

(19) World Intellectual Property Organization  
International Bureau(43) International Publication Date  
6 March 2008 (06.03.2008)

PCT

(10) International Publication Number  
WO 2008/025391 A2

(51) International Patent Classification: Not classified

(21) International Application Number: PCT/EP2007/005054

(22) International Filing Date: 7 June 2007 (07.06.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

PA 2006 0773	7 June 2006 (07.06.2006)	DK
PA 2006 0774	7 June 2006 (07.06.2006)	DK

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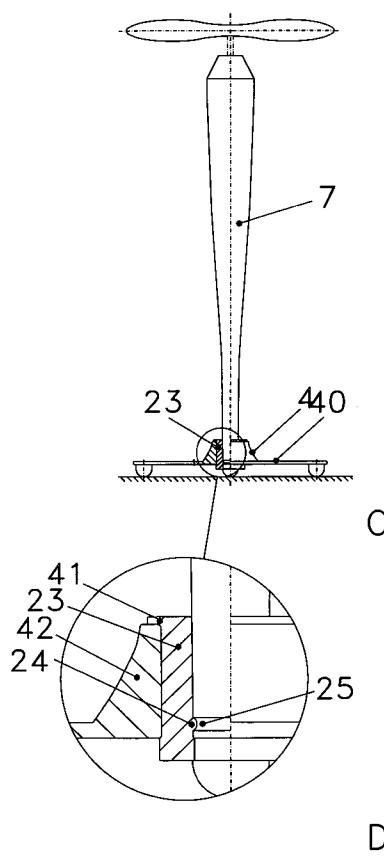
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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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(54) Title: A PISTON-CHAMBER COMBINATION



(57) **Abstract:** A piston-chamber combination comprising an elongate chamber which is bounded by an inner chamber wall, and comprising piston means in said chamber to be sealingly movable relative to said chamber wall at least between a first and a second longitudinal position of the chamber, said chamber having cross-sections of different cross-sectional areas at the first and second longitudinal positions, and at least substantially continuously differing cross-sectional areas at intermediate longitudinal positions between the first and second longitudinal positions, the cross-sectional area at said second longitudinal position being smaller than the cross-sectional area at said first longitudinal position, said piston means can change dimensions thereby providing for different cross-sectional areas of the piston means adapting the same to said different cross-sectional areas of the chamber during the relative movements of the piston means between the first and second longitudinal positions through said intermediate longitudinal positions of the chamber, said combination engaging a rigid surface. Said combination is movable relative to said surface.

**Declarations under Rule 4.17:**

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *of inventorship (Rule 4.17(iv))*

**Published:**

- *without international search report and to be republished upon receipt of that report*

## A Piston-Chamber Combination

### TECHNICAL FIELD

A piston-chamber combination comprising an elongate chamber which is bounded by a inner chamber wall, and comprising a piston in said chamber to be sealingly movable relative to said chamber wall at least between a first longitudinal position and a second longitudinal positions of the chamber, said combination engaging a rigid surface.

### BACKGROUND OF THE INVENTION

This invention deals with solutions for avoiding damaging the combination, as the piston rod and/or the chamber may use a path during the stroke which is not the line or curve of the movement of the force provider, or force receiver, respectively, the last mentioned provider / receiver engaging the piston rod / chamber.

In specifically Dutch prior art of the beginning of the last century, a number of flexible transitions between the basis e.g. a foot plate and the bottom of the cylinder can be observed for classic bicycle floor pumps: a piece of rubber, enabling the cylinder to move in a cone shaped path relative to its basis, e.g. a foot plate, having the suspension of the cylinder in/on the foot plate as top of the upside down positioned cone. This enables the torso of the human user (or any other force provider and/or receiver) to move along a curve while pumping by moving the piston rod and/or the chamber, while the piston rod can slide on its own path relative to the chamber and vice versa. This eases the pumping operation for the user.

Floor pumps having a foot plate, e.g. held down to the ground by the foot of the user, and the bottom of the cylinder rigidly fastened to the foot plate, so that the above mentioned movement besides a straight line, is not possible. Many classic pumps have shown the problem that the transition between the cylinder and the foot plate has been damaged by this non-compliance.

Specifically chambers, having differing cross-sectional area's, where the smallest cross-sectional area may just be positioned there where the reaction force of the foot plate to said chamber is highest, may suffer damage. This problem occurs irrespective the chamber type, e.g. having different circumferential length of the cross sections of the chamber or not.

This invention deals additionally with solutions for the problem of optimizing ergonomical aspects, such as optimizing the size of the force during the stroke, and the force transfer by manual operation of a handle of a piston chamber combination, Current straight handles do

not comply to the position of the hands of a user in rest, so that the hands need to turn a bit, grip the handle and transfer forces of a substantial magnitude through it, which may be unpleasant.

## 5 OBJECT OF THE INVENTION

The object is to provide a device comprising a combination of a piston and a chamber which comply to a path of a force provider or receiver during the stroke. This path may be of any kind.

Additionally to provide a device which has been optimized ergonomically.

10

## SUMMARY OF THE INVENTION

In the first aspect, the invention relates to a combination of a piston and a chamber, comprising an elongate chamber which is bounded by an inner chamber wall, and comprising a piston in said chamber to be sealingly movable relative to said chamber wall at least between a first longitudinal position and a second longitudinal position of the chamber, said combination engaging a rigid surface, enabling said movement, where said combination is movable relatively to said surface.

15

Force providers for enabling the relative movement of the parts of the combination may move themselves, and the path of the last mentioned movement does not at any time comply exactly with the path of the relative movement of the piston rod, the piston and the chamber.

20

Thus the system of the force provider and the combination may provide a flexibility somewhere in the system in order to avoid damage. When the force provider may engaging the combination with changing forces, and which may also keeping the non-moving part of the combination towards a rigid surface, in order to enable said relative movement, there may

25

be conflicting demands towards the combination, if said rigid surface also has the function of providing reaction forces for the combination. The last mentioned may happen when a pump is engaged by a human body, while the pump is being held down to the rigid surface e.g. a floor, by a foot of said user. Specifically when a standing person is using a floor pump for pumping a tyre, and specifically if the floor is not in level. The combination ought therefore be movable in relation to the rigid surface, in order to follow the path of the force provider.

30

In a second aspect is the problem of non-compliance specifically important when a chamber is used with having cross-sections of different cross-sectional areas at the first and

second longitudinal positions, and at least substantially continuously different cross-sectional areas and circumferential lengths at intermediate longitudinal positions between the first and second longitudinal positions, the cross-sectional area and circumferential length at said second longitudinal position being smaller than the cross-sectional at said 5 first longitudinal position – this is also valid in the case where the cross-sectional area's at the first and second longitudinal position having a different size, but an equal circumferential size.

In an optimized embodiment for obtaining the highest level of reduction of energy, the 10 chamber of e.g. a floor pump for tyre inflation has a smallest possible cross-sectional area at its bottom and a biggest at its top. Thus at the smallest cross-sectional area is the biggest force moment engaging the transition from the chamber to the basis of the pump. The combination should therefore be movable in relation to the rigid surface, in order to follow the path of the force provider.

15 In a third aspect the combination comprises a basis for engaging the combination to a rigid surface, enabling the relative movement of the piston and the chamber, the combination is rigidly fastened to a basis, said basis is movable relatively to said rigid surface.

20 The basis may have three engaging surfaces on the rigid surface, ensuring a stable positioning of the combination, even the rigid surface would not be flat. The combination may then turn around any line between two of the three engaging surfaces. This however is a poor solution, as the path of a human force provider normally is a 3-dimensional path. And compensation for a positioning of the combination when said surface is not in level, cannot be obtained by this solution. And, in the case of floor pumps for tyre inflation is 25 normally the foot of a user pressing the basis of the pump towards the rigid surface, which might prohibit said movement(s).

30 In a fourth aspect the combination comprises a basis for engaging the combination to a rigid surface, enabling the relative movement of the piston and the chamber, the combination is flexibly fastened e.g. by means of an elastically deformable bushing, to said basis.

This solution, combined with a basis with three engaging surfaces, is an optimized solution which complies to all demands: the path of the combination may be any path which is used

by the force provider (e.g. user), while the basis is standing on the surface, held down e.g. by the foot of the user. Not only can a rigid surface, not in level, be compensated, so that the combination, but not the basis, still is being perpendicular to the water, the user of the floor pump is able to initiate any path during the stroke. After use may the combination 5 automatically come back to its rest position, namely perpendicular to the rigid surface.

Alternative technical solutions for said bushing are of course possible, e.g. a ball joint at the end of the cylinder, holding within a ball bearing of the basis – the ball may be combined with a spring, which limits the deflection of the combination, and returns a deflection to default after use. This solution (not shown) may be more expensive than the 10 bushing.

In a sixth aspect, the combination may be joined together with the basis by means of an elastically deformable bushing. The bushing is mounted in a hole of the basis, and the chamber is mounted in the hole of the bushing, or vice versa. With 15 appropriate fittings, the combination may be assembled in the basis without being able to move in the longitudinal direction. The combination may at least now rotate in the bushing relative to the basis, and thus relative to the rigid surface. The deflection of the combination is deforming the flexible wall of the bushing. The wall thickness of the bushing may be much bigger than the wall thickness of the chamber, enabling substantial 20 deflection angles of the chamber.

Moreover, it might be possible that the fitting is of such a character, that it may also hold the forces of the combination in relation to the basis during the stroke, incl. the ends of the stroke, so that a translation in the longitudinal direction of the combination relative to the basis is prevented.

25 In a seventh aspect, an improved bushing may have a protrusion on its top, which is connected to the top of the basis. This prevents the bushing to move in a direction towards the basis. By adding another protrusion on the inside of the bushing or at the outside of the combination, combined with a groove the combination and bushing, 30 respectively a possible translation of the combination to and from the basis may be prevented.

Moreover, the elastically deformable bushing may serve as the soft stop of the combination, when the piston and/or the chamber is reaching its end point of the

movement. This function makes in classic floor pumps for tyre inflation the spring on the piston rod, between the handle and the cap superfluous.

In a eighth aspect, the combination comprising an elongate chamber which  
5 is bounded by an inner chamber wall, and comprising a piston in said chamber to be  
sealingly movable relative to said chamber wall at least between a first longitudinal  
position and a second longitudinal position of the chamber, said combination engaging a  
rigid surface, enabling said movement, where the combination comprises a piston rod, said  
piston rod guided by a guiding means connected to the combination, e.g. the cab, said  
10 guiding means is movable relatively to the chamber.

This is also valid for piston-chamber combinations with differing cross-sectional area's and  
equal of differing circumferential sizes.

The guiding means may be comprising a washer with a small hole with an appropriate  
15 fitting with the piston rod, while this washer may be movable within a bigger hole within  
the cap: the piston rod may mainly translate in a transversal direction of the combination.  
The washer may come back to its default position by means of a spring-force e.g. an O-  
ring between the hole in the cab, and the outside of the guiding means.

The size of the last mentioned hole is determining the deflection degree of the piston rod,  
20 together with how much the construction of the piston is allowing it. If the piston rod is  
rigidly fastened to the piston, the construction of the piston determines the deflection  
degree. If e.g. a ball joint is applied between the piston and the piston rod, the deflection  
degree is only determined by the guiding means.

25 In a nineth aspect, in order to allow a deflection of the piston rod in relation to the  
longitudinal centre axis of the rest of the combination, the contact surface of the guiding  
means may be circular line, e.g. by a convex cross-sectional inner wall of the hole in the  
guiding means.

30 In a tenth aspect, the piston may be rounded off, so as to comply to the movement  
of the piston rod, or the connection of the piston to the piston rod may be flexible, turnable.

In the eleventh aspect, the invention relates to a combination of a piston and a

chamber, wherein:

- the centre line of the portions of the handle, positioned opposite the centre axis of the combination have an in between angle different from 180°.

5 The centre lines of the hands of a user when operating a handle of a pump have different positions, depending on how the handle is being gripped by the hand(s).

In the case of classic floor pumps, with cylinders with circular cross sections of constant size, high working forces may occur. If relatively high forces are to be transferred from the arm of the user through the hand, connected to this arm, the hand will be best positioned in relation

10 to the arm, when no force moments would arise. This is obtained if the longitudinal axis of the arm goes through the center point of the axis of a portion of the handle, the handle gripped by the hand, connected to the arm.

Due to the relative big size of the force, the grip of the hand on the handle ought to be firm – this may be done by a hand curve like an open fist: the design of the handle may comprise a 15 portion which has circular cross sections. The sizes of the sections may vary, depending on the distance to the centre axis of the piston chamber combination.

A preferred angle between the portions of the handle may in a plane perpendicular the centre axis of the piston-chamber combination be 180°. However, it may also be different from 180°.

Additionally may the angle be in a plane which comprises said centre axis less than 180°. In

20 order to avoid the hands from gliding from these portions, stops may be provided for – these may also be used for the force transfer. The other options, 180° and more than 180° may of course also occur.

In the case of innovative floor pumps with a chamber with transversal cross sections 25 of varying sizes between two positions of the chamber in a longitudinal direction, the forces may be low. If relatively low forces are to be transferred from an arm of the user through a hand, connected to said arm, the hand may be positioned in relation to the arm, so that a certain force moment may arise. The contact area is that of an open hand. The handle may be designed with a cross section bounded by the curve of e.g. an ellips. The axis perpendicular 30 the centre axis of the piston-chamber combination may be larger than the axis parallel to said axis.

Preferred angles between the two portions of the handle in a plane perpendicular to the centre axis of the piston-chamber combination may be bit less than bit bigger (best!) than 180°.

These positions of the portions of the handle comply to the rest position(s) of the hand(s).

Both positions may be obtained by one handle design, if the handle may be able to turn around the centre axis of the piston-chamber combination.

In order to avoid the existence of a force moment, a line through the centres of both portions

5 of the handle in a plane perpendicular the centre axis of the piston-chamber combination cut the last mentioned axis.

In a plane which comprises the centre axis of the piston-chamber combination the angle may be 180° or less, or different than that.

10 The conical shape of the cylinder may provide a substantial reduction of the size of the working force. By a special arrangement is the shape of the conical cylinder in the longitudinal direction of the chamber formed in such a way, that the force on the handle remains constant during the stroke. This force may be altered when a valve is opening late, e.g. due to the fact that the valve piston is sticking on the valve seed, or that there be 15 dynamic frictions, e.g. due to small sizes of cross sections of channels – thus by forces originated by other sources than the shape of the chamber. Additionally may the friction of the piston to the wall of the chamber alter during the stroke, due to a change in size of the contact area. The shape of the cylinder shown in the longitudinal direction in all relevant drawings of this patent application is made in the above mentioned way while the 20 transversal cross-sections of the conical cylinder are circular – also this is shown in relevant drawings. The limitation to the shape is the smallest size of the piston. (approx. 17mm).

Thus, the invention also relates to a pump for pumping a fluid, the pump comprising:

- a combination according to any of the above aspects,
- means for engaging the piston from a position outside the chamber,
- a fluid entrance connected to the chamber and comprising a valve means, and
- a fluid exit connected to the chamber.

30 In one situation, the engaging means may have an outer position where the piston is in its first longitudinal position, and an inner position where the piston is in its second longitudinal position. A pump of this type is preferred when a pressurised fluid is desired.

In another situation, the engaging means may have an outer position where the piston is in its second longitudinal position, and an inner position where the piston is in its

first longitudinal position. A pump of this type is preferred when no substantial pressure is desired but merely transport of the fluid.

In the situation where the pump is adapted for standing on the floor and the piston/engaging means to compress fluid, such as air, by being forced downwards, the 5 largest force may, ergonomically, be provided at the lowest position of the piston/engaging means/handle. Thus, in the first situation, this means that the highest pressure is provided there. In the second situation, this merely means that the largest area and thereby the largest volume is seen at the lowest position. However, due to the fact that a pressure exceeding that in the e.g. tyre is required in order to open the valve of the tyre, the smallest 10 cross-sectional area may be desired shortly before the lowest position of the engaging means in order for the resulting pressure to open the valve and a larger cross-sectional area to force more fluid into the tyre (See Fig. 2B).

Also, the invention relates to a shock absorber comprising:

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- a combination according to any of the combination aspects,
- means for engaging the piston from a position outside the chamber, wherein the engaging means have an outer position where the piston is in its first longitudinal position, and an inner position where the piston is in its second longitudinal position.

20 The absorber may further comprise a fluid entrance connected to the chamber and comprising a valve means.

25 Also, the absorber may comprise a fluid exit connected to the chamber and comprising a valve means.

It may be preferred that the chamber and the piston forms an at least substantially sealed cavity comprising a fluid, the fluid being compressed when the piston moves from the first to the second longitudinal positions.

30 Normally, the absorber would comprise means for biasing the piston toward the first longitudinal position.

Finally, the invention also relates to an actuator comprising:

- a combination according to any of the combination aspects,

- means for engaging the piston from a position outside the chamber,
- means for introducing fluid into the chamber in order to displace the piston between the first and the second longitudinal positions.

5 The actuator may comprise a fluid entrance connected to the chamber and comprising a valve means.

Also, a fluid exit connected to the chamber and comprising a valve means may be provided.

10 Additionally, the actuator may comprise means for biasing the piston toward the first or second longitudinal position.

#### BRIEF DESCRIPTION OF THE DRAWINGS

In the following, preferred embodiments of the invention will be described with reference to the drawings wherein the invention is explained in detail below by means of diagrams and drawings. The following is shown in the diagrams or drawings - a transversal cross-section means a cross-section perpendicular to the moving direction of the piston and/or the chamber, while the longitudinal cross-section is the one in the direction of said moving direction:

20 Fig. 1A shows a top view of a pump of a floor pump type of Fig 1B, where the combination can turn around a line XX, YY or ZZ in relation to the floor surface, while the angle is not restricted by the suspension.

Fig. 1B shows a back view of the floor pump of Fig. 1A.

25 Fig. 2A shows top view of a pump of a floor pump type of Fig 2B, where the combination can move in 3 dimensions in relation to the surface, while the angle is restricted by spring force of the transition between the combination and the basis.

Fig. 2B shows the back view of the floor pump.

30 Fig. 2C shows a top view of the pump of Fig 2B, where the handle has been moved to a position in front of its rest position.

Fig. 2D shows a top view of the pump of Fig 2B, where the handle has been moved to a position at the back of its rest position.

Fig. 2E shows a top view of the pump of Fig 2B, where the handle has been

5 moved to a left position in front of its rest position.

Fig. 2F shows a top view of the pump of Fig 2B, where the handle has been moved to a left position at the back of its rest position.

Fig. 2G shows a top view of the pump of Fig 2B, where the handle has been 10 moved to a right position in front of its position when out of function.

Fig. 2H shows a top view of the pump of Fig 2B, where the handle has been moved to a right position at the back of its rest position.

Fig. 3A shows a side view of a floor pump with a flexible transition between the chamber of the combination and the basis.

15 Fig. 3B shows an enlargement of the transition of Fig. 3A.

Fig. 3C shows a back view of a floor pump with another flexible transition between the chamber of the combination and the basis.

Fig. 3D shows an enlargement of the transition of Fig. 3C.

20 Fig. 4A shows a back view of of a floor pump with a cab

which allows the piston rod to move in the transversal direction of the combination.

Fig. 4B shows an enlargment of a transversal cross-section of the cab of Fig. 4A when the piston rod is pulled out to its maximum – no transversal movement.

25 Fig. 4C shows the transversal cross-section of Fig. 4B when the piston rod is pulled out to its maximum, with a rottation o the piston rod to the left.

Fig. 4D shows an enlargement of a transversal cross-section of the cab of Fig. 4A w when the piston rod is not pulled out – no transversal movement.

30 Fig. 4E shows the transversal cross-section of Fig. 4D when the piston rod is not pulled out, with a transversal translation of the piston rod to the left.

Fig. 5A shows a top view of a floor pump type of Fig 5B, where the angle between the centerlines of the handle parts opposite the centerline of the combination is less than 180°.

Fig. 5B shows a side view of handle of the floor pump of Fig. 5A.

Fig. 6A shows a top view of a floor pump type of Fig 6B, where the angle between the centerlines of the handle parts opposite the centerline of the chamber is more than 180°.

Fig. 6B shows a side view of handle of the floor pump of Fig. 6A.

### DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1A shows line XX between two of the three engaging surfaces 1,2 of the basis 4 with a rigid surface 5, around which the combination 6 may move. The line Y-Y between two of the three engaging surfaces 2,3 of the basis 4 with a rigid surface 5, around which the combination 6 may move. The line Z-Z between two of the three contact points 1,2 of the basis 4 with a rigid surface 5, around which the combination 6 may move.

Fig. 1B shows the combination 6, comprising a chamber 7, a guiding 8 for the piston rod 9, a handle 10. The basis 4 with contact points 1, 2 and 3, which are rounded off towards the rigid surface. The chamber 7 is rigidly connected to the basis 4 by means of reinforcement 11.

Fig. 2A shows the handle 10 of the combination 6 when the combination 6 is in its rest position 12.

Fig. 2B shows the combination 6 in its rest position 12, when the transition 13 between the combination 6 and the reinforcement 14 of the basis 40 is in its rest position. The transition 13 may be made of a flexible material, and is positioned around the chamber 7.

Fig. 2C shows the activated position 14 of the handle 10, when the handle 10 has been moved from its rest position 12 at the front side of the said rest position.

Fig. 2D shows the activated position 15 of the handle 10, when the handle has been moved from its rest position 12 at the back side of the said rest position.

Fig. 2E shows the activated position 16 of the handle 10, when the handle has been moved from its rest position 12 at the left front side of the said rest position.

Fig. 2F shows the activated position 17 of the handle 10, when the handle has been moved from its rest position 12 at the left back side of the said rest position.

Fig. 2G shows the activated position 18 of the handle 10, when the handle has been moved from its rest position 12 at the right front side of the said rest position.

Fig. 2H shows the activated position 19 of the handle 10, when the handle has been moved from its rest position 12 at the right back side of the said rest position.

Fig. 3A shows a floor pump where the transition between the chamber 7 and the basis 4 is an elastically deformable bushing 20.

Fig. 3B shows an enlargement of the transition between the chamber 7 and the basis 40. The chamber 7 has a protrusion 21 which complies with a groove 22 in the

bushing 20, enabling a simple mounting of the chamber 7 in the base 40. The protrusion 41 on top of the reinforcement 42 of the basis 40.

Fig. 3C shows a floor pump where the transition between the chamber 7 and the basis 4 is an elastically deformable bushing 23.

5 Fig. 3D shows an enlargement of the transition between the chamber 7 and the 40. The chamber 7 has a groove 25 which complies with a protrusion 24 in the bushing 23, enabling a simple mounting of the chamber 7 in the basis 40.

Fig. 4A shows the combination 6 in the form of a floor pump with a cab 25 which 10 allows a transversal translation and/or deflection of the piston rod in relation to the rest of the combination 6 and the basis 43. The basis 43 may be directly, by means of the reinforcement 42, or indirectly e.g. by means of a flexible bushing be connected to the basis 41.

Fig. 4B shows an enlargement of the cap 25 of Fig. 4A, when the piston 44 is at the 15 end of a stroke farthest from the basis 43. The piston rod 9 is moving in a guiding means 26, of which the convex contact inner surface 31 is in line contact at its centre line 27 with the piston rod 9. The guiding means 26 is being held within the cap 9 by surfaces 36 and 37, and by a flexible O-ring 28. The cross-sectional area of the space 29 between surfaces 36 and 37 of the cap 9 and the guiding means 26 is shown bigger than the cross-sectional area of the ring 28 itself, so as to make a substantial compression of the ring 28 possible 20 (see e.g. Fig. 4C). The distance a between the outside of the piston rod 9 and the wall 38 of the spaces 33 and 34 of the cab 9. Said distance a may be approximately the same distance b between the piston rod and the wall 38 of the cab 9 in the top of the cab.

Fig. 4C shows Fig. 4B where the centre axis 32 of the piston rod 9' is deflected 25 angle  $\alpha$  in relation to the centre axis 30 of the rest of the combination. The space 29' is almost being filled up by the compressed ring 28', which is compressed by the translated guiding means 26'. The space 34'. The space 33'. The contact surface 35 between the guiding means 26' and the piston rod 9'. Distance a' is smaller than distance a of Fig. 4B. Distance b' is smaller than ditance b of Fig. 4B, and more than the diifference between distances a and a'.

30 Fig. 4D shows an enlargement of the cap 25 of Fig. 4A, when the piston 44 may be at the end of a stroke closest to the basis 43. The centre line 30 of the combination. The spaces 33 and 34 between the inner walls 38 of the cab 25 and the piston rod 9.

Fig. 4E shows Fig. 4D when the piston rod 9' is translated to teh left, to a

distancea'' between the outside of the piston rod 9' abd the inner wall 38 of the cab 25. The guiding means 26'' is moved to the left, compressing the ring 28'' – shown is that the space 29'' has been filled up in this cross-sectoion by the compressed ring 28''. The space33'' is approximately equal the space 34'' with a distance a'' which is equal distance 5 b'' which is smaller than distance a.

Fig. 5A shows the left portion 51 of the handle 52 and the right portion 53 of the handle 52, in relation to the centre axis 54 of the combination 55. The angle  $\alpha$  between the centre axis 56 of the left portion 51 of the handle 52 and the centre axis 57 of the right portion 53 of the handle 52 is less than  $180^\circ$ , when viewing from the position X of the user. The 10 center point 61 of the left portion 51 and center point 62 of right portion 53.

Fig. 5B shows the a front view of the floor pump of Fig. 5A, comprising the handle 52 and the combination 55. Handle 52 with the left 51 portion and the right 53 portion. The centre axis 54 of the combination 55.

Fig. 6A shows the left portion 58 of the handle 59 and the right portion 60 of the handle 59, in relation to the centre axis 54 of the combination 55. The angle  $\beta$  between the centre axis 56 of the left portion 58 of the handle 59 and the centre axis 61 of the right portion 60 of the handle 59 is more than  $180^\circ$ , when viewing from the position X of the user. 15

Fig. 6B shows the a front view of the floor pump of Fig. 6A, comprising the handle 59 and the combination 55. The handle 59 with the left 58 portion (= turned around right 20 portion 53) and the right portion 60 (= turned around left portion 51).

## Claims

1. A piston-chamber combination comprising an elongate chamber which is bounded by an inner chamber wall, and comprising a piston in said chamber to be sealingly movable relative to said chamber wall at least between a first longitudinal position and a second longitudinal position of the chamber, said combination engaging a rigid surface,

**wherein**

said combination is movable relatively to said surface.

2. A piston-chamber combination comprising an elongate chamber which is bounded by an inner chamber wall, and comprising a piston in said chamber to be sealingly movable relative to said chamber wall at least between a first longitudinal position and a second longitudinal position of the chamber,

10 said chamber having cross-sections of different cross-sectional areas and different circumferential lengths at the first and second longitudinal positions, and at least substantially continuously differing cross-sectional areas and circumferential lengths at intermediate longitudinal positions between the first and second longitudinal positions, the cross-sectional area and circumferential length at said second longitudinal position being smaller than the cross-sectional area and circumferential length at said first longitudinal position,

15 said piston means can change dimensions thereby providing for different cross-sectional areas and circumferential lengths of the piston means adapting the same to said different cross-sectional areas and different circumferential lengths of the chamber during the relative movements of the piston means between the first and second longitudinal positions through said intermediate longitudinal positions of the chamber,

20 said combination is engaging a rigid surface,

**wherein**

said combination is movable relative to said surface.

25 3. A piston-chamber combination comprising an elongate chamber which is bounded by an inner chamber wall, and comprising a piston means in said chamber to be sealingly movable relative to said chamber wall at least between a first longitudinal position and a second longitudinal position of the chamber,

30 said chamber having cross-sections of different cross-sectional areas and equal circumferential lengths at the first and second longitudinal positions, and at least substantially

continuously differing cross-sectional areas and circumferential lengths at intermediate longitudinal positions between the first and second longitudinal positions, the cross-sectional area and circumferential length at said second longitudinal position being smaller than the cross-sectional area and circumferential length at said first longitudinal position,

5           said piston can change dimensions thereby providing for different cross-sectional areas and circumferential lengths of the piston adapting the same to said different cross-sectional areas and equal circumferential lengths of the chamber during the relative movements of the piston means between the first and second longitudinal positions through said intermediate longitudinal positions of the chamber,

10           said combination engaging a rigid surface,

**wherein**

said combination is movable relative to said surface.

4.           A piston-chamber combination according to claims 1, 2 or 3, where the combination  
15           comprises a basis for engaging the combination to a rigid surface the combination is rigidly fastened to a basis,

**wherein**

said basis is movable relatively to said surface.

20           5.           A piston-chamber combination according to claim 1, 2, 3 or 4, where the combination comprises a basis for engaging the combination to a rigid surface,

**wherein**

the combination is flexibly fastened to said basis.

25           6.           A piston-chamber combination according to claim 5,

**wherein**

the transition from the combination to the basis comprises an elastically flexible bushing.

7.           A piston-chamber combination according to claim 6,

**wherein**

the elastically flexible bushing comprising a fitting with an adjacent member.

8. A piston-chamber combination according to claim 6,

**wherein**

the bushing comprising a groove

5 9. A piston-chamber combination according to claim 6,

**wherein**

the bushing comprising a protrusion.

10. A piston-chamber combination, according to claims 6 – 9,

10 **wherein**

the wall thickness of the bushing is substantially bigger than the wall thickness of the chamber.

11. A piston-chamber combination comprising an elongate chamber which is bounded by

15 an inner chamber wall, and comprising a piston means in said chamber to be sealingly movable relative to said chamber wall at least between a first longitudinal position and a second longitudinal position of the chamber, said combination engaging a rigid surface, where the combination comprises a piston rod, a cap connected to the chamber, said piston rod guided by a guiding means connected to the cap,

20 **wherein**

said guiding means is movable relatively to the cap.

12. A piston-chamber combination comprising an elongate chamber which is bounded by

25 an inner chamber wall, and comprising a piston means in said chamber to be sealingly movable relative to said chamber wall at least between a first longitudinal position and a second longitudinal position of the chamber,

30 said chamber having cross-sections of different cross-sectional areas and different circumferential lengths at the first and second longitudinal positions, and at least substantially continuously differing cross-sectional areas and circumferential lengths at intermediate longitudinal positions between the first and second longitudinal positions, the cross-sectional area and circumferential length at said second longitudinal position being smaller than the cross-sectional area and circumferential length at said first longitudinal position,

said piston means can change dimensions thereby providing for different cross-

sectional areas and circumferential lengths of the piston means adapting the same to said different cross-sectional areas and different circumferential lengths of the chamber during the relative movements of the piston means between the first and second longitudinal positions through said intermediate longitudinal positions of the chamber,

5           said combination is engaging a rigid surface,

**wherein**

      said guiding means is movable relatively to the cap.

13.       A piston-chamber combination comprising an elongate chamber which is bounded by  
10       an inner chamber wall, and comprising a piston means in said chamber to be sealingly  
      movable relative to said chamber wall at least between a first longitudinal position and a  
      second longitudinal position of the chamber,

15       said chamber having cross-sections of different cross-sectional areas and equal  
      circumferential lengths at the first and second longitudinal positions, and at least substantially  
      continuously differing cross-sectional areas and circumferential lengths at intermediate  
      longitudinal positions between the first and second longitudinal positions, the cross-sectional  
      area and circumferential length at said second longitudinal position being smaller than the  
      cross-sectional area and circumferential length at said first longitudinal position,

20       said piston can change dimensions thereby providing for different cross-sectional  
      areas and circumferential lengths of the piston adapting the same to said different cross-  
      sectional areas and equal circumferential lengths of the chamber during the relative  
      movements of the piston means between the first and second longitudinal positions through  
      said intermediate longitudinal positions of the chamber,

      said combination engaging a rigid surface,

25       **wherein**

      said guiding means is movable relatively to the cap.

14.       A piston-chamber combination, according to claims 11, 12 or 13,

**wherein**

30       said guiding means comprising a convex guiding surface with the piston rod.

15       A piston-chamber combination, according to claims 11, 12 or 13,

**wherein**

the piston is rounded off at the connection with the wall of the chamber

16. A piston-chamber combination, according to claims 11, 12 or 13,

**wherein**

5 the connection of the piston rod to the piston is flexible.

17. A piston-chamber combination, according to claims 1, 2 or 3

**wherein**

10 said portions of the handle may have an angle between the centre lines of said portions which is different from 180°.

18. A handle according to claim 1, 2 or 3,

**wherein**

15 said angle in a plane perpendicular to the centre axis of said piston-chamber combination is different from 180°.

19. A handle according to claim 1, 2 or 3,

**wherein**

20 said angle in a plane comprising the centre axis of said piston-chamber combination is different from 180°.

22. A handle according to claim 18,

**wherein**

25 additionally the angle in a plane comprising the centre axis of said piston-chamber combination is different from 180°.

21. A handle according to claim 19,

**wherein**

30 additionally the angle in a plane perpendicular the centre axis of said piston-chamber combination is different from 180°.

23. A handle according to claims 1, 2, 3,

**wherein**

the handle is turnable around the centre axis of the piston-chamber combination.

23. A handle according to claim 1, 2 , 3 or 17, where each portion of the handle has a centre point where the force of the hand of the user is concentrated,

5 **wherein**

the line which is drawn from one centre of a portion to the other is cutting the centre axis of the piston-chamber combination.

24. A piston-chamber combination comprising an elongate chamber which is bounded by an 10 inner chamber wall, and comprising a piston in said chamber to be sealingly movable relative to said chamber wall at least between a first longitudinal position and a second longitudinal position of the chamber,

15 said chamber having cross-sections of different cross-sectional areas and different circumferential lengths at the first and second longitudinal positions, and at least substantially continuously differing cross-sectional areas and circumferential lengths at intermediate longitudinal positions between the first and second longitudinal positions, the cross-sectional area and circumferential length at said second longitudinal position being smaller than the cross-sectional area and circumferential length at said first longitudinal position,

20 said piston means can change dimensions thereby providing for different cross-sectional areas and circumferential lengths of the piston means adapting the same to said different cross-sectional areas and different circumferential lengths of the chamber during the relative movements of the piston means between the first and second longitudinal positions through said intermediate longitudinal positions of the chamber,

25 said combination is engaging a rigid surface,

**wherein**

the shape of the chamber in the longitudinal direction of the chamber is formed in such a way, that the force on the handle remains constant during the stroke.

25. A piston chamber combination according to claim 24,

30 **wherein**

the force on the handle during the stroke may vary, due to superseeded forces such as frictions.

26. A pump for pumping a fluid, the pump comprising:

- a combination according to any of the preceding claims,
- means for engaging the piston from a position outside the chamber,
- a fluid entrance connected to the chamber and comprising a valve means, and
- 5 - a fluid exit connected to the chamber.

27. A pump according to claim 26, **wherein** the engaging means have an outer position where the piston is at the first longitudinal position of the chamber, and an inner position where the piston is at the second longitudinal position of the chamber.

10

28. A pump according to claim 26, **wherein** the engaging means have an outer position where the piston is at the second longitudinal position of the chamber, and an inner position where the piston is at the first longitudinal position of the chamber.

15

29. A shock absorber comprising:

- a combination according to any of claims 1 to 25,
- means for engaging the piston from a position outside the chamber, wherein the engaging means have an outer position where the piston is at the first longitudinal position of the chamber, and an inner position where the piston is at the second longitudinal position.

20

30. A shock absorber according to claim 29, further comprising a fluid entrance connected to the chamber and comprising a valve means.

25

31. A shock absorber according to claim 29 or 30, further comprising a fluid exit connected to the chamber and comprising a valve means.

30

32. A shock absorber according to any of claims 29 to 31, **wherein** the chamber and the piston form an at least substantially sealed cavity comprising a fluid, the fluid being compressed when the piston moves from the first to the second longitudinal positions of the chamber.

33. A shock absorber according to any of claims 29 to 31, further comprising means for biasing the piston toward the first longitudinal position of the chamber.

34. An actuator comprising:

- a combination according to any of claims 1 to 25,
- means for engaging the piston from a position outside the chamber,
- 5 - means for introducing fluid into the chamber in order to displace the piston between the first and the second longitudinal positions of the chamber.

35. An actuator according to claim 34, further comprising a fluid entrance connected to the chamber and comprising a valve means.

10

36. An actuator according to claim 34 or 35, further comprising a fluid exit connected to the chamber and comprising a valve means.

15

37. An actuator according to any of claims 34 to 36, further comprising means for biasing the piston toward the first or second longitudinal position of the chamber.

38. An actuator according to any of claims 34 to 37, **wherein** the introducing means comprise means for introducing pressurised fluid into the chamber.

20

39. An actuator according to any of claims 34 to 37, **wherein** the introducing means are adapted to introduce a combustible fluid, such as gasoline or diesel, into the chamber, and **wherein** the actuator further comprises means for combusting the combustible fluid.

25

40. An actuator according to any of claims 34 to 37, further comprising a crank adapted to translate the translation of the piston into a rotation of the crank.

30

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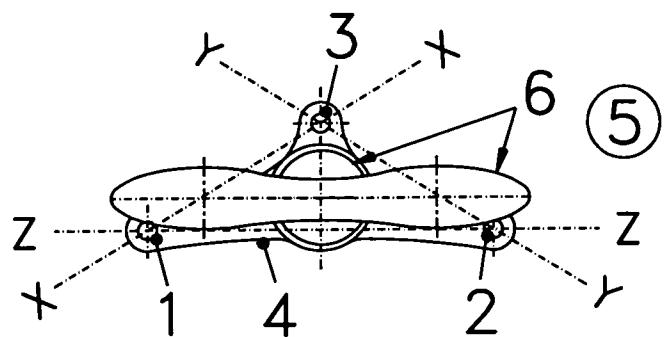


Fig. 1A

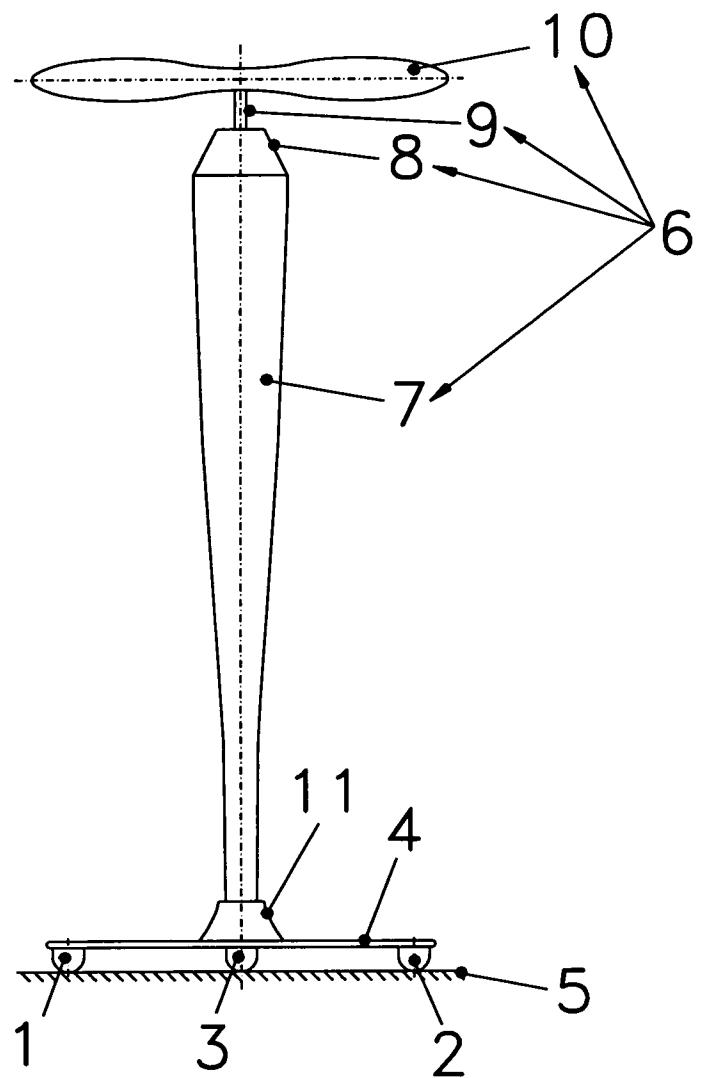
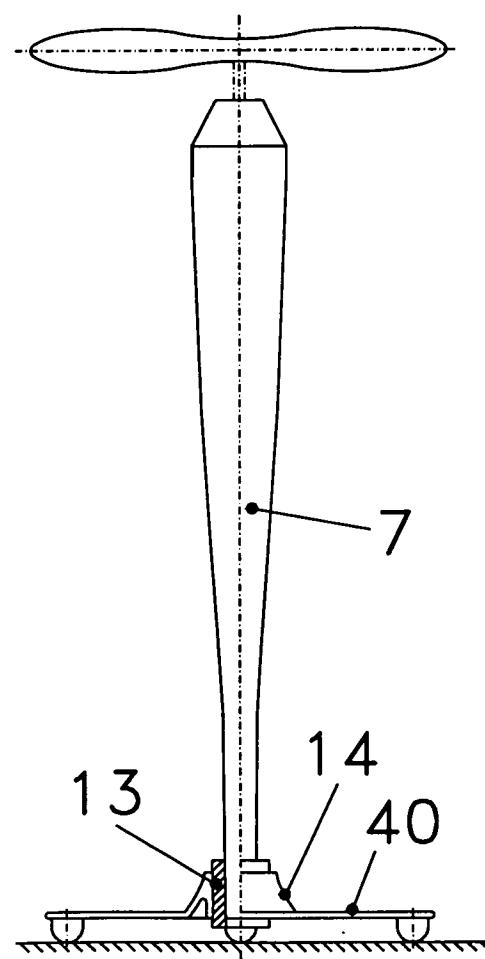
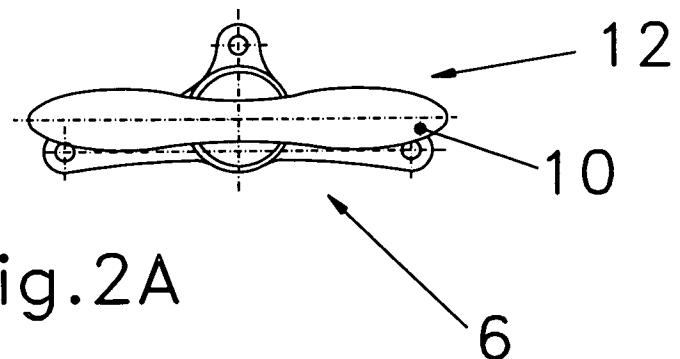


Fig. 1B

(2/9)



(3/9)

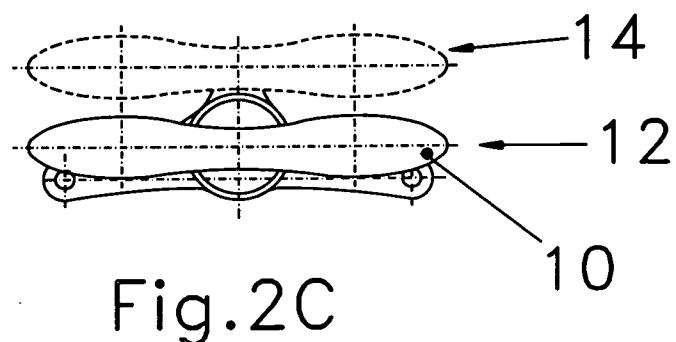


Fig.2C

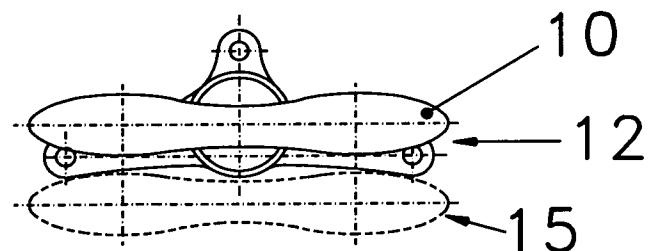


Fig.2D

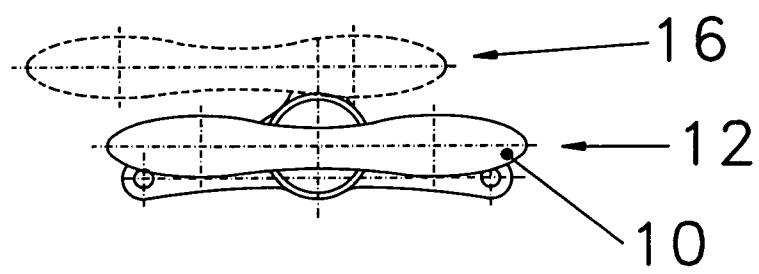


Fig.2E

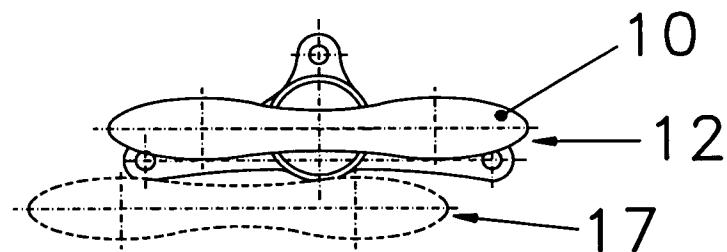


Fig.2F

(4/9)

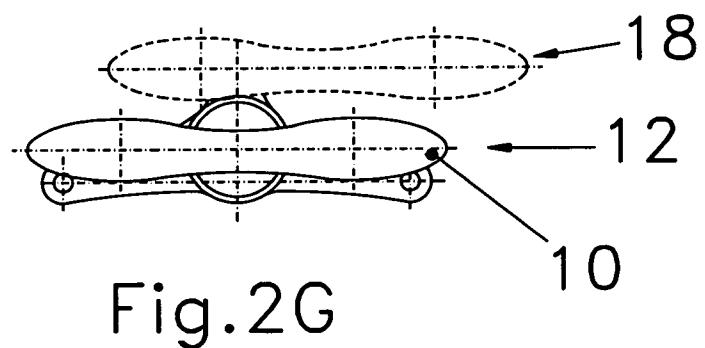


Fig.2G

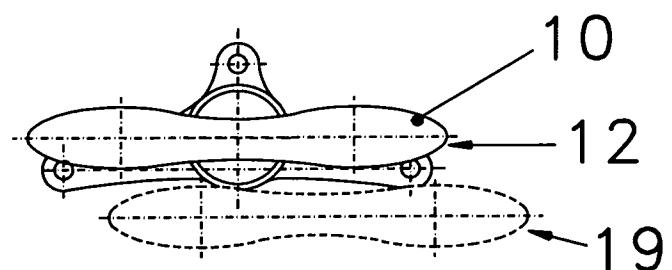


Fig.2H

(5/9)

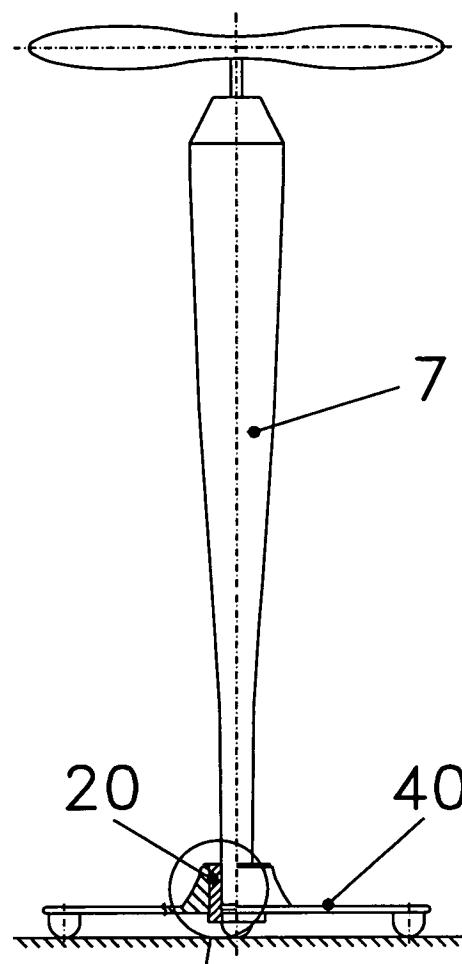


Fig. 3A

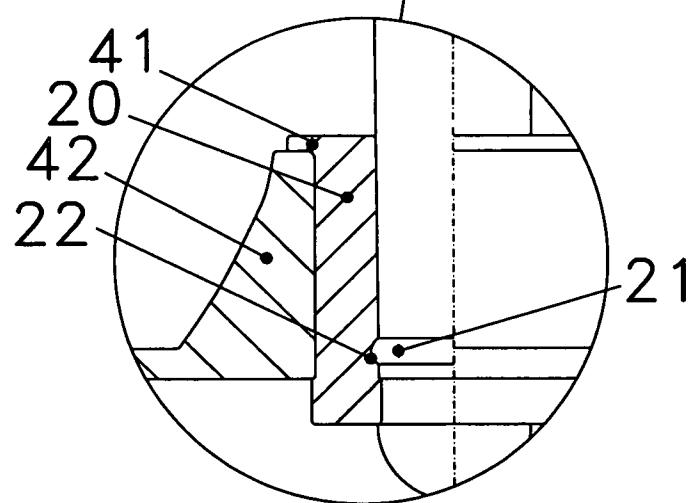


Fig. 3B

(6/9)

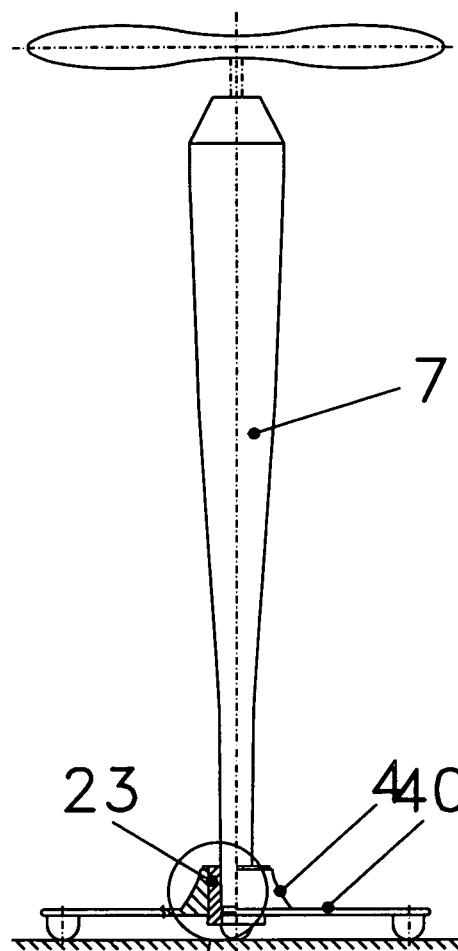


Fig.3C

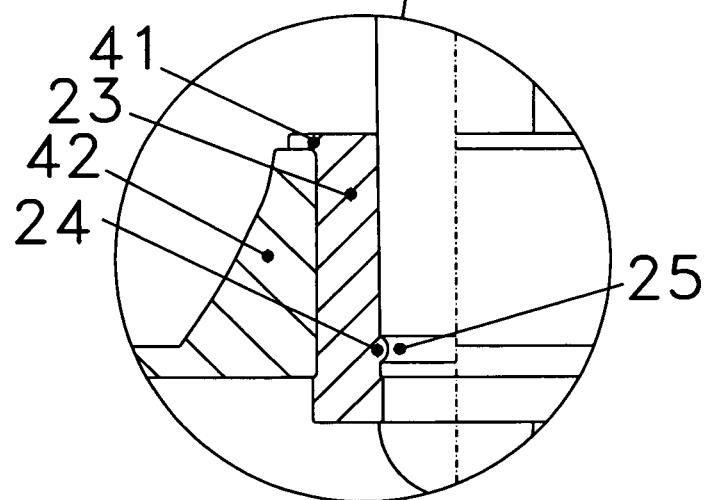


Fig.3D

(7/9)

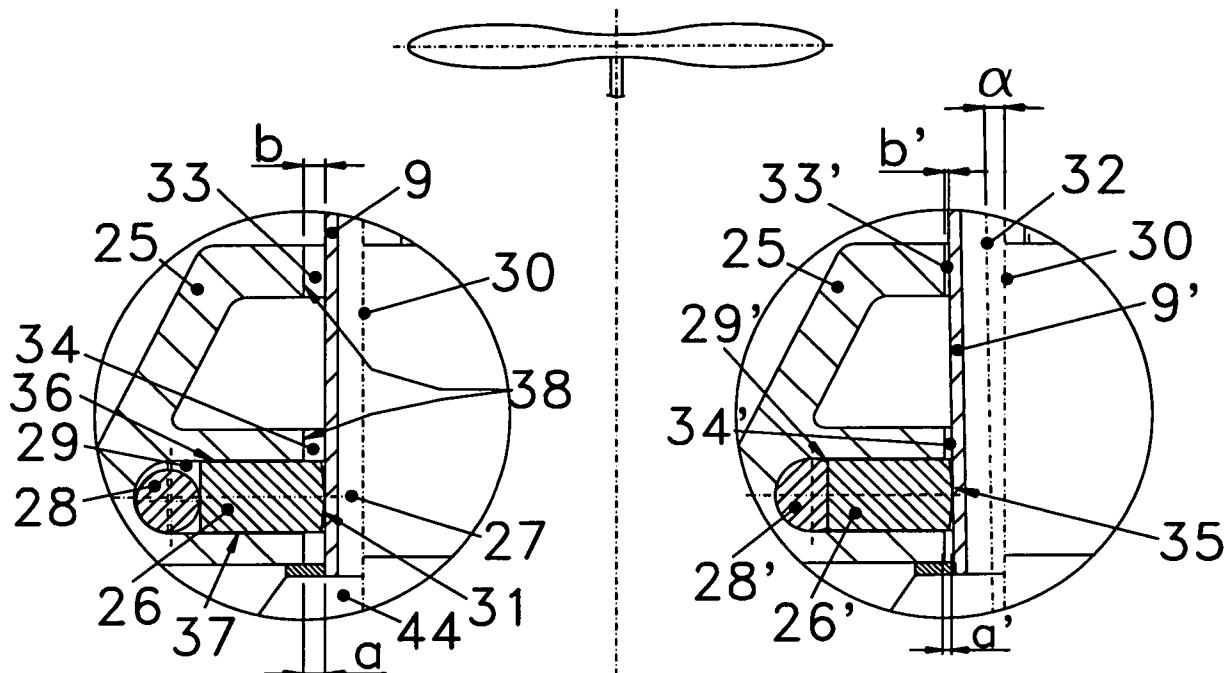


Fig. 4B

Fig. 4C

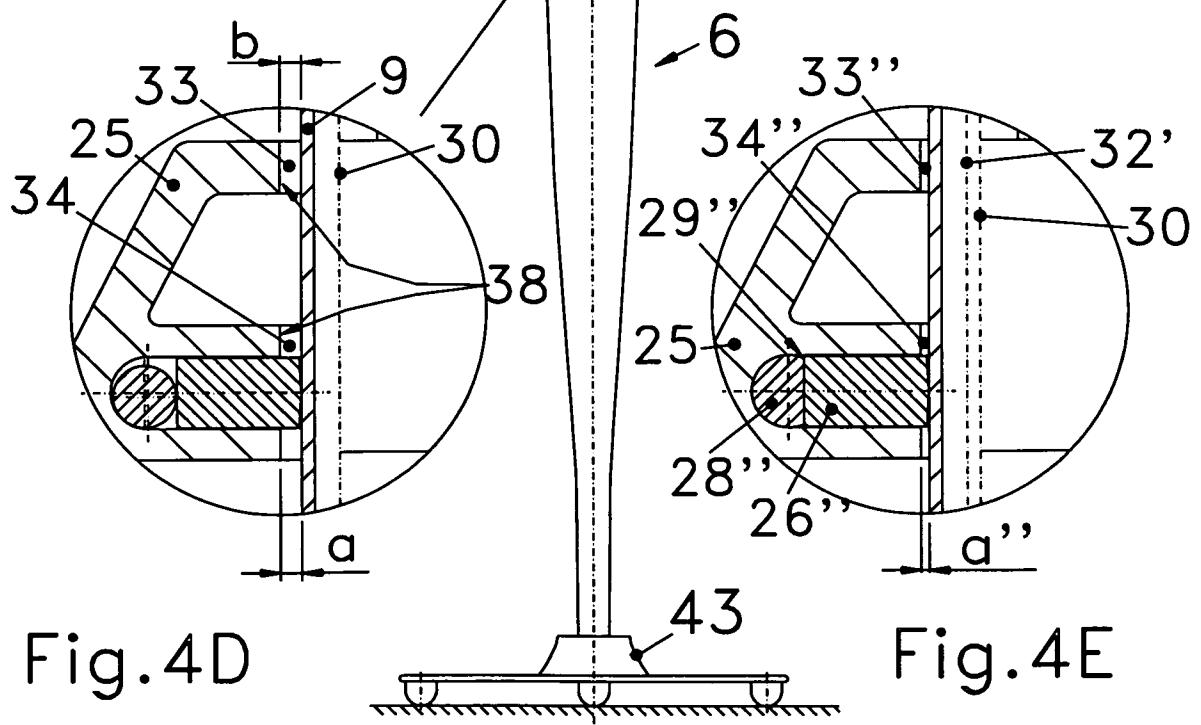


Fig. 4D

Fig. 4E

Fig. 4A

(8/9)

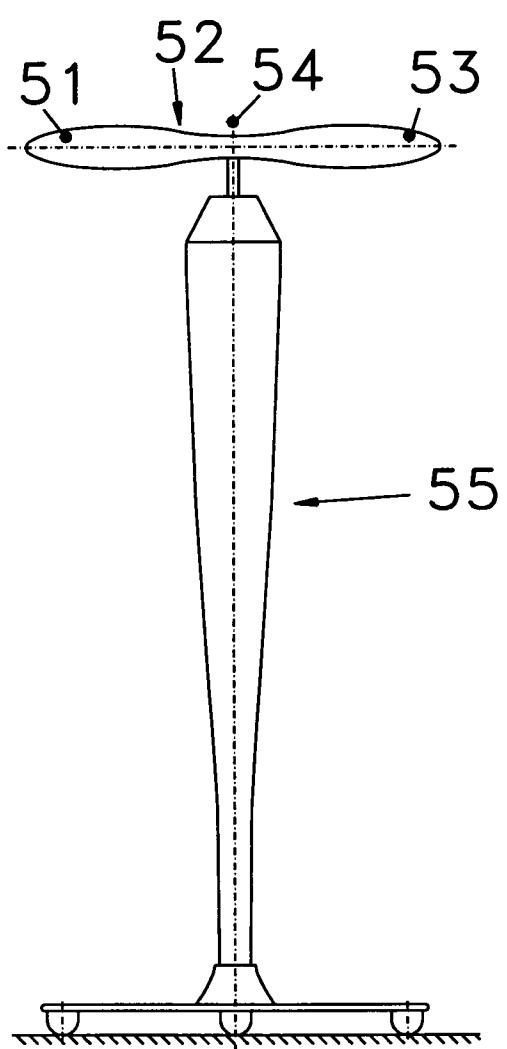
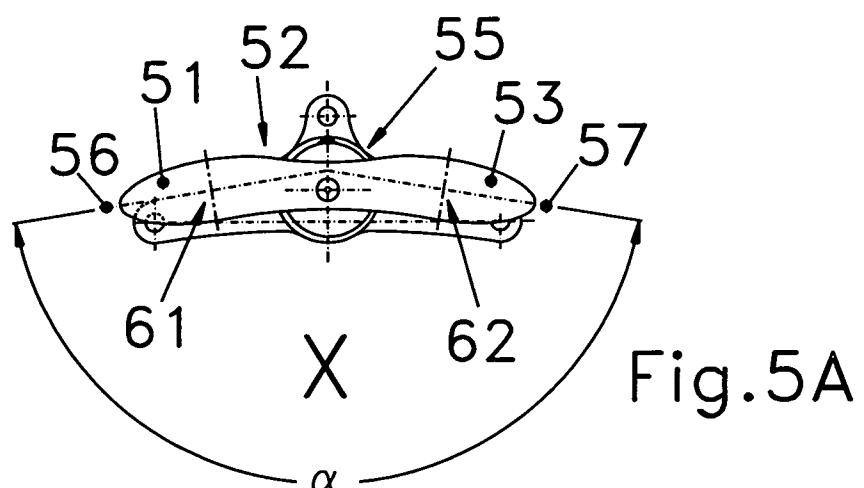


Fig. 5B

(9/9)

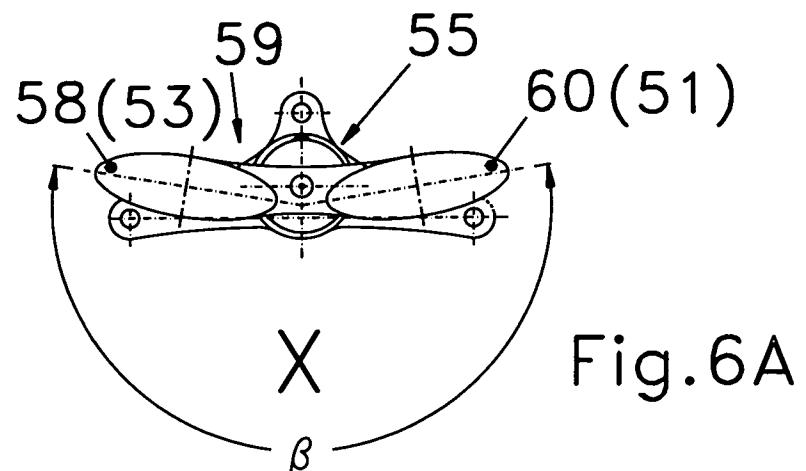


Fig.6A

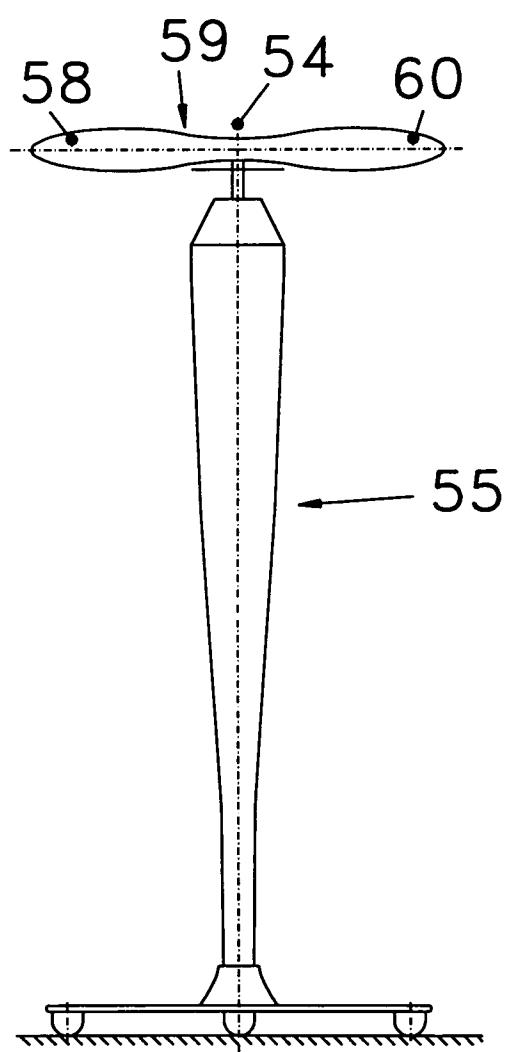


Fig.6B