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(54) **Titre : CENTRIFUGEUSE ET ELEMENT D'ORIFICE DE REFOULEMENT D'UNE CENTRIFUGEUSE PERMETTANT DE REDUIRE LA PUISSANCE**

(54) **Title: CENTRIFUGE AND DISCHARGE PORT MEMBER OF A CENTRIFUGE FOR POWER REDUCTION**

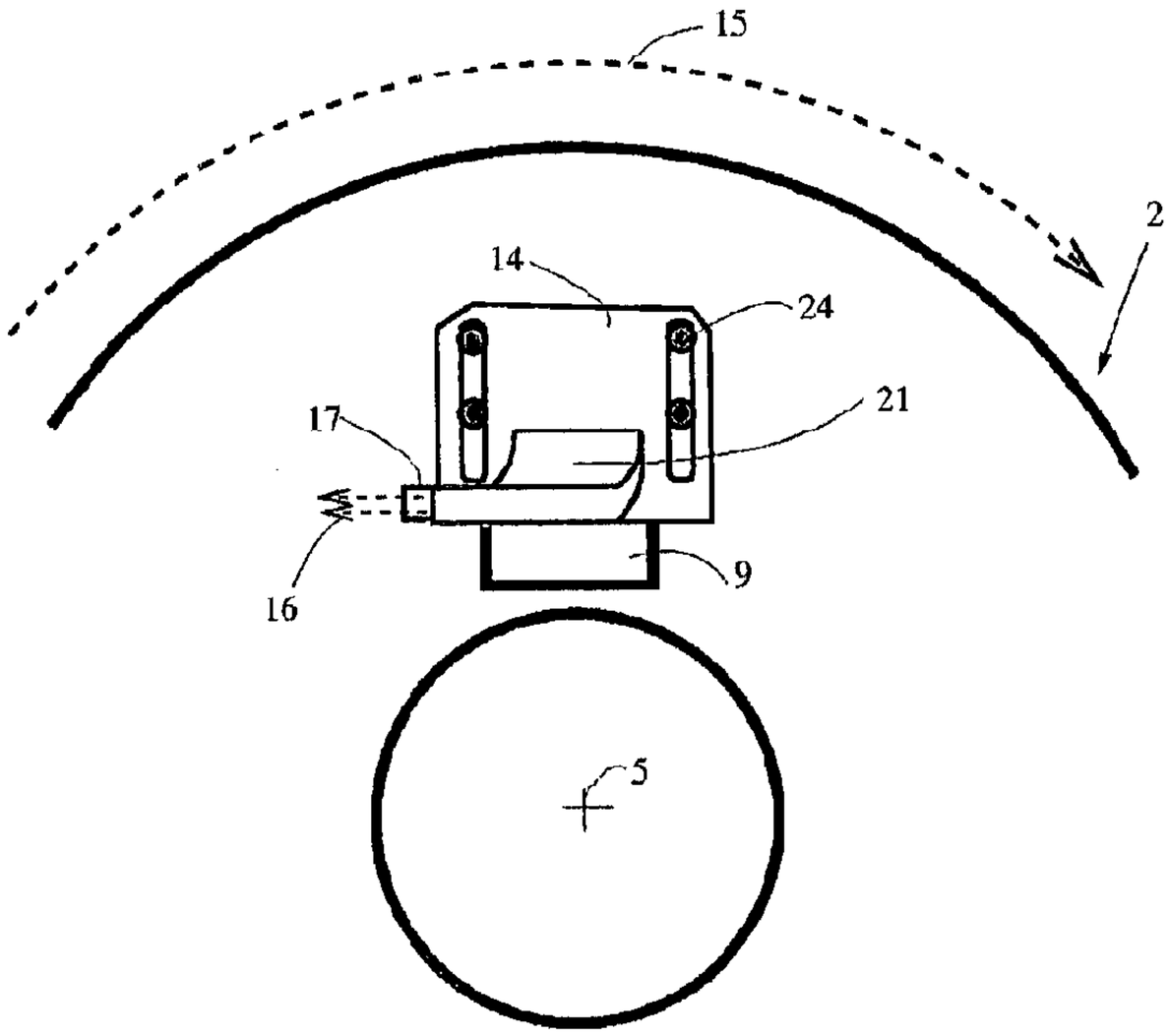

Fig 2.a

(57) **Abrégé/Abstract:**
The invention relates to a rotating machine (1), especially a decanter centrifuge, comprising a bowl (2) rotatable about an axis (5) to generate a cylindrical pool of a feed slurry, said bowl (2) having a heavy phase discharge port (10); and a base plate (6) provided at

CA 2843483 A1 2013/02/07

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(57) **Abrégé(suite)/Abstract(continued):**
one longitudinal end (8) of said bowl (2); at least one outlet opening (9) provided in said base plate (6); a liquid phase discharge port member (14, 22) placed over the at least one outlet opening (9); characterised by said liquid phase discharge port member (14, 22) including at least one open straight channel (17) with a longitudinal axis (18); wherein the longitudinal axis (18) of said channel (17) extends at an acute angle (a) relative to said base plate (6) and said channel (17) has an extension in the direction of said longitudinal axis (18). The invention also relates to a liquid phase discharge port member (14, 22) adapted to be placed over an outlet opening (9) of a rotating machine (1), especially a decanter centrifuge.

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(54) **Title**: CENTRIFUGE AND DISCHARGE PORT MEMBER OF A CENTRIFUGE FOR POWER REDUCTION

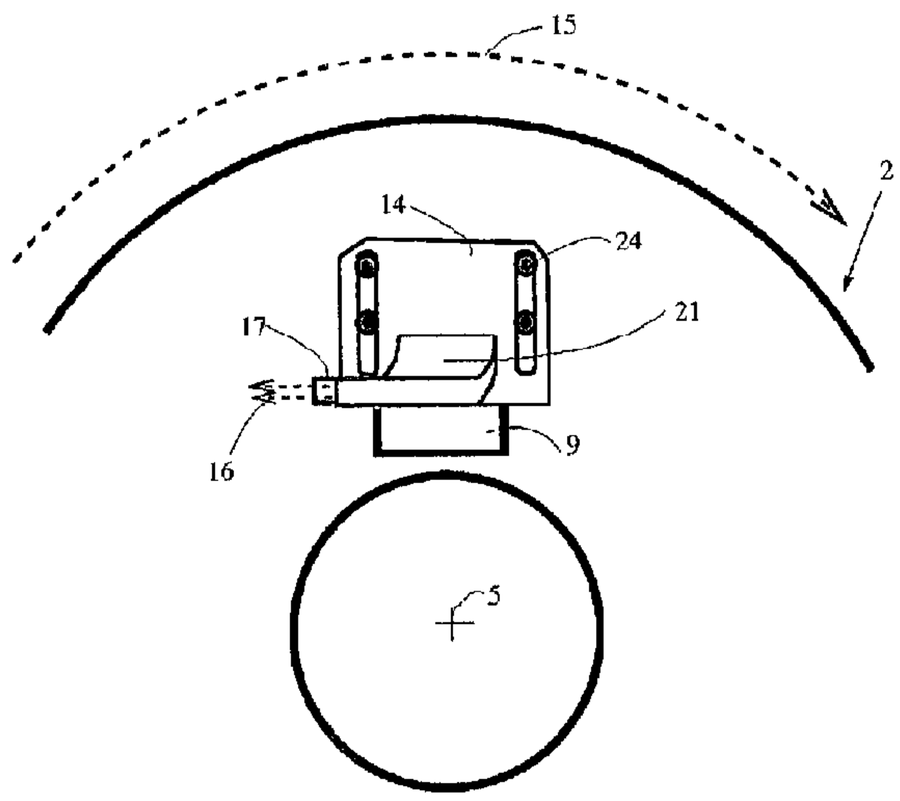

Fig 2.a

(57) **Abstract**: The invention relates to a rotating machine (1), especially a decanter centrifuge, comprising a bowl (2) rotatable about an axis (5) to generate a cylindrical pool of a feed slurry, said bowl (2) having a heavy phase discharge port (10); and a base plate (6) provided at one longitudinal end (8) of said bowl (2); at least one outlet opening (9) provided in said base plate (6); a liquid phase discharge port member (14, 22) placed over the at least one outlet opening (9); characterised by said liquid phase discharge port member (14, 22) including at least one open straight channel (17) with a longitudinal axis (18); wherein the longitudinal axis (18) of said channel (17) extends at an acute angle (a) relative to said base plate (6) and said channel (17) has an extension in the direction of said longitudinal axis (18). The invention also relates to a liquid phase discharge port member (14, 22) adapted to be placed over an outlet opening (9) of a rotating machine (1), especially a decanter centrifuge.

WO 2013/017223 A1

Centrifuge and discharge port member of a centrifuge for power reduction

The invention relates to a rotating machine comprising a bowl rotatable about an axis to generate a cylindrical pool of a feed slurry, said bowl having a heavy phase discharge port and a base plate provided at one longitudinal end of said bowl, at least one outlet opening provided in said base plate and a liquid phase discharge port member placed over the at least one outlet opening. The invention further relates to a liquid phase discharge port member adapted to be placed over an outlet opening of a rotating machine.

A rotating machine from this type is known from US 7022061 which has a tubular outlet member with an elbow bend in opposite direction of bowl rotation. A similar rotating machine is described in US 2004/072668 and describes a casing provided with a nozzle in the casing side. Above the casing a weir may be provided. The liquid discharge has an angle with the base plate. However the nozzle in certain applications of such a machine tends to clog and thus the liquid will flow by overflow which can increase power consumption.

Another rotational machine, especially a centrifugal separator, is described in WO 2008/138345. Here a casing is also provided with a discharge opening in an angle to the base plate. The pond level is generated by a weir with an overflow edge. This weir operates similar to the weirs known from e.g. US 4575370 with the only difference that the flow is in a direction where it cannot clinge to the outside of the base plate.

The separator of the above-mentioned WO 2008/138345 seems to solve the problem of US 4575370. However there is an uncontrolled flow of the liquid in radial direction and low liquid acceleration at the outlet compared with US4575370.

The present invention therefore aims at providing a rotational machine and a liquid phase discharge port member for such rotational machine that eliminates or reduces the problems mentioned above and wherein the power recovery is improved.

A rotating machine comprises, in accordance with the present invention, a bowl rotatable about an axis to generate a cylindrical pool of a feed slurry, said bowl having a heavy phase discharge port and a base plate provided at one longitudinal

end of said bowl, at least one outlet opening provided in said base plate and a liquid phase discharge port member placed over the at least one outlet opening.

The invention is characterised by said liquid phase discharge port member including at least one open straight channel with a longitudinal axis, wherein the longitudinal axis of said channel extends at an acute angle relative to said base plate and said channel has an extension in the direction of said longitudinal axis. With this extension the flow of the liquid is directed by the channel at an acute angle to the base plate more or less in circumferential direction and the reaction forces may be used to rotate the bowl, thus reducing the energy consumption considerably.

With the length of said channel being between 0.1 and 5 times, advantageously between 1 and 3 times, the width the flow can be directed to the intended direction more securely.

If an additional closed channel is arranged radially outwardly with respect to said at least one channel having a longitudinal axis arranged parallel to said longitudinal axis of said at least one channel there is an additional source of energy recovery.

When the length of said closed channel is approximately equal to the length of said channel the flow of both streams is in an approximately similar direction and thus not disturbing each other.

If a nozzle member is placed at the end of said closed channel the flow can even be better directed into a desired direction and due to the high velocity of the flow an even higher energy recovery is possible. In case that the nozzle is clogged the liquid will discharge by the open channel with low increase in power consumption.

A further improvement is given when said nozzle member is adjustable and/or exchangeable. So the liquid flow can be adjusted to the desired production.

Further if slots or other mechanical solutions are provided in said liquid phase discharge port member to adjust said liquid phase discharge port member in radial direction, the level in the bowl can easily be changed.

A further object of the invention is to provide a liquid phase discharge port member adapted to be placed over an outlet opening of a rotating machine. The liquid phase discharge port member, according to the invention comprises a flange, an inlet opening provided in said flange. The invention is characterised by said liquid phase discharge port member including an open straight channel with a longitudinal axis,

Duration: 29.05.2013 12:43:54 - 29.05.2013 12:51:48. This page 5 of 1 :013 12:46:33
Received at the EPO on May 29, 2013 12:51:48. Page 5 of 14

discharge port member including an open straight channel with a longitudinal axis, wherein the longitudinal axis of said channel extends at an acute angle relative to said flange and said channel has an extension in the direction of said longitudinal axis. With this extension the flow of the liquid is directed by the channel at an acute angle to the base plate more or less in circumferential direction and the reaction forces may be used to rotate the bowl, thus reducing the energy consumption of a rotating machine, e.g. centrifuge, considerably.

Preferably said liquid phase discharge port member has a length of said channel being equal or more than the width so the flow can be directed to the intended direction more securely.

If said liquid phase discharge port member has additional tubular opening arranged below a bottom of said channel having a longitudinal axis arranged parallel to said longitudinal axis of said channel there is a second source for energy recovery.

It is of advantage when the length of said tubular opening is approximately equal to the length of said channel so the flow of both streams is in an approximately similar direction and thus not disturbing each other.

A further improvement is characterised by a nozzle member being placed at the end of said tubular opening, whereby said nozzle member may be adjustable and/or exchangeable. If a nozzle member is placed at the end of said tubular opening the flow can even be better directed into a desired direction and due to the high velocity of the flow an even higher energy recovery is possible and by the adjustable and/or exchangeable nozzle member the liquid flow can easily be adjusted to the desired production of the rotating machine, e.g. centrifuge.

If the liquid phase discharge port member according to the invention has slots to adjust said liquid phase discharge port member with respect to said outlet opening of said rotational machine, the level in the bowl of said rotational machine, e.g. centrifuge, can easily be changed.

The invention will now be described in further details based on exemplary, but not limiting, embodiments with reference to the drawings. In the drawings,

Fig. 1 shows a schematic view of a rotational machine, e.g. a decanter centrifuge, of prior art,

Fig. 2 a shows a section of the base plate at the end of a rotational machine, equipped with liquid phase discharge members of one embodiment according to the invention,

Fig. 2 b shows a top view on Fig. 2 a,

Fig. 3 shows a view of a liquid phase discharge member of one embodiment according to the invention,

Fig. 4 a shows a top view of a liquid phase discharge members of one embodiment according to Fig. 3,

Fig. 4 b shows a section along lines IV-IV in Fig. 4a

Fig. 5 a shows the base plate at the end of a rotational machine, equipped with liquid phase discharge members of another embodiment according to the invention,

Fig. 5 b shows a top view on Fig. 5 a,

Fig. 6 shows a 3D view of a liquid phase discharge members according to Fig. 5,

Fig. 7 shows a front view of a liquid phase discharge members according to Fig. 5,

Fig. 8 shows a section through lines VIII-VIII in Fig. 7 and

Fig. 9 shows a third embodiment of a liquid phase discharge member according to the invention.

Fig. 1 shows a prior art decanter centrifuge 1 which comprises a bowl and a screw conveyor 3 which are mounted on a shaft 4 such that they in use can be brought to rotate around an axis 5 of rotation, the axis 4 of rotation extending in a longitudinal direction of the bowl 2. The bowl 2 comprises further a base plate 6 provided at one longitudinal end of the bowl 2, which base plate 6 has an internal side 7 and an external side 8. The base plate 6 is provided with a number of liquid phase outlet openings 9. Furthermore the bowl 2 is at an end opposite to the base plate 6 provided with solid phase discharge openings 10.

Further the screw conveyor 3 comprises inlet openings 11 for feeding e.g. slurry to the centrifugal separator 1, the slurry comprising a light or liquid phase 12 and a heavy or solid phase 13. During rotation of the centrifugal separator 1, separation of the liquid 12 and solid 13 phases is obtained. The liquid phase 12 is discharged through the outlet openings 9 in the base plate 6, while the screw conveyor 3

transports the solid phase 13 towards the solid phase discharge openings 10 through which the solid phase 13 is discharged.

Fig. 2 a shows a view to a section of the base plate 6 with mounted with a liquid phase discharge member 14 and fixed with bolts 24 according to one embodiment of the invention. Also the direction of rotation 15 of the bowl 2 is shown. Further it can be seen that the direction 16 of the liquid flow is essentially in opposite direction to the direction of rotation 15. However there is a component also in direction of the axis 5 of rotation, which leads to a better flow not interfering with other liquid phase discharge members. This can be seen from Fig. 2 b.

Fig. 3 shows a view of liquid phase discharge member 14 with an open straight channel 17. Here the channel 17 can be seen with its longitudinal axis 18. Channel 17 is covered only at three sides, i.e. it is open on top. So there is no risk of clogging or similar closing of the channel 17. Further there can be seen slots 19 in flange 20 which allow to adjust the liquid phase discharge member 14 to a specific level in the bowl. However there can be other mechanical solutions for fixing the flange 20 to the base plate 6. Further this allows to mount it on different types or sizes of rotational machines or centrifugal separators. Further there is shown the progressive reduction 21 before channel 17. This progressive reduction for the liquid when it is approaching the channel leads to a low liquid pressure loss. Also channel 17 may have a cross section in U-form, half circle, or any other appropriate form.

In Fig. 4 a a top view to the liquid phase discharge member 14 is shown. Here clearly angle α between the flange 20 and the longitudinal axis 18 of channel 17 can be seen. Angle α may be in the range of 1-35°, more preferably between 10 and 20 °, with a preferred value of 15°. Flange 20 may be rectangular (as shown), circular or of other shape. Fig. 4 b shows a section along line IV-IV in Fig. 4a where a rise of wall 21 of flange 20 at an angle β can be seen. Angle β may be in the range of 1 – 80°, more preferably between 25 and 45°, specifically approximately 35°. This rise of the wall 21 creates a progressive reduction when the liquid is approaching the channel. Thus the liquid pressure loss is not high. With this pressure drop reduction the liquid speed does not decrease too much at the beginning of the channel. Therefore this leads to a high speed at the end of the channel and an increased power reduction.

Fig. 5 a shows a view to a base plate 6 similar to Fig. 2 a but with a liquid phase discharge member 22 according to another embodiment of the invention. Again the direction of rotation 15 is shown and the flow 16 and 16' of the liquid in opposite direction to the direction of rotation 15. Through the closed channel 23, which is arranged outwardly from the axis 5 with respect to channel 17, there is a second flow 16'. Again there is a component also in direction of the axis 5 of rotation, which can be seen in the top view in Fig 5 b.

In Fig. 6 a view of an embodiment of a liquid phase discharge member 22 according to the invention is shown. This liquid phase discharge member 22 consists of a flange 20, which may be rectangular (as shown), circular or of other shape, with slots 19 through which screws 24 are mounted to the base plate 6 of the bowl 2. There is an open straight channel 17 which directs the flow in an angle away from base plate 6. Below it, which also refers to the level of the fluid in the bowl, a closed channel 23 is arranged. The closed channel 23 can be adjusted or equipped with an exchangeable nozzle 26 with another open diameter to be adapted to different volumes of flow. The flow of the centrate of the rotating machine, e.g. decanter centrifuge can be at a ratio of 10 to 90 up to 70 to 30 of flow through the channel 17 to flow through nozzle 23 in normal operation but may go up to 100 to 0 if especially all nozzles are clogged. Preferred is a ratio of less than 50 to 50, as this allows a better directed flow and a higher velocity leading to a higher amount of energy recovered.

Fig. 7 shows a drawing of the liquid phase discharge member 22 with slots 19 arranged in flange 20. Open straight 17 can be seen with its outlet opening and further closed channel 23, which might have a tubular, rectangular, polygonal or other cross section, can be seen. As the opening of closed channel 23 (and open straight channel 17) can be seen, it is clear that these are in an angle to the plane of the flange 20.

Fig. 8 shows a section through liquid phase discharge member 22 along line VIII-VIII in Fig. 7. The diameter 25 of (shown) tubular closed channel 23 corresponds to the width of open straight channel 17 and the central axis of closed channel 23 is accordingly in the direction of the longitudinal axis 18 of channel 17 and encloses an angle α to flange 20. The length 24 of closed channel 23 is in the range of between 0.1 and 5 times the diameter or width, most favourably at 1 to 2 times.

Fig. 9 shows another embodiment of a liquid phase discharge port similar to Fig. 2 a. However here the channel 17 is curved.

From Figs. 5 a, 5 b, 6, 7, 8 and 9 it can be seen that the progressive reduction for the liquid when it is approaching the channel can have various shapes. The main effect of this progressive reduction is that the liquid pressure loss is not high.

In general liquid discharge phase port 14, 22 is provided with two parts. One part has a progressive restriction 21 until the channel(s) 17, 23. The other part includes at least one open channel 17 or closed channel 23 with or without nozzle.

Although the invention has been described in terms of particular embodiments, it is not limited to these examples but can be other embodiments within the scope of the claims. For example the cross section of the channels may have all kind of shapes.

Claims:

1. A rotating machine (1), especially a decanter centrifuge, comprising:
a bowl (2) rotatable about an axis (5) to generate a cylindrical pool of a feed slurry, said bowl (2) having a heavy phase discharge port (10); and
a base plate (6) provided at one longitudinal end (8) of said bowl (2);
at least one outlet opening (9) provided in said base plate (6);
a liquid phase discharge port member (14, 22) placed over the at least one outlet opening (9);
characterized in that said liquid phase discharge port member (14, 22) includes at least one open straight channel (17) with a longitudinal axis (18);
wherein the longitudinal axis (18) of said channel (17) extends at an acute angle (α) relative to said base plate (6) and said channel (17) has an extension in the direction of said longitudinal axis (18).

2. A rotating machine according to claim 1, characterised by the length of said channel (17, 23) being 0.1 to 5 times the width.

3. A rotating machine according to claim 1, characterised by an additional closed channel (23) arranged radially outwardly with respect to said at least one channel (17) having a longitudinal axis (18) arranged parallel to said longitudinal axis (18) of said at least one channel (17).

4. A rotating machine according to claim 3, characterised by the length of closed channel (23) being approximately equal to the length of said at least one channel (17).

5. A rotating machine according to claim 3, characterised by a nozzle member being placed at the end of said closed channel (23).

6. A rotating machine according to claim 5, characterized by said nozzle member being adjustable and/or exchangeable.

7. A rotating machine according to claim 1, characterised by said liquid phase discharge port member (14, 22) including a progressive reduction before said channel (17, 23).

Duration: 29.05.2013 12:43:54 - 29.05.2013 12:51:48. This page 3 of 14
Received at the EPO on May 29, 2013 12:51:48. Page 3 of 14

8. A rotating machine according to claim 1, characterized by slots (19) being provided in said liquid phase discharge port member (14, 22) to adjust said liquid phase discharge port member (14, 22) in radial direction.

9. A liquid phase discharge port member adapted to be placed over an outlet opening of a rotating machine (1), especially a decanter centrifuge, comprising:

a flange (20);

an inlet opening (9) provided in said flange (20);

characterized in that said liquid phase discharge port member (14, 22) includes at least one open straight channel (17) with a longitudinal axis (18); wherein the longitudinal axis (18) of said channel (17) extends at an acute angle (α) relative to said flange (20) and said channel (17) has an extension in the direction of said longitudinal axis (18).

10. A liquid phase discharge port member according to claim 9, characterised by the length of said channel (17) being 0.1 to 5 times the width.

11. A liquid phase discharge port member according to claim 9, characterised by an additional closed channel (23) arranged below a bottom of said at least one channel (17) having a longitudinal axis (18) arranged parallel to said longitudinal axis (18) of said at least one channel (17).

12. A liquid phase discharge port member according to claim 11, characterised by the length of said closed channel (23) being approximately equal to the length of said at least one channel (17).

13. A liquid phase discharge port member according to claim 11, characterised by a nozzle member being placed at the end of said closed channel (23), which nozzle member advantageously being adjustable and/or exchangeable.

14. A liquid phase discharge port member according to claim 9, characterised by said liquid phase discharge port member (14, 22) including a progressive reduction before said channel (17, 23).

15. A liquid phase discharge port member according to claim 9, characterized by slots (19) being provided in said liquid phase discharge port member (14, 22) to adjust said liquid phase discharge port member (14, 22) with respect to said outlet opening (9) of said rotational machine (1).

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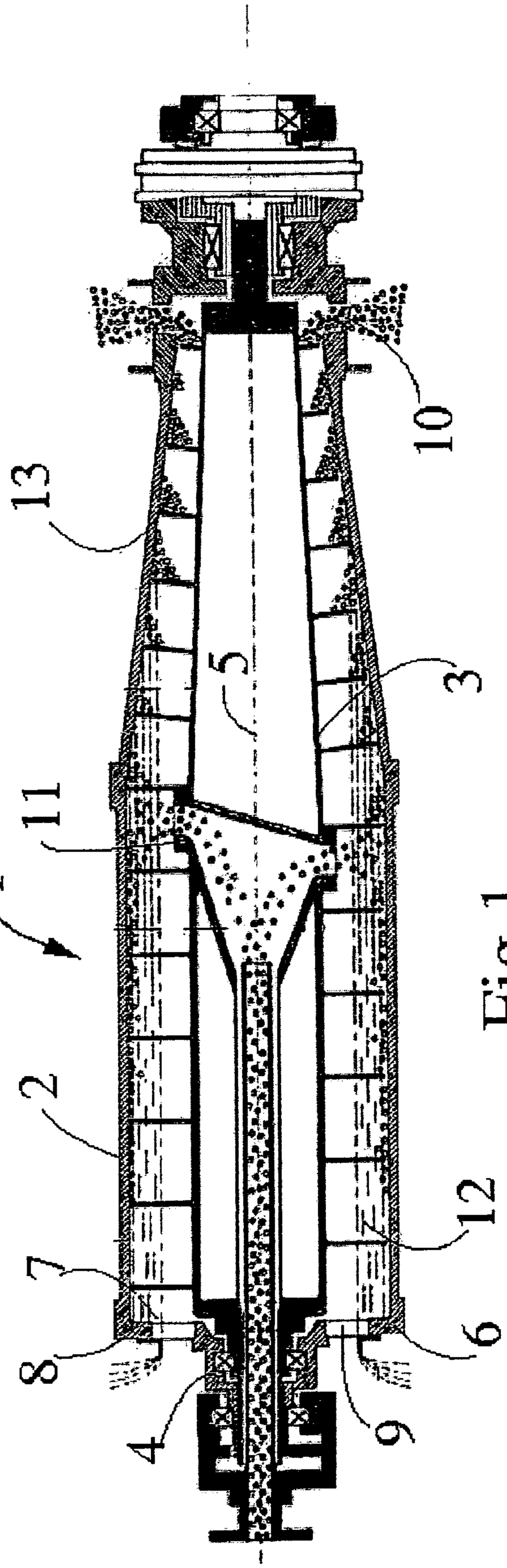

Fig 1

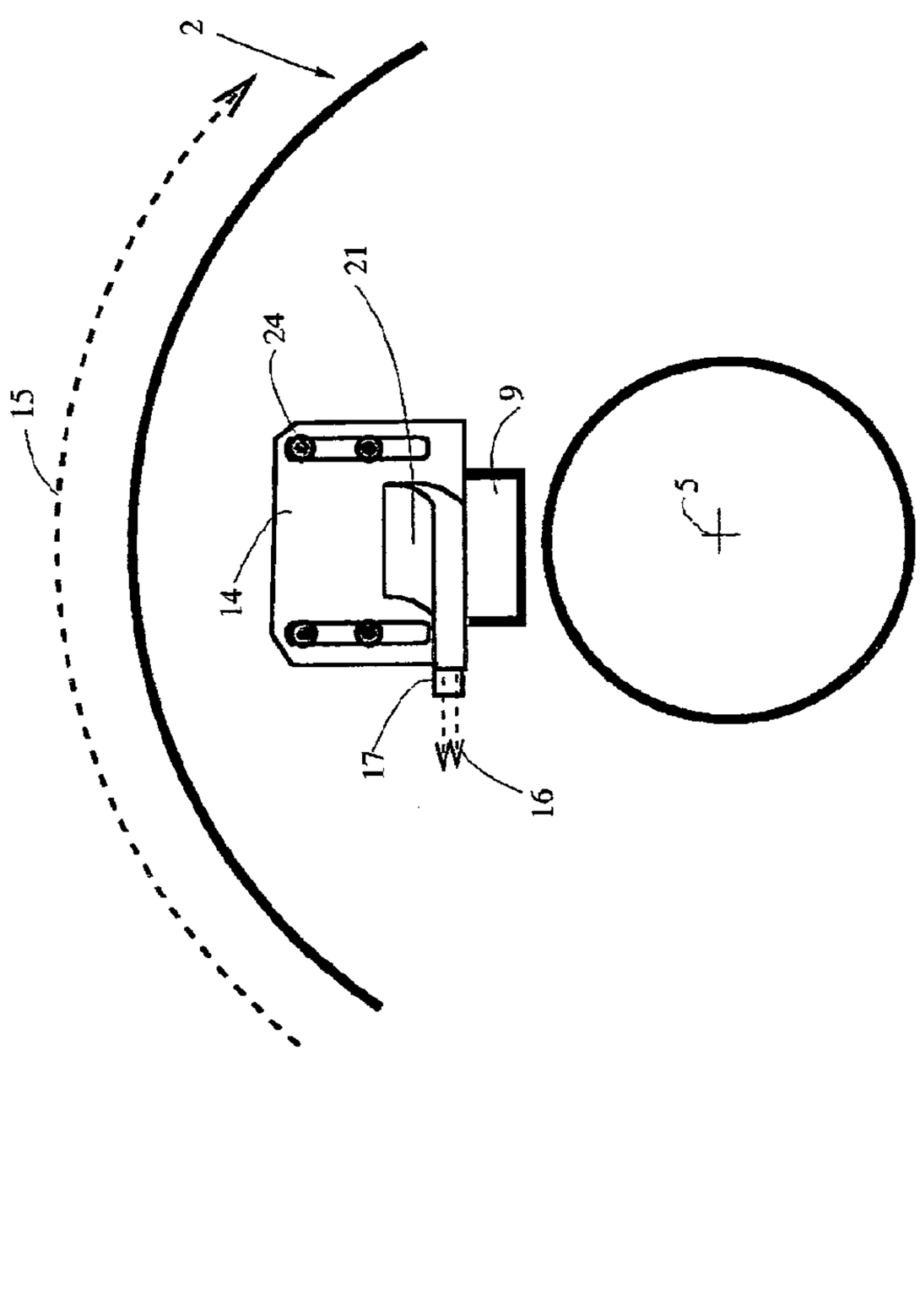

Fig 2.a

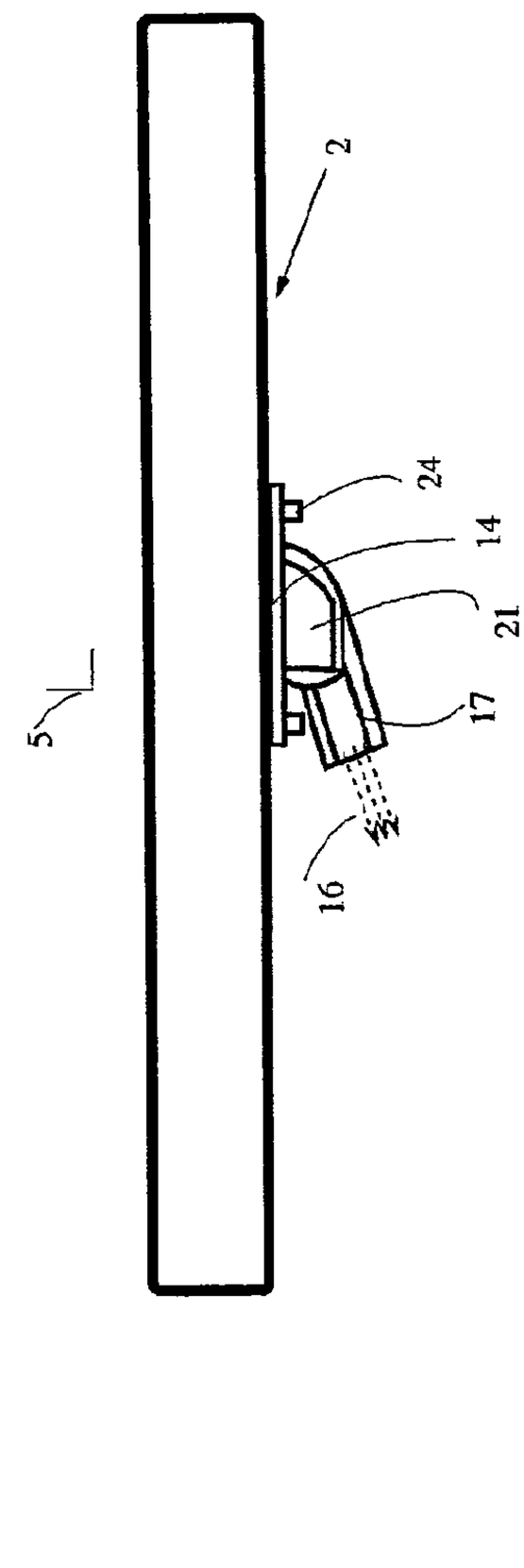

Fig 2.b

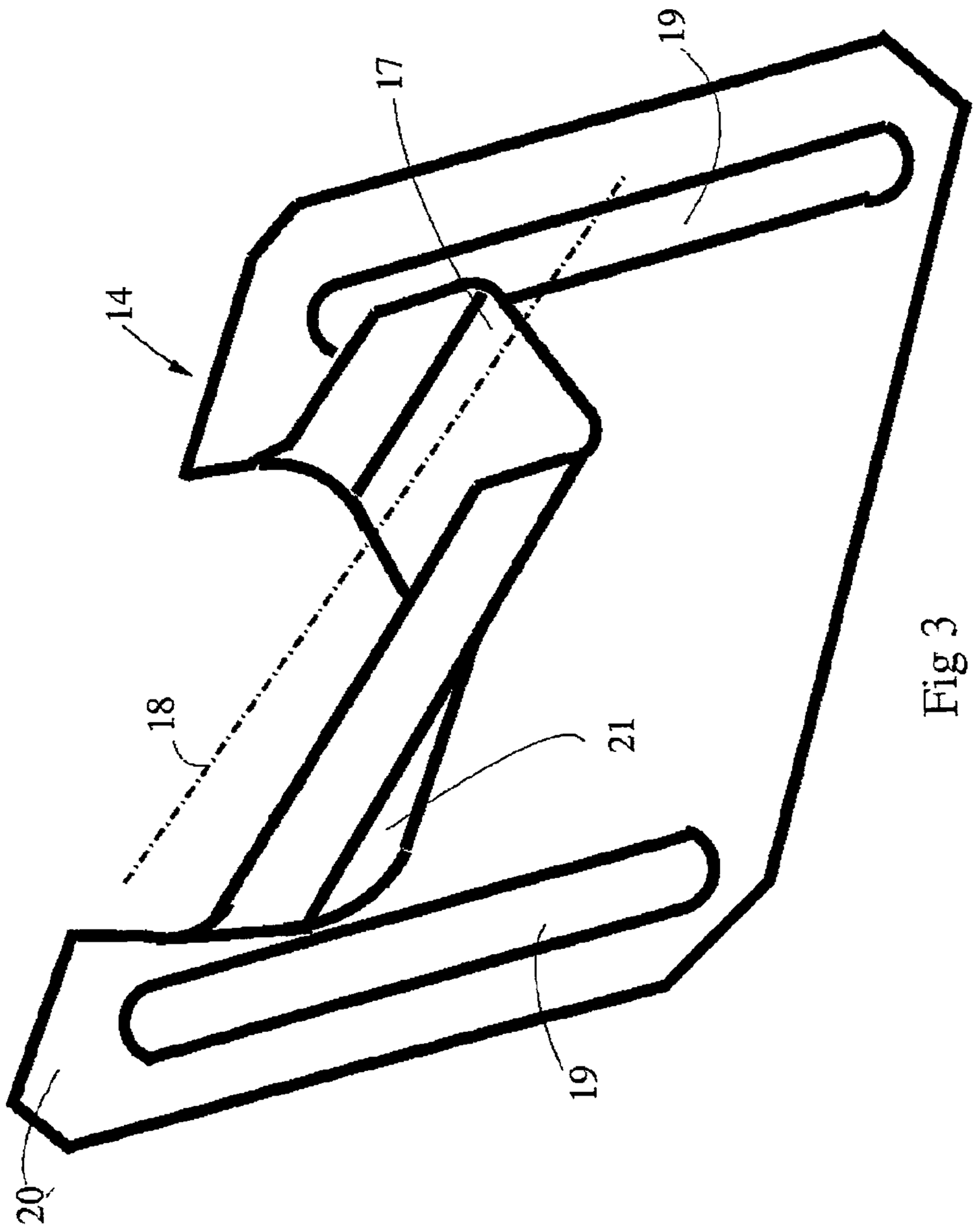

Fig 3

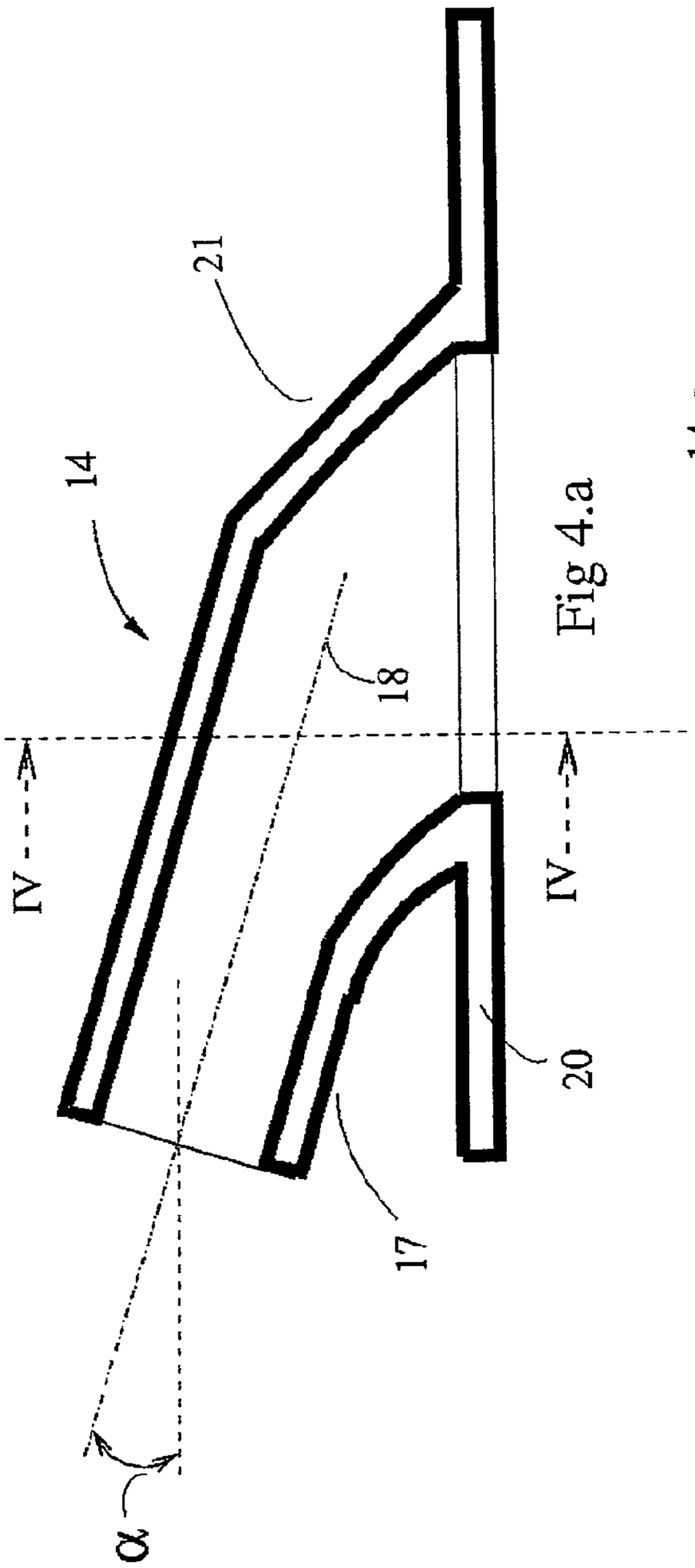

Fig 4.a

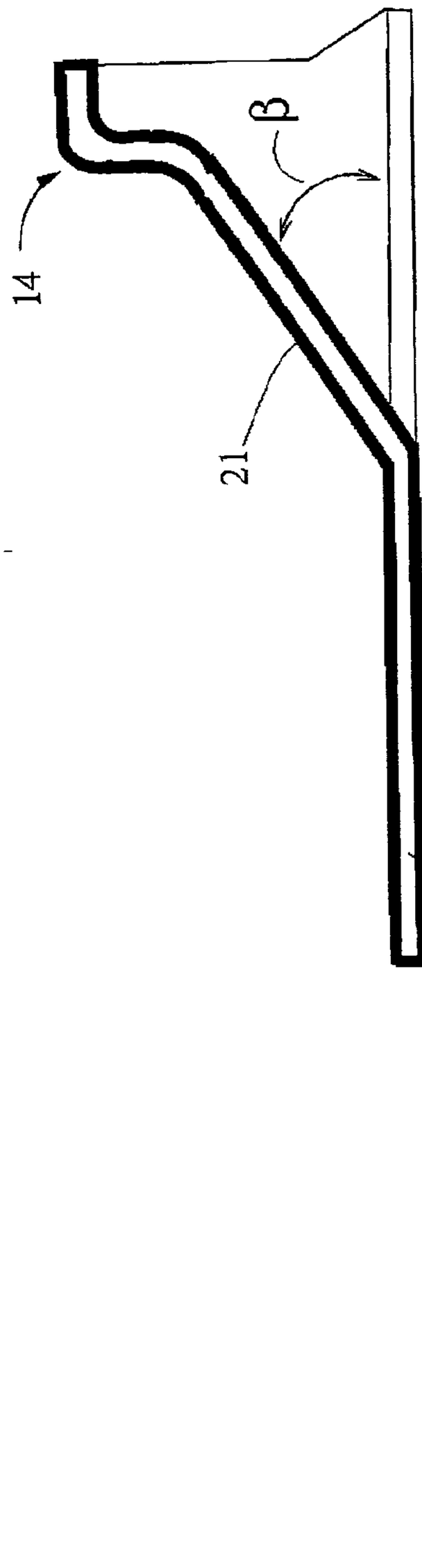

Fig 4.b

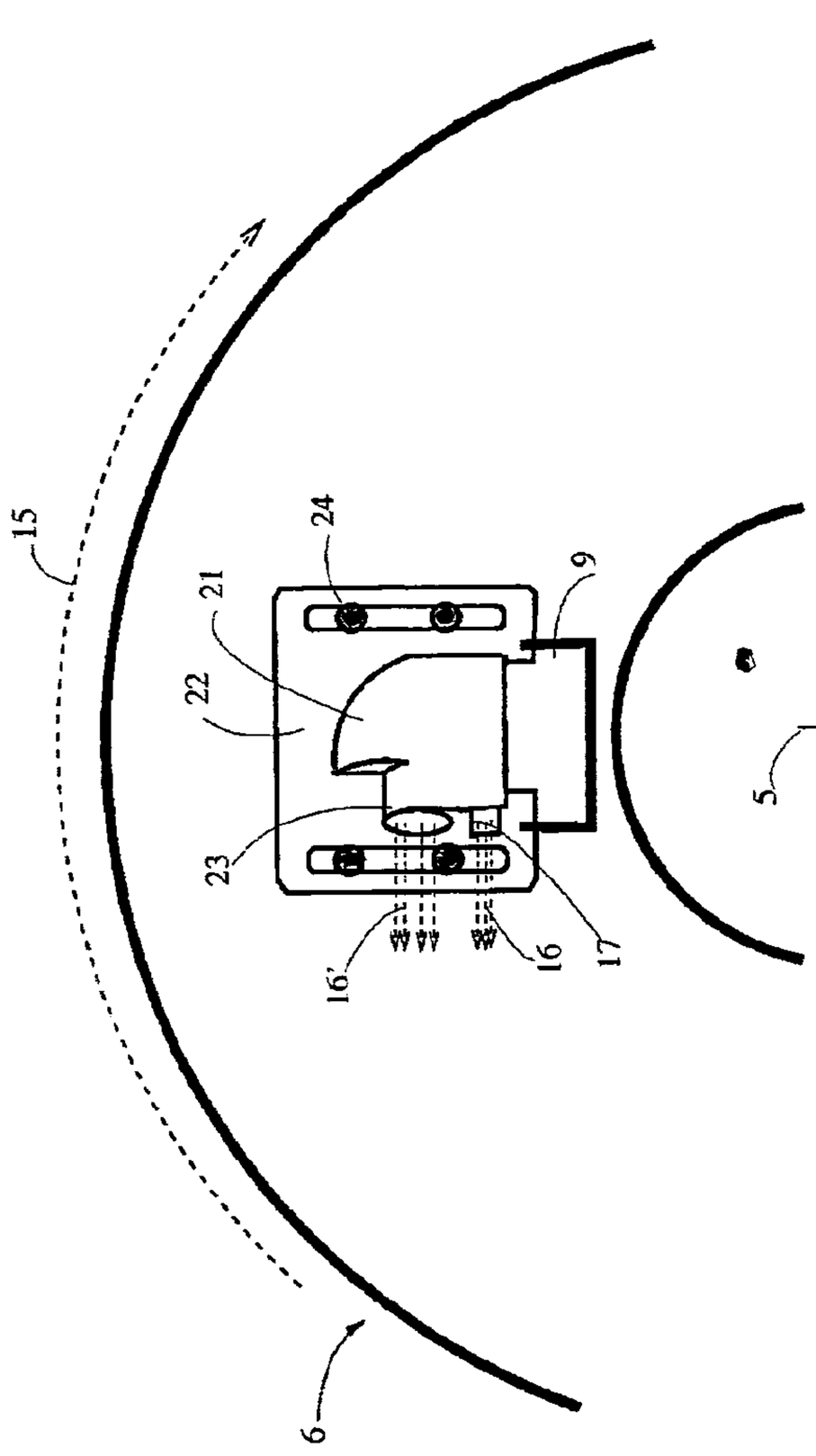

Fig 5.a

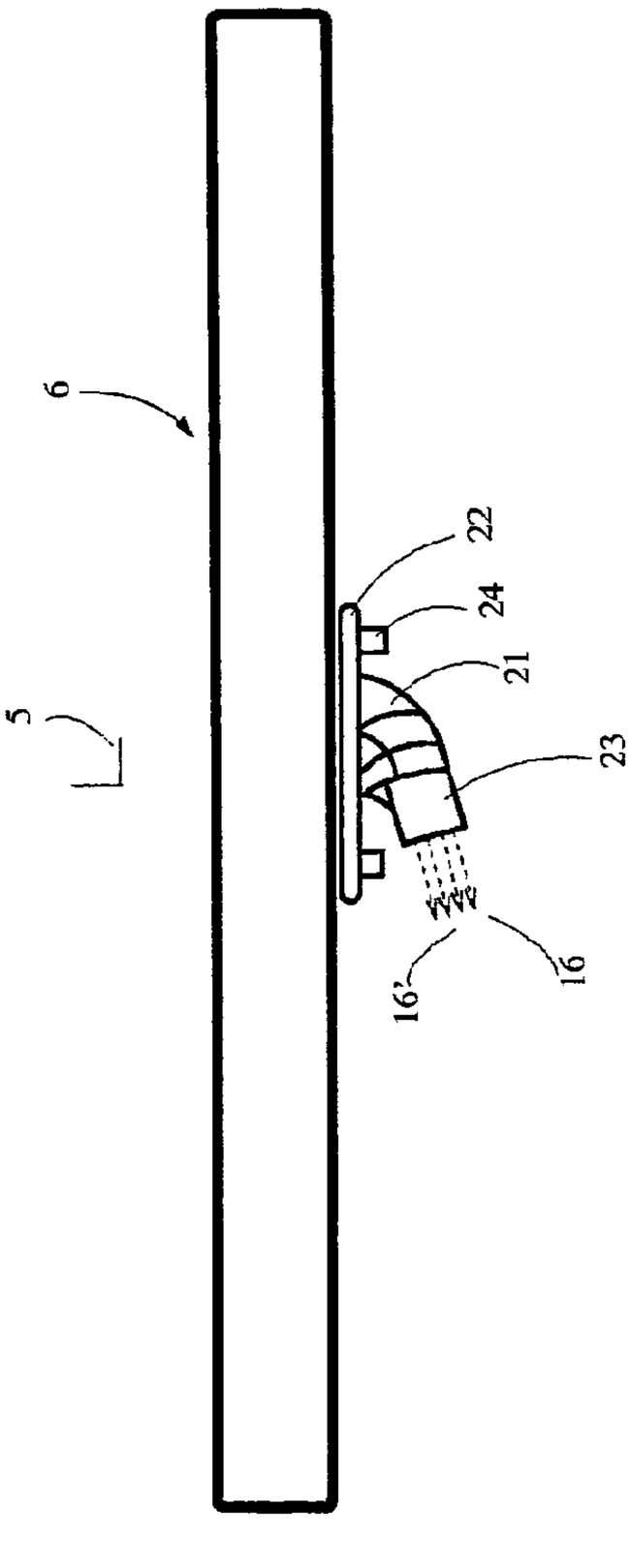

Fig 5.b

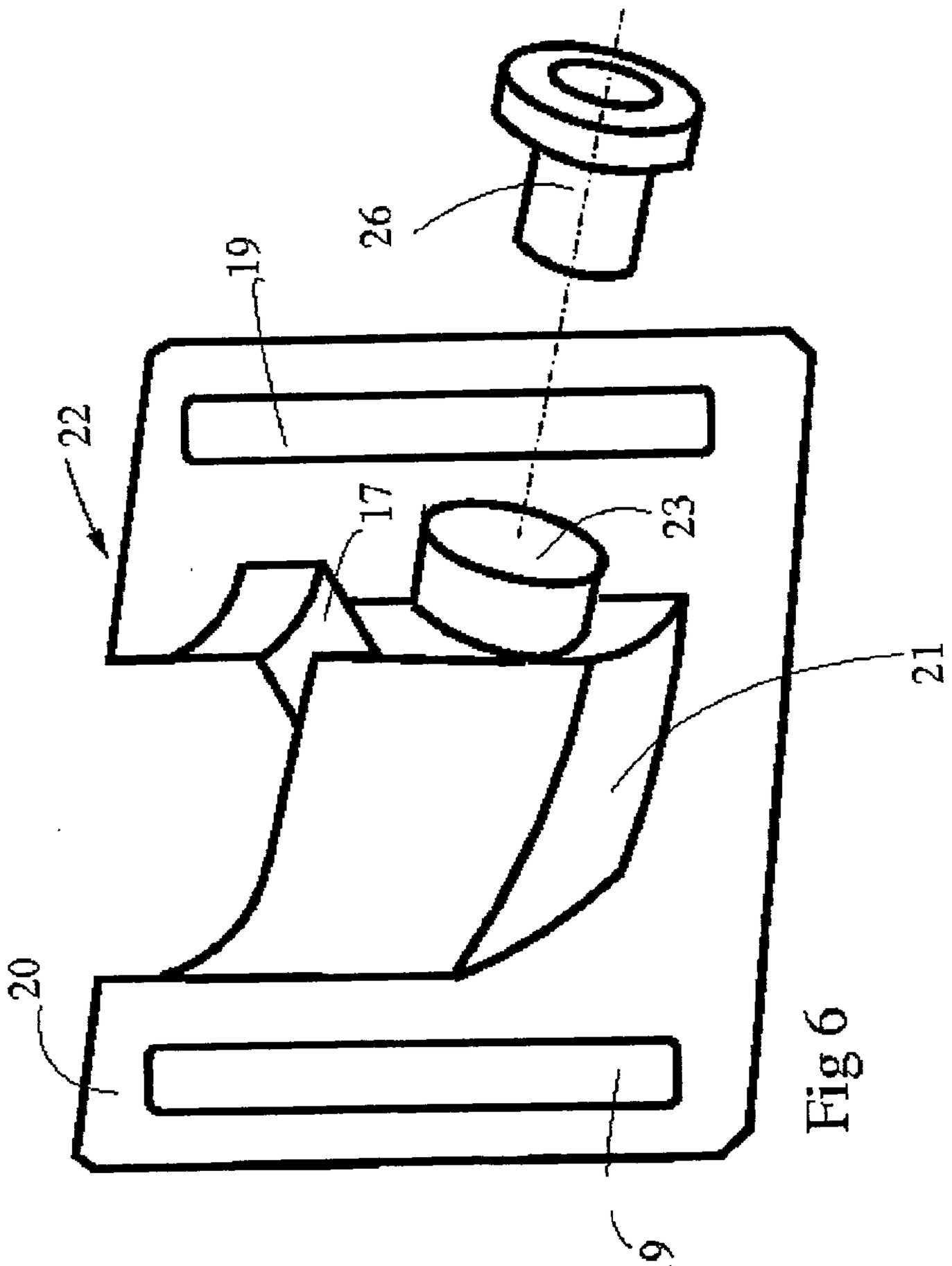

Fig 6

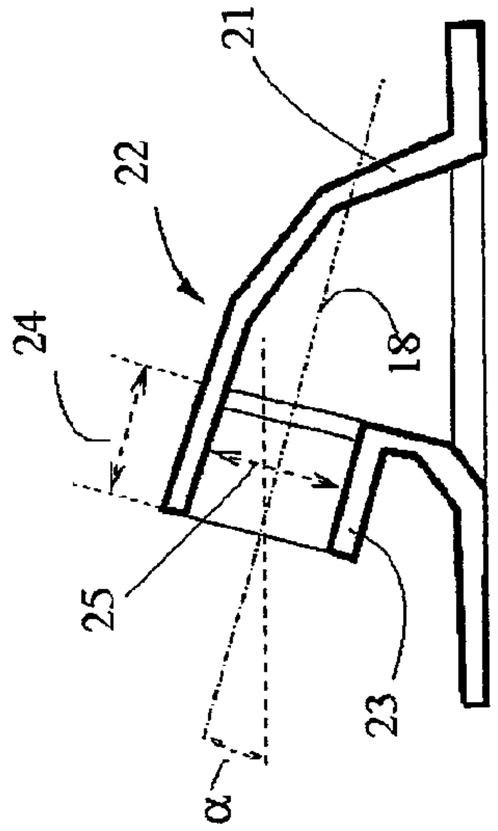

Fig 8

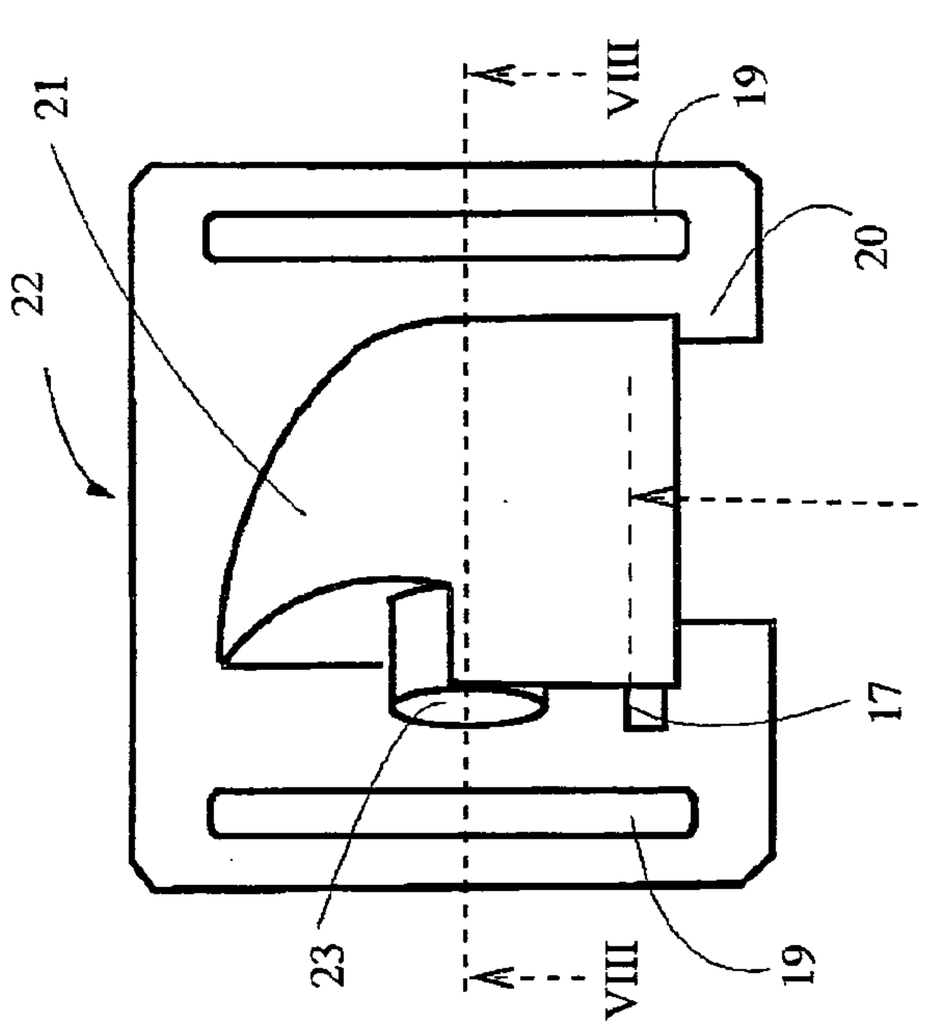

Fig 7

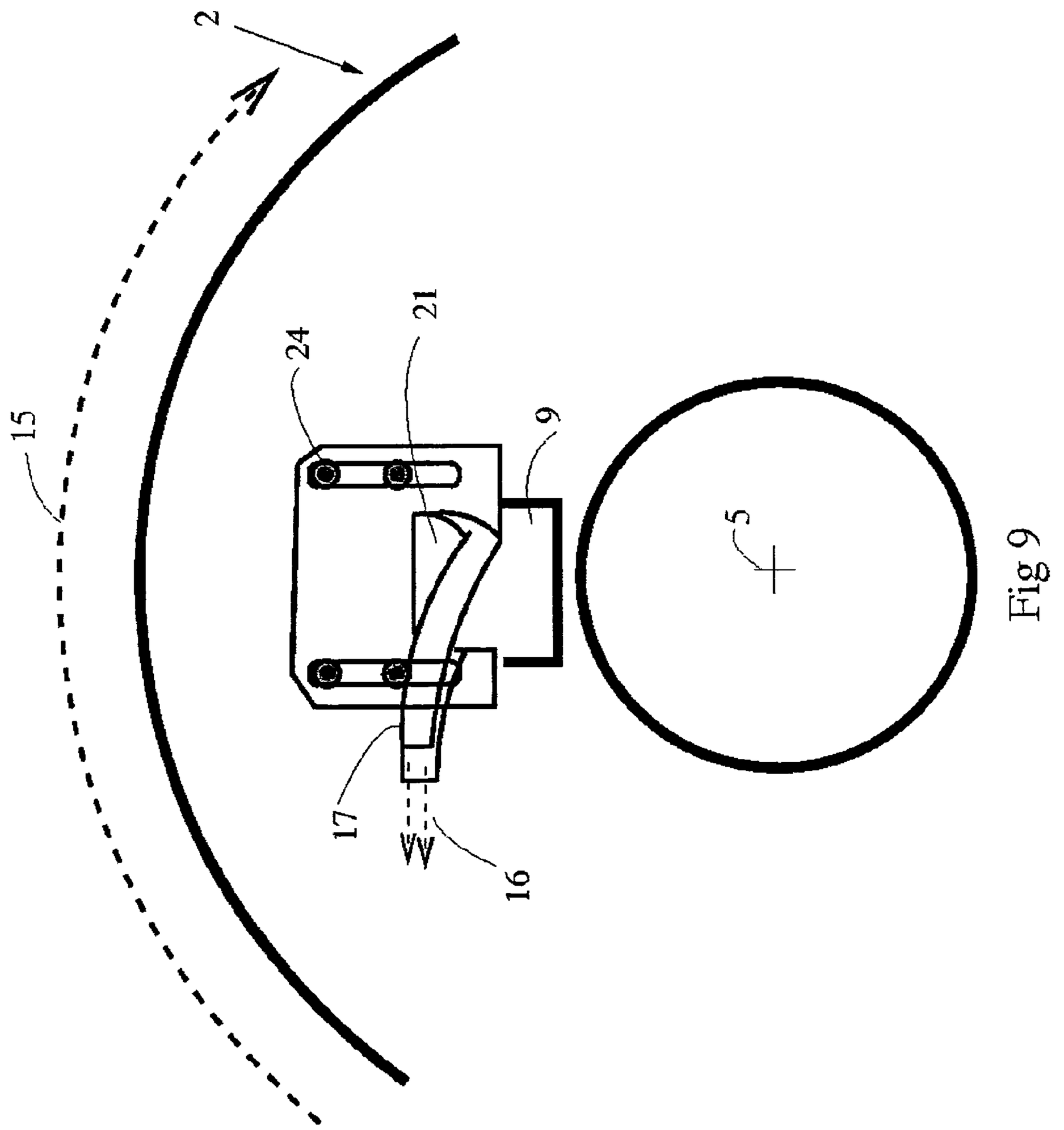

Fig 9

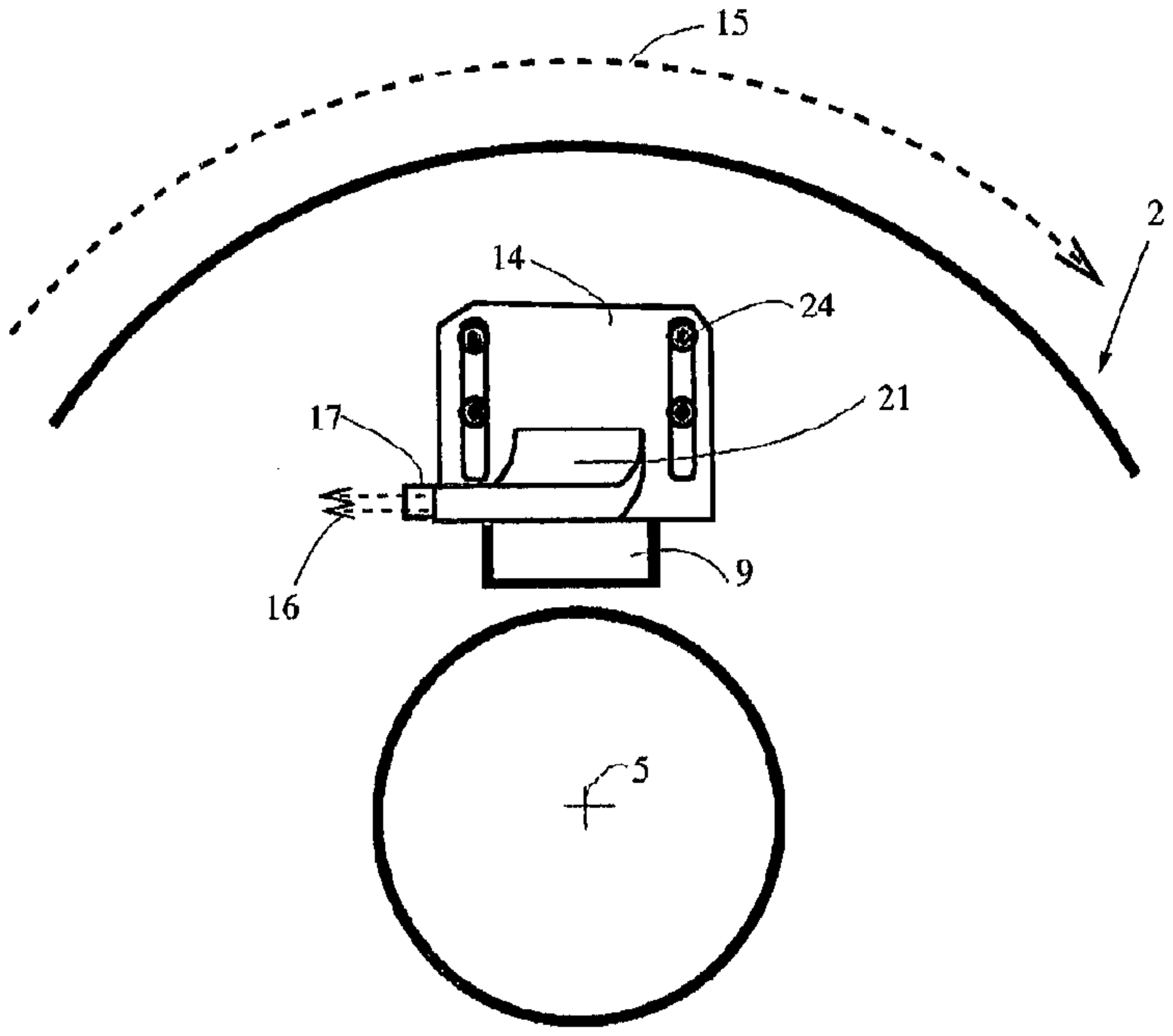

Fig 2.a