(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 922 812 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
16.06.1999 Bulletin 1999/24

(51) Int. Cl.[6]: **E02F 7/10**

(21) Application number: **98204191.5**

(22) Date of filing: **09.12.1998**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **10.12.1997 NL 1007763**

(71) Applicant: **Ingenieursbureau JBR**
2641 VW Pijnacker (NL)

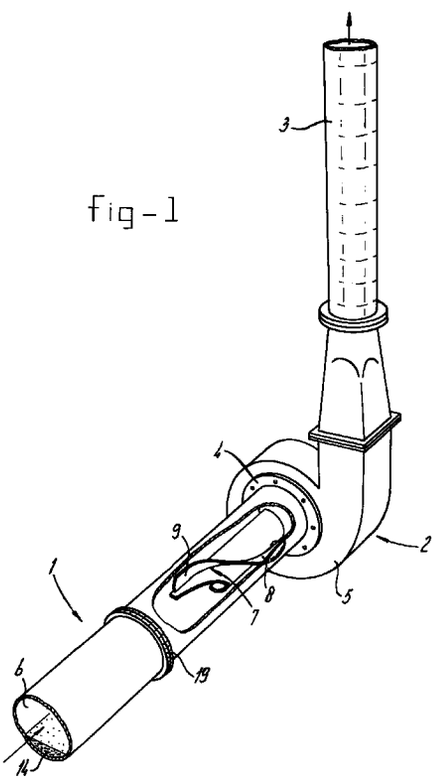
(72) Inventor: **Brouwer, Jan**
2641 VW Pijnacker (NL)

(74) Representative:
de Bruijn, Leendert C. et al
Nederlandsch Octrooibureau
P.O. Box 29720
2502 LS Den Haag (NL)

(54) Conveying system for a two-phase flow

(57) A conveyor system for a two-phase flow, such as water containing sand, gravel and the like, comprising at least one conveyor pipeline (1) with means (2) for generating a flow, characterized in that the internal surface of the conveyor line bears guide means (7) for influencing the flow. A pump (2) is accommodated in the conveyor pipeline, and the guide means (7) are situated immediately upstream of the inlet of the pump. In case the pump is a rotary pump, the guide means are designed to impart a preliminary rotation to the flow.

Fig-1



EP 0 922 812 A2

Description

[0001] The invention relates to the conveying of a two-phase flow in a conveyor pipeline. A two-phase flow of this nature occurs, for example, in the hydraulic conveying of dredged material.

[0002] The flow is formed by water containing a granular material, such as sand, gravel, stones and the like. A further example of a two-phase flow relates to the pneumatic conveying of solids.

[0003] Conveying by means of two-phase flows is used in many fields of industry for economically moving solid materials over relatively great distances. The resistance generated by the flow is in equilibrium with the pressure difference across the pipeline, which pressure difference can be generated with the aid of a rotary pump or plunger pump. In this context, the nature and size of the pieces of material to be conveyed are important.

[0004] Relatively small pieces of material lead to a flow behaviour which corresponds to a considerable extent to that of the homogeneous liquid. This is because the settling rate of relatively small particles is so low that they can be held in suspension by the turbulence in the water.

[0005] Even in the case of larger particles, for example grains of size of up to 150 μm in mixtures where the concentration of solid is not too high, the flow has still been found to approach that of a homogeneous flow, while the pipeline resistances also virtually correspond.

[0006] However, the picture is somewhat different for flow in which the dimensions of the particles are larger. Owing to the higher fall velocity of such particles, contact with the pipeline wall is more frequent and more intensive, resulting in measurable differences in speed between the liquid and the particles. The frictional resistance of such particles against the pipeline wall is such that differences in speed between the liquid and the particles are formed. A bed of settled particles, which advances slowly, forms on the bottom of the pipeline.

[0007] A consequence of this is that the average speed of the suspension, i.e. the liquid containing the still suspended particles, which flows over the bed is greater than the average speed of the bed. The more quickly flowing liquid (containing suspended particles) exerts a dragging action on the bed material lying below it. In this case, the bed may be present in a layered state, with transition zones forming between the successive layers, which have increasingly lower speeds. There is interaction between the liquid flow and the successive layers.

[0008] As the size of the particles conveyed increases, the difference in speed between the liquid flow, on the one hand, and the layers of particles in the bed, on the other hand, becomes greater. The average speed of the mixture comprising liquid and suspended particles therefore increases as the size of the particles increases. However, this phenomenon also has an effect on the dragging action exerted on the bed by the mixture.

[0009] In addition, the bed also moves forwards under the influence of the pressure difference across the pipeline, generated by a pump, for example. This pressure difference, together with the interaction between flow and bed, causes the bed to move.

[0010] To summarize, during the hydraulic conveying of earth, as is customary in the dredging and mining industries (conveying of coarse sand, gravel, stones and mixtures thereof; conveying of minerals such as ores and coal), the above-described phenomenon of bed formation leads to a higher pipeline resistance, which in turn leads to a higher conveying energy being required.

[0011] It has been attempted to reduce this higher pipeline resistance by making the particles to be conveyed smaller (comminution, crushing) or by adding polymers to the mixture. However, there are drawbacks associated with both these approaches. Crushing or pulverising is not always desirable and represents an additional operation which increases costs. Adding polymers is also an expensive affair.

[0012] Therefore, the object of the invention is to provide a conveyor system for conveying a mixture of liquid and solid particles which are to be conveyed which provides improved efficiency. This is achieved by means of a conveyor system for a two-phase flow, such as water containing sand, gravel and the like, comprising at least one conveyor pipeline with means for generating a flow, in which system the internal surface of the conveyor line bears guide means for influencing the flow.

[0013] The guide means on the internal surface of the conveyor line offer the option of locally transferring momentum from the liquid flow to the bed. The ideal situation would then again result in a homogeneous mixture with a specific average speed. In reality, the average speed of a mixture of this nature will be higher than that of the original bed and lower than that of the original flow.

[0014] The advantages of influencing the conveying through the conveyor pipeline in this way are numerous. One example which may be mentioned is the improvement which is consequently achieved in the efficiency of the rotary pump. The vanes of a pump of this nature have an inflow angle which is best suited to the design flow rate of a homogeneous liquid which is to be pumped. As a result of low impact losses, the inflow losses are therefore minimal and the hydraulic efficiency is at a maximum. This inflow angle can normally only be achieved for a homogeneous flow. The flow components in an in-homogeneous flow, in which both the liquid and the bed differ from the ideal flow associated with the design flow rate, however, have different inflow angles which entail a lower efficiency of the pump.

[0015] A significant further drawback which results

from a differing approach angle of this nature relates to the high level of wear to the vanes.

[0016] Therefore, according to the invention, in a conveyor system in which a pump is accommodated in the conveyor pipeline, there is provision for the guide means to be situated immediately upstream of the inlet of the pump.

[0017] If the pump is a rotary pump, the guide means may be designed to impart a preliminary rotation to the flow.

[0018] The guide means are preferably situated opposite the advancing bed of solid particles, which usually means in the highest part of the conveyor pipeline. However, this does not always have to be so. In non-horizontal parts of the conveyor pipeline, the guide means may also be situated at a different location from the highest part. Moreover, the bed of mineral constituents may be situated at numerous other positions if there are bends and branches in the pipeline.

[0019] The material in the bed then does not come into contact with the guide means, but rather only the liquid or suspension flow does so. This liquid flow is therefore given a momentum in the direction of rotation by the guide means. The liquid flow then transmits this rotational momentum to the bed, which as a result acquires a direction of movement and speed which are such that the approach to the vanes of a rotary pump can take place in a more uniform manner and at a more suitable inflow angle, with less intensive impacts.

[0020] The movement and speed of the bed, which have been influenced in this way, consequently lead to a higher pump efficiency and to less intensive and more evenly distributed wear to the vanes. These characteristics also have an advantageous effect on the wear to the pump casing. A further advantage is that a suitably configured guidance also reduces the susceptibility of the pump to cavitation, despite the flow resistance caused by the guidance.

[0021] The guide means may be plate-like and extend essentially radially from the internal surface. The guide means may extend radially to a distance from the centre axis of the conveyor pipeline. This distance depends on the (average) level of bed conveyance per unit time and the extent to which the momentum is to be transferred in order to achieve the desired effect, while it is desirable to minimize the surface area of the guide in order to keep the inevitable associated pressure drop as low as possible.

[0022] The guide means may form at least one essentially helical plate, optionally with a pitch angle which increases in the direction of flow. Furthermore, the guide means may have a plate section which is straight and axial in the direction of conveyance and which adjoins a helical plate section.

[0023] The guide means are preferably accommodated in a pipeline section which has an orientation which can be adjusted in the circumferential direction. In this case, the rotational position of the guide means may be adjusted in such a manner, for example with respect to a pump, that the maximum effect is ensured.

[0024] In order to prevent the rotational effect of the annular flow being reduced by the rectilinear core flow, the radially inner edge of the plate-like guide means may be provided with an end plate which extends in the longitudinal direction. The end plate may be curved in a corresponding manner to the curvature of the conveyor pipeline and may be designed as a concentric pipe piece.

[0025] The invention will now be explained in more detail with reference to an exemplary embodiment which is illustrated in the figures.

Figure 1 shows a perspective view, partially in section, of a conveyor system with a vane pump according to the invention.

Figure 2 shows a detail of the conveyor pipeline in section and in plan view.

Figure 3 shows a cross section III-III from Figure 2.

Figure 4 shows a second embodiment of the conveyor pipeline in plan view, partially in section.

Figure 5 shows the section V-V from Figure 4.

[0026] The conveyor system according to the invention which is illustrated in Figure 1 comprises a conveyor pipeline which is denoted overall by 1, a rotary pump 2, more particularly a centrifugal pump, and a discharge line 3. The conveyor pipeline 1 is connected to the spiral casing 5 of the centrifugal pump 2 via a flange 4.

[0027] As can be seen from the cut-away section of the conveyor pipeline 1, a guide means, which is denoted overall by 7, is attached to the internal wall 6 thereof. As can also be seen from Figure 2, this guide means contains a guide plate 8 which has a straight section 9 which runs in the axial and radial direction of the conveyor line 1 and an adjoining helical plate section 8. The flow through the conveyor system, as indicated by the arrows in Figure 1, firstly meets the straight plate section 9, and then a rotary movement is imparted to the flow by the helical plate section 8.

[0028] A curved plate piece 11 which has bevelled front and rear edges 12 and 13, respectively, is welded to the radially inner side of the guide member 8, as indicated in Figures 2 and 3.

[0029] The conveyor system in accordance with Figure 1 is used for a two-phase flow, i.e. a liquid containing solid particles. In a two-phase flow of this nature, a relatively slow-moving bed 14 of larger solid pieces forms on the bottom of the conveyor pipeline 1, and liquid containing suspended smaller solid particles flows above this bed. At the location of the guide member 8, this liquid is given a velocity component in the rotational direction about the centre axis of the conveyor pipeline 1.

[0030] The liquid moving in this direction collides with the bed 14, resulting in a transfer of momentum. As a result, the bed 14 acquires an additional velocity com-

ponent in the direction of rotation and also moves/rotates in that direction, as illustrated by means of the bed section 15 in Figure 3. The helical section 9 has an end edge 21 which is preferably parallel to the displaced bed 15.

[0031] A further effect of the transfer of momentum between liquid and bed material is that a more uniform or more homogeneous mixture is obtained. These two effects, i.e. the more homogeneous mixture and the change in the direction of movement of the bed material, lead to a more advantageous approach to the vanes (not shown) of the rotary pump 2.

[0032] Rotating the conveyor pipeline 1, or at any rate that part of the pipeline which adjoins the rotary pump 2, which can be achieved by means of flanges 4 and 19, allows the position of the guide means 7 to be adjusted optimally with respect to the rotary pump 2. This is because the movement of the pipeline allows the bed 14 to approach the guide means with a preliminary rotation already in place.

[0033] The same effect can be obtained by means of at least two successive paddles 16 which adopt an offset position with respect to one another or are positioned in line and are shown in Figures 4 and 5. These paddles 16 are held on a rotary plate 17 which can be operated from outside the conveyor pipeline 1 by means of projections 18 in order to adjust the angle of flow onto the paddles 16. An advantage of the design shown in accordance with Figure 4 is the possibility of the paddles 16 overlapping one another in the radial direction, so that the ultimate deflection angle can be adjusted.

[0034] Paddles of this nature also impart a velocity component in the direction of rotation to the liquid flow, which velocity component again leads to a transfer of momentum to the bed material 14. At least one of the paddles 16 may be designed with a fixed blade part 22 and an adjustable blade part 23, in order to be able to influence the size and direction of the deflection angle.

[0035] Although the guide means according to the invention have been described above in combination with a rotary pump, other applications are also conceivable. Another application of this nature relates to the positioning of guide means upstream of and in the vicinity of a pipe bend in order to reduce the wear in that area.

[0036] Another application is possible by arranging the guide means according to the invention at more or less regular intervals in straight conveyor pipelines, in order to allow the two-phase conveying to proceed more efficiently, i.e. the conveying results in a lower average pipeline resistance and the wear is distributed more uniformly over the pipeline wall.

[0037] Finally, combinations of the abovementioned installations may also be employed.

Claims

1. Conveyor system for a two-phase flow, such as water containing sand, gravel and the like, comprising at least one conveyor pipeline (1) with means (2) for generating a flow, characterized in that the internal surface (6) of the conveyor line (1) bears guide means (7, 16) for influencing the flow.

2. Conveyor system according to Claim 1, in which a pump (2) is accommodated in the conveyor pipeline (1) and the guide means (7, 16) are situated immediately upstream of the inlet of the pump.

3. Conveyor system according to Claim 2, in which the pump (2) is a rotary pump and the guide means (7, 16) are designed to impart a preliminary rotation to the flow.

4. Conveyor system according to one of Claims 1-3, in which the guide means (7, 16) are situated in that part of the conveyor pipeline (1) which lies opposite a bed of solid constituents which has been formed in the conveyor pipeline.

5. Conveyor system according to Claim 3 or 4, in which the guide means extend at least partially at an angle with respect to the conveyor pipeline (1).

6. Conveyor system according to Claim 5, in which the guide means (7) are plate-like and extend essentially radially from the internal surface (1).

7. Conveyor system according to Claim 6, in which the guide means (7) extend radially to a distance from the centre axis of the conveyor pipeline (1).

8. Conveyor system according to Claim 6 or 7, in which the guide means (7) comprise an essentially helical plate (10).

9. Conveyor system according to Claim 8, in which the helical plate has a pitch angle which increases in the direction of flow.

10. Conveyor system according to Claim 8 or 9, in which the guide means (7) have a plate section (9) which is straight and axial in the direction of conveyance and adjoins a helical plate section (18).

11. Conveyor system according to one of the preceding claims, in which the guide means (7) are accommodated in a pipeline section which has an orientation which can be adjusted in the circumferential direction.

12. Conveyor system according to one of Claims 6-10, in which a reinforcement edge or end plate (11) which extends in the longitudinal direction is provided on the radially inner edge of the plate-like guide means (8).

13. Conveyor system according to Claim 12, in which the end plate (11) is curved in a corresponding manner to the curvature of the conveyor pipeline (1).

14. Conveyor system according to Claim 12 or 13, in which the end plate is a pipe piece (11) which is concentric with respect to the conveyor line (1).

15. Conveyor system according to one of the preceding claims, in which a plurality of guide means are provided, which are situated one behind the other, at regular intervals, in an essentially straight conveyor pipeline.

fig-1

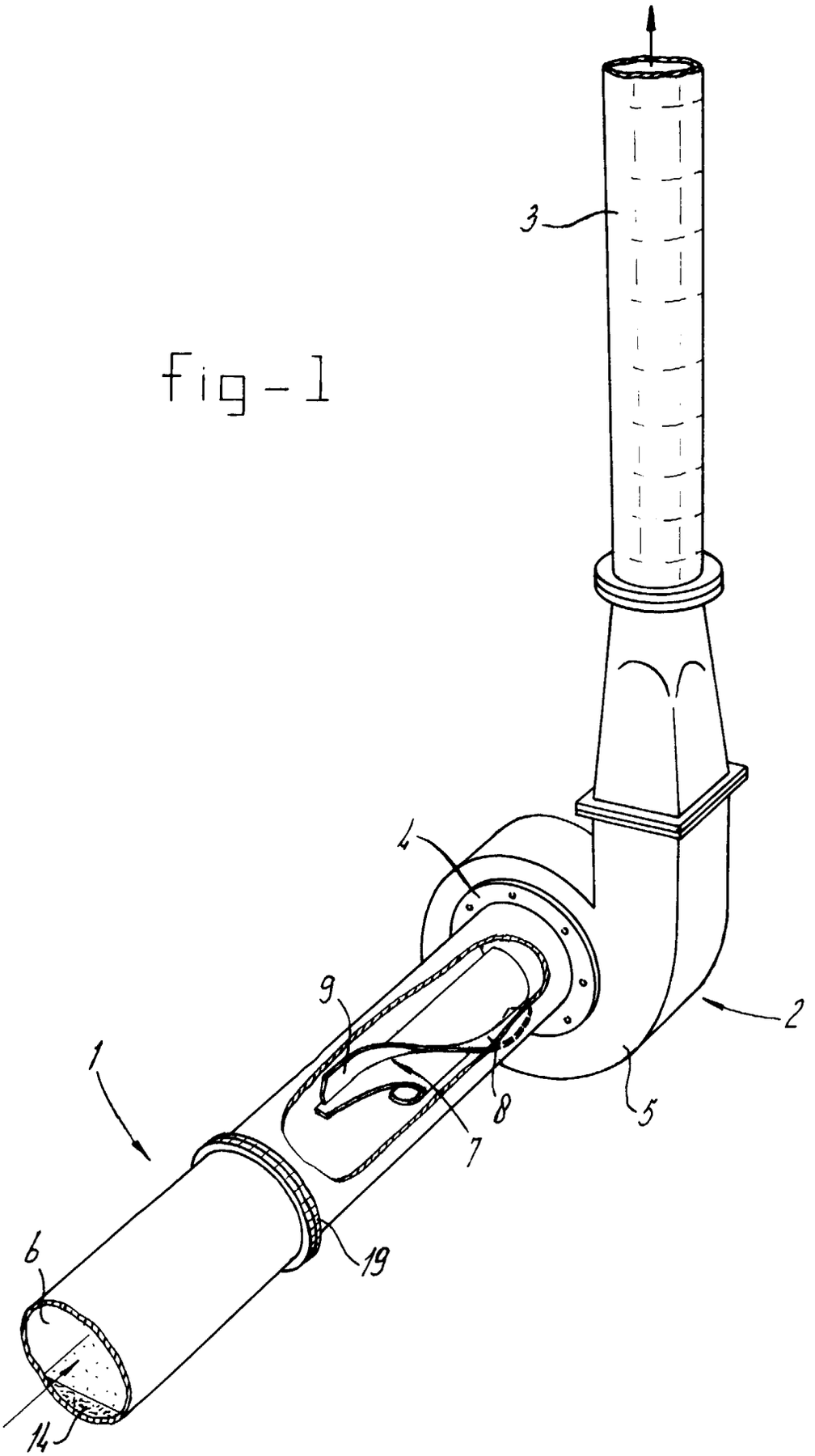


fig-2

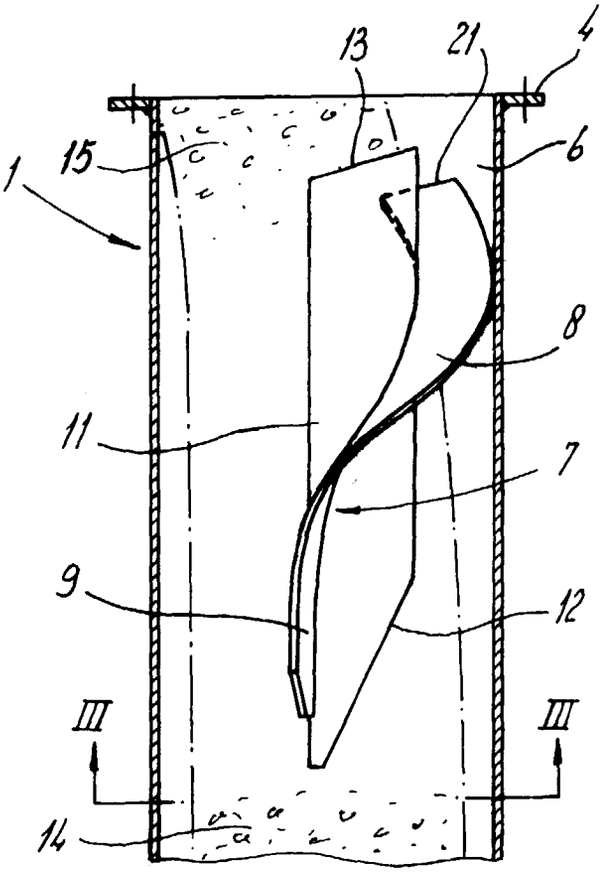


fig-3

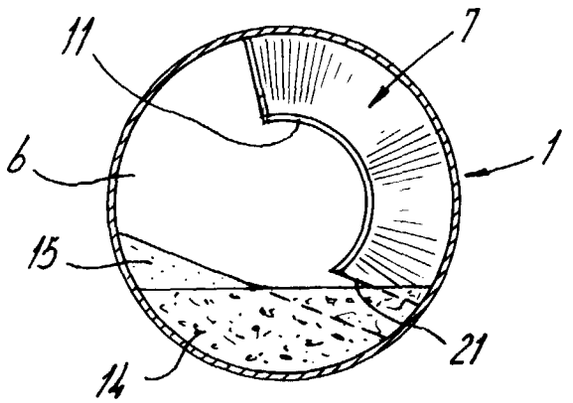


Fig-4

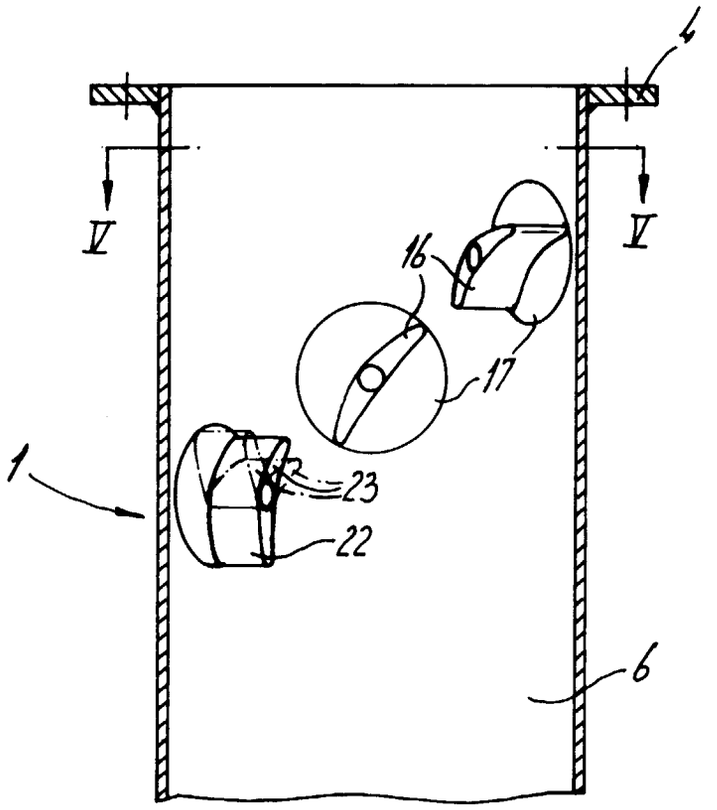
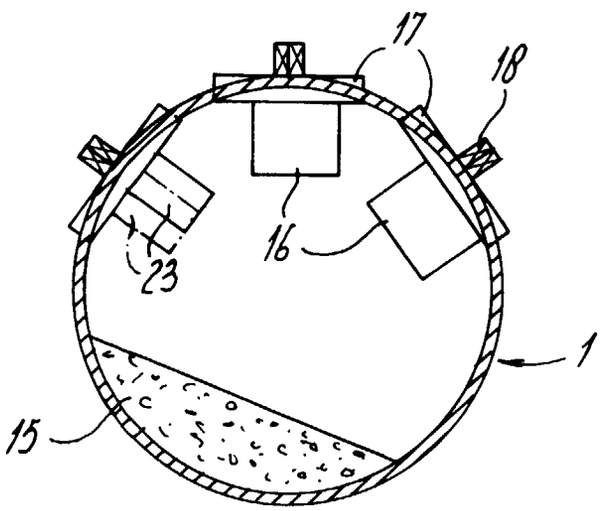



Fig-5