall 7 and curved outer wall 8.

30 As well as directing the product stream issuing from the outlet 5 at an angle to the loading spout 2, the curved loading spoon serves to direct the particulate product against the curved outer wall 8 such that the inertia in the entrained dust stream sitting above the

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product stream causes the dust to be re-entrained into the product stream, as the product stream curves up toward the dust layer.

The nature of the curvature of the duct 4 does not appear to be critical and the principle has been found to work well with either a constant radius curved duct as shown
5 in Fig. 1 or a duct formed to a parabolic curve as shown in Fig. 2 where the radius of curvature adjacent the inlet 3 is less than the radius of curvature adjacent the outlet 5.

Discharge spoons incorporating a curve in this manner have shown a significant reduction in airborne dust compared with prior art spoons without the curvature. The product stream exiting the spoon according to the invention is very well defined with a
10 sharp boundary layer between the air and the grain. The flow rate of the grain is not reduced and in experimental laboratory development was estimated to be approximately 4.5 to 5 metres per second. In a full scale application the flow rate is in the order of 7 to 8 metres per second with a large velocity component in the horizontal direction at the point of discharge. This increases the reach of the grain discharged from the spoon
15 without having to incline the vertical loading spout and enhances the ability of the operator to place grain under the coamings of ship holds.

The average dust concentration level in experimental testing showed more than a 50% reduction in dust compared with existing loading spoons. This reduction in dust levels is attributed to the concentrated product stream keeping the dust entrained within
20 the product.

Similar test results were obtained whether the curved duct is of a constant radius as shown in Fig. 1 or of a parabolic configuration as shown in Fig. 2.

In order to further enhance the dust entrainment in the product an optional air restrictive flap 9 can be incorporated into the design of the discharge spoon. For a given
25 grain mass flow rate, the flap is designed to rest just above the grain stream surface shown in broken outline at 10 (Fig. 3) at the point just before the grain exits through outlet 5.

As can be clearly seen in Fig. 3 the product stream is discharged into the spoon from the loading spout at 11 and impacts the curved outer wall 8 at point 12. The
30 provision of the air restrictive flap 9 further enhances the entrainment of the air stream into the product stream 13 exiting the outlet 5 and has been shown in experimental use to achieve a further 30% reduction in dust compared to the design without the flap.

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The flap may be formed in any convenient manner but is typically formed from a thin metal backing plate 14 mounted to the curved inner wall 7 either in a fixed manner or by way of a hinge 15. The trailing edge of the flap may be provided with a flexible rubber lip 16 to further enhance the fit of the trailing edge of the flap to the upper surface of the product stream 13.

As a further optional feature it has been found advantageous in some situations to concentrate the grain and direct the flow of grain from the loading spout 2 toward the outer curved wall of the loading spoon before the grain enters the curved portion. This configuration is shown in Fig. 4 where a converging duct 17 is provided immediately upstream of the curved loading spoon 1 arranged to direct the grain against the curved outer wall 8 at the inlet point 3. This also has the effect of concentrating the grain, forcing the dust back into the product and accelerating the flow rate of the grain and entrained air and is felt to enhance the re-entrainment of the dust into the main product stream as the product passes through the curved duct 4.

By selecting a small inclination angle of the tapered duct 17 to the vertical axis, impact zones between the stream of grains and the wall are significantly reduced. The area reduction through the tapered duct 17 also forces the stream of dust laden air to mix with the grain stream, hence reconcentrating the stream and reducing the amount of mobilized dust. The size of the area reduction has to be carefully selected based on the expected product velocity and tonnage to avoid choking the chute.

Although Fig. 4 shows the tapered chute 17 used in combination with the air restrictive flap 9, it has been found in testing that the tapered chute 17 in combination with the curved spoon 4 is fully effective in concentrating the dust and that the air restrictive flap 9 had virtually no further impact on dust concentration levels. It would therefore appear that the effectiveness of the invention is enhanced by using either the tapered chute 17 or the air restrictive flap 9 but that the combination of the two has little further effect in re-entraining the dust.

Overall it has been found that concentrating the product stream using a curved discharge spoon and keeping the product velocities high has a far more beneficial effect on reducing dust than previous attempts to decelerate the product stream. The efficiency of the apparatus can be further enhanced by using either the tapered inlet duct 17 or the air restrictive flap 9.

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Due to the high velocities, the dust is dragged down the vertical chute and consequently merges with the product stream in the curved spoon so that the discharge is more concentrated and streamlined than in previously known spoons, resulting in the dust being contained within the product stream.

5 Although the preferred embodiment of the invention has been described for use in a grain loader, and in particular for the discharge of wheat into the holds of ships, it will be appreciated that the same principles can be applied in many other situations involving the handling of particulate commodities where dust is a problem, including the conveying of coal and the transfer of coal or other particulate material from one
10 conveyor to another, or into a discharge hopper or stockpile.

1. An apparatus for reducing dust emissions from particulate commodities during discharge from an outlet, comprising:

a curved duct having an upward facing inlet and terminating in the outlet, wherein the outlet has an inclined, downwardly-facing orientation, and wherein the curved duct is enclosed from the inlet to the outlet;

a continuously converging duct comprising an inner wall and a protrusion extending from the inner wall, the protrusion arranged to cause the continuously converging duct to deliver the particulate commodities into the curved duct at a location adjacent a curved outer wall of the curved duct and away from a curved inner wall of the curved duct; and

a delivery source arranged to deliver particulate commodities under gravity to the inlet at least at a predetermined delivery velocity of at least 5 meters per second without additional driving force through the duct, thereby causing dust to arise from the particulate commodities,

wherein the curvature of the curved duct is arranged to cause said dust to be re-entrained within the commodities as the commodities are diverted from a straight path by the curvature of the duct.

2. An apparatus as claimed in claim 1, wherein the curved duct comprises a substantially rectangular cross-section with substantially flat side walls, a curved inner wall corresponding to an inner radius portion of the curved duct and a curved outer wall corresponding to an outer radius portion of the curved duct.

3. An apparatus as claimed in claim 2, wherein a radius of curvature of the inner and outer walls is substantially constant throughout the curve.

4. An apparatus as claimed in claim 2, wherein a radius of curvature of the inner and outer walls varies over the curve such that the curvature of the curved duct is parabolic.

5. An apparatus as claimed in claim 4, wherein a tighter radius portion of the parabolic curve is positioned adjacent the inlet.

6. An apparatus for reducing dust emissions from particulate commodities during discharge from an outlet, comprising:

a curved duct having an upward facing inlet and terminating in the outlet, wherein the outlet has an inclined, downwardly-facing orientation, and wherein the curved duct is enclosed from the inlet to the outlet; and

a delivery source arranged to deliver particulate commodities under gravity to the inlet at least at a predetermined delivery velocity of at least 5 meters per second without additional driving force through the duct, thereby causing dust to arise from the particulate commodities,

wherein the curvature of the curved duct is arranged to cause said dust to be re-entrained within the commodities as the commodities are diverted from a straight path by the curvature of the duct,

wherein the curved duct comprises a substantially rectangular cross-section with substantially flat side walls, a curved inner wall corresponding to an inner radius portion of the curved duct and a curved outer wall corresponding to an outer radius portion of the curved duct, and

wherein a portion of the curved inner wall comprises an air-restrictive flap extending inwardly into the curved duct upstream of the outlet and coupled to the interior of curved inner wall, the flap including a trailing edge arranged to rest in use just above the stream of particulate commodities issuing from the outlet.

7. An apparatus as claimed in claim 6, wherein the flap is hingedly connected to the curved inner wall such that the trailing edge can move toward or away from the curved outer wall depending on the volume of particulate commodities passing therebeneath at any point in time.

8. An apparatus as claimed in claim 6, wherein the trailing edge portion of the flap is flexible to automatically allow for changes in the mass flow rate of particulate commodities passing therebeneath.

9. An apparatus as claimed in claim 6, wherein a radius of curvature of the inner and outer walls is substantially constant throughout the curve.

10. An apparatus as claimed in claim 6, wherein a radius of curvature of the inner and outer walls varies over the curve such that the curvature of the curved duct is parabolic.

11. An apparatus as claimed in claim 10, wherein a tighter radius portion of the parabolic curve is positioned adjacent the inlet.

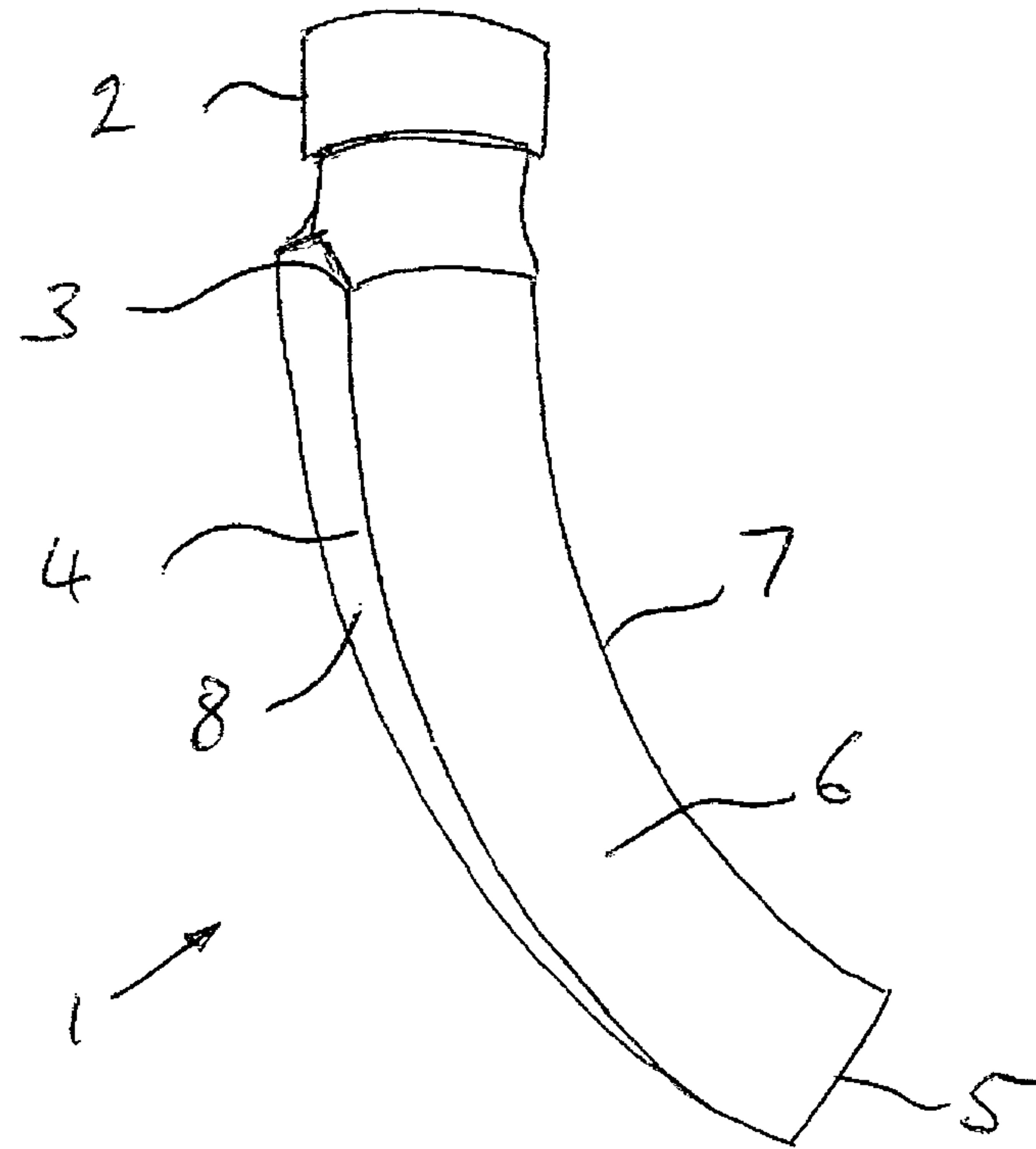


FIG 1

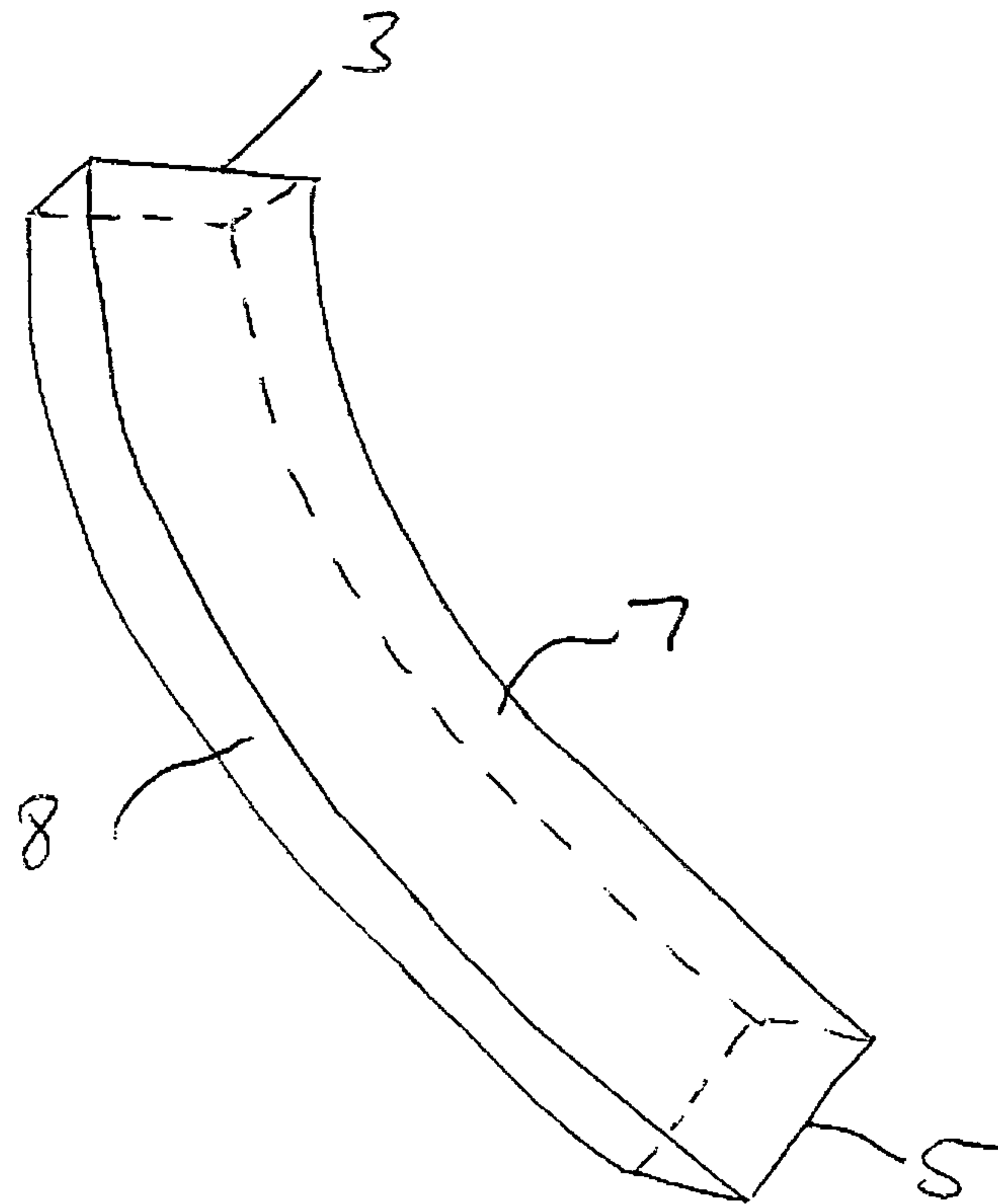


FIG 2

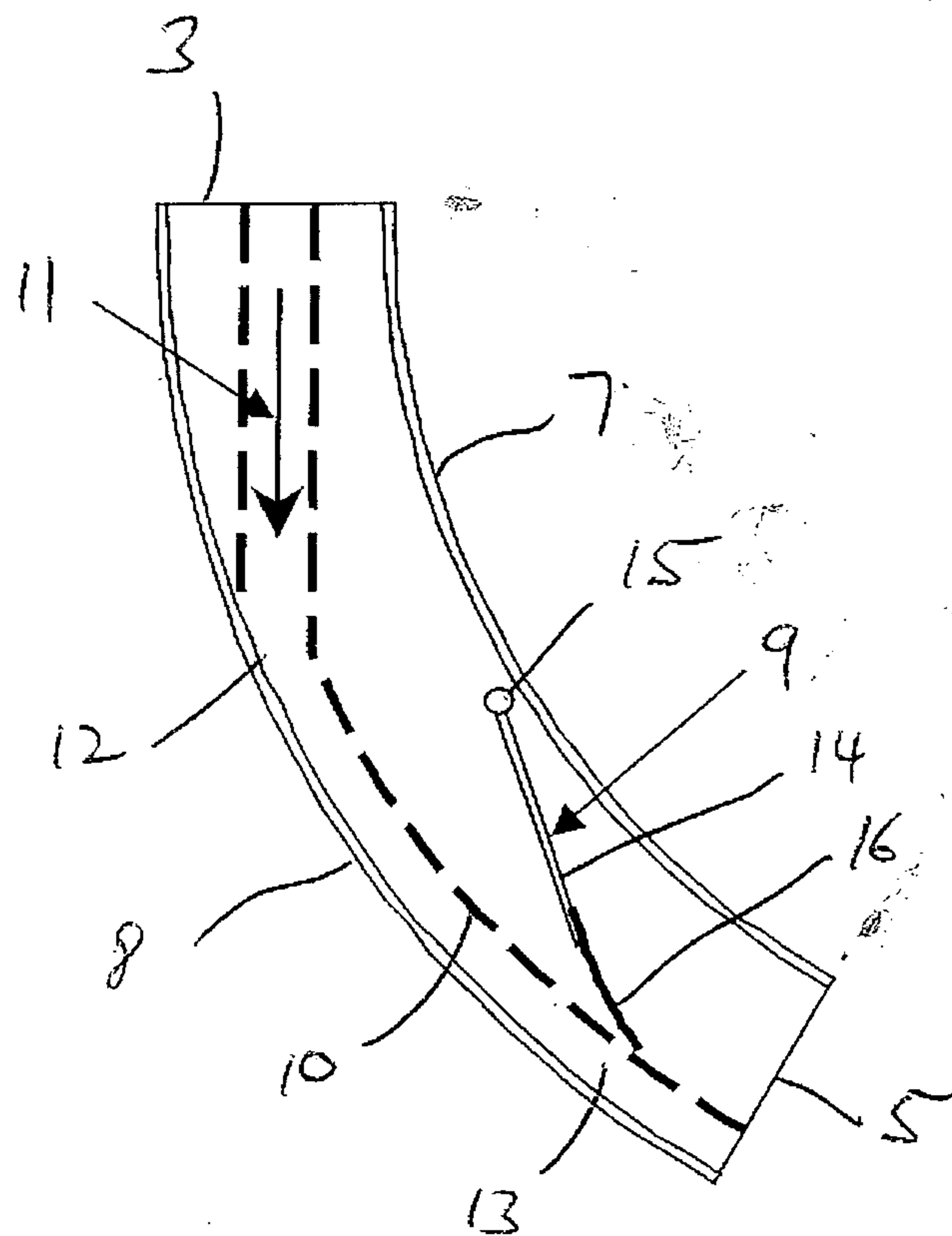


FIG. 3

