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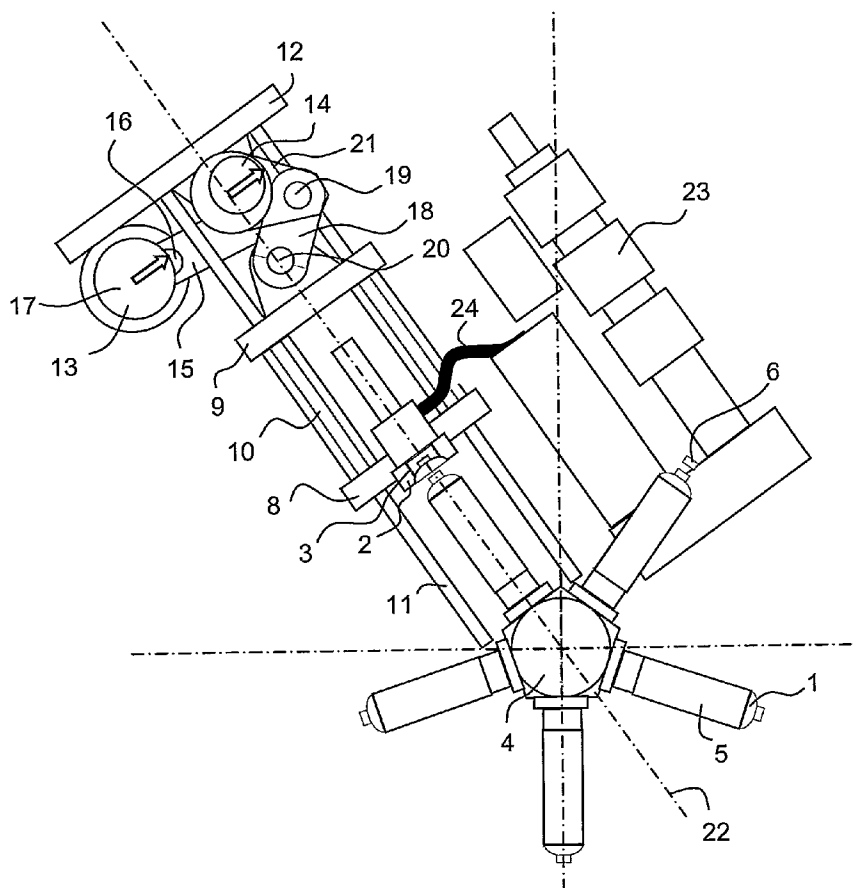
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(54) Title: INJECTION MOULDING MECHANISM



(57) Abstract: The present invention concerns an injection moulding mechanism, which is used in injection compression. The injection moulding mechanism comprises an extruder (23), an inner mould part (1) and an outer mould part (2). A first mechanism, in the form of a link system with three pivotable arms (15, 18, 21), is arranged to partly close the mould. A second mechanism in the form of an eccentric acting on parts of the link system is arranged to close the mould and compress the extruded material. The first and second mechanisms are driven by a servo-motor (13, 14) each.



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INJECTION MOULDING MECHANISM

Technical Field

5 The present invention concerns an injection moulding mechanism. The injection moulding mechanism has been developed for moulding of a thermoplastic top on the edge of a sleeve of paper laminate.

Prior Art

10 The present invention is developed for use with the injection moulding technique known as injection compression. In injection compression a partly closed mould is partly filled in a first step. Then the mould is completely closed giving a compression force on the material inside the mould, which material will fill up the mould due to the compression. Movements to close the mould and to
15 give the compression force are often given by means of a hydraulic cylinder and some kind of link mechanism. In one known device the second step, giving the compression force, is accomplished in that a link system is given a straight orientation. In practice it has been shown that the previously used mechanisms have been difficult to control in an exact manner and in some cases there has
20 been registered a potential risk for deformations instead of a suitable compression.

Summary of the Invention

25 One object of the present invention is to have a simple and yet reliable mechanism, giving a partly closed mould in a first step and a closed mould and compression force in a second step. Furthermore, the mechanism should be possible to control in a precise manner. A further object is to have a process that is repeatable in giving the same result. Still a further object is that the cycle time to produce one component should be relatively short.

30 The above objects are achieved by an injection moulding mechanism comprising an extruder, an inner mould part and an outer mould part. It further comprises a first mechanism to partly close the mould and a second mechanism to close the mould and compress the extruded material inside the

mould. One of the mould parts is arranged moveable towards the other mould part to form a mould cavity. At least one of the mould parts has a channel, opening into the mould cavity and connected to the extruder. The first mechanism, to partly close the mould, has a knee mechanism driven by a servo-motor. The second mechanism, to close and compress the extruded material inside the mould, has an eccentric being a part of the shaft of a second servo-motor.

By using servo-motors it is possible to have an exact control, as servo-motors as such can be controlled in an exact way. In that a small eccentric movement is given by a relatively large rotation of a servo-motor the possibility for exact control is improved further. It also facilitates giving exactly the desired movement needed in each specific case. The movement needed may e.g. be monitored by means of different sensors. Furthermore, the inherent elasticity of the mechanism will assist in taking up parts of the compression force used.

Further objects and advantages of the present invention will be obvious to a person skilled in the art when reading the detailed description below of at present preferred embodiments.

Brief Description of the Drawings

The invention will be described further below by way of an example and with reference to the enclosed schematic drawings. In the drawings:

Fig. 1 is a sectional view of a mould used in a mechanism according to the present invention and indicating a position during one step of a working cycle,

Fig. 2 is a side view of an injection moulding mechanism, according to the present invention, in a step of starting closing of the mould,

Fig. 3 is a view according to Fig. 2 but showing a step of finishing closing of the mould,

Fig. 4 is a view according to Fig. 2 but showing a step of compressing the mould with the second mechanism of the invention, and

Fig. 5 is a view according to Fig. 2, but showing a different embodiment of the injection compression mechanism according to the present invention.

Detailed Description of Preferred Embodiments

The mechanism shown in the Figs. has a mould, having an inner mould part 1 and an outer mould part 2. The outer mould part 2 has one or more channels 3 for receiving extruded plastic material and is arranged movable in relation to the inner mould part 1. In the shown embodiment the inner mould part 1 has the form of a mandrel placed on a mandrel wheel 4, having five mandrels. In other embodiments other numbers of mandrels may be placed on the mandrel wheel. The mandrels are placed projecting radially outwards on the mandrel wheel 4. The mandrel wheel 4 is provided to rotate intermittently on a shaft, in such away that the mandrels are placed one at the time in a correct position opposite the outer mould part 2.

In the example in Fig. 2 a sleeve 5 of paper laminate is placed together with a cap 6 on a mandrel in successive steps, which mandrel forms the inner mould part 1. The inner mould part 1 is then placed in-line with the outer mould part 2. When the inner and outer mould parts 1, 2 are brought together, see Fig. 1, a mould cavity 7 is formed between them. The channel(s) 3 of the outer mould part 2 opens into the mould cavity 7.

In Fig. 2 it can be seen that the outer mould part 2 is mounted on a moveable frame having a lower plate 8 and an upper plate 9, which lower and upper plates 8, 9 are held together by means of a number of rods 10. The plates 8, 9 are arranged at a distance from each other to give room for parts of the injection moulding mechanism. The outer mould part 2 is mounted on the lower plate 8. The frame, formed of the lower and upper plates 8, 9 and the rods 10, is arranged movable on rails 11.

On top of the rails 11 a support 12 is fixed, which support 12 holds a first servo-motor 13 and a second servo-motor 14. A first pivotable arm 15 is connected to the servo-motor by means of a first pivot axle 16, arranged eccentric on a disc 17, in that it is placed at a distance from the rotation axis of the disc 17. The disc 17 is rotated by the first servo-motor 13. The first pivotable arm 15 is connected to a second pivotable arm 18 by means of a second pivot axle 19. The second pivotable arm 18 is connected to the upper plate 9 of the frame for the outer mould part 2 by means of a third pivot axle 20.

A third pivotable arm 21 is connected at one end to the same pivot axle 19 as the first and second pivotable arms 15, 18. The other end of the third pivotable arm 21 is received at the second servo-motor 14.

In the starting position for the first servo-motor 13, i.e. before rotation of the first servo-motor 13, the second pivotable arm 18 is inclined in relation to an imaginary line 22, see Fig. 2. The imaginary line 22 goes through the centre of the mould, crossing the pivot axle 20 between the second pivotable arm 18 and the upper plate 9 of the frame, crossing the shaft and eccentric of the second servo-motor 14 and through the centre of the mandrel wheel 4. When the first servo-motor 13 has been rotated to its end position, in which the mould is partly closed, see Fig. 3, the second pivotable arm 18 has been moved to a position in-line with the imaginary line 22, due to the arrangement of the first, second and third pivotal arms 15, 18, 21 and the first, second and third pivot axles 16, 19, 20. The third pivotable arm 21 is arranged in such a way that it also will be in-line with the second pivotable arm 18 and the imaginary line 22, when the first servo-motor 13 has reached its end position.

The second servo-motor 14 is furnished with an eccentric, which is to act on the third pivotable arm 21. The eccentric is formed on the rotating shaft of the second servo-motor 14 and the third pivotable arm 21 is received journaled in a roller bearing. As the second servo-motor 14 is driven first after that the first servo-motor 13 has reached its end position the eccentric of the second servo-motor 14 will act on a straight link mechanism.

Thus, the first servo-motor 13 co-operates with a knee-mechanism, in the form of the first, second and third pivotable arms 15, 18, 21, to partly close the mould. The second servo-motor 14 co-operates with an eccentric and the second and third pivotable arms 18, 21 to close and lock the mould with a high clamping force, compressing the plastic material inside the mould.

An extruder 23 is placed at the injection compression mechanism. A pipe 24 is arranged to lead plastic material from the extruder, via the channel(s) 3 of the outer mould part 2 and into the mould cavity 7 formed between the outer and inner mould parts 2, 1.

The embodiment as shown in the enclosed Figs. has the following work cycle. The mandrel wheel 4 has five equally spaced mandrels, each forming an inner mould part 1. The mandrel wheel 4 will be rotated or indexed a fifth of a full turn during each work cycle. Thus, each mandrel will subsequently occupy five different positions. In a first position a sleeve 5 is placed on the mandrel. In a second position a cap 6 is placed on the mandrel. In a third position a plastic top is moulded between the sleeve 5 and the cap 6. Thus, after that position the

sleeve, the plastic top and the cap 6 form one unit. In a fourth position of the mandrel the formed unit is allowed to cool. In the fifth and last position the formed unit is released from the mandrel. The placement of parts on the mandrels and removing of the finished products are normally done in an automatic fashion. However, a person skilled in the art realises that it may also be performed at least partly manually. As this part does not have any importance for the present invention as such it will not be described further here.

At the start of a work cycle one mandrel, i.e. inner mould part 1, is placed in-line with the outer mould part 2. The inner mould part 1 holds a sleeve 5 and a cap 6. Then the first servo-motor 13 closes the mould, in that the outer mould part 2 is moved down towards the inner mould part 1, whereby the mould cavity 7 is formed. The movement of the first servo-motor 13 rotates the disc 17 holding a pivot axle 16 to which the first pivotable arm 15 is connected. By the movement of the first pivotable arm 15, also the second and third moveable arms 18, 21 will be moved. The first servo motor 13 will move the second and third arms 18, 21 to a position in which said arms 18, 21 will form a straight line in-line with the imaginary line 22. In that position the first servo-motor 13 is stopped, giving the end position of the first servo-motor 13, see Fig. 3.

The next step of the work cycle is that the extruder 23 will inject plastic material into the mould cavity 7, via the pipe 24 and the channel 3 of the outer mould part 2. The injected plastic material will not fill the mould cavity 7 completely. Then the second servo-motor 14 will be rotated, whereby the eccentric connected to the second servo-motor 14 will act on the third pivotable arm 21 in such a way that the outer mould part 2 will be moved further towards the inner mould part 1, closing the mould, see Fig. 4. The second servo-motor 14 will be rotated about one third to one half of a full turn. This relatively long movement of the second servo-motor 14 translates to a movement of the outer mould part of only 1-2 mm, by means of the eccentric. This further movement of the outer mould part 2 will compress the injected plastic material in such a way that the material will fill out the mould cavity 7. With both servo-motors 13, 14 in the end positions the injected material is cooled. Thus, the cooling is performed under compression and is normally done from the inside of the mould.

After cooling the mould is opened in that the outer mould part 2 is lifted from the inner mould part 1, by means of at least the first servo-motor 13.

Normally, the first and the second servo-motors 13, 14 are moved simultaneously. When both servo-motors 13, 14 are back in their starting positions the mandrel wheel 4 is indexed one fifth of a full turn. A new work cycle can now be started.

5 In Fig. 5 another embodiment of the present invention is shown, where the injection moulding mechanism is movably mounted on rails 11, which rails 11 are fastened at a base 25. This base 25 is located close to the mandrel wheel, which is mounted at a central hub. The injection moulding mechanism is attached to the support 12, at an upper end as seen in Fig. 5, via the knee-
10 mechanism 18, 21. The rails are relatively long, in the order of 100-120 cm, and are formed to be slightly flexible. During normal operation, the force on the rails from the knee-mechanism is about 50 to 100 kN. At these loads, the rails should be designed to flex about 0.05 to 0.1 percent, which for a 100 cm long rail translates into 0.5 mm to 1 mm. This means that in order to compress the
15 mould about 1 mm, the knee-mechanism must be extended about 1.5 to 2.0 mm, due to the flex of the rails. The flex of the rails 11 makes the setup of the injection moulding mechanism much easier, since overfilling of the mould will be compensated by said flexing. The rails 11 are at an outer end rigidly attached to the support 12 and are at an inner end rigidly attached to the base 25.

20 A further advantage of the flexing of the rails 11 appears when the injected plastic material in the mould 1, 2 is cooled. The plastic material will then shrink and will separate from the walls of a traditional moulding mechanism. The flexing of the rails 11 will, however, ensure that the mould 1, 2 is always in contact with the injected plastic material during cooling. This will also increase
25 the speed of cooling, since the mould transfers heat from the plastic material more efficiently if being in contact with the entire plastic detail.

The long and relatively slender rails 11 will give the injection moulding mechanism another advantage. The outer mould part 2 is slightly movable in a lateral direction, in addition to the longitudinal direction given by the longitudinal
30 flexing of the rails 11. This lateral movement is possible due to bending of the rails 11. The sideways movement will make the outer mould 2 self-aligning, since it will adjust to a force balance in the mould 1, 2. In compression moulding, where the injected plastic material enters the substantially open mould 1, 2 at two or more locations on the jacket 26 of the mould, see Fig. 1,
35 the compression of the mould will create a force balance which will strive to

ensure that the thickness of the finished plastic part is more or less uniform, despite of differences in injected amounts at different locations. This is possible if the mould parts 1, 2 are arranged such that they can move slightly in a lateral direction, and adjust to said force balance. By arranging the outer mould part 2
5 in a mechanism that is suspended on flexible rails 11, this is possible. The inner mould part 1 is connected to the mandrel wheel 4 and is more or less stationary. The maximum possible lateral movement of the injection moulding mechanism and hence the outer mould should be in the order of 0.5 to 1 mm (corresponding to 0.05 to 0.1 percent of the length of the rails 11 described
10 above), when the injection moulding mechanism is subjected to normal forces of injection compression moulding. The above flexing refers to a location where the outer mould part 2 is mounted on the injection moulding mechanism, which is suspended on the rails 11, such that the outer mould part 2 can move a distance of about 0.5 to 1 mm in a lateral direction.

15 Both the longitudinal flexing and the lateral flexing should be adapted to the specific application. In the above cases, the flexing is about half the distance compared to the movement given by a second eccentric mechanism, i.e. if a movement given by the eccentric mechanism 14 in the longitudinal direction is about 1 mm, the flexing in the longitudinal direction will be about 0.5 mm.

20 Other relationships between the movement in the longitudinal direction of the injection compression mechanism and the flexing of the rails 11 in the same direction are possible. The same applies for the lateral flexing of the rails 11.

A person skilled in the art realises that the exact form and design of the parts carrying the servo-motors 13, 14, the link system 15, 18, 21 and the outer
25 mould part 2 may vary, as long as they fulfil the intended function.

CLAIMS

1. An injection moulding mechanism comprising an extruder (23), an inner mould part (1), an outer mould part (2), a first mechanism to partly close the mould and a second mechanism to close the mould and compress extruded material inside the mould, whereby one mould part (2) is arranged moveable towards the other mould part (1) to form a mould cavity (7) between the mould parts (1, 2) and one mould part (2) has one or more channels (3), opening into the mould cavity (7) and connected to the extruder (23), **characterized** in that the first mechanism, to partly close the mould, has a knee mechanism driven by a first servo-motor (13), and that the second mechanism, to close and compress the extruded material inside the mould, has an eccentric being a part of the shaft of a second servo-motor.

2. The injection moulding mechanism of claim 1, **characterized** in that the knee mechanism is formed of three pivotable arms (15, 18, 21), of which a first pivotable arm (15) at one end is connected by means of a first pivot axle (16) to a disc (17) rotated by the first servo-motor (13) and at the other end by a second pivot axle (19) to one end of the second pivotable arm (18), the second pivotable arm (18) being connected at its other end by means of a third pivot axle (20) to a frame carrying the outer mould part (2) and the third pivotable arm (21) being connected at one end to the second pivot axle (19), also connecting the first and second pivotable arms (15, 18) and at the other end being connected to a shaft of the second servo-motor (14).

3. The injection moulding mechanism of claim 2, **characterized** in that the frame carrying the outer mould part (2) is arranged moveable in a linear direction in such away that the outer mould part (2) may be moved towards and away from the inner mould part (1) and that the frame is moved by means of rotation of the first servo-motor (13) being transferred to the frame by means of the knee-mechanism.

4. The injection moulding mechanism of claim 3, **characterized** in that the frame has one upper plate (9), to which the second pivotable arm (18) is mounted by means of the third pivot axle (20), one lower plate (8), carrying the outer mould part (2), and a number of rods (10) connecting the upper and lower plates (9, 8) and wherein the frame is received moveable on rails (11).

5. The injection moulding mechanism of claim 3, **characterized** in that in a starting position of the first servo-motor (13) the second pivotal arm (18)

inclines in relation to an imaginary line (22), going through the centre of a mandrel wheel (4) and through the centre of the mould and crossing the third pivot axle (20) and the shaft of the second servo-motor (14).

5 6. The injection moulding mechanism of claim 5, **characterized** in that the second and third pivotable arms (18, 20) are arranged to be in-line with each other and with the imaginary line (22) at an end position of the first servo-motor (13), in which position the mould is partly closed.

7. The injection moulding mechanism of claim 5, **characterized** in that the eccentric acts on the third pivotable arm (21) along the imaginary line (22).

10 8. The injection moulding mechanism of claim 5, **characterized** in that the inner mould part (1) has the form of a mandrel received on the mandrel wheel (4), having a number of mandrels projecting radially outwards on the mandrel wheel (4) and that the mandrel wheel (4) is rotated to place the mandrels in different positions during a work cycle.

15 9. The injection moulding mechanism of claim 8, **characterized** in that the mandrel wheel (4) has five mandrels, each forming an inner mould part (1).

20 10. The injection moulding mechanism of claim 8, **characterized** in that the extruded plastic material forms a top between a sleeve (5) of paper laminate and a cap (6), which sleeve (5) and cap (6) are placed in proper positions on one mandrel before the plastic material is injected and that it is used in the forming of packages for food products.

25 11. The injection moulding mechanism of claim 1, **characterized** by being suspended on rails (11), which are designed to flex 0.05 to 0.1 percent in a longitudinal direction when being subjected to normal compression forces of compression injection moulding.

30 12. The injection moulding mechanism of claim 1, **characterized** by being suspended on rails (11), which are designed to flex 0.5 to 1 percent in a lateral direction, at the location of the outer mould part (2), perpendicular to the longitudinal direction of the rails (11), such that the outer mould part (2) is laterally movable in relation to the inner mould part (1), which is substantially stationary, when being subjected to normal compression forces of compression injection moulding.

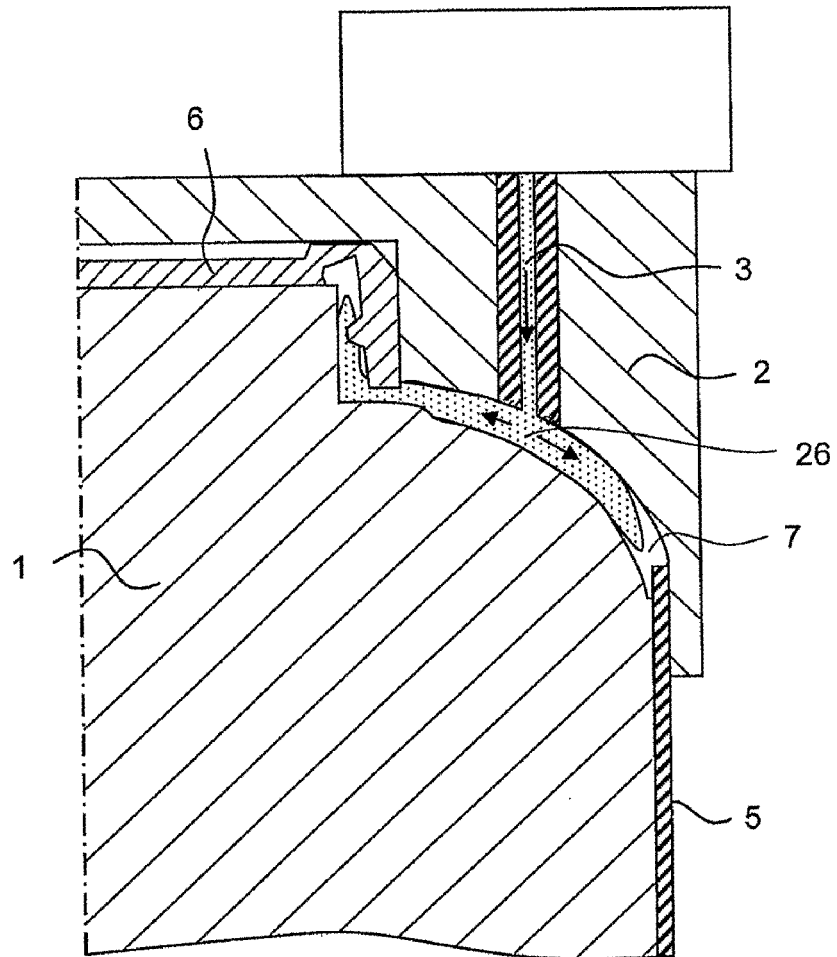


Fig. 1

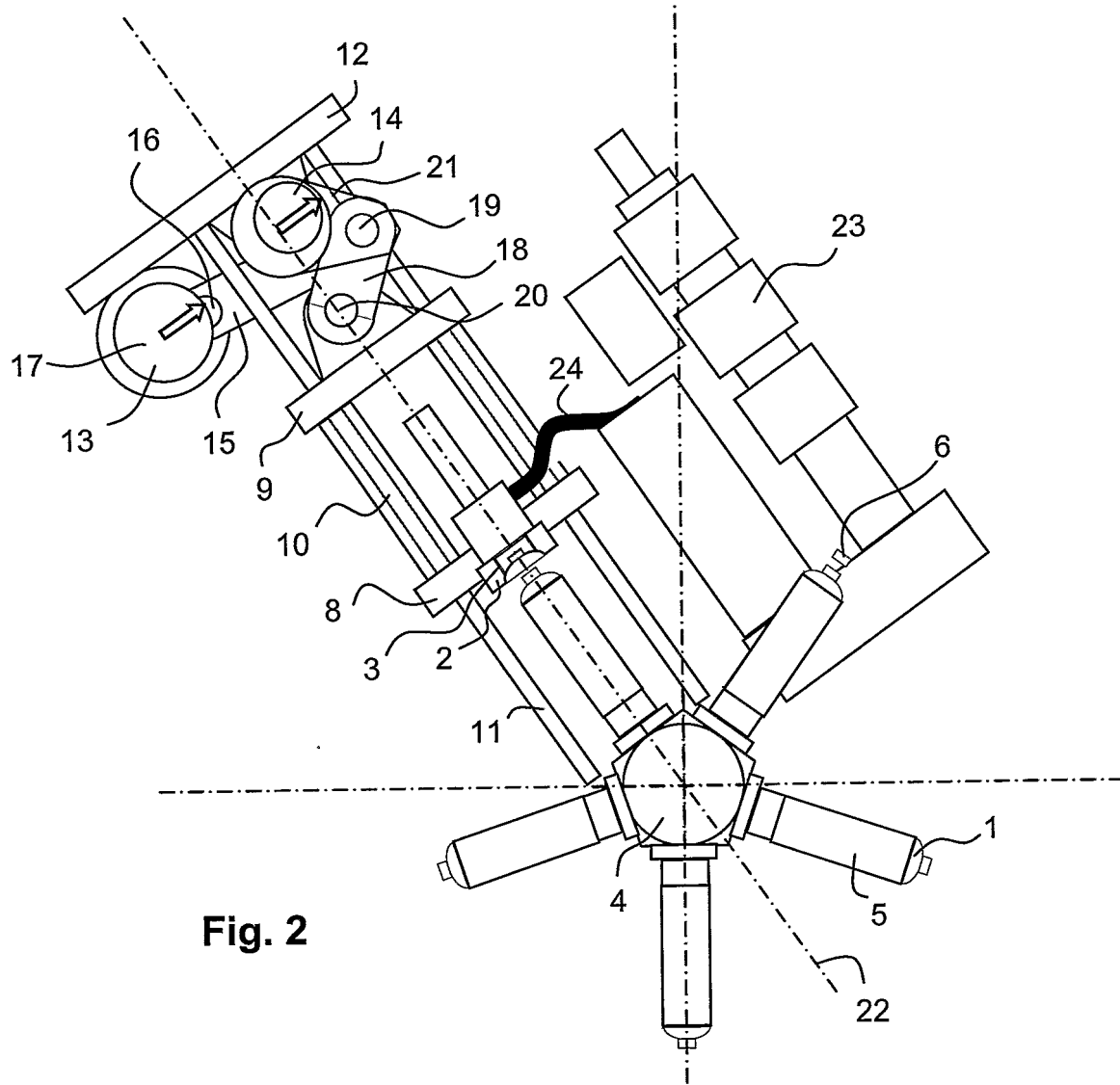


Fig. 2

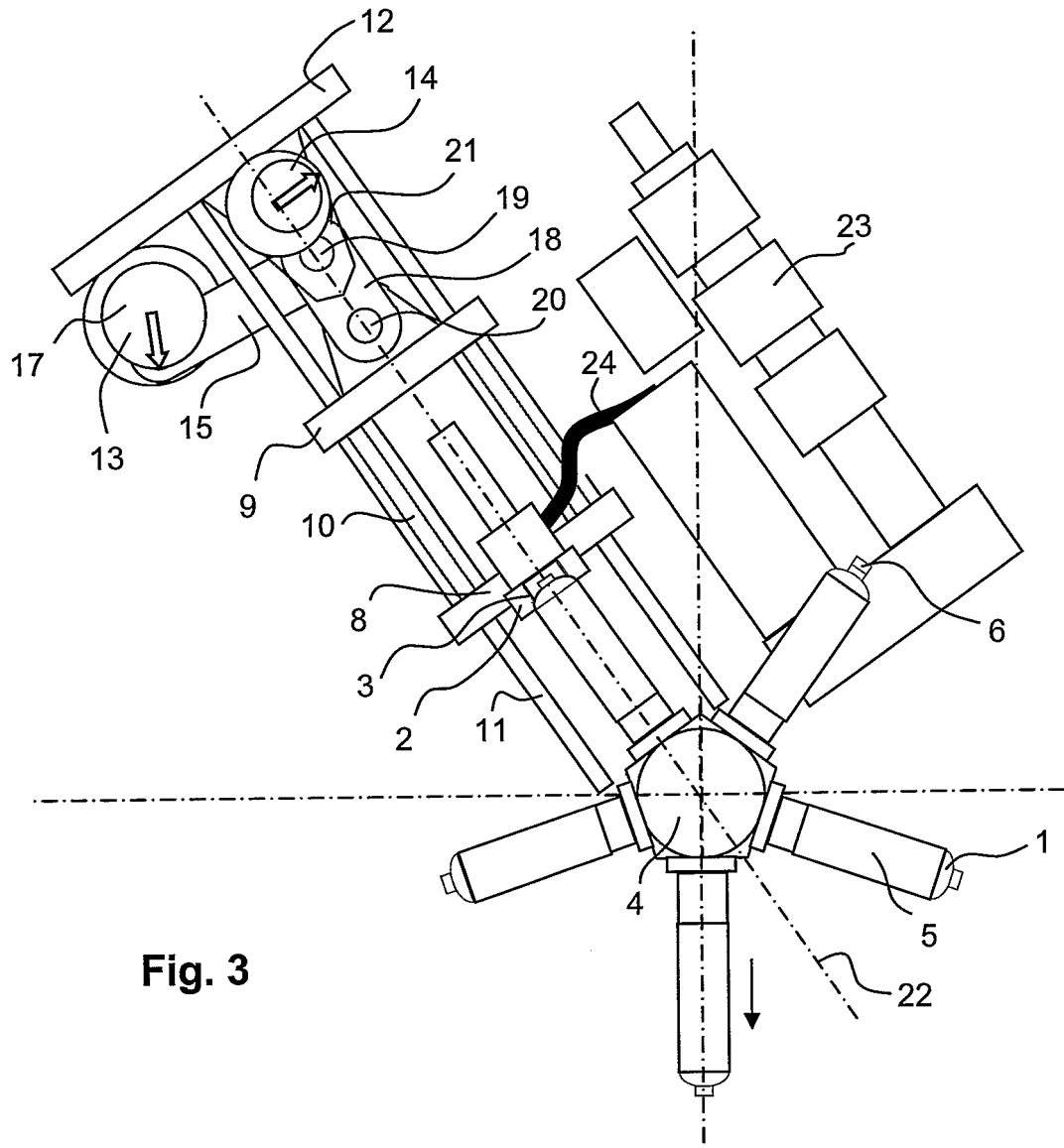
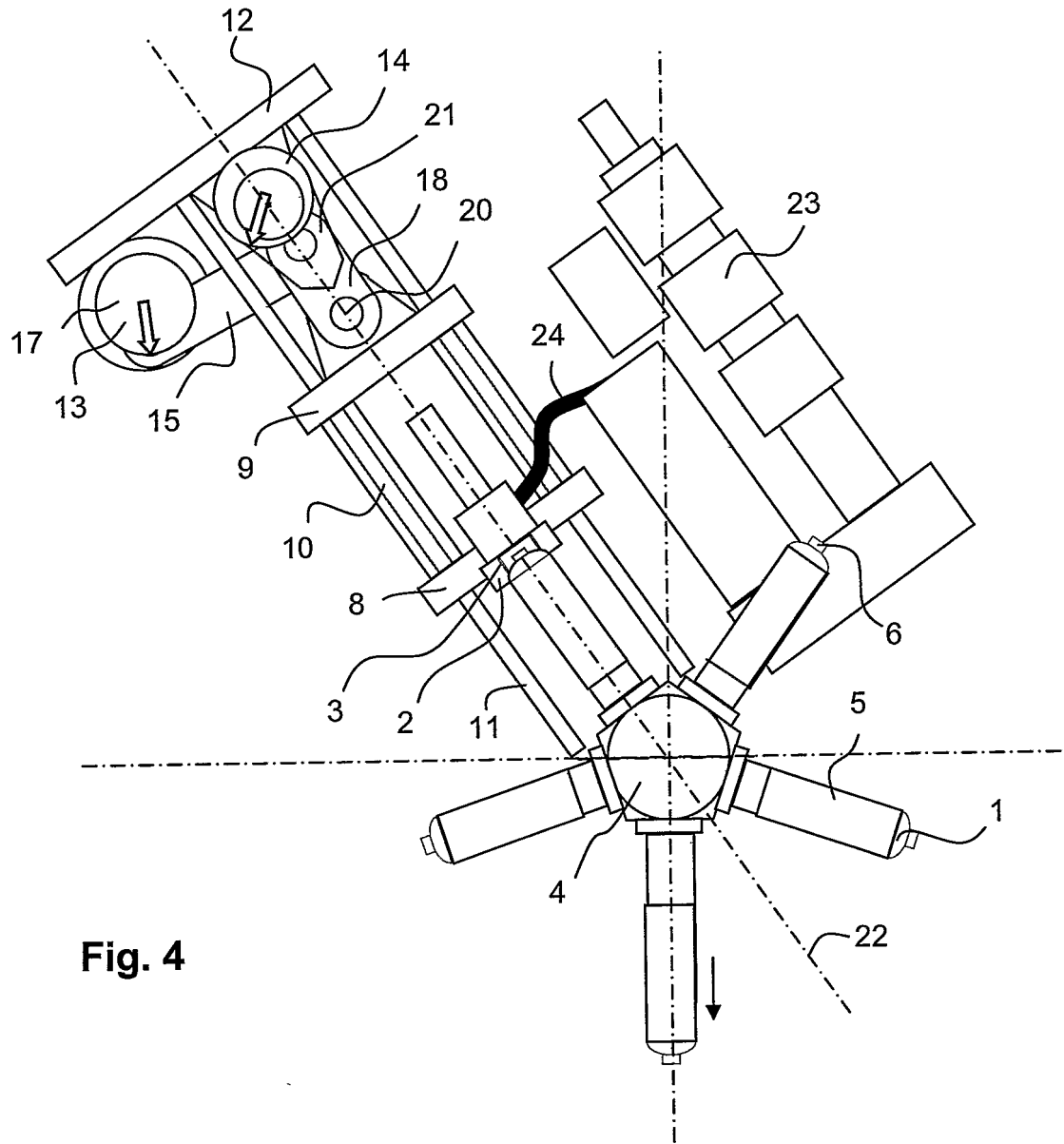


Fig. 3

**Fig. 4**

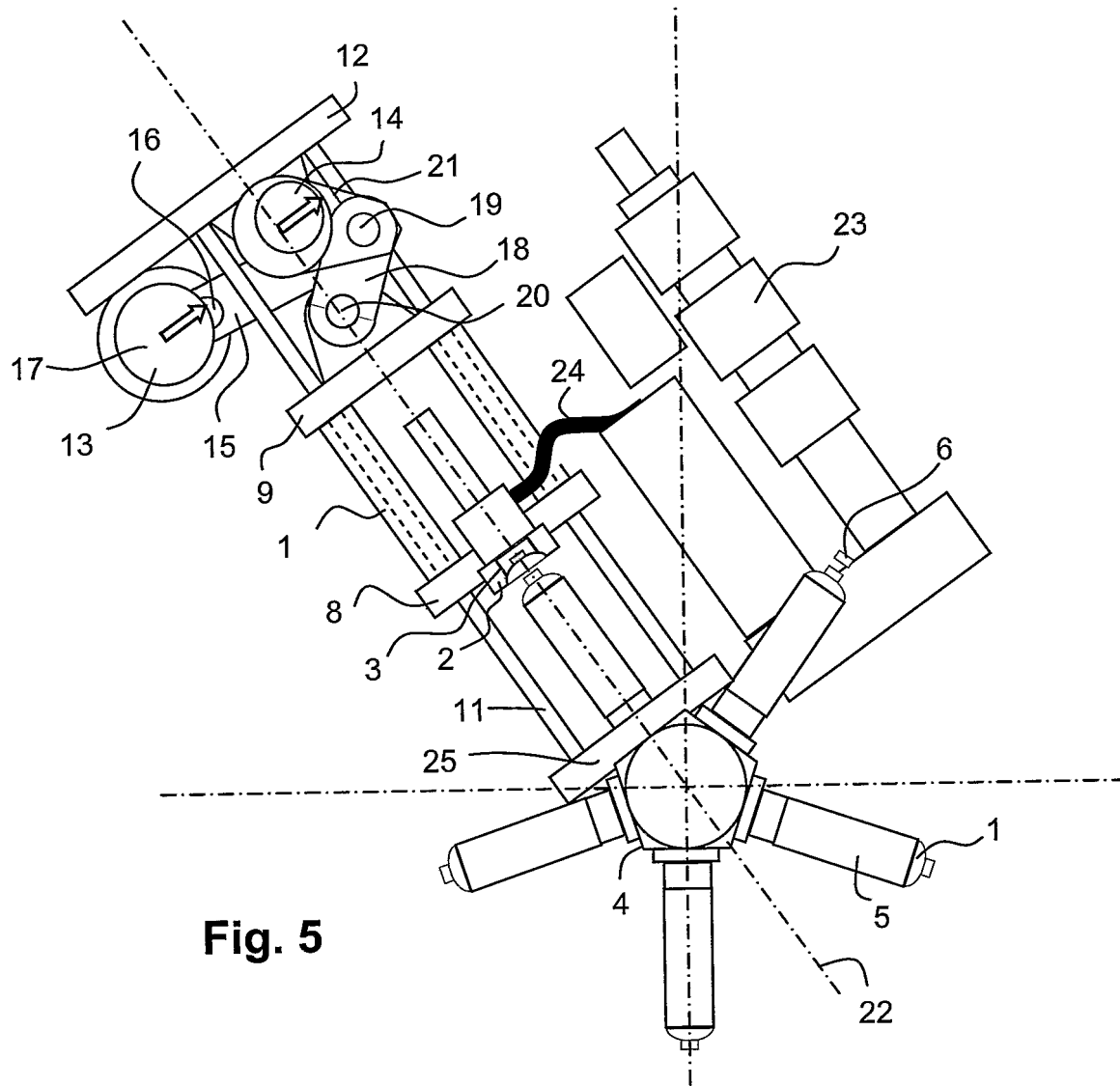


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2007/000638

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 3830614 A (KURTZ), 20 August 1974 (20.08.1974), abstract	1-12
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Date of the actual completion of the international search

5 October 2007

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2007/000638

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 02055283 A1 (HONGGUAN TECHNOLOGIES PTE LTD.), 18 July 2002 (18.07.2002), abstract -- -----	1-12

International patent classification (IPC)**B29C 45/66** (2006.01)**B29C 45/56** (2006.01)**Download your patent documents at www.prv.se**

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Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/09/2007

International application No.

PCT/SE2007/000638

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