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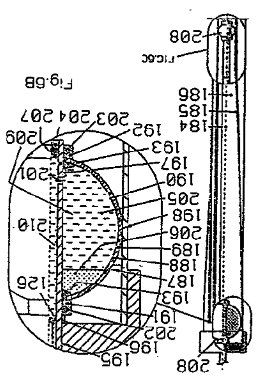
(54) **Titre :** A combination of a chamber and a piston, a pump, a shock absorber, a transducer, a motor and a power unit incorporating the combination.

(57) **Abrégé :**

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 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 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 area and circumferential length at said first longitudinal position, said piston comprising a container which is elastically deformable thereby providing for different cross-sectional areas and circumferential lengths of the piston adapting the same to said different cross-sectional areas and different circumferential lengths of the chamber during the relative movements of the piston between the first and second longitudinal positions through said intermediate longitudinal positions of the chamber. The piston is produced to have a production-size of the container in the stress-free and undeformed state thereof in which the circumferential length of the piston is approximately equivalent to the circumferential length of said chamber at said second longitudinal position, the container being expandable from its production size in a direction transversally with respect to the longitudinal direction of the chamber thereby providing for an expansion of the piston from the production size thereof during the relative movements of the piston from said second longitudinal position to said first longitudinal position. (Fig.6A)



A Combination of a Chamber and a Piston, a Pump, a Shock Absorber, a Transducer,a Motor and a Power Unit incorporating the Combination.

TECHNICAL FIELD

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 at least between first and second longitudinal positions of said chamber, said chamber having cross-sections of different cross-sectional areas and different circumpherential lengths at the first and second longitudinal positions of said chamber and at least substantially continuously different cross-sectional areas and different circumpherential length at intermediate longitudinal positions between the first and second longitudinal positions thereof, the cross-sectional area at the first longitudinal position being larger than the cross-sectional area at the second longitudinal position, said piston comprising an container having an elastically deformable container wall for sealing contact on the inner chamber wall, said container being elastically deformable and being inflatable to provide for different cross-sectional areas and circumferential lengths of the piston for adaptation to said different cross-sectional areas and different circumpherential lengths of said chamber during the relative movements of said piston between the first and second longitudinal positions through said intermediate longitudinal positions of said chamber.

Inflation valves which are mentioned are valves which enable inflation of a certain enclosed volume, and these may be the Dunlop-Woods valve, the Sclaverand valve and the Schrader valve. These are in use for inflation of closed chambers, e.g. tyres of vehicles. The last two mentioned valve types have a spring-force operated valve core pin, and may be opened by depressing this pin for inflation and deflation of the chamber. Depressing the valve core pin may be done by manual activating, by a pressure of a fluid or by a device such as an activating pin or a valve actuator. The first two mentioned valve types may be opened by the pressure of a fluid alone, while the last mentioned one best may be opened by a device, as otherwise a high pressure may be needed to depress the pin.

BACKGROUND OF THE INVENTION

This invention deals with solutions for the problem of obtaining a friction force low enough to at least avoid jamming between a piston, specifically a piston comprising a container having an elastically deformable container wall, and the wall of an elongate chamber during the stroke, the chamber having different sizes of cross-sectional area's in its longitudinal direction, specifically those having different circumpherential length's, when the piston is sealingly movable relative to said chamber.

A problem with embodiments of Figs. 6, 8 and 9 - 12 (incl.) of WO 00/70227 may be that the piston may jam in the smaller cross-sections of the chamber having cross-sections with different circumpherential sizes. Jamming may occur due to high frictional forces of the material of the wall of the pistons. These forces may mainly be created by the compression of the material(s) of the wall of the piston when the piston is moving from a first longitudinal position in the chamber having the biggest cross-sectional area to a second longitudinal position where the cross-sectional area and the circumpherential size is smaller. Figs. 1 - 3 (incl.) of the current patent application show examples of high frictional forces for non-moving pistons comprising a container in a non-moving chamber with or without internal pressure in the chamber. This results in high contact pressures between the piston and the wall of the chamber: jamming may occur.

A further problem may be that embodiments of pistons comprising a container of WO 00/70227 may leak their fluid, and thus may change their sealing capability. As in the solutions of the earlier mentioned problem for pistons comprising a container with an elastically deformable wall the sealing force is created by internal pressure, leakage may be an important problem.

OBJECT OF THE INVENTION

The object is to provide combinations of a chamber and a piston which may sealingly move when the chambers have different cross-sectional area's, at least when the circumpherencial length of these cross-sections is different.

SUMMARY OF THE INVENTION

In the first aspect, the invention relates to a combination of a piston and a chamber, wherein:

- the container is made to be elastically expandable and to have its circumpherical length in the stressfree and undeformed state of its production size approximately the circumpherential length of the inner chamber wall of the container at said second longitudinal position.

In the present context, the cross-sections are preferably taken perpendicularly to the longitudinal axis (= transversal direction).

Preferably, the second cross-sectional area is 98-5%, such as 95-70% of the first cross-sectional area. In certain situations, the second cross-sectional area is approximately 50% of the first cross-sectional area.

A number of different technologies may be used in order to realise this combination. These technologies are described further in relation to the subsequent aspects of the invention.

One such technology is one wherein the piston comprises a container comprising a deformable material.

In that situation, the deformable material may be a fluid or a mixture of fluids, such as water, steam, and/or gas, or a foam. This material, or a part thereof, may be compressible, such as gas or a mixture of water and gas, or it may be at least substantially incompressible.

The deformable material may also be spring-force operated devices, such as springs.

Thus the container may be adjustable to provide sealing to the wall of the chamber having different cross-sectional area's and different circumpherential sizes.

This may be achieved by choosing the production size (stress free, undeformed) of the piston approximately equivalent to the circumpherencial length of the smallest cross-sectional area of a cross-section of the chamber, and to expand it when moving to a longitudinal position with a bigger circumpherential length and to contract it when moving in the opposite direction.

And this may be achieved by providing means to keep a certain sealing force from the piston on the wall of the chamber: by keeping the internal pressure of the piston on (a) certain predetermined level(s), which may be kept constant during the stroke. A pressure level of a certain size depends on the difference in circumpherential length of the cross sections, and on the possibility to get a suitable sealing at the cross section with the smallest circumpherential length. If the difference is big, and the appropriate pressure level too high to obtain a suitable sealing force at the smallest circumpherential length, than change of the pressure may be arranged during the stroke. This calls for a pressure management of the piston. As commercially used materials are normally not tight, specifically when quite high pressures may be used, there must be a possibility to keep this pressure, e.g. by using a valve for inflation purposes. In the case when spring-force operated devices are being used to obtaine the pressure, a valve may not be necessary.

When the cross-sectional area of the chamber changes, the volume of the container may change. Thus, in a cross-section through the longitudinal direction of the chamber the container may have a first shape at the first longitudinal direction and a second shape at the second longitudinal direction, the first shape may be different from the second shape. In one situation, at least part when the deformable material is compressible and the first shape has an area being larger than an area of the second shape. In that situation, the overall volume of the container changes, whereby the fluid should be compressible. Alternatively or optionally, the piston may comprise an enclosed space communicating with the deformable container, said enclosed space having a variable volume. In that manner, that the enclosed space may take up or release fluid when the deformable container changes volume. The change of the volume of the container is by that automatically adjustable. It may result in that the pressure in the container remains constant during the stroke.

Also, the enclosed space may comprise a spring-biased piston. This spring may define the pressure in the piston. The volume of the enclosed space may be varied. In that manner, the overall pressure or maximum/minimum pressure of the container may be altered.

When the enclosed space is updivided into a first and a second enclosed space, the spaces further comprising means for defining the volume of the first enclosed space so that the pressure of fluid in the first enclosed space may relate to the pressure in the second enclosed space. The last mentioned space may be inflatable e.g. by means of a valve, preferably an inflation valve, such as a Schrader valve. A possible pressure drop in the container due to leakage e.g. through the wall of the container may be balanced by inflation of the second enclosed space through the defining means. The defining means may be a pair of pistons, one in each enclosed space.

The defining means may be adapted to define the pressure in the first enclosed space and in the container at least substantially constant during the stroke. However, any kind of pressure level in the container may be defined by the defining means: e.g. a pressure raise may be necessary when the wall of the container expands when the piston moves to such a big cross-sectional area at the first longitudinal position that the contact area and/or contact pressure at the present pressure value may become too little, in order to maintain a suitable sealing. defining means may be a pair of pistons, one in each enclosed space. The second enclosed space may be inflated to a certain pressure level, so that a pressure raise may be communicated to the first enclosed space and the container, despite the fact that the volume of the container and thus the second enclosed space may become bigger as well. This may be achieved by e.g. a combination of a piston and a chamber (the second enclosed space) with different cross-sectional area's in the piston rod. A pressure drop may also be designable.

Pressure management of the piston may also be achieved by relating the pressure of fluid in the enclosed space with the pressure of fluid in the chamber. By providing means for defining the volume of the enclosed space communicating with the chamber. In this manner, the pressure of the deformable container may be varied in order to obtain a suitable sealing. For example, a simple manner would be to have the defining means adapted to define the pressure in the enclosed space to raise when the container is moving from the second longitudinal position to the first longitudinal position. In this situation, a simple piston between the two pressures may be provided (in order to not loose any of the fluid in the deformable container).

In fact, the use of this piston may define any relation between the pressures in that the chamber in which the piston translates may taper in the same manner as the main chamber of the combination.

A device which is transportable directly from the piston rod into the container may also change the volume and/or the pressure in the container.

It may be possible that the piston does not have or communicate (closed system) or does have or communicate with a valve for inflation. When the piston does not have an inflation valve, the fluid may be non-permeable for the material of the wall of the container. A step in the mounting process may than be that the volume of the container is permanently closed, after having put the fluid in the volume of the piston, and after having been positioned at the second longitudinal position of the chamber. The obtainable velocity of the piston may depend on the possibility for a big fluid flow without too much friction to and from the first closed chamber. When the piston does have an inflation valve the wall of the container may be permeable for the fluid.

The container may be inflated by a pressure source which is comprised in the piston. Or an external pressure source, like one outside the combination and/or when the chamber is the source itself. All solutions demand a valve communicating with the piston. This valve may preferably an inflation valve, best a Schrader valve or in general, a valve with a spring force operated valve core. The Schrader valve has a spring biased valve core pin and closes independant of the pressure in the piston, and all kinds of fluids may flow through it. It may however also be another valve type, e.g. a check valve.

The container may be inflated through an enclosed space where the spring-biased tuning piston operates as a check valve. The fluid may flow through longitudinal ducts in the bearing of the piston rod of the spring biased piston, from a pressure source, e.g. an external pressure source or e.g. an internal pressure container.

When the enclosed space is divided up into a first and second enclosed space, the inflation may be done with the chamber as the pressure source, as the second enclosed space may prohibit inflation through it to the first enclosed space. The chamber may have an inlet valve in the foot of the chamber. For inflation of the container an inflation valve, e.g. a valve with a spring-force operated valve core such as a Schrader valve may be used, together with an actuator. This may be an activating pin according to WO 96/10903 or WO 97/43570, or a valve actuator according to WO99/26002 or US 5,094,263. The core pin of the valve is moving towards the chamber when closing. The activating pins from the above cited WO-documents have the advantage that the force to open the spring-force operated valve core is so low, that inflation may be easily done by a manually operated pump. The actuator cited in the US-patent may need the force of a normal compressor.

When the working pressure in the chamber is higher than the pressure in the piston, the piston may be inflated automatically.

When the working pressure in the chamber is lower than the pressure in the piston than it is necessary to obtain a higher pressure by e.g. temporary closing the outlet valve in the foot of the chamber. When the valve is e.g. a Schrader valve which may be opened by means of a valve actuator according to WO 99/26002, this may be achieved by creating a bypass in the form of a channel by connecting the chamber and the space between the valve actuator and the core pin of the valve. This bypass may be openened (the Schrader valve may remain closed) and closed (the Schrader valve may open) and may be accomplished by e.g. a movable piston. The movement of this piston may be arranged manually e.g. by a pedal, which is turning around an axle by an operator from an inactive position to an active position and vice versa. It may also be achieved by other means like an actuator, initiated by the result of a pressure measurement in the chamber and/or the container.

Obtaining the predetermined pressure in the container may be achieved manually - the operator being informed by a pressure gauge e.g. a manometer which is measuring the pressure in the container. It may also be achieved automatically, e.g. by a release valve in the container which releases the fluid when the pressure of the fluid exceeds the maximum pressure set. It may also be achieved by a spring-force operated cap which closes the channel from the pressure source above the valve actuator when the pressure exceeds a certain pre-determined pressure value. Another solution is that of a comparable solution of the closable bypass of the outlet valve of the chamber - a pressure measurement may be necessary in the container, which may steer an actuator which is opening and closing the bypass of the valve actuator according to WO 99/26002 of e.g. a Schrader valve of the container at a pre-determined pressure value.

The above mentioned solutions are applicable too to any pistons comprising a container, incl. those shown in WO 00/65235 and WO 00/70227.

One such technology is one wherein the piston comprises a container comprising an elastically deformable container wall.

Expansion or contraction of the container wall which is initiated by the changing size of the circumpherential length of a cross-section may be enabled by choosing a reinforcement which forces the wall of the container to expand or contract in 3 dimensions. Therefore, no surplus material between the wall of the container and the wall of the chamber will remain.
Withstanding the influence of a pressure in the chamber on the piston in order to limit the contact length (longitudinal stretching) may also be done by choosing a suitable reinforcement. The reinforcement of the wall of the container may be and/or may be not positioned in the wall of the container.

A reinforcement in the wall of the container may be made of a textile material. It may be one layer, but preferably at least two layers which cross each other, so that the reinforcement may be easier to mount. The layers may e.g. be woven or knitted. As the woven threads lay in different layers closely to each other, the threads may be made of an elastic material. The layers may be vulcanized within e.g. two layers of elastic material, e.g. rubber. When the container has its production size, not only the elastic material of the wall, but also the reinforcement is stress free and undeformed. Expansion of the reinforced wall of the container means that the distance between the crossings (= stitch size) may become larger as the threads expand, while contraction makes the stitch size smaller as the threads contract. The sealing of the wall of the container to the wall of the chamber may be established by pressurizing the container to a certain pressure. Hereby will the threads being expanded a little bit so that the stitch size becomes a little bit larger. The contact of the wall of the container prohibit the internal pressure to expand the container in such a way that the contact length will become too large, and avoids by that jamming.

A knitted reinforcement may be e.g. made of an elastic thread and/or elastically bendable thread. The expansion of the wall of the container may be made by stretching the bended loops of the knittings. The stretched loops may become back to its undeformed state when the wall of the container contracts.

A textile reinforcement may be produced on a production line where the woven or knitted textile reinforcement lay as a cylinder within two layers of elastic material. Within the smallest cylinder a bar is positioned on which caps are being held in a sequence top-down-top-down etc. and these may move on that bar. At the end of the line an vulcanisation oven is being held. The inside of the oven may have the size and the form of the container in a stressfree and underformed state. The part of the cylinders being inside the oven is being cut on length, two caps being positioned within the cylinders at both ends, and being kept there. The oven is closed, and steam of over

100°C and high pressure is put in. After approx. 1-2 minutes the oven may be opened and the ready produced container wall with the two caps vulcanised in that wall. In order to use the minutes lead time of the vulcanisation, there may more than one oven, e.g. rotating or translating, and all ending at the end of the production line. It may also be possible to have more than one oven on the production line itself, using the transport lead time as the vulcanisation time.

Production of the fiber reinforced wall of the container may be done similar. The reinforced fibers may be produced by e.g. injection moulding, incl. an assembling socket òr by cutting a string, which thereafter is being put at both ends onto assembling socket. Both options may easily series produced. For the rest will the production process be analogeous with the above mentioned ones rearding the textile reinforcement.

The piston comprising an elastically deformable container may also comprise reinforcement means which are not positioned in the wall, e.g. a plurality of elastic arms, which may or may not be inflatable, connected to the wall of the container. When inflatable, the reinforcement functions also to limit the deformation of the wall of the container due to the pressure in the chamber.

Another option is a reinforcement outside the wall of the container.

Another aspect of the invention is one relating to a combination of a piston and a chamber, wherein:

the chamber defines an elongate chamber having a longitudinal axis,

- the piston being movable in the chamber at least from a second longitudinal position to a first longitudinal position,
- the chamber having an elastically deformable inner wall along at least part of the inner chamber wall between the first and second longitudinal positions,
- the chamber having, at a first longitudinal position thereof when the piston is positioned at that position, a first cross-sectional area thereof and, at a second longitudinal position thereof when the piston is positioned at that position, a second cross-sectional area, the first cross-sectional area being larger than the second cross-sectional area, the change in cross-section of the chamber being at least substantially continuous between the first and second longitudinal positions when the piston is moved between the first and second longitudinal positions.

Thus, alternatively to the combinations where the piston adapts to the cross-sectional changes of the chamber, this aspect relates to a chamber having adapting capabilities.

Naturally, the piston may be made of an at least substantially incompressible material - or a combination may be made of the adapting chamber and an adapting piston - such as a piston according to the above aspects.

Preferably, the piston has, in a cross section along the longitudinal axis, a shape tapering in a direction from to the second longitudinal positions.

A preferred manner of providing an adapting chamber is to have the chamber comprise:

- an outer supporting structure enclosing the inner wall and
- a fluid held by a space defined by the outer supporting structure and the inner wall.

In that manner, the choice of fluid or a combination of fluids may help defining the properties of the chamber, such as the sealing between the wall and the piston as well as the force required etc.

In yet another aspect, the invention relates to a combination of a piston and a chamber, wherein:

the chamber defines an elongate chamber having a longitudinal axis,

- the chamber having, at a first longitudinal position thereof, a first cross-sectional shape and area thereof and, at a second longitudinal position thereof, a second cross-sectional shape and area, the first cross-sectional shape being different from the second cross-sectional shape, the change in cross-sectional shape of the chamber being at least substantially continuous between the first and second longitudinal positions,
- the piston being adapted to adapt itself to the cross-section of the chamber when moving from the first to the second longitudinal position of the chamber.

This very interesting aspect is based on the fact that different shapes of e.g. a geometrical figure have varying relations between the circumference and the area thereof. Also, changing between two shapes may take place in a continuous manner so that the chamber may have one cross-sectional shape at one longitudinal position thereof and another at a second longitudinal position while maintaining the preferred smooth variations of the surface in the chamber.

In the present context, the shape of a cross-section is the overall shape thereof - notwithstanding the size thereof. Two circles have the same shape even though one has a diameter different from that of the other.

Preferably, the first cross-sectional area is at least 2%, such at least 5%, preferably at least 10%, such as at least 20%, preferably at least 30%, such as at least 40%, preferably at least 50%, such as at least 60%, preferably at least 70%, such as at least 80, such as at least 90%, such at least 95% larger than the second cross-sectional area.

In a preferred embodiment, the first cross-sectional shape is at least substantially circular and wherein the second cross-sectional shape is elongate, such as oval, having a first dimension being at least 2, such as at least 3, preferably at least 4 times a dimension at an angle to the first dimension.

In another preferred embodiment, the first cross-sectional shape is at least substantially circular and wherein the second cross-sectional shape comprises two or more at least substantially elongate, such as lobe-shaped, parts.

When, in the cross-section at the first longitudinal position, a first circumference of the chamber is 80-120%, such as 85-115%, preferably 90-110, such as 95-105, preferably 98-102% of a second circumference of the chamber in the cross-section at the second longitudinal direction, a number of advantages are seen. Problems may arise when attempting to seal against a wall having varying dimensions due to the fact that the sealing material should both provide a sufficient sealing and change its dimensions. If, as is the situation in the preferred embodiment, the circumference changes only to a small degree, the sealing may be controlled more easily. Preferably, the first and second circumferences are at least substantially identical so that the sealing material is only bent and not stretched to any significant degree.

Alternatively, the circumference may be desired to change slightly in that when bending or deforming a sealing material, e.g. a bending will cause one side thereof to be compressed and another stretched. Overall, it is desired to provide the desired shape with a circumference at least close to that which the sealing material would automatically "choose".

One type of piston, which may be used in this type of combination, is the one comprising a piston comprising a deformable container. The container may be elastically or non-elastically deformable. In the last way the wall of the container may bent while moving in the chamber. Elastically deformable containers with a production size approximately the size of the circumpherencial length of the first longitudinal position of the chamber, having a reinforcement type which allows contraction with high frictional forces may also be used in this type of combination, and may be specifically with high velocities of the piston.

Elastically deformable containers with a production size approximately the size of the circumpherencial length of the second longitudinal position of the chamber, having a reinforcement type of the skin which allows parts of the wall of the container having different distances from the central axis of the chamber in a longitudinal cross-section of the chamber may also be used.

It is clear that depending on from where the combination is seen, one of the piston and the chamber may be stationary and the other moving - or both may be moving. This has no impact on the functionning of the combination.

The piston may also slide over an internal ànd an external wall. The internal wall may have a taper form, while the external wall is cylindrical.

Naturally, the present combination may be used for a number of purposes in that it primarily focuses on a novel manner of providing an additional manner of tailoring translation of a piston to the force required/taken up. In fact, the area/shape of the cross-section may be varied along the length of the chamber in order to adapt the combination for specific purposes and/or forces. One purpose is to provide a pump for use by women or teenagers - a pump that nevertheless should be able to provide a certain pressure. In that situation, an ergonomically improved pump may be required by determining the force which the person may provide at which position of the piston - and thereby provide a chamber with a suitable cross-sectional area/shape.

Another use of the combination would be for a shock absorber where the area/shape would determine what translation a certain shock (force) would require. Also, an actuator may be provided where the amount of fluid introduced into the chamber will provide differing translation of the piston depending on the actual position of the piston prior to the introducing of the fluid.

In fact, the nature of the piston, the relative positions of the first and the second longitudinal positions and the arrangement of any valves connected to the chamber may provide pumps, motors, actuators, shock absorbers etc. with different pressure characteristics and different force characteristics.

The preferred embodiments of the combination of a chamber and a piston have been described as examples to be used in piston pumps. This however should not limit the coverage of this invention to the said application, as it may be mainly the valve arrangement of the chamber besides the fact which item or medium may initiate the movement, which may be descisive for the type of application: pump, actuator, shock absorber or motor. In a piston pump a medium may be sucted into a chamber which may thereafter be closed by a valve arrangement. The medium may be compressed by the movement of the chamber and/or the piston and thereafter a valve may release this compressed medium from the chamber. In an actuator a medium may be pressed into a chamber by a valve arrangement and the piston and/or the chamber may be moving, initiating the movement of an attached device. In shock absorbers the chamber may be completely closed, wherein a compressable medium may be compressed by the movement of the chamber and/or the piston. In the case a non-compressable medium may be positioned inside the chamber, e.g. the piston may be equipeed by several small channels which may give a dynamic friction, so that the movement may be slowed down.

Further the invention may also be used in propulsion applications where a medium may be used to move a piston and/or a chamber, which may turn around an axis as e.g. in a motor. Any kind of

The principles according this invention may be applicable on all above mentioned applications. The principles of the invention may also be used in other pneumatic and/or hydraulic applications than the above mentioned piston pumps.

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.

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 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 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.
As the pump according to the invention may use substantial less working force than comparable pumps based on the traditional piston-cylinder combination, e.g. water pumps may extraxt water from greater depths. This feature is of great significance e.g. in underdeveloped countries. Also, inthe case of pumping a liquid when the pressure difference is almost zero, the chamber according to the invention may have another function. It may comply to the physical needs (ergonomical) of the user by a proper design of the chamber, e.g. as if there existed a pressure difference: e.g. according to Figs. 17B and 17A respectively. This may also be accomplished by the use of valves.

The invention also relates to a piston which seals to a cylinder, and at the same time to a tapered cylinder. The piston may or may not comprise an elastically deformable container. The resulting chamber may be of the type where the cross-sectional area's have different circumpherential sizes or that these may be identical. The piston may comprise one of more piston rods. Also the cylinder at the outside may be cylindrical or tapered as well.

Also, the invention relates to a shock absorber comprising:

- 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.

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

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.

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

Also, the invention 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.

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.

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

The invention relates to a motor comprising

- a combination according to any of the above mentioned combination aspects.

Finally, the invention also relates to a power unit, which preferably may be movable, e.g. by parachute - a M(ovable) P(ower) U(nit). Such a unit may comprise a power source of any kind, preferably at least one set of solar sells, and a power device, e.g. a motor according to the invention. There may be at least one service device present, such as e.g. a pump according to the invention, and/or any other device utilising the excess energy derived from the low working force of a device comprising a combination of a piston and a chamber according to the invention. Due to the very low working force it may be possible to transport a MPU by parachute, as the construction of devices based on the invention may be constructed with lighter weight than those based on the classic piston-cylinder combination.

The various embodiments described above are provided by way of illustration only and should not be construed to limit the invention. Those skilled in the art will readily recognize various modifications, changes, and combinations of elements which may be made to the present invention without strictly following the exemplary embodiments and applications illustrated and described herein, and without departing from the true spirit and scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, preferred embodiments of the invention will be described with reference to the drawings wherein:

Fig. 1A	shows a longitudinal cross-section of a non-moving piston in a non-pressurized cylinder at the first longitudinal position - the piston is shown in its production size, and when pressurized.
Fig. 1B	shows the contact pressure of the pressurized piston of Fig. 1A on the wall of the cylinder.
Fig. 2A	shows a longitudinal cross-section of the piston of Fig. 1A in a cylinder at the first (right) and second (left) longitudinal position, the piston is non-pressurized.
Fig. 2B	shows the contact pressure of the piston of Fig. 2A on the wall of the cylinder at the second longitudinal position.
Fig. 2C	shows a longitudinal cross-section of the piston of Fig. 1A in a cylinder at the second longitudinal position, the piston is pressurized on the same pressure level as the one of Fig. 1A - also is shown the piston at the first longitudinal position (production) size.
Fig. 2D	shows the contact pressure of the piston of Fig. 2C on the wall of the cylinder at the second longitudinal position.
Fig. 3A	shows a longitudinal cross-section of a piston of Fig. 1A in a cylinder at the first longitudinal position shown in its production size, and pressurized while the piston is subjected to a pressure in the chamber.
Fig. 3B	shows the contact pressure of the piston of Fig. 3A on the wall of the cylinder.
Fig. 4A	shows a longitudinal cross-section of a non-moving piston according to the invention in a non-pressurized cylinder at the second longitudinal position, shown in its production size, and when pressurized to a certain level.
Fig. 4B	shows the contact pressure of the pressurized piston of Fig. 4A on the wall of the cylinder.
Fig. 4C	shows a longitudinal cross-section of a non-moving piston according to the invention in a cylinder at the second longitudinal position, shown in its production size, and at the first longitudinal position when pressurized to the same level as that of Fig. 4A.
Fig. 4D	shows the contact pressure of the piston of Fig. 4C on the wall of the

cylinder.

Fig. 5A shows a longitudinal cross-section of the piston of Fig. 4A in a non-pressurized cylinder at the second longitudinal position, the piston with its production size, and when pressurized.

Fig. 5B shows the contact pressure of the pressurized piston of Fig. 5A on the wall of the cylinder.

Fig. 5C shows a longitudinal cross-section of the piston of Fig. 4A in a cylinder at the second longitudinal position, the piston with its production size, and when pressurized, subjected to a pressure from the cylinder.

Fig. 5D shows the contact pressure of the piston of Fig. 5C on the wall of the cylinder.

Fig. 6A shows a longitudinal cross-section of a chamber with fixed different areas of the transversal cross-sections and a first embodiment of the piston comprising a textile reinforcement with radially-axially changing dimensions during the stroke - the piston arrangement is shown at the beginning, and at the end of a stroke - pressurized - where it has unpressurized its production size.

Fig. 6B shows an enlargement of the piston of Fig. 6A at the beginning of a stroke.

Fig. 6C shows an enlargement of the piston of Fig. 6A at the end of a stroke.

Fig. 6D shows a 3-dimensional drawing of a reinforcement matrix of an elastic textile material, positioned in the wall of the container when the container is to be expanded,

Fig. 6E shows the pattern of Fig. 6D when the wall of the container has been expanded,

Fig. 6F shows a 3-dimensional drawing of a reinforcement pattern of an inelastic textile material, positioned in the wall of the container when the piston is to be expanded,

Fig. 6G shows the pattern of Fig. 6F when the wall of the container has been expanded,

Fig. 6H shows production details of a piston with a textile reinforcement.

Fig. 7A shows a longitudinal cross-section of a chamber with fixed different areas of the transversal cross-sections and a second embodiment of the piston comprising a fiber reinforcement ('Trellis Effect') with radially-axially changing dimensions of the elastic material of the wall during the stroke - the piston arrangement is shown at the beginning, and at the end of a stroke - pressurized - where it has unpressurized its production size.

Fig. 7B shows an enlargement of the piston of Fig. 7A at the beginning of a stroke.

Fig. 7C shows an enlargement of the piston of Fig. 7A at the end of a stroke.

Fig. 8A shows a longitudinal cross-section of a chamber with fixed different areas of the transversal cross-sections having different circumpherical length, and a third embodiment of the piston comprising a fiber reinforcement (no 'Trellis Effect') with radially-axially changing dimensions of the elastic material of the wall during the stroke - the piston arrangement is shown at the first longitudinal position, and at the second longitudinal position - pressurized - where it has unpressurized its production size.

Fig. 8B shows an enlargement of the piston of Fig. 8A at the beginning of a stroke.

Fig. 8C shows an enlargement of the piston of Fig. 8A at the end of a stroke.

Fig. 8D shows a top view of the piston of Fig. 8A with a reinforcement in the wall in planes through the central axis of the piston - left: at the first longitudinal position, right: at the second longitudinal position.

Fig. 8E shows a top view of the piston alike the one of Fig. 8A with a reinforcement in the wall in planes partly through the central axis and partly outside the central axis of the piston - left: at the first longitudinal position, right: at the second longitudinal position.

Fig. 8F shows a top view of the piston alike the one of Fig. 8A with a reinforcement in the wall in planes not through the central axis of the piston - left: at the first longitudinal position, right: at the second longitudinal position.

Fig. 8G shows production details of a piston with a fiber reinforcement.

Fig. 9A shows a longitudinal cross-section of a chamber with fixed different areas of the transversal cross-sections having different circumpherical length and a fourth embodiment of the piston comprising an "octopus" device, limiting stretching of the container wall by tentacles, which may be inflatable - the piston arrangement is shown at the first longitudinal position of the chamber, and at the second longitudinal position of the chamber - presssurized - where it has unpressurized its production size.

Fig. 9B shows an enlargement of the piston of Fig. 9A at the first longitudinal position of the chamber.

Fig. 9C shows an enlargement of the piston of Fig. 9A at the second longitudinal postion of the chamber.

Fig. 10A shows the embodiment of Fig. 6 where the pressure inside the piston may be changed by inflation through e.g. a Schrader valve which is positioned in the handle and/or e.g. a check valve in the piston rod, and where an enclosed space is balancing the change in volume of the piston during the stroke.

Fig. 10B shows instead of an inflation valve, a bushing enabling connection to an external pressure source.

Fig. 10C shows details of the guidance of the rod of the check valve.

Fig. 10D shows the flexible piston of the check valve in the piston rod.

Fig. 10E shows the embodiment of Fig. 6, where the volume of the enclosed space of Fig. 10A-D has been exchangend by a pressure source and an inlet valve for inflating the piston from the pressure source, and an outlet valve for pressure releave to the pressure source – enlarged details of the valve-valve actuator combinations according to Fig. 11D.

Fig. 10F shows the embodiment of Fig. 10E, where there are steerable valves and a jet or a nozzle – shown as black boxes.

Fig. 11A shows the embodiment of Fig. 6 where the pressure inside the piston may be maintained constant during the stroke and where a second enclosed space may be inflated through a Schrader valve which is positioned in the handle, communicating with the first enclosed space through a piston arrangement - the piston may be inflated by a Schrader valve + valve actuator arrangement with the pressure of the chamber as pressure source, while the outlet valve of the chamber may be manually controlled by a turnable pedal.

Fig. 11B shows a piston arrangement and its bearing where the piston arrangement is communicating between the second and the first enclosed space.

Fig. 11C shows a alternative piston arrangement adapting itself to the changing cross-sectional area's in its longitudinal direction inside the piston rod.

Fig. 11D shows an enlargement of the inflation arrangement of the piston of Fig. 11A at the end of the stroke.

Fig. 11E shows an enlargment of the bypass arrangement for the valve actuator for closing and opening of the outlet valve.

Fig. 11F shows an enlargement of an automatic closing and opening arrangement of the outlet valve - a comparable system is shown for optaining a predetermined pressure value in the piston (dashed).

Fig. 11G shows an enlargement of an inflation arrangement of the piston of Fig. 11A, comprising a combination of a valve actuator and a spring-force operated cap, which makes it possible to automatically inflate the piston from the chamber to a certain predetermined pressure.

Fig. 11H shows an alternative solution for the one of Fig. 11G, comprising a combination of a valve actuator and a spring positioned below the piston of the valve actuator.

Fig. 12 shows an arrangement where the pressure in the container may depend of the pressure in the chamber.

Fig. 13A shows a longitudinal cross-section of a chamber with an elastical or flexible wall having different areas of the transversal cross-sections and a piston with fixed geometrical sizes - the arrangement of the combination is shown at the beginning and at the end of the pump stroke.

Fig. 13B shows an enlargement of the arrangement of the combination at the beginning of a pump stroke.

Fig. 13C shows an enlargement of the arrangement of the combination during a pump stroke.

Fig. 13D shows an enlargement of the arrangement of the combination at the end of a pump stroke.

Fig. 14 shows a longitudinal cross-section of a chamber having an elastical or flexible wall with different areas of the transversal cross-sections and a piston with variable geometrical sizes - the arrangement of the combination is shown at the beginning, during and at the end of the stroke.

Fig. 15A shows examples of transversal cross-sections made by Fourier Series Expansions of a pressurizing chamber of which the transversal cross-sectional area decreases, while the circumpherical size remains constant.

Fig. 15B shows a variant of the pressurizing chamber of Fig. 7A, which has now a longitudinal cross-section with fixed transversal cross-sections which are designed in such a way that the area decreases while the circumference of it approximately remains constant or decreases in a lower degree during a pump stroke.

Fig. 15C shows transversal cross-section G-G (dotted lines) and H-H of the longitudinal cross section of Fig. 15B.

Fig. 15D shows transversal cross-section G-G (dotted lines) and I-I of the longitudinal cross section of Fig. 15C.

Fig. 15E shows other examples of transversal cross-sections made by Fourier Series Expansions of a pressurizing chamber of which the transversal cross-sectional area decreases, while the circumpherical size remains constant.

Fig. 15F shows an example of an optimized convex shape of the transversal cross section under certain contraints.

Fig. 16 shows a combination where the piston in moving in a cylinder over a tapered center.

Fig. 17A shows an ergonomical optimized chamber for pumping purposes and manual operation.

Fig. 17B shows the corresponding force-stroke diagram.

Fig. 18Á shows an example of a Movable Power Unit, hanging under a parachute.

Fig. 18B shows details of the Movable Power Unit.

DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1A shows the longitudinal cross-section of a non-moving non-pressurized piston 5 at the first longitudinal position of a non-pressurized chamber 1, having at that position a circular cross-sections with a constant radius. The piston 5 may have a production size approximately the diameter of the chamber 1 at this first longitudinal position. The piston 5* when pressurized to a certain pressure level is shown. The pressure inside the piston 5* results in a certain contact length.

Fig. 1B shows the contact pressure of the piston 5* of Fig. 1A. The piston 5* may jam at this longitudinal position.

Fig. 2A shows the longitudinal cross-section of a non-moving non-pressurized piston 5 at the first longitudinal position and the piston 5' at the second longitudinal position of a non-pressurized chamber 1, the chamber having circular cross-sections with a constant radius at both the first and second longitudinal positions. The piston 5 may have a production size approximately the diameter of the chamber 1 at this first longitudinal position. The piston 5' shows the piston 5, non-pressurized positioned into the smaller cross-section of the second longitudinal position.

Fig. 2B shows the contact pressure of the piston 5' on the wall of the chamber at the second longitudinal position. The piston 5' may jam at this longitudinal position.

Fig. 2C shows the longitudinal cross-section of a non-moving non-pressurized piston 5 at the first longitudinal position and the piston 5' at the second position of a non-pressurized chamber 1, the chamber having circular cross-sections with a constant radius at both the first and second longitudinal positions. The piston 5 may have a production size approximately the diameter of the chamber 1 at this first longitudinal position. The piston 5'* shows the piston 5, pressurized to the same level as the one of Fig. 1A, positioned into the smaller cross-section of the second longitudinal position.

Fig. 2D shows the contact pressure of the piston 5'* on the wall of the chamber at the second longitudinal position. The piston 5'* may jam at this longitudinal position: the friction force may be 72 kg.

Fig. 3A shows the piston 5 of Fig. 1A, and the deformed piston 5''* when pressurized to the same pressure level of that of piston 5* of Fig. 1A. The deformation is caused by the pressure in the chamber 1*, when the piston may not have means to limit the stretching, which is mainly in the meridian (longitudinal direction of the chamber) direction.

Fig. 3B shows the contact pressure. The piston 5''* may jam at this longitudinal position.

Fig. 4A shows the longitudinal cross-section of a piston 15 at the second longitudinal position of a non-pressurized chamber 10, having a circular cross-section. The piston 15 may have a production size approximately the diameter of the chamber 10 at this second longitudinal position. Piston 15'* shows the deformed piston 15 pressurized to a certain level. The deformation is due to the fact that the Young's modulus in the hoop direction (in a cross-sectional plane of the chamber) is choosen lower than that in the meridian direction (in the longitudinal direction of the chamber).

Fig. 4B shows the contact pressure on the wall of piston 15'*. This results in an appropriate friction force (4.2 kg), and suitable sealing.

Fig. 4C shows the longitudinal cross-section of piston 15 at the second longitudinal position (production size) of the non-pressurized chamber 10, and when pressurized 15''* at the first longitudinal position - the piston 15''* may have the same pressure as when the piston 15'* is positioned at the second longitudinal position of the chamber 10 (fig. 4A). Also here is the deformation in the hoop- and meridian direction different.

Fig. 4D shows the contact pressure on the wall of piston 15''*. This results in an appropriate friction force (0.7 kg) and a suitable sealing.

Therefore, it is possible to sealingly move a piston comprising an elastically deformable container from a smaller to a bigger cross-sectional area while having the same internal pressure - within the limitations for the diameters of the cross-sections which were chosen in this experiment.

Fig. 5A shows the longitudinal cross-section of the piston 15 (production size) and the piston 15'* at the second longitudinal position of the non-pressurized chamber 10. The piston 15'* is showing the deformed structure of piston 15 when the piston 15 is pressurized. The piston 15, 15'* have been attached at the lower end to an imaginair piston rod in order to prevent piston movement during application of the chamber pressure.

Fig. 5B shows the contact pressure of the piston 15'* of Fig. 5A. This is low enough to allow movement (friction force 4.2 kg) and suitable for sealing.

Fig. 5C shows the longitudinal cross-section of the piston 15 (production size) and 15''* pressurized and deformed by the chamber pressure at the second longitudinal position of the pressurized chamber 10*. The piston 15, 15'* have been attached at the lower end to an imaginair piston rod in order to prevent piston movement during the application of the chamber pressure. The deformed piston 15''* is approximately twice as long as the undeformed piston 15.

Fig. 5D shows the contact pressure of the piston 15''* of Fig. 5C. This is low enough to allow movement (friction force 3.2 kg) and suitable for sealing.

Therefore, when applying a chamber pressure on a piston comprising a pressurized elastically deformable container, it is possible to sealingly move as well, at least at the longitudinal position with the smallest cross-sectional area. The stretching due to the applied chamber force is big and it may be necessary to limit this.

Fig. 6-9 deal with the limitation of the stretching of the skin of the piston, which may result in a contact area small enough to enable appropriate sealing and a friction force low enough to enable movement of the piston. This comprises a limitation of the stretching in the longitudinal direction when the container may or may not be subjected to a pressure in the chamber, and to allow expansion in the transversal direction, when moving from the second to the first longitudinal position of the chamber, and specifically allow contraction when moving the other way around.

The stretching in the longitudinal direction of the wall of the container-type piston may be limited by several methods. It may be done by a reinforcement of the wall of the container by using e.g. textile and/or fiber reinforcement. It may also be done by an inside the chamber of the container positioned expanding body with a limitation for its expansion, while it is connected to the wall of the container. Other methods may be used, e.g. pressure management of a chamber in-between two walls of the container, pressure management of the space above the container etc. TThe reinforcement may also be positioned outside the piston.

The expansion behaviour of the wall of the container may be depending on the type of the stretching limitation used. Moreover, the keeping of the piston which is moving over the piston rod, while expanding, may be guided by a mechanical stop. The positioning of such a stop may be depending on the use of the piston-chamber combination. This may also be the case for the guidance of the container over the piston rod, while expanding and/or sujected to external forces.

All kinds of fluids may be used - a combination of a compressable and a non-compressable medium, a compressable medium only or a non-compressable medium only.

As the change of the size of the container may be substantial from the smallest cross-sectional area, where it has its production size, and expanded at the biggest cross-sectional area, a communication of the chamber in the container with a first enclosed space, e.g. in the piston rod may be necessary. In order to keep the pressure in the chamber, the first enclosed space may be pressurized as well, also during the change of the volume of the chamber of the container. Pressure management for at least the first enclosed space may be needed.

Fig. 6A shows a longitudinal cross-section of the chamber 186 with a concave wall 185 and an inflatable piston comprising a container 208 at the first longitudinal position in the chamber 186 and the same 208' at the second longitudinal position in the chamber 186. The central axis 184 of the chamber 186. The container 208' shows its size, when pressurized, which is approximately its production size, having a textile reinforced 189 in the skin 188 of the wall 187. During the stroke starting at the second longitudinal position of the chamber 186, the wall 187 of the container expands until a stop arrangement, which may be the textile reinforcement 189 and/or a mechanical stop 196 outside the container 208 and/or another stop arrangement stops the movement during the stroke. And thus the expansion of the container 208. Depending on the pressure in the chamber 186, there still may occur a longitudinal stretching of the wall of the container, due to pressure in the chamber 186. The first main function however of the textile reinforcement is to limit this longitudinal stretching of the wall 187 of the container 208. It results in a small contact area 198. The second main function of the textile reinforcement 189 is to allow a contraction when the container is moving to the second longitudinal position (and vice versa where an expansion is necessary). During the stroke the pressure inside the container 208,208' may remain constant. This pressure depends on the change in the volume of the container 208,208', thus on the change in the circumpherical length of the cross-sections of the chamber 186 during the stroke. It may also be possible that the pressure changes during the stroke. It may also be possible that the pressure changes during the stroke, depending or not of the pressure in the chamber 186.

Fig. 6B shows a first embodiment of the expanded piston 208 at the first longitudinal position of the chamber 186. The wall 187 of the container is build up by a skin 188 of a flexable material, which may be e.g. a rubber type or the like, with a textile reinforcement 189, which allows expansion and contraction. The direction of the textile reinforcement in relation to the central axis 184 (= braid angle) is different from 54°44'. The change of the size of the piston during the stroke results not necessarily in an identical shape, as drawn. Due to the expansion the thickness of the wall of the container may be smaller than that of the container as produced when positioned at the second longitudinal position) of the chamber 186. An impervious layer 190 inside the wall 187 may be present. It is tightly squeezed in the cap 191 in the top and the cap 192 in the bottom of the container 208,208'. Details of said caps are not shown and all kinds of assembling methods may be used - these may be capable to adapt themselves to the changing thickness of the wall of the container. Both caps 191,192 may be able to translate and/or rotate over the piston rod 195. These movements may be done by various devices as e.g. different types of bearings which are not shown. The cap 191 in the top of the container may move upwards and downwards. The stop 196 on the piston rod 195 outside the container 208 limits the upwards movement of the container 208. The cap 192 in the bottom may only move downwards because the stop 197 prevent a movement upwards - this embodiment may be thought to be used in a piston chamber device which has pressure in chamber 186 beneath the piston. Other arrangements of stops may be possible in other pump types, such as double working pumps, vacuum pumps etc. and depends solely of the design specifications. Other arrangements for enabling and/or limiting the relative movement of the piston to the piston rod may occur. The tuning of the sealing force may comprise a combination of an incompressable fluid 205 and a compressable fluid 206 (both alone are also a possibility) inside the container, while the chamber 209 of the container may communicate with a second chamber 210 comprising a spring-force operated piston 126 inside the piston rod 195. The fluid(s) may freely flow through the wall 207 of the piston rod through the hole 201. It may be possible that the second chamber is communicating with a third chamber (see Fig. **12**), while the pressure inside the container also may be depending on the pressure in the chamber 186. The container may be inflatable through the piston rod 195 and/or by communicating with the chamber 186. O-rings or the like 202, 203 in said cap in the top and in said cap in the bottom, respectively seal the caps 191,192 to the piston rod. The cap 204, shown as a screwed assembly at the end of the piston rod 195 thighthens said piston rod. Comparable stops may be positioned elsewhere on the piston rod, depending on the demanded movement of the wall of the container. The contact area 198 between the wall of the container and the wall of the chamber.

Fig. 6C shows the piston of Fig. 6B at the second longitudinal position of the chamber . The cap 191 in the top is moved over a distance a' from the stop 196. The spring-force operated valve piston 126 has been moved over a distance b'. The bottom cap 192 is shown adjacent to the stop 197 - when there may be pressure in the chamber 186 below the piston, than the chamber 186' may be pressed against the stop 197. The compressable fluid 206' and the non-compressable fluid 205'.

Fig. 6D is a 3-dimensional drawing and shows a reinforcement matrix of textile material, allowing elastically expansion and contraction of the wall of the container 208,208', when sealingly moving in the chamber 186.

The textile material may be elastical, and laying in separate layers over each other. The layers may also lay woven in each other. The angle between the two layers may be different from 54°44'. When the material type and thickness is the same for all layers, and the number of layers even, while the stitch sizes for each direction are equal, the expansion and contraction of the wall of the container may be equal in the XYZ-direction. When expanding the stitch ss and tt, respectively in each of the directions of the matrix will become bigger, while contracting these wil become smaller. As the material of the threads may be elastical, another device may be necessary to stop the expansion, such as a mechanical stop. This may be the wall of the chamber and/or a mechanical stop shown on the piston rod, as shown in Fig. 6B.

Fig. 6E is a 3-dimensional drawing and shows the reinforcement matrix of Fig. 6D which has been expanded. The stitches ss' and tt' which are larger than the stitches ss and tt. The result of the contraction may result in the matrix shown in Fig. 6D.

Fig. 6F is a 3-dimensional drawing and shows a reinforcement matrix of textile material which may be made of inelastic thread (but elastically bendable), and lay in separate layers over each other or knitted in each other. The expansion is possible because of the extra length of each loop 700, which is available, when the container is in the production size - also pressurized, when positioned at the second longitudinal position of the chamber. Stitches ss'' and tt'' in each direction. When the wall of the container is expanding the inelastic material (but elastically bendable) may limit the maximum expansion of the wall 187 of the container 217. It may be necessary to stop the movement of the container 217 over the piston rod 195 by e.g. stop 196, so that sealing may remain. The lack of such a stop 196 may give the possibility of creating a valve.

Fig. 6G is a 3-dimensional drawing and shows the reinforcement matrix of Fig. 6F which has been expanded. The stitches ss''' and tt''' which are larger than the stitches ss'' and tt''. The result of the contraction may result in the matrix shown in Fig. 6F.

Fig. 6H shows three stages I, II and III of a production process of the piston comprising an elastically deformable container. Over a rod 600 is a rubber manchet 601 positioned, over which a reinforced manchet 602 e.g. according to those of Fig. 6E-G is positioned. Over the last mentioned another rubber manchet has been positioned. Between the machet 601 and the rod one or more caps 604 may be positioned. All may slide over the rod 600. The rod 600 may be hollow and may be connected to a high pressure steam source. Stage II: the pressurized steam may enter the cave 608 of the oven 606 by outlets 605 which may be positioned at the end of the rod. A piece of the complete rubber/reinforcement manchets 607 may be cut and transported over the rod 600 into the cave 608. The cave may than be closed and pressurized steam is injected into the cave. Vulcanisation may take place, incl. the mounting of the wall of the container on the caps 604. The manchet may take the form of the curve. After vulcanisation the cave may be opened and the container which has than its production size, is pushed out (III). In order to use the vulcanisation time of a piston to also produce other pistons several methods may be used. Bulging of the (complete: incl. textile reinforcement) rubber manchets 607 may take place before the vulcanisation. The rod 600 may than be updivided in several parts, each approximately the height of a container at its production size. Each may be disconnected from the main rod before entering a cave. And/or, several caves may be present at the end of the production feed line, which may each stand, receive a complete manchet 607 and vulcanize it. This may be achived by the caves rotating and/or translating to and from the end of the production feed line. It may also be possible that a number of vulcanisation caves are integrated in the production feed line.

Fig. 7A shows a longitudinal cross-section of the chamber 186 with a concave wall 185 and an inflatable piston comprising a container 217 at the first longitudinal position of the chamber and the same 217' at the second longitudinal position. The container 217' shows, pressurized, approximately its production size.

Fig. 7B shows the expanded piston 217 at the first longitudinal position of the chamber. The wall 218 of the container is build up by a skin 216 of an elastical material, which may be e.g. a rubber type or the like, with a fiber reinforcement 219 according to the Trellis Effect, which allows expansion of the container wall 218. The direction of the fibers in relation to the central axis 184 (= braid angle) may be different from 54°44'. The contact area 211 between the wall 218 of the container 217 and the wall 185 of the chamber 186. Due to the expansion the thickness of the wall of the container may be smaller, but not necessarily very different than that of the container as produced when positioned at the second longitudinal position. An impervious layer 190 inside the wall 187 may be present. It may be tightly squeezed in the cap 191 in the top and the cap 192 in the bottom of the container 217,217'. Details of said caps are not shown and all kinds of assembling methods may be used - these may be capable to adapt themselves to the changing thickness of the wall of the container. Both caps 191,192 may translate and/or rotate over the piston rod 195. These movements may be done by various methods as e.g. different types of bearings which are not shown. The cap 191 in the top may move upwards and downwards until stop 214 limits this movement. The cap 192 in the bottom can only move downwards because the stop 197 prevent a movement upwards - this embodiment is thought to be used in a piston chamber device which has pressure in chamber 186 beneath the piston. Other arrangements of stops may be possible in other pump types, such as double working pumps, vacuum pumps etc. and depends solely of the design specifications. Other arrangements for enabling and/or limiting the relative movement of the piston to the piston rod may occur.

During the stroke the pressure inside the container 217,217' may remain constant. It may also be possible that the pressure changes during the stroke. The tuning of the sealing force may comprise a combination of an incompressable fluid 205 and a compressable fluid 206 (both alone are also a possibility) inside the container, while the chamber 215 of the container 217,217' may communicate with a second chamber 210 comprising a spring-force operated piston 126 inside the piston rod 195. The fluid(s) may freely flow through the wall 207 of the piston rod through the hole 201. It may be possible that the second chamber is communicating with a third chamber (see Fig. 10), while the pressure inside the container also may be depending on the pressure in the chamber 186. The container may be inflatable through the piston rod 195 and/or by communicating with the chamber 186. O-rings or the like 202, 203 in said cap in the top and in said cap in the bottom, respectively seal the caps 191,192 to the piston rod. The cap 204, shown as a screwed assembly at the end of the piston rod 195 thighthens said piston rod.

Fig. 7C shows the piston of Fig. 7B at the second longitudinal position of the chamber 186. The contact area 211', which is small. The cap 191 is moved over a distance c' from the stop 216. The spring-force operated valve piston 126 has been moved over a distance d'. The bottom cap 192 is shown adjacent to the stop 197 - if there is pressure in the chamber 186, than the 192 is pressed against the stop 197. The compressable fluid 206' and the non-compressable fluid 205' which may have changed volume in the container.

Fig. 8A,B,C deal with the construction of the piston which may be identical with that of Fig. 7A,B,C with the exception that the reinforcement comprises of any kind of reinforcement means which may be bendable, and which may ly in a pattern of reinforcement 'colums' which do not cross each other. This pattern may be one of parallel to the central axis 184 of the chamber 186 or one of where a part of the reinforcement means may be in a plane through the central axis 184.

Fig. 8A shows an inflatable piston comprising a container 228 at the first longitudinal position of the chamber 186 and the same 228' at the second longitudinal position of the chamber 186 - pressurized - where it has unpressurized its production size.

Fig. 8B shows the container 228 at the first longitudinal position of the chamber 186. The wall 221 of the container comprises an elastical material 222,224 and the reinforecement means 223 e.g. a fiber. An impervious layer 226 may be present. The contact area between the container 228 and the wall 185 of the chamber 186.

Fig. 8C shows the container 228' at the second longitudinal position of the chamber 186. The contact area 225' may be a bit larger than that of the contact area 225. The top cap 191 has been moving e' from the stop 214.

Fig. 8D shows a top view of the piston 228 and 228', respectively with the reinfor-cement means 223, and 223'' respectively at the first and second longitudinal position of the chamber 186 respectively.

Fig. 8E shows a top view of a piston alike the one of 228 and 228', respectively with an alternative embodiment of the reinforcement means 229, and 229' respectively at the first and second longitudinal position of the chamber 186 respectively. A part of the reinforcement does not ly in planes through the central axis 184 in the longitudinal direction of the chamber 186. Fig. 8F shows a top view of the piston alike the one of 228 and 228' with a reinforcement 227 and 227' in the wall in the wall of the container in planes not through the central axis 184 of the chamber 186. During the stroke the wall of the container turns around the central axis 184.

Fig. 8G shows schematically how fibers 802 may be mounted in caves 801 of the cap 800. This may be achieved by rotating the cap and the fibers around the central axis 803, each may have its own velocity, while the fibers 802 are being pushed towards and in the caves 801.

Fig. 9A shows a longitudinal cross-section of the chamber 186 with a convex wall 185 and an inflatable piston comprising a container 258 at the beginning and the same 258' at the end of a stroke. The pressurized container 258' at the second longitudinal position.

Fig. 9B shows the longitudinal cross-section of the piston 258 having a reinforced skin by a plurality of at least elastically deformable support members 254 rotatably fastened to a common member 255, connected to the an skin 252 of said piston 258,258'. These members are in tension, and depending on the hardness of the material, they have a certain maximum stretching length. This limited length limits the stretching of the skin 252 of said piston. The common member 255 may slide with sliding means 256 over the piston rod 195. For the rest is the construction comparable with that of the piston 208,208'. The contact area 253.

Fig. 9C shows the longitudinal cross-section of the piston 258'. The contact area 253':

Fig. 10-12 deal with the management of the pressure within the container. Pressure management for the piston comprising an inflatable container with an elastically deformable wall is an important part of the piston-chamber construction. Pressure management has to do with maintaining the pressure in the container, in order to keep the sealing on the appropriate level. This means during each stroke where the volume of the container changes. And in the long term, when leakage from the container may reduce the pressure in the container, which may effect the sealing capability. A flow of fluid may be the solution. To and from the container when it changes volume during a stroke, and/or to the container as such (inflation).

The change in the volume of the container may be balanced with a change in the volume of a first enclosed space, communicating with the container through e.g. a hole in the piston rod. The pressure may at the same time also be balanced, and this may be done by a spring force operated piston which may be positioned in the first enclosed space. The spring force may be originated by a spring or a pressurized enclosed space, e.g. a second enclosed space, which communicates with the first enclosed space by a pair of pistons. Any kind of force transfer may be arranged by each of the pistons, e.g. by a combination of the second enclosed space and a piston herein, so that the force on the piston in the first enclosed space remaines equal, while the force on the piston in the second enclosed space reduces, when the pair of pistons moves towards the first enclosed space e.g. when fluid is moving from the first enclosed space into the container. This complies well with p.V = constant in the second enclosed space.

The tuning of the pressure in the chamber of the container during the entire or a part of the stroke may also be done by a communication of the chamber and the chamber of the container. This has already been described in WO00/65235 and WO00/70227.

The container may be inflated through a valve in the piston and/or the handle of the piston rod. This valve may be a check valve or an inflation valve, e.g. a Schrader valve. The container may be inflated through a valve which communicates with the chamber. If an inflation valve is used, a Schrader valve is preferable because of its security to avoid leakages and its ability to allow to control all kinds of fluids. In order to enable inflation, a valve actuator may be necessary, e.g. the one disclosed in WO99/26002 or in US 5,094,263. The valve actuator of WO99/26002 has the advantage that inflation may be enabled by a very low force - thus very practical in case of manual inflation. Moreover, combined with a valve with a spring-force operated valve core, the valve closes automatically when equal pressure levels has been obtained.

If the flow of pressurized volume from the enclosed space to the container and *vice versa* may be substantial, it may be preferred to have a pressure/volume source with a bigger volume than the volume of the enclosed space and a pressure level which is equal, lower or higher than the pressure in the container. In the last mentioned case the volume of the pressure source may be reduced in comparison with a pressure source with an equal pressure level of that of the container.

In the case that the pressure level in the pressure source is higher of that of the container it may be necessary that during the stroke the flow between the pressure/volume source and the container may be steered by means of valves. These valves may have a springforce operated core pin, which may be is actuated. The actuators may open/close the valves of even contineously change the flow. An example is a analogeous construction used for inflating the container due to pressure drop by leakage (please see the next page). Other valve types and valve steering solutions are possible. This may also be a method of contiously maintaning the pressure level in the container at a predetermined level.

Having a valve communicating with the chamber, it may enable automatic inflation of the container, when the pressure in the container is lower than the pressure in the chamber. When this may not be the case, such higher pressure in the chamber may be created temporarily by closing the outlet valve of the chamber near the second longitudinal position of the container in the chamber. This closing and opening may be done manually, e.g. by a pedal, which opens a channel which communicates with a space between the valve actuator (WO99/26002) and e.g. a Schrader valve. When open, the valve actuator may move, but lacks the force to depress the spring-force operated core pin of the valve and hence the Schrader valve may not open - thus the chamber may be closed, and any high pressure may be build up for enabling inflation of the container. When the channel is closed, the actuator functions as disclosed in WO99/26002. The operator may check the pressure in the container by a pressure gauge, e.g. a manometer. Opening and closing of this outlet valve may also be done automatically. This may be done by all kinds of means, which initiate the closing of the outlet by a signal of any kind as a result of a measurement of pressure being lower than a predetermined value.

The automatic inflation of the container to a certain pre-determined value may be done by a combination of a valve communicating with the chamber and e.g. a release valve of the container. It releases at a certain predetermined value of the pressure, e.g. to the space above the container or to the chamber. Another option may be that the valve actuator of WO99/26002 may be open firstly when a pre-determined value of the pressure has been reached, e.g. by combining it with a spring. Another option may be that the opening to the valve actuator is closed when the pressure reaches a value over the pre-determined one, by e.g. a spring force operated piston or cap. Or, by combining the piston 292 of Fig. 11E with means so that the piston opens the channel 297 when a certain pressure has been reached (not shown).

Fig. 10A shows a piston-chamber system with a piston comprising a container 208,208' and a chamber 186 having a central axis 184 according to Fig. 6A-C. The inflation and pressure management described here may also be used for other pistons comprising a container. The container 208,208' may be inflated through a valve 241 in the handle 240 and/or a valve 242 the piston rod 195. If no handle is used, but e.g. a rotating axle, it could be hollow, communicating with e.g. a Schrader valve. The valve 241 may be an inflation valve, e.g. a Schrader valve, comprising a bushing 244 and a valve core 245. The valve in the piston rod 195 may be a check valve, having a flexable piston 126. The chamber between the check valve 242 and the chamber 209 of the container 208,208' was earlier described as the 'second' chamber 210. The manometer 250 enables control of the pressure inside the container - no further details are shown. It may also be possible to use this manometer to control the pressure in the chamber 186. It may also be possible that the chamber 209 of the container 208,208' has a release-valve (not drawn) which may be adjusted to a certain pre-determined value of the pressure. The released fluid may be directed to the chamber 209 and/or to the space 251.

Fig. 10B shows an alternative option for the inflation valve 241. Instead of the inflation valve 241 in the handle 240, only a bushing 244 without a valve core 245 may be present, which enables connection to a pressure source.

Fig. 10C shows details of the bearing 246 of the rod 247 of the check valve 126. The bearing 246 comprises longitudinal ducts 249 enabling passage of fluid around the rod 247. The spring 248 enables a pressure on the fluid in the second chamber 210. The stop 249.

Fig. 10D shows details of the flexible piston 126 of the check valve 242. The spring 248 keeps the pressure on the piston 126.

Fig. 10E shows the pressure source 701 which may have a pressure which exceeds the pressure level of the container. Inlet valve 702 with e.g. a valve actuator 703 (the configuration 709 shown is analogeous to the one of Fig. 11E (292,297)), and outlet valve 704 with e.g. a valve actuator 705 (the configuration 711 shown is analogeous to the one of Fig. 11E (292,297)). The space 710 is connected to the chamber 707, while the space 712 is connected to the chamber 708. The valves 702 and 704 may be mounted in the piston rod 706, which may be updivided in two chambers 707 and 708.

Fig. 10F shows the construction of Fig. 10E where two black boxes are shown comprising each a valve arrangement which may be steerable by external signals. The steering 715 may receive pressure signal 716 and 717, respectively from the inside of the piston at different longitudinal positions of the chamber. The steering 715 may send signals 718 and 719, respectively to the actuator 722 of the outlet valve arrangement 720 and to the actuator 723 of the inlet valve arrangenment 721. This valve and valve steering arrangement may be analogeously to the one shown in Fig.11F.

Fig. 11A shows a piston-chamber system with a piston comprising a container 248,248' of which the central part is identical with container 208,208' and a chamber 186 having a central axis 184 according to Fig. 6A-C. The inflation and pressure management described here may also be used for other pistons comprising a container. The container 248,248' may be inflated through a valve communicating with the chamber 186. This valve may be a check valve 242 according to Fig. 10A,D or it may be an inflation valve, preferably a Schrader valve 260. The first enclosed space 210 is communicating with the chamber 209 in the container by a hole 201, while the first enclosed space 210 is communicating through a piston arrangement with a second enclosed space 243, which may be inflated through e.g. an inflation valve like a Schrader valve 241 which may positioned in the handle 240. The valve has a core pin 245. If no handle is used, but e.g. a rotating axle, it may be hollow and a Schrader valve may communicate with this channel (not drawn). The Schrader valve 260 has a valve actuator 261 according to WO99/26002. The foot 262 of the chamber 186 may have an outlet valve 263, e.g. a Schrader valve, which may be equipped with another valve actuator 261 according to WO99/26002. In order to manually control the outlet valve 263, the foot 262 may be equipped with a pedal 265 which can turn an angle α around an axle 264 on the foot 262. The pedal 265 is connected to a piston rod 267 by an axle 266 in a non-circular hole 275 in the top of the pedal 265. The foot 262 has an inlet valve 269 (not drawn) for the chamber 186. The (schematically drawn) spring 276 keeps the pedal 265 in its initial position 277, where the outlet valve is kept open. The activated position 277' of the pedal 265 when the outlet valve is kept closed. The outlet channel 268.

Fig. 11B shows a detail of the communication by a pair of pistons 242,270 between the first enclosed space 210 and the second enclosed space 243. The piston rod 271 of the pair of pistons is guided by a bearing 246. The longitudinal ducts 249 in the bearing 246 enable the transport of fluid from the spaces between the bearing 246 and the pistons 242 and 270. The spring 248 may be present. The piston rod 195 of the piston type container 248,248' with internal wall 194. Pistons 242,270 seal on internal wall 194.

Fig. 11C shows an alternative wall 273 of the piston rod 272 of the piston type container 248,248' which has a angle β with the central axis 184 of the chamber 186. The piston 274 is schematically drawn, and can adapt itself to the changing cross-sectional area's of the inside the piston rod 272.

Fig. 11D shows piston 248' on which a housing 280 is build. The housing comprises a Schrader valve 260, with a core pin 245. The valve actuator 261 shown as depressing the core pin 261, while fluid may enter the valve 260 through channels 286, 287, 288 and 289. When the core pin 245 is not depressed, the piston ring 279 may seal the wall 285 of the inner cylinder 283. The inner cylinder 283 may be sealingly enclosed by sealings 281 and 284 between the housing 280 and the cylinder 282. The chamber 186.

Fig. 11E shows the construction of the outlet valve 263 with a core pin 245, which is shown depressed by the valve actuator 261. Fluid may flow through channels 304, 305, 306 and 307 to the openened valve. The inner cylinder 302 is sealingly enclosed between the housing 301 and the cylinder 303 by sealings 281 and 284. A channel 297 having a central axis 296 is positioned through the wall of the inner cylinder 302, the wall of the cylinder 303 and the wall of the housing 301. At the outside of the housing 301 has the opening 308 of channel 297 a widening 309 which enables a piston 292 to seal in a closing position 292' by a top 294. The piston 292 may be moving in another channel 295 which may have the same central axis 296 as channel 297. The bearing 293 for the piston rod 267 of the piston 292. The piston rod 267 may be connected to the pedal 265 (Fig. 11A) or to other actuators (schematically shown in Fig. 11E).

Fig. 11F shows the piston 248' and the inflation arrangement 368 of Fig. 11D, besides the arrangement 369 to control the outlet valve of Fig. 11E. The inflation arrangement 368 comprises now also the arrangement 370 to control the valve of Fig. 11E. This may be done to enabling the closing of the valve, when the predetermined pressure has been reached, and opening it when the pressure is lower than the predetermined value. A signal 360 is handled in a converter 361 which gives a signal 362 to an actuator 363, which is actuating through actuating means 364 the piston 292.

When the chamber has a lower working pressure than the pre-determined value of the pressure in the piston, the arrangement 369 to control the closing and opening of the outlet valve 263 may be controlled by another actuator 363 through means 367 initiated by a signal 365 from the converter 361. A measurement in the chamber, giving a signal 371 to the converter 361 and/or 366 may automatically detect whether or not the actual pressure of the chamber is lower than the working pressure of the piston. This may be specifically practical when the pressure of the piston is lower than the pre-determined pressure.

Fig. 11G shows schematically a cap 312, 312' with a spring 310 connected to the housing 311 of a valve actuator 315. The spring 310 may keep the opening 314 tigthly closed. The contact area 313 of the cap 312 with the cylinder 282 (fig. 11D). When the force on the cap 312 from the chamber becomes bigger, the cap may move to a position where the cap 312' is shown, until there is equivalence of the forces on the cap by the medium/media of the chamber. The spring 310 may determine the maximum value of the pressure to depress the valve core pin 245. A Schrader valve 260.

Fig. 12 shows en enlonged piston rod 320 in which a pair of pistons 321,322 are positioned at the end of a piston rod 323, which may move in a bearing 324.

Fig. 13A,B,C show the combination of a pump with a pressurizing chamber with elastically deformable wall with different areas of the transversal cross sections and a piston with a fixed geometrical shape. Within a housing as e.g. cylinder with fixed geometrical sizes an inflatabel chamber is positioned which is inflatable by a fluid (a non-compressable and/or a compressable fluid). It is also possible that said housing may be avoided. The inflatable wall comprising e.g. a liner-fiber-cover composite or also added an impervious skin. The angle of the sealing surface of the piston is a bit bigger than the comparative angle of the wall of the chamber in relation to an axis parallel to the movement. This difference between said angles and the fact that the momentaneous deformations of the wall by the piston takes place a bit delayed (by having e.g. a viscose non-compressable fluid in the wall of the chamber and/or the right tuning of load regulating means, which may be similar to those which have been shown for the pistons) provides a sealing edge, of which its distance to the central axis of the chamber during the movement between two piston and/or chamber positions may vary. This provides a cross-sectional area change during a stroke, and by that, a designable operation force. The cross-section of the piston in the direction of the movement however may also be equal, or with a negative angle in relation to the angle of the wall of the chamber - in these cases the 'nose' of the piston may be rounded of. In the last mentioned cases it may be more difficult to provide a changing cross-sectional area, and by that, a designable operation force. The wall of the chamber may be equiped with all the already shown loading regulating means the one showed on Fig. 12B, and if necessary with the shape regulating means. The velocity of the piston in the chamber may have an effect on the sealing.

Fig. 13A shows piston 230 at four positions of the piston in a chamber 231.
Around an inflatable wall a housing 234 with fixed geometrical sizes. Within said wall 234 a compressable fluid 232 and a non-compressable fluid 233. There may be a valve arrangement for inflation of the wall (not shown). The shape of the piston at the non-pressurized side is only an example to show the principle of the sealing edge. The distance between the sealing edge at the end and at the beginning of the stroke in the shown transversal cross-section
is approximately 39%. The shape of the longitudinal cross-section may be diferent from the one shown

Fig. 13B shows the piston after the beginning of a stroke. The distance from the sealing edge 235 and the central axis 236 is z_1. The angle ξ between the piston sealing edge 235 and the central axis 236 of the chamber. The angle v between the wall of the chamber and the central axis 236. The angle v is shown smaller than the angle ξ. The sealing edge 235 arranges that the angle v becomes as big as the angle ξ.
Other embodiments of the piston are not shown.

Fig. 13C shows the piston during a stroke. The distance from the sealing edge 235 and the central axis 236 is z_2 - this distance is smaller than z_1.

Fig. 13D shows the piston almost at the end of stroke. The distance from the sealing edge 235 and the central axis 236 is z_3 - this distance is smaller than z_2.

Fig. 14 shows a combination of a wall of the chamber and the piston which have
2-28 changeable geometrical shapes, which adapt to each other during the pump stroke, enabling a continuous sealing. It has its production size at the second longitudinal position of the chamber.

Shown is the chamber of Fig.13A now with only a non-compressable medium 237 and piston 450 at the beginning of a stroke, while the piston 450' is shown just before the end of a stroke. Also all other embodiments of the piston which may change dimensions may be used here too. The right choice of velocity of the piston and the viscosity of the medium 237 may have a positive effect on operations. The longitudinal cross-sectional shape of the chamber shown in Fig. 14 may also be different.

Figs. 15A-F show embodiments of the chamber with cross-sections of different sizes which have constant circumpherential sizes. This is another solution for the jamming problem of the cited pistons of WO 00/70227. The pistons according to claim 1 may also function well in these specific chambers, when the reinforcement of the skin allows parts of the wall of the container having different distances from the central axis of the chamber in a longitudinal cross-section of the chamber may also be used: e.g. the position of the reinforcement of e.g. Fig. 8D approximately paralell with the central axis of the chamber, and when the reinforcement is made of e.g. elastical threads (Figs. 6d,6E), or those shown in Figs. 6F,6G allowing each an individual size. The one showed in Figs. 9A,9B may also function well. Pistons comprising non-elastically deformable containers or elastically deformable containers with a production size approximately the size of the circumpherencial length of the first longitudinal position of the chamber, having a reinforcement which allow contraction with high frictional forces may move in such chambers without jamming, and may jam in chambers where the cross-sections have different circumpherencial sizes. If the braid angle of the reinforcement of a container may become 54°44' the otherwise elastically deformable container becomes non-elastical deformable, that is to say flexible deformable, but it will not jam in these chambers, as it may be bent. If the change of the area of a transversal cross-section of the piston and/or the chamber between two positions in the direction of movement is continuous but still so big that this results in leakages, it is advantageous to minimize the change of the other parameters of the cross-section. This can be illustrated by using e.g. a circular cross-section (fixed shape): the circumference of a circle is πD, while the area of a circle is $\frac{1}{4} \pi D^2$ (D = diameter of the circle). That is to say, a reduction of D will only give a linear reduction of the circumference and a quadratic reduction of the area. It is even possible to also maintain the circumference and only reduce the area. If also the shape is fixed e.g. of a circle there is a certain minimum area. Advanced numeric calculations where the shape is a parameter can be made by using the below mentioned Fourier Series expansions. The transversal cross-section of the pressurizing chamber and/or the piston can have any form, and this can be defined by at least one curve. The curve is closed and can approximately be defined by two unique modular parametrisation Fourier Series expansions, one for each co-ordinate function:

$$f(x)=\frac{c_0}{2}+\sum_{p=1}^{\infty}c_p\cos(px)+\sum_{p=1}^{\infty}d_p\sin(px)$$

where

$$c_p=\frac{2}{\pi}\int_0^{\pi}f(x)\cos(px)\,dx$$

$$d_p=\frac{2}{\pi}\int_0^{\pi}f(x)\sin(px)\,dx$$

$$0\leq x\leq 2\pi,\ x\in$$

$$p\geq 0,\ p\in$$

c_p = *cos-weighted average values of f(x),*
d_p = *sin-weighted average values of f(x),*
p = *representing the order of trigonometrical fineness*

Figs. 15A,15E show examples of said curves by using a set of different parameters in the following formulas. In these examples only two parameters have been used. If more coefficients are used, it is possible to find optimized curves which comply to other important demands as e.g. curved transitions of which the curves have a certain maximum radii and/or e.g. a maximum for the tension in the sealing portion which under given premisses may not exceed a certain maximum. As an example: Fig. 15F shows optimized convex curves and non-convex curves to be used for possible deformations of a bounded domain in a plane under the constraints that the length of the boundary curve is fixed, and its numerical curvature is minimized. By using a starting area, and a starting bourdary-length it is possible to count on a smallest possible curvature for a certain desired target area.

The pistons shown in a longitudinal cross-section of the chamber have been drawn mainly for the case that the boundary curve of the transversal cross-section is circular. That is to say: in the case that the chamber has transversal cross-sections according to e.g. those non-circular of Figures 15A,15E,15F the shape of the longitudinal cross-section of the pistons may be different.

All kinds of closed curves can be described with this formula, e.g. a C-curve (see PCT/DK97/00223, Fig. 1A). One characteristic of these curves is that when a line is drawn from the mathematical pole which lies in the section plane it will intersect the curve at least one time. The curves are symmetrical towards a line in the section plane, and could also have been generated by the single Fourier Series expansion which follow. A piston or chamber will be more easy to produce when the curve of the transversal cross-section is symmetric with reference to a line which lies in the section plane through the mathematical pole. Such regular curves can approximately be defined by a single Fourier Series expansion:

$$f(x) = \frac{c_0}{2} + \sum_{p=1}^{\infty} c_p \cos(px)$$

where

$$c_p = \frac{2}{\pi} \int_0^{\pi} f(x) \cos(px)\, dx$$

$$0 \leq x \leq 2\pi, \; x \in$$

$$p \geq 0, p \in$$

c_p = weighted average values of f(x),
p = representing the order of trigonometrical fineness.

When a line is drawn from the mathematical pole it will always intersect the curve only one time. Specific formed sectors of the cross-section of the chamber and/or the piston can approximately be defined by the following formula:

$$f(x) = \frac{c_0}{2} + \sum_{p=1}^{\infty} c_p \cos(3px)$$

where

$$f(x) = r_0 + a \cdot \sqrt[2m]{\sin^2\left(\frac{n}{2}\right)x}$$

$$c_p = \frac{6}{\pi} \int_0^{\frac{\pi}{3}} f(x) \cos(3px)\, dx$$

$$0 \leq x \leq 2\pi, x \in$$

$$p \geq 0, p \in$$

c_p = *weighted average values of f(x),*
p = *representing the order of trigonometrical fineness*

and where this cross-section in polar co-ordinates approximately is represented by the following formula:

$$r = r_0 + a. \sqrt[m]{\left| \sin\left(\frac{n}{2}\varphi\right) \right|}$$

where

$r_0 \geq 0$,
$a \geq 0$,
$m \geq 0$, $m \in$,
$n \geq 0$, $n \in$,
$0 \leq \quad \leq 2\pi$,

and where

r	=	*the limit of the "petals" in the circular cross section of the activating pin,*
r_0	=	*the radius of the circular cross section around the axis of the activating pin,*
a	=	*the scale factor for the length of the "petals",*
r_{max}	=	$r_0 + a$
m	=	*the parameter for definition of the "petal" width*
n	=	*the parameter for definition of the number of "petals"*
	=	*the angle which bounds the curve.*

The inlet is positioned close to the end of the stroke due to the nature of the sealing portion of the piston means.

These specific chambers may be produced by injection moulding, and e.g. also by the use of so-called superplastic forming methods, where aluminium sheets are heated and pressed by air pressure either forced in a tool cavity or formed using also tool movement.

Fig. 15A shows a series of transversal cross-sections of a chamber where the area decreases in certain steps, while the circumference remains constant - these are defined by two unique modular parametrisation Fourier Series expansions, one for each co-ordinate function. At the top left is the cross-section which is the start cross-section of said series. The set of parameters used is shown at the bottom of the figure. This series show decreasing area's of the transversal cross-section. The numbers in bold in the figures show the decreasing cross-sectional area's of the different shapes, with the one in the corner left up as the starting area size.

The area of the shape of the cross-section bottom, right is approximately 28% of the one of the top, left.

Fig. 15B shows a longitudinal cross-section of the chamber 162, of which the transversal cross-sectional area changes by remaining circumference along the central axis. The piston 163. The chamber has portions of different cross-sectional area's of its transversal cross-section of wall sections 155,156,157,158. The transitions 159,160,161 between said wall sections. Shown are cross-sections G-G, H-H and I-I. Cross-section G-G has a circelround cross-section, while cross-section H-H 152 has approximately an area between 90-70% of the one of cross-section G-G.

Fig. 15C shows transversal cross-section H-H 152 of Fig. 15B and in dotted lines as a comparison cross-section G-G 150. Cross-section H-H has approximately an area between 90-70% of that of cross-section G-G. The transition 151, which is made smooth. Also shown is the smallest part of the chamber, which has approximately 50% of the cross-sectional area of cross-section G-G.

Fig. 15D shows a transversal cross-section I-I of Fig. 15B and in dotted lines as a comparison cross-section G-G. The cross-section I-I has approximately an area of 70% of that of cross-section G-G. The transition 153 is made smooth. Also shown is the smallest part of the chamber.

Fig. 15E shows a series of transversal cross-sections of a chamber where the area decreases in certain steps, while the circumference remains constant - these are defined by two unique modular parametrisation Fourier Series expansions, one for each co-ordinate function. At the top left is the cross-section which is the start cross-section of said series. The set of parameters used is shown at the bottom of the figure. This series show decreasing area's of the transversal cross-section, but it is also possible to increase these areas by remaining the circumference constant. The numbers in bold in the figures show the decreasing cross-sectional area's of the different shapes, with the one in the corner left up as the starting area size. The size of the cross-sectional area bottom right is approximately 49% of the starting area size left, top.

Fig. 15F shows a convex curve optimized for a certain fixed length of the boundary curve, and a smallest possible curvature. The general formula for the smallest radius of curvature, corresponding to the largest curvature of the figure shown in Fig. 7L is:

$$r = \frac{1}{2}\pi(L - \sqrt{L^2 - (4\pi A_l)}$$

The length specified by y is determined by:

$$y = \frac{1}{2}\sqrt{L^2 - 4\pi A_1}$$

where

r	=	*smallest radius of curvature*
L	=	*boundary-length = constant*
A_1	=	*decreased value of the starting domain area A_0*

As an example: Domain area $A_0 = \pi(30)^2$ and boundary length $L = 60\pi = 188.5$ corresponding to the area and boundary length of a disk of radius 30. The length is required to be constant, but the area is decreased to the value A_1 to be specified. The desired final configuration should have the area $A_1 = \pi (19/2)^2 = 283.5$. The convex curve with the smallest possible curvature of the boundary curve is now:

$r = 1.54$

$\kappa = 1/r = 0.65$

$x = 89.4$

The curve on the Figure is not on scale and the Figure shows only the principle.
The curve may further be optimized by exchanging the straight lines by curves which may improve the sealing of the piston to the wall.

Fig. 16 shows a combination where the piston comprising an elastically deformable container 372 which is moving in a chamber 375 within a cylinder wall 374 and a taper wall 373 e.g. shown her in the centre around the central axis 370. The piston is hanged up in at least one piston rod 371. The container 372,372' is shown at the second longitudinal position of said chamber (372') and at the first longitudinal position (372).

All solutions disclosed in this document may also be combined with piston types for which the chambers having cross-sections with constant circumpherential sizes may be the solution for the problem of jamming.

Fig. 17A shows a convex chamber 400 witin a wall 401. "s" means stroke.

Fig. 17B shows the Force-Stroke diagram in the direction shown in Fig. 17A. This curve shows the optimized change of the force when an operator is pumping in strokes where the intake of fluid lies approximately at the first longitudinal position of the chamber and the outlet is approx. at the second longitudinal position of the chamber. The curve tangents the maximum operating force approximately at the end of the pumping stroke.

Fig. 18A shows an example of a Movable Power Unit 500, shown movable by parachute 501, and by wheels 502.

Fig. 18B shows the Movable Power Unit 500, with a power unit comprising a set of solar cells 503 on top and a motor 504. Moreover a water pump 505, and a compressor 506. The steering unit 507.

CLAIMS

1. A piston-chamber combination comprising an elongate chamber (162,186,231,375,400) which is bounded by an inner chamber wall (156,185,238,373), 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 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 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 area and circumferential length at said first longitudinal position,

said piston comprising a container (208,208',217,217',228,228',258,258', 372,372',450,450') which is elastically deformable thereby providing for different cross-sectional areas and circumferential lengths of the piston adapting the same to said different cross-sectional areas and different circumferential lengths of the chamber during the relative movements of the piston between the first and second longitudinal positions through said intermediate longitudinal positions of the chamber,

wherein

the piston is produced to have a production-size of the container (208,208',217,217',228,228',258,258',372,372',450,450') in the stress-free and undeformed state thereof in which the circumferential length of the piston is approximately equivalent to the circumferential length of said chamber (162,186,231,375,400) at said second longitudinal position, the container being expandable from its production size in a direction transversally with respect to the longitudinal direction of the chamber thereby providing for an expansion of the piston from the production size thereof during the relative movements of the piston from said second longitudinal position to said first longitudinal position.

2. A combination according to claim 1, **wherein** the container (208,208',217, 217',228,228',258,258',372,372',450, 450') is inflatable and said container being elastically deformable and being inflatable to provide for different cross-sectional areas and circumferential lengths of the piston.

3. A combination according to claim 1 or 2, **wherein** the cross-sectional area of said

chamber at the second longitudinal position thereof is between 98 % and 5 % of the cross-sectional area of said chamber at the first longitudinal position thereof.

4. A combination according to claim 1 or 2, **wherein** the cross-sectional area of said chamber at the second longitudinal position thereof is 95 - 15 % of the cross-sectional area of said chamber at the first longitudinal position thereof.

5. A combination according to claim 1 or 2, **wherein** the cross-sectional area of said chamber at the second longitudinal position thereof is approximately 50% of the cross-sectional area of said chamber at the first longitudinal position thereof.

6. A combination according to any of claims 1 to 5, **wherein** the container (208, 208',217,217',228,228',258,258',372,372',450,450') contains a deformable material (205,206).

7. A combination according to claim 6, **wherein** the deformable material (205,206) is a fluid or a mixture of fluids, such as water, steam and/or gas, or a foam.

8. A combination according to any of claims 1 to 6, **wherein** the deformable material comprises spring-force operated devices, such as springs.

9. A combination according to claim 6 or 7, **wherein**, in a cross-section through the longitudinal direction, the container, when being positioned at the first longitudinal position of the chamber (162,186,231,375,400), has a first shape which is different from a second shape of the container when being positioned at the second longitudinal position of said chamber.

10. A combination according to claim 9, **wherein** at least part of the deformable material (206) is compressible and wherein the first shape has an area being larger than an area of the second shape.

11. A combination according to claim 9, **wherein** the deformable material (206) is at least substantially incompressible.

12. A combination according to claim 6 or 7, **wherein** the container is inflatable, to a certain pre-determined pressure value.

13. A combination according to claim 12, wherein the pressure remains constant during the stroke.

14. A combination according to any of claims 6 to 13, wherein the container~~piston~~ (208, 208',217,217',228,228',258,258',372,372',450,450') comprises an enclosed space (210,243) communicating with the deformable container, the enclosed space (210,243) having a variable volume.

15. A combination according to claim 14, **wherein** the volume is adjustable.

16. A combination according to claim 14, **wherein** the first enclosed space (210) comprises a spring-biased pressure tuning piston (126).

17. A combination according to any of claims 14 to 16, further comprising means (126,195,246,248,249,273,274) for defining the volume of the first enclosed space (210) so that the pressure of fluid in the first enclosed space (210) relates to the pressure in the second enclosed space (243).

18. A combination according to claim 17, **wherein** the defining means (126,194,195,246, 248,249,273,274) are adapted to define the pressure in the first enclosed space (210) during the stroke.

19. A combination according to claim 17 **wherein** the defining means (126,195, 246,248,249,273,274) are adapted to define the pressure in the first enclosed space (210) at least substantially constant during the stroke.

20. A combination according to claim 16, **wherein** the spring-biased pressure tuning piston (126) is a check valve (242) through which fluid of an external pressure source can flow into the first enclosed space (210).

21. A combination according to claim 20, **wherein** the fluid from an external pressure source can enter the second enclosed space (243) through an inflation valve, preferably a valve with a core pin (245) biased by a spring, such as a Schrader valve (241) from an external pressure source.

22. A combination according to claim 1, **wherein** the piston (248) is communicating with at least one valve (260).

23. A combination according to claim 22, **wherein** the piston comprises a pressure source.

24. A combination according to claim 22, **wherein** the valve is an inflation valve, preferably a valve with a core pin (245) biased by a spring, such as a Schrader valve (260).

25. A combination according to claim 22, **wherein** the valve is a check valve.

26. A combination according to claim 1, **wherein** the foot (262) of the chamber (162,186,231) is connected to at least one valve (263,269).

27. A combination according to claim 26, **wherein** the outlet valve is inflation valve preferably a valve with a core pin (245) biased by a spring, such as a Schrader valve (263), said core pin is moving towards the chamber (162,186,231) when closing the valve.

28. A combination according to claim 24 or 26, **wherein** the core pin (245) of the valve (260,263) is connected to an actuator which opens or close the valve.

29. A combination according to claim 28, **wherein** the actuator is a valve actuator for operating with valves having a spring-force operated valve core pin, comprising
- a housing to be connected to a pressure medium source;
- within the housing
  - a coupling section for receiving the valve to be actuated,
  - a cylinder surrounded by a cylinder wall of a predetermined cylinder wall diameter and having a first cylinder end and a second cylinder end which is farther away from the coupling section than

the first cylinder end,

- a piston which is movably located in the cylinder and fixedly coupled to an activating pin for engaging with the spring-force operated valve core pin of the valve received in the coupling section, and

- a conducting channel,

for conducting pressure media from the cylinder to the coupling section when the piston is moved into a first piston position in which the piston is at a first predetermined distance from the first cylinder end, the conduction of the pressure media between the cylinder and the coupling section being inhibited when the piston is moved into a second piston position in which the piston is at a second predermined distance from the first cylinder end which second distance being larger than said first distance, wherein

- the conducting channel is arranged in the cylinder wall and opens into the cylinder at a cylinder wall portion having the predetermined cylinder wall diameter, and

- the piston comprises a piston ring with a sealing edge which sealingly fits with said cylinder wall portion thereby inhibiting the conduction of the pressure medium into the channel in the second position of the piston and opening the channel in the first position of the piston.

30. A combination according to claim 28, **wherein** the actuator is a valve actuator for operating with valves having a spring-force operated valve core pin, comprising

- a housing to be connected to a pressure medium source;

- within the housing

- a coupling section for receiving the valve to be actuated,

- a cylinder circumferentially surrounded by a cylinder wall of a predetermined cylinder wall diameter and having a first cylinder end and a second cylinder end which is farther away from the coupling section than said first cylinder end and is connected to the housing for receiving pressure medium from said pressure source,

- a piston which is movably located in the cylinder and fixedly coupled to an activating pin for engaging with the spring-force operated valve core pin of the valve received in the coupling section, and

- a conducting channel between said second cylinder end and said coupling section for conducting pressure medium from said second cylinder end to the coupling section when the piston is moved into a first piston position in which the piston is at a first predetermined distance from said first cylinder end, said conduction of pressure medium between said second cylinder end and the coupling section being inhibited when the piston is moved into a second piston position in which the piston is at a second predetermined distance from said first cylinder end which second distance being larger than said first distance,

- the conducting channel is arranged in said cylinder wall and has a channel portion which opens into the cylinder at a cylinder wall portion having said predetermined cylinder wall diameter, and

- the piston comprises a piston ring with a sealing edge which sealingly fits with said cylinder wall portion, said sealing edge of the piston ring being located between said channel portion and said second cylinder end in said second piston position, thereby inhibiting said conduction of the pressure medium from said second cylinder end into the channel in said second piston position, and being located between said channel portion and said first cylinder end in said first piston position, thereby opening the channel to said second cylinder end in said first piston position.

31. A combination according to claim 28, **wherein** the activator is an actuator valve for a container type piston pressure management system that selectively feeds pressurized air to the interior of a container type piston, said valve comprising, a valve body with a cylindrical central passage opening both to said pressurized fluid and to the interior of said container type piston,

- a spring loaded check valve tightly received in said central passage that blocks said central passage when closed and allows flow of fluid through when opened,

- a spring loaded piston slidably received within said passage above said check valve that slides from an off-position toward said check valve to an on-position when said pressurized fluid is supplied and off again when said pressurized fluid is removed, said piston engaging the surface of said central passage with sufficient clearance to allow unrestricted sliding, but not closely enough to prevent the leakage of pressurized fluid between said piston and central passage surface, a stem carried by said piston and engageable with said check valve to open it and allow the passage of pressurized fluid to said check valve and to said container type piston interior as said piston moves to the on-position,

- a stationary plug in said central passage between said check valve and piston through which said stem extends that is normally axially spaced from said piston but abuts said piston in its on-position, said plug having a vent path running from atmosphere into the space between said plug and piston at a vent point radially near said stem so that pressurized fluid leaking past said piston as it moves will not compress between said plug and piston to retard its motion, and,

- a circular compression seal surrounding said vent point that is compressed between said piston and plug when they are abutted so that pressurized air leaking past said piston can not vent to atmosphere when said check valve is open.

32. A combination according to claim 28, **wherein** the activator is an actuator valve for a container type piston pressure management system that selectively feeds pressurized fluid to the interior of said container type piston, said valve comprising, a valve body with a cylindrical central passage opening both to said pressurized fluid and to the interior of said container type piston,

- a spring loaded check valve tightly received in said central passage that blocks said central passage when closed and allows flow of fluid through when opened,

- a spring loaded piston slidably received within said passage above said check valve that slides from an off-position toward said check valve to an on-position when said pressurized fluid is supplied and off again when said pressurized fluid is removed, said piston engaging the surface of said central passage with sufficient clearance to allow unrestricted sliding, but not closely enough to prevent the leakage of pressurized fluid between said piston and central passage surface,

- a stem carried by said piston and engageable with said check valve to open it and allow the passage of pressurized fluid to said check valve and to said container type piston interior as said piston moves to the on-position,

- an outer annular disk and an inner annular disk abutted in said central passage to form a plug between said check valve and piston through which said stem extends, said piston being normally axially spaced from said outer disk but abutted therewith in its on-position, said outer disk having a series of holes radially close to said stem opening to a series of notches in said inner disk to create a vent path running from the atmosphere into the space between said plug and piston so that pressurized fluid leaking past said piston as it moves will not compress between said plug and piston to retard its motion, and,

- a circular compression seal surrounding said holes that is compressed between said piston and plug when they are abutted so that pressurized fluid leaking past said piston cannot vent to the atmosphere when said check valve is open.

33. A combination according to claim 28, **wherein** an activating pin for connecting to inflation valves, comprising

- a housing to be connected to a pressure source,
- within the housing
- a connection hole having a central axis and an inner diameter approximately corresponding to the outer diameter of the inflation valve to which the activating pin is to be connected, and
- a cylinder and means for conducting liquid media between the cylinder and the pressure source, and where the activating pin
- is arranged to engage a central spring-force operated core pin of the inflation valve,
- is arranged to be situated within the housing in continuation of the coupling hole coaxially with the central axis thereof, and
- comprises a piston part with a piston, which piston is to be positioned in the cylinder movable between a first piston position and a second piston position,
- the activating pin comprising a channel,
- said piston part comprises a first end and a second end, wherein the piston is located at said first end and said channel has an opening at said first end,
- a valve part being movable in the channel, drivable by difference in forces acting on surfaces of the valve part, between a first valve position and a second valve position, wherein said first valve position leaves said opening open, and said second valve position closes said opening, and
- the top of the piston part forming a valve seat for a seal face of the valve the valve means.

34. A combination according to claim 28, **wherein** the valve actuator is an activating pin for connecting to inflation valves, comprising

- a housing,
- within the housing a coupling hole for coupling with an inflation valve, the coupling hole having a central axis and an outer opening,
- positioning means for positioning the inflation valve when coupled in the coupling hole, and
- an activating pin, which is arranged coaxially with the coupling hole, for depressing a central spring-force operated core pin of the inflation valve,
- a cylinder having a cylinder wall provided with a pressure port which is connected to a pressure source, wherein
- the activating pin is shiftable between a proximal pin position and a distal pin position

relative to the positioning means so as to depress the core pin of the inflation valve in its distal pin position and disengage the core pin of the inflation valve in its proximal pin position when the inflation valve is positioned by the positioning means,

- the activating pin is coupled with a piston and the piston is slidingly arranged in the cylinder and is movable between a proximal piston position, which corresponds to the proximal pin position, and a distal piston position, which corresponds to the distal pin position,

- the piston is disposed in the cylinder between the pressure port and the coupling hole and is drivable from its proximal piston position to its distal piston position by the pressure supplied into the cylinder from the pressure source, and

- that flow regulating means are provided for selectively interrupting or freeing a flow path between the pressure source and the coupling hole depending on the piston positions and are adapted such that the flow path is interrupted in the proximal piston position and the flow path is freed in the distal piston position at least when the inflation valve is positioned by the positioning means.

35. A combination according to claim 22, **wherein** the piston comprising means to obtain a pre-determined pressure level.

36. A combination according to claim 22 or 35, **wherein** the valve is a release valve.

37. A combination according to claim 35, **wherein** a spring-force operated cap (312,312') which closes the channel (286) above the valve actuator (315) when the pressure comes above a certain pre-determined pressure value.

38. A combination according to claim 35 **wherein**

- a channel can be opened or closed, the channel connects the chamber (186) and the space (305,306,307) between the valve actuator (261) and the core pin (245),

- a piston (292) is movable between an opening position (294) and a closing position (295) of said channel, and

- the movement of the piston (292) is controlled by an actuator (363) which is steered as a result of a measurement of the pressure in the piston (208,208',217,217',228,228',238,238', 450,450').

39. A combination according to claim 27, **wherein** a channel (297) can be opened or closed, which connects the chamber (186) and the space (305,306,307) between the valve actuator (261) and the core pin (245).

40. A combination according to claim 27 or 39, **wherein** a piston (292) is movable between an opening position (294) and a closing position (295) of said channel.

41. A combination according to claim 40, **wherein** the piston (292) is operated by a operator controlled pedal (265), which is turning around an axle (264) from a inactive position (277) to an activated position (277') and vice versa.

42. A combination according to claim 40, **wherein** the piston (292) is controlled by an actuator (366) which is steered as a result of a measurement of the pressure in the piston (208,208',217,217',228,228',238,238',450,450').

43. A combination according to any of claims 14 to 16, further comprising means (321,322,323,324) for defining the volume of the enclosed space (325) so that the pressure of fluid in the enclosed space (210) relates to the pressure acting on the piston (208,208') during the stroke.

44. A combination according to any of claims 7 to 19, wherein the foam or fluid is adapted to provide, within the container, a pressure higher than the highest pressure of the surrounding atmosphere during translation of the piston (148,149) from the second longitudinal position of the chamber (216) to the first longitudinal position thereof or vice versa.

45. A combination according to claim 2, **wherein** the combination comprises a pressure source (701).

46. A combination according to claim 45, **wherein** pressure source (701) has a higher pressure level than the pressure level of the container (208,208',217,217',228,228', 238,238',450,450').

47. A combination according to claim 45, **wherein** pressure source (701) is communicating with the container (208,208',217,217',228,228', 238,238',450,450') by an outlet valve (704) and an inlet valve (702).

48. A combination according to claim 47, **wherein** the outlet valve (704) is inflation valve preferably a valve with a core pin biased by a spring, such as a Schrader valve, said core pin is moving towards the pressure source (701) when closing the valve.

49. A combination according to claim 47, **wherein** the inlet valve (702) is inflation valve preferably a valve with a core pin biased by a spring, such as a Schrader valve, said core pin is moving towards the container (208,208',217,217',228,228', 238,238',450,450') when closing the valve.

50. A combination according to claim 48, **wherein** a channel (297) can be opened or closed, which connects the chamber (708) and the space (305,306,307) between the valve actuator (261) and the core pin (245).

51. A combination according to claim 49, **wherein** a channel (297) can be opened or closed, which connects the chamber (707) and the space (305,306,307) between the valve actuator (261) and the core pin (245).

52. A combination according to claim 50 or 51, **wherein** a piston (292) is movable between an opening position (292') and a closing position (292) of said channel.

53. A combination according to claim 48 **wherein**

- a channel (297) can be opened or closed, the channel connects via the space (712) the chamber (708) and the space (305,306,307) between the valve actuator (261) and the core pin (245),
- a piston (292) is movable between an opening position (292) and a closing position (292') of said channel, and
- the movement of the piston (292) is controlled by an actuator (722) which is steered as a result of the measurement of the pressure level in the piston (208,208',217,217',228,228', 238,238', 450,450') and that of the pressure source (701).

54. A combination according to claim 49 **wherein**
- a channel (297) can be opened or closed, the channel connects via the space (710) the chamber (707) and the space (305,306,307) between the valve actuator (261) and the core pin (245),
- a piston (292) is movable between an opening position (292) and a closing position (292') of said channel, and
- the movement of the piston (292) is controlled by an actuator (723) which is steered as a result of the measurement of the pressure level of the pressure in the piston (208,208'208', 217,217',228,228',238,238',450,450') and that of the pressure source (701).

55. A combination according to any of claims 6 to 19, **wherein** the wall of the container comprises an elastically deformable material comprising reinforcement means,

56. A combination according to claim 55, **wherein** the reinforcement windings having a braid angle which is different from 54°44'.

57. A combination according to claim 55 or 56, **wherein** the reinforcement means comprise a textile reinforcement, which enable expansion of the container when moving to a first longitudinal position, and enable contraction when moving to a second longitudinal position.

58. A combination according to claim 57, **wherein** the piston may be produced by a production system with multiple vulcanisation caves.

59. A combination according to claim 55 or 56, **wherein** the reinforcement means comprise fibres, which enable expansion of the container when moving to bigger a first longitudinal position, and enable contraction when moving to a second longitudinal position.

60. A combination according to claim 59, **wherein** the piston may be produced by a production system with multiple vulcanisation caves 801 and where the fibers 802 are being mounted in the caves 801 of the caps 800 by rotation of the fibers 802 and the cabs 800 at different speeds, while the fibers 802 are being pushed onto the inside of the caps 800.

61. A combination according to claim 59, wherein the fibers are arrangend as to the Trellis Effect.

62. A combination according to claim 55, wherein the reinforcement means comprises a flexable material positioned in the container, comprising a plurality of at least substantially elastic support members rotatably fastened to a common member, the common members connected to the skin of the container.

63. A combination according to claim 62, **wherein** said members and/or the common member are inflatable.

64. A combination according to claim 1 or 2, wherein the pressure on the wall of the container is build up by spring-force operated devices.

65. A combination according to claim 1 or 2, **wherein** the piston comprises a reinforcement which is positioned outside the container.

66. A combination according to claim 1 or 2, **wherein** the chamber 375 is bounded by a cylinder wall 374 and a tapered wall 373

67. A combination according to claim 1 or 2, wherein the chamber is convex and the operating force tangents a set maximum force during the stroke.

68. A combination according to any of the preceeding claims òr a combination of a piston comprising a container which has a wall which is bendable, òr a combination of a piston comprising a container with a production size approximately the size of the circumpherencial length of the first longitudinal position of the chamber, having a reinforcement which allow contraction with high frictional forces, **wherein** the cross-sections of the different cross-sectional areas have different cross-sectional shapes, the change in cross-sectional shape of the chamber (162) being at least substantially continuous between the first and second longitudinal positions of the chamber (162), wherein the piston (163) is further designed to adapt itself and the sealing means to the different cross-sectional shapes.

69. A combination according to claim 68, wherein the cross-sectional shape of the chamber (162) at the first longitudinal position thereof is at least substantially circular and wherein the cross-sectional shape of the chamber (162) at the second longitudinal position thereof is elongate, such as oval, having a first dimension being at least 2, such as at least 3, preferably at least 4 times a dimension at an angle to the first dimension.

70. A combination according to claim 68 or 69, wherein the cross-sectional shape of the chamber (162) at the first longitudinal position thereof is at least substantially circular and wherein the cross-sectional shape of the chamber (162) at the second longitudinal position thereof comprises two or more at least substantially elongate, such as lobe-shaped, parts.

71. A combination according to any of claims 68 to 69, wherein a first circumferential length of the cross-sectional shape of the cylinder (162) at the first longitudinal position thereof amounts to 80-120%, such as 85-115%, preferably 90-110, such as 95-105, preferably 98-102%, of a second circumferential length of the cross-sectional shape of the chamber (162) at the second longitudinal position thereof.

72. A combination according to claim 70, wherein the first and second circumferential lengths are at least substantially identical.

73. A piston-chamber combination comprising an elongate chamber (231) bounded by an inner chamber wall and comprising a piston in the chamber to be sealingly movable in the chamber,

- the piston (230) being movable in the chamber (231) at least from a second second longitudinal position thereof to a first longitudinal position thereof,
- the chamber (231) comprising an elastically deformable inner wall (238) along at least part of the length of the chamber wall between the first and second longitudinal positions,
- the chamber (231) having, at the first longitudinal position thereof when the piston (230) is positioned at that position, a first cross-sectional area, which is larger than a second cross-sectional area at the second longitudinal position of the chamber (231) when the piston (230) is positioned at that position, the change in cross-sections of the chamber (231) being at least substantially continuous between the first and second longitudinal positions when the piston (230) is moved between the first and second longitudinal positions
- the piston including an elastically expandable container having changeable geometrical shapes which adapt to each other during the piston stroke thereby enabling a continuous sealing, and the piston having its production size when positioned at the second longitudinal position of the chamber.

74. A combination according to claim 73, wherein the piston (230) is made of an at least substantially incompressible material.

75. A combination according to claim 73 or 74, wherein the piston (230) has, in a cross section along the longitudinal axis, a shape tapering in a direction from the first longitudinal position of the chamber (231) to the second longitudinal position thereof.

76. A combination according to claim 75, wherein the angle (î) between the wall (238) and the central axis (236) of the cylinder (231) is at least smaller than the angle (õ) between the wall of the taper of the piston (230) and the central axis (236) of the chamber (231).

77. A combination according to any of claims 73 to 76, wherein the chamber (231) comprises:

- an outer supporting structure (234) enclosing the inner wall (238) and
- a fluid (232,233) held by a space defined by the outer supporting structure (234) and the inner wall (238).

78. A combination according to claim 77, wherein the space defined by the outer structure (234) and the inner wall (238) is inflatable.

79. A combination according to claim 73, wherein the piston (450') comprises an elastically deformable container comprising a deformable material and designed according to claims 1-16.

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

- a combination according to any of the preceeding 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
- a fluid exit connected to the chamber.

81. A pump according to claim 80, 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.

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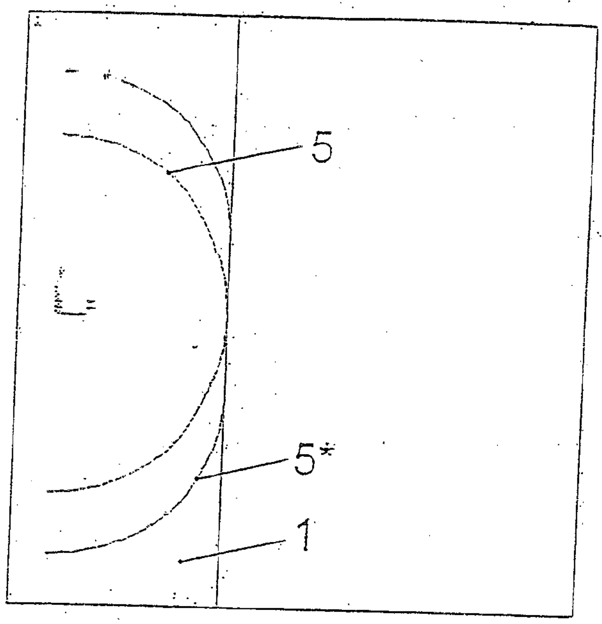

Fig. 1A

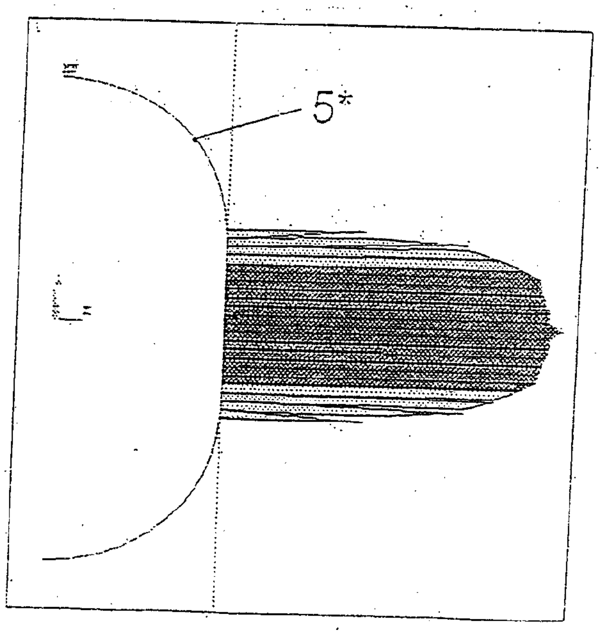

Fig. 1B

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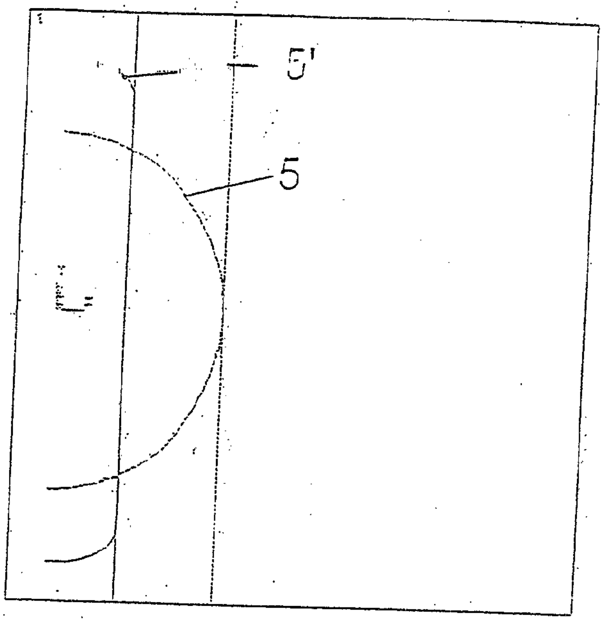

Fig. 2A

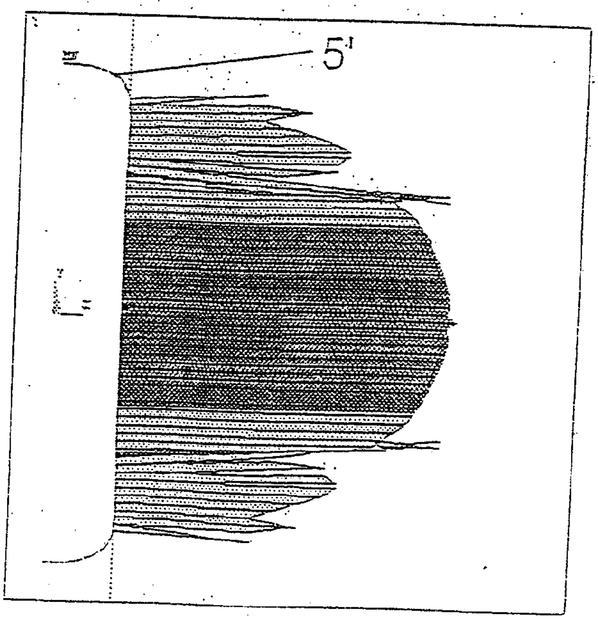

Fig. 2B

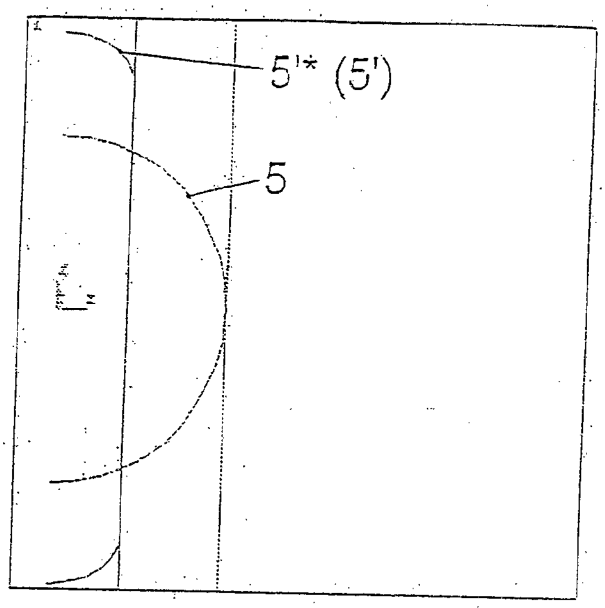

Fig. 2C

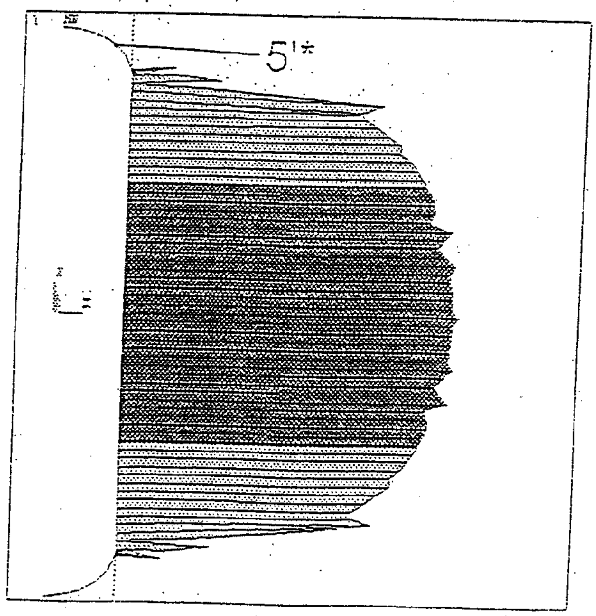

Fig. 2D

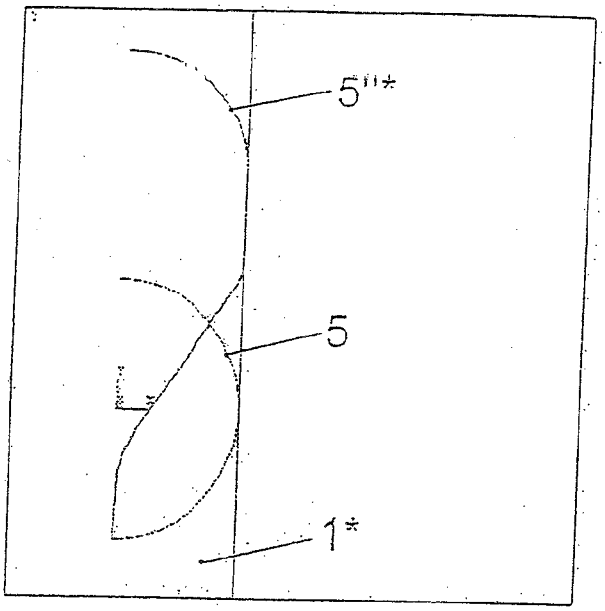

Fig. 3A

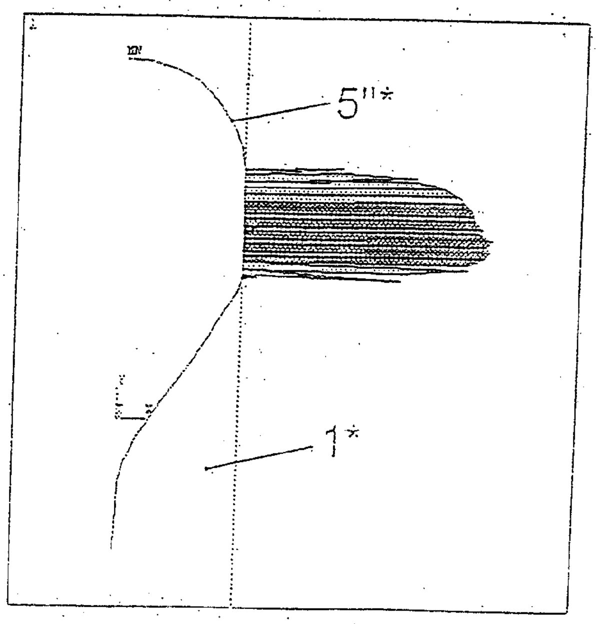

Fig. 3B

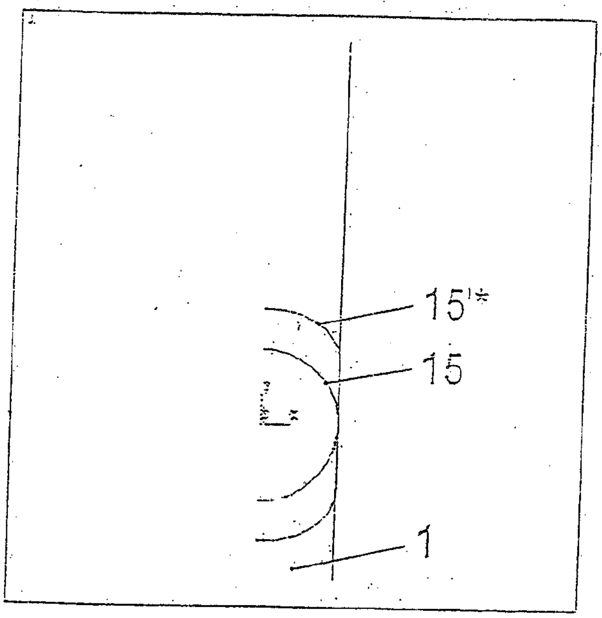

Fig. 4A

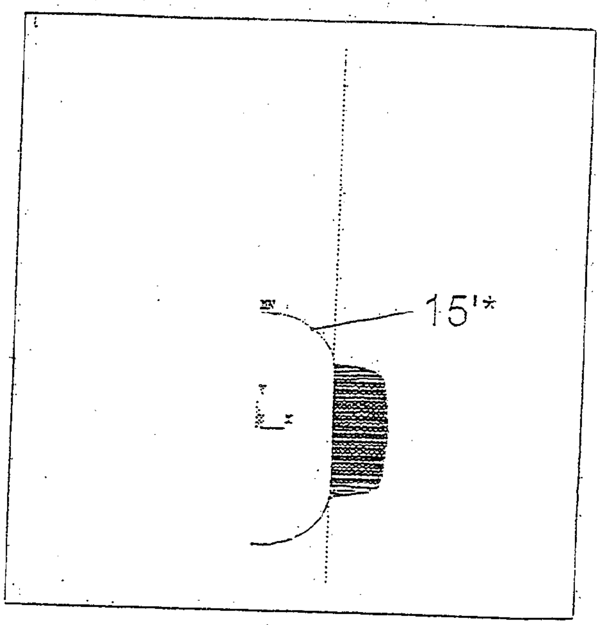

Fig. 4B

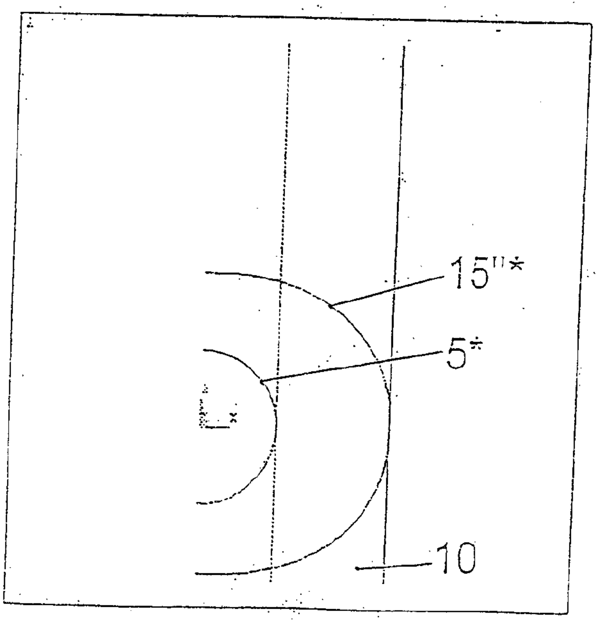

Fig. 4C

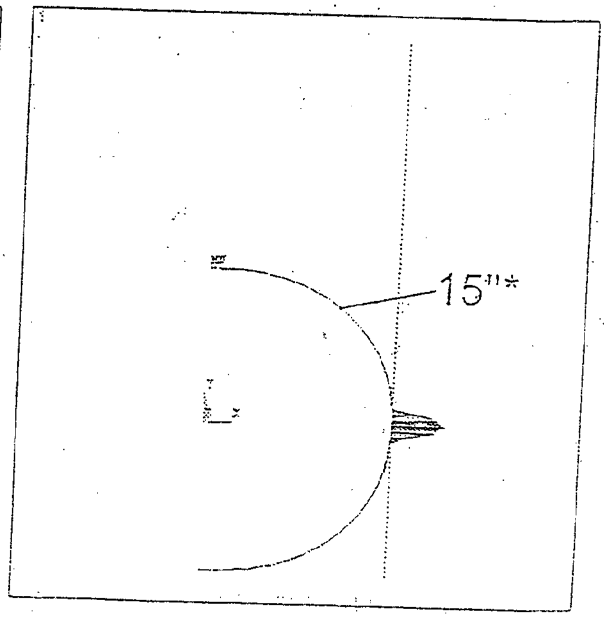

Fig. 4D

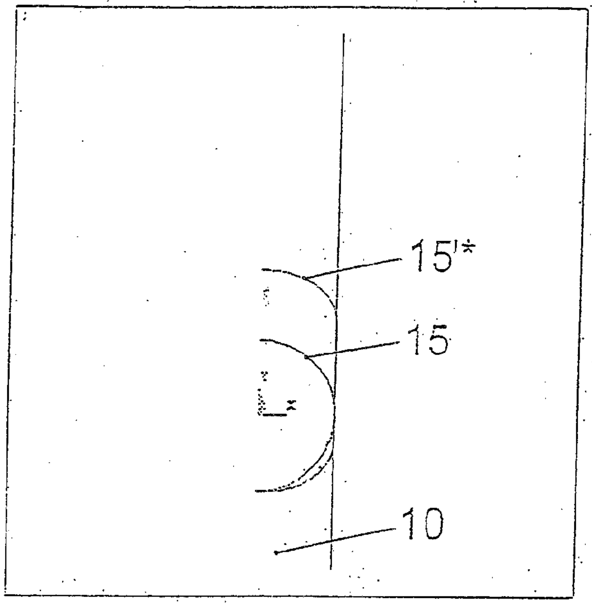

Fig. 5A

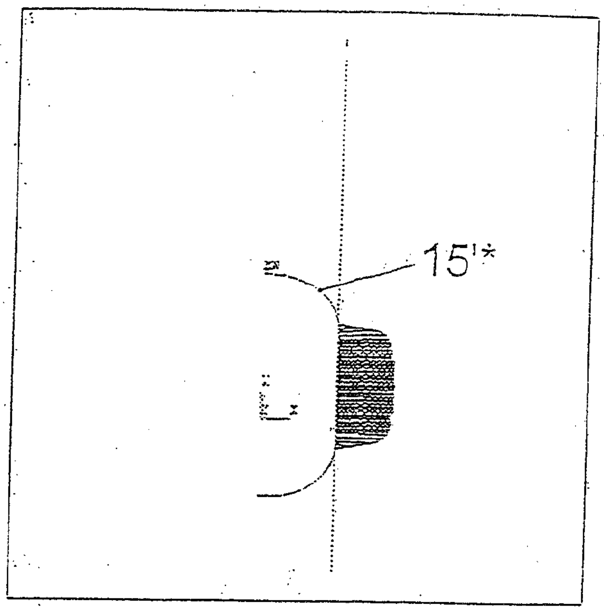

Fig. 5B

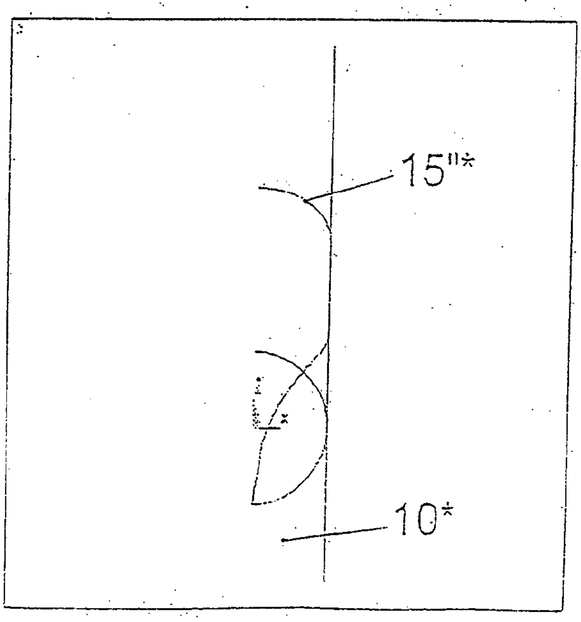

Fig. 5C

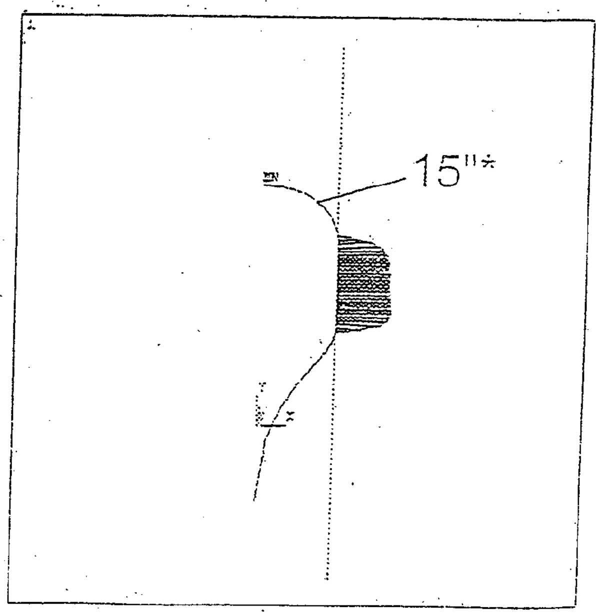

Fig. 5D

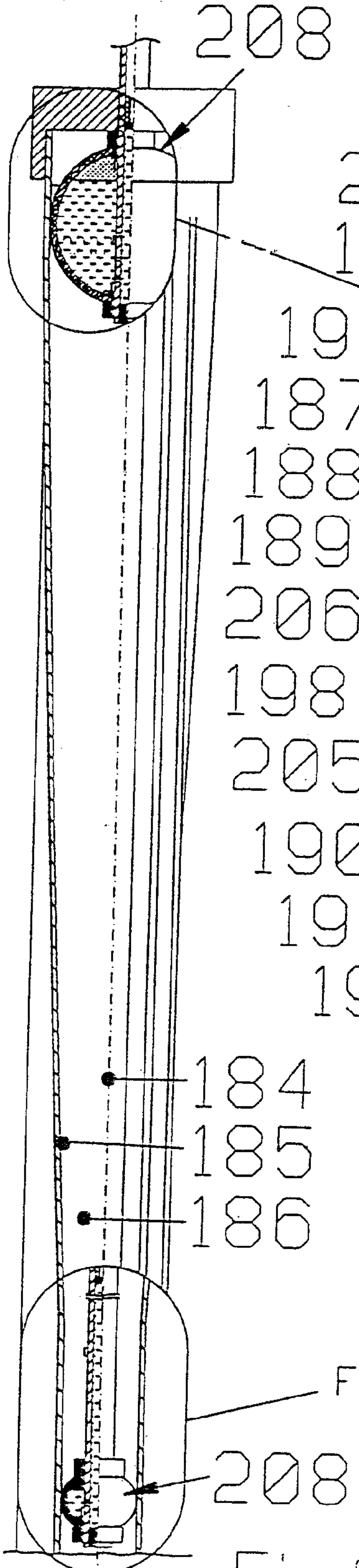
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FIG.6C
184
185
186
208

Fig.6A

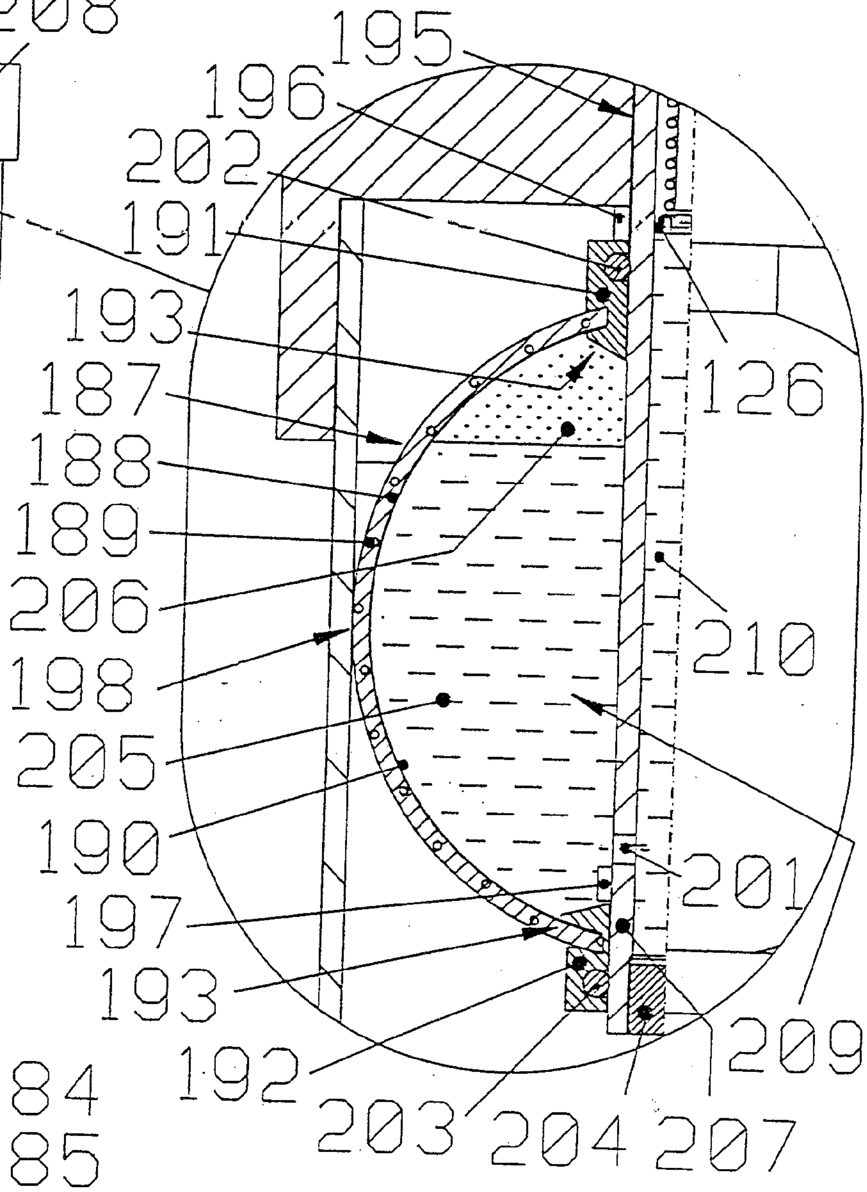
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Fig.6B

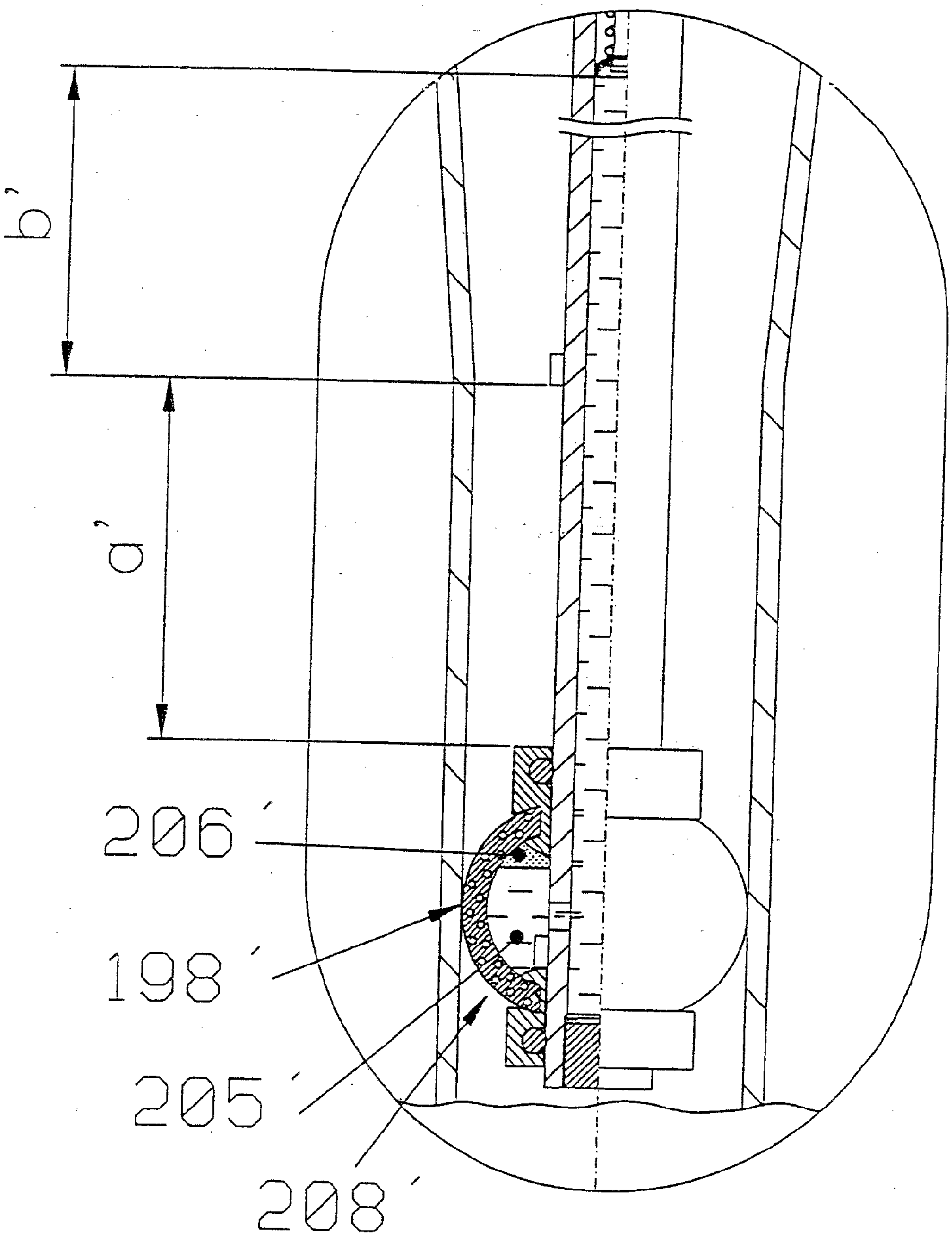


Fig.6C

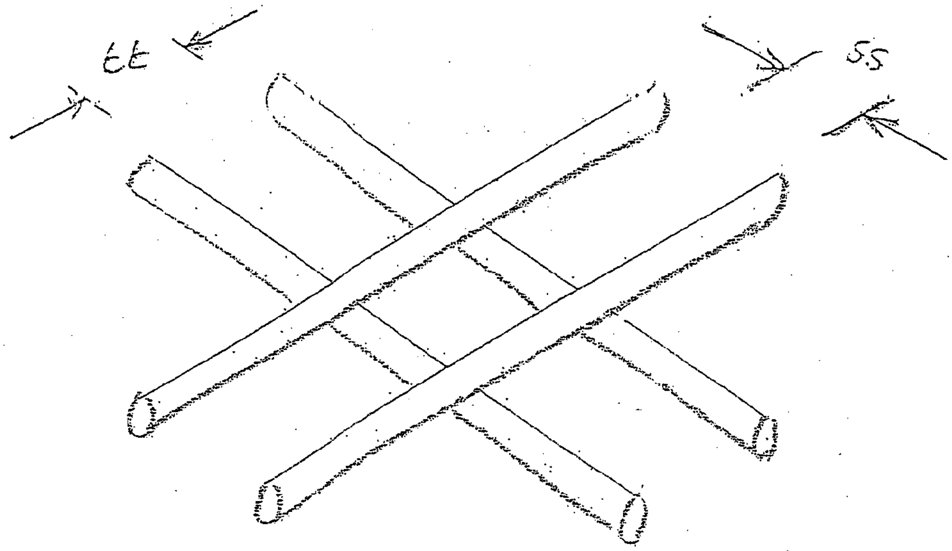


Fig.6D

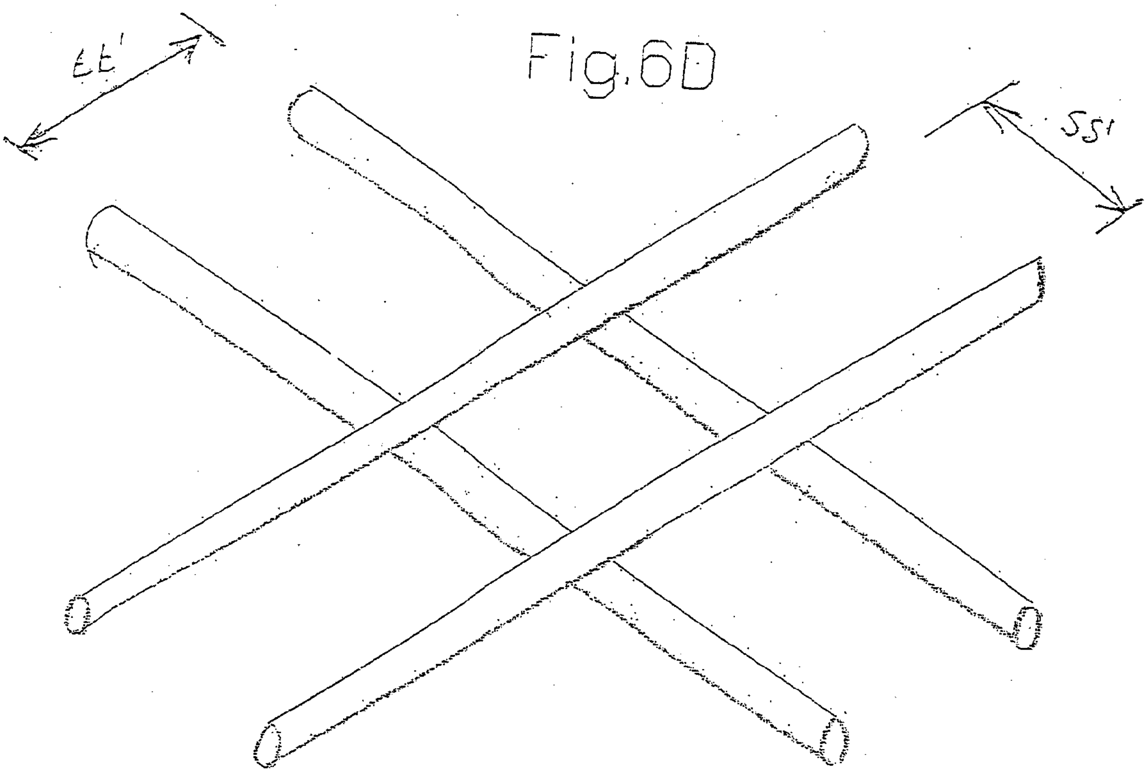


Fig.6E

013078

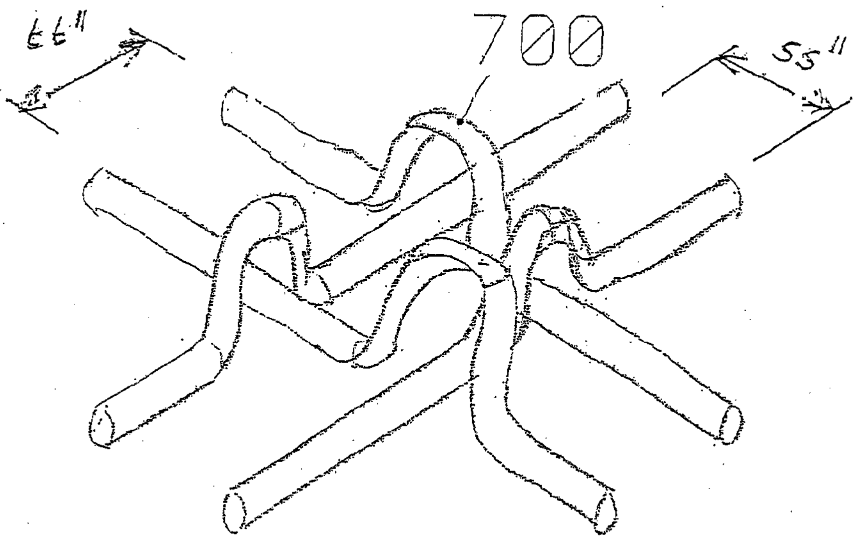


Fig.6F

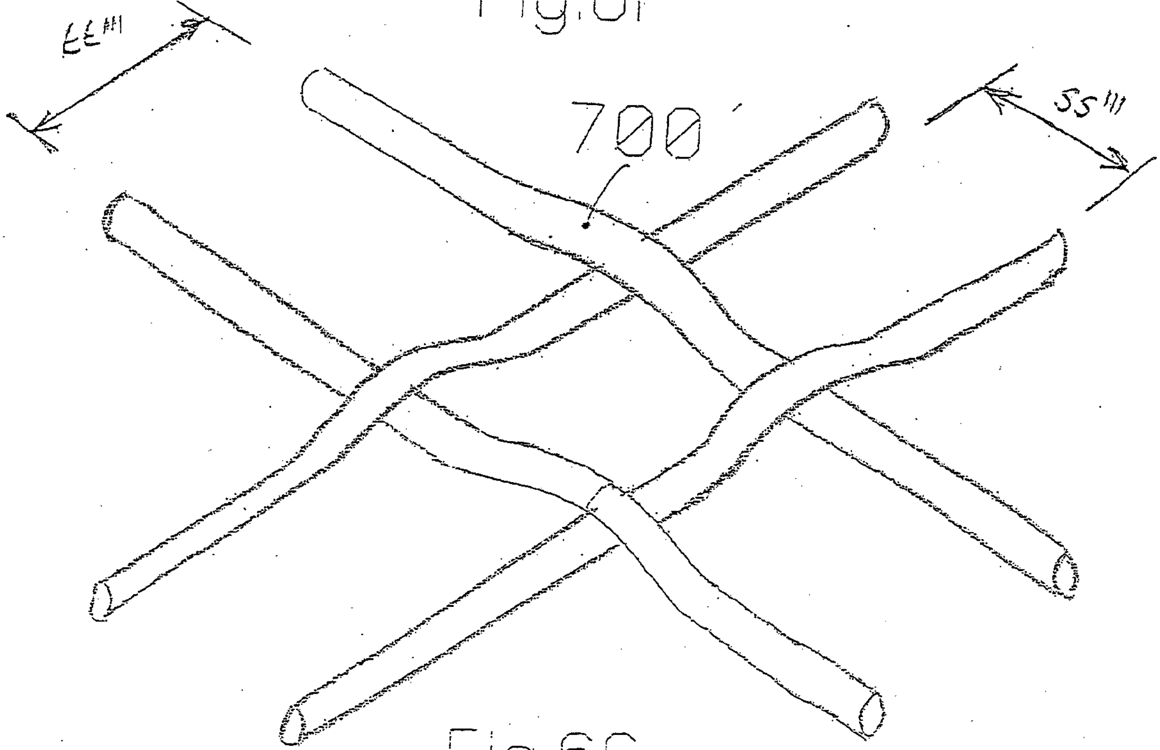


Fig.6G

013078

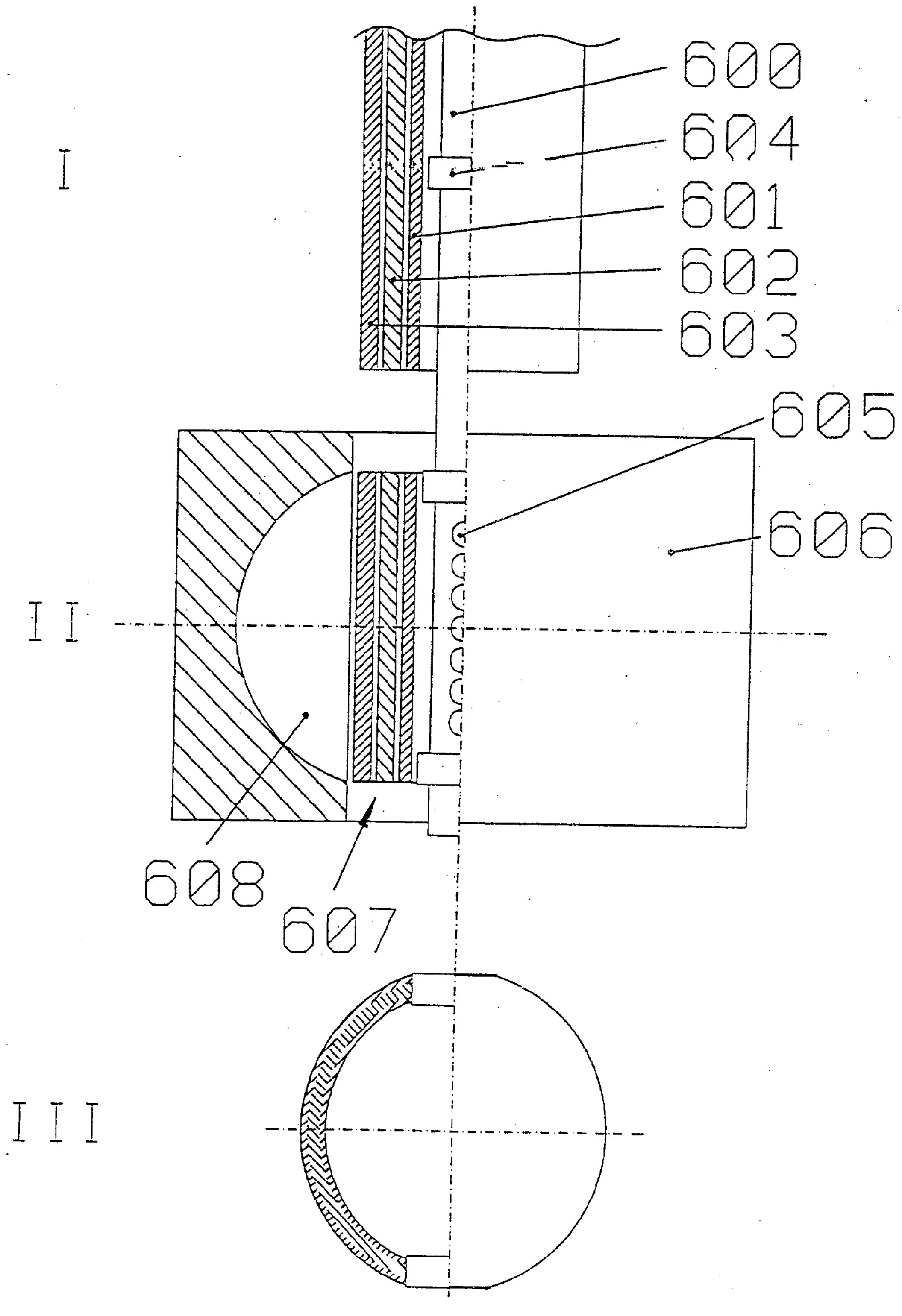


Fig.6H

013078

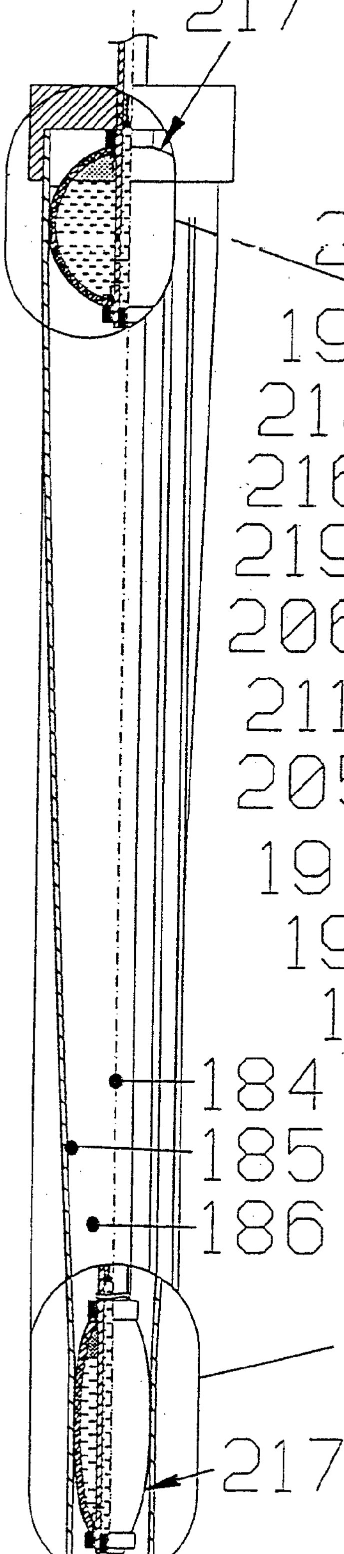


Fig.7A

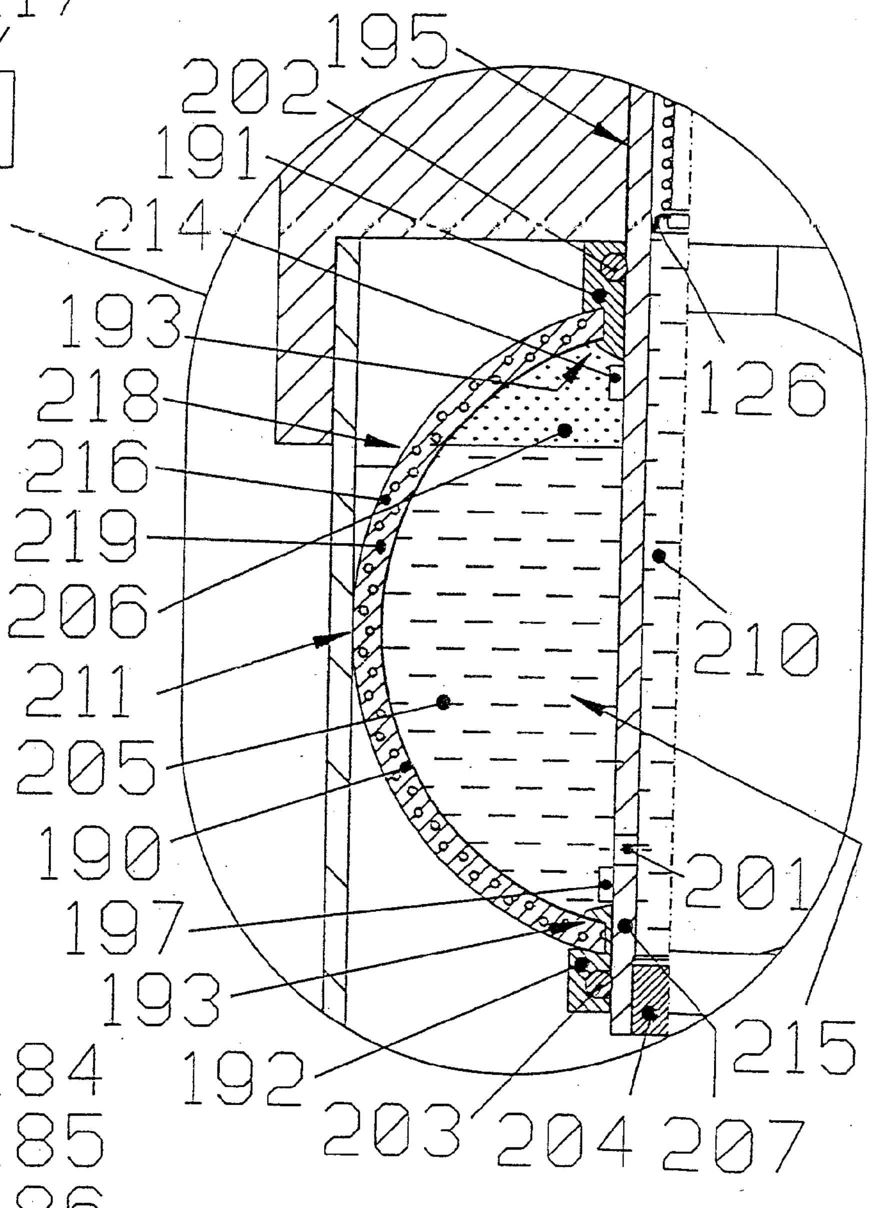


Fig.7B

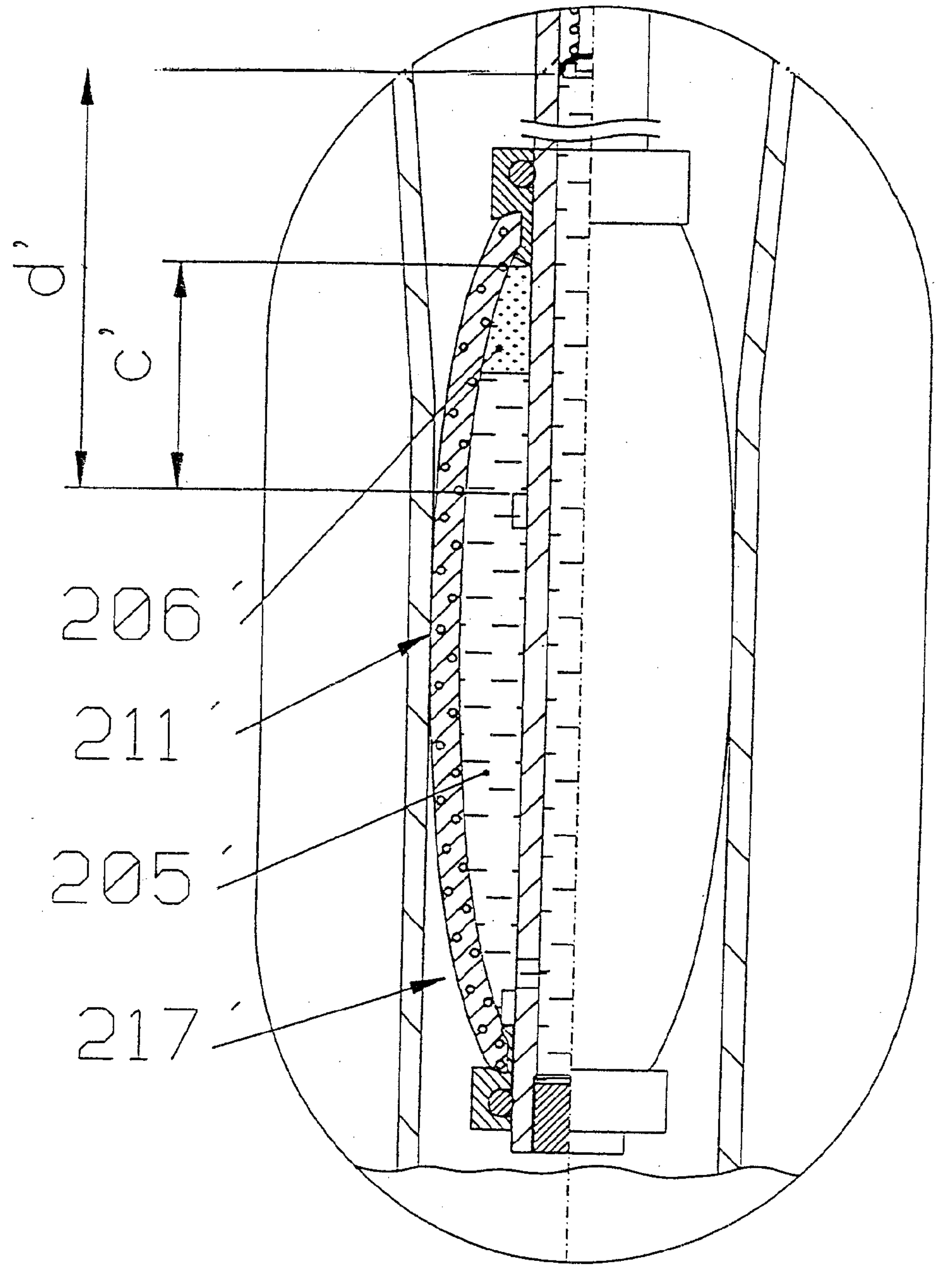


Fig.7C

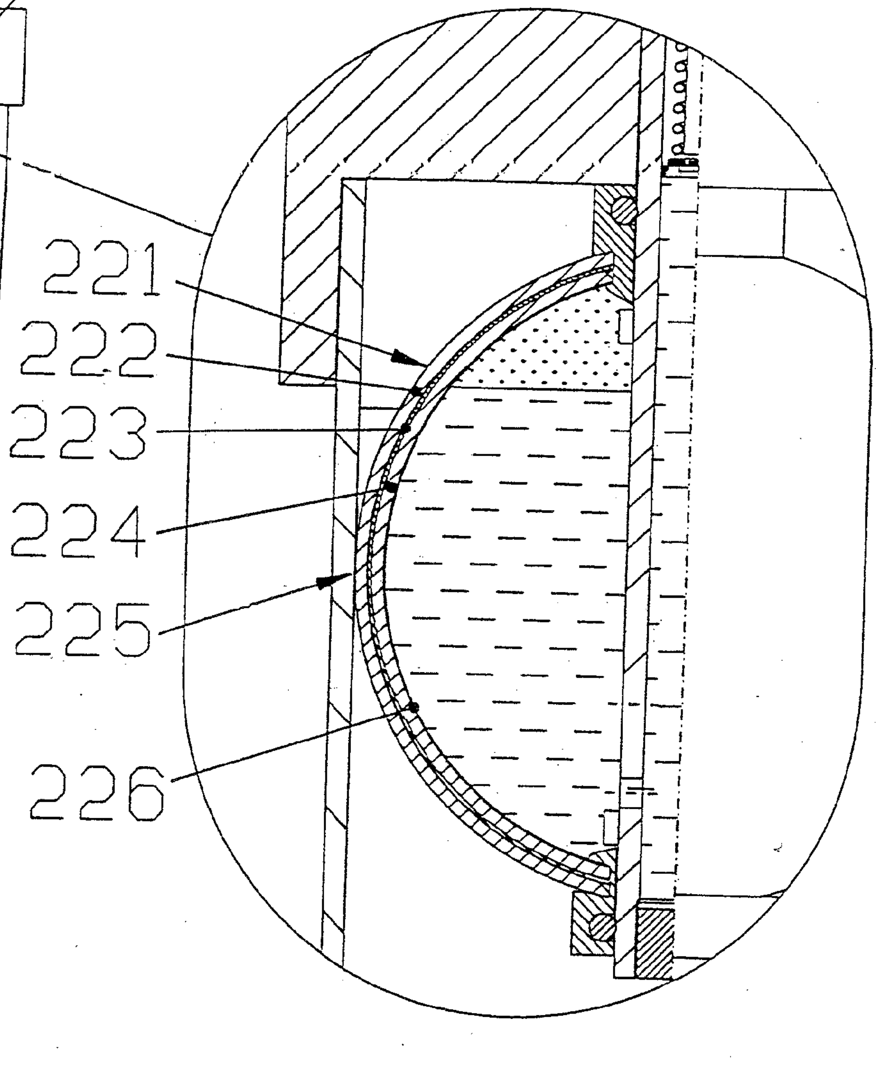


Fig.8B

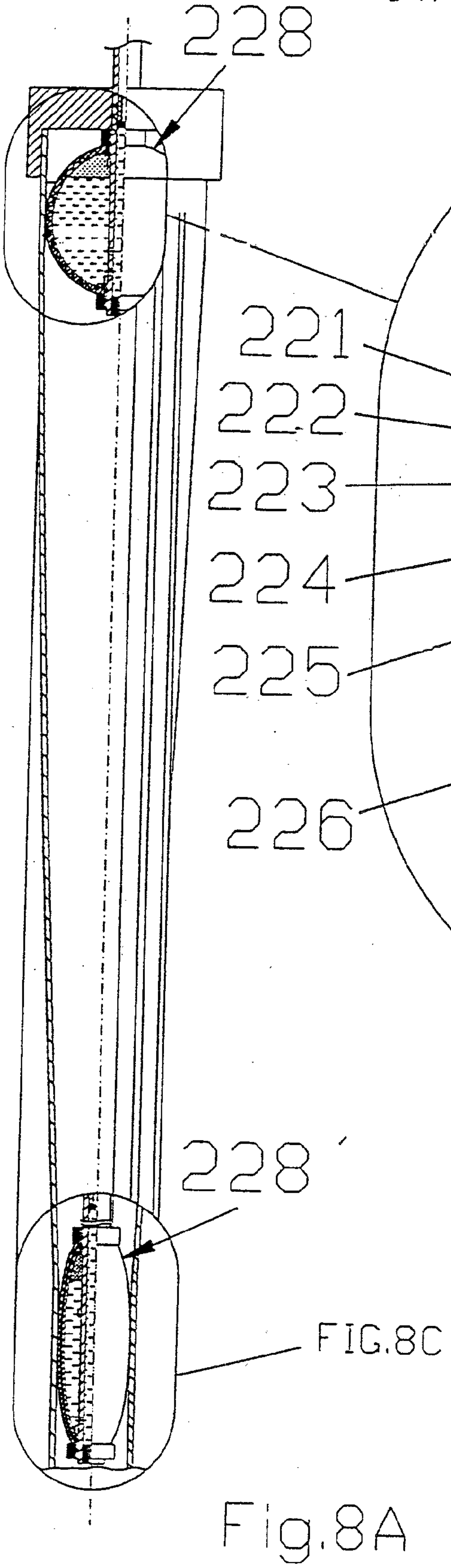


Fig.8A

013078

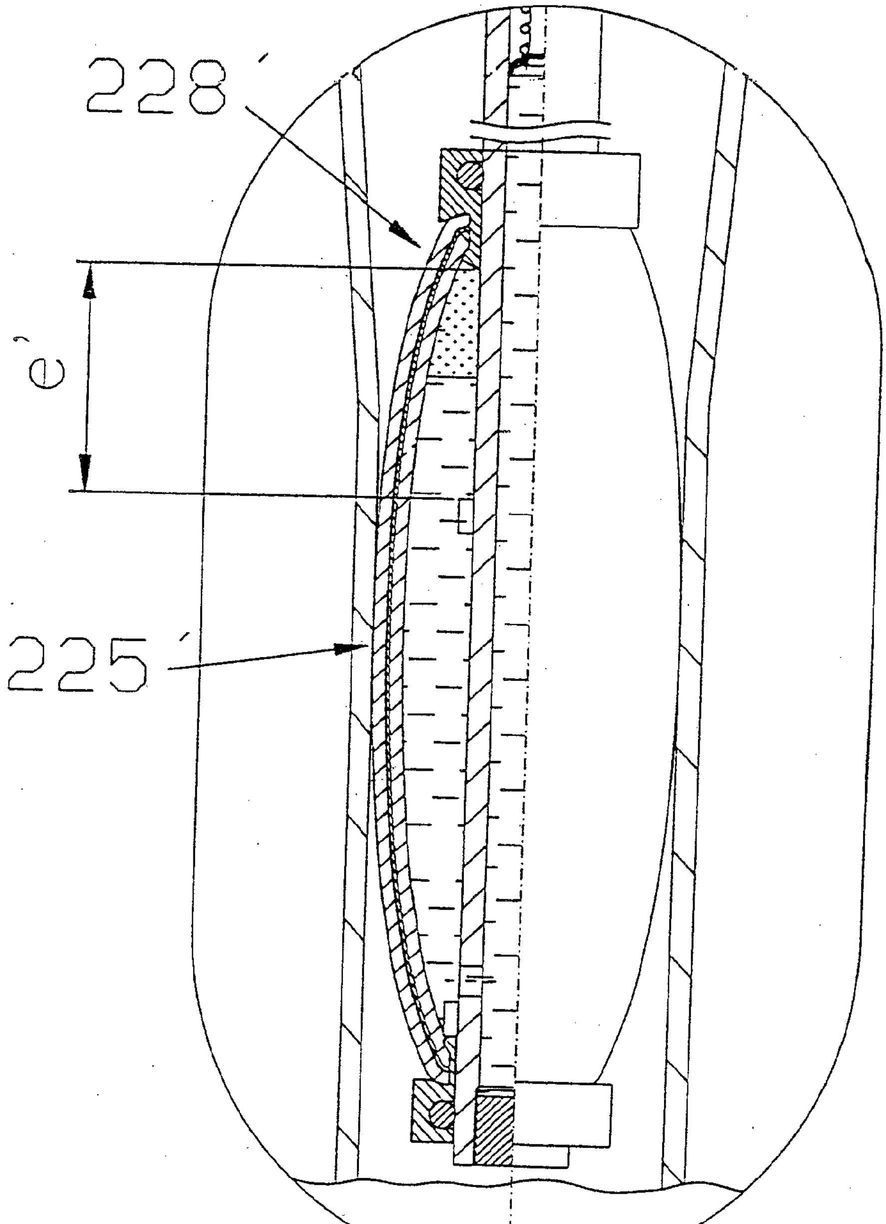


Fig.8C

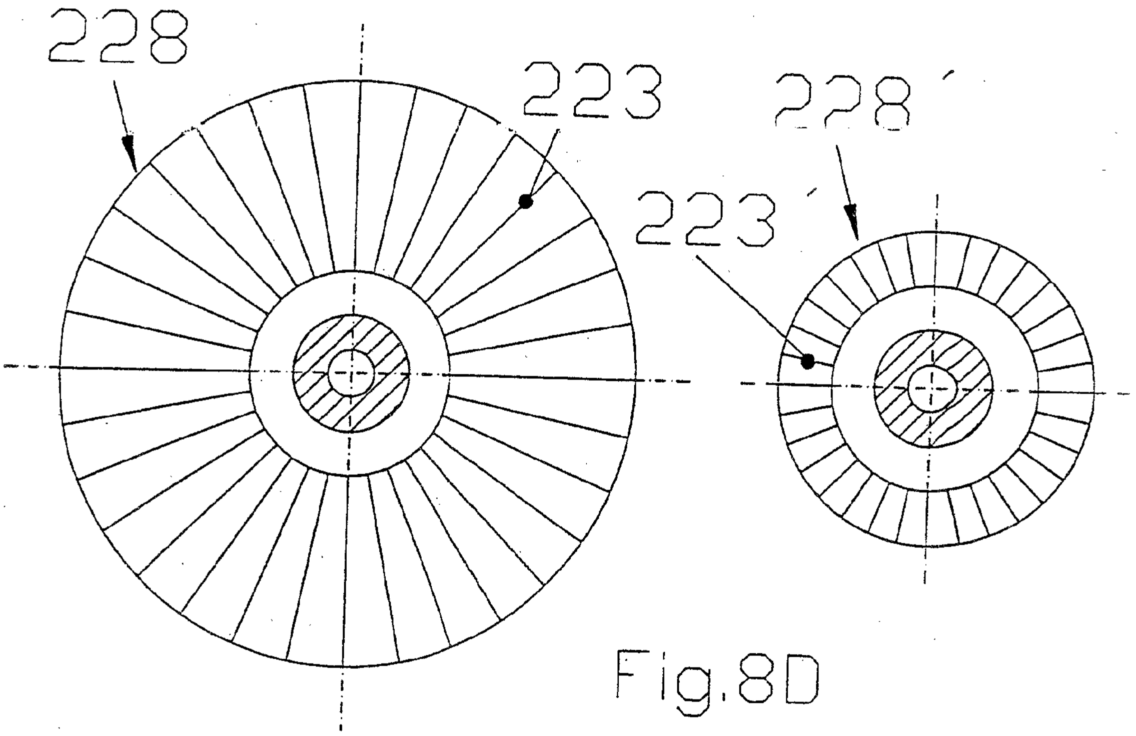
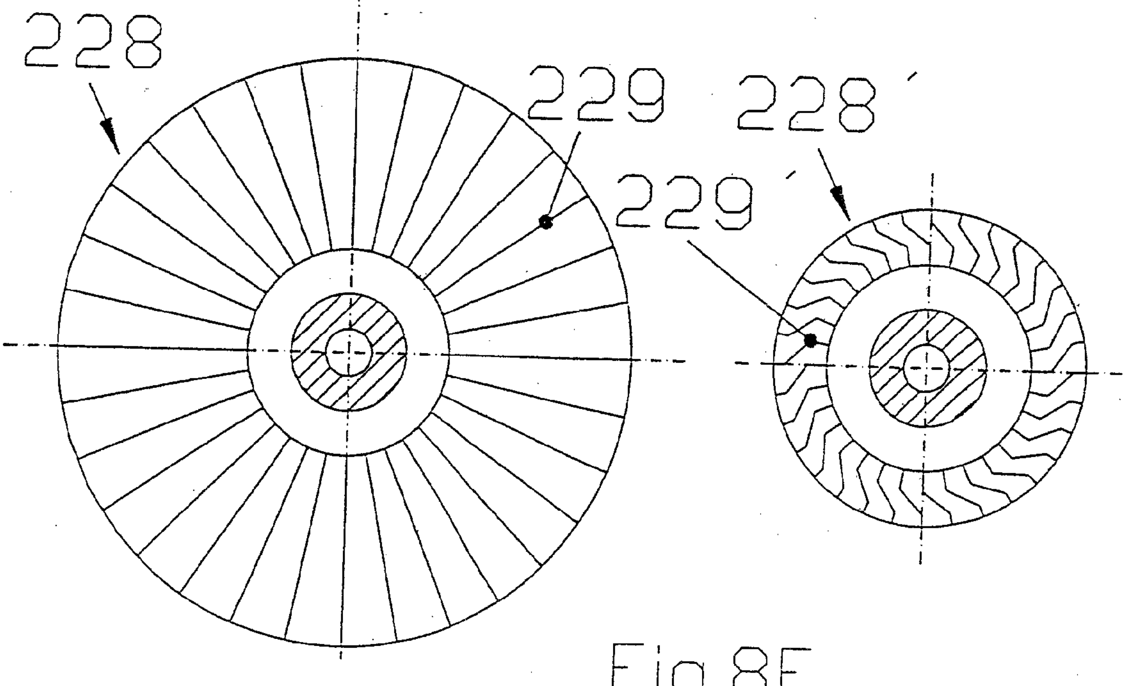


Fig.8D



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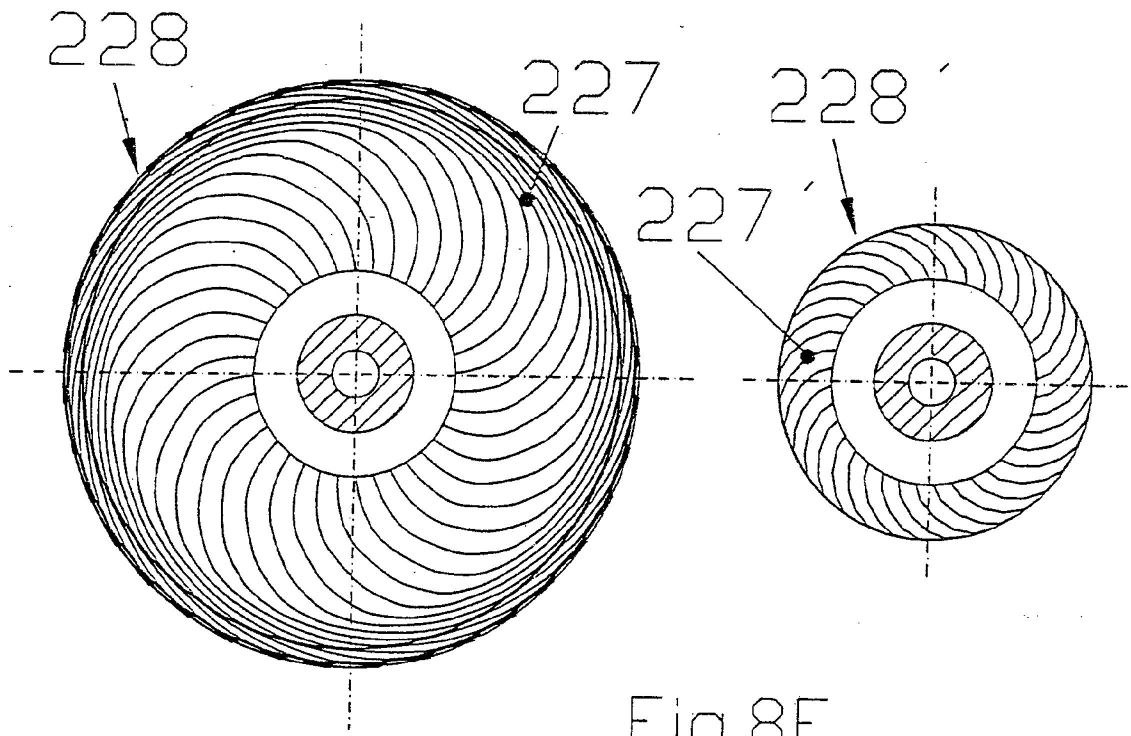

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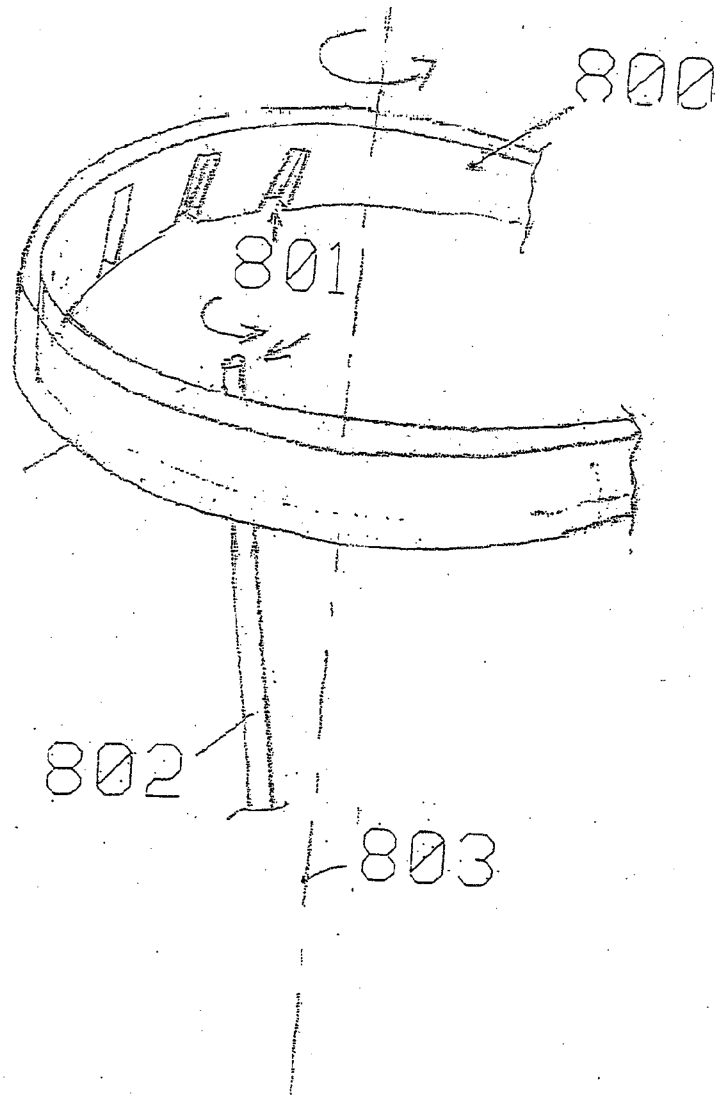


Fig.8G

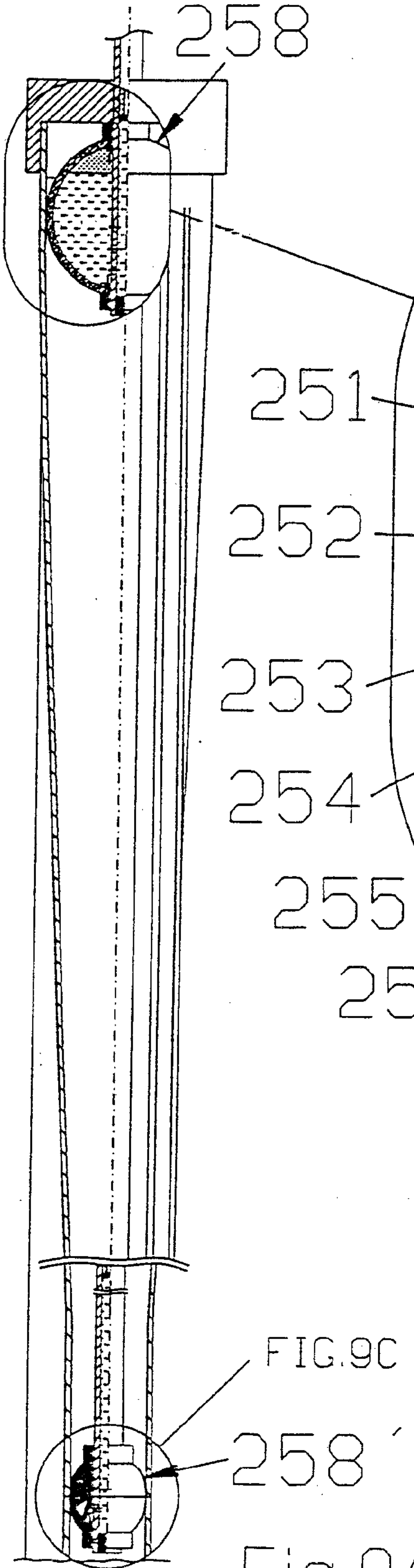


Fig.9A

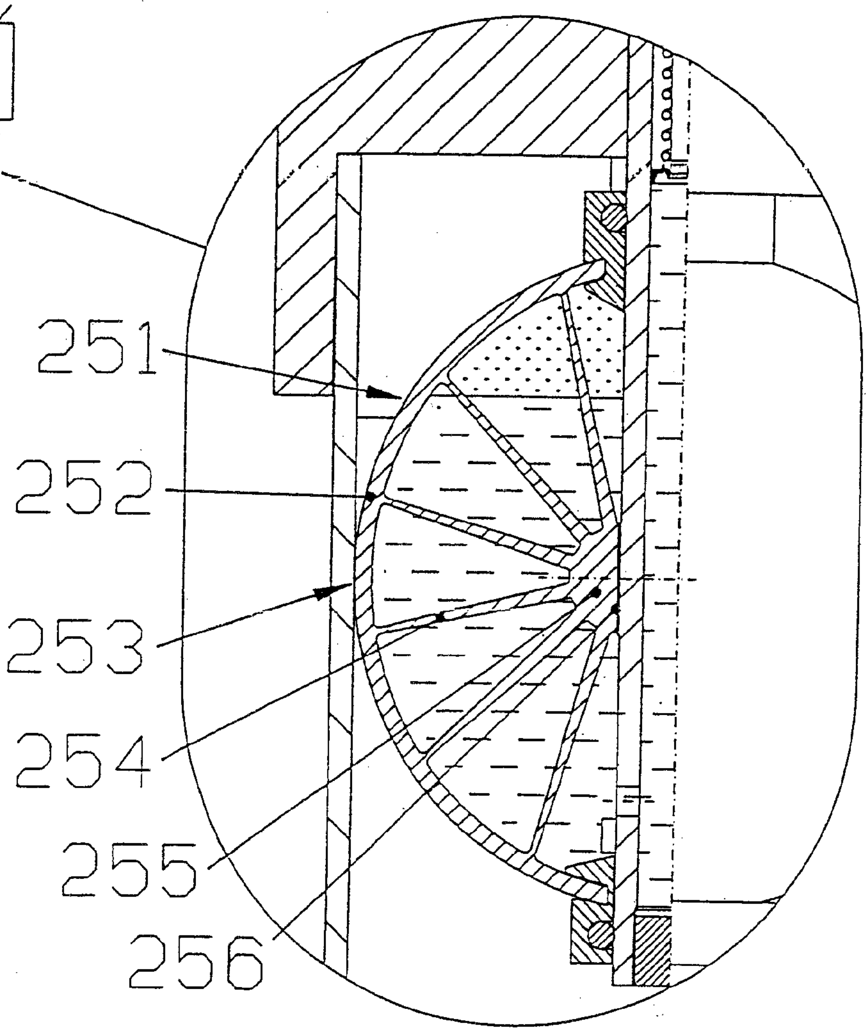


Fig.9B

013078

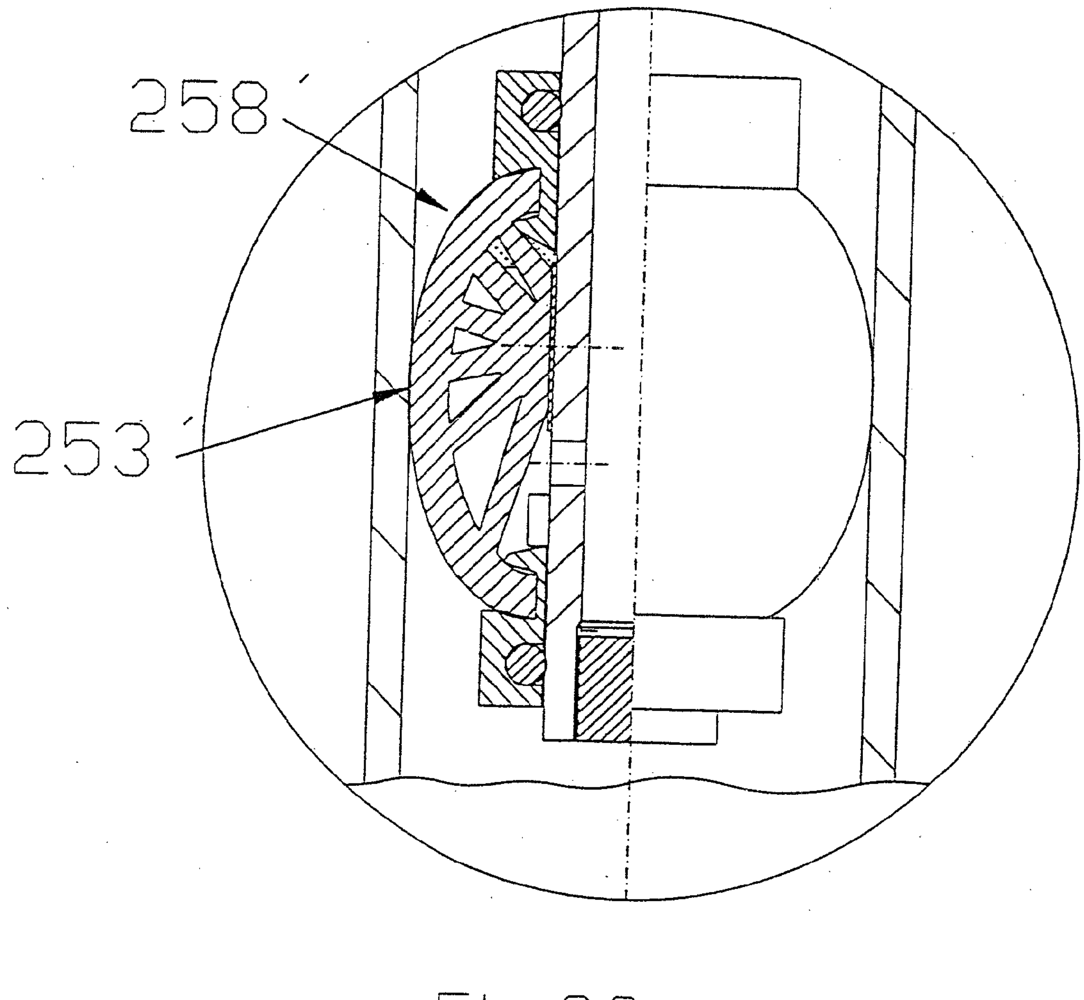


Fig.9C

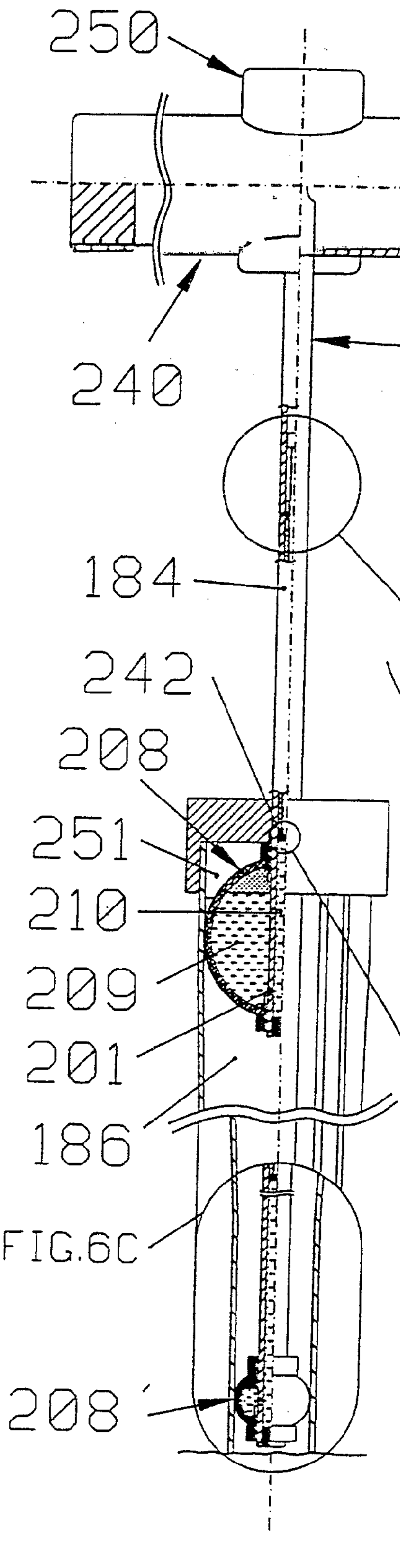


Fig.10A

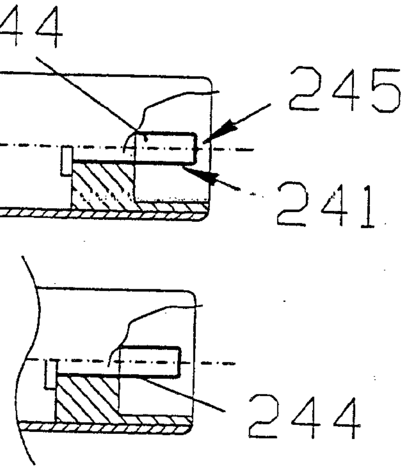


Fig.10B

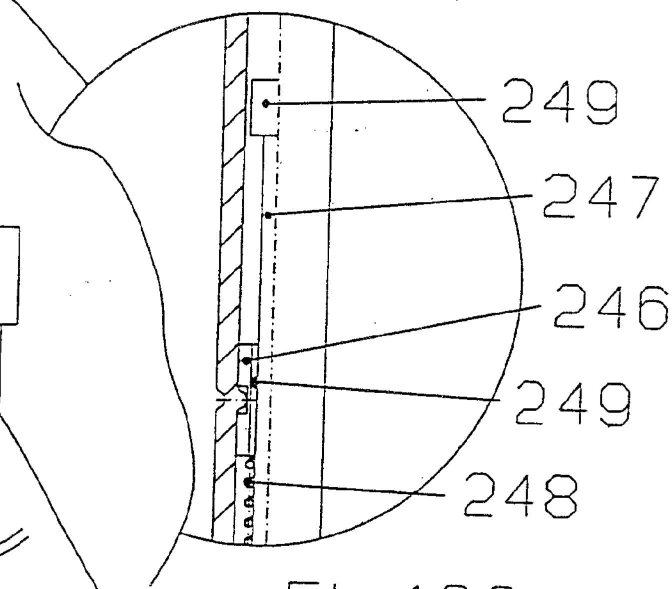


Fig.10C

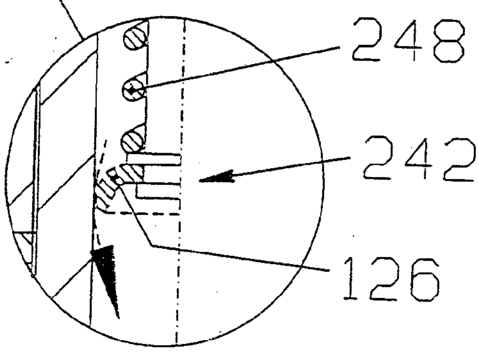


Fig.10D

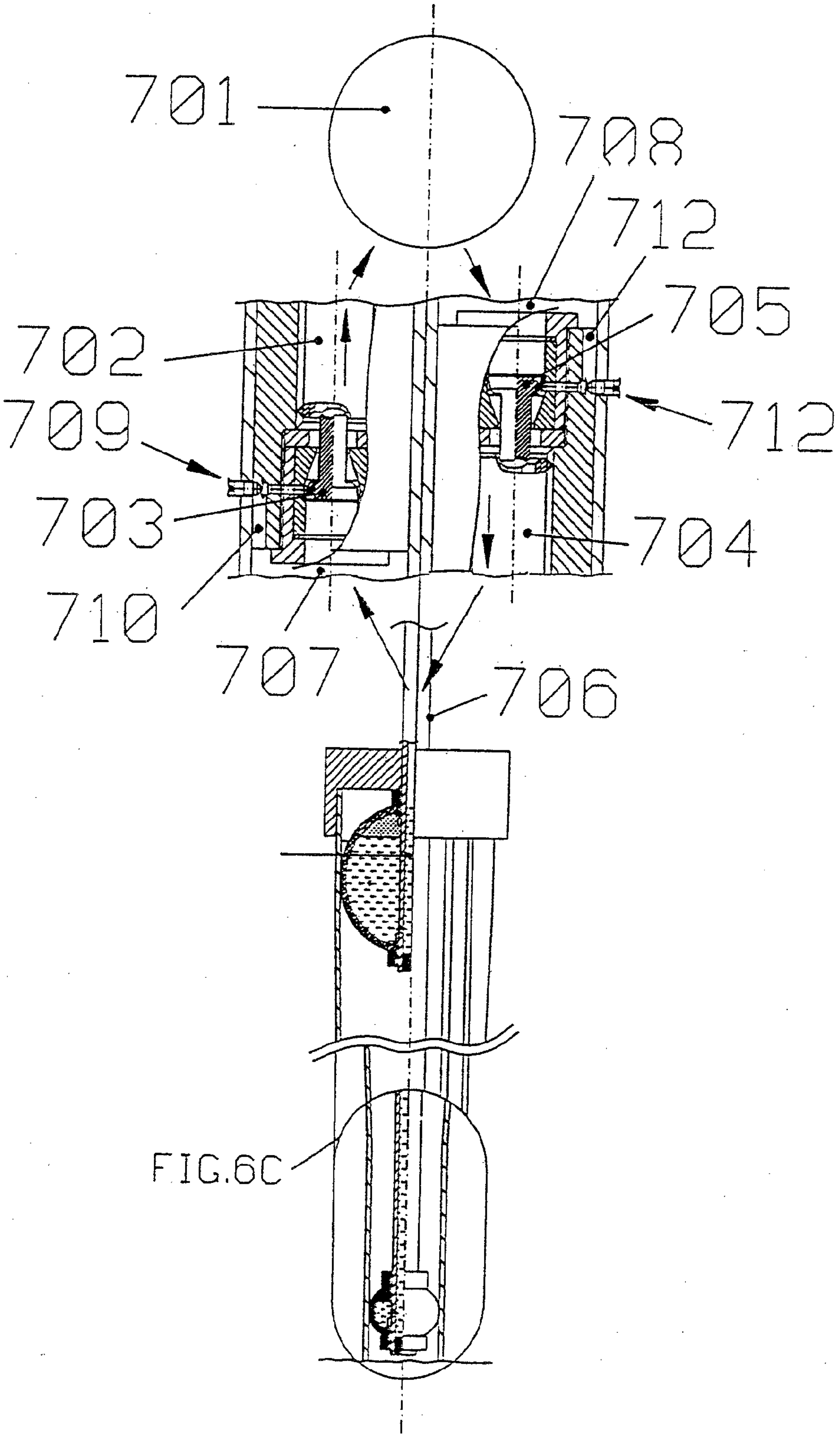
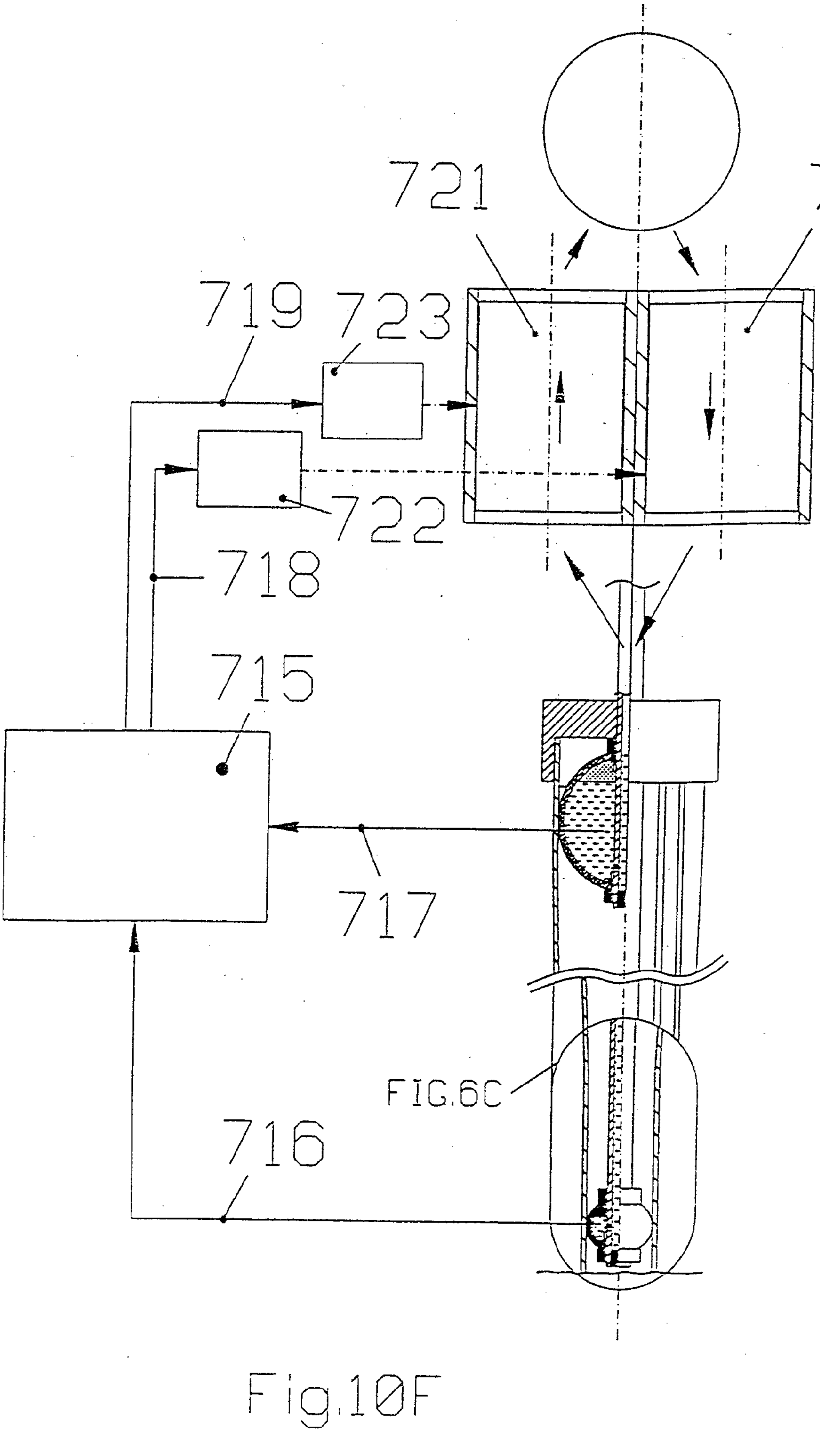


Fig.10E



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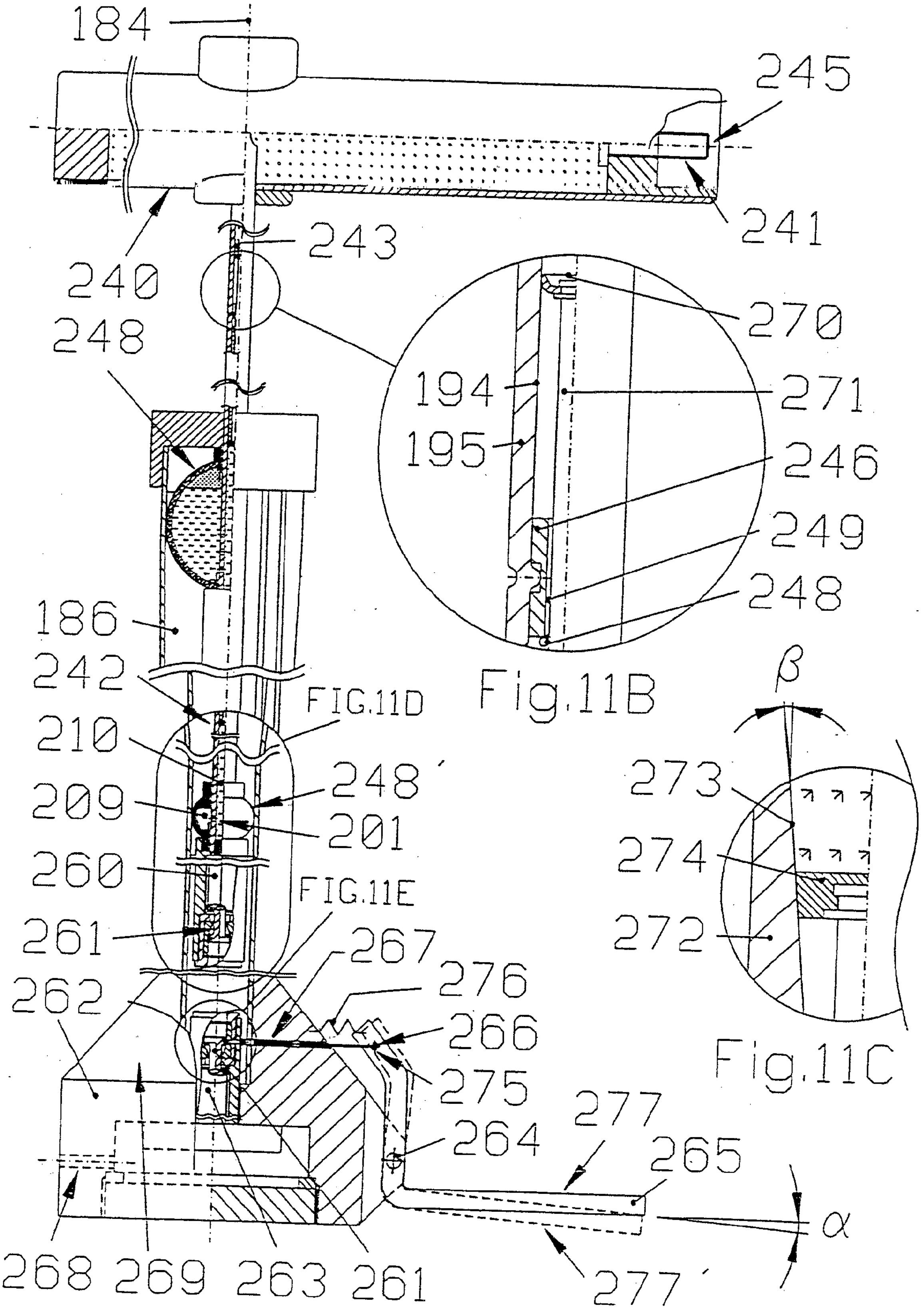

Fig.11B

Fig.11C

Fig.11A

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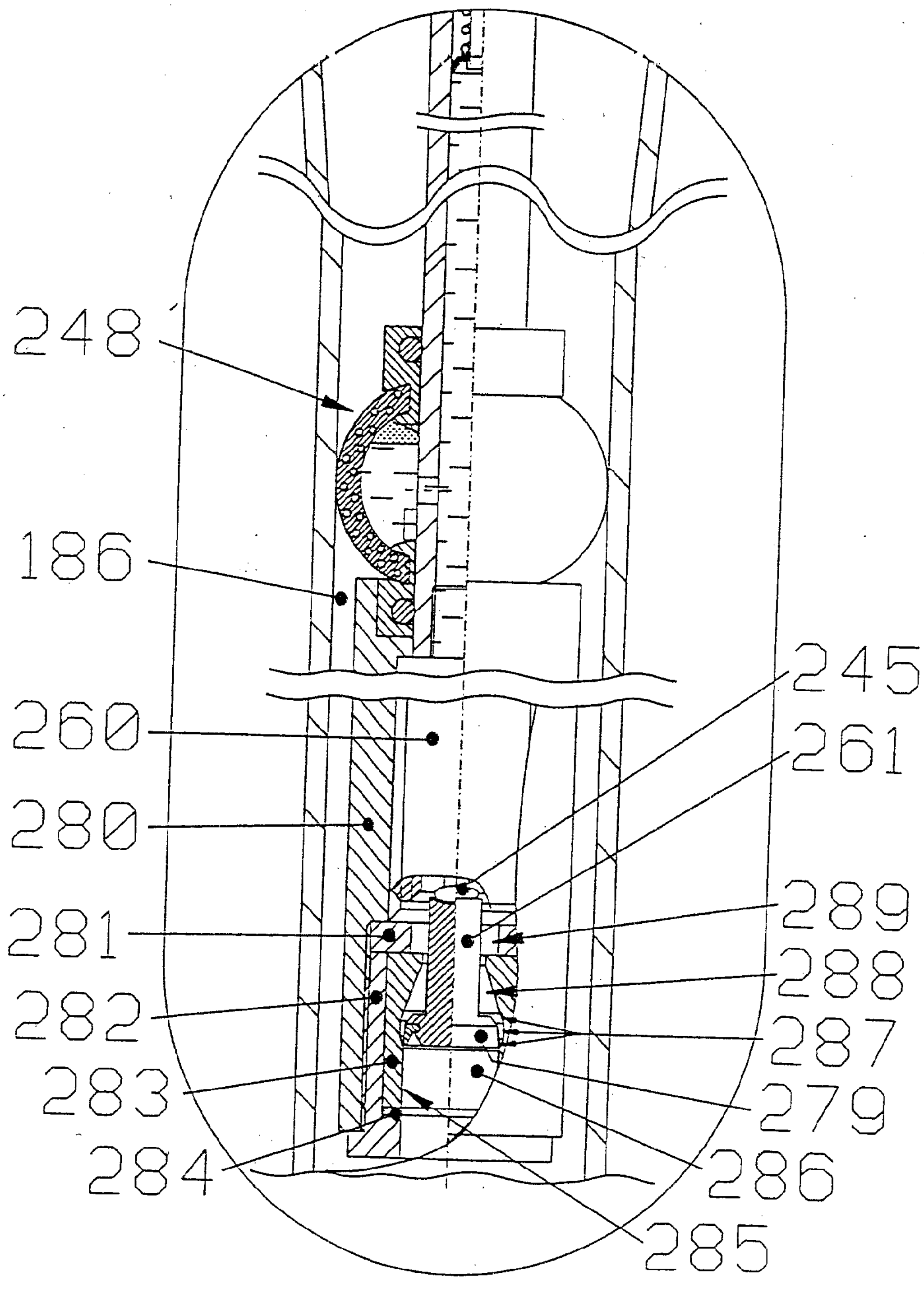


Fig.11D

013078

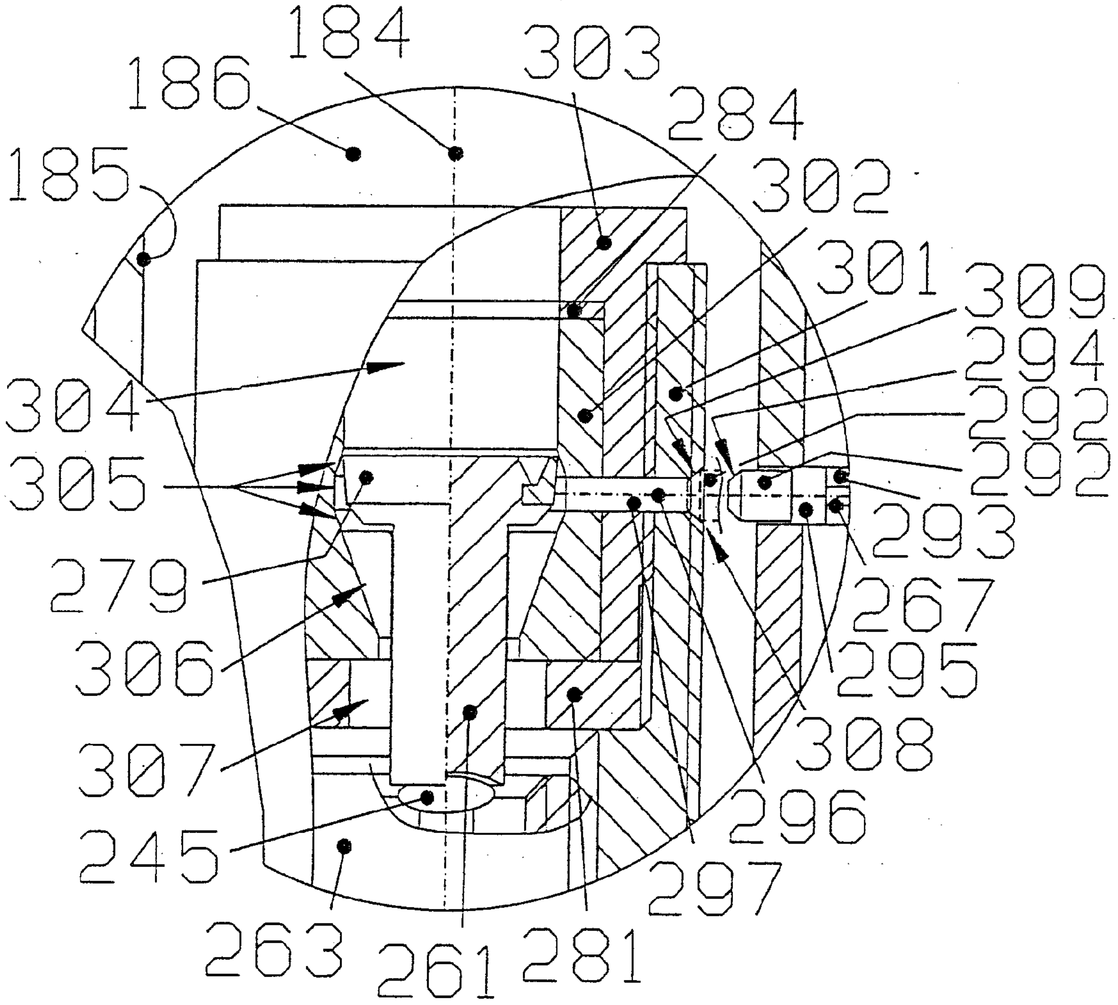


Fig.11E

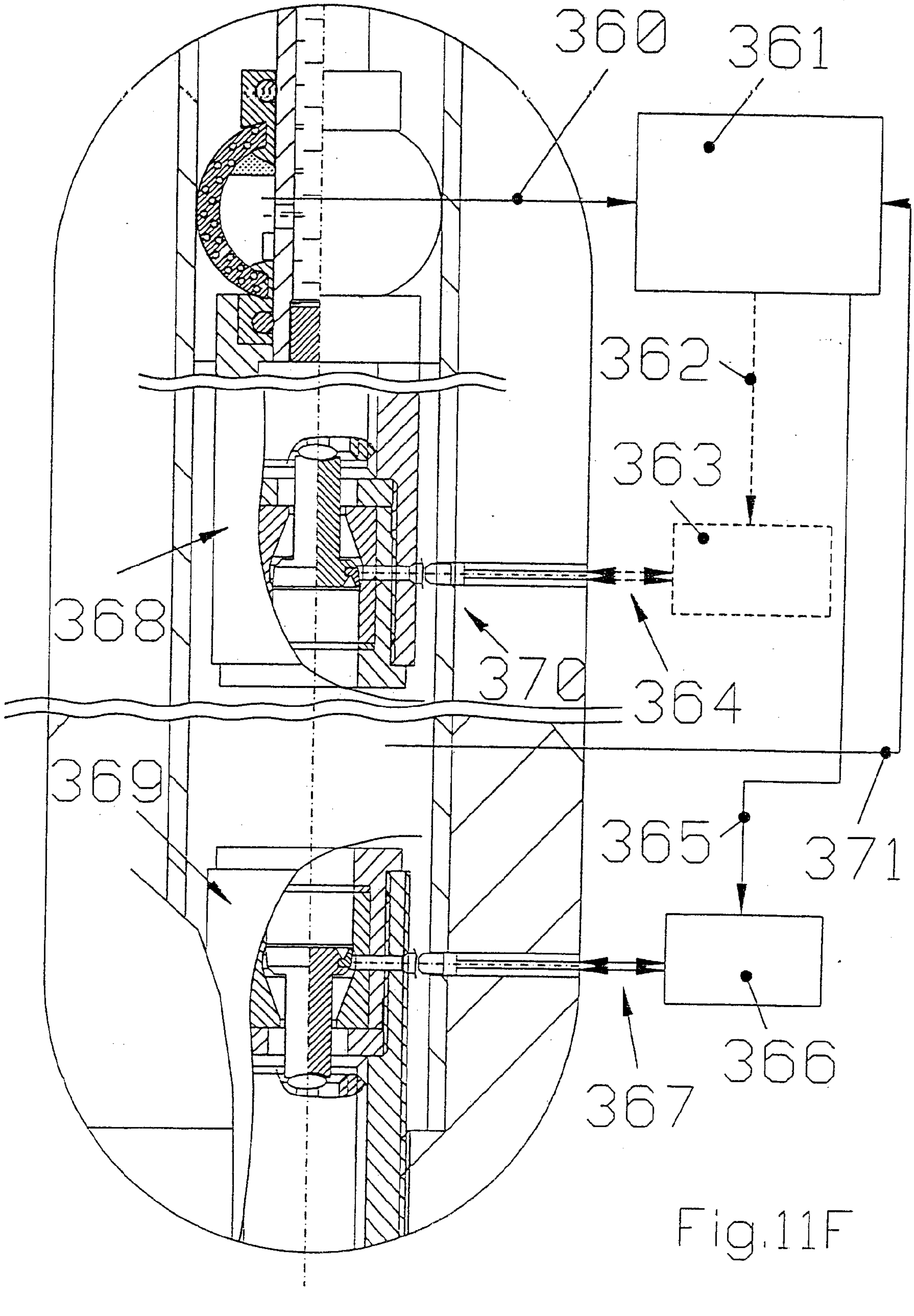


Fig.11F

013078

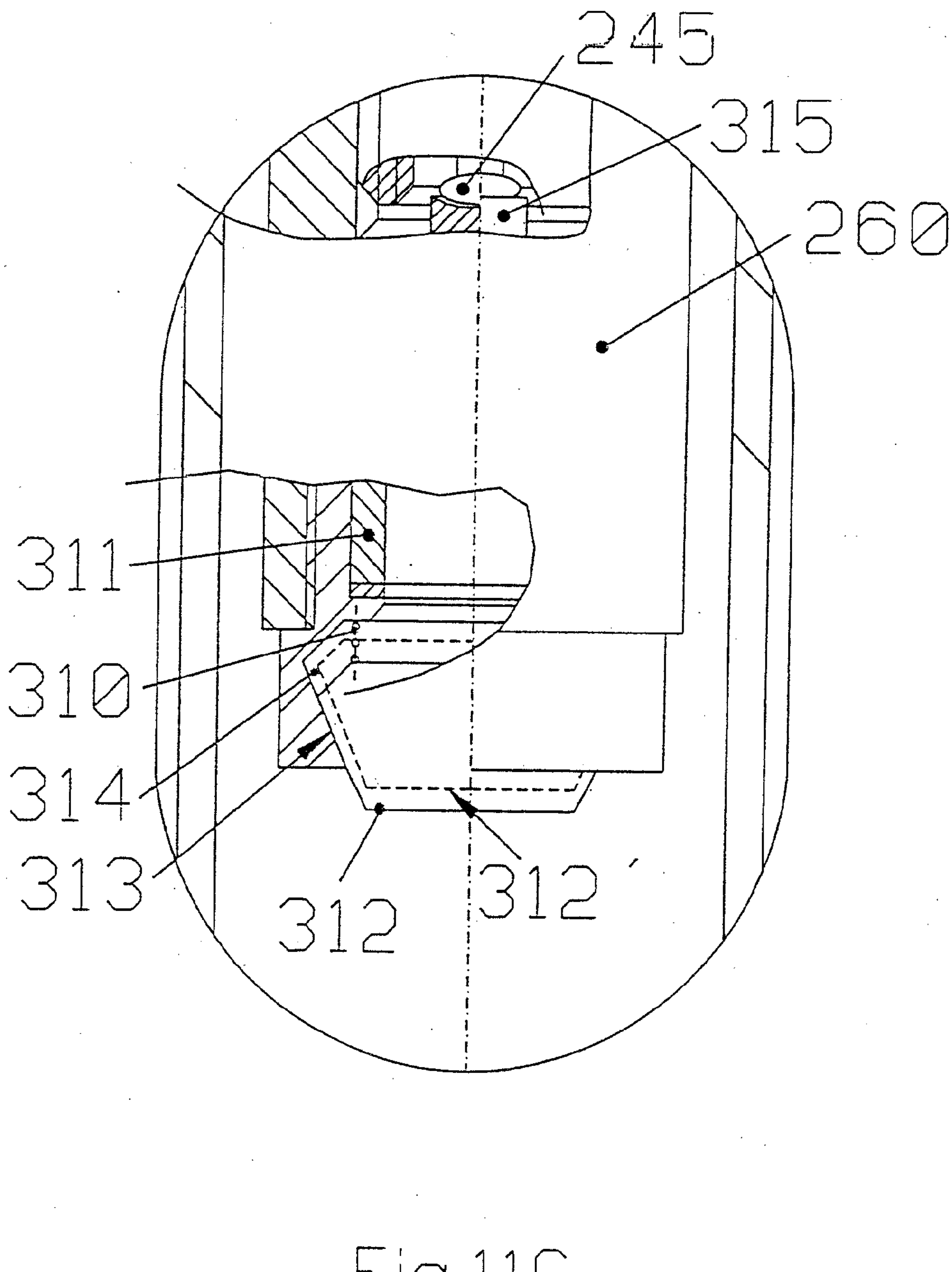


Fig.11G

013078

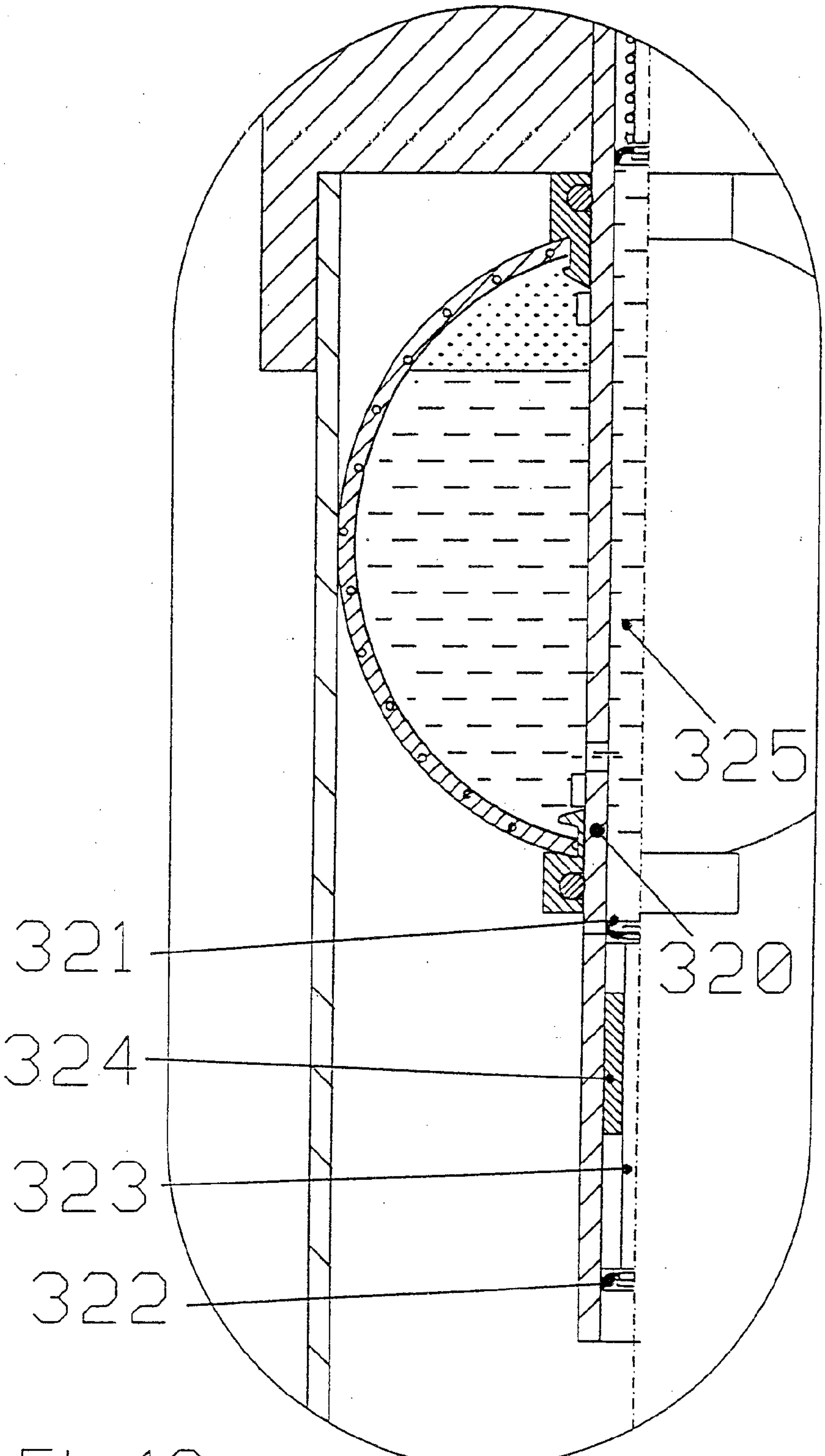


Fig.12

013078

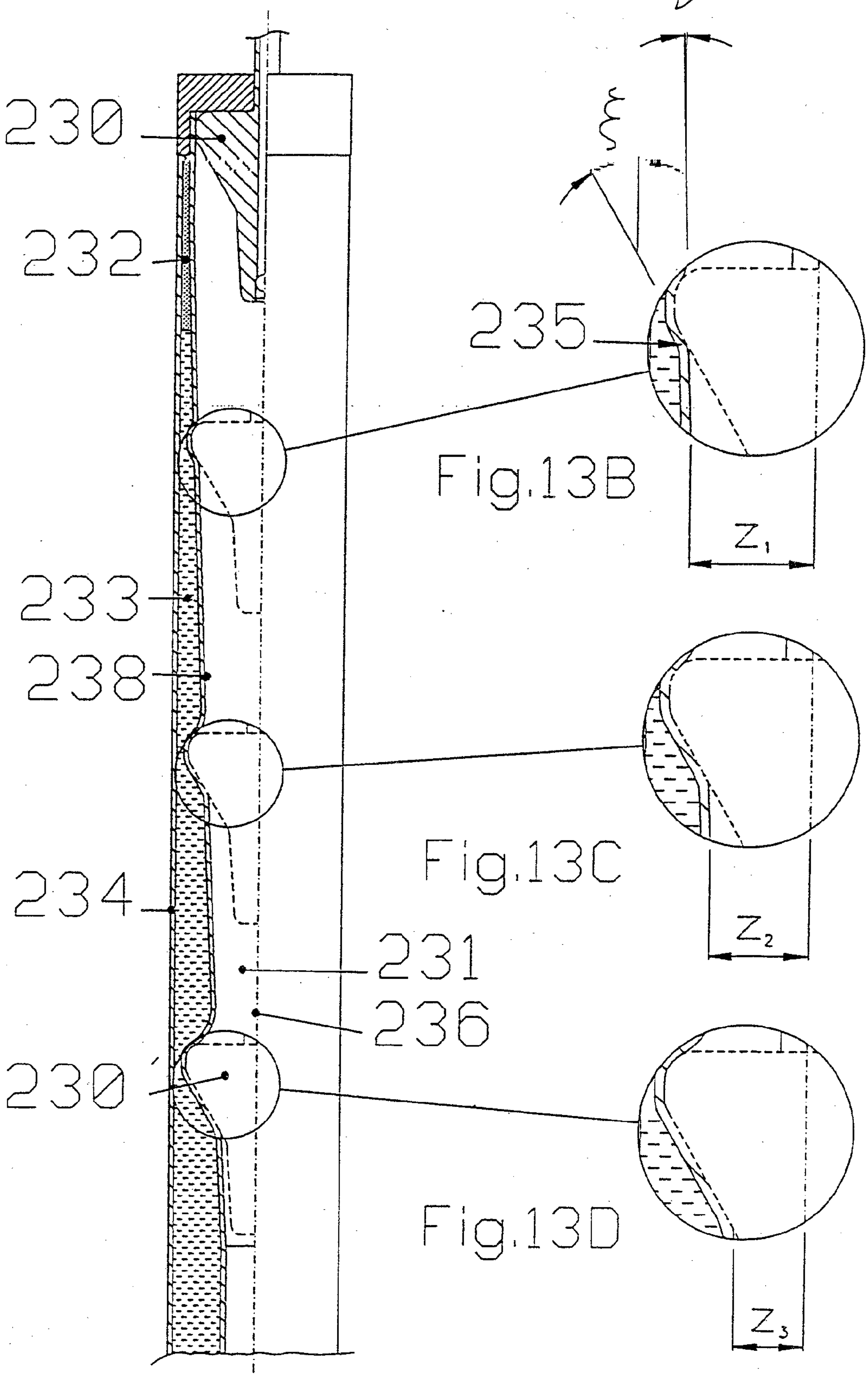


Fig.13A

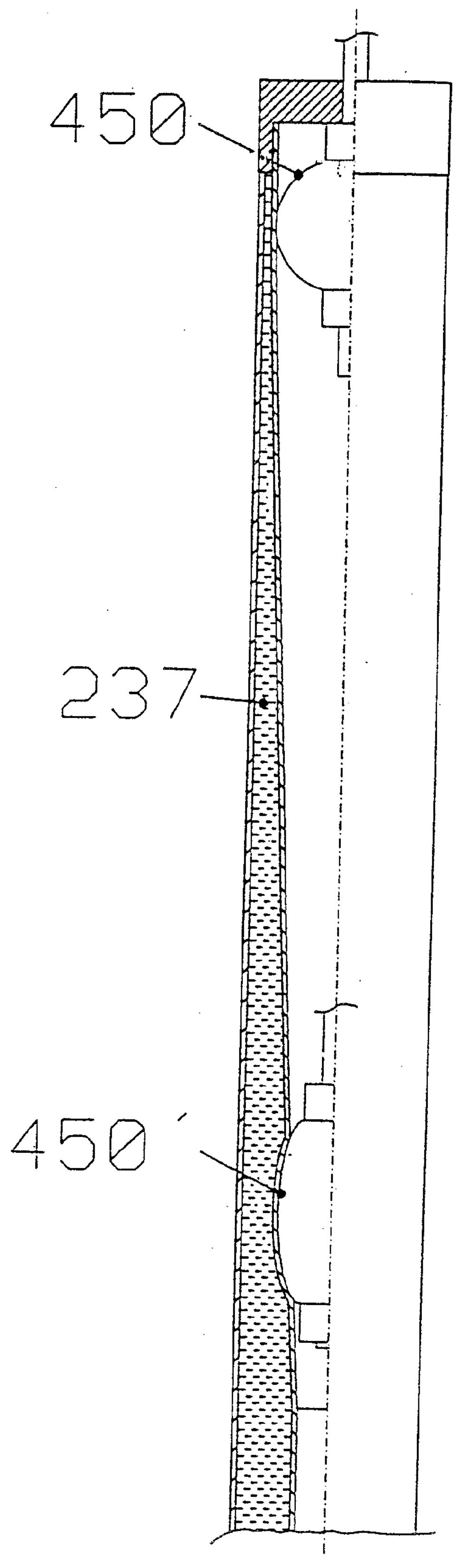
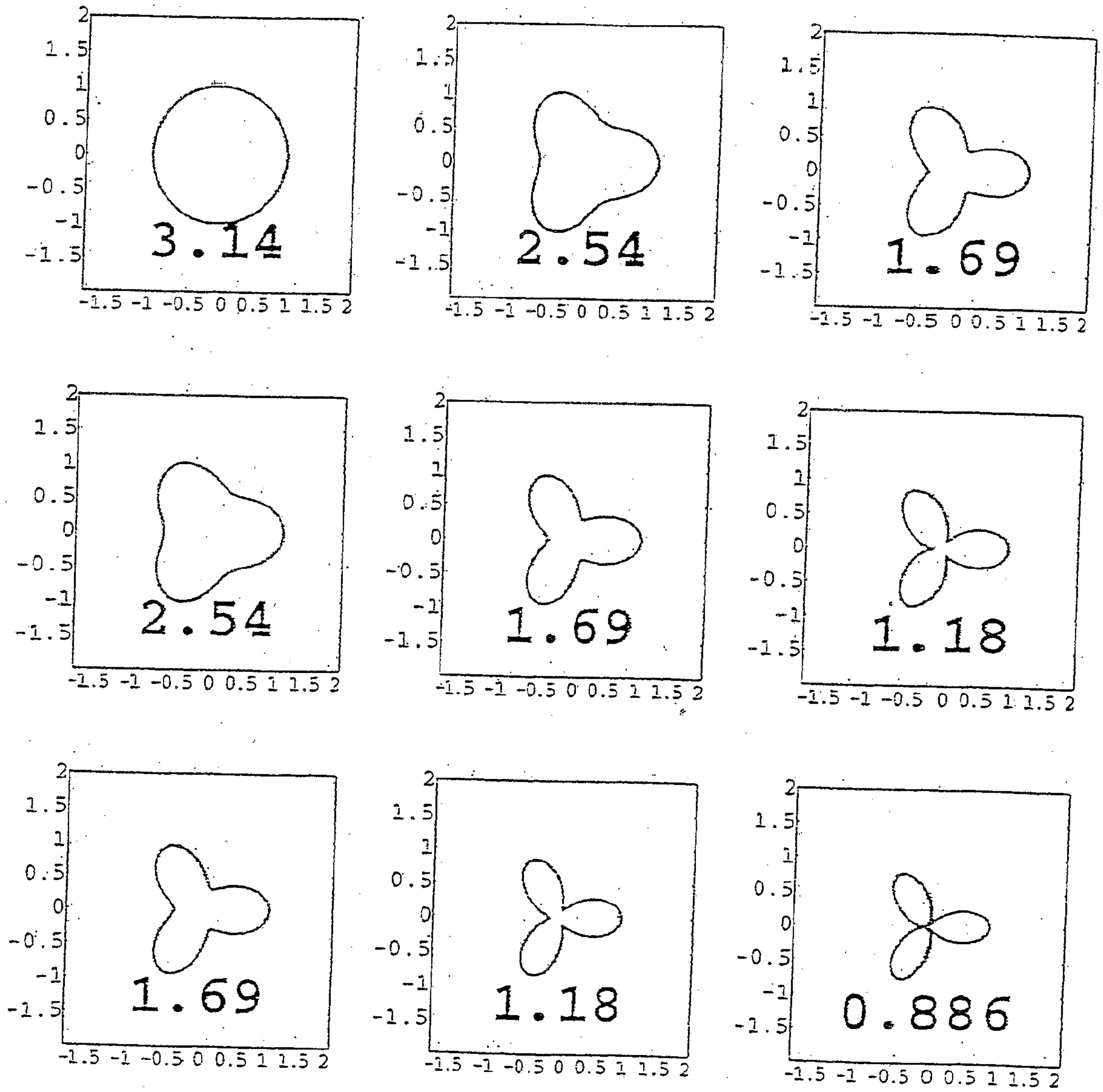


Fig.14



$\frac{C_0}{2}=1$ p=0, 0.25, 0.5

$C_1=0$

$C_2=0$ q=0, 0.25, 0.5

$C_3=p+q$

Fig.15A

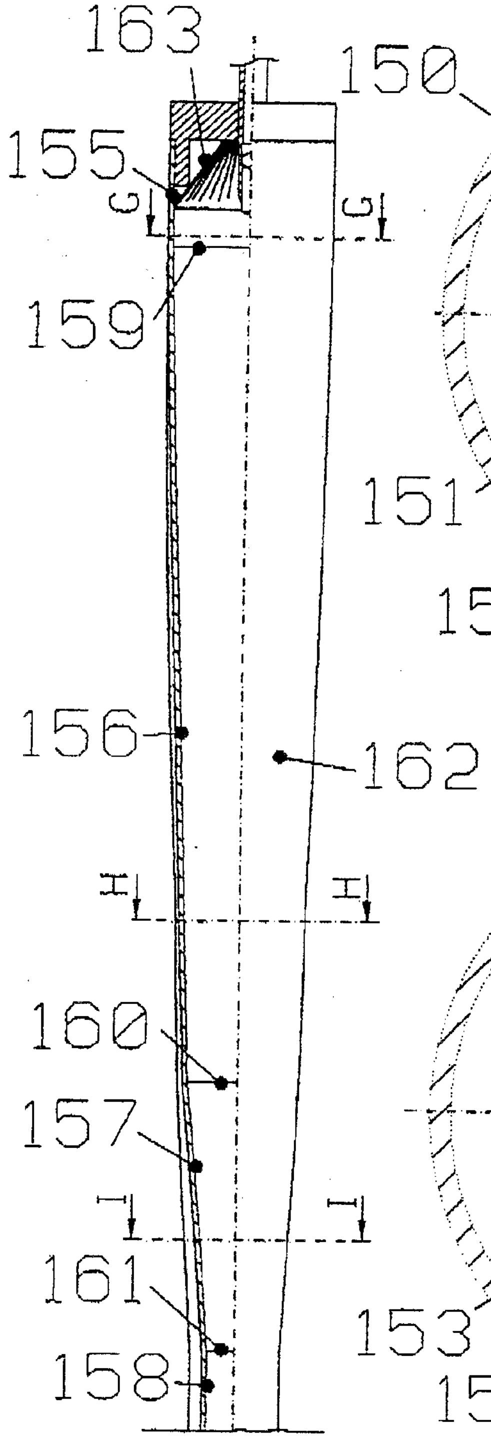


Fig.15B

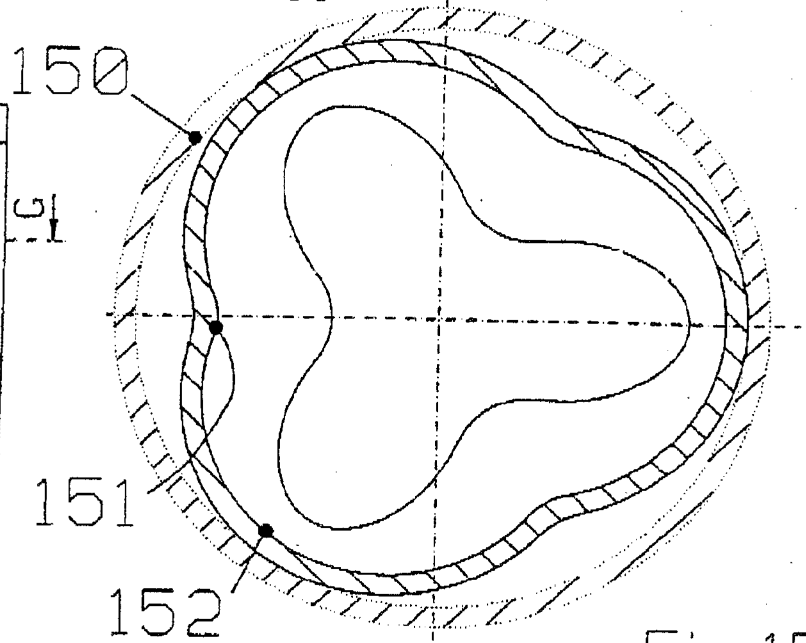


Fig.15C
section H-H (G-G)

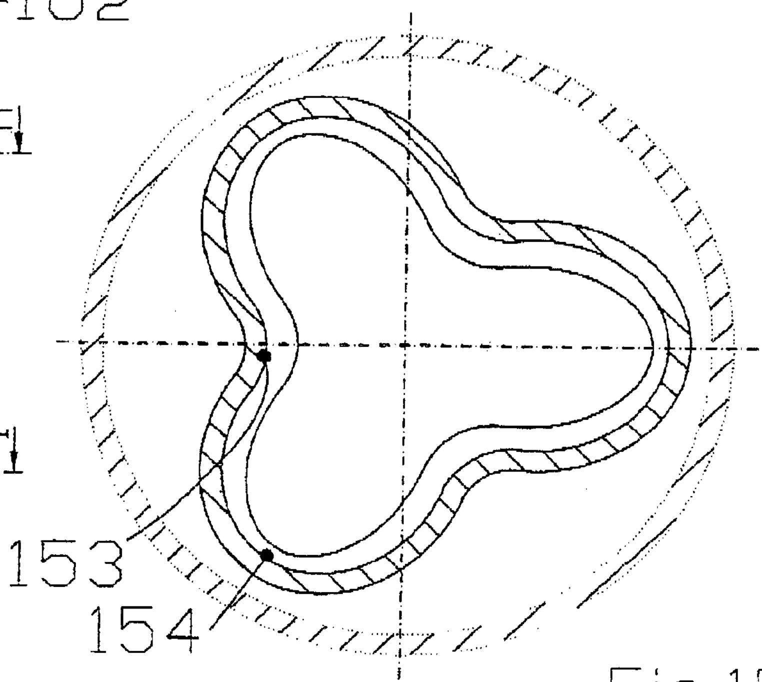
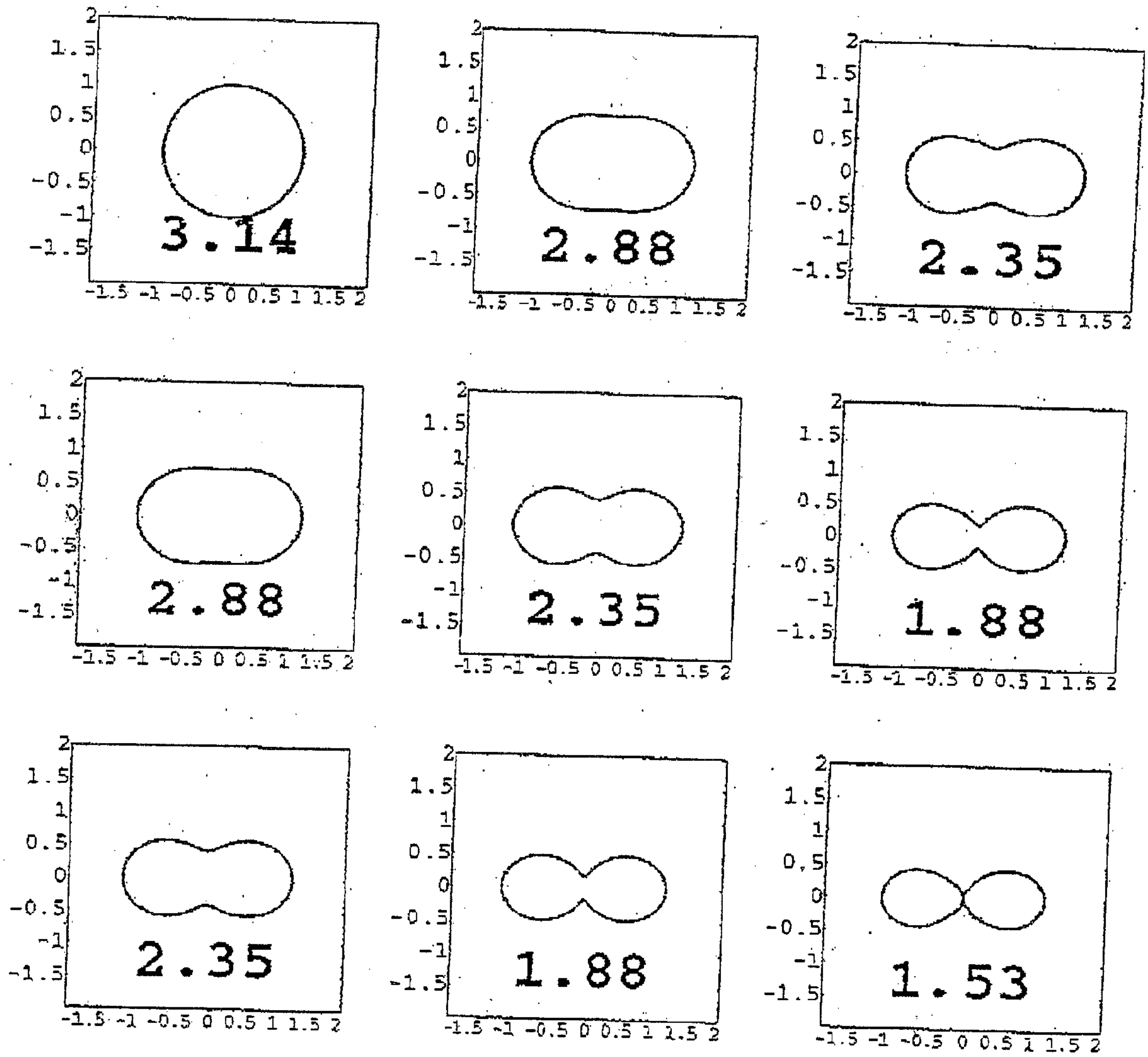


Fig.15D
section I-I (G-G)



$\frac{c_0}{2}=1$ p=0, 0.25, 0.5

$c_1=0$

$c_2=p+q$ q=0, 0.25, 0.5

Fig.15E

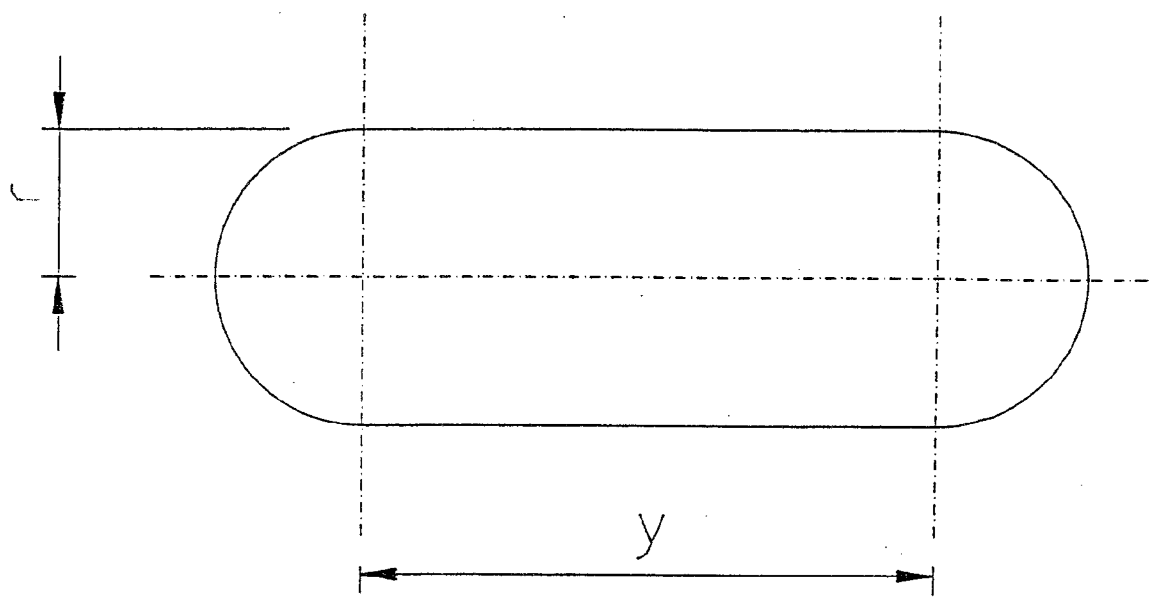


Fig.15F

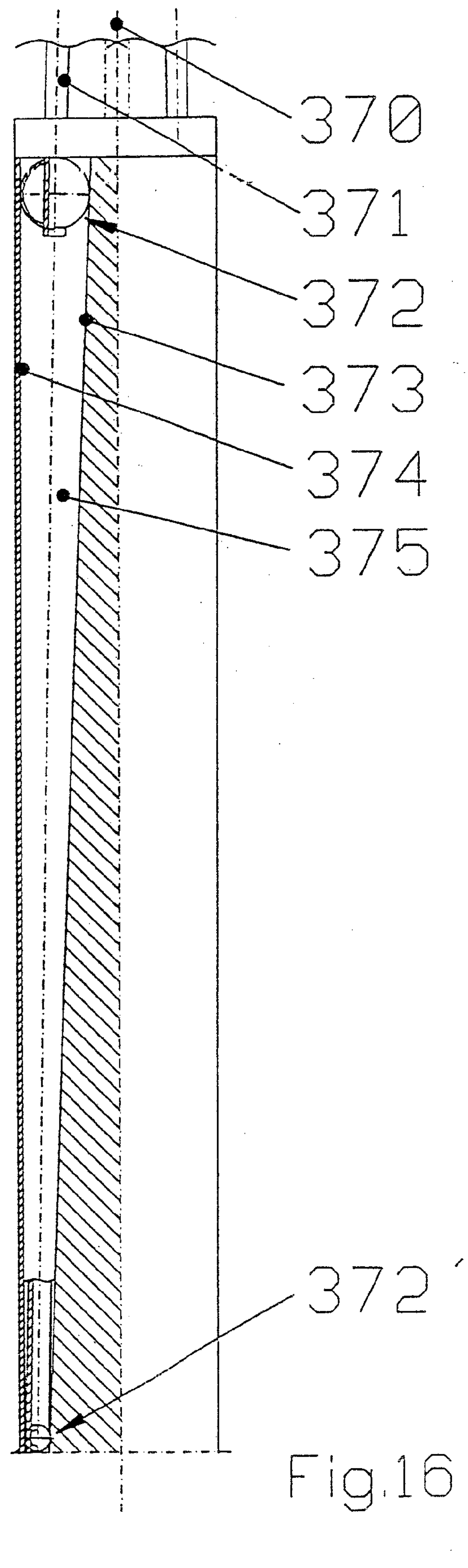


Fig.16

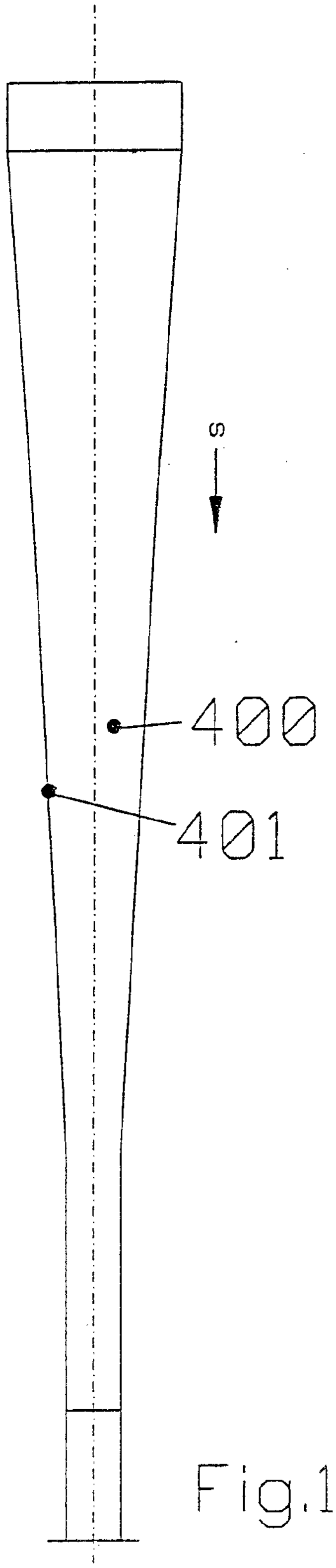


Fig.17A

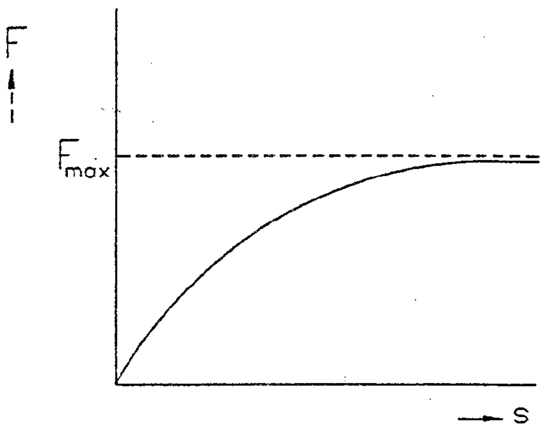


Fig.17B

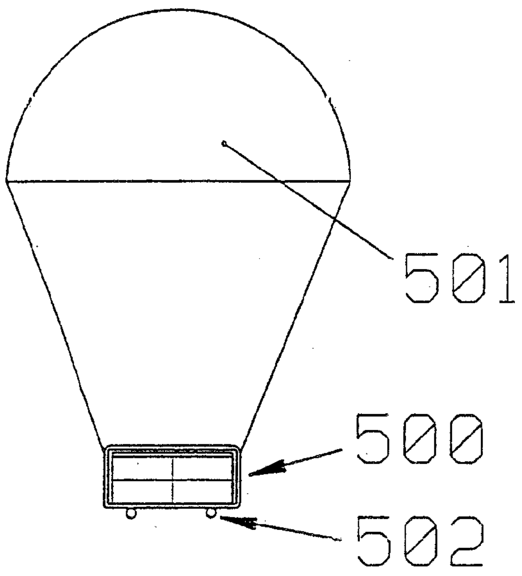


Fig.18A

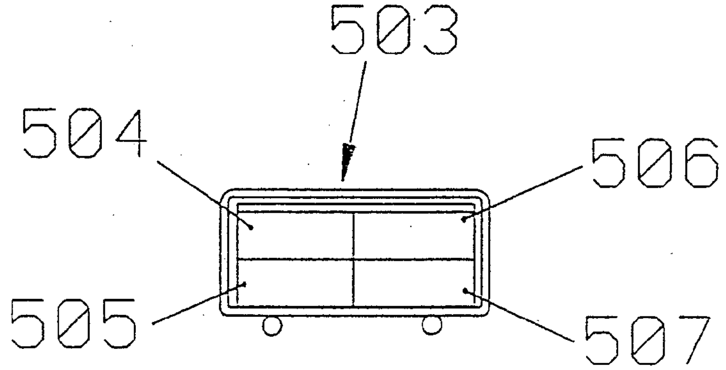


Fig.18B