



(12) **EUROPEAN PATENT APPLICATION**

(21) Application number : **92303997.8**

(51) Int. Cl.⁵ : **B28B 13/02**

(22) Date of filing : **01.05.92**

(30) Priority : **07.05.91 FI 912206**

(43) Date of publication of application :
11.11.92 Bulletin 92/46

(84) Designated Contracting States :
AT BE DE DK ES FR GB IT NL SE

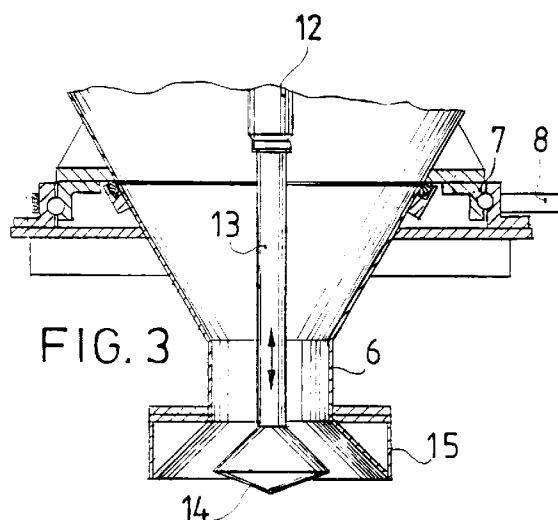
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(54) **Concrete casting nozzle and method for casting concrete.**

(57) The present publication discloses an apparatus and a method for casting concrete mix into a mold accurately to the final shape of the product without the need for vibrating the concrete mix after casting. The concrete mix is fed into the casting mold by means of a casting nozzle having a gating element (14 or 17) and a vibrator element (13) adapted to the nozzle body (6). The nozzle comprises a nozzle body (6) with an exit (15) of the nozzle at its lower end, while the upper end of the nozzle is connected to feed or storage means (5) of the concrete mix. Adapter over the length of the nozzle body (6) is a vibrator element (13), capable of compacting and plasticizing the concrete mix fed in the nozzle. Furthermore, the nozzle body (6) incorporates a gating element (14 or 17) for controlling and shutting off the concrete flow through the nozzle.



The present invention relates to a concrete casting nozzle in accordance with the preamble of claim I for metering compacted concrete into casting molds.

The method also concerns a method in accordance with the preamble of claim II for casting concrete.

In the fabrication of various concrete products, the concrete mix is conventionally fed in an uncompacted form into the casting mold. The metering of the concrete mix is implemented using shutter gates, vibratory feeders, band conveyors, augers or similar conventional feeder means. Such feeder means do not generally employ nozzles for confining the flow of the concrete mix into the mold from all sides of the flow, whereby the flow and the filling of the mold cannot be controlled accurately. Therefore, the metering of the concrete mix remains inaccurate. When open molds are used, the surface of the cast concrete is levelled using vibratory beams, troweling strips and boards and similar tools, and the concrete in the mold is compacted by vibrating the mold or using vibrator beams or rods.

Because the concrete mix is compacted only in the mold, the amount of cast concrete and final level of the cast material in the mold cannot be seen before the vibratory compaction. Therefore, the concrete mix must be added to or removed from the mold to attain the correct level. The vibratory compacting means conventionally employed are also extremely noisy in use.

The Finnish patent application 886043 discloses a casting method in which the concrete mix is compacted prior to its feed into the mold. The concrete mix is compacted in a separate bin equipped with under- and overpressure generating means and a vibrator. The compacted mix is fed into the mold with the help of the high pressure or a pump. Because the concrete mix is compacted prior to being fed, the feeding action must be continuous to avoid losing the compaction effect. To achieve a continuous flow of material, the feed point must be throttled by a gate to generate a counterpressure, or alternatively, the mold must be filled by feeding the concrete mix upward against gravity via the bottom of the mold. Because the concrete mix is not vibrated after compaction, it flows unsatisfactorily thus causing problems in the filling of the mold and possibly leaving voids in the mold.

In SU inventor's certificate I 351 793 is disclosed an apparatus comprising a feed bin having a feed opening in its bottom and expansible shutter means, which can be lowered in the opening for metering the flow of concrete mix. This apparatus further comprises vibrator means within the shutter means and outside the bin. By this apparatus, the flow of the concrete mix out of the bin can be assured in a great extent. The mix flows nevertheless quite rapidly by the shutter means and out of the opening. Therefore the compaction time is very short. The compaction effi-

ciency is further hampered by the large volume of the bin, which allows the vibrating effect to spread in a large volume of concrete mix. A high energy density can not be achieved, and because of resulting low compaction efficiency, cast concrete mix has to be further compacted by vibratory compacting means.

In SU inventor's certificate 395 265 is disclosed an apparatus comprising a feed bin having a feed opening in its bottom and conical shutter means, which can be lifted to close the opening for metering the flow of concrete mix. A vibrator is fitted in the cone of the shutter means. This apparatus has the same drawbacks as the apparatus described in SU I 351 793.

It is an object of the present invention to achieve an apparatus and a method capable of casting the concrete mix in a mold accurately to the final form of the product without resorting to the vibration of the mix after casting.

The method is based on feeding the concrete mix into the mold by means of a casting nozzle, whose body incorporates both a shutter element and a vibrator element.

More specifically, the casting nozzle according to the invention is characterized by what is stated in the characterizing part of claim I.

Furthermore, the casting method according to the invention is characterized by what is stated in the characterizing part of claim II.

According to the invention it is advantageous to place the shutter element adapted to the inside of the nozzle body close to the nozzle exit, whereby the gating plane of the shutter element is adapted to be situated in the area formed between the lower end of the nozzle body and the lower exit end of the nozzle. Such an arrangement provides an extremely effective way of controlling the flow of the concrete mix. The nozzle can also be readily gated by the same arrangement. The apparatus according to the invention has at least one such vibrator element whose vibratory output power is adjustable. If the power level of one vibrator element proves insufficient, the apparatus according to the invention can be equipped with several vibrator elements. Then, they can be adapted in the same plane, or more advantageously, at different heights within the nozzle body, whereby the latter arrangement permits the vibration of the fed concrete mix over a greater length.

The invention offers significant benefits. For instance, the concrete mix to be cast can be transferred to the casting machine without pretreatment such as precompaction. If desired, the concrete mix can also be precompacted. The concrete mix is compacted prior to its placement in the mold, thus obviating the need for vibrating the mold or the concrete poured into it and so compacting a large amount of concrete, whereby the energy consumed in vibration remains smaller. The compacting effect can thus be imposed

on a smaller volume of the mix by virtue of the nozzle, whereby a high energy density is attained and the compaction becomes effective. The compaction takes place in the flow channel as a continuous process. The agitation caused by vibrator element is most effective at the interface between the concrete discharging from the nozzle and that already cast in the mold at which the vibration is concentrated to a confined area thus achieving a high energy density. Due to the effective vibration, the concrete mix flows readily into the mold and conforms well to the shape of the mold. Noise disturbance can be avoided even if high-frequency vibration is used, because the vibrator element can be totally immersed in the concrete mix where it is fully insulated from the surrounding structures of the apparatus. The concrete mix flow can be metered with a high degree of accuracy, since the mix is already compacted when entering the mold and its volume remains unaltered in the mold by further compaction. The top surface of an open casting mold can be levelled without post-vibrating or troweling, thus allowing the completion of the product being cast in a single workphase. Narrow gaps and thin molds can be filled without problems by virtue of the narrow exit of the nozzle. The height of the nozzle from the mold bottom can be steplessly adjusted, thus allowing the control of the nozzle height position to match the height of the product being cast. In other words, the height of the product being cast can be controlled by varying the exit level of the nozzle, whereby products of different height can be cast in a single mold without changing the walls of the mold. The concrete mix feed bin and line can be reliably closed for the duration of casting pauses and the casting process is easy to automate.

The invention is next examined in greater detail with the help of the appended drawings, in which

Figure 1 shows an overview diagram of a casting machine equipped with a casting nozzle according to the invention.

Figure 2 shows a detail of the machine illustrated in Fig. 1 in an enlarged scale.

Figure 3 shows the lower part of the diagram of Fig. 2 in a sectioned view illustrating an embodiment of the invention.

Figure 4 shows another embodiment of the invention in a sectioned view.

Figure 5 shows a third embodiment of the invention in a sectioned view.

Fig. 1 illustrates the adaptation of the invention to a casting machine having portal transfer functions. A feed bin 5 with a nozzle 6 is supported by means of a lift 4 and a trolley 3 from an overhead bridge 2. The overhead bridge 2 is movable on wheels 22 running on rails 21. A casting mold 1 is placed under the casting machine. Casting into the mold 1 occurs from above into the mold and the nozzle 6 is moved in the mold 1 by controlling the motions of the overhead bridge 2,

the trolley 3 and the lift 4. The structures and control of such portal transfer arrangements are known in the art, so their closer examination in this context can be omitted.

Fig. 2 illustrates the external structures of the bin 5 and the nozzle 6 in greater detail. The bin 1 has a conical shape tapering downwards. The body of the nozzle 6 is mounted via a bearing 7 to the bin 5, thus allowing the rotation of the nozzle about the center axis of the bin 5 and the body of the nozzle 6 in the bearing 7. The nozzle is rotated by means of a belt drive 8 and an actuator. The rotation of the nozzle improves its function, but is not essential for the function of the nozzle. Above the bin 5 is mounted a lift lever 11 having a pivotal joint at its one end and the other end connected to a lift cylinder 10. A lift rod 12 with a pivotal joint at its end is adapted to the center of the lever 11, at the center axis of the bin 5.

Fig. 3 illustrates the nozzle structure in a sectional view. The conical shape of the bin 5 is continued in the upper part of the body of the nozzle 6. The upward widening shape of the nozzle entrance is advantageous for compaction, because entrained gas bubbles can then readily escape from the concrete mix undergoing compaction by upward flotation in such a construction. At the inside of its lower part, the body of the nozzle 6 widens downward to form a conical exit 15. The lower end of the lift rod 12 carries a vibrator rod 13 with a gate plate 14 mounted to its end. The vibrator rod 13 is insulated from the rest of the machine frame by means of vibration insulating elements. The concrete mix low passing through the nozzle 6 is controlled by altering the height position of the gate plate 14 in the nozzle 6 with the help of the lift rod 12.

The invention functions as follows. A desired amount of concrete mix is transferred to the bin 5 using any conventional transfer means. At the start of a casting, the gate plate 14 is lowered to a desired height and the vibrating and rotating means of the nozzle are activated. The vibration of the vibrator rod 13 and the gate plate 14 plasticize the concrete mix so as to make it readily flow through the nozzle 6. Simultaneously, the vibration compacts the mix, and moreover, the compacting effect becomes stronger toward the exit 15 of the nozzle, so the concrete mix flowing from the exit 15 of the nozzle into the mold has the longest possible history of compaction in the nozzle. The gate plate 14 furthermore imparts a vibrating effect on the concrete mix just laid in the mold 1, thereby keeping the mix laid in the mold compacted and augmenting the flow of the mix into the mold. The relative height of the plate 14 to the mold and its shape can be varied to alter the compacting effect imparted on the mix laid in the mold 1. The compacting effect and flow rate within the body of the nozzle 6 can be controlled by adjusting the vibratory frequency and amplitude of the vibrator rod 13, that is, the input power to the rod. The control can be simply implemented by varying the ro-

tational speed of the eccentric of the vibrator rod 13. These facilities make it possible to control the properties and casting speed of the laid concrete according to, e.g., the thickness of the cast product and fluidity of the concrete mix.

The exit 15 of the nozzle discharges the concrete mix into the mold 1. The mix laid in the mold 1 stays in a levelled layer without spreading in the mold, so an exactly metered amount of concrete mix can be laid in the mold. The diameter of the exit 15 of the nozzle can typically be in the order of 200...500 mm, thus rendering the nozzle capabilities of also casting narrow-width products. The dimensioning of the nozzle is not, however, crucial for the implementation of the invention, whereby said dimensions can readily be varied. Essential for the invention is, that the nozzle forms a closed path for the concrete mix, wherein the mix can be compacted. Usually the nozzle should be narrow compared to the volume of the feed bin or other feed elements, which may be used in connection of the invention. Furthermore, the cross section of the nozzle can be varied so as to be circular, elliptical, rectangular or polygonal, for instance.

Fig. 4 illustrates an alternative embodiment of the invention. In this construction of the apparatus, the feed action of the concrete mix has been augmented by means of an auger 16 which is placed so as to partially extend to the inside of the bin 5. The auger 16 is continued as a self-supporting flight into the inside of the body of the nozzle 6. The vibrator rod 13 is mounted to the end of the shaft 20 of the auger 16, thus allowing it to stay within the nozzle 6 in the center of the self-supporting flight 16 without touching the flight 16. The vibrator rod 13 can be lowered and elevated within the shaft 20 of the feed auger, thereby controlling the concrete mix flow by altering the relative height position of the gate plate 14 placed to the end of the vibrator rod 13 in the same manner as described above for the preceding embodiment. The length of the vibrated concrete mix column can be relatively long in this embodiment, whereby a good compaction result is attained.

In the embodiment illustrated in Fig. 5, the gate plate performing as the gating element is replaced by a collar bellows valve 17. The rims of the bellows 17 are attached to the inner rims of the exit 15, and a line 18 for pressurized hydraulic oil is routed to the inside of the bellows through the structures of the exit 15 of the nozzle. The bellows 17 can be made of rubber, synthetic materials or other resilient materials. When pressurized oil is fed to the inside of the bellows 17, the bellows is expanded in the manner indicated by dashed lines and the cross section of the nozzle to the concrete mix flow is thereby reduced. Thus, the flow of the concrete mix through the nozzle can be controlled in a simple and effective way. The vibrator rod 13 can now advantageously be a conventional vibrator rod, whose tip is placed approximately level with the lower

rim of the exit of the nozzle 15. This and the other embodiments of the invention can employ additional vibrators 19 to augment the compaction and feed of the concrete mix.

In addition to those described above, the invention can have different embodiments. For instance, the gating element of the nozzle can be implemented using different types of elements, yet advantageously utilizing such a construction of the gating element in which the vibrator rod 13 can be inserted so as to extend through the gating element.

The gating surface of the gating element must be placed close to the exit 15 of the nozzle and the lower end of the body part of the nozzle 6 in order to make the compaction of the concrete mix possible before exiting past the gating element. If a bellows valve is used as the gating element, its pressurizing medium can be compressed air or other pressurized medium readily available at the casting site. The casting nozzle can be adapted to different types of casting machines. Replacing the vibrator rod, other mechanical vibrating means or different types of sonic transducers can be used, yet the vibrator rod offers a simpler construction of the nozzle, and when necessary, an extremely compact form of the nozzle. The vibrator means can also be placed outside the nozzle, but such a construction causes noise disturbance. The nozzle design presented here is also applicable to the casting inclined and vertical surfaces and shaped objects. Such casting operations require the use of a stiff concrete mix and forced feed by means of, e. g., overpressure or a feed auger.

Claims

1. A rusting nozzle for concrete mix suited to the compaction and metering of concrete mix, which is fed from a feed bin (5) or via other feed elements, into a casting mold (1), **characterized** by
 - a nozzle body (6), forming a compared to the volume of the feed bin (5) or the feed elements narrow passage for feeding the concrete mix, and having an upper end attached to the feed bin or the feed elements, and an exit (15) of the nozzle at its lower end,
 - at least one vibrator element (13) extending over at least a part of the length of the nozzle body (6), capable of compacting and plasticizing the fed concrete mix, and
 - a gating element (14 or 17) adapted to the nozzle body (6), capable of controlling and shutting off the flow of the concrete mix via the nozzle.
2. A nozzle as defined in claim 1, **characterized** in that the gating element (14 or 17) is adapted to that end of the nozzle body (6) which incorporates the

exit (15) of the nozzle, whereby the gating surface of said element is adapted to the area confined by the lower end of the nozzle body (6) and the lower end of the exit (15) of the nozzle.

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3. A nozzle as defined in claim 1 or 2, **characterized** in that the vibrating element (13) is a vibrating rod, which extends through the gating surface of the gating element (14, 17).

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4. A nozzle as defined in claim 1 or 3, **characterized** in that the vibratory effect of the vibrator element (13) is adjustable through the control of, e.g., its vibrating frequency and amplitude.

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5. A nozzle as defined in any foregoing claim, **characterized** in that the number of the vibrating elements is at least two (13, 19), both of which adapted to different heights within the nozzle body (6).

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6. A nozzle as defined in claim 1, **characterized** in that the gating element is a bellows valve (17).

7. A nozzle as defined in claim 1, **characterized** in that the gating element is a gating plate (14) which, together with the nozzle body (6) and the exit (15) of the nozzle, forms the gating surface.

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8. A nozzle as defined in claims 3 and 7, **characterized** in that the gating plate (14) is adapted to the end of a vibrator element.

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9. A nozzle as defined in claim 1, **characterized** in that the inside surface of the nozzle body (6) has the shape of a cone tapering toward the exit (15) of the nozzle.

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10. A nozzle as defined in claim 1, **characterized** in that the relative height position of the nozzle is steplessly adjustable for fabricating objects of different heights.

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11. A nozzle as defined in claim 1, **characterized** by means (7 - 9) for rotating the nozzle in relation to the feed bin (5).

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12. A method for casting concrete mix in a casting mold, **characterized** in that concrete mix to be cast is compacted by means of a vibrator (13) within the casting nozzle prior to the metering of the mix into the mold.

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13. A method as defined in claim 12, **characterized** in that the flow of the concrete mix into the mold is controlled by means of a gating element (14, 17) adapted to the nozzle.

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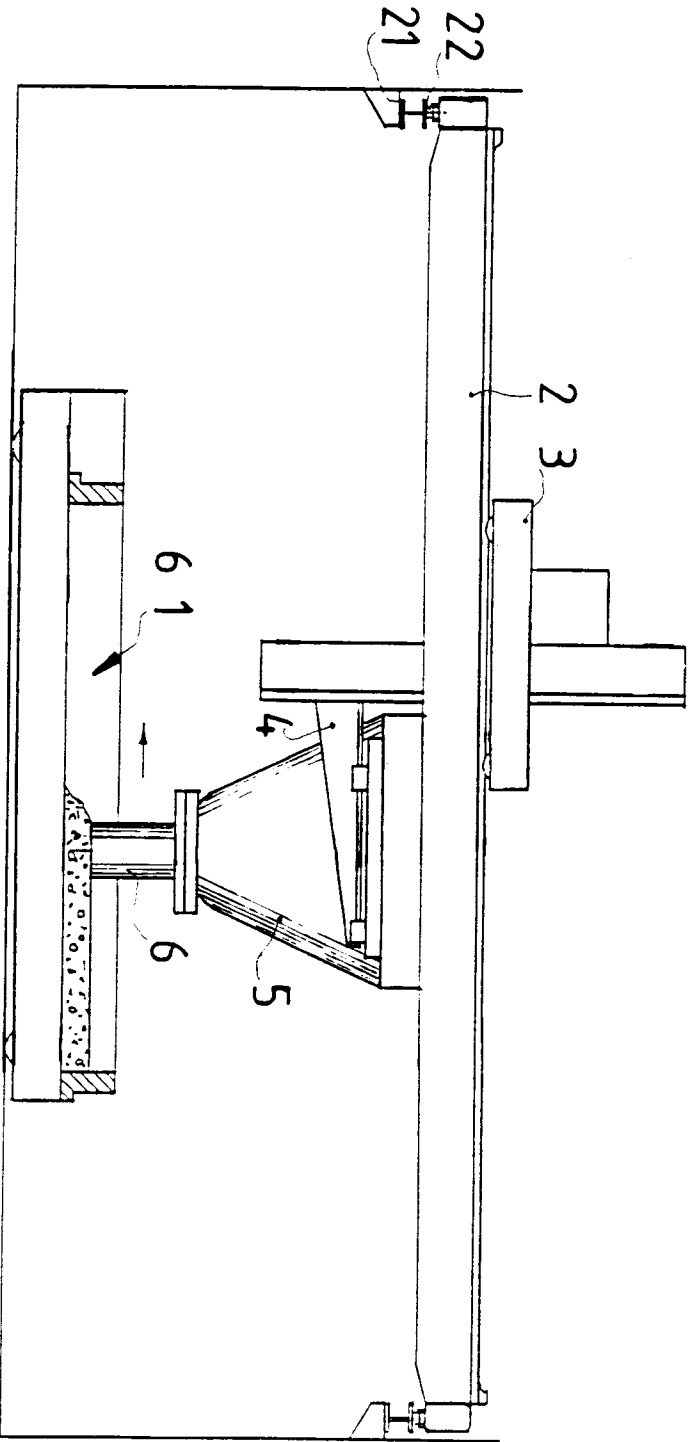
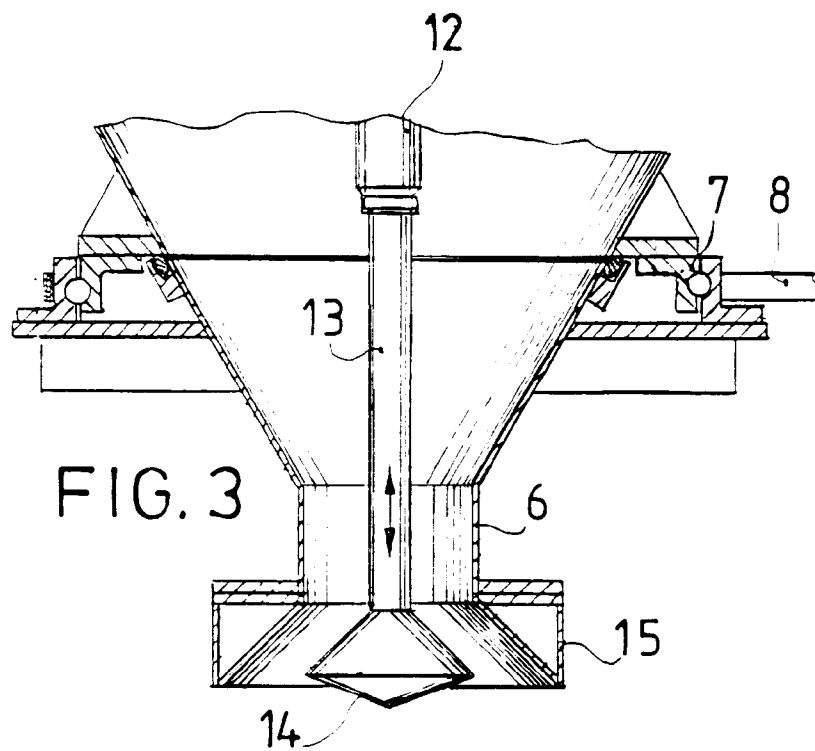
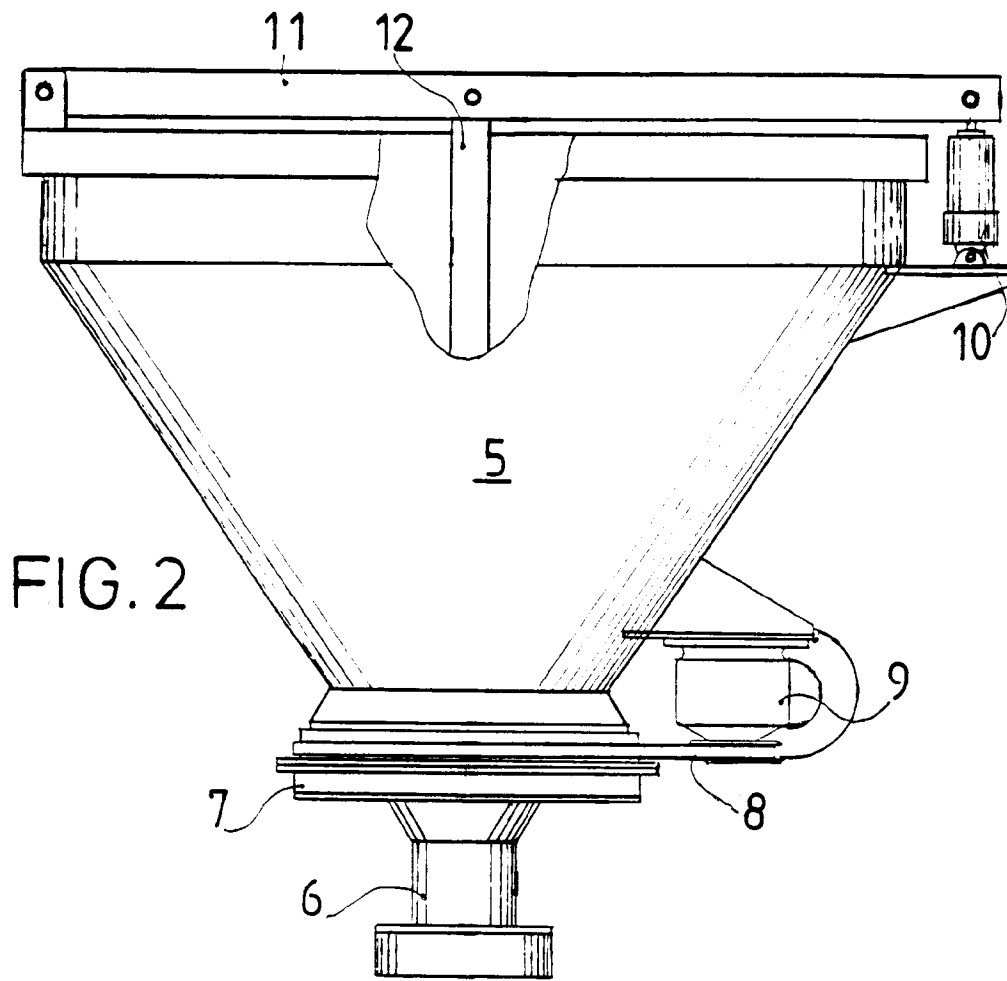
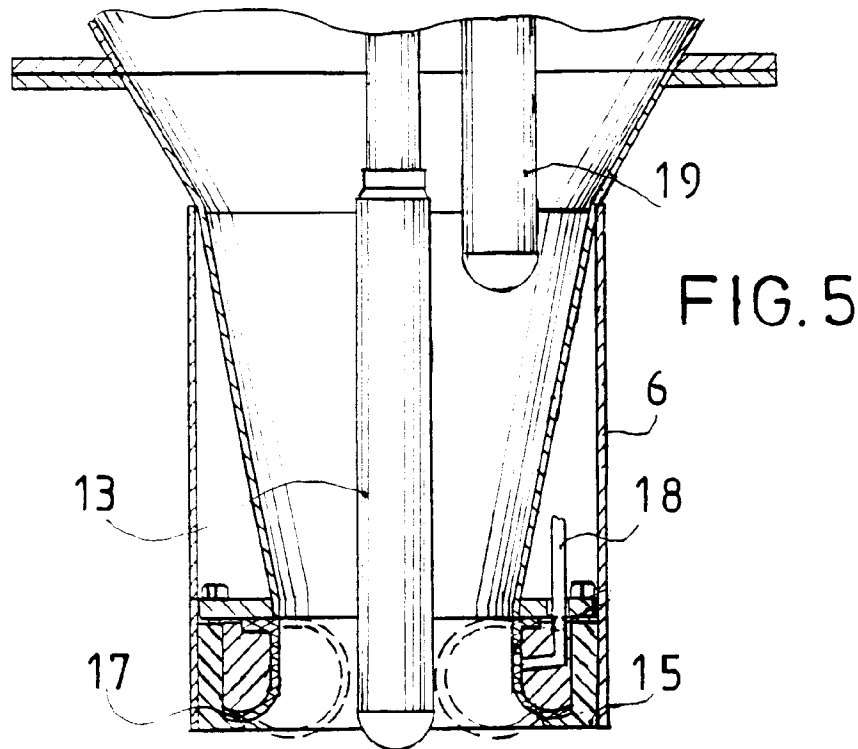
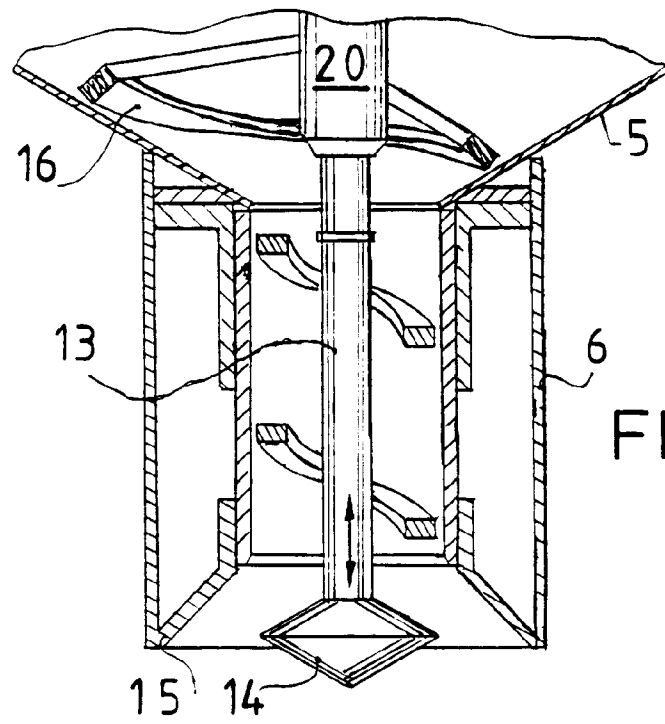


FIG. 1







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Application Number

EP 92 30 3997

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Place of search THE HAGUE		Date of completion of the search 24 JULY 1992	Examiner GOURIER P. A.
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EPO FORM 1503 (03.92) (P0601)



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Place of search THE HAGUE		Date of completion of the search 24 JULY 1992	Examiner GOURIER P. A.
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