(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
1 November 2012 (01.11.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/146333 A2

(51) International Patent Classification: Not classified

(21) International Application Number:
PCT/EP2012/000913

(22) International Filing Date:
27 February 2012 (27.02.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11075033.8 25 February 2011 (25.02.2011) EP

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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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(54) Title: PISTON - CHAMBER COMBINATION - VANDERBLOM MOTOR

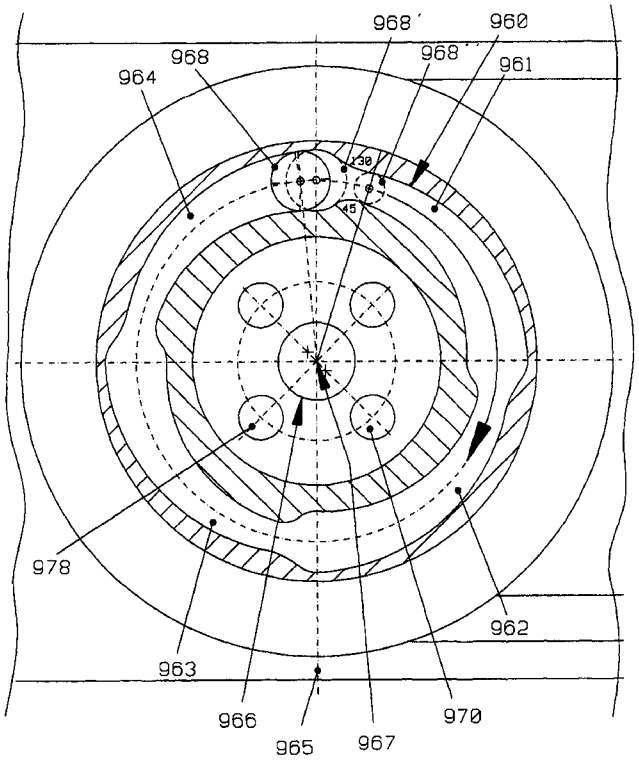


Fig.10G

(57) Abstract: A piston-chamber combination comprising a chamber which is bounded by an inner chamber wall and comprising a piston inside said chamber to be engagingly 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,

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

the container being elastically deformable to provide for different cross-sectional areas and circumferential lengths of the piston. This is accomplished by the combination comprises means for introducing fluid from a position outside said container into said container, thereby enabling pressurization said container, and thereby expanding said container and displacing said container between second and first longitudinal positions of the chamber.

19626 - Piston – Chamber Combination *Vanderblom Motor* **25-02-2012**

19626 TECHNICAL FIELD

A piston-chamber combination comprising a chamber which is bounded by an inner chamber wall and comprising an piston inside said chamber wall to be engagingly movable relative to said chamber wall at least between first and second longitudinal positions of said chamber, said chamber having cross-sections of different cross-sectional areas and differing 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 actuator piston comprising a container having an elastically deformable container wall for engagingly contact with the chamber wall, said container being elastically deformable to provide for different cross-sectional areas and differing circumferential lengths of the piston for adaptation to said different cross-sectional areas and different circumferential 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 the actuator 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 actuator piston is approximately equivalent to the circumferential length of said chamber at said second longitudinal position.

19626 BACKGROUND OF THE INVENTION

This invention deals with solutions for alternatively and efficiently functioning actuators, in relation to existing actuators, and with the important goal of such actuators for fighting climate change, in motors, and specifically car motors. Additionally deals this invention with solutions for an efficient shock absorber, and a pump.

This invention deals specifically with solutions for the problem of obtaining a motor, which does not use combustible techniques of oil derivatives like petrol, diesel, and which can compete with current motors based on said combustible technics. And additionally to comply with the demand for reducing CO_2-emission, so as to compete as well with combustible motors based on H_2, or even air, as it does not need new distribution networks for providing the energy source for the motor.

The combustible motor based on oil derivatives is after today's technical standards only an optimized version of a concept which is approximately one century old. This means that it does not comply anymore to today's standards of living: a waist of valuable and limited available oil, and a source of pollution, such as emission of among others toxic gasses like CO, and gasses like CO_2 which is an important cause of the climate change. Additionally combustible motors tend to be heavy, so that the Transport Weight Ratio (= weight of one person in relation to the weight of what is being transported in total) may be approx. 12 (small passenger car) – 33 (limousine, 4 wheel drive) for a passenger car.

The new combustible motors based on H_2, or even air are lacking the distribution network for deliverance of the energy sources for said motors, such as petrol stations today for the delivery of petrol, diesel and NLG gas. Even the current motor functioning on air needs 'filling' stations for providing the necessary high compressed air in large and heavy cylinders – the lack of such a distribution network was the reason why said motor on air is constructed in such a way that is also can function on combustible means e.g. petrol or diesel – thus back to the Otto Motor again, which ought to be avoided.

The setting up of new networks of providers for these last mentioned new to be used combustible materials needs very high financial investments, and that gives difficulties due to the Catch 22 situation: without a proper fine masked network will these motors not be distributed, because nobody will buy such motor, due to lack of availability, and nobody wants to invest in the network, before there is evidence that there is a market. For a quick introduction and widespread distribution of a non-polluting motor, it is necessary that this motor is independent of networks for providing the energy source. A current development of a home filling station for H_2 seems an interesting but quite so tricky thought, because this gas is a very dangerous gas, and should only be handled by instructed personnel.

19626 OBJECT OF THE INVENTION

The object is to provide combinations of a piston and a chamber to be used in pumps, actuators, shock absorbers and the use of said actuators in among others a motor.

19626 SUMMARY OF THE INVENTION

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

> the combination comprises means for introducing fluid from a position outside said piston said container, thereby enabling pressurization of said container, and thereby expanding said container and displacing said container between second and first longitudinal positions of the chamber.

A classic actuator piston is positioned in a straight cylinder, and said piston is comprising a piston rod. It is moving as a consequence of a pressure difference between both sides of said piston – the last mentioned may be a piston, which is made of a non-elastic material and comprising at least a sealing ring, sealing the piston to the cylinder wall, in which the piston is relatively moving to said cylinder. A piston rod may be guided by a bearing on one or both sides of the cylinder. The piston rod outside the cylinder may be pushing or pulling an external device. It may also be engaging a crank shaft, so that a rotation occurs of the crank shaft axel, which may result in motion of e.g. a vehicle, comprising said actuator and crank shaft.

The actuator piston, when positioned in a straight cylinder may also be an inflatable piston, e.g. a container type piston according to claim 5 and claims 28 and 34 of EP 1 179 140 B1. If said inflatable piston has been pressurized inside, its, preferably reinforced, wall may engage or seal, respectively to the wall of the cylinder, and may act regarding its motion in said cylinder, as the above mentioned classic piston in said straight cylinder. For enabling the motion, a valve on both sides of the piston, e.g. in the wall of the chamber, may be necessary, and a fluid in the cylinder on both sides of said piston with a certain pressure difference, preferably controlled by control means. Changing the size of the pressure inside the last mentioned container wall may only have an influence on the ability to engage or seal of said piston wall to the wall of the chamber. Still, through the friction between the wall of the container, and the wall of the chamber, said internal pressure may have influence on the speed of the motion of the piston.

An actuator according to the invention is a piston chamber combination which has an inflatable piston. Inside the piston may preferably be a fluid and/or a foam under a certain pressure, the piston of which its wall comprising material(s) and preferably reinforcement(s)l may allow it to change shape

and/or size, and the piston may be moving in the chamber or vice versa preferably without the need for a fluid in the chamber and/or without a pressure difference of said fluid or foam on both sides of the piston in the chamber – a fluid in the chamber may of course still be present as e.g. air at atmospheric pressure, e.g. for control purposes.

A further necessary parameter may be that the wall of the chamber is not parallel to the centre axis of said chamber, while the angle of said chamber wall in the direction of the intended motion of the piston has a positive value, so that the piston can expand in said direction. Expansion may preferably be done from a second longitudinal position of the piston, where the piston has its smallest circumferential size: its stressfree production size, to a first longitudinal position of said piston, where the piston has its biggest circumferential size – please see EP 1 384 004 B1.

The motion of the piston may be initiated by the forces towards the inner chamber wall of said container type piston which arise, when the container is expanding. Thus said motion may be initiated by reaction forces from the wall of the chamber to the wall of the container. These forces are a reaction on the expansion of the wall of said container, and said expansion may be a consequence of increasing the volume and/or pressure of the fluid in the piston, as a result of the introduction of more fluid through an enclosed space from a position outside said piston to said container.

In a working prototype of a piston according to Figs. 7A-C (WO 2004/031583) with a reinforcement of Fig, 8D (WO 2004/031583) is the piston *rocketing* from a second longitudinal position to a first longitudinal position, and if unloaded, with a fluctuating speed in a chamber with a so-called constant maximum working force shape (WO2008/025391 – Fig.6B), already at a few Bars overpressure inside the piston in relation to the atmospheric pressure, which was present at both sides of the piston in the chamber, and with a fluctuating positive angle of the inner chamber wall with the centre axis of said chamber in the direction from a second to a first longitudinal position. Said experienced fluctuation of the speed of the piston is explained below.

The contact between the wall of the container and the wall of the chamber may be engagingly or sealingly. It depends more or less on the load on the piston rod, as said prototype reveals. With no load on the actuator, the contact may be engagingly, and not sealingly. With a load on the actuator, the driving forces on the container are bigger than in the case without a load on said actuator, which is why there may be enough force on the chamber wall from the wall of the container, so that the contact

between said walls is sealingly. It may also be that during a move of the piston the contact with the wall of the chamber may be sequencially engagingly and sealingly.

The reasoning why the piston is moving may be as follows. If the longitudinal component of the reaction force from the wall of the chamber to the wall of the container, which is directed to a first longitudinal piston position, is bigger than the longitudinal component of the friction force between the wall of the chamber and the wall of the piston, which is directed to a second longitudinal piston position, the total resulting force will be directed toward a first longitudinal piston position, and consequently the piston will move from second to first longitudinal positions. As preferably the end of the container closest to a second longitudinal piston position is fastened to the piston rod by a cab (192), the piston rod will move as well. A self-propelling actuator has been born, which may be the alternative for a piston which is moving by a pressure difference outside said piston, inside the chamber. Preferably is the other end of the container slidingly movable over the piston rod by means of a cab (191), which means to that the expansion of said container brings said cabs (191) and (192) closer to each other, by the movement of cab (191) toward the cab (192) over the piston rod. This is due to the chosen reinforcement of the wall of the container, which is preferably a one layer of reinforcement strengs directed from cab (191) to cab (192), which lies in a plane which is parallel to the centre axis of said chamber (e.g. WO2004/031583, Fig.8D), and optionally with a slight angle with the centre axis of the chamber and/or at least two layers of reinforcements crossing each other with a very small angle.

Due to the positive slope of the wall relative to the centre axis of said chamber in the direction of first longitudinal piston positions, and the fact that the contact surface of the piston and the wall of the chamber is positioned in the longitudinal direction preferably under the middle point of the elastically deformable wall of the piston, optionally approximately just under said middle point of the elastically deformable wall of said piston, said movement will result in an expansion of the wall of the container. Thus the original contact area between said walls will become larger, and an increased friction force results. Said motion may slow down, as the total resulting force toward first piston positions decreases.

Approximately at the same time that the wall of the container between said increased contact area and said movable cap is expanding, said motion will result in that the cap (191), the movable end of the piston, is coming closer to the cap (192) which is fastened to the piston rod. This means that due to the still present overpressure inside said container (the volume of the enclosed space may need during

the motion from second to first longitudinal piston positions to be constant), the reinforcement in the wall of said container, said wall is expanding as well, more round nearest a second longitudinal position. This means that the wall of the container is rolling over the wall of the chamber, so that said contact area moves toward first longitudinal positions, thereby increasing the component of the reaction force of the wall of the chamber to the wall of said container. The component of the resulting force toward first longitudinal piston positions will increase and will become rapidly bigger than the friction component, so that the part of the container closest to the second longitudinal piston position is moving with increasing speed toward first longitudinal piston positions, thereby taking the non-movable cap (192) with it, thus also the piston rod – the piston is moving from a second to a first longitudinal piston position.

The overpressure is measured in relation to the atmospheric pressure, which is why when the piston may be positioned inside a closed chamber, the last mentioned may need on both sides of the piston to be able to communicate with its surroundings of the combination, which may preferably be under atmospheric pressure.

Instead of the enclosed chamber space may the fluid in the chamber communicate with an enclosed chamber space, so that fluid in the chamber is not prohibiting said movement of said piston. This is a concept which may be used in a shock absorber.

Whether or not an enclosed chamber space òr a channel to the atmospheric surroundings may be necessary depends on the sealing ability of the piston to the chamber wall. A leakage of the piston to the wall may also due, and may be present, as a 100% sealing of the piston to the chamber wall may not be necessary (engaging). Thus, a channel which connects the spaces of the chamber on each side of said container, may be interconnected by a channel, which said piston is comprising.

Said piston may comprising an enclosed space, e.g. a hollow piston rod. The inside of said piston may be communicating with said enclosed space. The volume of said enclosed space may be constant or variable, and adjustable. Said enclosed space may be communicating with a pressure source.

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

A piston-chamber combination further comprising means for removing fluid

from said container through said enclosed space to a position outside the piston, thereby enabling contraction of said container.

The movement during the return part of the stroke of said piston from its first longitudinal position to a second longitudinal position may be done by at least three possible ways.
The traditional way, where the piston is sealingly engaging the wall of the chamber. Said movement however may cost energy, because the surplus of the fluid inside the container type piston, which is shrinking and by that is reducing its internal volume, may be transported towards said enclosed space, of which its internal pressure may increase. In order to save energy, the piston may engage, but not seal to the wall of the chamber – this will reduce the friction force between said piston and said chamber wall.
The last way may be done by reducing the internal pressure of the container during said part of the stroke, by sucking out the fluid from the container That may be accomplished by controlling means, controlling the pressure in said enclosed space.

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

the piston is movable relative to said chamber wall at least from first to second longitudinal positions of said chamber.

It may be possible to move the piston from first to second longitudinal positions, without engaging the wall of the chamber. This may be done by reducing the pressure inside the piston to a minimum level, e.g. that the wall of the piston is stressfree and its circumference is that of its production size at a pressure when it was produced (e.g. the atmospheric pressure), so that the piston can arrive at a second longitudinal position without jamming.

In the **fourth** and **fifth** aspects, the invention relates to a combination of a piston and a chamber, wherein

the piston is comprising a piston rod, which is comprising said enclosed space.

the piston is comprising engaging means outside said chamber.

The suspension of the piston rod may be special, e.g. according to those bearing types shown in WO2008/025391, in order to guide the piston during said part of the stroke, without the guidance of the piston itself, if the piston would not engage the wall of the chamber.

The piston rod may be extending from the piston in one longitudinal direction, and guided by a bearing at an end of the chamber. That means that the piston rod may comprising the enclosed space, and also comprising an engaging means, e.g. positioned outside the chamber. The engaging means may be pushing or pulling when the piston is moving from second to first longitudinal positions. The other way around would the engaging means not be able to push nor to pull. A force outside the piston may be driving the piston from first to second longitudinal positions. When the piston may not be sealingly moving from first to second longitudinal positions, a force on the piston rod may be driving the piston, when the piston is comprising the piston rod. This may be accomplished by said engaging means.

It may however also be possible that the piston is comprising a piston rod which extends in two longitudinal directions, and one piston rod may normally be a continuation of the other. One or both piston rods may comprising engaging means, e.g. positioned outside the chamber. When both piston rod ends may extend outside the chamber, one bearing of the piston rod may be fastened rigidly to the chamber, while the other may be floating in relation to the chamber. The engaging means may be pulling and pushing at the same time, when the piston is moving from second to first longitudinal positions. The other way around – the return stroke - would the engaging means not be able to push nor to pull. A force outside the piston may be driving the piston from first to second longitudinal positions. When the piston may not be sealingly moving relative to the chamber from first to second longitudinal positions, a force on the piston rod may be driving the piston, when the piston is comprising the piston rod. This may be accomplished by said engaging means.

In the **sixth** and **seventh** aspect, the invention relates to a combination of a piston and a chamber, of which the piston rod is connected to a crankshaft, wherein:

a crank is adapted to translate the motion of the piston between second and first longitudinal positions of the chamber into a rotation of said crank.

the crank is translating its rotation into a movement of the piston from first to second longitudinal positions of the piston.

The engaging means may be a crankshaft, which is connected to the piston by said piston rod. In order to be able to at least initiate the motion of the piston from first to second longitudinal positions of the chamber, the crankshaft should turn before said motion commences by said piston, so that the impuls of the contra weights of said crankshaft generated by the motion of the piston from second to first longitudinal positions can be transferred to the piston.

Another option is that the motion of the piston between first and second longitudinal positions may be done by the motion of the crankshaft, initiated by e.g. another piston-chamber combination, of which the piston is simultaneously moving from second to first positions of its chamber (at least two cylinder, working together on the same crankshaft).

The initial motion of the piston may done be e.g. an electric motor, which initiates and shortly maintains the rotation of the crankshaft – a kind of starter motor – until the crankshaft is turning by a piston chamber combination.

In the **seventh** and **eigth** aspect, the invention relates to a combination of a piston and a chamber, of which the piston rod is connected to a crankshaft, wherein:

the crankshaft is comprising a second enclosed space.

the second enclosed space is communicating with a power source.

The crankshaft may be hollow and comprising a second enclosed space. This means that the crankshaft axel and its contraweights are hollow, in such a way, that these together form a channel from a container type piston toward the end of the crankshaft axel. With an O-ring sealing may this channel be communicating with a pressure source

It may also be positioned in the crankshaft inclusively the axis bearing of said crankshaft, so that it may be communicate with an external power source.

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

- said second enclosed space is communicating with the first enclosed space in the piston rod during a period of the time when the piston is moving from first to second longitudinal positions of the chamber.

During the part of the stroke from first to second longitudinal positions, the piston may be depressurized to a certain pressure level at which the piston was produced, and this may be done by connecting the first enclosed space in the piston to the second enclosed space in the crankshaft the necessary period of time during the time when the piston is moving from first to second longitudinal positions. The pressure level under which the piston was produced may not be atmospheric pressure, but may be any pressure level. The higher the pressure level is, the less energy may be lost, when the first and second enclosed space are connecting to each other.

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

- said crankshaft is comprising a third enclosed space, which is communicating with the first enclosed space of the piston rod during a period of the time when the piston is moving from second to first longitudinal positions of the chamber.

This third enclosed space has the function to pressurize the piston again, when its movement changes direction from moving toward a final second longitudinal position of the chamber

towards a first longitudinal position of the chamber. The pressurization is done by connecting the third enclosed space, which has overpressure in relation to the first enclosed space, to the first enclosed space. Pressurization may be done as quickly as possible after the motion of the piston has changed direction.

In an **eleventh** aspect, the invention relates to a combination of a piston and a chamber, wherein:

- said third enclosed space is communcating said second enclosed space during a period of the time when the piston is moving from second to first longitudinal positions of the chamber.

A shock absorber comprising:

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

A shock absorber may further comprising an enclosed space, which may communicating with the container. The enclosed space may have has a variable volume, or a constant volume. The volume may be adjustable.

A shock absorber may comprise the container and the enclosed space which may forming an at least substantially sealed cavity comprising a fluid, the fluid may be compressed when the piston moves from the first to the second longitudinal positions of the chamber.

A pump for pumping a fluid, the pump may comprising means for engaging a second piston in a second chamber from a position outside the chamber, a fluid entrance connected to the second chamber and comprising a valve means, and a fluid exit connected to the second chamber.

A pump wherein the engaging means may have an outer position where the piston may be at the first longitudinal position of the chamber, and an inner position where the piston may be at the second longitudinal position of the chamber.

A pump, wherein the engaging means may have an outer position where the piston may be at the second longitudinal position of the chamber, and an inner position where the piston may be at the first longitudinal position of the chamber.

The technology of the piston-chamber combination may be used in a motor, specifically in a car motor – specifically the self-propelling actuator.

The piston may also move relatively with the tapered wall, within a chamber, which may be cylindrical, or conical (not shown).

The chamber in which the (actuator) piston is positioned, may be of the type wherein said chamber may be comprising internal convex shaped walls of longitudinal cross-sectioned sections near a first longitudinal position, said section may be updivided from each other by a common border, a distance between two following common borders defines the height of the walls of said longitudinal cross-sectional sections, said heights are decreasing by an increasing internal overpressure rate of said piston, or in the direction from first to second longitudinal position the transversal length of the cross-sectional common borders may be determined by the maximum work force, which may be chosen constant for said common borders.

Additionally may said chamber comprising a wall of a cross-sectional border which is parallel to the centre axis of said chamber.

And, said piston-chamber combination may comprise a transition between said convex shaped walls and said parallel wall when said transition may be comprising at least a concave shaped wall, which may be positioned near a second longitudinal position.

And said piston-chamber combination may comprise a concave shaped wall, which may be positioned at least on one side to a convex shaped wall.

19617 SUMMARY OF THE INVENTION – feasibility study

The feasibility study for a 'green' motor is as follows – please review Fig. 10B and Fig. 11B which gives a good helicopter view on the issue. This is a system, where the output of the motor is being generated by a new propulsion system, where an inflatable actuator piston in a chamber with continuously differing cross-sectional area's, is moving by means of internal pressure from a smallest cross-sectional area to a bigger one, thereby decreasing internal pressure, while during the return stroke the fluid of said actuator piston is further depressurized, wherein said fluid is being repressurized by a cascade pumping system using the energy efficient piston-chamber combination according to WO2000/070227, of which at least one step is being energized by an external green power source, e.g. the sun, or preferably any other sustainable power source, or optionally a non-sustainable power source. Still more efficient and reliable solutions can be seen in Figs. 11G and 13F. That system is complying to the earlier stated specifications.

TRANSLATIONAL POWER SOURCE for a 'green' motor based on the principle of Fig. 11A

The overall system solution regarding this invention is, that said 'green' motor as such may be based on comparable construction elements as currently used in combustible engines, but that the new construction elements need to function much more efficiently than those of current combustible motors, and so much more, that the energy used, may be obtained from preferably a 'green' energy source, e.g. like the sun, combustion of H_2 generated preferably when the motor is running by e.g. electrolyses, or optionally by a H_2 refillable storage tank + fuel cell, and/or from a pressure storage vessel, containing a pressurized fluid, preferably of low pressure (e.g. approx. 10 Bar), optionally of high pressure (e.g. <300 Bar) filled once and for all while the motor is produced and preferably repressurized during operation of said motor, optionally refilled when the motor is out of operation, and/or a battery, charged when the motor is produced, and preferably continuously recharged when the motor is running, and/or optionally recharged when the motor is not running, and from the system itself, preferably because the energy needed may be less than the available total energy which the system may perform for the task of generating motion, optionally from another power source

WO2000/070227 discloses a piston-chamber combination technology which can save a substantial amount of energy e.g. up to 65% energy for a pump at 8 Bar (the current working pressure of car motors) – e.g. 10 Bar in a tube with an ø17 mm (from ø 60mm at first longitudinal positions), at second longitudinal piston positions, if the smallest cross-sectional area of a chamber is positioned there where the highest pressure occurs: at a second longitudinal position. The other way around, by using said technology in an actuator instead of a pump, is of even efficiency. WO2004/031583 discloses an expandable piston type (e.g. ellipsoide ↔ sphere: small sphere ↔ big sphere) which is not jamming in said chamber, when the non-stressed production size of a piston has a circumference, which is approximately the size of the circumference of that part of said chamber which has the smallest cross-sectional area: this may be at a second longitudinal position. This piston type shows special characteristics, used as an actuator piston in said chamber, and these characteristisc are claimed in this invention: *the actuator is self-propelling*, if said piston is pressurized through its enclosed space from a pressure source outside said chamber, at said second longitudinal position, and when there is no pressure difference between both sides of said piston in said chamber, while there is an angle not being zero between the wall of the chamber and the centre axis of said chamber – in a working prototype is the actuator piston expanding and rocketing with 260 N to first longitudinal piston positions, where the cross-sectional area is largest, in a chamber which has been designed having a constant maximum working force of 260 N (WO2008/025391, WO2009/083274). This phenomenon may be used in this 'green' motor, thereby exchanging motion based on energy derived from combustible technics, however still using a crankshaft. The energy used due to the expansion may be approximately 5 Bars (e.g. from 10 Bar to 5 Bar overpressure, due to an increase of the piston's volume), e.g. from ellipsoide → sphere by a constant volume of the enclosed space (WO2009/083274). This pressure drop has to be re-gained in the system, because in the return stroke, the actuator piston needs to become unstressed at a second longitudinal piston position, where it has its production size, thus with e.g. 0 bar internal overpressure. The 5 Bar overpressure at first longitudinal piston positions can be re-used, when the piston's enclosed space is connected to another enclosed space, which may be positioned e.g. within the crankshaft, and which is through an e.g. two-stepped pumping process, increasing the pressure from 5 Bar to 10 Bars again. This may be done efficiently by using another aspect of the piston-chamber combination technology which is disclosed in WO2000/070227, so that in the repressurization process also a 65%

energy may be saved: e.g. by using a piston based on e.g. claim 1 of EP1179140B1 or on Figs.5A – 5H of WO2000/065235, of which further developments are additionally claimed in this invention. From these 65% energy reduction can still additional energy be saved, by connecting the crankshaft of said pump to the main crankshaft of said actuator piston: say, said additional saving may be assumed to be 35%. Thus total savings are: 76,7 % (65 + 1/3 x 35%). Thus 23,3 % of the energy should be gained from another pump, e.g. identical with the last mentioned, but which now is getting its energy from e.g. an electric motor which receives its electricity from said battery charged optionally by a solar cell (which should not be bigger than a roof of a common car, òr a solar cells, incorporated in the paint of a car), or optionally by a fuel cell, or preferably by an alternator, which may gets its rotation from an axle of the system of the motor itself or from an axle of a small H_2 combustible engine.
The energy necessary for letting that pump function is 35% of the 23,3 % which is 8,2 %

Neither heat may be generated by said motor, nor noise, while the weight of this motor may be substantially (e.g. 60%) lower than that of current combustible motors, while almost all additional controlling devices which a combustible motor needs, such as controlling water temperature for cooling purposes, oil temperature and the exhaust system, may be unnecessary, as well as a petrol tank – with an aluminum an/or plastic body, may the future car be half of the weight of current cars – e.g. a VW Golf Mark II weights 836 kg, while designed and produced according to this invention may it weight approx. 425 kgs: with only the driver present is the TWR: 6,3!

A problem remaining may be driving during a long time in the dark of the night, when solely a solar cell may be used for recharging said battery. However, the light of lamps of lamp posts in the streets of a town may give enough light for the solar energy cell.

And, a gearbox may be necessary, because the rpm's of such a 'green' motor may be lower than that of current combustible motors.

19617 (amended) added matter to the description – feasibility study

The feasibility study until now did not incorporate quantitatively the lack of heat generated by a motor of this invention, in comparison with Otto Motor types.

When heat loss may be incorporated, than the motor types of this invention are still more interesting and convincing. Heat losses may give a current Otto Motor an efficiency of 25%. When it may be assumed in the first instance that said motor types of this invention do not generate heat at all (isothermal), than it may be possible to reduce the energy used to pressurize the fluid from 5 Bar to say 10 Bar (10 Bar was already present in the pressure storage vessel, when the motor was produced) by approx. 65%. The total efficiency of a motor type according to this invention may then come under 10%, namely 8,75%, by the self-propelling actuator piston, and this is up to now may be unprecedented (David JC Mackay, Sustainable Energy - without the hot air – 2009). When the pumps for regenerating pressure, shown in this invention, again are using the piston-chamber combination types according this invention, than another 65% of energy may be saved. Thus this may result in a total energy use of 8,75% x 0,875 = 7,6%, if we would disregard that heat is being generated by the pump. However, when a part of the energy used for pumping may come from another energy source (than from the total motor power), such as a battery, charged by e.g. solar energy (photovoltaic) and/or a fuel cell (e.g. a H_2), from a flywheel or from regenerative braking devices coupled to a generator, than the total used energy still may end under 10%.

Earlier has already been concluded that the configuration of a motor type according to Fig. 11G, 15C or 15D and Fig.13F,G and Fig.14D may be the most efficient (simple construction, almost isothermal thermodynamics), and may additionally be the most reliable (no leaks), and of which the configuration of Fig. 13F,G and Fig.14D is without the use of a crank generating rotation, will the configuration of Fig. 13F be used in a quantitative assessment of a car motor.

We use a current VW Golf Mark II model RF, 1600cc, weight 836kg, with a 53 kW / 71 pk gasoline motor, comprising 4 cylinders of each ø 81mm, and a pressure of 9 Bar, and a stroke of 77 mm as a benchmark for the invention. This gives a max. force of 1159 N per cylinder, which is approx. 116 kg per cylinder. A weight reduction of approx. 50% may be assumed, if all the combustion parts would be taken out of the car body, and aluminium would be used instead of steel for said body. Thus necessary may be 58 kg per cylinder to drive an aluminium body, up to 4 passengers and luggage.

The chamber of the pump shown in WO2008/025391 has a max. working force of 260N (26 kg), over approximately the whole stroke of 400mm from 2 - 10 Bar, and with a diameter of ø 58mm – ø17mm, respectively. Using an inflatable ellipsoïde shaped piston in this chamber, the actuator is functioning very well in practise. Thus, two of these chambers, now used as part of an actuator could be equivalent with one cylinder of the gasoline motor of said VW Golf Mark II, now made of aluminium, and all parts related to combustion taken out.

In the motor according to this invention, will the pressure in the enclosed space of an actuator piston be changed from x Bar (stroke: $2^{nd} \rightarrow 1^{st}$ longitudinal positions) to approx. 0 bar (stroke: $1st \rightarrow 2^{nd}$ longitudinal positions). The value of "x" may be chosen as small as possible, in order to limit the energy use. Because using said special chamber type, the size of the working force is independent of the pressure value, it may be possible to limit the pressure with using a pressure window to 3,5 Bar at the highest level to approx. 0,5 Bar at the lowest level.

Said starting points may be taken over to the configuration of the pressure in the sphere shaped piston, positioned in a rotating chamber of Fig. 13F – however, the chamber may now be still more simply shaped as the one shown in Fig. 13F, as 3½ Bar uses only a part (216,2mm of the 400mm) of the stroke in said specific chamber – the Force per actuator piston is max. 260N.

The change of the volume of said sphere may be quite big: from

V_2= 4/3 x 3,14 x $12,55^3$ (ø25.1mm; P_2=0,35 N/mm^2)= 8280 mm^3 to V_1= 4/3 x 3,14 x $23,45^3$ (ø 46.9mm; P_1=0,05 N/mm^2) = 54015 mm^3 – which is a ΔV of 6,5 and a ΔP = 7. The angle of the wall relative to the centre axis of said chamber is: L_1=302,78 – 86,57= 216,21, Δr= 10,9: angle= 2,9°- this angle is good.

The energy used for the "virtual" compressing the volume of said actuator piston at a first longitudinal position (index 1) to the volume at a second longitudinal position (index 2) for one cylinder for one complete stroke L_1 is:

$W_{isothermal} = -P_1V_1\ln(P_2/P_1)$= 0,35 x 54015 x ln 7= 0,35 x 54015 x 2,302585 x log 7 = 36788 Nmm/channel/piston/revolution = 36,8 J/channel/piston/revolution, if there would only be one actuator piston per channel. Said motor according to this invention is not as quick as said gasoline motor (900 rev/m), regarding the number of strokes/minute – this is due to the assumed slower expanding and contracting of the actuator piston, which is made of reinforced rubber. Let us assume

the number of revolutions/minute is 60, thus 1 per second (15x slower than said combustible motor). The W= 36,8 J/channel/piston/s. There are 2 x 4 'comparable' chambers (cylinders) - the power is than 294,3 J/s/piston, which is 0,295 kW/piston. When using 5 pistons, one in each of the 5 sub-chambers of each of said 360° channels (Fig. 13F), than may the generated power be: 5 x 0,295 kW = 1,47 kW.

Check of the assumption 1 revolution per second: a combustible gasoline motor amounting 53 kW, of which it was stated earlier in this study, that it may save 92,4%: 7,6% may only be used: 4,03 kW. That may firstly complying to the above mentioned calculation, if the number of revolutions per second may approx. be (rounded off): 3 revolutions/sec.

Thus, a motor comprising 2x4 'comparable' chambers, each comprising 5 pistons in 5 sub-chamber, rotating at 3 revolutions per second (= 180 rev/min.), resulting in a power of approx. 3 x 1,47 = 4,4 kW - this may be enough to drive a VW Golf Mark II with an aluminium body.

The literature (David JC Mackay, Sustainable Energy - without the hot air - p.127, Fig. 20.20/20.21) reveals a small electric car using approx. 4,8 kW power to run, and which is coming from 8x 6V batteries - that car could run 77 km on one batteries' charge, and charging time is several hours. If the energy is coming from batteries, which cannot be charged during the drive of said car, this may be an option, but not a preferred embodiment.

How much energy is necessary to get the actuator pistons pressurized and depressurized, and, can that be done while the car is driving?

It is necessary to get the pressure change in said actuator pistons of said motor energized. We use the principle hown in Fig. 11F and Fig. 13F.

The energy may come from the kinetic energy from said rotating chambers, where e.g. the piston of a classic piston-chamber combination is being moved by a camshaft, which is communicating with a main motor axle of said motor. If we use the data, which have been used for calculating the motor power, than the change in pressure of the inflatable sphere piston may be done by changing the volume of the enclosed space of said actuator piston, by changing the volume 'under' the classic piston.

The volume change per piston per stroke needed by the actuator piston from a second to a first longitudinal position , thus from a small sphere shape (ø 25,1 mm) with a medium internal pressure (3,5 Bar) to a bigger sphere shape (ø 46,9 mm) with a low pressure (0,5 Bar), with a constant volume of the enclosed space is done by the internal pressure change of said actuator piston. The Force is 260N/stroke/piston, irrespective the internal force, thus with 8 chambers, each comprising 5 pistons, and with 3 revolutions per second, the generated power is: 4,4 kW.

In order to come from the first to the second longitudinal position the energy needed is (Fig.14A and 14B):

1. change the sphere shape (ø 46,9mm; 0,5 Bar) of the actuator piston to its production shape (ø 25,1 mm; 0 Bar (overpressure)), by deflation of the actuator piston into the enclosed measuring space, which is now increasing volume - this may be cost no energy, if the friction forces between the pump piston and the wall of the enclose space are small enough,
2. to inflate the sphere (ø 25,1 mm, 0 Bar) to (ø 25,1 mm, 3,5 Bar), by decreasing the volume of the enclosed space, where a pump piston is coming nearer the actuator piston - the energy needed is:

$W_{isothermal} = -P_1V_1\ln(P_2/P_1) = -1$(check this) x 4/3 x 3,14 x $12,55^3$ x ln 4,5*/1 = -1 x 8280 x 2,302585 x log 4,5 = 12454 Nmm/channel/piston/revolution, and for 2x4 chambers, 5 actuator pistons per chamber, 3 revolutions per second. = 12,5 x 8 x 5 x 3 Js= 1,5 kW.

(* P_2 absolute is 4,5 bar, if P_1 = 1 bar absolute).

Thus: generated brutto power is 4,4 kW and needed power for getting the motor run is at least 1,5 kW, thus approx. 2 kW necessary, besides eventual other losses.

In order to access the motor, if a pump complying to the above mentioned should be present in a car, we compare it to what is available: a present compressor has the following specification 220V, 170 l/min, 2,2kW, 8 Bar, pressure storage vessel 100 l. We need the power, but at a lower pressure, so that this modifcated compressor is a bit quicker charging the pressure storage vessel.

P = 2200 W for 8 Bar, hence for 3½ bar may be needed using the same repressuration time as for 8 Bar) only 3/8 x 2200 = 825 W. Even if a battery is a 24V battery, the current will be 825/24 = 34,4 A – this is very much for a battery, and consequently would many batteries be available, in the motor configuration Figs. 11A,B,G and Figs. 12A, 13A, that the pump with reference numbers 826 / 831 should be electrical. Charging these batteries would only be possible by an external power source, so that a car should be ineffective during many hours – the capacitator solution (Fig. 15E) is still in its research phase – this would not be a preferred embodiment, but an optional.

It may be better to avoid a conversion of power, and to use the motor configuration of Fig. 15C where the pump 826 / 831 is communicating with the axle of a combustible motor, using e.g. H_2, which has been generated by preferably electrolyses, and optionally by a fuel cell. The last mentioned process is powered by electricity from a battery which is charged by an alternator, which is communicating with said axle.

The 825 W needs to be generated by said combustible motor – this may be a 24cc / 66cc (VW Golf Mark II has motor of 53kW, 1600cc, ø 90mm, 4 cylinder → 825W is approx. 24cc, 90mm one cylinder òr if 3x faster: 2,2kW is approx. 66cc, 90mm one cylinder) classic motor, using the Otto cycle, which may be compared with a big currently used moped motor. A moped has been shown on television for a couple of months ago, using a electrolyses of water, stored in a tank (originally for gasoline), and using the generated H_2 for the combustion process – this is feasible. For a car is this size of external motor indeed an *auxiliarly motor* – all extra combustible equipment, which we earlier had thrown out of the VW Golf Mark II to gain lower weigth, needs to be replaced by comparable equipment of a moped motor, which is regrettably necessary – no pollution or CO_2 emission, and the noise may be successfully reduced by proper noise reducing measurements, and the weight is only an assume 1/6 (= approx. 35 kg) of that for a car ànd a tank of 15 l water = 15 kgs. – still may this feasibility study hold.

END 19626 amended 19617 added matter to the description – feasibility study

A further development may be that the inflatable piston is moving in a specially designed chamber, so that the generated force of the piston has been maximized, with a minimum of expansion (= pressure drop). And, that the interrupted movement, or 'hesitation behaviour' (please see page **xx**) of said piston may be compensated by an amended internal shape of said chamber.

Controlling said motor according to said first principle according to Fig. 1A is a new aspect as well – for one actuator piston-chamber combination per crankshaft is this as follows.
It is assumed that the pressure storage vessel may have been pressurized by an external pressure source once and for all, thus at the production of the motor. Said actuator piston may start by means of an electric starting motor, using the battery, which has been charged by the solar cells, and/or by a classic dynamo, which is turned around by the main axle of said motor. Said starting motor is

initially turning the crankshaft, and as a consequence of that movement said actuator piston is being pressurized internally – the pressurization of the actuator piston will thereafter take over the initiative of the movement of said actuator piston, and consequently the initiation of the turning of said crankshaft. Said starting motor may then be decoupled from said crankshaft.

It may also be possible that the motor is starting by means of opening up the pressure storage vessel 814, so that fluid 822 is pressurizing said actuator piston internally, which is initiating the movement of said piston – please see Fig.1B.

Speeding up said motor, that is to say, speeding up the rotation of said crankshaft may be done by raising the pressure inside said actuator piston, by means of opening up a so-called reduction valve between said pressure vessel and said actuator piston in the (lead) line [829]. Slowing down the rotation of said crankshaft may be done by reducing the pressure inside said actuator piston, by closing down the opening of said reduction valve.

In order to give the motor more power (torque on the main axle) may be done, by increasing pressure for an existing configuration of actuator piston-chamber combination, or there may be more than one actuator piston-chamber combination per axle. Stopping the motor may be done by totally closing said reduction valve in said (lead) line [829]. Said reduction valve may be communicating with a speeder.

The pressure management in more detail of said actuator piston may be organized as follows. Both in the wall of the crank of the crankshaft and at the end of the piston rod may be holes, which communicate with a second and third enclosed space, and the enclosed space, respectively. At a certain point of time may these holes communicating with each other, so that the enclosed space of the actuator piston may be communicating with the second or the third enclosed space within the crankshaft – while communicating with the second enclosed space, the piston may then be pressurized through its enclosed space and may be moving from a second to a first longitudinal position in the chamber. While communicating with the third enclosed space, deflation of the piston may occur when the piston may be moving from a first to a second longitudinal position. The main piston pump (818) initiates the decrease of pressure in the third enclosed space in the crankshaft and the decrease of the pressure in the enclosed

space in the piston rod, due to the interrelated default positions of the crankshaft of the pump, and of the crankshaft of the actuator piston, respectively, which may be assembled on the same axle.

More in detail may the pressure management of said actuator piston working as follows.
At the final second longitudinal position of the piston may the hole
FILL IN

More than one actuator piston-chamber combination in said motor may be present on the same axle. This concept however may not be helpfull complying to said specifications. As it is with current combustion motors, more than one piston-chamber combination per axle may make the motor running more smoothly. And, of course, the torque will be increased on said axle.
HOW IS IT RUNNING AND HOW IS THE INTERRELATIONSHIP BETWEEN THE ACTUATOR PISTON/CHAMBER COMBINATIONS PER ONE CRANKSHAFT ORGANIZED??

The crankshaft itself may be an inefficient way to generate rotational motion, and moreover, the stroke length of this type of piston-chamber combination may be larger than that of e.g. a current combustion motor – that is to say, that the r(otation)p(er)m(inute)'s of said crankshaft may be substantially lower than that of a current combustion motor. A gear may be necessary, and the gearing ratios may be different from that of current combustion motors. The gearbox may reduce the efficiency with say 25%, and said efficiency may be improved (by say 50%) by using low friction bearings such as Fluid Dynamic Bearings. As the motor may run the whole time, a clutch may be needed. Thus the **33.2**% of energy needed for a car motor should come from e.g. green energy, e.g. solar energy from e.g. solar cells on the roof / hood of the car / the paint of the whole body, and that may be too much. Of course could there be added some special batteries, if these are being charged with energy from wind power or solar energy – this adds to the dead weight of a vehicle and increases the WTR ratio – the last mentioned would partially need a distribution structure. Thus, this motor type may not fully complying to said specifications, when one would aim e.g. a 'green' car motor.

Thus, in order to complying to specifications a crankshaft may be avoided, as well as a gear.

ROTATING POWER SOURCE FOR A 'GREEN' MOTOR based on the principle of Fig. 2A

This bring us to the point where said piston may be rotate instead of translate – this new type of motor may be a kind of a 'green' Wankel Motor.

A1

A still better use of energy may be obtained by a motor without a crankshaft, using the same principle as above mentioned, at least for the propulsion system. Besides the foregoing mentioned, may this decreased use of energy specifically be obtained in a chamber around a circleround centre line, which may be concentrically positioned around the main axle of said motor, by reducing the distance from a 1st rotational position to a 2nd rotational position of a piston in said chamber to approximately the radius of said piston, so that the motor almost continuously may be powering said axle.

A1

A conical chamber, wherein a piston may function as a self-propelled actuator, may be bended circularly in the longitudinal direction, and may be filling 360° or a part of it. There may be at least one piston functioning in said chamber. The motor may comprising one of more actuator piston-chamber combinations, which may be using the same axel. In the center of the circular motion of said actuator piston and/or said chamber may be an axle, which may be connected to the construction elements which makes a car or another vehicle run, such as wheels c.q. a propeller.

There may be two ways to construct such a motor. One is, to have the centre axis of the actuator piston rod moving in the plane where the centre axis of said chamber lies. Another possibility may be that the centre axis of the actuator piston rod may be positioned perpendicular the plane where the centre axis of the chamber lies. In both cases may said actuator piston moving or the chamber, or both.

Running an actuator piston like the one which was used in the elongated conical chamber – an ellipsoide to sphere and *vice versa* formed piston (e.g. WO2000/070227 – Figs. 9A,B,C) in a circularly bend chamber seems unlikely, as the chamber may be circularly bend in its longitudinal direction, so that the bearings of the piston rod of said actuator piston are missing.

Instead, a (smaller) sphere to (bigger) sphere and *vice versa* type actuator piston may be used (e.g. WO2002/077457 Figs. 6A-H, 9A-C), which due to its symmetrical form enables a less complex construction for the bearings of the piston rod. E.g. the piston rod may be positioned through said actuator piston perpendicular to the plane where the centre axis of said circularly formed chamber lies.

Said actuator piston may be moving in said chamber, because of the fact that said chamber is identically shaped as the straight chamber which was used when using a transitionally moving piston, but now, circularly.

However, the size of the part of the wall of said piston which lies behind the transitional centre axis of said piston perpendicular the centre axis of said chamber, and a direct line from the centre of the piston to the place where chamber and piston engaging (or sealing or both), is substantially smaller than that of the ellipsoide ↔ sphere piston which is translating on the centre axis of an elongate chamber. That is why the assumed power which each actuator piston (sphere – sphere) has, may be less than of a ellipsoide ↔ sphere actuator piston. This calls for a motor, where more than one actuator piston per chamber is being used. Additional issues call for the same, because the actuator piston is moving interruptedly (please see later), and more than one piston in the same 360° chamber, may create a smooth motion. And, when said actuator piston(s) having expanded to its maximum, a very short moment occurs, that the pressure within said actuator piston is decreasing, and this may also give a 'moment of hesitation' in the motion – in order that one actuator piston is overcoming 'hesitations' in the motion of another actuator piston, said actuator pistons may be positioned on different positions on the centre axis of said chamber. As an example, if the 360° chamber has been updivided in 4 identical subchambers, the number of actuator pistons may be five, equally divided over the 360°.

The major advantage of such a rotational motor may be, that the length of the return stroke of an actuator piston from a 1st circular position to a 2nd circular position has been substantially reduced in comparison with the crankshaft option and may be at least the size of the biggest radius of the piston at a

1st circular position, because the circular 1st position and the circular 2nd position are in direct continuation of each other in the direction of rotation.

Thus the drop of pressure inside said actuator piston and the raise of pressure immediately thereafter may need to be managed.

There may be two fundamental ways to do change the inside pressure of the actuator pistons. One option is that each of the actuator pistons may be connected by a channel to a valve which may be able to increase / decrease the pressure in said actuator pistons. Said valves may be computer steered, so that the pressure inside each actuator piston is optimal to its position in said chamber. Additionally may be accomplished that said computer is steering the pressure from a pressure vessel, which is serving as a pressure source, so that the distribution of the available pressure in each of the actuator pistons may optimize the use of the available fluid pressure for said actuator pistons. A second option is e.g. by a very short change in the volume of the enclosed space. This change may be done by a movable piston which is sealingly connected to the wall of e.g. an elongated chamber. Said chamber may very well be of the kind having differing cross-sectional in the transitional direction. Because of the speed of the movement may this chamber be of a kind having a constant circumpherence, so that the piston only is bending during operation. But of course, chambers having differing sizes of the transitional circumpherence may also be an option. A piston moving within said chamber may have a piston rod, which may be communicating with a camdisk, which may be connected to the axle on which the motor is mounted. At the end of a piston rod may be a wheel, which is rolling over said camdisk. Thus, as such is this motor type not consuming fluid, only the contained energy (pressure) of said fluid.

The 360° chamber may turn around an axle, of which centre axis may be crossing the centre of said chamber. Said chamber may be part of a wheel, and the outerpart of said wheel may have a notch, in which a drive belt, which may be driving auxiliary devices, such as a electric generator.

Clearly is the type of motor where the chamber is rotating and the piston(s) non-moving the less complex solution of the two options of rotatable motors. Also is the generated torque better, e.g. 5x in said solution, because there are 5x more pistons per chamber of the same dimensions.

The most reliable system may be a fixed piston in a rotating chamber. An advantage may be, that the motor may be comprising more than one piston, e.g. 5 pistons, which each may be positioned at different rotational positions, which may make the motor turning smoothly, because the transition of a piston from its 1st rotational position to its 2nd rotational position may be powered by e.g. 4 other pistons. And the "hesitation behaviour" (please see later) of a piston while moving from a 2nd to a 1st rotational position may be also supported by e.g. the 4 other pistons, so that no "hesitations" may being observed.
A gearbox may be unnessary, as the pressure rate of the fluid inside the piston will define the speed of the main axle – this necessary pressure window may easily be obtained by the construction of this motor, while this pressure may easily be defined by a speeder. Thus a gearbox may be superfluously and that adds to a further weight reduction of approx. 50 kg. The VW Golf Mark II conversion has now been additionally reduced to approx. 350 kg. The TWR is now approx. 5,6.

Controlling the rotational motor may be done in a similar way as the controlling of the motor with translating pistons (or even with translating chambers and non-moving pistons, or even when both are moving – not shown).
Controlling means: putting into function, starting up, speeding up, slowing down, powering up, stopping, and taking the motor out of use.
Putting the motor into function may be done by en electrical on/off switch, which is switching on the electrical system, and another switch which is connecting the starter motor to the electricity circuit, so that it is connecting to the axle, and turning.
On the same axle as the moving piston or moving chamber is using, may there be a starter motor, which is using electricity from a starter battery, which itself is loaded by electricity from a solar energy. The starter motor may be turning said axle, and so initiate the rotation.

FILL IN

The pressure management may be done as follows.
A

In the motor where the piston is moving, needs this piston to be pressurized, and so that pressure is changing at the transition point where the biggest circumpherence is changing to the smallest. This may be done electronically by means of a computer and injection jet. As the pressurized fluid needs to be sustained, said solution needs a new solution.

NEW electronic/mechanic SOLUTION

Otherwise, would it be possible to create a mechanical solution, as the change of pressure is of a certain frequency: e.g. a camshaft, which is communicating with the drive shaft through a time belt. The camshaft may be pressing a flexible membrane which is communicating with said fluid, of which the pressure needs to be managed.
In order to make this solution less complex, may the chamber comprising one instead of e.g. 4 sub-chambers, so that the pressure needs to change only once.

AA
In the motor where the chamber is moving, needs the e.g. 5 pistons to be pressurized, and so that pressure is changing at the transition point where the biggest circumpherence is changing to the smallest. This may be done electronically by means of a computer and injection jet. As the pressurized fluid needs to be sustained, said solution needs a new solution.

NEW electronic/mechanic SOLUTION

In the motor where the chamber is moving, need the inside pressure of e.g. 5 pistons be managed differently from each other, but in the same order, and that pattern repeats itself for every turn, so that also here a camshaft solution may be possible: a camshaft which is communicating with the drive shaft through a time belt. The camdisk may be pressing a flexible membrane which is communicating with said fluid, of which the pressure needs to be managed per piston.

TRANSLATIONAL POWER SOURCE for a motor based on the principle of Fig. 11F

B

A still more reliable system may be obtained by a new principle according to Figs. 11F and 13F for the pressure management, namely by separating the fluid in the piston and the enclosed space, from the fluid in the repressurization stages – the change of pressure in the piston may be obtained by a change of volume of the enclosed space of the piston. The improved reliability may relate to reducing the number of transitions of pressurized fluid, which may leak. In this principle may mainly the controlling devices be using energy for changing the volume of the enclosed space. This may very well be done so that also here energy is being reduced, by using again a piston (e.g. one for the function of said piston, and preferably one for the speed/power – optionally a separate piston for the power management) which is moving sealingly in a cylinder, said cylinder having continuously differing transitional cross-sectional area's and e.g. changing circumferences so that again a 65% reduction of the energy used may be obtained. Also for this principle may the embodiment with a fixed piston in a rotational chamber be the best option for reducing the use of energy. Constant circumferences may also work, but the gained reduction may be lower.

B

The change (and consumption) of pressure of a fluid within an inflatable piston may also be done in an alternative way, alternative to the principle shown in Fig. 11A. By temporary changing the volume of the enclosed space of said piston, while an adjustment of said volume may give a change in the power (torque) of said motor, and this may be done serially of simultaneously. The energy is coming from

This is still a more efficient way to use the available energy, and it may increase the reliability of said motor in relation to the principle of that shown in Fig. 1A. There will in this new principle be no leaks between high pressure fluid when the piston is moving from 2nd to 1st longitudinal positions, and low pressure fluid when the piston is moving vice versa in the joints, such as crankshaft – big end bearing, and the two parts of the connecting rod.

The energy used may be used to move a piston in a conical chamber which may be optimized to reducing the working force on the piston rod of said piston, for changing the volume of the enclosed space. Additionally is the energy used may be used in a similar piston-chamber combination as the one used for said volume changing, for adjusting the volume of the enclosed space.

The movement of the volume changing piston may be done by using pressurized liquid which is moving a piston in a chamber from one point to another an *vice versa by means of e.g. valves or other kind of control devices*, or by magnetic guidance. This is also valid for the piston which is adjusting the volume of the enclosed space – the control of the movement of said piston may be done by communicating with a speeder, which is controlled by e.g. a person or a computer.

ROTATING POWER SOURCE FOR A MOTOR based on the principle of Fig. 13E

The change (and consumption) of pressure of a fluid within an inflatable piston may also be done in an alternative way, alternative to the principle shown in Fig. 12A. By temporary changing the volume of the enclosed space of said piston, while an adjustment of said volume may give a change in the power (torque) of said motor, and this may be done serially of simultaneously.

This principle is in rotating power sources still more efficient than for transitional power source systems, because the distance from 1st to 2nd rotational positions is almost nil – therefore may the piston which is changing the volume of the enclose space be guided by a cam disk, which may be mounted on the axle, around which the motor power source is rotating.

In fact this is the most efficient motor.

A motor with a circular chamber may comprise a wall, at least a part of the length* of the centerline of said chamber, which is parallel to the centre axis of said chamber.

*

In a motor may a conical chamber(elongate or circular*) be of a type where the force of the piston rod, generated by the actuator piston, is constant. That may also be the case for any of the pumps which are incorporating in said motor, where a fluid is pressurized.

The chamber in which said actuator piston is positioned may be comprising internal convex shaped walls of longitudinal cross-sectional sections near a first longitudinal position, said section may be updivided from each other by a common border, a distance between two following common borders define the height of the walls of said longitudinal cross-sectional sections, said heights are decreasing by an increasing internal overpressure rate of said piston, or in the direction from first to second longitudinal positions, the transversal height of the cross-sectional common borders may be determined by the maximum work force, which be chosen constant for said common borders.

In case the piston is positioned in a cylindrical chamber with an internal tapered center, said convex shaped walls are concave shaped.

And, said piston-chamber combination may comprise a wall of a cross-sectional border which is parallel to the centre axis of said chamber.

*

And, said piston-chamber combination may comprise a transition between said convex shaped wall and said parallel wall, where said transition may be comprising at least a concave shaped wall, which may be positioned near a second longitudinal position.

And, said piston-chamber combination may comprise a concave shaped wall which may be positioned at least on one side to a convex shaped wall.

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.

All piston types, specifically those which are containers with an elastically deformable wall may be sealingly connected to the chamber wall during its move between longitudinal positions, engagingly connected or not connected to the wall of the chamber. Or may be engagingly and sealingly connected to the chamber wall. Additionally may there be no engaging between said walls either, possibly touching the walls each other, and this may happen e.g. in the situation where the container is moving from a first to a second longitudinal position in a chamber.

The type of connection (sealingly and/or engagingly and/or touching and/or no connection) between said walls may be accomplished by using the correct inside pressure inside said container wall: high pressure for sealingly connection, a lower pressure for engagingly connection and e.g. atmospheric pressure for no connection (production sized container) – thus, a container with an enclosed space may be preferred, because the enclosed space may be controlling the pressure inside the container from a position outside the piston.

Another option for an engagingly connection is thin wall of the container, which may have reinforcements which are sticking out of the surface of said wall, so that leaking may happen between the wall of container and the wall of the chamber.

In the case of an actuator piston, which is connected to the main axle by a crankshaft, and there are more than one actuator pistons present, all connected to the same main axle, the advantage may be that the turning of said main axle may be more smoothly, if the longitudinal position of said actuator pistons is different from each other, so that the "hesitation moment" for each of said actuator pistons, when moving from a second to a first longitudinal position, may occur on other points of time.

It may be necessary that all of said actuator pistons are engagingly or sealingly (this may be different from a longitudinal position to another longitudinal position when moving in said chamber) moving from a second to a first longitudinal position in a chamber and vice versa, which has the characteristics that the force on the piston rod - thus the connection rod from the actuator piston to the crankshaft - may be independent of the position which the actuator piston has (please see the description and drawings with referent "19620"), in order to synchronise the force of each of said actuator pistons to said main axle.

The feasibility study until now did not incorporate quantitatively the lack of heat generated by a motor of the invention, in comparison with Otto Motor types.

When we incorporate heat loss, than the motors of this invention are still more interesting and convincing. Heat losses give a current Otto Motor an efficiency of 25%. When we assume in the first instance that said motors of this invention do not generate heat at all, than it is possible to reduce the energy used to pressurize the fluid from 5 Bar to say 10 Bar (10 Bar was already present in the pressure storage vessel, when the motor was produced) by approx. 65% reduction.. The total efficiency of a motor according to this invention will then become under 10%, namely 8,75%, by the self-propelling actuator piston, and this is up to now unprecedented (David JC Mackay, Sustainable Energy - without the hot air). When the pumps for regenerating pressure, shown in this invention, again are using the piston-chamber combination types according this invention, than another 65% of energy is saved. Thus this would give a total energy use of 8,75% x 0,875 = 7,6%, if we would disregard that heat is being generated by the pump. However, when a part of the energy used for pumping may come from another source, such as solar energy (photovoltaic), from a flywheel or from regenerative braking devices, than the total used energy still may end under 10%.

The motor based on a crankshaft solution (Figs. 11A-D and 11F) with an elongate chamber and a piston which is connected to said crankshaft by a piston rod / connection rod, may preferably be used as a main motor of a transport vehicle, e.g. a car. Said wheels or propellors may be connected to the central main motor by drive shafts and a distibution device such as a cardan.. Optionally may said motor type be used as a decentrally positioned motor, which may be directly connected to each of the propulsion devices, such as wheels or propellors.

The motor based on a chamber which is positioned around a circleround centre axis and a piston which is increasing and decreasing its size (Figs. 12A-C, 13A-G), may preferably be used as a decentrally positioned motor in a transport vehicle, e.g. a car. Each of said motors may be directly connected to each of the propulsion devices. Optionally as a central motor, which may be connected to said propulsion devices by driveshafts.

The control of said motors may preferably be done by a computer, specifically when each motor is directly connected to one of more than one propulsion devices which a transport vehicle is using.

A flywheel which may preferably be connected to a main central motor, and optionally decentrally positioned to each of the propulsion devise. A flywheel may be used for keeping the motion smoothly – the classic solution – or to regaining energy for acceleration, after braking (and simultaneously storing the kinetic braking energy) of a transport vehicle – or to give energy to one of the pumps (e.g. references 818, 821,821', 826, 826' in Figs. 11A,B,C, F, 12A,C, 13 A,B,E,F) which are communicating with a pressure storage vessel (e.g. references 814, 839, 890, 889). All or a few of said types of flywheels may be present in a transport vehicle, which is comprising a motor according to this invention.

Another aspect of the regaining energy while braking may be pumps which are directly connected to a main axel, which may be a central driveshaft (e.g. references 821, 821'), which may pump the fluid to a much higher pressure and communicate the resulting high pressure fluid to a pressure storage vessel (e.g. references 814, 839, 890, 889).

19617 optimal configuration of chambers for actuators

The geometry of chambers to be optimally used in co-operation with an actuator piston may be different from those, which are aiming an optimal use of a pump, because the conditions for the use in said actuator and said pump may be different.

For example the actuator piston needs to give a maximum force, by using as less energy as possible, while moving at an appropriate speed. And, for an actuator piston which is communicating with a crank, the sub-conditions may be different from the sub-conditions of e.g. an actuator piston which is communicating with a rotating chamber: e.g. the point of time where the maximum force is being needed.

In order to use the actuator piston as a self-propelled piston, it is necessary that an elongate chamber is of a type where the wall of said chamber is widening outwards when moving from a second to a first longitudinal position. Thus, the angle of the wall in relation to the centre axis of said chamber, from a second to a first longitudinal position needs to be positive. This angle may be fixing the speed of the actuator piston. And of course need the transitions from one point of the wall to another in the longitudinal direction be smooth, so as to limit friction between said actuator piston and said wall of the chamber.

The inflatable actuator piston itself needs to have an internal pressure in order to be able to load the wall of the chamber. In order for said actuator piston to be able to move needs the centre of the flexible wall be closer to a first longitudinal position than the circumference which is engagingly connected to the wall of the elongate chamber. The larger this distance is, the higher the speed of said actuator piston in said chamber.

The reaction force of the wall of the chamber on said actuator piston is fixing the force which with the piston is pushing itself off the wall of the chamber in the direction of a first longitudinal position. Thus also the force on the piston rod, if at least one cap of the actuator piston, best nearest a second longitudinal position, is assembled on said piston rod.

In section 19620 of this patent application is a chamber shown (e.g. Fig.21A), which, when used in a pump, reduces the working force on the piston rod with approx. 65% at 8-10 Bar of the pumped fluid – this is excellent for pumping purposes. This reduction should be seen in comparison with the force needed in a straight cylinder, and comes from a comparison of

a classic high pressure bicycle pump, and an advanced bicycle pump where the chamber has the shape of Fig. 21A. In said chamber is the maximum force approximately independant of the pressure of the fluid in said chamber, thus approximately constant (e.g. from 2 Bar, when the maximum force has been reached) during a pumping stroke.

An identical chamber used in an actuator, comprising an actuator piston, may have the advantage that the force is approximately constant during the stroke from a second to a first longitudinal position – the price to be paid may than be that the working force may only be approximately 1/3 in relation to the working force when the maximum pressure has been reached in a straight cylinder having a certain diameter (same comparison source as mentioned above). The size of the force may not be appropriate for the purpose of an actuator piston, while additionally the force, being constant, may not be appropriate either in relation to the use with a crank.

The same may be valid if the chamber is circleround ('circular') instead of elongate. In the particular solution where an actuator piston is non-moving, and positioned in a rotational moving chamber may such a chamber type as mentioned above be used. If more than one piston is used, e.g. 5 pistons (e.g. Fig.10B), than such a chamber may be necessary, when each piston is at a different circular position in each sub-chamber, thus different pressure, the force derived by each piston may be the same for all pistons, so that none of said pistons is pushing others - the total force is 5x that of when only one piston would have been used. A gear may than be necessary to obtain the required torque, and speed, depending on the purpose.

Other optimal configurations of for actuator chambers may be possible.

The parameters for an elongate chamber of which the actuator piston is connected to a crank, may be:

- relative short length L of the chamber, so as to obtain a relative short stroke length,
- the force $F(p,d,\mu)$ may vary during the stroke from a 2nd to 1st longitudinal positions, so that the maximum force is obtained when the actuator piston is almost reaching the extremity of first longitudinal positions [where F= the force from the piston rod; p= the pressure inside the actuator piston; d= the diameter of the chamber at a certain longitudinal position; μ= the friction coefficient between the wall of the chamber and the flexible wall of the actuator piston],

- the friction force F( ) during the entire return stroke is zero, which is obtained by lightly sucking out the overpressure of said actuator piston [F( )= the friction force between the wall of the chamber and the flexible wall of the actuator piston],
- the velocity v(,F) should be optimised with the length L of said chamber [where v=speed of the actuator piston relative to the chamber; =angle between the wall of the chamber and the cdentre axis of said chamber; F= force from the piston rod],
- the energy used is as less as possible - thus: the pressure drop (V) when the actuatore piston is moving from a 2nd to a 1st longitudinal position, while changing its volume, while the enclosed space temporarely has been closed, needs to be as less as possible.

The parameters for a chamber of which its wall is positioned around a circleround centre axis, of which its center is positioned on the centre of the main motor axle, where said chamber is rotating, and where more than one actuator piston is present and non-moving, and being engaging said chamber wall, may be, additionally to said chamber of Fig. 21A, having a circleround transversal cross-section:

- the circumference of chamber wall, irrespective the distance to the centre of rotation, needs to be identical - this may affect the shape of the transversal cross-section of said chamber
- the friction force needs to be optimally small, e.g. by using enhanced libricators like Superlube which has a much smaller friction coëfficient than other libricant, and which is functioning well with rubber and metal, like steel or aluminium.

It may however be necessary to produce an optimal configuration of the piston as well to achieve the effect of that the circumference of chamber wall, irrespective the distance to the centre of rotation, needs to be identical. the circumference of chamber wall, irrespective the distance to the centre of rotation, needs to be identical -

19617 thermodynamical issues

When the fluid in the system (elongate chambers with a an actuator piston communicating with a crankshaft – chambers which may be symmetrically arranged around a circleround centre axis, which may be either communicating with a crankshaft, or with the main axle of a motor) is compressed, heat may very well be produced.

The storage of a fluid in a pressure storage vessel may have been arranged while the device, in which the motor is being used, was produced. While the motor runs, a smaller portion of heat may be generated in said storage vessel, when fluid of a higher pressure from the last pump of the pressurization cascade enters the fluid of said vessel, which may have a lower pressure (Figs. 11A-C, 12A-C, 13A-B).

The pressurization of the fluid which comes from the third enclosed space of a motor type which uses a crank, which is assembled on the main axle of said motor, generates a much bigger portion of heat in the first pump of the pressurization cascade, which may receive its energy from the main axle. And another portion of approximately the same magnitude of heat may be generated with a pump which may gets its energy from the other energy source(s) (preferably any sustainable energy source(s) such as solar cells, a fuel cell, electric batteries which have been loaded by solar energy or optionally a classic energy source, such as electric batteries, which are being loaded by a generator which is communicating with a combustion engine) (Figs. 11A-C, 12A).

In the actuator piston takes both pressurization in the enclosed space + the cavity within the actuator piston body from the second enclosed space, and expansion to the third enclosed space place. As the pressurization may be a bit more than the expansion, the actuator piston may get a higher temperature than its temperature when the motor started (Figs. 11A-C, 11F, 12A-C, 13A-E).

Thus this system is generating heat, which e.g. may be used for heating the cabin of a car, or to heat the third enclosed space, where expansion takes place (adiabatic). Because this is positioned in the crankshaft, it will not be easy to be done. Thus this may be more or less a diabatic situation.

Better of course is it to compensate the production of heat, there where it is being produced: the isothermal situation. In case the change of the pressure inside the actuator piston is being controlled by a piston which is moving in a chamber of a bi-directional pump – which is in

fact an enclosed space of said actuator piston, both compression and pressurization will take place in said chamber by changing its volume, so that heat and cooling may balancing: this may be the case with the combination of a non-moving actuator piston and a moving (rotating) cha,ber (Fig, 13F-G). Again, now with thermodynamic's aspect, is this the most efficient motor principle, because the (theoretical) efficiency may be near 100%.

19617 (amended) energy sources working together with the motor

The motor may be working together with any other energy source, preferably sustainable, optionally non-sustainable. Such energy source may be necessary to feed the approximately 7.5% of the motor, which may be the limit of the efficiency improvement in relation to a classic motor burning fossile fuel, e.g. by using the Otto cyclus.

Sustainable energy sources like e.g. the sun, potential energy from water and wave power and other sources, which do not result in emissions of undesirable chemicals such as CO, CO_2, NO etc., when the energy has been generated.

For a motor according the invention may the energy source(s) preferably be e.g. electricity, a capacitator (= electricity stored in a very big condensator) or electric batteries of any type, charged by solar power through e.g. photo voltaic solar cells with or without focus means (mirrors), or by fuel cells e.g. using H_2, or air compressed by potential hydroenergy etc. An H_2 fuel cell may be 'charged' with H_2, which may have been derived from electrolyses of H_20, which may be stored in a vessel – the electricity may come from a special battery, capable of giving continuously energy (no starter battery) – this battery may be charged by an alternator, communicating with an axle of said motor and/or from photo voltaic solar cells. The H_2 may also be stored in a special vessel, and may directly be inserted in the fuel cell.

Optional energy sources may be electricity, a capacitator or electric batteries of any type, loaded by an electric generator which is turning around on the basis of steam, generated by a fossil fueled burner, or a compressor driven by a motor, burning fossil fuel etc.

A motor according the invention may have one energy source or a combination of energy sources, preferably sustainable, optionally sustainable and non-sustainable.

When the motor is used as a motor in a transport device, such as ships, trains, cars or aeroplanes, which has limited possibilities to connect to big energy sources, the batteries may be temporary charged by an external energy source, e.g. through an electric cable. Filling up of other energy containing materials, e.g. H_2 may be done by hoses etc. Thus charging the energy bearing material positioned in said device by a temporary suitable connecting to said external energy source(s).

It may preferably be that said devices be able to move over such a strategic distance, where it is self-supporting without a longduring external fill up from an external available power

source (e.g. electrical). A strategic distance may have several definitions, e.g. for a commuting car, 2x 50 km commuting + 40 km random per day may be enough without a refill, and e.g. a car used for traveling longer distances may need to travel 500 km without a refill, or even twice that distance. The last mentioned may be the limit for what humans may perform per day.

Preferably may a movable power source (e.g. a battery, a fuel cell, an electrolyses of H_2O resulting in available H_2 for combustion purposes, pressurized fluid or other possibilities not mentioned here) which have been mounted in said transport device be self-supporting for at least one day. It may preferably also be possible to travel at night. Said power source may preferably not add very much to the extra dead weight (increasing the RAT), specifically important for cars, although this may not be decisive for the efficiency.

There are several battery types, and the newest are high power, are efficient, but add much to the extra weight and space. It takes a long time to charge these, while an rapid exchange of batteries is not feasible, as it demands an infrastructure, while one may not be able to separate new from old batteries. A charging from a and/or a solar cell may not be enough for the use of energy (see the feasibility study). It is necessary to have a plug, and a connection to the electricity network, which is an available infra-structure.

In order to reduce the charging time to 1-2 minutes, the 'battery' based on loading a condensator of the size of a suitcase, and release controlled the electricy again to the motor system may very well be the solution for all the problems mentioned above while using a battery. It is still under development in the USA.

A fuel cell may not be cheap, not very efficient to generate electricity, but adds not very much to the extra weigth, and it is n't noisy – this contrary the traditional method when a combustible (fossile) motor is communicating with a alternator – the e.g. necessary H_2 may be a security hazard, and storage of H_2 may be difficult, due to leaking from vessels, which for other matter are leak free. It may also need a distribution infrastructure, although there are already home based electrolyses systems on the market, which with electrolyses produces H_2 for own use. However, after having seen in 2009 a moped, with a combustible motor (< 50cc), using H_2 from instant electrolyses of water, said water being contained in the tank where normally gasoline was stored, it may be possible to do this for this motor according to this invention as well. The electricity for the electrolyses may come from a battery which is designed to be used for

equipment (constant use), and which may be charged by an alternator, using the rotational kinetic energy from said motor, while electricity is additionally charged by e.g. a solar cell.
The electricity generated by a fuel cell, e.g. using H_2, may be used to charge said battery, of which generated electricity may be used for the motor fuctions. An alternator may be communicating with the main axle of said motor, and additionally charge a battery, e.g. said constant use battery and a possible present start motor battery for a possible present start motor. Solar cells may add to charge said batteries. The electricity generated by a fuel cell, e.g. using H_2, may be connected directly to the motor functions, bypassing said batter(y)(ies).

Another possibility may be that e.g. H2 is being used for combustible purposes – e.g. a motor comprising a classic piston-straight cylinder combination with a crankshaft, turning an axle which is communicating with an alternator, said alternator being charging a battery. The alternator may also be directly connected by wires with the other motor functions. The power of said combustible motor may be complying to the complement need for power, thus what the motor according this invention cannot generate. The power of said combustible motor may be very small in comparison with current combustible motors when used for 100% for the motor functions, which makes it feasible that e.g. the eletrolyses process for generating H_2 may be made movable, e.g. to be used in a car.

What may be needed for the current invention is that a bi-directional pump, which is changing the volume of the enclosed space of e.g. the non-moving sphere piston, positioned in a rotating chamber may need electricity, if e.g. an electric motor may be used for turning around an axle which is communicating with a crank, on which the piston rod of said pump has been assembled. Said axle may be the main axle of said combustible motor using e.g. H_2 as fuel.

In another configuration, where said pump is used for a repressuration of a fluid, which is used to control an actuator, which is controlling said pump, it may have the same configuration as in the overall solution mentione above.

Another configuration may be used without using electricity for changing the volume of said enclosed space, when said pump has been exchanged by a camshaft – electricity may than only be necessary for a starter motor, and that may come from a starter battery, which may be charged by an alternator driven by the main axle of said motor, and/or by solar cells. A camshaft

solution may preferably be using more than one piston, optionally one piston. A small pump may be necessary for speeding up, which means a higher pressure in the actuator piston, driven by the main axle or by an electric motor, which gets its energy from a battery, designed for constant use.

The tank, comprising conductive water may be filled up from an external storage of water, and, if the water is not conductive, it may be possible to add conductive material, so that the water is becoming conductive.

The pressure storage vessel may be pressurized, not only by a cascade of pumps, but optionally also from an external pressure source, by a pluggable connection (ref. 2701 in the respective drawings).

The battery may be charged, not only by an alternator, solar cells or/and the H_2-fuel cell, but optionally by an external electric power source, through a pluggable connection. (ref. 2700 in the respective drawings).

The piston and the chamber may rotate both around the middlepoint around which the chamber is rotating.

invention may be constructed with lighter weight than those based on the classic piston-cylinder combination.

For at the motor may function in the dark, a complement or addition to the solar cells may be necessary. This may be e.g. any other sustainable power source e.g. a fuel cell, e.g. of a H_2 type which reacts with the O_2 of the atmosphere, and giving electricity and H_20. This fuel cell may need a relative small storage vessel, which may be of reduced pressure. This is to say, that the distribution system for h_2 may be at home, or that the distribution system may be not very dense.

In the motor type where an enclosed space is communicating with a repressurisation cascade of pumps, the electricity may be used to give energy to electric motor, which is driving the piston pump through another crankshaft - this may be done as a complement to the energy of the solar cells, e.g. when it is dark, or this may be done at any time.

Additionally may a generator been added to this motor type, which may be driven by the main axle, and which may load the accumulator.

In the motor type where the fluid in the enclosed space has been separated from the repressurisation cascade, possibly ore electric energy may be needed, for the control of valves. This may make the necessity of another sustainable power source, e.g. a fuel cell as described above, than the solar cells more likely.

It may also be used for an external cascade system, which has not yet been added to the drawings Fig 11F. and Fig. 13F, which may be needed for the repressurisation of the pressure vessel 1063, and 889, respectively. This may be done by a cascade of pumps, of which at least one is communicating with the main axle, and at least one with an external power source. The pumps may communicate with a pressure vessel. For the solution in Fig. 13F may a pump also be sufficient.

19617 gearbox - clutch

The motor according this invention may have a certain maximum for the number of revolutions per minute (rpm), which is limited by the change of shape and/or pressure at both turning points (first- and second longitudinal positions) when the piston is running in an elongate chamber, or when running in a circular chamber the change point from the first- to the second circular point. The flexibility of the inflatable piston is the key: its wall, which e.g. may be made of rubber – thus the hardness of the rubber – and the reinforcement layer, and how many reinforcement layers are being used, and, if used more than one layer is being used, the in between angle of the reinforcement layers – please see chapter **19650**.

The motor according this invention is a two-stroke motor when a piston is running in an elongate chamber: one half revolution = power stroke, and the other half is the return stroke. When we compare it in the feasibility study with a four-stroke 4 cylinder 1595 cc VW Golf Mark II petrol motor, which has an idle speed of 700-800 rpm, and a maximum of 2500 (check) rpm, the comparable speeds of the motor according this invention may be half of the above mentioned, in order to generate the same power, with the configuration according the feasibility study. This reduced speed would suit the motor according this invention.

A reduced speed would limit the impuls of the main motor axle, when a clutch is starting to engage with the flywheel. In the feasibility study has we figured out the configuration of the motor, when having a comparable torque per kg weight of the car, in relation to the above mentioned Golf Mark II – the 50% reduction of net weight of the car according to this invention, cannot be taken into account now, if we keep said configuration.

If a gearbox (manual, autmatic – e.g. the Van Doorne's Variomatic® or a common automatic gearbox with a fluid), is being used, the ratio's and the number of gears may be different from those in cars currently used. The last mentioned has to do with the specific characteristics (limitation of the functional window in terms of rpm of teh main motor axle) of a combustion motor, which is not present as the main part of the motor according the invention. The last mentioned would, if a gearbox would be necessary, preferably have an automatic gearbox, optionally a manual gearbox.

Quantitative considerations may be as follows:

- wheel diameter: ø 0,65m (VW Golf Mark II),
- motor idle speed: 350 – 400 rpm – motor driving speed: 2x idle speed.

Thus:

60 km/h: motor: 750 rpm
wheels: 490 rpm thus: gear ratio: 1:1,5 down

90 km/h: motor: 1000 rpm
wheels: 735 rpm thus: gear ratio: 1:1,35 down

120 km/h: motor: 1250 rpm
wheels: 980 rpm thus: gear ratio: 1:1,28 down

140 km/h: motor: 1500 rpm
wheels: 1143 rpm thus: gear ratio: 1:1,31 down

Conclusions:

- If no reverse traction was necessary, a gearbox may be unnecessary, and by that another reduction of weigth could be obtained.
- The rpm. seems still too high for the change of shape of the inflatable piston, and if that has been proved to be correct, a gearbox may be necessary – if so, the relatively slow turning motor may be needed to gear up its rpm., in order to be able to couple the motor to the wheels by a clutch; in order to be able to use these rpm. for normally sized wheels, it may be necessary to gear down again.

19617 motor sound

The sound pitch of the power part of the motor according this invention is of very little magnitude due to the lack of explosions, and that may make a big difference with the common well-know engine sound of petrol motors based on the Otto Motor design (please see Classiccars, issue no. 402, pages 86-89, February 2007, "Why engines sound so good" for prior art). Instead, there may be a sound of lubricated (e.g. Super Lube) friction of an inflatable rubber piston body on metal or plastic from the chamber – the sound may be of low frequency.
Only in the elongate chamber design will be a frequency of pitches of sounds (from second to first longitudinal positions) / silence (from first to second longitudinal positions), while there will be contineously sounds in the circular chamber designs – as these also are friction sounds, the sound may be of low frequency.
Because the motor according this invention is a two-stroke motor (remember: a green one!) while most of the car motors today are four-stroke motors, the revolutions per minute in the motor according this invention may be half of that in a motor according the Otto design, in order to achieve the same or comparable power. Also this lowers the number of revolutions per minute which may add the sound to be of low frequency.

Additionally is there sound from a pump (compressor) which is generating the pressure for repressuration of the pressure vessel. When a pump is a piston-chamber type according this invention, it may give some noise from valves and noise from the release of fluid from the chamber to the pressure vessel, and the intake of depressurized fluid – according the type of motor repressuration according to Figs. .....

Current air compressors based on a piston moving in an elongate chamber sound absolutely ungly. These sounds may come from the fact that the speed of the air may be over the speed of sound, so that shock waves are the source of the ugglyness.
In the design according this invention will preferably the speed of the fluid be lower than the speed of sound, optionally will a schock wave from an over air speed wave be damped, e.g. by contra wave designs (such as Audi did in its race cars, which were almost without noise, even the motor was a combustibel motor type).

In the repressuration type according Figs..... there are no valves, and only extra piston chamber combinations, for deriving the pressure change. This motor type is besides being the most efficient, additionally the most quiet of all motor types according this invention.

The generating of electric power for (re)loading a battery for powering the pumps, which may re-pressurize the presure vessel, which may be serving the pressure for the main motor part, may need an Otto Motor of approx. 60 cc (comparable to a moped motor) on preferably H_2 as power fluid, optionally petrol/diesel or any other combustible fluid (please see the feasibility study). The sound of such a moped motor is normally ugly, but may be sounding acceptable, if sound dampened enough.

Thus, the total sound of the motor according this invention is not zero, such as is the case with an electric motor, but a low pitching low frequency sound. This enables the car to be identified by sound as being a car, which is better is this aspect than a car with only an electric motor running at low speeds.

The low frequency may be altered if it is concluded from a working prototype that the low frequency is that of the

19620 SUMMARY OF THE INVENTION

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

said chamber comprising a wall of a cross-sectional border which is parallel to the centre axis of said chamber.

[said chamber comprising a second chamber, which is communicating with said first chamber through a channel comprising a longitudinal cross-sectional section o which the wall is concave shaped, the wall of said second chamber is parallel to the centre axis of said chamber.]

The conical chamber of e.g. an advanced bicycle pump may be updivided into longitudinal cross-sectional sections of which its common borders are defined by an over pressure (e.g. over the atmospheric pressure) rating such as e.g. 1 Bar, 2 Bar .....10 Bar which a piston may produce, while moving from a first to a second longitudinal position of said chamber. Said chamber comprising convex and concave shaped sections of longitudinal cross-sectional sections, said sections are updivided from each other by common borders, the resulting heigth of the walls of said longitudinal cross-sectional sections are decreasing by an increasing overpressure rate, the transversal length of the cross-sectional common borders is determined by the maximum work force, which is chosen constant for said common borders, at least near a second longitudinal position.

Another factor which is decisive for the proper shape of the longitudinal cross-section of said chamber, regarding proper sealing of the piston to the wall of the chamber, in a bottom position (a 2nd position) of the piston, is that, there must be enough space to have the piston at that position and allowing it to move, e.g. when the chamber has been designed for lowering working force: the smallest longitudinal cross-sectional area at the point of the highest pressure: e.g. WO/2008/025391, where the smallest part of the chamber was ø 17mm.

The longitudinal cross-sectional sections may have convex and/or concave sides. The part of the chamber where convex shapes end and where a concave wall part is beginning, and which is matching a cone shaped bottom part, is used in a bicycle floor pump for the purpose to keep the convex / concave shaped part of the chamber on a certain ergonomical height, so that pumping is comfortable for the user (WO/2008/025391).

A spring-force operated piston, e.g. a flexible expandable inflatable container piston (e.g. EP 1 384 004 B1) may begin to move by itself from a second longitudinal position to a first longitidinal position in said chamber, where the cross-sectional area and circumference of a second longitudinal postion is smaller than the cross-sectional area and circumference of a first longitudinal position, if a sealing pressure exists from the piston to the wall of convex / concave chamber walls, and if the longitudinal component of the friction force between the piston and the wall of the chamber is lower than the longitudinal component of the sealing force. In order for the piston rod to maintain its position controlled by a user of e.g. a bicycle pump, it may be necessary that the wall of the chamber which is in contact with said piston, is parallel to the central axis of the chamber. This parallellity provides a sealing force without a longitudinal component, and so remains the piston which is sealing to the wall of the chamber in a position only there, where the user wants it to be. E.g. EP 1 179 140 B1 shows chambers, where in the top (first longitudinal positions) and the bottom (second longitudoinal positions) of the chamber a part of the inner wall of said chamber is parallel to the central axis: thus there where the piston rod is positioned when the pump is either not in use or where the piston rod is changing its direction, the last mentioned which also occurs in the top of the chamber, by a user, when the pump is in use. No reasoning was disclosed for the parallellity in EP 1 179 140 B1

For said piston type to move from second to first longitudinal positions in said chamber is possible when said piston is engagingly movable or when said piston is sealingly movable in said chamber.

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

said chamber has an exit between a convex wall and concave wall,

said exit is communicating with a hose.

The longitudinal cross-sectional sections may have convex and/or concave sides. The part of the chamber where convex shapes end and where a concave wall part may begin, and which may matching a cone shaped bottom part, is used in a bicyle floor pump for the purpose to keep the convex /concave shaped part of the chamner on a certain ergonomical height, so that pumping is comfortable for the user (WO/2008/025391).

If said bottom part is hollow, it may be used it in tree ways.

An option is to keep this part open, and add an exit to said chamber at its second longitudinal position. Said exit may preferably communicate directly with a hose.

Optionally said exit comprises a check valve, where said check valve is communicating with an expansion chamber, which is built in the bottom part of said chamber. The problem is, that such expansion chamber may be only nessessary for higher pressures, and is than delaying the speed of the pump at lower pressures, because the volume of said expansion chamber is to be inflated as well, irrespectively the pressure. Such a solution may be nessesary if a piston would jam in a concave shaped transition from convex shaped wall parts to a further longitudinal position of the chamber, or the piston would be too big to travel to a further longitudinal position.

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

said concave shaped inner walls are positioned at least between two common borders.

Preferably may said hollow part be used as an additional pumping volume of said chamber, and the piston should be able to move toward and in said bottom part without jamming. Necessary is than a smooth transition from convex shaped wall of cross-sectional sections, said transition comprising a concave shaped wall. Depending on the heigth of the cross-sectional sections – thus the pressure rate - these concave shaped walls may be positioned at least between more than two common borders, the last mentioned at high pressures.

If there is not enough space near a second longitudinal position for the piston to move, one can chose to use that, there must be enough space to have the piston at that position and allowing it to move,

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

said second chamber comprising a third chamber, communicating through a check valve with said second chamber

Thus, there may be a point on the wall of said chamber where counted from a first longitudinal position, the convex shape of the sides of the longitudinal cross-sectional area's have to transfer to that part of the chamber in the bottom, where the wall of the chamber wall is parallel to the central axis. In order to do that smoothly, the transition needs to be from convex to concave – thus the shape of a side of the longitudinal cross-section at the transition needs to be concave in the direction from a first to a second longitudinal position.

If the piston has a sealing which takes a certain longitudinale length, so much that the sealing cannot comply to the transition from convex shaped sides of the longitidinal cross-section to a concave shape, then a solution may be to close the chamber there and create an exit by a non-return valve, and use the rest of the chamber as an expansion vessel. This may be usefull for a proper pumping at high pressures.

The positions of said common borders are in both cases (the bottom part used as additional pumping space vs. used as expansion vessel) on different lengths from a first longitudinal position, while their in-between distances are different – the stroke volume of a pump with an expansion vessel is less that that of a pump which is using the bottom part as part of the stroke volume.

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

Said chamber is elivated by a fourth chamber which is open, said chamber has an exit, which end in said fourth chamber.

The fourth chamber is just the basic chamber with its chacteristic shape, and nothing more. Said chamber may have an exit which is a nippel.

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

said exit is communicating with a hose,

In order to optimize the pumping speed, the hose of a bicycle pump may be expandable upon a certain pressure, so that an expansion vessel is created there. That means that the pump is pumping very efficiently at low pressures, where the hose is not creating an expansion vessel – such a pressure vessel creates more volume to the volume of the tyre alone, to be pumped. Most of the pumping is done for low pressure tyres. The expansion of the hose may be limited by a reinforcement of the hose, and the expansion may be done only on a part of the hose.

The piston may be engagingly movable relative to said chamber wall.

The piston may be scalingly movable relative to said chamber wall

19617 – added matter to the description of 19620

Using the chamber from Fig. 21A, which is used in an advanced bicycle pump, the amount of energy used may be reduced by approx. 65% at 8-10 Bars pressure, in relation to current high pressure bicycle pumps. This has been calculated as follows:

The chamber of Fig. 21A has been designed, so that max. force is 260 N, at any pressure, specifically the higher pressures, thus also at 8 or 10 Bars.
Current high pressure pumps are comprising a straight cylinder with an internal diameter of ø 27 mm, so that the working force at 8 Bar is: $F = p \times O = 0,8 \times 0,25 \times 3,14 \times 27^2 = 458$ N. At 10 Bar this is: 572 N
The reduction at 8 Bar is: 458-260/458 = 198/458, so that the reduction is: 43%, and at 10 Bar: 54%. At 12 Bar: 687-272*/687 results in 60%, while 14 Bar gives: 801-318**/801= 66% and 16 Bar: 916-363'''/916 = 60,3%.
The efficiency of said advanced bicycle pump is much higher than the current high pressure bicycle pumps, and that has influenced the choice of the 260N as a maximum force. However, the design has been made that the pump may have a higher pressure rate than 10 Bar, when the ø 17mm straight cylinder part is being used as well, besides the conical part of the chamber: F at 12 Bar: $1,2 \times 0,25 \times 3,14 \times 17^2 = 272$N*; F at 14 Bar: 318N**, 16 bar. 363N***.

Conclusion: the stated 65% at 8-10 Bar should have been 54% - however, as the chosen maximum force of F = 260N influences the result, it may be a good to recalculate the chamber which as optimized for a bicycle pump, but now specifically for the use in a motor.

19617 – added matter for 19620 elongate conical chamber design

The chambers of Figs. 21A,21B, 22-25 (incl.) of EP Patent Application No. 100754027 (08-09-2010) have been designed, based on the following mathematical considerations.

The shape of an elongate conical chamber of a pump, having a centre axis, is a line connecting certain dots (x-coordinate: along said centre axis, y-coordinate: perpendicular on said centre axis) outside said centre axis. Said chamber having different cross-sectional area's, and a first and a second longitudinal position, the first longitudinal position having a bigger cross-sectional area than that of a second longitudinal position, wherein between a piston is moving, said piston is sealingly connected to the wall of said chamber, having a production size corresponding with the circumference of said second longitudinal position, said piston having a certain pre-determined maximum working force due to said shape of teh chamber. The position of said dots relative to said centre axis is determined as follows.

When said piston is moving in an elongate conical chamber, from said first to said second longitudinal position, is the rest volume V_x , which is defined as the volume of said chamber at a position L_x , L_x measured from the overpressure side of said piston to e.g. a farthest away second longitudinal position (0-point), where there is an overpressure P_x , the overpressure P_x is counted in relation to a standard pressure, e.g. the atmospheric pressure, used in this calculation:

$$V_x = 3{,}14.[0{,}00046.\ S_x^3 + (1{,}118 - 0{,}00139.L).\ S_x^2 + (900 - 2{,}236.L + 0{,}00139.L^2).S_x]$$

where:

V_x is the rest volume at P_x= z Bar over standard pressure, where $V_x = V_0 / (z+1)$.

V_0 = is the total volume of said conical chamber, where S = L = the total length of said conical chamber.

S_x = a step in the iterative calculation process.

The longitudinal positions where P_x = z Bar (z) occurs within a certain predefined pressure window (e.g. 1 – 10 Bar overpressure), can now be calculated iteratively (in order to overcome calculations of 3rd degree equations, when no computer software is available), with the step S, which may be a part (e.g. 1/1000) of the total length L of said conical chamber, counted along said centre axis: The S_x is found from said equation, and gives the x-coordinate of said dot, as S_x.L.

If said chamber is comprising non-conical parts (as can be seen in e.g. Figs.21A,B), than only the projected length of conical wall parts on said centre axis need to be used in the calculation of L and L_x.

The y-coordinate of said dot is found as follows.
If a certain maximum working force F_{max} has been chosen, than the position of said dots at a certain longitudinal position L_x at the centre axis, from a chosen 0-point, can be derived as follows:

$D_x = \sqrt{F_{max} / 0{,}008 \,.\, P_x}$ (P_x in Bar, D in mm, F in kgf)

The y-coordinate of said dot from said centre axis at said longitudinal position S_x.L is $D_x/2$, if a symmetrical chamber design in the transversal direction has been chosen, as is in said Figures.

The shape of the chamber wall is than a line through all the points found. In practise is it possible to smoothen ('peditise') said line, if it is drawn as a polyline, so that a contineous shape of a chamber wall results.

19630 SUMMARY OF THE INVENTION: circular chamber design

The circular chamber shown in Fig.13C and 14D, where a chamber may be moving and the piston(s) do(es) non-moving, has been updivided into e.g. four identical sub-chambers. These chambers have been constructed in such a way that that the effect of each may be that the circular force of each piston, having a different position in each of the circular sub-chambers, on the chamber wall may be identical. This, to avoid unnessary friction, which would decrease efficiency, and add to wear of the pistons. The chamber may have a constant circular force, thus a constant torque. The size may only be depending on the pressure.

As such is it not necessary to updivide a circular chamber into more than one chambers, in order to comprise more than one piston. However, the angle of the wall of said sub-chambers is bigger than that of one chamber, having the same circle as centre axis. Thus the force of each chamber is bigger, than if onely one chamber was used for several pistons.

The chamber shown in Fig. 12B, where the piston may be moving and the chamber may not, may have in fact the same basic design as the one mentioned above for Figs. 13C and 14D. The piston may have a constant circular force on said chamber wall.

Said sub-chambers have been constructed, so that the chamber is comprising two circle sections in the circular section. Each of the circle sections have its own centerpoint, which are lying in opposite quadrants, around and at an identical distance of the center point of the circular centre axis of the (sub)chamber. Said circle sections are lying around a centre axis of the chamber, which may be a circle.

SM – PVT1

In a final version, we expect a cross-sectional section of such a chamber, in comparison with that of the elongate chamber of Figs. 21A/B where there are (virtual) common border lines (9,11,13,15,17,19,21,23,25,27) parallel to each other and perpendicular to the centre axis (3) of said elongate chamber (1), that a common border line in a longitudinal cross-section of the circular chamber is converging with a line drawn from the farthest boundary of said chamber in the cross-section to the centre point of the centre axis of said circular chamber (e.g. the two arrowed lines in Fig.27C with two center points) – but not is known where the exact centre point is, and whether or not the centre point of the farthest circular chamber line of said cross-section is identical with the centre point of the nearest circular chamber line of said cross-section (in Figs. 27A-C we assumed two centre points), in view of the requirement, that the maximum force of the actuator in

said chamber on said chamber wall is independant of the position of said actuator in said chamber, and thus independant of the inside pressure of the actuator.

SM – PVT2

A chamber (with the above mentioned characteristics) is engagingly and/or sealingly moving over said sphere shaped piston (Fig.10H with said attempted configuration of the chamber), which is positioned in said chamber. By moving the chamber over said piston a comparable problem arizes, as exists with the front wheels of a car, turning around a corner – both front wheels are not positioned at the same distance to the rotation center(s?), and in order to get the car around the corner, the wheels need to have independant axles, and neither the angles of said wheels in relation to said direction are not the same at the same time, nor the speed of said wheels. Thus, the reaction forces from the chamber on a contact area of the piston are not equally divided over the circumference of said contact line, which should (?) be identical with said common border lines (of an elongate chamber).

Thus, in that case may the engagingly/sealingly connection to the wall of said piston not be a circle line, but more a combination of a circle point (on the boundery of the cross-section nearest to the center of the circular chamber) to a circle section (on the farthest boundery of said cross-section from the center of the circular chamber), and in between said point and section sections of different sizes and possibly also shape(s). This may not be a big hazard, as the connection to the wall of said chamber only needs to be engagingly, in order to generate motion of said chamber. Due to the several sizes of a circumference, said contact may become from sealingly (nearest the centre of the circle round centre axis of said chamber) to engagingly (farthest to from the centre of the circle round centre axis of said chamber), and in between all kinds of combinations of sealingly- and engagingly contacts. This affects the size of the friction between the piston and the chamber wall, and thus the direction in which the relative motion may be generated – in this assumed configuration should said direction be that of the shape of the chamber – is it in our attempted configuration (Figs 27A-C).

In order to reduce the friction may the sphere piston be rotatable around its piston rod – thus around the centre axis of the piston rod, which may be parallel to an axis through a centre point of said chamber, perpendicular the cross-sectional section of said chamber.

ACTUATOR PISTON AND CHAMBER GEOMETRY

Configurations of piston and piston chambers are considered: Circular conic tubes containing a constant area, variable volume, flexible actuator, piston with wall contact. Chambers are constructed as Fermi tubes. Explicit calculations of volumes and contact areas are appended in a roughly commented Maple worksheet. The actuator force distribution is indicated. Figures are somewhat extreme – for the sake of illustrating the importance of the geometry.

1. Fermi tube construction

The central base circle (around which the chamber is 'bent') is parametrized by 'unit speed', has radius R and center at the origin $(0,0,0)$ in a fixed (x,y,z)-coordinate system. See blue circle in figures ~~7, 8~~ 32G, 32H etc. The vector function for the base circle is standard:

$$\gamma(u) = R \cdot (\cos(u/R), \sin(u/R), 0) \quad . \tag{1.1}$$

Along this base circle we will consider only the turning angle interval $u \in [0, L]$ for which the piston has contact with the chamber wall.

In each orthogonal plane (see figures 1 and 2) to the base circle for $u \in [0, L]$ we define a circle, which will eventually trace out the full chamber and thence also that part of the piston which has chamber-wall contact. These circles have radii $\rho(u)$ which depend on the base circle parameter $u \in [0, L]$; and they all have their respective centers on the base circle.

The family of circles trace out a tube surface, a so-called Fermi tube, around the base circle.

We will assume that the function $\rho(u)$ is linear in u so that the corresponding Fermi surface may be called *conic*, see corresponding figures ~~6, 7, and 8~~ 32F, 32G and 32H. The conic effect (which will eventually drive the piston inside the chamber) can be obtained by any other *increasing* function of u. The linear radial function is then the following (this is applied for specific values of α and β in the Maple appendix and used for illustrations in this report):

$$\rho(u) = \alpha \cdot u + \beta \quad . \tag{1.2}$$

The parametrized Fermi tube *surface* with radius function $\rho(u)$ which is 'bent' around the base circle is then given by the vector function:

$$r(u,v) = \gamma(u) + \rho(u) \cdot (\cos(v) \cdot e_1(u) + \sin(v) \cdot e_2(u)) \quad , \tag{1.3}$$

where $e_1(u)$ and $e_2(u)$ are orthogonal unit vectors which span the orthogonal plane to the base circle as shown in figure 1:

$$\begin{aligned} e_1(u) &= (\cos(u/R), \sin(u/R), 0) \quad , \\ e_2(u) &= (0,0,1) \quad . \end{aligned} \tag{1.4}$$

The parametrized Fermi tube *solid* with radius function $\rho(u)$ which is likewise 'bent' around the base circle is then:

$$\widehat{r}(u,v,w) = \gamma(u) + w \cdot \rho(u) \cdot (\cos(v) \cdot e_1(u) + \sin(v) \cdot e_2(u)) \quad . \tag{1.5}$$

Note that the surface is obtained from the corresponding solid simply by setting $w = 1$:

$$r(u,v) = \widehat{r}(u,v,1) \quad . \tag{1.6}$$

The volume of the Fermi tube solid (corresponding to the turning angle interval $[0, L]$) is determined by

$$\text{Vol} = \int_{w=0}^{1} \int_{v=-\pi}^{\pi} \int_{u=0}^{L} \widehat{J}(u,v,w)\, du\, dv\, dw \quad , \tag{1.7}$$

where the Jacobi function integrand is given by the partial derivatives of $\widehat{r}$ as follows:

$$\widehat{J}(u,v,w) = |(\widehat{r}'_u \times \widehat{r}'_v) \cdot \widehat{r}'_w| \quad . \tag{1.8}$$

The area of the Fermi tube surface is (corresponding to the turning angle interval $[0, L]$) :

$$\text{Area} = \int_{v=-\pi}^{\pi} \int_{u=0}^{L} J(u,v)\, du\, dv \quad , \tag{1.9}$$

where now the Jacobi function integrand is:

$$J(u,v) = |r'_u \times r'_v| \quad . \tag{1.10}$$

The Maple output appendix contains an example of the calculation of the respective total area and total volume calculated from the chosen values of the constants defining the geometry in the particular case considered and shown. This is fully general and can be numerically evaluated with any other choice of geometric descriptor values.

The total area and total volume includes the values from the end caps which we now discuss.

2. The end caps

We assume that the end caps are spherical. This is not absolutely needed. What we need is a circular fit to the tube part of the chamber in both ends and a handle on the enclosed volume and total surface area of the piston. Both are obtained most easily – for the present model considerations – by spherical end caps, see figures 4 and 5. 32D 32E

In fact the sperical assumption is not completely realistic either:

Given a perfectly elastic piston material it will at all times have constant mean curvature wherever it has no wall contact, i.e. in this setting it will (tend to) have the same spherical radius at both ends. This condition is not implemented in the present discussion.

With a physically precise description of the flexible piston material it is possible to estimate the actual shape of the end caps, the volume they enclose, and thence at each instance of time the internal pressure inside the piston.

Spherical caps have simple geometric expressions for their area and 'enclosed' volume, i.e. the volume cut off from a solid sphere when cutting off the cap by a planar cut. Here we will therefore continue with this Ansatz of spherical caps.

The area of the cap with height h and base radius a is (see figure 3):

$$A(h,\rho) = \pi \cdot (a^2 + h^2) \quad . \tag{2.1}$$

The volume of the cap with height h and base radius a is

$$V(h,\rho) = \frac{1}{6} \cdot \pi \cdot h \cdot (3a^2 + h^2) \quad . \tag{2.2}$$

For completeness we display also the radius of the virtual sphere from which the respective end caps are taken for $u = 0$ and $u = L$ respectively:

$$r(u) = \rho(u) \cdot \sqrt{1 + (\rho'(u))^2} \quad . \tag{2.3}$$

In the tube geometry the values of a and h are determined only by the radius function $\rho(u)$ and its derivative $\rho'(u)$ at the u end-values $u = 0$ and $u = L$ respectively; the base circle radius plays no role!

$$\begin{aligned} a &= \rho(u) \quad , \\ h &= \rho(u) \left(\sqrt{1 + (\rho'(u))^2} - \rho'(u) \right) \end{aligned} \tag{2.4}$$

Thus the end cap areas and volumes are determined solely by the respective values of ρ and ρ' when the spherical Ansatz is assumed to

hold.

Since the end cap(s) are supported or attached to a shaft, say a rigid version of the base circle, this attachment and the induced coupling of forces there between shaft and piston will alter the spherical geometry of the piston end(s). Given a precise description of the attachment and of the piston material it could be possible to estimate the geometry of the resulting deformed end caps. This will not be considered here.

3. Moving the piston and shaft attachment

Most important is the area and the geometry of the precise contact between the piston and the chamber wall. It is via this contact that the driving force on the piston is activated. In the present model the wall contact is modeled by a Fermi tube around a given base circle; volume (pressure) and area (forces at the wall) are calculated accordingly.

The actual sliding force *along the wall* of the chamber is obtained by geometrically symmetric (around that direction as axis) double projection of the gray total force on the chamber segment shown in figures ~~8, 9, 10, 11, 12, and 13 below~~. Hence the resulting sliding force is proportional to the longitudinal length of the segment and to the internal pressure of the piston; pressure = force per area.

32H–32M(ind)

Depending on the friction model (friction between chamber wall and piston) and depending on the material properties (elasticity etc) of the piston, this resulting force will drive the segment in the longitudinal direction. Since the force at each segment is proportional to the longitudinal length of the segment and hence proportional to the *distance of the segment* from the center of the base circle, it will tend to (to first order and again very much depending on the physical descriptors alluded to above) orchestrate the resulting *motion* of the free piston surface as a rotation around the center of the base circle.

If the piston is attached to a shaft along the base circle in the chamber, the force described can likewise be applied to pull or push the attached circular shaft into circular motion around the center of the base circle.

19640 SUMMARY OF THE INVENTION

EP 1179140B1 shows on Figs. 5A-5H (incl.) a piston (Figs. 105A-105H of this patent application), which is comprising six support means 43, which are rotatably fastened around an axle 44 to a piston rod 45. The other ends of said support means are assembled on an impervious flexible sheet, positioned between a flexible O-ring, which is sealingly connected to the wall of a piston-chamber combination, where the chamber is conical. Said O-ring is squeezed to the wall by said support means, due to pulling springs which at one side have been assembled on said piston rod, and at the other end on said support means near said O-ring, so as to spread said support means from the piston rod to the wall of the chamber. Additionally a spiral spring, which is circleround laid on the impervious sheet, having its center on the centre axis of said chamber, and pressing said O-ring to the wall of said chamber, there where said support means are not supporting directly said O-ring. This was a main solution as a solution principle.

The not yet solved aspect of this construction is that said impervious flexible sheet is free hanging and it may be pushed inwards (change shape) the piston (Fig. 5G, 5H) when pressurized by a fluid under said sheet. Another not yet fully developed aspect is a proper assembling of the O-ring to said support means. And, a proper asssembling of said support means to a means which is keeping the O-ring in place between the assembling points of said support means to said O-ring.

There may be two prefered solutions for avoiding the change of shape of the impervious flexible sheet. Other solutions may be possible, but have not been not shown.

One is that said impervious flexible sheet may be assembled at the end of the piston rod, e.g. by a screw. Another solution may be, just to vulcanize said sheet on and around the piston rod. This fastening of said sheet to the piston rod may substantially reduce (but bot avoid) the change of shape of said sheet, when pressurized. And, additionally, a shape change of said sheet may additonally be reduced by a proper reinforcement of said sheet. First of all, the sheet may need to have a production size having a circumference which is approximately that of the circumference of the chamber wall at a second longitudinal position. In order to seal said sheet to the wall of the chamber, when the piston is moving to a second longitudinal position, said sheet may need in the first instance to be spreaded, when firstly moving the piston from said second longitudinal position to a first longitudinal position. The pulling springs on said support means may be pulling a bit more than the pulling forces in said impervious sheet, pulling it back to its

production size, when the piston is not at a second longitudinal position. A third force may be pulling the O-ring from the wall, and that happens when said sheet would bend upwards when pressurized. In order to substantially prevent that, the reinforcement may comprise concentric reinforments, which may have been made of flexible material in its length, òr, if made of non-flexible material as a spiral, having the centre axis of the piston rod as centrum. Other reinforcement possibilities may be possible, but are not shown. The use of said reinforcement patterns mean that the sheet may be widened in 2D, in a transversal plane, perpendicular the centre axis of said chamber, and only a bit in the direction of the centre axis of said chamber. Preferably is the reinforcment layer of said sheet positioned closest to the high pressure side of said sheet, and another layer without reinfocements may be vulcanized on the first mentioned layer. The production thickness of each layer may be so thick, that the decreased thickness at a first longitudinal position may be enough for a longduring proper functioning of said piston.

Also the O-ring may have a production size where its external circumference is approximately the size of the circumference of said chamber at a second longitudinal position. Also here should the production diameter of said O-ring be big enough to compensate for the decrease of thickness when the piston has been moved to a first longitudinal position.

The impervious sheet may be vulcanised on / in said O-ring, so as to achieve a proper sealing, when the O-ring is sealingly connected to the wall of the chamber.

The lying spring may be vulcanized on both said O-ring, the ends of said support means and on the impervious sheet. This keep the whole together.

Having assembled the impervious flexible sheet onto the piston rod, the widening of said sheet may substantially be caused by the pulling forces of the springs on said support means, and by the rotation forces of said support means. There may be a balance of forces of the internal pull forces of the impervious flexible sheet , O-ring and the pushing forces of the lying spiral spring and the pushing forces of said support means, and the reaction forces of the wall to the O-ring, so that allways the O-ring may be pressed onto the wall of the chamber for achieving a sealingly connection. The lying spiral spring shown in the Figures of said prior art, which mainly should keep the O-ring in place between the support means ends, would possibly not give enough force to do that job. Instead, an elastic metal rod may keep the O-ring better in place. Both ends

of said rod may be sliding between two adjacent support means, while two rods may slied along each other through a support means.

19650 SUMMARY OF THE INVENTION

EP 1 179 140 B1 discloses an elasticallyl deformable means, which has been stiffened by stiff members, which are rotatably fastened to a common member, such as a piston rod, in case a piston may be made of said elastically deformable means. The elastically deformable means may have a tranversal cross-section of that of a trapezium. When moving in the chamber from a first longitidinal position to a second longitudinal position, wherein the wall of said chamber at a second longitudinal position is parallel to the centre axis of said chamber, the trapezium becomes more and more a rectangular. Said stiffereners may rotate to an angle where the stifferers are approx. positioned parallel to said centre axis, when the piston is moving from a first to second longitudinal position.

A foam may expand from a second longitudinal position in a elongate chamber to a bigger shape at a first longitudinal posirtion. But it may be done in a different way than expanding an inflatable container which is comprising a flexible wall, with a production size so that the circumference is approximately the circumference of the wall of the chamber at a second longitudinal position (please see e.g. EP 1 384 004 B1). When it is moved to a first longitudinal position, and it may need to be engagingly connected to the wall of said chamber, the thickness of the wall of said container may be decreased ("balloon effect").

A motor wherein a pump having a piston engagingly and/or sealingly movable in a chamber, wherein

- in the elastically deformable means is made of Polyurethane-foam,
- the PU-foam is comprising a Polyurethene Memory foam and a Polyurethane foam.
- the Polyurethane foam is comprising a major part is Polyurethane Memory foam, and a minor part Polyurethane foam.

An elastically deformable means may be made of a foam. Specifically good characteristics for harsh circumstances as e.g. a moving piston in a chamber of a pump may be Polyurethan Foam.

The growing in size of a foam when moving from a second to a first longitudinal position may be done by enlarging the cells wherein the fluid is positioned, which may be present in said chamber. That may be possible, when the cells are open, that is to say, that the inside of said cells may be communicating with the atmosphere around said foam, in said chamber. Thus the foam at a second longitudinal position needs to be under pressure so as to be able to decrease the size of the open cells in the foam, and, at a second longitudinal position needs the foam be under pressure, in order to be able to expand itself, when moved to a first longitudinal position. The foam, thus the material of the walls of the open cells may than needed being very elastically. Such a material may be a Polyurethane (shortly 'PU') foam, and a very flexible type of PU foam may be the so-called Memory Foam.

Materials which are very flexible may however not withstand very well big pressure by itself, such what a piston needs to be capable of. In order to gain a better resistance to pressure, a kind of a sandwich may be made, which may be made of e.g. a two layer PU, of which one layer is made of less flexible PU foam than PU Memory Foam, and a layer of PU Memory Foam – the two layers may be glued to each other. If there is no space for layers and/or a sandwich may be difficult to be produced, a mixture of a PU foam and a PU Memory Foam may be the solution. The percentage of a normal PU Foam may be a minor part of the total mixture.

A motor wherein said pump having said piston wherein

- the support members are bendable,
- said support members have been pre-determined bending force,
- said members being locked in a holder, which is connected to the piston rod, and being rotatable around said bend of said stiffener in said holder,
- said end is being under pressure of an adjustable member,
- said longer end of said stiffener having an increased thickness.

Said Memory Foam material is quickly regaining its original size when released, after having been depressed, at normal working temperatures, such as 10^0 - 100^C C. At lower temperatures such as around the freezing point, it takes longer time, and that may be too loong, in

order to comply to the demand of engagingly and/or sealingly connected to teh wall of the chamber. It may be necessary that said stiffeners are being made of a spring material, so that when the piston is moving from a second to a first longitudinal position, said stiffeners may be pressing the foam outwards. A pre-determined bending force may be necesasary, and that may be done by e.g. the end of said stiffener, being bended a much shorter length than the total length of said stiffener, thereby the angle being capable of locking the end of said stiffener in a holder – said holder may be connected to the piston rod. The pre-determined bending force may be obtained by an adjustable member, which presses the short end of said stiffeners – it may be a rotatable member, which can be locked in a certain position.

When moving from a first to a second longitudinal position said foam may be being pressed inward by the wall of said chamber, and said foam may need to be in such a shape, that no lateral forces are present, so that the cast foam, which glues to said stiffeners (which may be preferably made of Polyurethane), has become unstuck, so that its function is lost.

In order to avoid that said stiffeners are becoming instuck another measure is to increase the thickness of the long end of said stiffeners, close to where pressure is obtained from the fluid under the piston in said chamber.

A motor wherein said pump having said piston wherein

- said flexible impervious layer has an unstressed production size with a circumference which is approximately the same as the circumference of the wall of the chamber at a second longitudinal position.

A foam piston with open cells is engaingly connected to the wall of said chamber. In order to make it sealingly connectable to said chamber wall it is necessary to add an impervious layer, such as a nature rubber type. This may need to comply to approximately the same sizes of a circumference as an inflatable container type piston. Thus may need the size of said layer having a circumference of that of the chamber wall at a second longitudinal position, unstressed – thus needs the assembling be around a foam under pressure. When moving from a second to a first longitudinal position, the foam and thus said stiffeners) need to press the layer into the shape

(trapez) of the foam when being positioned at a first longitudinal position. When returning to said second longitudinal position, said layer may be shrinking into the approx. rectangular shape of said foam at a second longitudinal position: it needs to be flexible. The impervious layer may need to be able to communicate with the fluid of the non-pressure side of said piston in order to be able the open cells to communicate ('breath'), when moving from second to first longitudinal positions and *vice versa*.

19660 SUMMARY OF THE INVENTION

EP 1 179140 B1 shows an inflatable container piston type, while EP 1 384 004 B1 shows that this piston type should have an unstresed production size wherein its circumference at the second longitudinal position of an elongate chamber, should have a circumference which is approximately the same as the one of the chamber, so as to avoid that the piston is jamming when moving from a first to a second longitudinal position.

The piston is expanding when moved from a second to a first longitudinal position. EP 1 384 004 B1 shows that a reinforcement for such a desired behaviour may be a layer where the reinforcement strengs are laying parallel besides each other in an unstressed production model, and these strengs are connecting the two end parts, of which one is mounted on the piston rod, while the other ican glide of the piston rod - the rubber is directly vulcanized on both ends. The reinforcemnet layer is the inner layer, while another, thicker layer than the layer with reeinforcement strengs, is protechting said reinforcement layer. Both layers are being vulcanized on each other, and at the end parts, there may be another extra layer on top of the two. The function of the second layer is additionally to avoid that the reinforcement strengs are 'sticking' out of the outer layer, thereby making a sealingly contact with the wall of the chamber impossible – however, for an engagingly contact is this just fine. Hacving the second layer on top of the reinforcement layer is working fine in practise, and it has shown be possible to expand near the 330%, e.g. in a chamber of a pump (please see 19620) where the force on the piston rod is constant, from an ø17 mm (2nd longitudinal position) to an ø 59 mm (1st longitudinal position). With two reinforcement layers on top of each other with a very small angle for overlapping each other, and on top the above mentioned 'second' layer makes the container more strong, but expansions possible are much less 330%.

The types of rubber of the layers rubber may be different, but should be compatibel so, that these can be vulcanized on each other, without getting lose from each other under normal working conditions.

It was observed that when the ellipsoide shaped container type piston was expanding completely to its sphere shape, the chance of breaking apart was very present – that is why the design may be changed so that the length of the piston as unstressed production model be increased, by keeping the other variables, such as the chamber design unchanged – thus, the sphere shape may not be reached and neither an expansion to 330%, only an ellipsoïde which has almost become the shape of a sphere – this makes the piston reliable, even with one layer with reinforcements.

The shape of the container in an unstressed production state may also be that the wall of the container is not parallel with the centre axis, but parallel to the wall of the chamber because the wall of the

chamber at a second longitudinal position is not parallel to the centre axis. Just the wall of the chamber is free of the wall of the container in said unstressed production state.

19660-1 Update on the functionning of actuator piston

The actuator piston is comprising a container, said container is comprising awall around a cavity, said cavity may be inflatable and pressurized by a fluid and/or may comprise a foam, said container is moving from 2nd to 1st longitudinal positions of the chamber, when pressurized, in a 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, due to sliding of the wall of said container of said actuator piston on the wall of said chamber.

This may also be the case for chambers having cross-sections of different cross-sectional areas and equal circumferential lengths at the first and second longitudinal positions, and at an intermediate longitudinal position.

Said wall of the piston may preferably having a symmetrical shape in the longitudinal direction of the chamber between the end cabs (the movable and the non-movable), around a transversal central axis, wherein each symmetrical half part having longitudinal cross-sections of different cross-sectional areas and different circumferential lengths at least substantially continuously different cross-sectional areas and circumferential lengths at intermediate longitudinal positions between said transversal centre axis and an end cab.
This may also be the case when said circumferential lengths are equal.

Having a reinforcement layer in the wall of said container of actuator piston makes the outside of said wall smooth, and preferably convex shaped, when pressurized from within the cavity of said container. This provides a small contact area with the wall of said chamber. The expansion forces of the wall of said container are directed perpendicular the surface of the wall of said chamber. The expansion forces may be much larger than the pressure inside the cavity of the actuator piston, depending on the t/R ratio (R= transversal radius of a longitudinal cross-sectional section, t = wall thickness of the actuator piston), specifically when t/R<<<,

When said actuator piston is being positioned in a wall of a chamber having an positive angle with the centre axis of said chamber in the direction from a 2nd to a 1st longitudinal position, an asymmetry arises in the reaction forces from the wall of said chamber, because there will be no reaction forces on chamber positions nearest a 1st longitudinal position of the chamber on the ultimate position nearest a 1st longitudinal position part of the contact area (wall chamber – contaiber), and the consequences are that the wall of said container at these positions will bend towards the wall of said chamber, until the reaction foces of the wall equal the expansion forces of the wall of said container – the wall of said conatiner of the actuator piston is rolling over the wall of said chamber. This rolling is adding to the contact height of the contact area of the wall of said container and the wall of said chamber, where so the frictional forces increase. Said expansion of the wall of container of the actuator piston is causing a small pressure drop inside the wall of said container, when the volume of the enclosed space remaims constant, said pressure drop causes that the expansion forces of the wall of said piston are decreasing, thus also the friction forces. A movement of said actuator piston towards a 1st longitudinal position may occur (sliding). This may reduce said contact height, because the portion of said wall of the container nearest a 2nd longitudinal position may reduce its circumference, and thus also that of the contact area nearest a 2nd longitudinal position.

Due to the lubrication between the wall of said chamber and the wall of said container, the propulsion forces are still bigger than said friction forces, and the actuator piston will slide to a new chamber position nearer a first longitudinal position, until said asymmetri of forces occurs again, whereafter the cycle may start again.

It is the ability to increase (= rolling) a contact heigth in a longitudinal cross-section of the engaging wall of the container and the wall of the chamber, thereby making the height in immediate continuation of the existing height larger, that is the main reason of the behavouir of the actuator piston.

The means to do so are:

- a bendable reinforcement layer of which the reinforcement is in longitudinal direction approx. parallel to the centra axis of the chamber,

- none of almost no reinforcement in the transversal direction,
- a symmetrical wall of the container around a transversal symmetri axis,

than,

the wall of the container will under internal pressure bend out from an ultimate circumference of the contact area nearest a first longitudinal position, between the wall of the chamber and the wall of the container, and reaching the wall of the chamber, thereaby increasing the contact surface area, and

the wall of the container near a second longitudinal position will thereafter under said bending retract from the wall of the chamber,

whereafter the contact surface area area between the wall of the container and the wall of the chamber again is decreasing.

The actutaor piston will stop running towards a 1st longitudinal position, when there may be not sufficient internal pressure to press the wall of the container of the actuator piston towards the wall of the chamber, so that a circumferential leak occurs. This may happen e.g. in case of a chamber shown in section **19620** of this patent application, when the common border of 1 Bar overpressure exists in the chamber – this is earlier in the description disclosed as the "hesitation behaviour".

In practise a behaviour is seen that a container of an actuator piston, of which the movable cab is positioned nearest a 1st longitudinal position, is moving *stepwardsly,* when the pressure inside the cavity of the actuator piston is quite low.

The reason may be that the expansion of the wall of said actuator piston, when moving from 2nd to 1st longitudinal positions, is additionally forcing the contact area of the wall of said actuator piston to the wall of the chamber nearest to the 1st longitudinal position, besides the expansion of the wall of the container due to the internal pressure, thus also increasing the friction force.

In case the non-movable cab is positioned nearest a 1st longitudinal position, thus 'ahead' of the container in the direction of the movement, even the pressure is low, the movement is smoothly.

The reason may be that the extra force of the expansion of the wall of the container may add to the reduced expansion force, and not exceeding the friction force.

Thus: the wall of the piston is made of a flexible reinforced material, when pressurized by a pressure source through the enclosed space, which is resulting in a smooth outer surface of said piston wall, and by that, providing a height of the contact area circumferentially in a longitudinal cross-section of said piston, between said piston wall and the wall of the chamber, said height is changing in size during the movement of the piston at intermediate longitudinal positions between the second and first longitudinal positions.

This sliding may done over several different contact area's of the wall of said actuator piston, with the wall of said chamber. This is possible, because the wallof said container is convex shaped, flexible, while the several different area's are positioned in continuation of each other.

207 SUMMARY OF THE INVENTION

In general, a new design for a combination of a chamber and a piston for e.g. a pump must ensure that the force to be applied to operate the pump during the entire pumping operation is low enough to be felt as being comfortable by the user, that the length of a stroke is suitable, especially for women and teenagers, that the pumping time is not prolonged, and that the pump has a minimum of components reliable and almost free of maintenance time.

In a first 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 area thereof and, at a second longitudinal position thereof, a second cross-sectional area, the second cross-sectional area being 95% or less of the first cross-sectional area, the change in cross-section 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.

In the present context, the cross-sections are preferably taken perpendicularly to the longitudinal axis.

Also, due to the fact that in order for the piston to be able to seal against the inner wall of the chamber during movement between the first and second longitudinal positions, the variation of the cross-section of the chamber is preferably at least substantially continuous - that is, without abrupt changes in a longitudinal cross section of the inner wall.

In the present context, the cross-sectional area of the chamber is the cross-sectional area of the inner space thereof in the cross-section selected.

Thus, as will become clear in the following, the fact that the area of the inner chamber changes brings about the possibility of actually tailoring the combination to a number of situations.

In a preferred embodiment, the combination is used as a pump, whereby the movement of the piston will compress air and output this through a valve into e.g. a tyre. The area of the piston and the pressure on the other side of the valve will determine the force required in order to provide a flow of air through the valve. Thus, an adaptation of the force required may take place. Also, he volume of air provided will depend on the area of the piston. However, in order to compress the air, the first

translation of the piston will be relatively easy (the pressure is relatively low), whereby this may be performed with a large area. Thus, totally, a larger amount of air may be provided at a given pressure during a single stroke of a certain length.

Naturally, the actual reduction of the area may depend on the intended use of the combination as well as the force in question.

Preferably, the second cross-sectional area is 95-15%, 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 plurality of at least substantially stiff support members rotatably fastened to a common member,
- elastically deformable means, supported by the supporting members, for sealing against an inner wall of the chamber,

- the support members being rotatable between 10° and 40° relative to the longitudinal axis.

In that situation, the common member may be attached to a handle for use by an operator, and wherein the support members extend, in the chamber, in a direction relatively away from the handle.

Preferably, the support members are rotatable so as to be at least approximately parallel to the longitudinal axis.

Also, the combination may further comprise means for biasing the support members against an inner wall of the chamber

Another technology is one wherein the piston comprises an elastically deformable 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.

Also, in a cross-section through the longitudinal direction, the container may have a first shape at the first longitudinal direction and a second shape at the second longitudinal direction, the first shape being different from the second shape.

Then, at least part of the deformable material may be compressible and wherein the first shape has an area being larger than an area of the second shape.

Alternatively, the deformable material may be at least substantially incompressible

The piston may comprise an enclosed space communicating with the deformable container, the enclosed space having a variable volume. The volume may be varied by an operator, and it may comprise a spring-biased piston.

Yet another technology is one , wherein the first cross-sectional shape is 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.

In that situation, the first cross-sectional area may be 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% larger than the second cross-sectional area.

Also, the first cross-sectional shape may be 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 addition, the first cross-sectional shape may be at least substantially circular and wherein the second cross-sectional shape comprises two or more at least substantially elongate, such as lobe-shaped, parts.

Also, in the cross-section at the first longitudinal position, a first circumference of the chamber may be 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. Preferably, the first and second circumferences are at least substantially identical.

An optional or additional technology is one wherein the piston comprises:

- an elastically deformable material 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, and
- a coiled flat spring having a central axis at least substantially along the longitudinal axis, the spring being positioned adjacently to the elastically deformable material so as to support the elastically deformable material in the longitudinal direction.

In that situation, the piston may further comprise a number of flat supporting means positioned between the elastically deformable material and the spring, the supporting means being rotatable along an interface between the spring and the elastically deformable material.

The supporting means may be adapted to rotate from a first position to a second position where, in the first position, an outer boundary thereof may be comprised within the first cross-sectional area and where, in the second position, an outer boundary thereof may be comprised within the second cross-sectional area.

In a second 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 area thereof and, at a second longitudinal position thereof, 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,

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,

the piston comprising:

- a plurality of at least substantially stiff support members rotatably fastened to a common member,
- elastically deformable means, supported by the supporting members, for sealing against an inner wall of the chamber

the support members being rotatable between 10° and 40° relative to the longitudinal axis.

Preferably, the support members are rotatable so as to be at least approximately parallel to the longitudinal axis.

Thus, the manner in which the piston is able to adapt to different areas and/or shapes is one wherein the piston comprises a number of rotatably fastened means holding a sealing means. One preferred embodiment is one wherein the piston has the overall shape of an umbrella.

Preferably, the common member is attached to a handle for use by an operator, such as when the combination is used as a pump, and wherein the support members extend, in the chamber, in a direction relatively away from the handle. This has the advantage that increasing the pressure by forcing the handle into the chamber, will simply force the supporting means and the sealing means against the wall of the chamber - thus increasing the sealing.

In order to ensure sealing also after a stroke, the combination preferably comprises means for biasing the support members against an inner wall of the chamber.

In a third 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 area thereof and, at a second longitudinal position thereof, 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,

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

the piston comprising an elastically deformable container comprising a deformable material.

Thus, by providing an elastically deformable container, changes in area and/or shape may be provided. Naturally, this container should be sufficiently fastened to the piston in order for it to follow the remainder of the piston when the piston is moved in the chamber.

The deformable material may be a fluid or a mixture of fluids, such as water, steam, and/or gas, or 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.

When the cross-sectional area changes, the volume of the container may change. Thus, in a cross-section through the longitudinal direction, the container may have a first shape at the first longitudinal direction and a second shape at the second longitudinal direction, the first shape being different from the second shape. In one situation, at least part of 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, piston may comprise a second enclosed space communicating with the deformable container, the enclosed space having a variable volume. In that manner, that enclosed space may take up fluid when the deformable container changes volume. The volume of the second container may be varied by an operator. In that manner, the overall pressure or maximum/minimum pressure of the container may be altered. Also, the second enclosed space may comprise a spring-biased piston.

It may be preferred to provide means for defining the volume of the enclosed space so that a pressure of fluid in the enclosed space relates to a pressure of fluid between the piston and the second longitudinal position of the container. In this manner, the pressure of the deformable container may be varied in order to obtain a suitable sealing.

A simple manner would be to have the defining means adapted to define the pressure in the enclosed space at least substantially identical to the pressure between the piston and the second

longitudinal position of the container. 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 enclosed space in which the piston translates may taper in the same manner as the main chamber of the combination.

In order to withstand both the friction against the chamber wall and the shape/dimension changes, the container may comprise an elastically deformable material comprising enforcement means, such as a fibre enforcement.

In order to achieve and maintain a appropriate sealing between the container and the chamber wall, it is preferred that an internal pressure, such as a pressure generated by a fluid in the container, is higher than the highest pressure of the surrounding atmosphere during translation of the piston from the first longitudinal position to the second longitudinal position or vice versa.

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 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% 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 plurality of at least substantially stiff support members rotatably fastened to a common member,
- elastically deformable means, supported by the supporting members, for sealing against an inner wall of the chamber.

Another type of piston is the one comprising an elastically deformable container comprising a deformable material.

Another aspect of 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 area thereof and, at a second longitudinal position thereof, 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, the piston comprising:
- an elastically deformable material 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, and
- a coiled flat spring having a central axis at least substantially along the longitudinal axis, the spring being positioned adjacently to the elastically deformable material so as to support the elastically deformable material in the longitudinal direction.

This embodiment solves the potential problem of merely providing a large mass of a resilient material as a piston. The fact that the material is resilient will provide the problem of deformation of the piston and, if the pressure increases, lack of sealing due to the resiliency of the material. This is especially a problem if the dimension changes required are large.

In the present aspect, the resilient material is supported by a helical flat spring. A helical spring is able to be expanded and compressed in order to follow the area of the chamber while the flat structure of the material of the spring will ensure that the spring is not deformed by the pressure.

In order to e.g. increase the area of engagement between the spring and the deformable material, the piston may further comprise a number of flat supporting means positioned between the elastically deformable material and the spring, the supporting means being rotatable along an interface between the spring and the elastically deformable material.

Preferably, the supporting means are adapted to rotate from a first position to a second position where, in the first position, an outer boundary thereof may be comprised within the first cross-sectional area and where, in the second position, an outer boundary thereof may be comprised within the second cross-sectional area.

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 from a first longitudinal position to a second 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.

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 function of the combination.

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.

If the piston pump is a handpump for tire inflation purposes it can have an integrated connector according to those disclosed in PCT/DK96/00055 (including the US Continuation in Part of 18 April 1997), PCT/DK97/00223 and/or PCT/DK98/00507. The connectors can have an integrated pressure gauge of any type. In a piston pump according to the invention used as e.g. a floor pump or 'carpump' for inflation purposes a pressure gauge arrangement can be integrated in this pump.

Certain piston types as e.g. those of Fig. 4A-F, 7A-E,7J, 12A-C may be combined with any type of chamber.

The combination of certain mechanical pistons as e.g. the one shown in Fig. 3A-C, and and of certain composite pistons as e.g. the one shown in Fig. 6D-F and chambers having a constant circumferical length of the convex type as e.g. the one shown in Fig. 7L may be a good combination.

The combination of composite pistons as e.g. those shown in Fig. 9-12 may be used well with chambers of a convex type, irrespective of a possible change in the circumferical length.

Pistons of the 'embrella type' shown in this application have their open side at the side where the pressure of the medium in the chamber is loading the 'embrella' at the open side. It may also very well possible that the 'embrella' is working upside down.

The inflatable pistons with a skin with a fiber architecture which has been shown have an overpressure in the piston in relation to the pressure in the chamber. It is however also possible to have an equal or lower pressure in the piston than in the chamber - the fibers are than under pressure instead of under tension. The resulting shape may be different than those which are shown in the drawings. In that case, any loading regulating means may have to be tuned differently, and the fibers may have to be supported. The load regulating means showed in e.g. Fig. 9D or 12B may then be constructed so that the movement of the piston of the means gives a suction in the piston, e.g. by an elongation of the piston rod, so that the pistons are now at the other side of the holes in the piston rod. The change in the form of the piston is than different and a collaps may be obtained. This may reduce the life-time.

Through these embodiments, reliable and inexpensive pumps optimized for manual operation, e.g. universal bike pumps to be operated by women and teenagers, can be obtained. The shape of the walls of the pressurerizing chamber (longitudinal and/or transversal cross-section) and/or piston means of the pumps shown are examples and may be changed depending on the pump design specification. The invention can also be used with all kinds of pumps, e.g. multiple-stage piston pumps as well as with dual-function pumps, piston pumps driven by a motor, pumps where e.g. only the chamber or piston is moving as well as types where both the chamber and the piston are moving simultaneously. Any kind of medium may be pumped in the piston pumps. Those pumps may be used for all kinds of applications, e.g. in pneumatic and/or hydraulic applications. And, the invention is also applicable for pumps which are not manually operated. The reduction of the applied force means a substantial reduction of investments for equipment and a substantial reduction of energy during operation. The chambers may be produced e.g. by injection moulding, from taper swaged tubes etc.

In a piston pump a medium is sucked into a chamber which may thereafter be closed by a valve arrangement. The medium is compressed by the movement of the chamber and/or the piston and a valve may release this compressed medium from the chamber. In an actuator a medium may be pressed into a chamber through a valve arrangement and the piston and/or the chamber is moving, initiating the movement of an attached devise. In shock absorbers the chamber may be completely closed, wherein the chamber a compressible medium can be compressed by the movement of the chamber and/or the piston. In the case of a non-compressible medium is inside the chamber, e.g. the piston may be equipped with several small channels which give a dynamic friction, so that the movement is slowed down.

Further, the invention can also be used in propulsion applications where a medium may be used to move a piston and/or a chamber, which can turn around an axis as e.g. in a motor. The above combinations are applicable on all above mentioned applications.

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 (See Fig. 2B).

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.

Finally, the invention also relates to an actuator comprising:

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

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 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.

All piston types, specifically those which are containers with an elastically deformable wall may be sealingly connected to the chamber wall during its move between longitudinal positions , engagingly connected or not connected to the wall of the chamber. Or may be engagingly and sealingly connected to the chamber wall. Additionally may there be no engaging between said walls either, possibly touching the walls each other, and this may happen e.g. in the situation where the container is moving from a first to a second longitudinal position in a chamber.

The type of connection (sealingly and/or engagingly and/or touching and/or no connection) between said walls may be accomplished by using the correct inside pressure inside said container wall: high pressure for sealingly connection, a lower pressure for engagingly connection and e.g. atmospheric pressure for no connection (production sized container) - thus, a container with an enclosed space may be preferred, because the enclosed space may be controlling the pressure inside the container from a position outside the piston.

Another option for an engagingly connection is thin wall on the container, which may have reinforcements which are sticking out of the surface of said wall, so that leaking may happen between the wall of container and the wall of the chamber.

653 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 obtain 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 independent 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 or 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 analogoous 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 functioning of the combination.

The piston may also slide over an internal and 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 decisive for the type of application: pump, actuator, shock absorber or motor. In a piston pump a medium may be sucked 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, in the 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.

All piston types, specifically those which are containers with an elastically deformable wall may be sealingly connected to the chamber wall during its move between longitudinal positions , engagingly connected or not connected to the wall of the chamber. Or may be engagingly and sealingly connected to the chamber wall. Additionally may there be no engaging between said walls either, possibly touching the walls each other, and this may happen e.g. in the situation where the container is moving from a first to a second longitudinal position in a chamber.

The type of connection (sealingly and/or engagingly and/or touching and/or no connection) between said walls may be accomplished by using the correct inside pressure inside said container wall: high pressure for sealingly connection, a lower pressure for engagingly connection and e.g. atmospheric pressure for no connection (production sized container) - thus, a container with an enclosed space may be preferred, because the enclosed space may be controlling the pressure inside the container from a position outside the piston.

Another option for an engagingly connection is thin wall on the container, which may have reinforcements which are sticking out of the surface of said wall, so that leaking may happen between the wall of container and the wall of the chamber.

507 SUMMARY OF THE INVENTION

The valve actuator of the present invention and embodiments thereof are subjects of claims 1 and 2 to 17, respectively. A valve connector and a pressure vessel or hand pump, comprising a valve actuator of the present invention are subjects of claims 18 and 19, respectively. Claim 20 is directed to the use of the valve actuator in a stationary construction.

The present invention provides a valve actuator which comprises an inexpensive combination of a cylinder, within in which the piston driving the activating pin moves, and an activating pin, having a simple construction. This combination can be used in stationary constructions, such as chemical plants, where the activating pin engages the spring-force operated core pin of a valve (e.g. a release valve), as well as in valve connectors (e.g. for inflating vehicle tires). The disadvantage of conventional valve connectors have been overcome by the valve actuator of the present invention. This valve actuator features a piston having a piston ring fitting into the cylinder, where the piston, in its first position, is at a first predetermined distance from the first end of the cylinder. In the piston's second position, it is at a second predetermined distance from the first end of the cylinder, wherein the second predetermined distance is larger than the first predetermined distance. The cylinder wall comprises a conducting channel for allowing conduction of gaseous and/or liquid media between the cylinder and the coupling section when the piston is in the first position, whereas conduction of gaseous and/or liquid media between the cylinder and the coupling section is inhibited by the piston when the piston is in the second position.

One embodiment of the valve actuator of the present invention according to claim 6 features a conducting channel from the pressure source to the valve to be actuated that comprises an enlargement of the cylinder diameter which is arranged around the piston of the activating pin in the bottom of the cylinder, when the piston is in the first position, enabling the medium from the pressure source to flow to the opened spring-force operated valve core pin, e.g. from a Schrader valve. The enlargement of the cylinder's diameter may be uniform, or the cylinder wall may contain one or several sections near the bottom of the cylinder where the distance between the center line of the cylinder and the cylinder wall increases so that gaseous and/or liquid media can freely flow around the edge of the piston ring when the piston is in the first position. A variant of this embodiment has a valve actuator arrangement of which its cylinder has the enlargement of the diameter twice. The distance between the enlargements can be the same as the distance between the sealing levels of the sealing means. When three valves of different sizes can be coupled the valve actuator may comprise a cylinder with three enlargements. It is however also possible to connect valves of different sizes to a valve actuator having a single arrangement for the enlargement of the diameter of the cylinder. Now therefore the number of enlargements

can be different from the number of different valve sizes of valves which can be coupled.

Another embodiment of the present invention according to claim 10 features a conducting channel through a part of the body of the valve actuator. The channel forms a passage for gaseous and/or liquid media between the cylinder and the part of the valve actuator which is coupled to the valve. The orifice of the channel opening in the cylinder is located such that, when the piston is in the first position, pressurized gaseous and/or liquid media flowing from the pressure source to the cylinder may flow further through the channel to the valve to be actuated. When the piston is in the second position, it blocks the cylinder so that the flow of pressurized gaseous and/or liquid media into the channel is not possible.

Instead of air, (mixtures of) gases and/or liquids of any kind can activate the activation pin and can flow around the piston of the valve actuator when the piston is in its first position The invention can be used in all types of valve connectors to which a valve with a spring-force operated core pin (e.g. a Schrader valve) can be coupled irrespective of the method of coupling or the number of coupling holes in the connector. Furthermore the valve actuator can be coupled to for example a foot pump, car pump, or compressor. The valve actuator can also be integrated in any pressure source (e.g. a handpump or a pressure vessel) irrespective of the availability of a securing means in the valve connector. It is also possible for the invention to be used in permanent constructions where the activating pin of the actuator engages the core pin of a permanently mounted valve.

19597 SUMMARY OF THE INVENTION

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

Force providers for enabling the relative movement of the parts of the combination may move themselves, and the path of the last mentioned movement does not at any time comply exactly with the path of the relative movement of the piston rod, the piston and the chamber. Thus the system of the force provider and the combination may provide a flexibility somewhere in the system in order to avoid damage. When the force provider may engaging the combination with changing forces, and which may also keeping the non-moving part of the combination towards a rigid surface, in order to enable said relative movement, there may be conflicting demands towards the combination, if said rigid surface also has the function of providing reaction forces for the combination. The last mentioned may happen when a pump is engaged by a human body, while the pump is beying held down to the rigid surface e.g. a floor, by a foot of said user. Specifically when a standing person is using a floor pump for pumping a tyre, and specifically if the floor is not in level. The combination ought therefore be movable in relation to the rigid surface, in order to follow the path of the force provider.

In a second aspect is the problem of non-compliance specifically important when a chamber is used with having cross-sections of different cross-sectional areas at the first and second longitudinal positions, and at least substantially continuously different cross-sectional areas and circumferential lengths at intermediate longitudinal positions between the first and second longitudinal positions, the cross-sectional area and circumferential length at said second longitudinal position being smaller than the cross-sectional at said first longitudinal position – this is also valid in the case where the cross-sectional area's at the first and second longitudinal position having a different size, but an equal circumferential size.

In an optmized embodiment for obtaining the highest level of reduction of energy, the chamber of e.g. a floor pump for tyre inflation has a smallest possible cross-sectional area at its bottom and a biggest at its top. Thus at the smallest cross-sectional area is the biggest

force moment engaging the transition from the chamber to the basis of the pump. The combination should therefore be movable in relation to the rigid surface, in order to follow the path of the force provider.

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

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

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

This solution, combined with a basis with three engaging surfaces, is an optimized solution which complies to all demands: the path of the combination may be any path which is used by the force provider (e.g. user), while the basis is standing on the surface, held down e.g. by the foot of teh user. Not only can a rigid surface, not in level, be compensated, so that the combination, but not the basis, still is beying perpendicular water , the user of the floor pump is able to initiate any path during the stroke. After use may the combination automatically coming back to it rest position, namely perpendicular the rigid surface.

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

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

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

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

Moreover, the elastically deformable bushing may serve as the soft stop of the combination, when the piston and/or the chamber is reaching its end point of the movement. This function makes in classic floor pumps for tyre inflation the spring on the piston rod, between the handle and the cap superfluous.

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

This is also valid for piston-chamber combinations with differing cross-sectional area'sand eqaul of differing cicumferentiual sizes.

The guiding means may be comprising a washer with a small hole with an appropriate fitting with the piston rod, while this washer may be movable within a bigger hole within the cap: the piston rod may mainly translate in a transversal direction of teh combination. The washer may come back to its default position by means of a sprong-force e.g. an O-ring between the hole in the cab, and the outside of the guiding means.
The size of the last mentioned hole is determing the deflection degree of the piston rod, together with how much the construction of the piston is allowing it. If the piston rod is rigidly fastened to the piston, the construction of the piston determines the deflection degree. If e.g. a ball joint is applied between the piston and the piston rod, the deflection degree is only determined by the guiding means.

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

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

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

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

The centre lines of the hands of a user when operating a handle of a pump have different positions, depending on how the handle is beying gripped by the hand(s).
In the case oi classic floor pumps, with cylinders with circular cross sections of constant size, high working forces may occur. If relatively high forces are to be transferred from the arm of the user through the hand, connected to this arm, the hand will be best positioned in relation to the arm, when no force moments would arise. This is obtained if the longitudinal axis of

the arm goes through the center point of the axis of a portion of the handle, the handle gripped by the hand, connected to the arm.

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

A preferred angle between the portions of the handle may in a plane perpendicular the centre axis of the piston-chamber combination be 180°. However, it may also be different from 180°. Additionally may the angle be in a plane which comprises said centre axis less than 180°. In order to avoid the hands from gliding from these protions, stops may be provided for – these may also be used for the force transfer. The other options, 180° and more than 180° may of course also occur.

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

Preferred angles between the two portions of the handle in a plane perpendicular to the centre axis of the piston-chamber combination may be bit less than bit bigger (best!) than 180°. These positions of the portions of the handle comply to the rest position(s) of the hand(s). Both positions may be obtained by one handle design, if the handle may be able to turn around the centre axis of the piston-chamber combination.

In order to avoid the existance of a force moment, a line through the centres of both portions of the handle in a plane perpendicular the centre axis of the piston-chamber combination cut the last mentioned axis.

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

The conical shape of the cylinder may provide a substantial reduction of the size

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

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 (See Fig. 2B).

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.

Finally, the invention also relates to an actuator comprising:

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

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.

19626 BRIEF DESCRIPTION OF THE DRAWINGS

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

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Fig. 1A 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. 1B shows an enlargement of the piston of Fig. 1A at the beginning of a stroke.

Fig. 1C shows an enlargement of the piston of Fig. 1A at the end of a stroke.

Fig. 2A 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. 2B shows an enlargement of the piston of Fig. 2A at the beginning of a stroke.

Fig. 2C shows an enlargement of the piston of Fig. 2A at the end of a stroke.

Fig. 3A shows a longitudinal cross-section of a chamber with fixed different areas of the transversal cross-sections and a third embodiment of the piston comprising a fiber reinforcement (no 'Trellis Effect') with radially-axially changing dimensions during the stroke - the piston arrangement is shown at the beginning, and at the end of a stroke, where it has its production size.

Fig. 3B shows an enlargement of the piston of Fig. 3A at the beginning of a stroke.

Fig. 3C shows an enlargement of the piston of Fig. 3A at the end of a stroke.

Fig. 3D shows a top view of the piston of Fig. 3A 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. 3E shows a top view of the piston of Fig. 3A with a reinforcement in the skin in planes partly through the central axis and partly outside the central axis - left: at the first longitudinal position, right: at the second longitudinal position.

Fig. 4 shows a non-moving expandable piston inside a chamber with walls, which are parallel to the centre axis, while there are no pressure differences in the chamber between both sides of said piston.

Fig. 5A shows the piston of Fig. 4, instantaneously non-moving inside a chamber with a conical shaped wall, where the piston is beginning to expand – the movable cab is moving toward the non-movable cab.

Fig. 5B shows the piston of Fig. 5A, instanteneously non-moving, and thereby expanding, so that the contact area of the piston wall with the wall of the chamber increases at second longitudinal positions of said contact area – the movable cab is non-moving.

Fig. 5C shows the piston of Fig. 5B, instanteneously non-moving, and thereby expanding, so that the contact area of the piston wall with the wall of the chamber decreases at second longitudinal positions of said contact area, while the contact area of the piston wall with the wall of the chamber increases at first longitudinal positions of said contact area – the movable cab is non-moving.

Fig. 5D shows the piston of Fig. 5C, where the non-movable cap is instanteneously beginning to move from second to first longitudinal positions, thereby moving the piston in the same direction.

Fig. 5E shows the piston of Fig. 5D, where the movement of the piston is decreasing due to a increasing contact area.

Fig. 6A shows an expandable piston moving in a closed cone shaped chamber.

Fig. 6B shows an expandable piston moving in a closed cone shaped chamber, where said chamber on both sides of the piston is communicating with the surrounding's atmosphere.

Fig. 6C shows an expandable piston moving in a closed cone shaped chamber, where said chamber on both sides of the piston is communicating with each other through a closed channel outside said chamber.

Fig. 6D shows an expandable piston moving in a closed cone shaped chamber, where said chamber on both sides of the piston is communicating with each other through a closed channel inside said piston.

Fig. 6E shows an expandable piston moving in a closed cone shaped chamber, where said chamber on both sides of the piston is communicating with each other through a

channel between the chamber wall and the piston wall

Fig. 7D 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. 7E shows the pattern of Fig. 6D when the wall of the container has been expanded,

Fig. 7F shows a 3-dimensional drawing of a reinforcement matrix of an inelastic textile material, positioned in the wall of the container when the piston is to be expanded,

Fig. 7G shows the reinforcement matrix of Fig. 7F which has been expended

Fig. 8 shows a combinatio where the piston is moving in a chamber and around a taper wall.

Fig. 9A shows a longitudinal cross-section of a chamber with fixed different areas of the transversal cross-sections 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 beginning, and at the end of a stroke where it has its production size.

Fig. 9B shows an enlargement of the piston of Fig. 9A at the beginning of a stroke.

Fig. 9C shows an enlargement of the piston of Fig. 9A at the end of a stroke.

Fig. 9D shows the piston of Fig. 9A just entering a conical part of the chamber

Fig. 10A shows a piston-chamber combination where a pressurized ellipsoïde shaped piston is moving from a second longitudinal position to a first longitudinal position, enlarging the internal volume of said piston, the enclosed space having a fixed volume, thereby reducing the internal pressure of said piston, the piston may change its shape into a sphere – the dashed lines at both ends show the outer contour of said piston, where the chamber has a wall parallel to the centre axis of said chamber, in the middle the size of said piston compared to where same size of said piston in Fig. 10B occurs, thereby showing that the piston in Fig. 10B may engagingly be connected to the wall of said chamber, while in Fig.10A this is sealingly connected.

Fig. 10B shows the piston-chamber combination of Fig.10A where the internal pressure of the piston additionally has been decreased by changing the volume of the enclosed space, at a furthest first longitudinal position or during its return to the second longitunal position, thereby changing the size of said piston, adapting it contineously to the size of the chamber, in order to avoid jamming.

Fig. 10C shows a piston-chamber combination as that of Fig. 10A,B, but where the internal pressure of the piston alternatively has been decreased by removing fluid from the enclosed space, at a furthest first longitudinal postion or during its return to the second longitunal position, thereby changing the size of said piston, adapting it contineously to the size of the chamber, in order to avoid jamming.

Fig. 10D shows the process of Fig.10A, when the piston is a sphere type, as produced at a second longitudinal position.

Fig, 10E shows the process of Fig. 10B, when the piston is a sphere type, as produced at a second longitudinal position.

Fig. 10F shows the process of Fig. 10C, when the piston is a sphere type, as produced at a second longitudinal position.

Fig. 10G shows schematically a motor of the configuration of Figs. 12A and 12C? having a propulsion system comprising an expandable inflatable actuator piston rotating in a circular chamber, having a circleround centre axis,

around the centre of the centre axle of said motor.

Fig. 10H shows schematically a motor of Fig. 13A, 13B having a propulsion system comprising (e.g) 5 non-moving expandable inflatable actuator pistons, within a rotating circular chamber, said chamber having a centre line which is concentrical to the centre of rotation, comprising four sub-chambers in continuation of each other, having continuing differing transitional cross-sectional area's and circumferences, said chamber is rotating around a main axle through the center of said axle

CONSUMPTION TECHNOLOGY

Fig. 11A shows schematically a motor having a propulsion system comprising an expandable inflatable actuator piston, and a two step piston pumping system, within an elongated chamber having continuing differing cross-sectional area's and circumferences, all assembled on a crankshaft axle, and a pressure storage vessel, and an electric starter motor, the smallest pump and starter motor being energized by among others solar energy.

Fig. 11B shows schematically the controling means and the pressure management for the motor of Fig. 11A.

Fig. 11C shows some worked out mechanical assemblies of the motor of Figs. 11A and 11B, where the main cylinder is not moving.

Fig. 11D shows the pressure management of the inflatable actuator piston on the joint of the crankshaft and the connecting rod, shown in Fig. 11C.

Fig. 11E shows a detail of the joint of the piston rod and the connecting rod, shown in Fig. 11C.

Fig. 11F shows a detail of the suspension of the crankshaft, and the channel inside said crankshaft, shown in Figs. 11A and 11B.

ENCLOSED SPACE VOLUME TECHNOLOGY

Fig. 11G shows an alternative method of managing the pressure change in the inflatable actuator piston, by changing the volume of the enclosed space through a piston of a second piston-chamber combination, and an additional adjustment of the pressure through a piston of a third piston-chamber combination for managing the speed/power of said motor, without a constant repressuration of the pressure storage vessel, for pressurizing the 2-way actuator for said change of volume of the enclosed space.

Fig. 11H shows the configuration of Fig. 11G, where a constant repressuration of the pressure storage vessel is done by a cascade of pumps, shown in e.g. Fig. 11A.

Fig. 11I shows a partially worked out one cylinder motor, based on the concept shown in Fig. 11H, where the velocity controller and the ESVT-pump are being

powered by a 2-way actuator, which is powered by a battery; the pump for re-pressurating the pressure storage vessel is being powered by a separate electric motor, powered by a battery – the respective power lines are clearly shown – auxilliarly power sources are according to Figs. 15A,B,C,E,F of which at least one may charging said batteries.

Fig. 11J shows a partially worked out two cylinder motor, based on Fig. 11I, where each actuator piston-chamber combination has a separate velocity controller and an ESVT-pump – said velocity controllers are communicating with each other.

Fig. 11J left shows a scaled up of the left part of Fig. 11J.

Fig, 11J right shows a scaled up of the right part of Fig. 11J.

Fig. 11K shows a partially worked out one cylinder motor, based on the concept shown in Fig. 11H, where the ESVT-pump of the actuator piston now is being powered by a crankshaft, the last mentioned being powered by an electric motor, which is powered by a battery – the velocity controller (2 way-actuator) is according the one of Fig. 11H; the pump for re-pressurating the pressure storage vessel is being powered by a separate electric motor, powered by a battery; auxilliarly power sources are according to Figs. 15A,B,C,E,F of which at least one may charging said batteries.

Fig. 11L shows a partially worked out two cylinder motor, based on Fig. 11K. One crankshaft is being used for the ESVT-pumps, one for each actuator-piston combination. The velocity controllers, one for each actuator piston are communicating with each other; the pump for re-pressurating the pressure storage vessel is being powered by a separate electric motor, powered by a battery; auxilliarly power sources are according to Figs. 15A,B,C,E,F of which at least one may charging said batteries.

Fig. 11L left shows a scaled up of the left part of Fig. 11L.

Fig, 11L right shows a scaled up of the right part of Fig. 11L.

Fig. 11M shows a partially worked out one cylinder motor, based on the concept shown in Fig. 11H, where the ESVT-pump for the actuator piston chamber combination now is being powered by a camshaft, said camshaft driven by an

electric motor, powered by a battery; the velocity controller is a 2-way actuator, which is communicating with a speeder. The pump for repressurating the pressure storage vessel is being powered by a separate electric motor, powered by a battery; auxilliarly power sources are according to Figs. 15A,B,C,E,F of which at least one may charging said batteries.

Fig. 11N shows a partially worked out two cylinder motor, based on Fig. 11M – one camshaft is used for the ESVT-pumps, one for each actuator piston-chamber combination.The velocity controllers, one for each actuator piston, are communicating with each other; the pump for repressurating the pressure storage vessel is being powered by a separate electric motor, powered by a battery; auxilliarly power sources are according to Figs. 15A,B,C,E,F of which at least one may charging said batteries.

Fig. 11N left shows a scaled up of the left part of Fig. 11N.

Fig, 11N right shows a scaled up of the right part of Fig. 11N.

Fig. 11o shows a partially worked out one cylinder motor, based on the concept shown in Fig. 11K, where the ESVT-pump of the actuator piston-chamber is being powered by a crankshaft, which is directly driven by the auxilliarly power from a gas (e.g. air) cooled combustion motor, using H_2, derived by the electrolyses of H_2O, said electrolyses powered by a battery; the pump which is re-pressurating the pressure storage vessel is additionally directly driven by said combustion motor; the velocity controller is powered by a 2-way actuator, powered by a battery; the batteruies according to Fig. 15D are being charged by an alternator, which is mounted on the main motor axle. The generated heat of said combustion motor may be used e.g. for warming up the vehicle interior.

Fig. 11P shows a partially worked out two cylinder motor, based on Fig. 11o, where the ESVT-pumps, one for each actuator piston-chamber combination, are being powered by a crankshaft, which is directly driven by the auxilliarly power from a forced liquid cooled combustion motor, using H_2, derived by the electrolyses of H_2O, said electrolyses powered by a battery; the pump pump, which is re-pressurating the pressure storage vessel is directly driven

by said combustion motor; the velocity controllers, one for each actuator piston chamber combination are powered by a 2-way actuator, are communicating with each other, and are powered by a battery; the batteries according to Fig. 15D are being charged by an alternator, which is mounted on the main motor axle. The generated heat of said combustion motor may be used e.g. for warming up the vehicle interior.

Fig. 11P left shows a scaled up of the left part of Fig. 11P.

Fig, 11P right shows a scaled up of the right part of Fig. 11P.

Fig. 11Q shows a partially worked out one cylinder motor, based on the concept shown in Fig. 11K, where the ESVT-pump of the actuator piston-chamber combination are being powered by a camshaft which is directly driven by the auxilliarly power from a forced gas (e.g. air) cooled combustion motor, using H_2, derived by the electrolyses of H_2O, said electrolyses powered by a battery; the pump, which is re-pressurating the pressure storage vessel is directly driven by said combustion motor; the velocity controller is powered by a 2-way actuator, powered by a battery; the batteries according to Fig. 15D are being charged by an alternator, which is mounted on the main motor axle. The generated heat of said combustion motor may be used e.g. for warming up the vehicle interior.

Fig. 11R shows a partially worked out two cylinder motor, based on Fig. 11Q – where the ESVT-pumps, one for each actuator piston-chamber combination, are being powered by a camshaft, which is directly driven by the auxilliarly power from a gas (e.g. air) forced cooled combustion motor, using H_2, derived by the electrolyses of H_2O, said electrolyses powered by a battery; the pump which is re-pressurating the pressure storage vessel is directly driven by said combustion motor; the velocity controllers, one for each actuator piston-chamber combination are powered by a 2-way actuator, are communicating with each other, and are powered by a battery; the batteries according to Fig. 15D are being charged by an alternator, which is mounted on the main motor axle. The generated heat of said combustion motor may be used e.g. for warming up the vehicle interiour.

Fig. 11R left shows a scaled up of the left part of Fig. 11R.

Fig. 11R right shows a scaled up of the right part of Fig. 11R.

Fig. 11S shows a detail of the joint of the base of the piston-chamber combination 1061 of Figs. 11I - 11R with the main axle of the motor.

Fig. 11T shows a detail of the joint of the connecting rod of the actuator piston and the crankshaft on the main axle of the motor according to Figs. 11I – 11R.

Fig. 11U shows a detail of the joint of the base of the piston-chamber combination 1060 of Figs. 11I - 11R with the main axle of the motor.

Fig. 11V shows the mechanism driving a pump of Figs. 11H – 11R, and its base.

Fig. 11W shows the connecting joint between the two crankshafts of the 2-cylinder motor according to Figs. 11J, 11L, 11N, 11P, 11R.

CONSUMPTION TECHNOLOGY

Fig. 12A shows schematically a motor having a propulsion system comprising an expandable inflatable actuator piston rotating in a circular chamber, and a two step piston pumping system, within an elongated chamber having continuing differing transitional cross-sectional area's and circumferences, all assembled on a crankshaft axle, and a pressure storage vessel, and an electric starter motor, the smallest pump and starter motor being energized by solar energy, including control means.

Fig. 12B shows schematically a motor of Fig. 12A having a propulsion system comprising an expandable inflatable actuator piston moving within a non-moving chamber, having a centre line which is concentrically the centre of rotation, comprising four sub-chambers in continuation of each other, having continuing differing transitional cross-sectional area's and circumferences.

Fig. 12C shows schematically the controlling means and pressure management for the motor of Fig. 12B, where the change of the pressure in the actuator piston is controlled by adding to and removing fluid from the actuator piston

ENCLOSED SPACE VOLUME TECHNOLOGY

Fig. 12D shows schematically the controlling means and pressure management for the motor of Fig. 12B, where the change of the pressure in the actuator piston is controlled by changing the volume of the enclosed space of the actuator piston.

CONSUMPTION TECHNOLOGY

Fig. 13A shows schematically a motor having a propulsion system comprising more than one non-moving expandable inflatable actuator pistons in a rotating chamber, said chamber having a centre line which is concentrically the centre of rotation, and a two step piston pumping system, within an elongated chamber having continuing differing transitional cross-sectional area's and circumferences, all assembled on a crankshaft axle, and a pressure storage vessel, and an electric starter motor, the smallest pump and starter motor being energized by solar energy.

Fig. 13B shows the motor of Fig. 13A, wherein the piston pumps of the two step piston pumping system have been exchanged by rotational pumps, mounted on the main axle of the motor.

Fig.13C shows schematically a motor of Fig. 13A, 13B having a propulsion system comprising non-moving expandable inflatable actuator pistons, within a rotating chamber, said chamber having a centre line which is concentrically the centre of rotation, comprising four sub-chambers in continuation of each other, having continuing differing transitional cross-sectional area's and circumferences, said chamber is rotating around an axle through the center of said chamber.

Fig. 13D shows schematically the suspension of the motor of Fig. 13A, 13B, incl. a drive belt.

Fig. 13E shows schematically the controlling means and pressure management for the motor of Fig. 13A,13B incl. a storage pressure vessel, where the contineously changing internal pressures of said actuator pistons are determined by a separate piston-chamber combination for each of said actuator pistons, computer controlled.

ENCLOSED SPACE VOLUME TECHNOLOGY

Fig. 13F shows the pressure management of the inflatable pistons of Fig. 13C, according to the principle of Fig. 11F, where each actuator piston is managed by two piston-chamber combinations – one for the contineously changing pressure and one for the adjustment of the pressure level for adjusting the speed/power of the motor.

Fig. 13 G shows the pressuration system for the configuration of Fig. 13F.

ENCLOSED SPACE VOLUME TECHNOLOGY

Fig. 14A shows the several stages of an actuator piston, around which a circular chamber is running, and what is necessary to change the inside pressure of said actuator piston, by changing the volume under a pump piston of a connected chamber.

Fig. 14B shows the configuration of Fig. 14A, where a cam-wheel which is connected to the piston rod of the pump piston, is communicating with a cam of an appropriate profile.

Fig. 14C shows

Fig. 14D shows a moving circular chamber according to Fig. 13A, where the pressure in actuator pistons is being defined by the pressure in a piston-chamber combinationm which has a cam-wheel communicating with the piston of said piston-chamber combination, said cam-wheel is running over a main axle, which is comprising a cam with a certain profile.

Fig. 14E shows a rim with its suspension, in which the configuration of Fig. 14D has been built in, together with an auxilliarly motor, shown as an electric motor, which is turning said cam profile; communicating to a channel comprising the enclosed space of said actuator piston is a pressure controller according to the configuration of Fig. 16 ("drive by wire") , which is communicating with a remotely speeder.

Fig. 14F shows an enlarged detail of the cross-section of said piston in said circular chamber of Fig. 14E, when the piston is at a first circular position.

Fig. 14G shows an enlarged detail of the cross-section of said piston in said circular chamber of Fig. 14G, when the piston is at a second circular position.

Fig. 14H shows the configuration of Fig. 14E, wherein between the rim of the wheel and said circular chamber has been built in a gearbox, e.g. of the type of a planet gear.

AUXILLIARLY POWER SOURCES

Fig. 15A shows a H_2-fuel cel as electrical power source for repressuration pump(s) for pressurizing the pressure storage vessel, the necessary components and the power lines.

Fig. 15B shows a combustion motor, using H_2 as power source, which has been generated by electrolyses of conductive water – the axle of said combustible is driving an alternator which is charging a battery – the battery let an electric motor run, which is communicating with (a) pump(s), for repressuration of the pressure storage vessel.

Fig. 15C shows a combustion motor, using H_2 as power source, which has been generated by electrolyses of conductive water – the axle of said combustible is directly communicating with (a) pump(s) through (a) crankshaft, for repressuration of the pressure storage vessel.

Fig. 15D shows a combustion motor, using H_2 as power source, which has been generated by electrolyses of conductive water – the axle of said combustible is directly communicating with (a) rotational pump(s), for repressuration of the pressure storage vessel.

Fig. 15E shows a capacitator, which is electrically charged, and which is the power source for electrical motor(s), which are communicating with (a) pump(s) for repressuration of the pressure storage vessel.

ESVT – CRANKSHAFT DESIGN – MULTIPLE USE OF COMPONENTS

Fig. 16A shows a scaled up 2-way actuator of the Figs. 11G-R.

Fig. 16B shows a pre-study of the 2-way actuator of Fig. 16A.

ESVT – CRANKSHAFT DESIGN – MULTIPLE USE OF COMPONENTS

Fig. 17A shows schematically the two strokes of an actuator piston according to Figs. 10A,B of a one cylinder motor, where the stroke from a 2nd to a 1st longitudinal position is the power stroke, and the stroke from the 1st to the 2nd longitudinal position the (powerless) return stroke.

Fig. 17B shows a two cylinder motor ("A" and "B") with strokes according to Fig. 17A, whereby the crankshaft (comprising of two sub-crankshafts) is designed, so that the power strokes of each cylinder are moving in opposite (180°) direction.

Fig. 17C shows a two cylinder motor according to Fig.11R, whereby the combustion motor here is forced liquid cooled, whereby one of the ESVT-pumps has been exchanged by an inlet/outlet for one sub-crankshaft, which is communicating with the ESVT-pump for the other sub-crankshaft, and where said communcation is controlled by valve actuators according to Fig. 210E, of which motion are initiated by cams of a camshaft, said camshaft being driven by said combustible motor, and, such that the beginning of the power stroke of the left cylinder, is synchronized with the beginning of the return stroke of the right cylinder; the second enclosed space of one sub-crankshaft has been separated from the third enclosed space of the other sub-crankshaft.

Fig. 17C l. shows an enlagement of Fig. 17C left and a diagram of the in-between relationship of the connection rods of both actuator pistons.

Fig. 17C r. shows an enlagement of Fig. 17C right.

Fig. 17D shows the middle of the power stroke of the left cylinder, and the middle of the return stroke of the right cylinder of the motor according to Fig. 17C.

Fig. 17D l. shows an enlagement of Fig. 17D left and a diagram of the in-between relationship of the connection rods of both actuator pistons.

Fig. 17D r. shows an enlagement of Fig. 17D right.

Fig. 17E shows the end of the power stroke of the left cylinder and the end of the return stroke of the right cylinder of the motor according to Fig. 17D.

Fig. 17E l. shows an enlagement of Fig. 17E left and a diagram of the in-between relationship of the connection rods of both actuator pistons.

Fig. 17E r. shows an enlagement of Fig. 17E right.

Fig. 17F shows the beginning of the return stroke of the left cylinder and the beginning of the power stroke of the right cylinder of the motor according to Fig. 17E.

Fig. 17F l. shows an enlagement of Fig. 17F left and a diagram of the in-between relationship of the connection rods of both actuator pistons.

Fig. 17F r. shows an enlagement of Fig. 17F right.

Fig. 17G shows the middle of the return stroke of the left cylinder and the middle of the power stroke of the right cylinder of the motor according to Fig. 17F.

Fig. 17G l. shows an enlagement of Fig. 17G left and a diagram of the in-between relationship of the connection rods of both actuator pistons.

Fig. 17G r. shows an enlagement of Fig. 17G right.

Fig. 17H shows the end of the return stroke of the left cylinder and the end of the power stroke of the right cylinder of the motor according to Fig. 17G.

Fig. 17H l. shows an enlagement of Fig. 17H left and a diagram of the in-between relationship of the connection rods of both actuator pistons.

Fig. 17H r. shows an enlagement of Fig. 17H right.

ESVT – CRANKSHAFT DESIGN – MULTIPLE USE OF COMPONENTS

Fig. 18A shows a two cylinder motor ("A" and "B") with strokes according to Fig.17A, whereby the crankshaft (comprising of two sub crankshafts) is designed, so that the power strokes of each actuator pistons are moving in the same (0°) direction.

Fig. 18A l. shows an enlagement of Fig. 18A left and a diagram of the in-between relationship of the connection rods of both actuator pistons.

Fig. 18A r. shows an enlagement of Fig. 18A right.

Fig. 18B shows a simple configuration of a two cylinder motor according to Fig.17C, whereby the combustion motor here is forced liquid cooled, comprising one ESVT-pump serving both actuator pistons has, the second enclosed space of one sub-crankshaft is communicating with the third enclosed space of the other sub-crankshaft,
such that the beginning of the power stroke of the left cylinder, is synchronized with the beginning of the power stroke of the right cylinder.

Fig. 18B l. shows an enlagement of Fig. 18B left and a diagram of the in-between relationship of the connection rods of both actuator pistons.

Fig. 18B r. shows an enlagement of Fig. 18B right.

Fig. 18C shows the middle of the power strokes of the left and the right cylinder of the motor according to Fig. 18B.

Fig. 18C l. shows an enlagement of Fig. 18C left and a diagram of the in-between relationship of the connection rods of both actuator pistons.

Fig. 18C r. shows an enlagement of Fig. 18C right.

Fig. 18D shows the end of the power strokes of the left and the right cylinder of the motor according to Fig. 18C.

Fig. 18D l. shows an enlagement of Fig. 18D left and a diagram of the in-between relationship of the connection rods of both actuator pistons.

Fig. 18D r. shows an enlagement of Fig. 18D right.

Fig. 18E shows the beginning of the return stroke of the left and the right cylinder of the motor according to Fig. 18D.

Fig. 18E l. shows an enlagement of Fig. 18E left and a diagram of the in-between relationship of the connection rods of both actuator pistons.

Fig. 18E r. shows an enlagement of Fig. 18E right.

Fig. 18F shows the middle of the return stroke of the left and the right cylinder of the motor according to Fig. 18E.

Fig. 18F l. shows an enlagement of Fig. 18F left and a diagram of the in-between relationship of the connection rods of both actuator pistons.

Fig. 18F r. shows an enlagement of Fig. 18F right.

Fig. 18G shows the end of the return stroke of the left and the right cylinder of the motor according to Fig. 18F.

Fig. 18G l. shows an enlagement of Fig. 18G left and a diagram of the in-between relationship of the connection rods of both actuator pistons.

Fig. 18G r. shows an enlagement of Fig. 18G right.

CT – CRANKSHAFT DESIGN – MULTIPLE USE OF COMPONENTS

Fig. 19A shows a one cylinder motor, based on Figs. 11B, 11C, where some parts have been worked out further – the auxilliarly power source is a combustion motor, which is burning H_2, derived from electrolyses of H_20.

Fig. 19B shows a two cylinder motor, based on Fig. 19A, where the two cylinders have been mirrowedly positioned to the center line of the connection, so that the 3rd enclosed spaces (exits) are communicating with each other through the connection of the two sub-crankshafts, while the 2nd enclosed spaces (inlets) are communicating outside said crankshaft with each other (with a check valve), and where the crankshaft (comprising of two sub-crankshafts) is designed, so that the power strokes of each actuator piston are moving simultaneously in the same (0°) direction (synchrone), according to the principle of Fig. 18A.

Fig. 19B l. shows an enlargement of Fig. 19B left.

Fig. 19B r. shows an enlargement of Fig. 19B right.

Fig. 19C shows a two cylinder motor, based on Fig. 19A, where the comparable enclosed spaces (here the 3rd enclosed spaces) have been connected to each other through the sub-crankshafts, while the 2nd enclosed spaces have been brought externally together (with a check valve), and where the whereby the crankshaft (comprising of two sub-crankshafts) is designed, so that the power strokes of each actuator pistons are moving in the same (180°) direction (asynchrone), according to the principle of Fig. 18A.

Fig. 19C l. shows an enlargement of Fig. 19C left.

Fig. 19C r. shows an enlargement of Fig. 19C right.

19620 BRIEF DESCRIPTION OF THE DRAWINGS

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

Fig. 21A shows a longitudinal cross-section of a conical shaped chamber with constant maximum work force characteristics of a pump showing the common (pressure) borders, and the convex and conical shapes of the sides of the longitudinal cross-sectional sections between said borders.

Fig. 21B shows the chamber of Fig. 21A (10 Bar overpressure), and (dashed) the shape of another chamber (16 Bar overpressure), for the same chamber length

Fig. 22 shows a longitudinal cross-section of a conical shaped chamber of Fig. 21 showing an expansion chamber as part of said chamber.

Fig. 23 shows a advanced conical shaped chamber with constant maximum work force characteristics of a pump showing the specific internal concave transition from the internal conically shaped part of the chamber to the straight inside at secind longitudinal positions, which is paralel to the centre axis of the chamber.

Fig. 24 shows an expandable deformable piston, which will not move by itself from a second longiudinal pisiotion to a first longitudinal position, because the internal wall of the chamber of Fig. 23 is parallel to the centre axis.

Fig. 25 shows a chamber of a constant force type, with a hose nipple as exit, which is connected to a hose.

19630 BRIEF DESCRIPTION OF THE DRAWINGS

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

Fig. 30A shows the circular chamber of Fig. 12B, where a piston is moving in a non-moving chamber.

Fig. 30B shows the circular chamber of Figs. 13C and 14D where the piston is not moving, but the chamber. Here is the design of the circular chamber and the sub-chambers identical with the design of Fig. 30A.

Fig. 31A shows the Fig. 14D, where the section X-X has shown.

Fig. 31B shows an scaled up detail of section X-X of the chamber of Fig. 31A.

MATHEMATICAL DESCRIPTION OF THE CIRCULAR CHAMBER AND A PISTON

Fig. 32A shows the wall of the chamber and the orthogonal plane to the base circle intersects in a circle whose center is at the bas circle.

Fig. 32B a section of the boundary of the piston.

Fig. 32C shows the cap geometri – for area and internal volume of the cap we need need values of a and h only - see formulas (2.1) and 2.2) – the radius of the virtual sphere is given in (2.3).

Fig. 32D shows the piston with end caps.

Fig. 32E shows the piston with end caps inside a transparent Fermi tube chamber.

Fig. 32F shows the pure contact area between the piston and the chamber, visible inside the transparent chamber wall.

Fig. 32G shows the contact area between the piston and the chamber.

Fig. 32H shows a section of the chamber wall – the chamber reaction force is marked by gray – the total force on the section is orthogonal to the chamber wall – for the section is the value of the force proportional to the (variable) longitudinal length of the shown section and to the internal pressure of the piston.

Fig. 32I shows the section of Fig. 32H, with an additional section in order to provide an open view.

Fig. 32J shows Fig. 32H, and the red vector is the component of the gray force in the longitudinal direction.

Fig. 32K shows Fig. 32J, with an additional section in order to provide an open view.

Fig. 32L shows Fig. 32J, where the actual sliding force along the wall is shown in blue – it is obtained by projecting the red vector orthogonally to the chamber wall.

Fig. 32M shows Fig. 32L, with an additional section in order to provide an open view.

19640 BRIEF DESCRIPTION OF THE DRAWINGS

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

Fig. 40A shows a longitudinal cross-section of a pump with a piston comprising support means, an O-ring and a flexible impervious layer, the last mentioned supported by a foam, at a first longitudinal position.

Fig. 40B shows a detail of the suspension of the support means, O-ring and the flexible impervious layer, vulcanised together.

Fig. 40C shows a longitudinal cross-section of the piston of Fig. 40A at a second longitudinal position.

Fig. 41A shows top view of the piston of Fig. 40A and a cross-section of the chamber from a first longitudinal position.

Fig. 41B shows a detail of the suspension on the support means of the O-ring and the lying spring of the piston of Fig. 40A.

Fig. 41C shows a transversal cross section of the chamber with the piston of Fig. 40A at a second longitudinal position.

Fig. 41D shows a bottom view of the piston of Fig. 40A, and cross-section of the chamber at a first longitudinal position, showing the spriral reinforment of the impervious sheet.

Fig. 41E shows a bottom view of the piston of Fig. 40A, and cross-section of the chamber at a first longitudinal position, showing the spiral reinforments of the impervious sheet.

Fig. 42A shows a longitudinal cross-section of a piston comprising support means, an O-ring and a flexible impervious layer, the last mentioned at a centain angle with the centre axis of the chamber, at a first longitudinal position.

Fig. 42B shows a detail of the suspension of the support means, O-ring and the flexible impervious layer, vulcanised together.

Fig. 42C shows a longitudinal cross-section of the piston of Fig. 42A at a second longitudinal position.

19650 BRIEF DESCRIPTRION OF THE DRAWINGS

Fig. 50. shows the top view of a foam piston, specifically the suspension of the reinforcement pins.

Fig. 51 shows a longitudinal cross-section A-A of a piston made of a PU foam.

Fig. 52 shows a longitudinal cross-section B-B of the piston of Fig. 50

19660 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 60 shows a longitudinal view and cross-sections of the ends of a container type piston

Fig. 61 shows the details of both end of the container type piston of Fig. 60.

Fig. 62 shows the container type piston at the begin and end of a stroke, in a chamber where the force on the piston rod is constant (please see 19620).

207 BRIEF DESCRIPTION OF THE DRAWINGS

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

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

Fig. 100	shows a so-called indicator diagram of a one-stage single working piston pump with a cylinder and a piston with a fixed diameter.
Fig. 102A	shows an indicator diagram of a piston pump according the invention part A shows the option where the piston is moving, while part B shows the option where the chamber is moving.
Fig. 102B	shows an indicator diagram of a pump according to the invention where the transversal cross-section increases again from a certain point of the pump stroke, by still increasing pressure.
Fig. 103A	shows a longitudinal cross-section of a pump with fixed different areas of transversal cross-sections of the pressurizing chamber and a piston with radially-axially changing dimensions during the stroke - the piston arrangement is shown at the beginning and at the end of a pump stroke (first embodiment).
Fig. 103B	shows an enlargement of the piston arrangement of Fig. 103A at the beginning of a stroke.
Fig. 103C	shows an enlargement of the piston arrangement of Fig. 103A at the end of a stroke.
Fig. 103D	shows a longitudinal cross-section of a chamber of a floor pump according to the invention with such dimensions that the operating force remains approximately constant - as a comparison the cylinder of an existing low pressure (dotted) and high pressure floor (dashed) pump are shown simultaneously.

Fig. 104A shows a longitudinal cross-section of a pump with fixed different areas of the transversal cross-sections of the pressurizing chamber and a piston with radially/partially axially changing dimensions during the stroke - the piston arrangement is shown at the beginning and at the end of the pump stroke (second embodiment).

Fig. 104B shows an enlargement of the piston arrangement of Fig. 104A at the beginning of a stroke.

Fig. 104C shows an enlargement of the piston arrangement of Fig. 104A at the end of a stroke.

Fig. 104D shows section A-A of Fig. 104B.

Fig. 104E shows section B-B of Fig. 104C.

Fig. 104F shows an alternative solution for the loading portion of Fig 104D.

Fig. 105A shows a longitudinal cross-section of a pump with fixed different areas of the transversal cross-sections of the pressurizing chamber and a piston with radially-axially changing dimensions during the stroke - the piston arrangement is shown at the beginning and at the end of the pump stroke (third embodiment).

Fig. 105B shows an enlargement of the piston arrangement of Fig. 105A at the beginning of a stroke.

Fig. 105C shows an enlargement of the piston arrangement of Fig. 105A at the end of a stroke.

Fig. 105D shows section C-C of Fig. 105A.

Fig. 105E shows section D-D of Fig. 105A.

Fig. 105F shows the pressurizing chamber of Fig. 105A with a piston means with sealing means which is made of a composite of materials.

Fig. 105G shows an enlargement of the piston means of Fig. 105F during a stroke.

Fig. 105H shows an enlargement of the piston means of Fig. 105F at the end of a stroke, both while it is still under pressure and while it is not anymore under pressure.

Fig. 106A shows a longitudinal cross-section of a pump with fixed different areas of the transversal cross-sections of the pressurizing chamber and a fourth embodiment of the piston with radially-axially changing dimensions during the stroke - the piston arrangement is shown at the beginning and at the end of the pump stroke.

Fig. 106B shows an enlargement of the piston arrangement of Fig. 106A at the beginning of a stroke.

Fig. 106C shows an enlargement of the piston arrangement of Fig. 106A at the end of a stroke.

Fig. 106D shows the pressurizing chamber of Fig. 106A and a fifth embodiment of the piston with radially-axially changing dimensions during the stroke - the piston arrangement is shown at the beginning and at the end of a pump stroke.

Fig. 106E shows an enlargement of the piston arrangement of Fig. 106D at the beginning of a stroke.

Fig. 106F shows an enlargement of the piston arrangement of Fig. 106D at the end of a stroke.

Fig. 107A shows a longitudinal cross-section of a pump comprising a concave portion of the wall of the pressurizing chamber with fixed dimensions and a sixth embodiment of the piston with radially-axially changing dimensions during the stroke - the piston arrangement is shown at the beginning and at the end of the pump stroke.

Fig. 107B shows an enlargement of the piston arrangement of Fig. 105A at the beginning of a stroke.

Fig. 107C shows an enlargement of the piston arrangement of Fig. 105A at the end of a stroke.

Fig. 107D shows section E-E of Fig. 107B.

Fig. 107E shows section F-F of Fig. 107C.

Fig. 107F 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. 107G shows a variant of the pressurizing chamber of Fig.107A, 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. 107H shows transversal cross-section G-G (dotted lines) and H-H of the longitudinal cross section of Fig. 107G.

Fig. 107I shows transversal cross-section G-G (dotted lines) and I-I of the longitudinal cross section of Fig. 107H.

Fig. 107J shows a variant of the piston of Fig. 107B, in section H-H of Fig. 107H.

Fig. 107K 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. 107L shows an example of an optimized convex shape of the transversal cross section under certain contraints.

Fig. 107M shows an example of an optimized non-convex shape of the transversal cross section under certain contraints.

Fig. 108A shows a longitudinal cross-section of a pump comprising a convex portion of the wall of the pressurizing chamber with fixed dimensions and a seventh embodiment of the piston with radially-axially changing dimensions during the stroke - the piston arrangement is shown at the beginning and at the end of a pump stroke.

Fig. 108B shows an enlargement of the piston arrangement of Fig. 105A at the beginning of a stroke.

Fig. 108C shows an enlargement of the piston arrangement of Fig. 105A at the end of a stroke.

Fig. 109A shows a longitudinal cross-section of a pump with fixed different areas of the transversal cross-sections of the pressurizing chamber and an eight embodiment of the piston with radially-axially changing dimensions during the stroke - the piston arrangement is shown at the beginning and at the end of a pump stroke.

Fig. 109B shows an enlargement of the piston arrangement of Fig. 109A at the beginning of a stroke.

Fig. 109C shows an enlargement of the piston arrangement of Fig. 109A at the end of a stroke.

Fig. 109D shows the piston of Fig. 109B with a different tuning arrangement.

Fig. 110A shows a nineth embodiment of the piston similar to the one of Fig. 109A with fixed different areas of the transversal cross-section of the pressurizing chamber.

Fig. 110B shows an enlargement of the piston of Fig. 110A at the beginning of a stroke.

Fig. 110C shows an enlargement of the piston of Fig. 110A at the end of a stroke.

Fig. 111A shows a longitudinal cross-section of a pump with fixed different areas of the transversal cross-sections of the pressurizing chamber and an tenth embodiment of the piston with radially-axially changing dimensions during the stroke - the piston arrangement is shown at the beginning and at the end of a pump stroke.

Fig. 111B shows an enlargement of the piston of Fig. 111A at the beginning of a stroke.

Fig. 111C shows an enlargement of the piston of Fig. 111A at the end of a stroke.

Fig. 112A shows a longitudinal cross-section of a pump with fixed different areas of the transversal cross-sections of the pressurizing chamber and an eleventh embodiment of the piston with radially-axially changing

dimensions during the stroke - the piston arrangement is shown at the beginning and at the end of a pump stroke.

Fig. 112B shows an enlargement of the piston of Fig. 112A at the beginning of a stroke.

Fig. 112C shows an enlargement of the piston of Fig. 112A at the end of a stroke.

Fig. 113A shows a longitudinal cross-section of a pump with variable different areas of the transversal cross-section of the pressurizing chamber 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. 113B shows an enlargement of the arrangement of the combination at the beginning of a pump stroke.

Fig. 113C shows an enlargement of the arrangement of the combination during a pump stroke.

Fig. 113D shows an enlargement of the arrangement of the combination at the end of a pump stroke.

Fig. 114 shows a longitudinal cross-section of a pump with variable different areas of the transversal cross-section of the pressurizing chamber and a piston with variable geometrical sizes - the arrangement of the combination is shown at the beginning, during and at the end of the pump stroke.

653 BRIEF DESCRIPTION OF THE DRAWINGS

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

Fig. 201A 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. 201B shows the contact pressure of the pressurized piston of Fig. 201A on the wall of the cylinder.

Fig. 202A shows a longitudinal cross-section of the piston of Fig. 201A in a cylinder at the first (right) and second (left) longitudinal position, the piston is non-pressurized.

Fig. 202B shows the contact pressure of the piston of Fig. 202A on the wall of the cylinder at the second longitudinal position.

Fig. 202C shows a longitudinal cross-section of the piston of Fig. 201A in a cylinder at the second longitudinal position, the piston is pressurized on the same pressure level as the one of Fig. 201A - also is shown the piston at the first longitudinal position (production) size.

Fig. 202D shows the contact pressure of the piston of Fig. 202C on the wall of the cylinder at the second longitudinal position.

Fig. 203A shows a longitudinal cross-section of a piston of Fig. 201A 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. 203B shows the contact pressure of the piston of Fig. 203A on the wall of the cylinder.

Fig. 204A 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. 204B shows the contact pressure of the pressurized piston of Fig. 204A on the wall of the cylinder.

Fig. 204C 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. 204A.

Fig. 204D shows the contact pressure of the piston of Fig. 204C on the wall of the cylinder.

Fig. 205A shows a longitudinal cross-section of the piston of Fig. 204A in a non-pressurized cylinder at the second longitudinal position, the piston with its production size, and when pressurized.

Fig. 205B shows the contact pressure of the pressurized piston of Fig. 205A on the wall of the cylinder.

Fig. 205C shows a longitudinal cross-section of the piston of Fig. 204A 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. 205D shows the contact pressure of the piston of Fig. 205C on the wall of the cylinder.

Fig. 206A 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. 206B shows an enlargement of the piston of Fig. 206A at the beginning of a stroke.

Fig. 206C shows an enlargement of the piston of Fig. 206A at the end of a stroke.

Fig. 206D 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. 206E shows the pattern of Fig. 206D when the wall of the container has been expanded,

Fig. 206F 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. 206G shows the pattern of Fig. 206F when the wall of the container has been expanded,

Fig. 206H shows production details of a piston with a textile reinforcement.

Fig. 207A 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. 207B shows an enlargement of the piston of Fig. 207A at the beginning of a stroke.

Fig. 207C shows an enlargement of the piston of Fig. 207A at the end of a stroke.

Fig. 208A 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. 208B shows an enlargement of the piston of Fig. 208A at the beginning of a stroke.

Fig. 208C shows an enlargement of the piston of Fig. 208A at the end of a stroke.

Fig. 208D shows a top view of the piston of Fig. 208A 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. 208E shows a top view of the piston alike the one of Fig. 208A 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. 208F shows a top view of the piston alike the one of Fig. 208A 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. 208G shows production details of a piston with a fiber reinforcement.

Fig. 209A 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. 209B shows an enlargement of the piston of Fig. 209A at the first longitudinal position of the chamber.

Fig. 209C shows an enlargement of the piston of Fig. 209A at the second longitudinal position of the chamber.

Fig. 210A shows the embodiment of Fig. 206 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. 210B shows instead of an inflation valve, a bushing enabling connection to an external pressure source.

Fig. 210C shows details of the guidance of the rod of the check valve.

Fig. 210D shows the flexible piston of the check valve in the piston rod.

Fig. 210E shows the embodiment of Fig. 206, where the volume of the enclosed space of Fig. 210A-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. 211D.

Fig. 210F shows the embodiment of Fig. 10E, where there are steerable valves and a jet or a nozzle – shown as black boxes.

Fig. 211A shows the embodiment of Fig. 206 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. 211B shows a piston arrangement and its bearing where the piston arrangement is communicating between the second and the first enclosed space.

Fig. 211C shows a alternative piston arrangement adapting itself to the changing cross-sectional area's in its longitudinal direction inside the piston rod.

Fig. 211D shows an enlargement of the inflation arrangement of the piston of Fig. 211A at the end of the stroke.

Fig. 211E shows an enlargment of the bypass arrangement for the valve actuator for closing and opening of the outlet valve.

Fig. 211F shows an enlargement of an automatic closing and opening arrangement of the outlet valve - a comparable system is shown for obtaining a predetermined pressure value in the piston (dashed).

Fig. 211G shows an enlargement of an inflation arrangement of the piston of Fig. 211A, 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. 211H shows an alternative solution for the one of Fig. 211G, comprising a combination of a valve actuator and a spring positioned below the piston of the valve actuator.

Fig. 212 shows an arrangement where the pressure in the container may depend of the pressure in the chamber.

Fig. 213A 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. 213B shows an enlargement of the arrangement of the combination at the beginning of a pump stroke.

Fig. 213C shows an enlargement of the arrangement of the combination during a pump stroke.

Fig. 213D shows an enlargement of the arrangement of the combination at the end of a pump stroke.

Fig. 214 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. 215A 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. 215B shows a variant of the pressurizing chamber of Fig. 207A, 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. 215C shows transversal cross-section G-G (dotted lines) and H-H of the longitudinal cross section of Fig. 215B.

Fig. 215D shows transversal cross-section G-G (dotted lines) and I-I of the

longitudinal cross section of Fig. 215C.

Fig. 215E 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. 215F shows an example of an optimized convex shape of the transversal cross section under certain constraints.

Fig. 216 shows a combination where the piston in moving in a cylinder over a tapered center.

Fig. 217A shows an ergonomical optimized chamber for pumping purposes and manual operation.

Fig. 217B shows the corresponding force-stroke diagram.

Fig. 218A shows an example of a Movable Power Unit, hanging under a parachute.

Fig. 218B shows details of the Movable Power Unit.

507 DESCRIPTION OF THE DRAWINGS

The foregoing features and other aspects of the invention are explained in the following description in connection with the accompagning drawings, wherein:

Figure 301 shows a first embodiment of the valve actuator in a clip-on valve connector to which a Schrader valve can be coupled,

Figure 301A shows an enlargement of a detail of Figure 301 with channels around the piston,

Figure 301B shows section G-G of Figure 301A,

Figure 302 shows a second embodiment of the valve actuator in a universal clip-on valve connector with a streamlined activating pin,

Figure 302A shows an enlargement of a detail of Figure 302,

Figure 302B shows section H-H of Fig. 302A,

Figure 303 shows a third embodiment of the valve actuator in a squeeze-on valve connector,

Figure 303A shows an enlargement of a detail of Figure 303,

Figure 304 shows the valve actuator including an activating pin and the wall of the cylinder in a permanent assembly (e.g. from a chemical plant),

Figure 305 shows a fourth embodiment of the valve actuator in a universal valve connector.

19597 BRIEF DESCRIPTION OF THE DRAWINGS

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

Fig. 401A	shows a top view of a pump of a floor pump type of Fig 401B, where the combination can turn around a line XX, YY or ZZ in relation to the floor surface, while the angle is not restricted by the suspension.
Fig. 401B	shows a back view of the floor pump of Fig. 401A.
Fig. 402A	shows top view of a pump of a floor pump type of Fig 402B, where the combination can move in 3 dimensions in relation to the surface, while the angle is restricted by spring force of the. transition between the combination and the basis.
Fig. 402B	shows the back view of the floor pump.
Fig. 402C	shows a top view of the pump of Fig 402B, where the handle has been moved to a position in front of its rest position.
Fig. 402D	shows a top view of the pump of Fig 402B, where the handle has been moved to a position at the back of its rest position.
Fig. 402E	shows a top view of the pump of Fig 402B, where the handle has been moved to a left position in front of its rest position.
Fig. 402F	shows a top view of the pump of Fig 402B, where the handle has been moved to a left position at the back of its rest position.
Fig. 402G	shows a top view of the pump of Fig 402B, where the handle has been moved to a right position in front of its position when out of function.
Fig. 402H	shows a top view of the pump of Fig 402B, where the handle has been moved to a right position at the back of its rest position.
Fig. 40 3A	shows a side view of a floor pump with a flexible transition between the chamber of the combination and the basis.

Fig. 403B shows an enlargement of the transition of Fig. 403A.

Fig. 403C shows a back view of a floor pump with another flexible transition between the chamber of the combination and the basis.

Fig. 403D shows an enlargement of the transition of Fig. 3C.

Fig. 404A shows a back view of of a floor pump with a cab which allows the piston rod to move in the transversal direction of the combination.

Fig. 404B shows an enlargment of a transversal cross-section of the cab of Fig. 4A when the piston rod is pulled out to its maximum – no transversal movement.

Fig. 404C shows the transversal cross-section of Fig. 404B when the piston rod is pulled out to its maximum, with a rotation of the piston rod to the left.

Fig. 404D shows an enlargement of a transversal cross-section of the cab of Fig. 404A when the piston rod is not pulled out – no transversal movement.

Fig. 404E shows the transversal cross-section of Fig. 404D when the piston rod is not pulled out, with a transversal translation of the piston rod to the left.

Fig. 405A shows a top view of a floor pump type of Fig 405B, where the angle between the centerlines of the handle parts opposite the centerline of the combination is less than 180°.

Fig. 405B shows a side view of handle of the floor pump of Fig. 405A.

Fig. 406A shows a top view of a floor pump type of Fig 406B, where the angle between the centerlines of the handle parts opposite the centerline of the chamber is more than 180°.

Fig. 406B shows a side view of handle of the floor pump of Fig. 406A.

19626 DESCRIPTION OF PREFERRED EMBODIMENTS

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

Fig. 1-3 deal with the limitation of the stretching of the wall of the piston. This comprises a limitation of the stretching in the longitudinal direction when the piston is 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.

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.

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 subjected to external forces.

All kinds of fluids may be used - a combination of a compressable and a non-compressible 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. 1A shows a longitudinal cross-section of the chamber 186 with a concave wall 185 and an inflatable piston comprising a container 208 at the beginning (= first longitudinal position in the chamber 186) and the same 208' at the end of a stroke (= second longitudinal position in the chamber 186).
Central axis of the chamber 186 is 184. The container 208' shows its production size, having a textile reinforced 189 in the skin 188 of the wall 187. During the stroke, 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 main function however of the reinforcement is to limit this longitudinal stretching of the wall 187 of the container 208. 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 circumferential 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. 1B shows a first embodiment of the expanded piston 208 at the beginning of a stroke. The wall 187 of the container is build up by a skin 188 of a flexible material, which may be e.g. a rubber type or the like, with a textile reinforcement 189, which allows expansion. 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 end of the stroke (= second longitudinal position). 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 can 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 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

the wall 185a of the chamber 186 which is parallel to the centre axis 184. It is positioned approx. at the end of the stroke at first longitudinal positions.

(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 between the wall of the container and the wall of the chamber is 198.

Fig. 1C shows the piston of Fig. 1B at the end of a pump stroke, where it has its production size. 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 is pressure in the chamber 186, then the bottom cap 192 is pressed against the stop 197. The compressable fluid 206' and the non-compressable fluid 205'. The contact area 198' between the container 208'and the wall of the chamber at the second longitudinal position.

The wall 185b of the chamber 186, which is parallel to the centre axis 184. It is positioned approximately at the end of the stroke at second longitudinal positions

Fig. 2A 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 its production size, having a fiber reinforcement 219 in the skin 216 of the wall 218 according to the Trellis Effect . During the stroke the wall 218 of the container expands until a stop arrangement, which may be the fiber reinforcement 219 and/or a mechanical stop 214 inside the container and/or another stop arrangement stops the movement during the stroke. And thus stops the expansion of the wall 218 of the container 217. The main function of the fiber reinforcement is to limit the longitudinal stretching of the wall 218 of the container 217. During the stroke the pressure inside the container 217, 217' may remain constant. This pressure depends on the change in the volume of the container 217, 217', thus on the change in the circumferential length of the cross-sections of the chamber 186 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. The contact area 211 between the container 217 and the wall of the chamber at the first longitudinal position.

Fig. 2B shows a second embodiment of the expanded piston 217 at the beginning of a stroke. The wall 218 of the container is build up by a skin 216 of a flexible material, which may be e.g. a rubber type or the like, with a fiber reinforcement 219, which allows expansion of the container wall 218, and thus the direction of the fibers in relation to the central axis 184 (= braid angle) may be different from 54°44'. 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 end of the stroke (= second longitudinal position). 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 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 can 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 can 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. 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 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.

The wall 185a of the chamber 186, which is parallel to the centre axis 184. It is positioned approximately at the end of the stroke at first longitudinal positions

Fig. 2C shows the piston of Fig. 2B at the end of a pump stroke, where it has its production size. The cap 191 is moved over a distance c' from the stop 214. 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 cap 192 is pressed against the stop 197. The compressable fluid 206' and the non-compressable fluid 205'. The contact area 211' of the container 217'and the wall of the chamber 186 at the second longitudinal position.

The wall 185b of the chamber 186, which is parallel to the centre axis 184. It is positioned approximately at the end of the stroke at second longitudinal positions.

Fig. 3A,B,C show an inflatable piston comprising a container 228 at the beginning and 228' at the end of a stroke. The production size is that of piston 228'at the second longitudinal position in the chamber 186. The construction of the piston 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. 3B shows the wall 218 with the skin 222 and 224. The reinforcement 223. The contact area 225 between the container 228 and the wall of the chamber at the first longitudinal position. The impervious layer 226.

Fig. 3C shows the contact area 225 ' between the container 228' and the wall of the chamber at the second longitudinal position.

Fig. 3D shows a top view of the piston 228 and 228', respectively with the reinforcement means 227, and 227' respectively.

Fig. 3E shows a top view of the piston 228 and 228', respectively with the reinforcement means 229, and 229' respectively.

Fig. 4 shows a non-moving expandable piston 228' inside a chamber 186 with a wall 185a, which is parallel to the centre axis 184 of said chamber 186 at a position where the contact surface 225' between the piston 228''and the wall 185 of said chamber 186, while there are no pressure differences in the chamber between both sides of said piston. The part 185 of the chamber further to a first position has an angle α with the centre axis 184. The projection 1000 of the middle point (centre) 1001 of the elastically deformable wall of the piston on the centre axis 184.

Fig. 5A shows the piston of Fig. 4, instantaneously non-moving inside a chamber 186 with a conical shaped wall 185, where the piston is beginning to expand – the movable cab 191 is moving toward the non-movable cab 192. The contact surface 225'' has been increasing, and is now positioned below the centres 1002 and 1003, respectively of the elastically deformable wall of the piston – its projection on the centre axis 1004 (old) and 1005 (new), respectively. The distance f'. The direction of moving 1006 of the movable cab 191. The force 1007 from the wall 187 of the piston to the wall 185 of the chamber 186. The distance g'.

Fig. 5B shows the piston of Fig. 5A, instanteneously non-moving, and thereby expanding, so that the contact area 225''' of the piston wall 187 with the 185 wall of the chamber 186 increases at second longitudinal positions of said contact surface 225''' – the movable cab 191 is currently non-moving. The contact surface 225''' is around the point where the middle point (centre) is of the elastically deformable wall of the container. The centres 1008 (old) and 1009 (new) of the the elastically deformable wall of the piston – its projections 1010 (old) and 1011 (new) on the centre axis 184 respectively. The distance f'. The force 1012 from the piston wall 187 on the wall 185 of the chamber. The direction of movement 1013 of the force 1012. The movement 1014 of the movable cap 191.

Fig. 5C shows the piston of Fig. 5B, instanteneously non-moving, and thereby expanding, so that the contact surface 225'''' of the piston wall 187 with the wall 185 of the chamber decreases at second longitudinal positions of said contact area, while the contact area of the piston wall with the wall of the hamber increases at first longitudinal positions of said contact area – the movable cab is non-moving. The centres 1015 (old) and 1016 (new) of the the elastically deformable wall of the piston – its projections 1017 (old) and 1018 (new) on the centre axis 184 respectively. The distance g'. The

direction of movement 1019 of the reaction force 1020 of the chamber wall 185 on the wall 187 of the piston. The direction of the movement 1021 of wall 187 of the piston.

Fig. 5D shows the piston of Fig. 5C, where the non-movable cap 192 is instanteneously beginning to move from second to first longitudinal positions, thereby moving the piston in the same direction. The contact area 225''''', which is much smaller than that 225'''' of Fig. 5C. The distance h'. The projection 1022 of the centre 1023 of the elastically deformable wall of the piston on the centre axis 184 respectively. The moving direction 1024 of the movable cap 191, and that 1025 of the non-movable cab 192, thus that of the whole piston. The leakage 1026, which occurs at that point of time.

Fig. 5E shows the piston of Fig. 5D, where the movement of the piston is decreasing due to a increasing contact area 225 ''''''. The projection 1027 on the centre axis 184 of the centre 1028 of the elastically deformable wall of the piston. The moving direction 1029 of the movable cap 191. The moving direction 1030 and 1031 of the wall of the piston.

Fig. 6A shows an expandable piston 898, moving engagingly or/and sealingly 900 in a cone-formed chamber 899, comprising a reinforced (not shown) wall 901, which is embedded in unmovable cab 903, and a movable cab 904. Said cab 904 is slidingly movable over the piston rod 902, which is hollow, comprising the enclosed space, and communicating with the space in the piston 898. There is fluid or a mixture of fluids in the piston. Said chamber is closed at both sides of the piston with spaces 906, 907, and may be comprise a fluid or a mixture of fluids at one or at both sides of the piston 898. The contact area 905 between the wall 901 of the piston 898 and the wall 897 of the chamber 899. The existence of fluid at both sides of the piston may cause the piston move in a different manner than desired.

Fig. 6B shows the piston 898 of Fig. 6A moving engagingly or/and sealingly 900 in a cone-formed chamber 896, which has spaces 908 and 909 at the respective sides of the piston 898. In the wall 895 of the cone formed chamber 896 at 1st longitudinal positions is a tube 911, which allows communication between the space 908 with the atmosphere 910 of the surroundings, while tube 912 is assembled in the wall 895 of said cone-formed chamber 896, which allows communication between the space 909 with the atmosphere 910 of the surroundings. The contact area 905 between the wall 901 of the piston 898 and the wall 897 of the chamber 896.

Fig. 6C shows the piston 898 of Fig. 6A moving engagingly or/and sealingly 900 in a cone-formed chamber 894, which has spaces 908 and 909 at the respective sides of the piston 898. In the wall 893 of the cone formed chamber 894 at 1st longitudinal positions is a tube 913, which allows communication between the space 908 with the inside of tube 915 which communicates with the tube 914, which is assembled in the wall 893 of said cone-formed chamber 896, and which communicates with the space 909 of said cone–shaped chamber 894. The contact area 905 between the wall 901 of the piston 898 and the wall 893 of the chamber 896.

Fig. 6D shows the piston 892 moving engagingly in a cone-shaped chamber 899, which has spaces 906 and 907 at the respective sides of the piston 892. Said spaces 906 and 907 are communicating with each other through tube 918, which is assembled in cabs 891 and 890, respectively. The contact area 905 between the wall 901 of the piston 898 and the wall 897 of the chamber 899.

Fig. 6E shows the piston 898 engagingly movable in a cone-shaped chamber 899 Said chamber is closed at both sides of the piston with spaces 906, 907, and may be comprise a fluid or a mixture of fluids at one or at both sides of the piston 898. There is no contact area between the internal wall 922 of the cone-formed chamber 899 and the external wall 923 of the piston 924, and instead there is a gab 920 between said walls 922 and 923, allowing a flow of fluid 921 in the opposite direction of the motion 900 of said piston 898.

Fig. 7D 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 F1-3°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. 7B.

Fig. 7E is a 3-dimensional drawing and shows the reinforcement matrix of Fig. 7D 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. 7D.

Fig. 7F 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. 7G is a 3-dimensional drawing and shows the reinforcement matrix of Fig. 7F 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. 7F.

Fig. 8 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 here 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. 9A shows a longitudinal cross-section of the chamber with a convex/concave wall 185 and an inflatable piston comprising a container 258 at the beginning and the same 238' at the end of a stroke. The container 258' shows its production size.

Fig. 9B shows the longitudinal cross-section of the piston 258 having a wall 251 and a reinforced skin 252 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. 9D shows the longitudinal cross-section of the piston 258'' with a common area 253''. The centre 1020 of the elastically, deformed wall 251 of the piston. The projection of the centre point 1020 on the centre axis 1022.

Fig. 10A shows a piston-chamber combination with a chamber 186, having a centre line 184, a wall 185 of said chamber 186, where a pressurized ellipsoïde shaped piston 217' - as described in sections **207, 653** and **19660** of this patent application - is moving 2003 from a second longitudinal position 2000 to a first longitudinal position 2001. At said first longitudinal position 2001 has said piston 217' has been expanding into a piston 217, having a sphere shape, while having a fixed volume of the enclosed space 210. This means that the pressure inside the piston has been decreased when arriving at said first longitudinal position 2001. The shape of the piston 217 may also be at said first longitudinal position be ellipsoide (not shown) - as described and shown in section **19660** of this patent application - and this will not effect the size of the internal pressure of said piston. The position 2004 of the valve 126 is during said run unchanged, so that the volume of the enclosed space 210 remains unchanged. The arrow 2005 shows that the next stage of the operation shown in Fig. 10B òr Fig 10 C, where the arrow is 2011.

Position 2025 of piston 217' at a second longitudinal position, where the wall of said chamber 186 is parallel to the centre axis 184. Position 2026 of piston 217 at a first longitudinal position, where the wall of of said chamber 186 is parallel to the centre axis 184. Shape 2027 is the piston 217, when at a first longitudinal position where the piston is (delayed) beginning to be depressurized. Shape and size 2028 is when the piston 217'' is approximately on half of the return stroke, where it is just free of the wall 185 of the chamber 186, due to a delayed depressuration. The same shape and size 2028 of the piston 217' may be positioned closer (distance y) to a second longitudinal position than when the piston 217'' is moving to a second longitudinal position, as said piston 217' is engaging the wall 185 of said chamber 186 (and not free of it).

Fig. 10B shows the valve 126 has been retracted 2006 from the its position 2004 to a position 2007 further away from said piston 217. The enclosed space 210'. The result is that the volume of the enclosed space 210' is decreasing so much that the pressure inside the piston 217'' has become approximately that of when said piston had been produced (e.g. atmospheric pressure) – the size and shape are approximately those of when the piston is on the second longitudinal postion 2000, but now unpressurized – this means that the piston 217'' may not engaging and/òr may engaging, but not seal the wall 185 of said chamber 186, when returning 2008 from the first longitudinal position 2001 to the second longitudinal position 2000. The wall 2024 of the piston.

When the piston 217'' is moving 2008 from a first 2001 to a second 2000 longitudinal position, may the internal pressure drop be so relatively slowly obtained, that the piston 217B''during said moving stil may have an ellipsoïde shape larger than that of the shape of 217' at a second longitudinal position 2000, so that said piston 217B'' during said moving 2008 is engaging and/or non-engaging the wall 185. As a comparison: the same size of said piston 217B'' is obtained further away to a 2nd longitudinal position than when the piston is (sealingly and/or engagingly) moving 2003 from a 2nd longitudinal position 2000 to a 1st longitudinal position 2001. Said pressure drop may also be obtained already at a first longitudinal postion.

When the piston 217'', 217B'' has returned to the second longitudinal position 2000, the position of valve 126 in the enclosed space 210' changes from 2007 to 2004 – arrowed 2009, so that the enclosed space 210' has become its original volume of Fig. 10A again, so that said piston 217' again has its original pressure. The arrow 2010 shows that the next stage of the operation shown in Fig. 10A.

Fig. 10C shows the alternative solution for changing the internal pressure of the piston 217, and shall be regarded together with Fig. 10A, where in this case the valve 126 is lacking and instead may an inlet/outlet configuration 2020 be present – e.g. please see Figs. 210A-F (incl.) and Figs. 211A-F (incl.) of section **653** of this patent application. The pressurized piston 217' is moving 2003 from the second longitudinal position 2000 to the first longitudinal position 2001, as described in Fig. 10A – please see above. No adding or removing fluid from the enclosed space 210 is occuring. The arrow 2011 shows that the next stage of the operation is shown in Fig. 10B. The depressurization in piston 217'' is obtained by removing the necessary amount of fluid from the enclosed space 210: arrow 2020. When said piston 217'' has been returned from the first longitudinal position 2001 to (arrow 2021) to the second longitudinal position 2000, sufficient fluid is added (arrow 2022) to the enclosed space 210, resulting in piston 217''' – the arrow 2023 shows that the next phase is shown in Fig. 10A, resulting in piston 217'. The wall 2024 of the piston.

It should be emphasized that a combination of both above mentioned technologies may be an additional solution for the pressure management of the piston. It may additionally be possible that the pressure drop from piston 217 òr 208 to piston 217'' òr 208'', respectively may be a gradual one – e.g. computerized - on the condition that the wall 2024 of the piston only is engaging the wall 185 of the chamber 186 or not at all during the return

The wall 185 of the chamber 186 in the drawings 10A-F at the second and first longitudinal positions may be not parallel to the centre axis. No channels as shown in Figs. 4, 5A-E (incl.),

The process (the socalled **E**(nclosed)**S**(pace)**V**(olumechange) **T**(echnology)) shown in Figs. 10A,10B or Figs. 10D,10E are being used in a motor according this invention, shown in Figs. 11F,G (crankshaft) and in Figs, 13F, 13G, 14A-D (incl.) (rotational).
The process (the so-called **C**(onsumption) **T**(echnology)) shown in Figs. 10A,10C or Figs. 10D,10F and in Figs. 210A-F (incl.) and Figs.211A-F (incl.) are being used in a motor according this invention, shown in Figs. 11A-D (incl.) (crankshaft) and in Figs. 12A-C (incl.), 13A-D (incl.).

In Figs. 10D,E is an analogus process shown as in Figs. 10A,B, with the difference, that the piston is a sphere type 208.

In Figs. 10D,F is an analogus process shown as in Figs. 10A,C, with the difference, that the piston is a sphere type 208.

Fig. 10G shows B-B section of Fig. 12 C (and said B-B section can be partly seen on Fig. 12A) and the motor where the piston of an actuator piston-chamber combination is moving, while the chamber is not moving. The motor comprising a chamber 960, which is comprising 4 sub-chambers 961, 962, 963 and 964, respectively, which lie around the same centre axis 965 in continuation of each other, which has an axle 966 through the center 967 of said chamber 960. Within said sub-chambers 961, 962, 963 and 964, respectively is 1 piston 968 positioned, shown on two important positions, namely position 968' when at a 1st rotational position of the sub-chamber 964, having the largest diameter, and position 968'' when at a 2nd rotational position of the sub-chamber 961, which is lying in continuation with sub-chamber 964, so that the 1st rotational position of sub-chamber 964 lies closest to the 2nd rotational position of sub-chamber 961, where it has its smallest diameter. Said actuator piston 968 is rotating clockwise around said axle 966 – there are shown 4 holes 970 for assembling said chamber 960 on axle 966.

Fig. 10H shows the B-B section of Figs. 13A and 13B and the motor is of a type where the chamber of an actuator piston-chamber combination is moving, and the piston is not moving.

The motor comprising a chamber 860, which is comprising 4 sub-chambers 861, 862, 863 and 864, respectively, which lie around the same centre axis 865 in continuation of each other, which has an axle 866 through the center 867 of said chamber 860. Within said sub-chambers 861, 862, 863 and 864, respectively are 5 pistons 868, 869, 870, 871 and 872, respectively positioned, each at a different rotational position said sub-chambers 861, 862, 863 and 864, on an angle $\alpha = 72°$ from each other. Each piston comprising a piston rod 873, 874, 875, 876 and 877, respectively. The pistons 868, 869, 870, 871 and 872 are of a "sphere – sphere" type, and are shown all having different diameters. Said chamber 860 is rotating clockwise around said axle 866 and the sub-chambers 861, 862, 863 and 864 having a second rotational position and a first rotational position in the clockwise rotational direction – there are shown 4 holes 878 for assembling said chamber 860 on axle 866.

The motor according to Figs. 10G and 10H may comprise a chamber 860 of which, at least a part, may be parallel to the centre axis of said chamber (not shown).

led - Regarding a pressure management system for Figs. 11F, 13F and Fig. 13E

It depends on the system of the bidirectional actuator (e.g. Fig. 11F references 1056 and 1057) whether or not a repressuration system is necessary, when the change of direction may cause a loss of pressure – this may be caused by a "consumption" of fluid, where the fluid during the directional change may be realesed to the atmosphere òr it may also be caused by a pressure drop – please see Fig. 13E. The repressuration system is than alike those shown in earlier drawings, e.g. Figs. 11A, 11B and Fig. 12A.

It may possible to develop a system which does not "consume" fluid, and possibly only "consume" pressure. In the drawings Fig. 11F, 13F it is assumed to be present already, so that only a pressure storage vessel of a certain volume may be necessary. The pressure should be preferably low pressure (e.g. 10-15 Bar), optionally high pressue (e.g. 300 Bar).
This system may comprising a classic cylinder, in which a bidirectional piston is positioned. On each sides of the piston has the cylinder an inlet and outlet valve, so that the inlet valve of one side is communicating with an outlet valve at the other side of the piston. Thus the total accumulated volume on both sides of said piston may remaim constant – this may lead to the fact that it is possible to move the piston from one side of said cylinder to another side, without consuming fluid. Either pressure is consumed. That means that there only would be e.g. electricity present for controling said valves, and this could very well come from anb accumulator which is loaded by a sustainable power source, e.g. a solar photovoltaics cell e.g. a volt and/or a generator which may be connected to a main axle. This reduces the energy needed still more for this motor. We assume, that the pressure storage vessel has been loaded at the production of the motor.

Instead of the bidirectional actuator an electric step motor may be used, controlled by a computer. Such a motor may be precisely and quickly enough react on controling impulses from said computer.
Òr, the system shown in Fig. 13F references 1093 and 1094 may be used here.

Addition to the description of preferred embodiments for Fig. 11F

The holes in the piston rod 805 within the container piston 810 have not been shown in the container piston 810 – these however have been shown already in Figs. 2B, 2C, reference 201, and should be present in the Fig. 11F.

Addition to the description of preferred embodiments for Fig. 13F

The holes in the piston rod 805 within the container piston 810 have not been shown in the container piston 810 – these however have been shown already in Figs. 1B, 1C, reference 201, and should be present in the Fig. 13F.

Regarding the pressure management system for Figs. 11A, 11B, 11C

When an actuator piston, which is connected to the main axle by a crankshaft, where the fluid within said actuator piston is depressurized, and thereafter pressurized by a system, where the space within the piston is sequencially connected and disconnected with a repressuration pump and a pressure storage vessel, respectively, (Figs. 11A, 11B, 11D), the following remarks are being made.

Just when having reached the turning point at the farthest second longitudinal position, when an actuator piston – depressurized - is moving from a first to a said second longitudinal position, a communication is made between the pressure vessel (e.g. Fig. 11B – ref. 314) and actuator piston, so that the piston is being pressurized immediately when having been at the farthest second longitudinal position. At that moment, there is (shortly) an open connection through two holes, one in the crankshaft and one in the connection rod, between said pressure storage vessel through the second enclosed space of said crankshaft and the enclosed space of the piston rod, and the holes in said piston rod within the container, which contineously communicate between the space within said container and the enclosed space.

This means that during the stroke from a second to a first longitudinal position the enclosed space of said piston has temporary a constant volume, which means that due to the increasing volume of said container (from ellipsoïde with a smaller circumference to an ellipsoïde with a bigger circumference / ellipsoide – sphere / sphere with a small diameter to a sphere with a bigger diameter), when moving, that the internal pressure within said container is being reduced contineously.

And when arriving to the farthest first longitudinal position, the internal pressure of said container may have been reduced, but may not have become to atmospheric level. Just before or just at the returning point at the farthest first longitudinal position, when returning to a second longitudinal position, a communication may take place between the space within the container, the holes between said space and the enclosed space of said container within the piston rod and the connection rod, with the third enclosed space in the crankshaft through two holes, which at that point of time have corresponding centre axles, one in said connection rod, the other in the crankshaft.

The pump, which communicates with said third enclosed space and is, at that moment, sucking for fluid from said container, so that the container is depressurized.

The second enclosed space may be pressurized constantly by a constant open communication with the pressure storage vessel. It may also that this connection is controlled by a valve.

Addition to the description of preferred embodiments for Fig. 11A, 11B, 11C.

The holes in the piston rod 805 within the container piston 810 have not been shown in the container piston 810 – these however have been shown already in Fig. 2B and 2C, reference 201, and should be present in the Figs. 11A, 11B and 11C

Regarding a pressure management system for Figs. 12A, 12B, 12C, 13A, 13B

In the case of a circular chamber, which is a chamber having a central axis which is circleround, with the same pressurization system as earlier mentioned for a crankshaft solutions (Figs. 11A, 11B, 11D), similar solutions may be valid in said circular chambers, but in a bit adapted way.

In case of a moving piston and a non-moving chamber (Figs. 12A, 12B, 12C) the sphere piston may be comprising an enclosed space which may be communicating trough a hole in the piston rod, with the space inside the container, and at the other end may the enclosed space communicating with a second enclosed space, which may be positioned in the main axle. The last mentioned may be communicating with a two way valve in a housing, which may be build around the main axle. A separator valve may be a T-valve, of which the shared portion is communicating with said second enclosed space. One of the non-shared portions may be communicating with a pressure storage vessel (e.g. reference 814) (high pressure) and the other (lower pressure) with the pump (e.g. reference 818). The control of which way said separator valve is opening and closing may be done by a computer, which is monitoring the position of the main acle in comparison with the opening of the enclosed space and the opening of the second enclosed space in said main axle. It may also be done by a camshaft, which is communicating with the main axle. Because the number of single chambers is 4 in Figs. 12A and 12B, there ought to be 4 outlet/inlets to the second enclosed spaces be in the main axle, and also 4 inlets/outlets to the T-valve, or there may exist 4x T-valves. Between the T-valve (low pressure end) and the pressure storage vessel (e.g. reference 814) a pump (e.g. references 818, 826) may be added, so that the pressure is liftet up to a bit over the pressure in said pressure storage vessel. All this makes this solution be non-optimized, e.g. the transitions from and to the second enclosed space in the main axle may cause leakages.

In case a piston is non-moving and a chamber is moving (Figs. 13A, 13B), there may be e.g. 5 pistons, each in a subchamber, which all have the same central circleround axis, while all subchamber are positioned in continuation of each other, and are communcating with each other. Each piston is communicating with a T-valve in the same way as mentioned above in case the piston was moving and the chamber non-moving. Also the pressurization system may be

alike – the only difference is that there are 5 T-valves, which may be opening/closing at different point of times, as the position of each piston may be different in identical subchambers.

Instead of piston pumps may centrifugal pumps be used (Fig. B). The efficiency of centrifugal pumps may be lower than that of the piston pumps with a conaical shaped chamber..

Addition to the description of preferred embodiments for Figs. 12A-C, 13A-F

The holes in the piston rod 805 within the container piston 810 have not been shown in the container piston 810 – these however have been shown already in Figs. 1B, 1C, reference 201, and should be present in the Figs. 12A-C, 13A-F.

Addition to the description of preferred embodiments for Fig. 12C.

The return channel 1150 from the 1074 to the pump 1151, of which exit is connected by channel 1152 to the storage pressure vessel 1075. The pump 1151 may be connected (not shown) to the main axle 966 and/or to an external sustainable energy source, such as solar power (not shown).

Addition to the description of preferred embodiments for Figs. 12A-C (incl.), 13A-F (incl.).

The holes in the piston rod 805 within the container piston 810 have not been shown in the container piston 810 – these however have been shown already in Figs. 1B, 1C, reference 201, and should be present in the Figs. 12A-C, 13A-F.

Addition to the description of preferred embodiments for Figs. 13A,13B, 13E.

The valve box 1160 is comprising 5x T-valves 1161 – 1165 (incl.) which are opening up for either the communication [829] from the pressure storage vessel 814 to each of the pistons 868, 869, 870, 871, 872 (see Fig. 13C) through piston rods 873, 874, 875, 876, 877, or to channel [817] to a repressuration pump 818, and indirectly to 826.The pressurized return channel [825] and/or [828] from said pumps to the pressure storage vessel 889.

The return channel 1150 from the 1074 to the pump 1151, of which exit is connected by channel 1152 to the storage pressure vessel 1075. The pump 1151 may be connected (not shown) to the main axle 966 and/or to an external sustainable energy source, such as solar power (not shown).

Fig. 11A shows schematically the overall system for a ('green') motor, which is complying to all demands, as stated in the Background of this invention chapter. On a schematically drawn crankshaft 800 with a U-shaped axle 801, with axle bearings 802 and 803, contraweights 804, is a piston rod 805 assembled, which is on the other side of said piston rod 805, connected to an expandable piston 806, which is shown Left "L" in a movement (arrowed) from first to second longitudinal positions, and Right "R" in a movement (arrowed) from second to first longitudinal positions. Said piston 806 is engagingly movable in a chamber 807 with an internal wall 808. Said chamber 807 has cross-sections with contineously differing cross-sectional area's and differing circumferences, and of which the internal wall 808 has a circumference which is at second longitudinal positions smaller than at first longitudinal positions. The piston 806 has been produced, so that its unstressed production size of the circumference is approximately the size of the circumference of the wall 808 of said chamber 807 at a second longitudinal position. Said piston 806 is connected to the piston rod 805 by a cap 809, while the flexible wall 810 of said piston 806, is comprising reinforcement means 811, and is connected to the piston rod 805 by a slidable cap 812, which can slide over the piston rod 805. When said piston 806 being positioned at a second longitudinal position, and is communicating through its enclosed space 813 with a pressure source, e.g. a pressure vessel 814, through a second enclosed space 815 in said crankshaft 800 (axel 801), so that said piston 806 is being pressurized by a fluid 822, said piston 806 will begin to move from a second longitudinal position to a first longitudinal piston position, thereby rotating said U-shaped axel 801 around the bearings 802 and 803. Said movement will change the direction of the movement of said piston 806 into an opposite direction, namely from a first to a second longitudinal piston position. The enclosed space 813 of said piston 806 may then be communicating with a third enclosed space 816 in said crankshaft 800 (axel 801), which is connected through a channel [817] to a **turbo** piston pump 818 (which may also be instead a rotation pump, e.g. a centrifugal pump), which is connected by a piston rod 819 to a crankshaft 820, with the U-shape axel 821. The crankshaft 820 may be connected to crankshaft 800, so that the rotation of the U-shaped axle 801 results in a rotation of said U-shaped axle 821. Due to said communication is the pressure of the fluid 823 inside said piston 806 be reduced, thus is the circumference of the wall 808 decreased, so that said piston 806 is being able to move from first to second longitudinal piston positions. The fluid 823 is at a reduced pressure (in relation to the pressure of the fluid 822 it had, when the piston was pressurized at a first longitudinal position) is thereafter pressurized by said turbo pump 818 to fluid 827 (of which pressure is of course still less than the pressure of fluid 822) and which is optionally directly transported to said pressure vessel 814 through channel [824], or is preferably transported by channel [825] to another

piston pump 826, whereafter said fluid 827 is being pressurized in said pump 826 into fluid 822, and thereafter transported through channel [828] to pressure vessel 814. From pressure vessel 814 is fluid 822 transported to the second enclosed space 815, through channel [829]. Piston pump 826 is electrically driven by motor 830 through another crankshaft 831. Said motor 830 may be connected with an electrical storage, e.g. an accumulator (or a condensator ('capacitator') storage type) 832, which is connected to a solar cell 833. The electric motor 830 is capable of being used as as a starting motor for the rotation of said crankshaft 800. This may be done by a clutch 836 (not shown). The crankshaft 800 may be connected to a flywheel 835 (not shown), and a gearbox 837 (not shown) – said gearbox 837 may be using Fluid Dynamic Bearings in order to reduce friction. The bearings 833 for the crankshaft 821 of the piston pump 818. The alternator 850 is communicating with the main axle 852, and is charging the battery 832 through connection .....The configuration 851 of auxilliarly power sources is shown in Figs. 15A, 15B , 15C or 15E.

Fig. 11B shows schematically the control devices for the motor of Fig. 11A. The electric starter motor 830 is comprising a clutch (not shown), connecting the axle 803 with the anker of the electric motor, when the motor needs to be started. An electric switch 838 can turn said starter motor 830 on and off, by connecting it to the battery ('accumulator') 832, which is being loaded by the solar cells 832. Said motor 830 will also be able to be stopped, when the pressure in the pressure vessel 814 meets a certain maximum limit, and said pressure measurement is being done by a pressure sensor 839.

The motor may also start without using the starter motor 830, but just by opening up the reduction valve 840, in the channel 829. Opening this reduction valve 838 more up causes the crankshaft 801 to rotate more quickly, screwing the reduction valve 838 down causes the crankshaft 801 to rotate slower. Closing the reduction valve 838 completely will stop the motor. The speeder 841 is communicating with the reduction valve 838. The alternator 850 is communicating with the main axle 852, and is charging the battery 832 through connection .....The configuration 851 of auxilliarly power sources is shown in Figs. 15A, 15B , 15C or 15E.

Figs. 11A-F (incl.) concern motor with an elongate cylinder and a piston communicating with a crankshaft, according to the **Consumption Technology**.

Fig. 11C shows the actuator piston pressure management of Figs. 11A and 11B. At the point of time when the piston has arrived from a 1st longitudinal position at the final 2nd longitudinal position of

the chamber – thus just after having reversed the direction of its motion - there starts a communication between the high pressurized second enclosed space 822 of said crankshaft, through a hole in said crankshaft and a hole at the end of said piston rod with the enclosed space of said piston rod and thereby also with the internal volume of the piston through holes...., so that the piston pressurizes to the maximum pressure rate. Due to its pressuration will the piston beginning to move to a 1st longitudinal position, thereby turning the crankshaft and closing said holes, so that said communication stops. Said movement is reducing its internal pressure due to its increased inside volume, due to the fact that the ellipsoide shaped piston is beginning to transform itself into the shape of a sphere. When having arrived at the 1st longitudinal position there is still a medium rate of pressure left in said piston and the enclosed space within the piston rod. When said piston has arrived at the primo 1st longitudinal position on its way back to a 2nd longitudinal position – thus just after having reversed the direction of its motion,
the enclosed space within the piston rod will begin to communicate through a hole at the end of the piston rod, and with the third enclosed space 823 within the crankshaft which is comprising a hole. The pressure inside the piston and the enclosed space drops to a certain minimum (e.g. atmospheric level), so that the shape of the piston is changing from a sphere to an ellipsoide. Due to the enertia of the crankshaft (or the driving force of another piston-chamber combination using the same crankshaft) the deflated piston will move to a second longitudinal position, and the process starts all over again.

The communications between the enclosed space of said actuator piston and the second and third enclosed spaces, respectively in the crankshaft may make that said piston may have to stop at a certain longitudinal position, in order to be able to move again, just by opening up the reduction valve, as the pressurized fluid needs to be able to reach the piston. That may only be a problem, when there is only one actuator piston-chamber combination on a crankshaft on one axle, where the piston may stop at a 1st longitudinal position, and may be returning a bit on its way to a second longitudinal position due to enertia. Said holes of said enclosed spaces may than not be able to communicate with each other – starting may than only be possible by using a starter motor.

The pressure drop in the piston may be caused by a sucktion in the third enclosed space 823, caused by the piston pump 818, being taking in fluid from channel [817]. The pressure drop in channel [817] may begin to happen a bit before the actuator piston is reversing its direction of motion from being approaching a 1st longitudinal position to a second longitudinal position, so that when said holes of the enclosed space and the third enclosed space open up, the fluid may be sucked out of said enclosed space of

the actuator piston. That means that the default angle between the crankshaft 801 of the actuator piston 810 and the crankshaft 821 of the piston pump 818 may be different from zero. The main axle 852.

Fig. 11D shows the assembly of the piston rod 805 and the U-bend axle 801 of Fig. 11, and is shown on a certain point of time, where the piston rod 805 and the U-bend axle 801 are turning over each other. The U-bend axle 801 on which the piston rod 805 has been assembled with a bearing 1100, 1100' and 1100'', and the O-rings 1104, 1104', 1104'' and 1104''' between the piston rod 805 and the axle 801. The enclosed space 813 is communicating with the third enclosed space 816 (with fluid 823) through (currently) hole 1102. The second enclosed space 815 with fluid 822 is communicating with current blind hole 1101, and is thus currently not communicating with the enclosed space 813. The separator 1103, which is separating the second enclosed space 815 and the third enclosed space 816. At another point of time is the current hole 1102 becomes a blind hole, while the current blind hole 1101 has become a hole. Said holes 1101 and 1102 are never commnicating with the enclosed space 813 at the same time.

Fig. 11E shows a detail of the joint of the piston rod and the connecting rod, shown in Fig. 11C.

Fig. 11F shows a detail of the suspension of the crankshaft, and the channel inside said crankshaft, shown in Figs. 11A and 11B.

Figs. 11G-W (incl.) concern a motor with at least one elongate cylinder and a piston communicating with a cranshaft according to the **E**nclosed **S**pace **V**olume **T**echnology (abbreviated by "ESTV"). Figs. 11G and 11H show the basic technology in two variants, regarding the pressurizing of a storage pressure vessel, where the pumps which are controlling the volume of the enclosed space is functioning by a 2-way actuator. Clearly are the different power lines shown, separating the use of the power, generated by the auxilliarly power sources.

Figs. 11I and 11M show a one and two cylinder motor, respectively, where the motor has been worked partially out for the main construction elements (e.g. axles and e.g. wheels and belts), which are communicating with each other. The main pump, which is controlling the volume of the enclosed space is powered by an actuator (Figs. 11I,J), a crankshaft (Figs. 11K,L) or a camshaft (Figs. 11M,N), respectively. Due to the different sizes of the loops said power type, the conical cylinders may have different sizes per each power type. The auxiliarly power sources are only referred to by reference number.

Figs. 11o,P and 11Q,R (incl.), respectively concern the configurations of Figs. 11K,L (crankshaft) and Figs. 11M,N (camshaft), respectively, where the auxilliarly power source is a

configuration according to Fig.15x, where a combustion motor, using e.g. H_2, which has been generated by electrolyses from conductive H_2O, is directly communicating with the main pump which is controlling the volume of the enclosed space. The fact that said combustion motor directly drives the power lines (ESVT-pump(s), crankshaft/camshaft, instead of first generating electricity, which drives an electric motor, means that it is 4x more efficient. Each drawing shows a different type of cooling for said combustion motor. The by said combustion motor heated fluid (e.g. air) may be used for heating purposes, e.g. for heating the personal compartment of a car.

Figs. 11S-W (incl.) show specifics of several construction elements, which has been used in the Figs. 11 A-R (incl.).

Fig. 11G shows schematically the basic configuration of Fig.11A with the U-shaped axle 801, the piston rod 805 and the expandable piston 806. One end of the axel may be connected to an electric starter motor 830, which may get its energy from an accumulator 832 – the last mentioned may be loaded by a solar cell 833, or any other preferably sustainable (or optionally non-sustainable) power source. At the other end may the axle 801 be connected to a flywheel 835 (not shown), a clutch 836 (not shown), and optionally a gearbox 837 (not shown).

The second enclosed space 822 is communicating constantly with the actuator 1050. This actuator 1050 regulates the pressure of the enclosed spaces 822, 805 and 823 by changing the volume of the sum of said enclosed spaces 822, 805 and 823, so that the piston is changing volume according to Figs. 10A-F.

This is done by reduction valves 1051 and 1052 which may be controlling the speed and direction of another actuator 1053 (piston 1059, chamber 1060), which is controlling the actuator 1050. Said reduction valves 1051 and 1052 are being controled [1054] by the rotational position of the axle 801, so that the piston 806 may be expanding and contracting at the right point of time, due to the pressure change. The reduction valves 1051 and 1052 may be communicating [829] with a pressure source 890, which may have been pressurized with a fluid 1063 when this motor was produced. The other side of the enclosed space 815 may be communicating constantly with the enclosed space 805 of the piston 806.

The first enclosed space 823 is communicating constantly with the actuator 1056, which is regulating the basic volume of the sum of enclosed spaces 822, 815 and 823, thereby regulating the speed of the motor.

This enclosed space 805 is also communicating constantly with the third enclosed space 823, and this third enclosed space 823 is constantly communicating with another actuator 1055 (piston 1061, chamber 1062). The function of this actuator 1055 is to control the pressure adjustment of the sum of the enclosed spaces

822, 805 and 823. Said adjustment sets the power of the motor. Also here another actuator 1056 which may control the position and speed of the actuator 1055. The reduction valves 1057, 1058 may be connected to a speeder 841. The reduction valves 1057, 1058 may be communicating [829] with a pressure vessel 890 within a fluid. The reducton valves 1052, 1058 may be preferably controlled by the fluid 1063, and optionally controlled electrically or electronically and connected [1064] to the accumulator 832.
Both actuators 1050 and 1055 may be of the type where a piston 1059, 1061 may be sealingly moving in a chamber 1060, 1062, respectively, having contineously changing sizes of the cross-sectional area's from a first longitudinal position to a second longitudinal position, the cross-sectional area of the first longitidinal position is smaller than the second longitudinal position.
The connection of the controlling actuators 1050 and 1055 to the seond enclosed space 822 and the third enclosed space 823 can be effectively secured against leakages by O-rings. The alternator 850 is communicating with the main axle 852, and is charging the battery 832 through connection .....The configuration 851 of auxilliarly power sources is shown in Figs. 15A, 15B , 15C or 15E.

_____Fig. 11H shows the configuration of Fig. 11G, where the repressuration cascade for the pressure storage vessel 890 has been shown – this vessel can be repressurized - the repressuration cascade is identical with that shown in Fig. 11A. The alternator 850 is communicating with the main axle 852, and is charging the battery 832 through connection .....The configuration 851 of auxilliarly power sources is shown in Figs. 15A, 15B , 15C or 15E. The pump 831 may also communicating with a flywheel (not shown) and/or a regenerative breaking system (not shown).

Figs. 11I – 11R (incl.) show several configurations of a one cylinder motor, and a two cylinder motor.
One of the aims is to show the clear updividing of the power delivered, and the power used – this has been also disclosed schematically in Figs. 15. Another aim is to show the differences between controlling the pressure rebuild of the actuator piston(s) by either wires, by a camshaft or by a crankshaft which may be communicating to the power delivered. In order to enhance the efficiency of the power delivered, Figs. 11o – 11R show a small combustion motor, using preferably H_2 as power source (derived from hydrolyses of H_20), which is directly communicating with a camshaft or a crankshaft. Several configurations are being shown of this combustion motor. Another aim is to show how the controlling means of the pressure per cylinder, may be combined or not in a more than one cylinder motor – it showed to be necessary to find out firstly how the subsequent cylinders would be working in relation to each other, under condition of a

combined crankshaft: please see Figs. 17A,B-H (incl.) where the power strokes of one of the two cylinders of the same motor is done simultaneaously with the return stroke of the other cylinder (serial power), while in Figs. 18A-G (incl.) the power strokes of the two cylinders of the same motor are functionning at the same time (parallel power). Thereafter, it is concluded which pressure controlling means (e.g. ESTV pumps) may be combined for said 2 cylinders or not, and whether or not the power lines (e.g. camshaft, crankshaft) may be combined.

Fig. 11I shows a partially worked out one cylinder (800) motor, of which the configuration has been based on that of Fig. 11H. Only new issues will be treated here. The actuator 1055 (piston 1061, chamber 1062) which is controlling the speed of said motor has been sealingly (by O-rings 1110) mounted onto the axle 852 by a bolt 1114 which is connecting the bearing holders 1112 with the mainframe 5000 of this motor (only shown as hatch). The bearings 1113 are mounted into the bearing holders 1112. The before mentioned bearing- and sealing arrangements are situated at both sides of the actuator centre line 1111. The top 1130 of the chamber 1062 of the actuator 1056 has been monted on the motor mainframe 5000. The arrangement of the communication between the enclosed space 823 of the axle 852 and the chamber 1062 can be seen in Fig.....

The actuator 1056 has been partially worked out, and is comprising a piston 1115 which with two O-rings 1116. These last mentioned are sealingly connected to the wall 1117 of the cylinder 1118. Reduction valves 1057 and 1058 are related to each other, in such a way that if one valve is being openened more, the other valve is simultaneously closing more. On both sides of said piston 1115 are spaces 1119 and 1120 within said cylinder 1118. Said spaces 1119 and 1120 are communicating with said reduction valves 1058 and 1057, respectively. Said chambers are additionally communicating with each other through a valve actuator arrangements 1121 and 1122, respectively, shown in Fig. 304, and if necessary are these additionally controlled according to Figs. 211E or 211F. Said valve actuator arrangements 1121 and 1122 are being positioned in opposite direction to each other. The chamber 1118 of the actuator 1056 has been mounted on the motor mainframe 5000. More details can be seen in Fig.....

The actuator 1050 is sealingly and rotationally connected to the main axel 852 has been sealingly (by O-rings 1123) mounted onto the axle 852 by a bolt 1124 which is connecting the bearing holders 1125 with the mainframe 5000 of this motor (only shown as hatch). The bearings 1126 are mounted into the bearing

holders 1125. The before mentioned bearing- and sealing arrangements are situated at both sides of the actuator centre line 1133. Please see Fig. 11V for a detailed suspension of the actuator 1050. And the arrangement of the communication between the enclosed space 822 of the axle 852 and the chamber 1060 can be seen in Fig.....

Instead of the actuator 1053, and reduction valves 1051 and 1052, with controlling connection [1054] to the cylinder (800), a separate crankshaft 1128 is being used to power said actuator 1050. The timing is controlled through a timebelt 1129. Said timebelt 1129 is connecting the axle 852 through a crankshaft pulley 1130 which has been mounted on axle 852, with the crankshaft pulley 1131 which has been mounted on the axle 1132 which is comprising said crankshaft 1128. Said timebelt 1129 is comprising tooth (preferably flad), in order to avoid slip (and thus changing the timing). Said axle 1132 is rotationally mounted in the motor mainframe 5000 (not shown).

Fig. 11J shows a partially worked out two cylinder motor, based on Fig. 11I, showing the particulars of combining two crankshafts, and having the benefit of one construction element for multiple similar tasks. In a two cylinder motor are there not many of the last mentioned, because of a choice that the two pistons are not in the same longitudinal position, at the same moment. That means that there are for each cylinder of the two, the controls of each speeder-actuator and/or ESTV-pump may communicating with each other. There may only be one pump for repressuration purposes.
Firstly when there are 3, or better 4 and even pairs over 4 cylinders in one motor, will there be a chance to combine the inlet/outlet of speeder-actuators, and the inlet/outlet of ESTV-pumps, so that the total number of said actiuators and pumps may be reduced.

Fig. 11J shows a two cylinder motor, where 2 actuator pistons are running in each an elongate cylinder, using each a crankshaft on a main motor axle, a 90° position in relation to each other, said crankshafts are connected to each other, each comprising an enclosed space, separate from each other, which continueously is communicating with each of the pistons.
A speeder is used for driving a 2-way actuator piston, where the controls of each speeder are communicating with each other. The ESTV pumps, one for each piston, are using each a 2-way actuator piston, of which controls are communicating with each other. Said two way actuators are powered by a pressurized fluid, said fluid being keept pressurized by a pressure storage vessel. Said vessel presurrized

by a pump, which is powered by an electric motor. Said motor is powered by a 'contineous' battery, which may be powered by an auxilliarly power source: please see Figs. 15A,B,C,E,F.
The two crankshafts on the main motor axle are connected to each other, by a connector, which may be a little bit flexible, in order to compensate for a timing difference of the changes of shapes of said actuator pistons, due to repressuration of said pistons.

Fig. 11J left shows a scaled up left part of Fig. 11J.

Fig. 11J right shows a scaled up right part of Fig. 11J.

Fig. 11K shows a one cylinder motor, using a crankshaft for driving the ESTV pump, while the speeder still is using said actuator piston.

Fig. 11L shows a two cylinder motor, using a combined crankshaft for each of the ESTV pumps, while the controls of the each of the speeders is communicating with each other.

Fig. 11L left shows a scaled up left part of Fig. 11L.

Fig. 11L right shows a scaled up right part of Fig. 11L.

Fig. 11M shows a partially worked out one cylinder motor, based on the concept shown in Fig. 11H, where the ESVT-pump for the actuator piston chamber combination now is being powered by a camshaft, said camshaft driven by an electric motor, powered by a battery; the velocity controller is a 2-way actuator, which is communicating with a speeder. The pump for repressurating the pressure storage vessel is being powered by a separate electric motor, powered by a battery; auxilliarly power sources are according to Figs. 15A,B,C,E,F of which at least one may charging said batteries.

Fig. 11N shows a partially worked out two cylinder motor, based on Fig. 11M – one camshaft is used for the ESVT-pumps, one for each actuator piston-chamber combination.The velocity controllers, one for each actuator piston, are communicating with each other; the pump for repressurating the pressure storage vessel is being powered by a separate electric motor, powered by a battery; auxilliarly power sources are according to Figs. 15A,B,C,E,F of which at least one may charging said batteries.

Fig. 11N left shows a scaled up of the left part of Fig. 11N.

Fig, 11N right shows a scaled up of the right part of Fig. 11N.

Fig. 11o shows a partially worked out one cylinder motor, based on the concept shown in Fig. 11K, where the ESVT-pump of the actuator piston-chamber is being powered by a crankshaft, which is directly driven by the auxilliarly power from a gas (e.g. air) cooled combustion motor, using H_2, derived by the electrolyses of H_2O, said electrolyses powered by a battery; the pump which is re-pressurating the pressure storage vessel is additionally directly driven by said combustion motor; the velocity controller is powered by a 2-way actuator, powered by a battery; the batteries according to Fig. 15D are being charged by an alternator, which is mounted on the main motor axle. The generated heat of said combustion motor may be used e.g. for warming up the vehicle interior.

Fig. 11P shows a partially worked out two cylinder motor, based on Fig. 11o, where the ESVT-pumps, one for each actuator piston-chamber combination, are being powered by a crankshaft, which is directly driven by the auxilliarly power from a forced liquid cooled combustion motor, using H_2, derived by the electrolyses of H_2O, said electrolyses powered by a battery; the pump which is re-pressurating the pressure storage vessel is directly driven by said combustion motor; the velocity controllers, one for each actuator piston chamber combination are powered by a 2-way actuator, are communicating with each other, and are powered by a battery; the batteries according to Fig. 15D are
being charged by an alternator, which is mounted on the main motor axle. The generated heat of said combustion motor may be used e.g. for warming up the vehicle interior.

Fig. 11P left shows a scaled up of the left part of Fig. 11P.

Fig, 11P right shows a scaled up of the right part of Fig. 11P.

Fig. 11Q shows a partially worked out one cylinder motor, based on the concept shown in Fig. 11K, where the ESVT-pump of the actuator piston-chamber combination are being powered by a camshaft which is directly driven by the auxilliarly power from a forced gas (e.g. air) cooled combustion motor, using H_2, derived by the electrolyses of H_2O, said electrolyses powered by a battery; the pump, which is re-pressurating the pressure storage vessel is directly driven by said combustion motor; the velocity controller is powered by a 2-way actuator, powered by a battery; the batteries according to Fig. 15D are

being charged by an alternator, which is mounted on the main motor axle. The generated heat of said combustion motor may be used e.g. for warming up the vehicle interior.

Fig. 11R shows a partially worked out two cylinder motor, based on Fig. 11Q – where the ESVT-pumps, one for each actuator piston-chamber combination, are being powered by a camshaft, which is directly driven by the auxilliarly power from a gas (e.g. air) forced cooled combustion motor, using H_2, derived by the electrolyses of H_2O, said electrolyses powered by a battery; the pump which is re-pressurating the pressure storage vessel is directly driven by said combustion motor; the velocity controllers, one for each actuator piston-chamber combination are powered by a 2-way actuator, are communicating with each other, and are powered by a battery; the batteries according to Fig. 15D are being charged by an alternator, which is mounted on the main motor axle. The generated heat of said combustion motor may be used e.g. for warming up the vehicle interiour.

Fig. 11R left shows a scaled up of the left part of Fig. 11R.

Fig. 11R right shows a scaled up of the right part of Fig. 11R.

Fig. 11S shows a detail of the joint of the base of the piston-chamber combination 1061 of Figs. 11I - 11R with the main axle of the motor.

Fig. 11T shows a detail of the joint of the connecting rod of the actuator piston and the crankshaft on the main axle of the motoer according to Figs. 11I – 11R.

Fig. 11U shows a detail of the joint of the base of the piston-chamber combination 1060 of Figs. 11I - 11R with the main axle of the motor.

Fig. 11V shows the mechanisme driving a pump of Figs. 11H – 11R, and its base.

Fig. 11W shows the connecting joint between the two crankshafts of the 2-cylinder motor according to Figs. 11J, 11L, 11N, 11P, 11R

Instead of toothed belts at the power side of the motor according to the Figs.11D-W, there where the pump(s) are being driven, may very well be exchanged by gear.

Fig. 12A shows the configuration 800 of the motor according to Fig. 11B, where the piston-chamber combination was communicating through a crankshaft with the main axle, and in this figure has been replaced by a configuration 800', which is comprising a fixed chamber wherein a piston is rotating clockwise according to Fig. 10A or Fig. 12B, and, where the suspension of said piston is shown in Fig. 12C. A 'black box' is shown which is for the entry communicating with a reduction valve 840 through channel [.....], and for the exit communicating with the pump 818 through channel [817]. The reduction valve 840 is being controlled by a speeder 841.

Fig. 12B shows the motor where the piston of an actuator piston-chamber combination is moving, while the chamber is not moving. The motor comprising a chamber 960, which is comprising 4 sub-chambers 961, 962, 963 and 964, respectively, which lie around the same centre axis 965 in continuation of each other, which has an axle 966 through the center 967 of said chamber 960. Within said sub-chambers 961, 962, 963 and 964, respectively is 1 piston 968 positioned, shown on two important positions, namely position 968' when at a 1st rotational position of the sub-chamber 964, having the largest diameter, and position 968'' when at a 2nd rotational position of the sub-chamber 961, which is lying in continuation with sub-chamber 964, so that the 1st rotational position of sub-chamber 964 lies closest to the 2nd rotational position of sub-chamber 961, where it has its smallest diameter. Said actuator piston 968 is rotating clockwise around said axle 966 – there are shown 4 holes 967 for assembling said chamber 960 on axle 966.

Fig. 12C (consumption) shows the A-A section of Fig. 12B, with the non-movable chamber 960, and movable the piston 968' and 968''. The enclosed space 1070 of said piston 968', 968'' (the same piston in two different sizes) is ending at the axle 966, where it is sealed with two O-rings 1071, positioned on each side of said enclosed space 1070. The enclosed space 1070 is communicating with a second enclosed space 1072 in the axle 966, where it ends in a housing 1073, where a T-valve 1074' is present, which is controlling the entry of fluid 822 from the pressure storage vessel 814 through channel [829] and reduction valve 840. Said fluid 822 is controlling the presssure inside the piston 968' and 968''. The exit from said pistons 968' and 968'' is through channel [817] to the cascade of pumps (translational of rotational).

The electrical signal 1076 is communicating with an electrical/electronical control unit 1077, which is controling the T-valve 1074' within the housing 1073 through signal [1078]. The rotation of the axle 966 is thereby controlling said T-valve 1074', and thus the pressure in the piston 968',968''. The signal [891] from the pressure source 1075 to the control unit 1077. The flange 1079 is connecting the chamber 960 to

the suspension 1080, which is mounted on the axle 966. The belt 1081. A pump as e.g.references 821' and/or 826' of Fig. 13B may be present, but has not yet been showing in this drawing – said pump is communicating with pressure source 1075. Said pump may be communicating with axle 966. It may also be communicating with a flywheel and/or a regenerative breaking system 1082.

Fig. 12D (enclosed space) shows the A-A section of Fig. 12B, with the non-movable chamber 960, and movable the piston 968' and 968''. The enclosed space 1070 of said piston 968', 968'' is ending at the axle 966, where it is sealed with two O-rings. The enclosed space 1070 is communicating with a second enclosed space 1072 in the axle 966, where it ends in a housing 1073, where a piston-chamber combination 1074 is present, which is controlling the pressure inside the piston 968' and 968''
(the same piston in two different sizes). Said piston-chamber combination may be in connectrion with the fluid 889 of the power source 1075, through channel 890.

The electrical signal [1076] is communicating with an electrical/electronical control unit 1077, which is controling the piston-chamber combination 1074 within the housing 1073 through signal [1078]. The rotation of the axle 966 is thereby controlling said piston-chamber combination 1074, and thus the pressure in the piston 968',968''. The signal [891] from the pressure source 1075 to the control unit 1077. A return channel 1050 with fluid with decreased pressure (to said fluid 889) is returning to the power source 1075, through a cascade repressuration system (translational and/or rotational pumps) (see Fig. 12A). The 1151.

The flange 1079 is connecting the chamber 960 to the suspension 1080, which is mounted on the axle 966. The belt 1081. A pump as e.g.references 821' and/or 826' of Fig. 13B may be present, but has not yet been showing in this drawing – said pump is communicating with pressure source 1075. Said pump may be communicating with axle 966. It may also be communicating with a flywheel and/or a regenerative breaking system 1082.

The motor according to Figs. 12A and 12B may comprise a chamber 960 of which, at least a part, may be parallel to the centre axis of said chamber (not shown).

Fig. 13A shows the motor as shown in Fig. 11A, where the crankshaft arrangement 800 has been exchanged by the rotational motor of Fig. 10B.

Fig. 13B shows the motor of Fig. 13A, wherein the piston pumps 818 and 826 have been exchanged by rotational pumps, e.g. centrifugal pumps: 821' and 826'.

Fig. 13C shows the B-B cross-section of Fig. 13B, and the motor is of a type where the chamber of an actuator piston-chamber combination is moving, and the piston is not moving.

The motor comprising a chamber 860, which is comprising 4 sub-chambers 861, 862, 863 and 864, respectively, which lie around the same centre axis 865 in continuation of each other, which has an axle 866 through the center 867 of said chamber 860. Within said sub-chambers 861, 862, 863 and 864, respectively are 5 pistons 868, 869, 870, 871 and 872, respectively positioned, each at a different rotational position said sub-chambers 861, 862, 863 and 864, on an angle $\alpha = 72°$ from each other. Each piston comprising a piston rod 873, 874, 875, 876 and 877, respectively. The pistons 868, 869, 870, 871 and 872 are of a "sphere – sphere" type, and are shown all having different diameters. Said chamber 860 is rotating anti-clockwise around said axle 866 and the sub-chambers 861, 862, 863 and 864 having a second rotational position and a first rotational position in the clockwise rotational direction – there are shown 4 holes 878 for assembling said chamber 860 on axle 866.

Fig. 13D shows the A-A cross-section of Fig. 13C. The chamber 860 having an incision 879 around the flange 861 of said chamber 860, where a belt 883 can be mounted. The chamber 860 has been assembled on said axle 866 which has a flange 880 by a recession. Said piston rods 873, 874, 875, 876 and 877 are assembled inside a housing 882.

Fig. 13E shows cross-section C-C of Fig. 13A, and another cross-section of said housing 882 in view A-A. The piston rods 872, 873, 874, 875, 876 are being connected to a pressure distribution center 884, where each piston is connected to a computer 885 steered reduction valve system 886, that is giving each of the piston rods the necessary pressure – a signal 887 giving the rotational position of said axle 866 to the computer 885 determines by signal 888 the pressures for each of the pistons. The pressure to said piston rods 872, 873, 874, 875, 876 comes through a channel 890 from a pressure vessel 889, and is controlled by a signal 891 to the computer 885. Both the fluctual pressure change in the enclosed space of each piston is being dealt with separately, but also is the adjustment electronically dealt with for each piston by the same computer 885. A pump (as e.g.references 821' and/or 826' of Fig. 13B may be present, but has not yet been showing in this drawing – said pump is communicating with pressure source 1075. Said pump may be communicating with axle 966. It may also be communicating with a flywheel and/or a regenerative breaking system.

Fig. 13F shows schematically an alternative solution for the motor repressurization system, which is now alike that of Fig. 11F. Each enclosed space (e.g.1090) of each pistons is communicating with a piston-chamber combination 873, 872,874,876,875, while 873 is comprising an actuator piston 1091 of

which its position in the chamber 1092 is controlled by the position of a camwheel 1093, which can turn over a cam 1094, while the cam 1093 is assembled on axle 866. NB: the cam and wheel are shown schematically, as each wheel should have a different distance to its related piston, while the wheel should be shown (partly) sideways. The pressure inside the enclosed space 1090 can be adjusted by another piston chamber combination 1055', which is an analogus of 1055 from Fig. 11F, and another controlling actuator 1056' (as 1056) and reduction valves 1057' and 1058' (as 1057, 1058), while additonally the speeder 841' (as 841). The pressure vessel 889 ic commincation [1095] with said reduction valves 1057' and 1058'. A pump (as e.g.references 821' and/or 826' of Fig. 13B may be present, but has not yet been showing in this drawing – said pump is communicating with pressure source 1075. Said pump may be communicating with axle 966. It may also be communicating with a flywheel and/or a regenerative breaking system.

The motor according to Figs. 13A, 13B and 13C may comprise a chamber 860 of which, at least a part, may be parallel to the centre axis of said chamber (not shown).

Fig. 14A shows the change in pressure and size of the actuator piston 1700 positioned in a chamber 1701, having a centre axis 1702, and a piston 1703, mounted on a piston rod 1704 when moving from a 2nd longitudinal / 2nd circular position 1705 to a 1st longitudinal / 1st circular position 1706. The actuator piston 1700 has been pressurized to e.g. 3½ Bar at said 2nd longitudinal / 2nd circular position 1705. Said piston 1700 is comprising an enclosed space 1707, which is comprising a pump part 1708. The pump part 1708 of said enclosed space 1707 separated from the rest of said enclosed space 1707 by said piston 1703, when the actuator piston 1700 has been pressurized to the above mentioned 3½ Bar at a second a 2nd longitudinal / 2nd circular position 1705 until depressurized to e.g. ½ Bar when moving from said 1st longitudinal / 1st circular position 1706 – the actuator piston 1709 at said 1st longitudinal / 1st circular position has now a much bigger diameter that said piston at said 2nd longitudinal / 2nd circular position 1705. In order to deflate said actuator piston 1705 to atmospheric pressure – position 1713, where in case of a crankshaft the return takes place toward a 2nd longitudinal postion - the ½ Bar overpressure is being released in said enclosed space 1707 by retracting said piston 1703 away from the actuator piston 1709: movement 1710. Said actuator piston 1711 is increasing in diameter to its production size, which is slightly smaller than the diameter of said actuator piston 1700, which had been pressurized to 3½ Bar at said 2nd longitudinal positoion 1705, within the wall of the chamber (not shown in this figure). Said piston 1703 is being retracted further away - movement 1712 - from said actuator piston 1711, so that a pump stroke 1716 toward said 2nd longitudinal postion 1714 can take place, pressurizing said actuator piston to 3½ Bar, when, in case of a crankshaft, the actuator piston has returned toward (1715) a first longitudinal position.

Fig. 14B shows schematically the process of Fig. 14A in time, and this process is shown in a sub-chamber 1720 positioned around a circleround centre axis 1721, which has been stretched out as a straight line, which is additionally the time line. Said sub-chamber 1720 is normally moving in the direction of the arrow 1740, while said actuator piston 1722 is non-moving. However, in this drawing is the sub-chamber non-moving while the piston 1720 is moving. Th piston 1722 is positioned at a 2nd longitudinal / circular position and the fluid 1723 inside said actuator piston has been pressurized to e.g. 3½ Bar. The pump 1724 is comprising a piston 1725, a piston rod 1726, a chamber 1727 and a cam wheel 1728. Said cam wheel 1728 is resting on a cam surface 1729. Said piston 1725 is positioned at a 2nd longitudinal piston (1730) of said pump 1724. The position of said piston 1725 remains unchanged when the actuator piston 1722 is moving from a 2nd longitudinal / circular position to a 1st longitudinal / circular position in said sub-chamber

1720, where the fluid 1723 is reducing its pressure to ½ Bar – actuator piston 1732. The cam wheel surface 1728 remains at its position, as the cam surface 1729 remains its height. Retracting the piston 1725 from position (1730) to position (1731) gives the actuator piston 1733 an internal pressure of 0 Bar (overpressure), and reduces its diameter to its production size. This is a result of the cam surface 1729 being sloped cam surface 1734 with a angle α in relation to the cam surface 1729, so that the cam wheel 1728 is becoming further away from said actuator piston 1733: cam wheel 1738. Directly thereafter returns the translation of cam wheel 1738 at end point 1735, and returns to said actuator piston 1733, which has been turning further to actuator piston 1736. When the cam wheel 1738 has come back to the original surface 1729, over the sloped cam surface 1739, which has an angle β (>90°) with said cam surface 1729. The actuator piston 1737 belongs to said position of said cam wheel 1728. It has to be emphasized that the reduction of size of the diameter of the actuator piston may be done gradually during a very small period of time, so that the actuato piston remaims a contact with the wall 1740 of said chamber 1720.

Fig. 14C shows the configuration of Fig. 14B which enables an injection of fluid into the actuator piston, when it is at a 2nd circular position. The cam wheel 1740 is now turning over a hose 1741, of which the chamber 1744 is comprising a wall 1742, and a fluid or a mixture of fluids 1743. Said hose 1741 has an exit 1745 to the enclosed space 1746 of the actuator piston 1747 which temporary closed, and only opened to said enclosed space 1746 of said actuator piston 1747, when the actuator piston 1747 is at a 2nd position (Fig. 14B ref. nr. 1737) where it may be repressurized from the fluid in the hose 1741.

The description of Fig. 14D1 is showning classic pumps.

Fig. 14D1 shows a chamber 1749, with a centre axis 1750 in a wheel 1751 - which is turning anti-clockwise around an axle 1752, which is mounted with roll bearings 1753. Said chamber is comprising 4 identical sub-chambers 1754, 1755, 1756 and 1757. Said channel 1750 is comprising 5 fixed identical pistons 1758, 1759, 1760, 1761 and 1762, each at a different circular position to each other, thus having different diameters and internal pressures. Each piston has a pump part 1763, 1764, 1765, 1766 and 1767, which is fixed in the centre of each of said pistons 1758, 1759, 1760, 1761 and 1762. Each of said pumps has a piston rod 1768, 1769, 1770, 1771 and 1772, which is comprising a cam wheel 1773, 1774, 1775, 1776 and 1777, running over a cam shaft 1778. This cam shaft 1778 is comprising 4x identical lowered portions 1779, 1780, 1781, and 1782, there where a piston 1758, 1759, 1760, 1761 and 1762 need to be repressurized, and just before a

piston need to be pressurized again. The actuator piston 1761 shows the use of the lowered portion for said pump to dashed 1761'.

Fig. 14D2 shows elongate conical pumps instead of pumps with straight cylinders.

Fig. 14E shows a section of a rim with its suspension on disk brake plate, which is mounted on a chamber housing, in which a circular chamber is present, shown in a section where a shere type piston is in a first circular position according to the configuration of Fig. 14D. The inside of said piston is communicating with an enclosed space, which is mounted in a housing, which itself is mounted on a part of a vehicle frame. The size of said enclosed space is regulated by a pump with a conical chamber, of which end is running over a cam profile. Said cam profile is driven by an auxilliarly electric motor which is turning said cam, and turning independantly of said motor around the same main motor axle. Shown are roller bearings for the chamber suspension on said main motor axle, and a roller bearing for the cam profile. The main motor axle is mounted on said vehicle frame as well. Communicating to a channel comprising the enclosed space of said actuator piston is a pressure controller according to the configuration of Fig. 16 ("drive by wire"), which is communicating with a remotely positioned speeder.

Fig. 14F shows an enlarged detail of the cross-section of said piston in said first circular chamber of Fig. 14E. Said piston, having a wall with a reinforcement according to Figs. 208E,F or Figs. 209A-C is being mounted (e.g. by vulcanisation) on a fixed end (left) on the piston rod, and on a movable end (right), which can sealingly slide on said piston rod. Said piston rod can sealingly (please see Fig. 14G) slide in a cylinder, which is mounted in a housing, mounted on said vehicle frame. Said sliding makes it possible to adapt the position of said piston to be in the center of the cross-section of said chamber, at all circular positions.

Fig. 14G shows an enlarged detail of the cross-section of said piston in said circular chamber of Fig. 14G, when the piston is at a second circular position.

Fig. 14H shows the configuration of Fig. 14E, wherein between the rim of the wheel and the brake plate, and said circular chamber has been built-in a gearbox, e.g. of the type of a planet gear.

Figs. 15A-E show several auxilliarly power sources working together with the motor. The electric power lines are carefully chosen.

Fig. 15A shows a H_2-fuel cell which deliveres electricity to a motor, which is driving a ESVT-pump. Today (February 2011) is this solution very costly, but just on the web site of the Carbon Trust was a message, that there was a technical breakthrough, which made it possible to use in the future a H_2-fuel cell in a car motor. The other difficulty is, that the storage of H2 is a difficult, and energy unfriendly.

Fig. 15B shows a solution which is a solution for the H_2 storage problem, because H2 is stored as H_2O, and is coming free through electrolyses. Because the feasibility study showed that less than 10% of the current energy is necessary for driving e.g. a car, is this way of generating and using H_2 in a combustible motor, which may resulting in rotation. An alternator is generating electricity, which is driving an electric motor for driving an ESVT-pump. The problem here is that the last mentioned process has an efficiency of only 25%.

The O_2 which comes free at the elecytrolyses of conductive H_2O, may be used in the combustible motor, so that the burning of H_2 is still more efficient (turbo-effect). The H_2O which comes free from the burning process in the combustible motor, may be re-used for deriving H_2 by electrolyses.

Fig. 15C shows a solution where the ESVT pump is directly driven by the axle of said combustible motor through a crankshaft, which now may be much smaller because the process of powering said pump is 100% efficient.

Fig. 15D shows a comparable solution as Fig. 15C, where the crankshaft has been exchanged bu a rotational ESVT-pump, which makes the process still more efficient. The H_2 comes here from both electrolyses and from the solar voltaic cells.

Fig. 15E shows a solution where a big capacitator is used as the power source for the ESVT-pumps. The big advantage is that this capacitator can be charged in a few minites, and a car may drive say 500 km, when the capacitator has a size of a suitcase.

Fig. 15A shows schematically a tank 1600 for H_2 (1601), which may be cooled, using electricity through a electric communication [1602], and which has been filled up through a channel [1603], which is connecting said tank 1600 with the outside (1604) of said motor. Said tank 1600 is communicating through a channel [1605] to a H_2-fuel cell 1606 wherein H_2 is being transformed into electricity, which is charging through electric communication [1607] either start battery 832B (short term, high current), or service 832C (longduring, medium current). Said channel [1605] is

comprising a non-return valve 1608 (not shown). The start battery 832B is electrically communicating [1609] with the starter 830 of the motor, while the service battery 832C is electrically communicating [1610] with a pump 826 of said motor. Said motor is further comprising a pressure vessel 814, which is communicating with pump 826 and with piston actuator arrangement 800. The main axle 852 of said motor is communicating with alternator 850, which is charging through an electrically communication [1611] the service battery 832A (longduring, medium current). Said battery is electrically communicating [1602] with the cooling of tank 1600. The batteries 832A-C (incl.) are referred as one piece in other drawings of this patent application, with reference number 832, and have been charged ab works. The photo solar voltaic cell 833, which is additionally charging battery 832. The pressure storage vessel 814, which are being charged by a pump 820/826. The piston actuator module 800 of the motor.

Fig. 15B shows schematically a tank 1612 for (conductive) H_2O (1613), which has been filled up through a channel [1614], which is connecting said tank 1612 with the outside (1604) of said motor. Said tank 1612 is communicating through a channel [1615] to a vessel 1616 in which electrolyses 1617 of said water (1613) is taking place. The exit [1622] of said vessel 1616 is communicating with a combustion motor 1620, which is communicating with its main axle 1621. Said channel [1622] is comprising a non-return valve 1618 (not shown). Said motor 1620 is burning the in vessel 1605 generated H_2, so that motion occurs – here, rotation of said axle 1621. Said axle 1621 is communicating with an electric start motor 1623, and with an alternator 1624. Said alternator 1624 is charging battery 832B (for high current, short time) for said start motor 1623, or battery 832C (medium current, longduring). The battery 832A (medium-high current, longduring) is being charged by an alternator 850 through electric communication 1625, which is communicating with the main axle 852 of the motor of the motor. Said battery 832A is giving power through electric communication [1626] for the electrolyses 1617 in vessel 1616. The battery 832C is giving power through electric communication [1627] to a pump 826 of the motor, while the battery 832B gives power to the start motor 1623 and 830, respectively through electric communication [1628]. Said batteries (832) have been charged ab works. The photo solar voltaic cell 833, which is additionally charging battery 832. The pressure storage vessel 814, which is being charged by a pump 820/826. The battery. The piston actuator module 800 of the motor.

The battery has an output electric communication [1614] to other functions of the motor in Figs. 11 A,B,C,F,G and Fig.12A and Figs. 13A,B according to function 851 in said drawings. The bypass

[1616] from the fuel cell 1607 to the output electric communication [1614], directly giving power to said functions.

Fig. 15C shows schematically the process according to Fig. 15B, where additionally a piston pump 1625 of the repressuration cascade 826 or 831, respectively is directly communicating with the main axle 1623 of said combustible motor 1620 through a crankshaft 1624 and piston rod 1626. The photo voltaic solar cell 833 which is charging the battery 832, besides the alternator 850, which is communicating with the main axle 1623. The battery 832 is electrically connected to the motor through an electric communication [1614]. The exit of the pump 1625 of motor function 826 is communicating with the motor according to Figs. 11A,B,C,F,G or Figs. 12A, 13A,B. The inlet 1623 of said pump 1625. The start motor 830.

Fig. 15D shows schematically in principle a comparable process of that of Fig. 15C, where the piston pump 1625 has been exchanged by a rotational pump 1627, which is communcating with said motor 1620 by axle 1628. Said rotational pump 1627 is communicating with motor functions 800'', 820' by channel [825] and with pressure storage vessel 814 of Fig. 13B by channel [828]. The start motor 830 is communicating with axle 1628 and gets its power from battery 832 through wires [1642] The battery 832 is being charged by photo solar cells 833' and alternator 850 through wires [1641], and is communicating with axle 1628. The battery 832 is connected to the motor functions 800'' and 820 by wires [1629]. The photo solar cells 833' are providing directly H_2 to te motor 1620 by channel [1640]. This system may preferably be used together with the configurations shown in Figs.13F,14B,C,D. The motor type according to Fig. 14D may be a specifically preferred embodiment.

Fig. 15E shows schematically a capacitator 1630 for instant storage of electricity 1631, which has been filled up through an electric wire [1632], which is connecting said capacitator 1630 with the outside (1603) of said motor. Said capacitator 1630 is communicating through a channel [1633] to to other functions of the motor in Figs. 11 A,B,C,F,G and Fig.12A and Figs. 13A,B according to function 851 in said drawings. Said functions are comprising an axle 852,866,1621 which is communicating communicating with an alternator 850. Said battery 832 is electrically connected by wires [1613] with said alternator 850. The battery 832 is additionally charged by a photo voltaic solar cell 833. Additionally is said capacitator 1630 connected to said battery 832 by wires [1634] for charging purposes.

Fig. 16A shows a scaled up 2-way actuator of the Figs. 11G-R. The 2-way actuator is comprising two channels, which are communicating from the outside to the inside of the cylinder, each communicating with a regulator (reduction valve) which are controlled by a speeder – both regulators are communicating to each other, so that one speeder can control both regulators. There are two overflow channels, which communicate to each of the two sides of the internal piston.

Fig. 16B shows a pre-study of the 2-way actuator of Fig. 16A. It is concluded that a more quickly reacting system is that the piston is comprising the overflow channels. Additionally it is concluded that the regulators need to have each a stop function for its flow. And, that the overflow channels need to have each (1) an automatic contra valve function (e.g. according to Fig. 210E) and (2) a check valve.

Fig. 17B-H show multiple cylinder motors, based on a two cylinder configuration, which is based on the 2-cylinder configuration of Fig. 17B, which is based on the one cylinder configuration of Fig. 17A. In Fig. 17B are two cylinders shown, which have simultaneously combined in time the power stroke of one cylinder and the return stroke (which is not powered) of the other cylinder. This is done by a crankshaft configuration of two identical piston-chamber combinations, where the 2nd longitudinal position of one cylinder is at the same geometrical level of the 1st longitudinal position of the second cylinder. Both actuator pistons are communicating with each other through a crankshaft (which may be comprising two connected sub-crankshafts, one for each actuator piston), where the connection rods to these actuator pistons are positioned 180° from each other. The result is that the motor deliveres power at all times, and this configuration may be used in a stand alone 2 cylinder motor, or in a multiple (>2) cylinder motor, where where each added cylinder is communicating through the enclosed spaces of the connected sub-crankshafts of the existing sub-crankshafts. A flywheel may be redundant, which may reduce weight of the vehicle.

The ESVT pumps may be combined for said two cylinders into one pump, through communication of the second enclosed space of one of the actuator pistons with a third enclosed space of the other of the actuator pistons, said enclosed spaces being comprised in said crankshaft, by an external (from said crankshaft) channel - said enclosed spaces are updivided at the connection point of said sub-crankshafts by a filler, which may be postioned between said second and said third enclosed spaces. There may be valves (e.g. by the use of valve actuators according to Fig. 210E), which are opening and closing the connection between said ESVT-pump and said second or third enclosed spaces, while each connection may have a check valve or check valve function. Said valves may be controlled by either the pressure of said ESVT-pump and/or by tappets, which may be communicating with a camshaft, which may be communicating with the main auxilliarly power line, e.g. an auxilliarly H_2 combustion motor. In this configuration of the actuator pistons may it very well be possible to combine said ESVT pumps into one pump, as the pressure increase and decrease, respectively to each of the actuator pistons, is reversed, at the same point of time. The piston-chamber combinations for each of the enclosed spaces in a sub-crankshaft, which are changing the speed/pressure in a cylinder may only be used for one cylinder. These piston-chamber combinations are communicating with each other through the electric pressure regulator of the 2-way actuators, which is moving the piston rod of each of said piston-chamber combinations, and thus communicating with the external speeder. However, it may be possible that one of the two

piston chamber combinations may be deleted, and exchanged by the same configuration which has been used to cut one of the ESVT-pumps. The many valves may be making the configuration vulnerable for miss-function, which is why the configuration shown in Figs. 18A-G (incl.) may be preferred. Instead of toothed belts at the power side of the motor, there where the pump(s) are being driven, may very well be exchanged by gear wheels.

Add description of preferred embodiments with reference numbers for Figs. 17A-H (incl.).

Fig. 18A-G (incl.) show multiple cylinder motors, based on a two cylinder configuration, which is based on the 2-cylinder configuration of Fig. 18A, which is based on the one cylinder configuration of Fig. 17A, which refers to Figs. 10A,B.

In Fig. 18A are two cylinders shown, which have simultaneously combined in time the power stroke of each cylinder. Both actuator pistons are communicating with each other through a crankshaft (which may be comprising two sub- crankshafts), where the connection rods to these actuator pistons are positioned 0° from each other.

This is done by a configuration of two identical piston-chamber combinations, where the 2nd longitudinal position of one cylinder is at the same geometrical level of the 2nd longitudinal position of the second cylinder. The return stroke is thus not powered, and such a configuration may be combined with other configurations (motor comprising > 2 cylinders) in order to fill the power gab at the return stroke.

The ESVT pumps may be combined for said two cylinders into one pump, through connecting the second enclosed space of one of the actuator pistons, and a third enclosed space of the other of the actuator pistons, which are comprised in said crankshaft. Said enclosed spaces are not updivided at the connection point of the crankshafts by a filler, which would normally be postioned between said second and third enclosed space.

If another group of actuator pistons is communicating through a crankshaft which is connected to said crankshaft, a filler may be necessary at that connection point, but the ESVT pumps of each group may be connected by a channel.

Instead of toothed belts at the power side of the motor, there where the pump(s) are being driven, may very well be exchanged by gear.

A motor, further comprising more than two cylinders, where the enclosed space(s) of each added (couple) cylinder(s) is(are) separated through a filler in the connection with said existing sub-crankshafts, and where the power strokes of the added cylinders are simultaneously occuring the return strokes of the existing cylinders, so that a power balance arises in said motor.

Not shown is the combination of two cylinders where the connection rods are in a position of 180° from each other, while the chambers have the identical geometrical position of their 1st and 2nd longitudinal positions.

Add description of preferred embodiments with reference numbers for Figs. 18A-G (incl.)

CT – CRANKSHAFT DESIGN – MULTIPLE USE OF COMPONENTS

Fig. 19A shows a one cylinder motor, based on Figs. 11B; 11C, where some parts have been worked out further – the auxilliarly power source is e.g. chosen as a combustion motor, which is burning H_2, derived from electrolyses of H_20.

Fig. 19B shows a two cylinder motor, based on Fig. 19A, where the two cylinders have been mirrowedly positioned to the center line of the connection of the sub-crankshafts, so that the 3rd enclosed spaces (exits) are communicating with each other through the connection of the two sub-crankshafts, while the 2nd enclosed spaces (inlets) are communicating externally with each other (with a check valve), and where the crankshaft (comprising of two sub-crankshafts) is designed, so that the power strokes of each actuator piston are moving in the same (0°) direction (synchrone), according to the principle of Fig. 18A.

When more than two cylinders are needed in a motor according this synchrone principle, more cylinders may be added, so that e.g. another 2nd enclosed space may be connected to the not yet used end for a connection to the 2nd enclosed space of the added cylinder, so that a 3-cylinder motor occurs. The then still free 3rd enclosed space of the added cylinder may be connected to a 3rd enclosed space of another added cylinder, so that the motor may functions with 4 cylinders. The now shown closed ends of the channels of the sub-crankshafts may need than to open up.

Fig. 19B l. shows an enlargement of Fig. 19B left.

Fig. 19B r. shows an enlargement of Fig. 19B right.

Fig. 19C shows a two cylinder motor, based on Fig. 19A, where the comparable enclosed spaces (here the 3rd enclosed spaces) have been connected to each other through the sub-crankshafts, while the 2nd enclosed spaces have been brought externally together (with a check valve), and where the whereby the crankshaft (comprising of two sub-crankshafts) is designed, so that the power strokes of each actuator pistons are moving in the same (180°) direction (asynchrone), according to the principle of Fig. 18A.

Fig. 19C l. shows an enlargement of Fig. 19C left.

Fig. 19C r. shows an enlargement of Fig. 19C right.

Instead of toothed belts at the power side of the motor, there where the pump(s) are being driven, may very well be exchanged by gear.

19620 DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 21A shows a so-called constant maximum force chamber 1, with a wall part 2 of the longitudinal cross-section, at a first longitudinal position of the piston (not shown), which is parallel with the centre axis 3. A part 4 of the chamber wall has a convex formed wall of the longitudinal cross-section of the chamber 1. A transition 5 of the longitudinal cross-section of the outside wall of the chamber from convex wall parts 4 to concave wall parts 7. The wall part 6, which is positioned at a second longitudinal position of the piston (not shown), is not parallel to the centre axis 3 of the chamber 1. Common border 9 of a longitudinal cross-sectional cross-section 10 of the chamber 1 at a longitudinal position where 1 Bar overpressure has been reached by the piston (not shown), when moving from a first to a second longitudinal position. The common borders 11 / 13 / 15 / 17 / 19 / 21 / 23 / 25 and 27, respectively, between the longitudinal cross-sectional sections 12 / 14 / 16 / 18 / 20 / 22 / 24 / 26 / 28 / 30 of the chamber 1 at a longitudinal position where 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 Bar, overpressure over atmospheric pressure, respectively in e.g. an advanced bicycle pump has been reached by the piston (not shown). The internal walls of longitudinal cross-sectional sections 28, 29, 30, 31, 32, 33, 34, 35 and 6 are convex shaped, while the internal wall of longitudinal cross-sectional section 7 is concave shaped (between 6 and 7 Bar overpressure) for a 10 Bar (overpressure) pump. Dashed is shown the outside shape (36-37-38) of the chamber if slavishly the mathematical equation had been followed – this is done for design purposes, so as to avoid that the chamber is looking top heavy. This adaptation as such has no influence on the max. working force, because it has been done in the beginning of the hyperbolic function (working force on the piston as a result of the shape of the chamber in a longitudinal direction, measured from a first to a second longitudinal position). Due to the small and constant size of the wall thickness over the total length of the chamber is this also the case for the external walls of said longitudinal cross-sections (not numbered): please see WO/2008/025391.

The longitudinal positioning of said common borders may be mathematically determined as a result of the rest volume of the stroke volume of a conical chamber under the piston, and its maximum value of the pressure, which is in this figure: 10 Bar. Characteristic

is that the distances between said common borders which follow each other counted from a first longitudinal position of the piston to a second piston positions are decreasing the higher the overpressure rate is. That is than also the case for the heights of the respective walls of said longitudinal cross-sections sections 28, 29, 30, 31, 32, 33, 34, 35, 6 and 7. The positions of the wall at said common borders is based on a chosen value of maximum working force – which is in this case 25 kgf (250 N). The result is the characteristic shape 1 of the chamber (WO/2008/025391).

Fig. 21B shows the shape 1 (continuous line) of the 10 Bar (overpressure) chamber of Fig. 21 and the shape of a 16 Bar (overpressure) chamber (dashed) for the same length of the chamber. If the transitional size of the internal diameter of the part 30 would give problems for the size of the piston, may a recalculation of the sizes of the chamber may be done, by enhancing the maximum value of the working force, by an unchanged maximum value of the overpressure. This will make the diameter of e.g. reference number 30 bigger. The wall thickness is approximately even over the length of the chamber, although at said concave part 7 the thickness might be a bit bigger than the wall thickness of the rest of the wall. Another recalculation may be done, if the maximum overpressure should be bigger than 10 Bar, e.g. 16 Bar. This may be accomplished by choosing a higher maximum work force, so that the circumference of a transversal cross-section may become bigger. This means that the conical shaped outer wall of the chamber can go nearer 2nd longitudinal positions, before the circumference reaches its minimum value in order to ensure, that a piston would not jam, which is defined by the piston type. Near first longitudinal positions would following verbatim the calculations, the size of the chamber would become too big, and that is why, one may define its shape there, so that the circumference becomes smaller – this may also be the case for other common borders as well.

A task to optimize the chamber to demands toward handpumps can be done in similar ways, as those described above. The problem here to be solved is a good compromise between the minimum size of the circumference of the inner chamber wall (depending on what a piston can perform) and the max. circumference of the outside of said chamber at first longitudinal positions, which is where a user is holding the handle, and the designated maximum working force.

Fig. 22A shows a bottom part of a chamber of an advanced bicycle floor pump where also the bottom part of the chamber 1 of Fig. 21 can be seen. The chamber 1 is mounted on a foot 41. A flexible manchet 42 assembles the chamber 1 on the foot 41. The hose 43, which is connected to the exit 44 of the pressure expansion vessel 49 – this exit is

without a check valve. The (schematically drawn) piston 45 is comprising a piston rod 46. At the bottom of the piston rod is a check valve 47 positioned, which is communicating with the external atmosphere (48), and is opening towards the chamber 1, so as to fill the chamber 1 when the piston 45 is moving from a second longitudinal position to a first longitudinal position. An expansion pressure vessel 49 with a chamber 56 is shown, comprising an inlet check valve 50, when open, the chamber 1 is communicating with the hose 43, through an exit 44. The cross-section of the external wall 51 of the expansion pressure vessel 49, with an internal wall 52. The expansion pressure vessel 49 is assembled between a top end 53 and a bottom end 54 of said vessel 49. The top end 53 of the expansion pressure vessel 49 is sealed to the wall of the chamber 1 by an O-ring 55, while the top end 53 and the bottom end 54 are sealed to the wall 52 of the expansion pressure vessel 49 by gas sealing thread 58 and 59 respectively.

This is a preferred embodiment for very high pressures (e.g. 16 Bar), and if the piston has difficulties in sealing to the internal chamber wall. This construction avoids the sealing on the transition from a longitudinal cross-sectional section with a convex wall to a longitudinal cross-section section with a concave wall – please see Fig. 1.

Fig. 23 shows another constant force chamber 80 for a maximum pressure of 10 Bar with the same specification as the chamber of Fig. 1, with the exception that it has to secure that a pressurized container type piston has to be non-moving on a second longitudinal piston position – the internal wall 81 of the chamber at said second longitudinal piston positions should be chosen and shown being parallel to the centre axis of the chamber:

The transition from said convex walls 82 of longitudinal cross-sectional sections between common borders 83 and 84, corresponding to 0 Bar and 7 Bar overpressure, respectively to said wall 81 parallel to the centre axis 85 of the chamber 80 has a special internal concave shape 86, comprising smaller inner concave shaped subsections 86.1, 86.2 and 86.3 respectively, between a common border 84, which corresponds to 7 Bar overpressure until the common border 88 for 10 Bar overpressure. The shape of the inside wall of said chamber and its outside wall may not anymore correspond to each other: between the common border 84 for 7 Bar overpressure and the common border 88 for 10 Bar overpressure is the outside wall is still convex, while the inside wall is concavely shaped. This difference in shape, makes it possible to increase the wall thickness in relation to that of the rest of the wall thickness of the chamber, there where the chamber has its weakest spot: the transition from concave internal wall sections to the inside wall parallel to the centre axis of said chamber. The external wall 89 of the chamber, which is positioned there where the internal wall of said chamber is

parallel to the centre axis of said chamber may be chosen as a straight line, but not necessarily parallel to said centre axis. This may be done for a good looking purpose, as curved shapes give some visual tension.

The transition from concave inside walls to said inside wall of said chamber which is parallel to the centre axis of the chamber may be made smoothly, in order to be able to let a piston pass this transition, without jamming.

Fig. 24 shows the foot 70 of an advanced floor pump for e.g. tyre inflation. The flexible manchet 71 keeps the cone formed chamber 80 of Fig. 3 in place. The inside wall 81 of the chamber 80 is parallel to the centre axis 85 of the chamber 80. The inflatable piston 73. The enclosed space 66. The tube 65. The inlet check valve 75. The outlet check valve 76. The hose 77. The measuring space 78, 79 (inside the hose). The valve connector 67 (not shown). The space 68 inside the valve connector 67 is also part of the measuring space (not shown).

Fig. 25 shows chamber 100, which is a 10 Bar overpressure chamber of the chamber 1 of Fig.21. It's second longitudinal positions end with a common border 27. This bottom of this chamber is screwed on a bottom part 101 which is corresponding the longitudinal cross-sectional section 30 of Fig.21. The thread connecting both parts of the chamber is gas thread 102, which makes a gas tight connection. In the bottom 103 of chamber part 100 is an exit 104, in which a hose nipple 105 has been screwed. The chamber part 100 is comprising a piston 106, which has been schematically drawn. The piston 106 is comprising a hollow piston rod 107, which is comprising a check valve 108, which opens the space 109 between the piston and the bottom 103, and thereby let air in from the atmosphere (48) into said space 109. On the hose nipple 105 is a hose 110 assembled with a hose clamp 111. The hose is at its other end connected to e.g. a valve connector 67. The hole 112 in hose 110.

19630 circular chamber design

DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 30A shows the circular chamber of Fig. 12B, where a piston is moving in a non-moving chamber. A circular sub-chamber 961 is having a centerpoint 980 for the circleround section line 981 closest to the centerpoint 967 of the circular chamber 960, in an earlier quadrant 982 than the quadrant 983 wherein said line 981 is lying. The radius line 987 between the circle centre 980 and the circle section line 981. The circleround section line 984 of the circular sub-chamber 961 farthest to the centerpoint 967 of the circular chamber 960 is having a centerpoint 985 in a later quadrant 986 than wherein the line 984 is lying. The radius line 988 between the circle centre 985 and the circle section line 984. This may be valid for all the other sub-chambers 962, 963 and 964. The said circleround section lines may be circular section lines in other preferred embodiments.

Fig. 30B shows the circular chamber of Figs. 13C and 14D where the piston is not moving, but the chamber. Here is the design of the circular chamber and the sub-chambers identical with the design of Fig. 30A.

Fig.31A shows the Fig. 14D, where the section X-X has shown, of said chamber 1749, and through the center axis 1750.

Fig. 31B shows an scaled up detail of section X-X of chamber 1749 of Fig. 31A. The chamber wall 1785 is shown in the section X-X. The wall 1785 is comprising ducts 1786, 1787, 1788, 1789, 1790, 1791, 1792, 1793, 1794, 1795, 1796, and 1797, respectively which have an opening towards the chamber 1749. Preferably there is no duct approximately where the section X-X is hitting the cross-section .....farthest from the center 1750 of the circular chamber 1749. From there, around the circumference of the chamber 1749, from both sides (1786/7/8/9/90/91, and 1796/5/4/3/2/1) of the line of section X-X are ducts with increased width: the duct 1791 has the biggest width. Said ducts are meant to reduce the size of the contact area of the wall 1785 of the chamber 1749 with the piston, so as to steer the piston through the circular chamber, in the direction of the circular chamber, and to get an adequate propulsion force, which may be equal around the circumference of the contact area of a piston inside said chamber 1749 and the wall 1785, due to said ducts.

Fig. 32A shows the wall of the chamber and the orthogonal plane to the base circle intersects in a circle whose center is at the base circle.

Fig. 32B shows a section of the boundary of the piston.

Fig. 32C shows the cap geometry – for area and internal volume of the cap we need values of a and h only - see formulas (2.1) and 2.2) – the radius of the virtual sphere is given in (2.3).

Fig. 32D shows the piston with end caps.

Fig. 32E shows the piston with end caps inside a transparent Fermi tube hamber.

Fig. 32F shows the pure contact area between the piston and the chamber, visible inside the transparent chamber wall.

Fig. 32G shows the contact area between the piston and the chamber.

Fig. 32H shows a section of the chamber wall. The chamber reaction force is marked by gray (1800). The total force on the section is orthogonal to the chamber wall. For the section is the value of the force proportional to the (variable) longitudinal length of the shown section, and to the internal pressure of the piston.

The local reaction force from the chamber wall is proportional to the longitudinal width of the section, which again is linear in the distance to the center of the center circle, i.e. the origin.

To first order the length varies around the section as in a tube of constant radius. Said length depends linearly on the distance to the origin. The local force varies correspondingly and hence it is coordinated to drive the full wall and hence the piston as a pure rotation around the origin.

The Fermi construction. The generator circle has at each point an orthogonal plane as shown. The chamber wall intersects every such orthogonal plane in a circle which has its center at the generator circle. The chamber wall is 'conical' when choosing the radius of said circle in the orthogonal plane to have a linear (or just increasing) value as function of arc length along the generator circle.

Fig. 32I shows the section of Fig. 32H, with an additional section in order to provide an open view.

Fig. 32J shows Fig. 32H, and the red (1801) vector is the component of the gray force (1800) in the longitudinal direction.

Fig. 32K shows Fig. 32J, with an additional section in order to provide an open view.

Fig. 32L shows Fig. 32J, where the actual sliding force along the wall is shown in blue (1802) – it is obtained by projecting the red (1801) vector orthogonally to the chamber wall.

Fig. 32M hows Fig. 32L, with an additional section in order to provide an open view.

19640 DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 40A shows a longitudinal cross-section of a pump 1500 with a piston 1501 comprising U-formed support means 1502, an O-ring 1503 and a flexible impervious layer 1504, the last mentioned supported by a foam 1505, the foam may comprise stiffeners, which may be rotatably fastened to the piston rod, at a first longitudinal position of a chamber 1506. The support means 1502 are being rotatably fastened to the piston rod 1507 with the suspension 1508, comprising an axle 1510. The pulling spring 1509 is being fastened to the piston rod 1507 above the axle 1510, and at the other end on the support means 1502 closer to the O-ring 1503. The horizontally positioned spring 1511 is supporting the O-ring 1503. The impervious flexible sheet 1504 is comprising a layer 1512 with reinforcements 1514 (only shown in Fig. 40B, 41D, 41E), which has been vulcanized on a layer without reinforcements 1513. The centre axis 1518 of the chamber 1506. The angle α between a line which is connecting the centre of the axle 1510 with the centre of the O-ring 1503, with the centre axis 1518. The impervious flexible sheet is, unstressed by a loading from the fluid in the chamber 1506, perpendicular the centre axis 1518 of the chamber 1506.

Fig. 40B shows the impervious flexible sheet 1504 is vulcanized in the O-ring 1503. The layer 1513 without reinforecements and the layer 1512 with reinforcements 1515, vulcanized on each other. The support means 1502 and the horizontal spring 1511 have been vulcanized on the O-ring 1503, and the impervious sheet 1504's layer 1513. The end of the support means 1502 has a small bended flat surface 1516, which fits the shape of the O-ring 1503 when produced. The O-ring 1503 is being squeezed on the wall 1517 of the chamber 1506.

Fig. 40C shows a longitudinal cross-section of the piston of Fig. 40A at a second longitudinal position. The piston rod 1507, the centre axis 1518 of the chamber 1506, with the wall 1517. The support means 1502 have been rotated around the axis 1510. the foam 1505' has been squeezed. The spring 1509' has been pulled longer. The O-ring 1503 has been increase in size, and is still squeezed to the wall 1517 of the chamber 1506. The impervious sheet 1504' has been increased in thickness, while the horizontal spring 1511' has been squeezed together. The angle β between a line which is connecting the centre of the axle 1510 with the centre of the O-ring 1503, with the centre axis 1518.

Fig. 41A shows top view of the piston 1501 of Fig. 40A and a cross-section of the

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$\alpha \approx 43^{\circ}$

$\beta \approx$ parallel to the centre axis

chamber 1506 from a first longitudinal position. The wall 1517 of the chamber 1506. The piston rod 1507. The suspension 1508 of the support means 1502. The axle 1510. The pulling spring 1509 of the support means 1502.

Fig. 41B shows a detail of the suspension of the support means 1502 on the O-ring 1503 and the lying spring 1511 of the piston 1501 of Fig. 40A. The small bended flat surface 1516 at the end of the support means 1502, which is vulcanized on the O-ring 1503. The end 1519 of the support means 1502 has a notch 1521, which fits with its size and shape of the horizontal lying spring 1511. The boundary 1520 of the lying spring 1511 – said spring is only partially shown, at the end of the support means 1502.

Fig. 41C shows a cross section of the chamber 1506 with the piston 1501 of Fig. 40A at a second longitudinal position. The suspension 1508 of the support means 1502.

Fig. 41D shows spiral reinformcements 1522, 1523, 1524 of the flexible impervious sheet 1504 – the material is flexble. These spirals are drawn approximately concentrically to each other, on a certain distance, around the centre axis 1518 of the chamber 1506. Other configurations, e.g. two layers with reinforcements which may cross each other with a small angle, may be possible, but not shown.

Fig. 41E shows another reinforcement configuration, namely more or less elastically reinforcement members 1525, lying concentrically around the centre axis 1518 of the chamber 1506.

Fig. 42A shows a longitudinal cross-section of a piston 1530 comprising support means 1502, an O-ring 1503 and a flexible impervious sheet 1531, the last mentioned at a certain angle λ with the centre axis 1518 of the chamber 1506, at a first longitudinal position. Said sheet 1531 is being vulcanized (1532) on the piston rod 1507. The angle α between a line which is connecting the centre of the axle 1510 with the centre of the O-ring 1503, with the centre axis 1518. The flexible impervious sheet 1531 has an angle γ with the centre axis 1518 of the chamber 1506.

Fig. 42B shows a detail of the suspension of the support means 1507, O-ring 1503 and the flexible impervious layer 1531, vulcanised together. The top layer 1533 is comprising the reinforcements (as those of Figs. 41D-E), while the bottom layer 1534 has no reinforcements. The angle β between a line which is connecting the centre of the axle 1510 with the centre of the O-ring 1503, with the centre axis 1518.

$180^{\circ} - \gamma \approx 110^{\circ} (> 90^{\circ})$

Fig. 42C shows a longitudinal cross-section of the piston 1530 of Fig. 42A at a second longitudinal position. The angle ξ between the flexible impervious sheet 1531 and the centre axis 1518 of the chamber 1506.

$180^{o} - \xi \approx 95^{o} (> 90^{o})$

19650 DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 50 shows a top view of the holder 1224, and the suspension in the three rows of holes 1240, 1241 and 1242, respectively of the stiffeners 1208, 1209 and 1210, respectively in said holder 1224. The small bended ends 1220, 1221 and 1222, respectively. Please note that the longer the stiffener 1208, 1209 and 1210, respectively, the longer said small bended ends 1220, 1221 and 1222, respectively are, the longer the stiffeners are. The hole 1243 of the piston rod (not shown). The centre axis 1244. The foam 1245 of said piston 1200.

Fig. 51 shows a piston 1200 of Fig. 50 build in a pump 1201 with a chamber 1202 and a top 1203 and shown ata first longitudinal position 1204 of said chamber 1202. In the top 1205 is a bearing 1206, in which a piston rod 1207 is moving. The bearing 1206 is assembled in said top 1203. The chamber 1202 is of a type where the force is independant of the pressure (see 19620). The wall 1207 of said shamber 1202. All stiffeners 1208, (1209 dashed) and 1210, respectively have a free end of increased diameter 1211, (1212) and 1213, respectively. The impervious layer 1214, which is closed by a clamp 1215 to the piston rod 1207, while at the top 1216 of the piston 1200, the foam can communicate with the fluid in the chamber 1202, at the non-pressurized side 1202'. The stiffeners 1208, (1209) and 1210 having a bend 1217, (1218), 1219, repectively and a small bended end 1220, (1221) and 1222, respectively. Said small bended ends 1220, (1221) and 1222, respectively may be pressed by an adjustment member 1223, which can turn within a holder 1224, which is sealed by an O-ring 1227 to the piston rod 1207. Said adjustment member 1223 is rotatable in said holder 1224, and sealingly connected to said impervious layer 1214. The piston 1200 is assembled onto the piston rod 1207 by the holder 1224 being mounted within a spring ring 1225 while the clamp 1215 being mounted to the spring ring 1226. The centre axis 1243 of the chamber 1202.

Fig. 52 shows the bend 1218 of the stifener 1209. The increased diameter 1212 of stiffener 1209. The chamber 1202. The end 1221.

19660 DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 60 shows the enlarged container type piston 1400, in a chamber 1401, which has a centre axis 1402, at the start and end of a stroke. The chamber is of a type where the force on the piston rod is approx. even dureing the stroke. The shape of the piston at a second longitudinal position is that of a 'starting' ellipsoïde 1403 after having been pressurized from a non stressed production model, where the shape is approximately cylinder like shaped (see Figs. 61 and 62). The shape of the piston near a first longitudinal position is an ultimate ellipsoïde 1404, which is almost a sphere 1405 (dashed). In between has the piston 1400 the shape of an ellipsoïde. The details of an ellipsoide instead of a sphere at a first longitudinal position are identical with these of a sphere.

Fig. 61 shows an unstressed produced container type piston 1400, which, stressed may have the shape of an ellipsoïde or a sphere. At the bottom of the figure the non-movable cap 1420, with a gland 1421 for a O-ring(not shown), which tightens on the piston rod (not shown). A recess 1422 which is more or less a gland for an O-ring (not shown), which tightens the bottom of the piston 1400 on a bolt (not shown) which locks the bottom of the piston rod (not shown), through the hole 1432. On top of the figure the movable cap 1423, which is movable on the piston rod (not shown). The gland 1424 for an O-ring (not shown), which makes the piston tight in the top of saud piston 1400. Both caps 1420 and 1423 having a recess 1425 and 1426, respectively, which is used to vulcanize the flexible wall 1427 of the container piston 1400 on said cabs 1420 and 1423, respectively. Said wall 1427 is shown in the figure with two layers: a reinforced layer 1428 and a layer which functions as a cover 1429 for the reinforced layer 1428. The dashed lines show a possible third layer 1430 and 1431, on top of the other layers 1428 and 1429, respectively, which is only present on the position where said two layers 1428 and 1429, respectively have been vulcanized on the cabs 1420 and 1423. The centre axis 1433. The wall 1427 of the piston 1400 is approximately parallel with the centre axis 1433. The reinforcement strengs 1440 lie in a parallel pattern, parallel to the centre axis 1433. The reinforcement pattern 1441 when there are two layers.

Fig. 61 shows both cabs 1420 and 1423, respectively of Fig. 61. At the outer side the rounded off transition 1434 and 1435, respectively, from the flexible wall 1427 to the portions of said wall 1427 which has been vulcanized on the portions 1425 and 1426 of said cabs 1420 and 1423, respectively. At the inner sides of the flexible wall 1427, just before said flexible wall 1427 meet the portions 1425 and 1426 of said cabs 1420 and 1423, respectively is a rounded off transition 1436 and 1437. These transitions 1436 and 1437 provide a stable transition of the wall, when the piston is being stressed by inflation.

207 DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 100 shows the so-called indicator diagram. This diagram schematically shows the adiabatic relation between the pressure p and the pump stroke volume V of a traditional single-stage one-way working piston pump with a cylinder with a fixed diameter. The increase in the operating force to be applied per stroke can be read directly from the diagram and is quadratic to the diameter of the cylinder. The pressure p, and thus the operating force F, increases during the stroke normally until the valve of the body to be inflated has been opened.

Fig. 102A shows the indicator diagram of a piston pump according the invention. It shows that the diagram for pressure p is simular to that of traditional pumps, but that the operating force is different and depends entirely on the chosen area of the transversal cross-section of the pressurizing chamber. This depends entirely on the specification, e.g. that the operating force should not exceed a certain maximum or that the size of the operating force is fluctuating according to ergonomic demands. This is specifically demanded in the case when a manually operated pump is only transporting the media without significant change in the pressure as it is e.g. the case with water pumps. The shape of the longitudinal and/or transversal cross-section of the pressurizing chamber may be any kind of curve and/or line. It is also possible that the transversal cross-section e.g. increases by increasing pressure (Fig. 102B). An example of the operating force is the dashed thick line, 1 or 2. The different wall possibilities marked 1 and 2 correspond to the earlier mentioned lines 1,2 of the diagram. The A-section relates to a pump of which only the piston is moving, while the B-section relates to pumps where only the chamber is moving. A combination of both movements at the same time is also possible.

Fig. 102B shows an example of an indicator diagram of a piston pump that has a chamber with a transversal cross-section that increases by increasing pressure.

Figs. 103A,B,C,D show details of the first embodiment. The piston moves in the pressu- rizing chamber which comprises cylindrical and cone-shaped portions with circular transversal cross-sections with diameters that decrease when the pressure of the gaseous and/or liquid media increases. This is based on the specification that the operating force should not exceed a certain maximum. The transition between the various diameters is gradual without discrete steps. This means that the piston can slide easily in the chamber and adapt itself to the changing areas and/or shapes of the transversal cross-sections without loss of sealing ability. If the operating force has to be lowered by increasing pressure,

the transversal cross-sectional area of the piston is decreasing and by that the length of the circumference as well. The circumferical length reduction is based on compression up to the buckling level or by relaxation. The longitudinal cross-section of the piston means is trapezoid with variable angle α less than e.g. 40° with the wall of the pressurizing chamber, so that it cannot deflect backwards. The dimensions of the sealing means change in three dimensions during every stroke. A supporting portion of the piston means, e.g. a disk or integrated ribs in the sealing means, e.g. positioned on the non-pressurized side during a pumping stroke of the piston protects against deflection under pressure. A loading portion of the piston means, e.g. a spring washer with several segments, may also be mounted e.g. on the pressurized side of the piston. This squeezes the flexible sealing portion towards the wall. This is expedient if the pump has not been used for some time and the piston means has been folded for some time. By moving the piston rod, the sides of the trapezoid cross-section of the sealing portion of the piston means will be pushed axially and radially, so that the sealing edge of the piston follows the decreasing diameter of the pressurizing chamber. At the end of the stroke, the bottom of the chamber in the centre has become higher in order to reduce the volume of the dead room. The piston rod may mainly be guided in the cap which locks the pressurizing chamber. As the piston in both directions of its movement seals to the wall of the chamber, the piston rod e.g. comprises an inlet channel with a spring force-operated valve, which is closed in case of overpressure in the chamber. Without the use of the loading portion in the piston means, this separate valve may be superfluous. In the pump design according to the invention, the parts of the pump have been optimized for working forces. The inside diameter of the pump is over the main part of the pump chamber length larger than that of existing pumps. Consequently, the inlet volume is higher, even though the volume of the remaining part of the chamber is lower than that of existing pumps. This ensures that the pump can pump quicker than existing pumps, while the maximum operating force required is significantly reduced and lower than the level reported by consumers to be comfortable. The length of the chamber can be reduced, so that the pump becomes practical, even for women and teenagers. The volume of a stroke is still higher than that of existing pumps.

Fig. 103A shows a piston pump with a pressurizing chamber 1 with portions of different areas of its transversal cross-sections of wall sections 2,3,4 and 5. The piston rod 6. The cap 7 stops the piston means and guides the piston rod 6. The transitions 16,17 and 18 between the section with the walls 2,3,4

and 5. The longitudinal centre axis 19 of the chamber 1. The piston 20 at the beginning and 20' at the end of the pump stroke.

Fig. 103B shows the sealing portion 8 made of an elastic material and the loading portion 9, e.g. a spring washer with segments 9.1, 9.2 and 9.3 (other segments not shown) and a support portion 10 of the piston means attached to the piston rod 6 between two portions of locking means 11. The piston rod 6 has an inlet 12 and a valve 13. The angle α_1 between the sealing portion 8 of the piston means and the wall 2 of the pressurizing chamber 1. The sealing edge 37. The distance a is the distance from the sealing edge 37 to the central axis of the chamber 1 in a transversal cross-section at the beginning of the stroke.

Fig. 103C shows outlet channel 14 in a means 15 which reduces the volume of the dead room. Angle α_2 between the sealing portion 8' of the piston means and the wall 5 of the pressurizing chamber 1. The distance a' is the distance from the sealing edge 37 to the central axis of the chamber 1 in a transversal cross-section at the end of the stroke. Shown is that distance a' is approximately 41% of distance a. The loading portion 9'.

Fig. 103D shows the longitudinal cross-section of the chamber of a floor pump ($\varnothing_{inside}$ 60 - 19.3 mm, length 500 mm) according to the invention of which the transversal cross-sections are chosen so that the operating force remains approximately constant and is chosen in accordance with ergonomic demands: e.g. as in the Figure: 277 N. Other force sizes can also be chosen. This is only giving the starting point for the quantification of a floorpump according to the invention as a constant operating force may not be ergonomically correct. As a comparison the cross-sections of an existing low pressure floor pump ($\varnothing_{inside}$ 32 mm, length 470 mm) is shown in dotted lines, and that of an existing high pressure floor pump ($\varnothing_{inside}$ 27 mm, length 550 mm) is shown in dashed lines. It is clearly shown that the floor pump according to the invention both has a bigger stroke volume, thus faster inflating tyres, and a lower operating force than existing pumps. The chamber according to the invention can be tailored to ergonomic demands during the entire stroke.

Figs. 104A,B,C,D,E,F show details of the second preferred embodiment. The sealing portion of the piston means is made of an elastically deformable material supported by a support means which can rotate around an axis parallel to the center axis of the chamber. The

consequence of this movement is that it supports a larger area of the sealing means the higher the pressure is in the chamber. The loading portion for the support portion initiates the movement of the support means. The loading portion in the form of a flat-shaped spring can change dimensions in a direction perpendicular to the centre line of the chamber. The spring becomes more and more stiff the higher the pressure in the chamber. It can also be a spring on the axis where the support means turns around. By decreasing the diameter of the sealing portion it increases its length. This is the case with an elastically deformable material which is only a bit compressable, like e.g. rubber. Therefore the piston rod sticks out of this sealing means at the beginning of a stroke. If other material for the sealing portion is chosen, its length may remain unchangend or may decrease by decreasing its diameter.

Fig. 104A shows a piston pump with a pressurizing chamber 21 with portions of different transversal cross-section areas. The chamber has cooling ribs 22 at the high-pressure side. The chamber can be (injection) moulded. The piston rod 23. The cap 24 guides the said piston rod. The piston 36 at the beginning and 36' at the end of a pump stroke.

Fig. 104B shows the elastically deformable sealing portion 25 which is fastened to the piston rod 23 by means 26 (not drawn). A part 27 of the piston rod 23 is sticking out of the sealing portion 25. Support portion 28 is hanged up on ring 29 which is fastened to the piston rod 23. Support portion 28 can turn around axis 30. Loading portion 31 comprises a spring which is fastened in a hole 32 onto the piston rod 23. The sealing edge 38.

Fig. 104C shows that part 27 of piston rod 23 is almost covered by the elastically deformed sealing means 25', which has now increased its length and decreased its diameter. The sealing edge 38'. The distance a' between the sealing edge 38 and the central axis 19 of the chamber is approximately 40% of that of distance a in the shown transversal cross-section.

Fig. 104D shows section A-A of Fig. 104B. The loading portion 31 is fastened at one end in the hole 32 of the piston rod 23. The support portion 28 and the ring 29. The support portion is stopped by a stop surface 33 (not drawn). The support portion 28 is guided by the guiding means 34 (not drawn).

Fig. 104E shows section B-B of Fig. 104C. The support means 28 and the loading means 31 are moved towards the piston rod 23. The rib 22.

Fig. 104F shows an alternative for the loading means 31. It comprises springs 35 on each axis 30.

Figs. 105A,B,C,D,E,F,G,H show details of the third embodiment. It is a variant of the first embodiment. The sealing portion comprises a flexible impervious membrane for gaseous and/or liquid media. This material can change its dimensions in three directions without folds. This sealing portion is mounted in an O-ring which seals to the wall of the chamber. The O-ring is loaded to the wall by a loading means, e.g. a spring in the circumference. The O-ring and spring are further supported by a support means which can rotate around an axle fastened to the piston rod. This support means can be loaded by a spring.

Fig. 105A shows a longitudinal cross-section of a piston pump analog to that of Fig. 103A. The piston 49 at the beginning and 49' at the end of the pump stroke.

Fig. 105B shows a piston means at the beginning of a stroke comprising a sealing means 40: e.g. a stressed skin, that is fastened to a sealing means 41: e.g. an O-ring. This O-ring is loaded by a spring 42 which is positioned on the circumference of the sealing menas 41 and sealing means 40. The central axis 39 of the spring 42. The O-ring 41 and/or spring 42 is supported by support means 43 that can rotate on axis 44 which is attached to the piston rod 45
and positioned perpendicular to the central axis 19. It comprises a certain amount of separate members 43', loaded in compression during the (compression) pump stroke. These are positioned around the circumference of the sealing means 40,41 and the loading means 42, which they support. The support means 43 can be loaded by a spring 46. The angle β_1 between the wall of the chamber 2 and the support means 43. The piston rod 45 is without an inlet or a valve. A supporting ring and/or loading ring in the form of a spring can be mounted in the O-ring as an alternative for spring 42 (not drawn). The sealing edge 48.

Fig. 105C shows the piston means at the end of the stroke. The sealing means 40', 41' is thicker than at the beginning of a stroke: 40,41. The spring 46'. The Angle β_2 between the wall 5 and the support means 43 at the end of a stroke. The distance a' between the sealing edge 48 and the central axis 19 of the chamber is approximately 22% of the distance a at the beginning of the stroke in the shown cross-section. Smaller distances e.g. 15%, 10% or 5% are possible, and depend only on the construction of the suspension of the piston on the piston rod. Therefore, this is also valid for all other embodiments.

Fig. 105D shows section C-C of Fig. 105A with support means 43, axle 44 and bracket 47.

Fig. 105E shows section D-D from Fig. 105A.

Fig. 105F shows the two positions of the piston 118 of Fig. 105G and 118' of Fig. 105H in a chamber.

Fig. 105G shows a piston which is made of a composite of materials. It comprises a skin 110 of elastic impervious material and fibers 111. The fiber architecture results in the dome-form when it is under internal pressure. This form stabilizes the piston movement. As an alternative the sealing means may comprise a liner, fibers and a cover (not drawn). If the liner is not tight, an impervious skin may be added (not drawn). All materials at the compressed side of the piston comply with the specific environmental demands of the chamber. The skin is mounted in a sealing portion 112. Within the skin and the sealing portion a spring-force ring 113 may be mounted and which can elastically deform in its plane, and which enhances the loading of the ring 114. The sealing edge 117.

Fig. 105H shows the piston of Fig. 105G at the end of a pump stroke. The dome has been compressed into shape 115, if there is still full overpressure. Shape 110' is a result if the overpressure is decreased e.g. after the media has been released.

Figs. 106A,B,C show details of the fourth embodiment. The piston means comprises a rubber tube which has a reinforcement, e.g. in the form of a textile yarn or cord wound around. The neutral angle between the tangent of the reinforcement winding and the centre line of the hose (= so-called braid angle) is mathematically calculated to be 54°44'. A hose under internal pressure will not change dimensions (length, diameter), assuming no elongation of the reinforcement. In this embodiment, the diameter of the piston means decreases in relation to the decreasing diameter of the cross-section of the chamber at increasing pressures. The braid angle should be wider than neutral. The shape of the main part of the longitudinal cross-section of the pressurizing chamber is approximately a cone shape due to the behaviour of the piston means. At the end of the pump stroke, when the compressed medium has been removed from the chamber, the piston means increases its diameter and its length is decreased. The diameter increase is no practical problem. The sealing force from the piston to the wall of the pressurizing chamber ought to increase by increasing pressure. This may e.g. be done by the choice of a braid angle so that the piston diameter decreases a bit less than the decrease in diameter of the transversal cross-section of the chamber. Therefore, the braid angle may also be chosen to be smaller

than neutral and/or being neutral. In general, the choice of the braid angle depends entirely on the design specification, and therefore the braid angle may be wider and/or smaller and/or neutral. It is even possible that the braid angle changes from place to place in the piston. Another possibility is that in the same cross-section of the piston several reinforcement layers are present with identical and/or different braid angles. Any type of reinforcement material and/or reinforcement pattern can be used. The place of the reinforcement layer(s) may be anywhere in the longitudinal cross-section of the piston. The amount of linings and/or covers may be more than one. It is also possible that a cover is absent. The piston means may also comprise loading and supporting means, e.g. those showed earlier. In order to be able to adapt to larger changes in the areas of cross-sections of the chamber a bit different construction of the piston means is necessary. The cone comprises now fibers which are under tension. These are coiled together in the top of the cone near the piston rod, and at the open side of the cone at the bottom of the piston rod. These may also be fastened to the piston rod itself. The pattern of the fibers is designed e.g. so that these are under higher tension the higher the pressure is in the chamber of pump where the media is to be compressed. Other patterns are of course possible, just depending on the specification. They deform the skin of the cone, so that it adapt itself to the cross-section of the chamber. The fibers may lie loose on the liner or loose in channels between a liner and a cover or they may be integrated on one of the two or in both. It is necessary to have a loading means in order to obtain an appropriate sealing to the wall if there is no pressure under the cone yet. The loading member e.g. a spring force member in the form of a ring, a plate etc. may be build in the skin e.g. by inserting in a moulding process. The suspension of the cone on the piston rod is better than of the foregoing embodiments because the piston will now be loaded by tension. Therefore being more in balance and less material is needed. The skin and the cover of the piston may be made of elastically deformable material which comply with the specific environmental conditions, while the fibers may be elastically or stiff, made of an appropriate material.

Fig. 106A shows a longitudinal cross-section of a pump with chamber 60. The wall portions 61,62,63,64,65 are both cylindrical 61,65 and cone-shaped 62,63,64. Transitions 66,67,68,69 between the said portions. The piston 59 at the beginning and 59' at the end of a pump stroke.

Fig. 106B shows piston means 50, a hose with a reinforcement 51. The hose is fastened to the piston rod 6 by clamp 52 or similar. The piston 6 has ribs 56 and 57. Ribs 56 prevent the movement of

the piston means 50 relative to the piston rod 6 towards the cap 7, while ribs 57 prevent the movement of the piston means 50 relative to the piston rod 6 away from the cap 7. Other configurations of the fitting may be possible (not shown). On the outside of the hose, a protrusion 53 seals against the wall 61 of the chamber 60. Besides the reinforcement 51 the hose comprises lining 55. As an example cover 54 is shown too. The shape of the longitudinal cross-section of the piston means is an example. The sealing edge 58.

Fig. 106C shows the piston means at the end of the stroke, where the gaseous and/or liquid medium is under pressure. The piston means may be designed in such a way that the diameter change only takes place via a radial change (not shown).

Fig. 106D shows the piston 189 of Fig. 106E and 189' of Fig. 106F at the beginning and at the end respectively of a pump stroke in a chamber of Fig. 106A.

Fig. 106E shows a piston means which has approximately the general shape of a cone with top angle $2\varepsilon_1$. It is shown when there is no overpressure at the side of the chamber. It is mounted in its top on a piston rod 180. The cone is open at the pressurized side of the piston. The cover 181 comprises a sealing portion shown as a protrusion 182 with a sealing edge 188 and an inserted spring force member 183, fibers 184 as support means and a liner 185. The member 183 provides a loading to the cover, so that said protrusion 182 seals the wall of the chamber if there is no overpressure at the side of the chamber. The fibers 184 can lie in channels 186, and these are shown situated between the cover 181 and the liner 185. The liner 185 can be impervious - if not, a seperate layer 209 (not shown) at the pressurized side is mounted on the liner 185. The fibers are mounted in the top 187 of the cone to the piston rod 180 and/or to each other. The same is the case at the bottom end of the piston rod 180.

Fig. 106F shows the piston means at the end of a stroke. The top angle is now $2\varepsilon_2$ and the distance a' between the sealing edge 188 and the central axis 19 of the chamber is now approximately 44% of that distance a at the beginning of the stroke in the shown cross-section.

Fig. 107A,B,C,D,E show details of the fifth embodiment of the pump, with a piston which is constructed as another composite structure, comprising a basic material which is very elastic in all three dimensions, with a very high degree of relaxation. If it is not tight of itself, it may be made tight with e.g. a flexable membrane on the pressurized side of the piston means. The axial stiffness is accomplished by several integrated stiffeners, which in a transversal cross-section lie in a pattern, which

optimally fills this section, while the in-between distance is reduced the smaller the diameter of the transversal cross-sectional section is, which in most cases means the higher the pressure in the pressurizing chamber is. In the longitudinal section of the piston the stiffeners lie in several angles between an axial direction and the direction of the surface of the piston means. The higher the pressure rates are, the more these angles are reduced and come near the axial direction. Now therefore the forces are being transferred to the support means, e.g. a washer, which is connected to the piston rod. The piston means can be mass-produced and is inexpensive. The stiffeners and, if necessary, the sealing means in the form of said flexible membrane, may be injection moulded together with said basic material in one operation. E.g. may the stiffeners be bonded together in the top, which makes handling easier. It is also possible to make the membrane by 'burning' it in said basic material, during or after injection moulding. This is specifically convenient if the basic material is a thermoplast. The hinges should than not be 'burned'.

Figs. 107F,G,H,I,J,K,L,M shows embodiments of the chamber and a sixth embodiment of the piston, fitting to this chamber. The sixth embodiment of the piston is a variant on the one of Fig. 107A,B,C,D,E. 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

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

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

$$0 \le x \le 2\pi,\ x \in \mathbb{N}$$

$$p \ge 0,\ p \in \mathbb{R}$$

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. 107F, 107K 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: Figs. 107L, 107M show 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 boundary-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 107F, 107K, 107L, 107M 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

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

$$0 \le x \le 2\pi,\ x \in \mathbb{N}$$

$$p \ge 0,\ p \in \mathbb{R}$$

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

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

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

$$0 \le x \le 2\pi,\ x \in \mathbb{N}$$

$$p \ge 0,\ p \in \mathbb{R}$$

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:

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

where

$r_0 \ge 0$,
$a \ge 0$,
$m \ge 0,\ m \in \mathrm{R}$,
$n \ge 0,\ n \in \mathrm{R}$,
$0 \le \varphi \le 2\pi$,

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"*

φ = *the angle which bounds the curve.*

The inlet is placed 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. 107A shows a piston pump with a pressurizing chamber 70 in a longitudinal section with a cylindrical portion 71, a transition 72 to a continuous concave curved portion 73, another transition 74 to an almost cylindrical portion 75. The piston means 76 and 76' is shown at the beginning respectively at the end of the pump stroke. At the end of the outlet channel 77 a check valve 78 can be mounted (not shown).

Fig. 107B shows the piston means 76 comprising an elastic material 79 which gives the longitudinal section of the piston at low pressures the form of approximately a cone. The material 79 functions also as a loading means. The bottom comprises a sealing means 80, which can be folded radially - this sealing means 80 is partially also working as a loading means. The main support means comprises of stiffeners 81 and 82, of which the stiffeners 81 mainly support the sealing edge 83 of the piston means to the wall of the pressurizing chamber 70 while the other stiffeners 82 transfer the load from the sealing means 80 and the basic material 79 to the support means 84 e.g. a washer which is itself supported by the piston rod 6. The sealing means 80 is in this position of the piston means 76 still a little bit folded, so that fold 85 will load the sealing edge 83 the more the higher the pressure will be in the chamber 70. Stiffeners 82 are joined together in the top by joint 86. In this position of the piston means 70 the stiffeners 81 and 82 having angles between γ and δ with the central axis 19, where δ is approximately parallel with the central axis 19 of the pressurizing chamber 70. The angle φ_1 between the surface of the piston 76 and the central axis 19.

Fig. 107C shows the piston means 76' at the end of the pump stroke. The sealing means 80 has been folded together, while the elastic material 79 has been squeezed together, resulting in the stiffeners 81,82 are directed approximately parallel with the central axis 19. The angle φ_2 between the surface of the piston means 76' and the central axis 19 is positive, but almost zero. The distance a'

between the sealing edge 83 and the central axis 19 in the shown cross-section is 39% of that distance a at the beginning of the stroke. The sealing means 80'.

Fig. 107D shows a transversal cross-section E-E of the piston means 76, showing the basic elastic material 79, stiffeners 81 and 82, folds 87 of the sealing means 80. Piston rod 6.

Fig. 107E shows a transversal cross-section F-F of the piston means 76', showing the basic elastic material 79, stiffeners 81 and 82, folds 87 of the sealing means 80. Clearly shown is that the elastic material 79 is squeezed together.

Fig. 107F 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. 107G 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. 107H shows transversal cross-section H-H 152 of Fig. 107G 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. 107I shows a transversal cross-section I-I of Fig. 107G 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. 107J shows a variant of the piston of Fig. 107A-C in cross-section H-H from Fig. 107G. The piston is now made of elastic material which is also impervious so that a separate sealing means is not necessary. The distance c and d are different and by that the deformations of the piston in the same transversal cross-section H-H.

Fig. 107K 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. 107L 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. 107L is:

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

The length specified by y is determined by:

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

where

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

As an example from Fig. 103D: Domain area $A_0 = (30)^2$ and boundary length $L = 60 = 188.5$ 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 $A_1 = (19/2)^2 = 283.5$. The convex curve with the smallest possible curvature of the boundary curve is now:

$$r = 1.54$$
$$= 1/r = 0.65$$
$$x = 89.4$$

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. 107M shows a non-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. 107L is:

$$r = \sqrt{\frac{A_1}{\pi + 4}}$$

The length specified by x is determined by:

$$x = \frac{1}{2} L - (1 + \pi) \sqrt{\frac{A_1}{\pi + 4}}$$

where

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

The non-convex curve (with obvious modifications of the string-like intermediate double curve) with the smallest possible curvature of the boundary curve:

$r = 6.3$

$= 1/r = 0.16$

$x = 42$

The curve on the Figure is not on scale and the Figure shows only the principle.

Fig. 108A,B,C show a seventh embodiment of the pump, with a piston means which is constructed as another composite structure, comprising a compressable medium as e.g. a gaseous medium like for example air (also is possible: only a non-compressible medium as e.g. a liquid medium like water or a combination of compressable and a non-compressible medium) within a closed chamber which is constructed as e.g. a reinforced hose. It may be possible that the lining, reinforcement and cover at the pressurized side of the piston means is different from that of the non-pressurized side - here the skin can be built up as a pre-formed shaped skin, holding this shape during the pump stroke. It is also possible that the skin is made of two or more parts, which itself are pre-formed shaped, one at the non-pressurized side of the piston means, the other on the pressurized side (please see Fig. 108B part X resp. parts Y+Z). During the pump stroke the two parts hinge in each other (please see Fig. 108B XY and ZZ). The adaptation of the sealing edge to the chamber in the transversal cross-section may result in a change of the cross-section of the piston at its sealing edge, and this may result in a change of the volume inside the piston. This volume change may give a change in the pressure of the compressable medium and may result in a changend sealing force. Moreover, the compressable medium functions as a support portion as it transfers the load on the piston to the piston rod.

Fig. 108A shows a longitudinal section of the pressurizing chamber 90, comprising a contineous convex curve 91, with the piston 92 at the beginning of the pump stroke, and 92' at the end hereof. The high pressure part of the chamber 90 comprises an outlet channel 93 and an inlet channel 94 both with a check valve 95 and 96, respectively (not shown). For low pressure purposes the check valve 95 can be removed.

Fig. 108B shows piston 92 which is vulcanised directly on the piston rod 97, comprising a compressible medium 103 within a lining 99, a reinforcement 100 and a cover 101. Part X of the skin 99,100,101 is pre-shaped as it is with the parts Y and Z at the pressurized part of the piston means 92. A hinge XY is shown between part X and part Y of the skin. Part X has an average angle , with the central axis 19 of the pressurized chamber 90. Part Y and Z are connected to each other and have an in-

between angle κ_1, which is chosen so that the forces will be directed mainly to the piston rod. The angle λ between parts Y' and Z', and is chosen so that the higher the force in the chamber, the more this part is perpendicular to the central axis. Hinge ZZ between the half of part Z. The sealing edge 102.

Fig. 108C shows the piston at the end of a stroke. Part X' of the skin has now an angle η_2 with the central axis, while parts X' and Y' has an in-between angle κ_2, and an approximately unchanged angle λ between Y' and Z'. The angle between the half parts of part Z is approximately zero. The distance a' between the sealing edge 102 and the cemtral axis 19 of the chamber in the shown transversal cross-section is approximately 40% of the distance a at the beginning of the stroke. The sealing edge 102' and compressed medium 103'.

Fig. 109A,B,C,D show details of a combination of a pressurizing chamber with fixed dimensions and an eight embodiment of a piston which can change its dimensions. The piston is an inflatable body which fills a transversal cross-section of the chamber. During the stroke it may constantly change its dimensions on and nearby the sealing edge. The material may be a composite of an elastically deformable liner and a support means like e.g. fibers (e.g. glass, boron, carbon or aramid), fabric, filatement or the like. Depending on the fiber architecture and the total resulting loading on the piston - the piston is shown having a bit internal overpressure -it may result in approximately the form of a sphere or approximately an elleptical curve ('rugby ball'-like form) or any shape in between, and also other shapes. A decrease of the transversal cross-sectional area of e.g. the chamber causes a decrease in the size of the inflatable body in that direction and a 3-dimensional reduction is possible due to the fiber architecture, which is based on the 'trellis-effect' where fibers are shearing layerwise independantly from each other. The cover is also made of an elastically deformable material, suitable for the specific environmental conditions in the chamber. If the liner nor the cover is impervious it is possible to use a separate bladder inside the body, as the body contains an gaseous and/or liquid media. The support means as e.g. fibers can only give strength by themselves if the pressure inside the body is bigger than outside, because these are than in tension. This pressure condition may be preferable to obtain a suitable sealing and life time. As the pressure in the chamber can change constantly, the pressure inside the body should do the same and be a bit higher, or should always be higher at any point of the pump stroke by remaining constant. The last solution can only be used for low pressures as otherwise the piston may jam in the chamber. For higher pressures in the chamber an arrangement may

be necessary so that the internal pressure vary accordingly to the variations of the pressure in the chamber + should be a bit higher. This may be achieved by several different arrangements - loading regulating means - which are based on the principles to change the volume and/or pressure of a medium inside the piston and/or to change the temperature of the medium inside - other principles are possible too, as e.g. the right choice of the material of the skin of the piston, e.g. a specific rubber type, where it is E-module which defines the deformability, or the right choice of the relative amount of the compressable part of the volume inside the inflatable body, and its compressability. Here a non-compressable medium is used inside the piston. By a change in the size of the transversal cross-sectional area at the sealing edge the volume of the piston may change, because the size of the piston in a direction of the movement is constant. This change causes the non-compressable medium to flow to or from the a spring-force operated piston inside the hollow piston rod. It is also possible that said spring-force operated piston is situated elsewhere. The combination of the pressure caused by the change of the volume of the piston and the change in the pressure due to said spring-force results in a certain sealing force. The said spring-force works as a fine-tuning for the sealing force. An improved load regulation may be achieved by exchanging the non-compressable medium by a certain combination of a compressable and a non-compressable medium, where the compressable medium works as a load regulating means. A futher improvement is when said spring is exchangend by the operation force of the piston of the chamber, as it makes the retraction of the piston easier, due to a lower sealing force and a lower friction. A temperature raise of a medium inside the piston may be achieved when specifically a medium is chosen which can quickly be warmed up.

Fig. 109A shows the longitudinal cross-section of the pressurizing chamber of Fig. 108A with the piston 146 of Fig. 109B at the beginning of a stroke, and of Fig. 109C at the end 146' of a stroke.

Fig. 109B shows a piston 146 with an inflatable body having a wall comprising fibers 130 which have a pattern, so that the inflated body becomes a sphere. Cover 131 and liner 132. An impervious bladder 133 is shown inside the sphere. The sphere is directly mounted on the piston rod 120. It is locked at one end by a cap 121, and at the other end by cap 122. The hollow channel 125 of the piston rod 120 has a hole 123 in its side inside the sphere, so that the loading means being e.g. an in compressible medium 124 contained within the sphere can flow freely to and from the channel 125 of

the piston rod 120. The other end of the channel 125 is closed by a movable piston 126 which is loaded by a spring 127. The spring is mounted on a piston rod 128. The spring 127 tunes the pressure in within the sphere and the sealing force. The sealing surface 129 is approximately in a line contact with the of the adjacent wall of the chamber. The fibers are only shown schematically (in all the drawings of this application).

Fig. 109C shows the piston of Fig. 109B at the end of a stroke where the area of the cross-section is smallest. The sphere has now a much bigger sealing surface 134 which is uniform with the adjacent walls of the chamber. The piston 126 has moved in relation to its position shown in Fig. 9B, as the non-compressible medium 124' has been squeezed out of the distorted sphere. In order to minimize the friction force it is possible that the cover at the sealing surface has ribs (not shown) or may have a low-frictional coating (as well as the wall of the chamber - not shown). As none of the caps 121 and 122 can move along the piston rod 120, the trellis effect only can be a part of the material surplus of the skin. The rest shows as a 'shoulder' 135 which may reduce the life time considerably, while it increases the friction as well. The sealing edge 129'. The distance a' between the sealing edge 129' and the central axis 19 of the chamber in the shown transversal cross-section is approximately 48% of the distance a of at the beginning of the stroke.

Fig. 109D shows an improved tuning of the sealing force, by having inside the sphere an incompressible medium 136 and a compressible medium 137. The pressure of the media is regulated by a piston 138 with a sealing ring 139 and a piston rod 140 which is directly connected to the operating force. The piston 138 can slide in the cylinder 141 of the sphere. The stop 145 secures the sphere on the piston rod 140.

Figs. 110A,B,C show an improved piston where the surplus of the skin by small cross-sections of the chamber can be released which means an improved life time and less friction. This method concerns the fact that a suspension of the piston on the piston rod can translate and/or rotate over the piston rod to a position farther from the side of the piston where there is the biggest pressure in the chamber. A spring between the movable cap and a stop on the piston rod functions as another loading regulating means.

Fig. 110A shows a longitudinal cross-section of the chamber 169 of a pump according to the invention with two positions of the piston 168 respectively 168'.

Fig. 110B shows a piston with an inflatable skin with a fibers 171 in at least two layers with a fiber architecture which results in approximately a sphere - ellipsoide, when inflated. Inside the piston can be an impervious layer 172, if the skin is not tight. The media is a combination of a compressible medium 173, e.g. air, and an incompressable medium 174, e.g. water. The skin 170 is mounted at the end of the piston rod in cap 175 which is fastened to the piston rod 176. The other end of the skin is hingend fastened in a movable cap 177 which can glide over the piston rod 176. The cap 177 is pressed towards the pressurized part of the chamber 169 by a spring 178 which is squeezed at the other end towards a washer 179 which is fastened to the piston rod 176. The sealing edge 167.

Fig. 110C shows the piston of Fig. 110B at the end of the pump stroke. The spring 178' is compressed. The same is valid for the incompressable medium 174' and the compressible medium 173'. The skin 170' is deformed, and has now a big sealing surface 167'. The distance a' between the sealing edge 167 and the central axis of the chamber is approximately 43% of the distance a at the beginning of the stroke.

Figs. 111A,B,C show a piston which has at both of its ends in the direction of movement on the piston rod a movable cap which takes the surplus of material away. This is an improvement for a piston in a one-way piston pump, but specifically is it possible now to use the piston in a dual operating pump where any stroke, also the retraction stroke, is a pump stroke. The movement of the skin during the operation is indirectly limited due to stops on the piston rod. These are positioned so that the pressure of a medium in the chamber cannot strip the piston from the piston rod.

Fig. 111A shows a longitudinal cross-section of the chamber with an improved piston 208 at the beginning and at the end (208') of a stroke.

Fig. 111B shows a nineth embodiment of the piston 208. The skin of the sphere is comparable with the one of Fig. 10. An impervious layer 190 inside is now tightly squeezed in the cap 191 in the top and the cap 192 in the bottom. Details of said caps are not shown and all kinds of assembling methods may be used. Both caps 191,192 can translate and/or rotate over the piston rod 195. This can be done by various methods as e.g. different types of bearings which are not shown. The cap 191 in the top can only move upwards because of the existance of the stop 196 inside the piston. The cap 192 in the bottom can only move downstairs because the stop 197 prevent a movement upwards. The 'tuning' of the sealing force comprises a combination of an incompressable medium 205 and a

compressible medium 206 inside the sphere, a spring-force operated piston 126 inside the piston rod 195. The media can freely flow through the wall 207 of the piston rod through holes 199, 200, 201. 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, showed as a screwed assembly at the end of the piston rod 195 tightens said piston rod. Comparable stops can be positioned elsewhere on the piston rod, depending on the demanded movement of the skin.

Fig. 111C shows the piston of Fig. 111B at the end of a pump stroke. The cap 191 in the top is moved over a distance x" from the stop 196 while the bottom cap 192 is pressed against the stop 197. The compressible medium 206' and the non-compressible medium 205'.

Figs. 112A,B,C show an improved piston in relation to the earlier one's. The improvements have to do with a better tuning of the sealing force by the loading regulating means, a reduction of friction by a smaller sealing contact surface, specifically by smaller cross-sectional area's. The improved tuning concerns the fact that the pressure inside the piston now directly is influenced by the pressure in the chamber due to a pair of pistons on the same piston rod and which is by that independent of the existence of an operation force on the piston rod. This may be specifically advantageous during a stop in the pump stroke, if the operation force would change, e.g. increase, because the sealing force remains constant and no loss of sealing occurs. At the end of a pump stroke when the pressure in the chamber is decreased, the retraction will be more easy due to lower friction forces. In the case of a dual operating pump, the loading regulating means may be influenced by both sides of the piston, e.g. by a double arrangenment of this load regulating means (not shown). The shown arrangement of the pistons is complying with a specification: e.g. an increase of the pressure in the chamber will give an increase of the pressure in the piston. Other specifications may result in other arrangements. The relation may be designed so that the increase can be different from a linear relation. The construction is a pair of pistons which are connected by a piston rod. The pistons may have an equal area, different size and/or a changing area.

Due to a specific fiber architecture and the total resulting loading - it is shown with a bit internal overpressure - the shape of the piston in a longitudinal cross-section is a rhomboid figure. Two of its corners in this section work as a sealing surface, which gives a reduced contact area by smaller transversals cross-sections of the chamber. The size of the contact surface may still be increased by the

existence of a ribbed outer surface of the skin of the piston. The wall of the chamber and/or the outside of the piston can have a coating as e.g. nylon or can be made of a low-friction material.

Not drawn is the possibility of a chamber which has transversal cross-sectional shapes according to e.g. those of Fig. 107F with a piston which has (in this case as an example) three separate pistons according to e.g. Fig. 112A-C which each seals in the first circular cross-sectional area (Fig. 107F top, left), each other and the boundary curve, while at another point of the longitudinal axis of the chamber each seal one of the three lobe-shaped parts and each other (Fig. 7F e.g. top, right), while at still another point each seal one of the three lobe-shaped parts only.

Fig. 112A shows a longitudinal cross-section of a piston chamber combination with a tenth embodiment of a piston 222 at the beginning and at the end (222') of a stroke in a chamber 216.

Fig. 112B shows a piston of which the main construction is described in Figs. 11B and 11C. The skin comprises at the outside ribs 210. The skin and the impervious layer 190 at the inside are squeezed at the top between an inner part 211 and an outer part 212, which are screwed together. At the bottom the similar construction exists with the inner part 213 and the outer part 214. Inside the piston there is a compressable medium 215 and a non compressable medium 219. The pressure inside the piston is tuned by a piston arrangement which is directly activated by the pressure of the chamber 216. The piston 148 in the bottom which is connected to the pressurizing chamber 216 is mounted on a piston rod 217 while at the other side another piston 149 is mounted and which is connected to a medium of the piston 222. The piston rod 217 is guided by a slide bearing 218 - other bearing types can also be used (not shown). The pistons on both sides of the piston rod 217 can have different diameters - it is even possible that the cylinder 221 in which these are moving, are exchanged by two chambers, which can be of a type according this invention - by that, the piston and/or pistons are also of a type according this invention. The sealing edge 220. The piston rod 224. Distance d_1 between the piston 148 and orifice 223.

Fig. 112C shows the piston of Fig. 112A at the end of a stroke, while there is still high pressure in the chamber 216. Sealing edge 220'. The load regulating means 148' have a different distance from the orifice 223 towards the chamber. Piston 148' and 149' are shown positioned at a larger distance than in Fig. 112B from the orifice 223: d_2.

Fig. 113A,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 medium (a non-compressable and/or a compressable medium). It is also possible that said housing can 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-compressible medium in the wall of the chamber and/or the right tuning of load regulating means, which are 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 ought to 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 equipped with all the already shown loading regulating means the one showed on Fig. 112B, and if necessary with the shape regulating means. The velocity of the piston in the chamber may have an effect on the sealing.

Fig. 113A 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 compressible medium 232 and a non-compressible medium 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 different from the one shown.

Fig. 113B 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 ν 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. 113C 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. 113D 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. 114 shows a combination of a wall of the chamber and the piston which have changeable geometrical shapes, which adapt to each other during the pump stroke, enabling a continuous sealing. Shown is the chamber of Fig.13A now with only a non-compressable medium 237 and piston 222 at the beginning of a stroke, while the piston 222" is shown just before the end of a stroke. Also all other embodiments of the piston which can change dimensions can 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.

207 SPECIFICALLY PREFERRED EMBODIMENTS

According to an embodiment of the invention, there is provided 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 area thereof and, at a second longitudinal position thereof, a second cross-sectional area, the second cross-sectional area being 95% or less of the first cross-sectional area, the change in cross-section 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.

Preferably the second cross-sectional area is between 95% and 15% of the first cross-sectional area.

Preferably, the second cross-sectional area is 95-70% of the first cross-sectional area.

Preferably, the second cross-sectional area is approximately 50% of the first cross-sectional area.

Preferably the piston comprises: a plurality of at least substantially stiff support members rotatably fastened to a common member, elastically deformable means, supported by the supporting members, for sealing against an inner wall of the chamber the support members being rotatable between 10° and 40° relative to the longitudinal axis.

According to an embodiment of the invention there is also provided a combination where the support members are rotatable so as to be at least approximately parallel to the longitudinal axis.

Preferably the common member is attached to a handle for use by an operator, wherein the support members extend, in the chamber, in a direction relatively away from the handle.

Preferably the combination further comprises means for biasing the support

members against an inner wall of the chamber.

Preferably the piston comprises an elastically deformable container comprising a deformable material.

Preferably the deformable material is a fluid or a mixture of fluids, such as water, steam, and/or gas, or a foam.

Preferably, in a cross-section through the longitudinal direction, the container has a first shape at the first longitudinal direction and a second shape at the second longitudinal direction, the first shape being different from the second shape.

Preferably at least part of the deformable material is compressible and wherein the first shape has an area being larger than an area of the second shape.

Preferably the deformable material is at least substantially incompressible.

Preferably the piston comprises a chamber communicating with the deformable container, the chamber having a variable volume.

Preferably the volume may be varied by an operator.

Preferably the chamber comprises a spring-biased piston.

Preferably the combination further comprises means for defining the volume of the chamber so that a pressure of fluid in the chamber relates to a pressure of fluid between the piston and the second longitudinal position of the container.

Preferably the defining means are adapted to define the pressure in the chamber at least substantially identical to the pressure between the piston and the second longitudinal position of the container.

Preferably the first cross-sectional shape is 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.

Preferably the first cross-sectional area is 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% larger than the second cross-sectional area.

Preferably 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.

Preferably 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.

Preferably, 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.

Preferably the first and second circumferences are at least substantially identical.

Preferably the piston comprises: an elastically deformable material 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, and a coiled flat spring having a central axis at least substantially along the longitudinal axis, the spring being positioned adjacently to the elastically deformable material so as to support the elastically deformable material in the longitudinal direction.

Preferably the piston further comprises a number of flat supporting means positioned between the elastically deformable material and the spring, the supporting means being rotatable along an interface between the spring and the elastically deformable material.

Preferably the supporting means are adapted to rotate from a first position to a second position where, in the first position, an outer boundary thereof may be comprised within the first cross-sectional area and where, in the second position, an outer boundary thereof may be comprised within the second cross-sectional area.

According to an embodiment of the invention, there is provided 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 area thereof and, at a second longitudinal position thereof, 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, 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, the piston comprising: a plurality of at least substantially stiff support members rotatably fastened to a common member, elastically deformable means, supported by the supporting members, for sealing against an inner wall of the chamber the support members being rotatable between 10° and 40° relative to the longitudinal axis.

According to an embodiment, there is provided a combination where the support members are rotatable so as to be at least approximately parallel to the longitudinal axis.

Preferably the common member is attached to a handle for use by an operator, and wherein the support members extend, in the chamber, in a direction relatively away from the handle.

Preferably, the combination further comprises means for biasing the support members against an inner wall of the chamber 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 area thereof and, at a second longitudinal position thereof, 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, 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 the piston comprising an elastically deformable container comprising a deformable material.

Preferably the deformable material is a fluid or a mixture of fluids, such as water, steam, and/or gas, or a foam.

Preferably, in a cross-section through the longitudinal direction, the container has a first shape at the first longitudinal direction and a second shape at the second longitudinal direction, the first shape being different from the second shape.

Preferably at least part of the deformable material is compressible and wherein the first shape has an area being larger than an area of the second shape.

Preferably the deformable material is at least substantially incompressible.

Preferably the piston comprises a chamber communicating with the deformable container, the chamber having a variable volume.

Preferably the volume may be varied by an operator.

Preferably the chamber comprises a spring-biased piston.

Preferably, the combination further comprises means for defining the volume of the chamber so that a pressure of fluid in the chamber relates to a pressure of fluid between the piston and the second longitudinal position of the container.

Preferably the defining means are adapted to define the pressure in the chamber at least substantially identical to the pressure between the piston and the second longitudinal position of the container.

Preferably the container comprises an elastically deformable material comprising

enforcement means.

Preferably the enforcement means comprise fibres.

Preferably 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 from the first longitudinal position to the second longitudinal position or vice versa.

Preferably, 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.

Preferably the first cross-sectional area is 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% larger than the second cross-sectional area.

Preferably 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.

Preferably 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.

Preferably, 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.

Preferably the first and second circumferences are at least substantially identical.

Preferably the piston comprises: a plurality of at least substantially stiff support members rotatably fastened to a common member, elastically deformable means, supported by the supporting members, for sealing against an inner wall of the chamber.

Preferably the piston comprises: an elastically deformable container comprising a deformable material.

According to another embodiment of the invention, there is provided 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 area thereof and, at a second longitudinal position thereof, 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, the piston comprising: an elastically deformable material 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, and - a coiled flat spring having a central axis at least substantially along the longitudinal axis, the spring being positioned adjacently to the elastically deformable material so as to support the elastically deformable material in the longitudinal direction.

Preferably the piston further comprises a number of flat supporting means positioned between the elastically deformable material and the spring, the supporting means being rotatable along an interface between the spring and the elastically deformable material.

Preferably the supporting means are adapted to rotate from a first position to a second position where, in the first position, an outer boundary thereof may be

comprised within the first cross-sectional area and where, in the second position, an outer boundary thereof may be comprised within the second cross-sectional area.

According to an embodiment of the invention there is provided 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 from a first longitudinal position to a second 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.

Preferably the piston is made of an at least substantially incompressible material.

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

Preferably the chamber comprises: 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.

According to an embodiment of the invention, there is provided a pump for pumping a fluid, the pump comprising: a combination according to any of the preceding claims, means for engaging the piston from a position outside the chamber, a fluid entrance connected to the chamber and comprising a valve means, and a fluid exit connected to the chamber.

Preferably 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.

Preferably the engaging means 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.

According to an embodiment of the invention, there is provided a shock absorber comprising: a combination as described above, 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.

Preferably the shock absorber further comprises a fluid entrance connected to the chamber and comprising a valve means.

Preferably the shock absorber further comprises a fluid exit connected to the chamber and comprising a valve means.

Preferably 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.

Preferably the shock absorber further comprises means for biasing the piston toward the first longitudinal position.

According to an embodiment of the invention there is also provided an actuator comprising: a combination as described above, 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.

Preferably the actuator further comprises a fluid entrance connected to the chamber and comprising a valve means.

Preferably the actuator further comprises a fluid exit connected to the chamber and comprising a valve means.

Preferably the actuator further comprises means for biasing the piston toward the first or second longitudinal position.

Preferably the introducing means comprise means for introducing pressurised fluid into the chamber.

Preferably the introducing means are adapted to introduce a combustible fluid, such as gasoline or diesel, into the chamber, and wherein the actuator further comprises means for combusting the combustible fluid.

Preferably the actuator according further comprises a crank adapted to translate the translation of the piston into a rotation of the crank.

653 DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 201A 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 evel is shown. The pressure inside the piston 5* results in a certain contact length.

Fig. 201B shows the contact pressure of the piston 5* of Fig. 201A. The piston 5* may jam at this longitudinal position.

Fig. 202A 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. 202B 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. 202C 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. 202D 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. 203A shows the piston 5 of Fig. 201A, and the deformed piston 5"* when pressurized to the same pressure level of that of piston 5* of Fig. 201A. 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. 203B shows the contact pressure. The piston 5"* may jam at this longitudinal position.

Fig. 204A 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 chosen lower than that in the meridian direction (in the longitudinal direction of the chamber).

Fig. 204B shows the contact pressure on the wall of piston 15'*. This results in an appropriate friction force (4.2 kg), and suitable sealing.

Fig. 204C 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. 204D 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. 205A 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. 205B shows the contact pressure of the piston 15'* of Fig. 205A. This is low enough to allow movement (friction force 4.2 kg) and suitable for sealing.

Fig. 205C 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. 205D shows the contact pressure of the piston 15"* of Fig. 205C. 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.

Figs. 206-209 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 subjected to external forces.

All kinds of fluids may be used - a combination of a compressible and a non-compressible medium, a compressible medium only or a non-compressible 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. 206A 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. 206B 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 flexible 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 tightens 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. 206C shows the piston of Fig. 206B 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 compressible fluid 206' and the non-compressible fluid 205'.

Fig. 206D 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. 206B.

Fig. 206E is a 3-dimensional drawing and shows the reinforcement matrix of Fig. 206D 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. 206D.

Fig. 206F 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. 206G is a 3-dimensional drawing and shows the reinforcement matrix of Fig. 206F 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. 206F.

Fig. 206H shows three stages I, II and III of a production process of the piston comprising an elastically deformable container. Over a rod 400 is a rubber manchet 401 positioned, over which a reinforced manchet 402 e.g. according to those of Fig. 406E-G is positioned. Over the last mentioned another rubber manchet has been positioned. Between the machet 401 and the rod one or more caps 404 may be positioned. All may slide over the rod 400. The rod 400 may be hollow and may be connected to a high pressure steam source. Stage II: the pressurized steam may enter the cave 408 of the oven 406 by outlets 405 which may be positioned at the end of the rod. A piece of the complete rubber/rein forcement manchets 407 may be cut and transported over the rod 400 into the cave 408. 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 404. 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 407 may take place before the vulcanisation. The rod 400 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 407 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. 207A 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. 207B 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 incompressible fluid 205 and a compressible 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. 210), 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 tightens said piston rod.

Fig. 207C shows the piston of Fig. 207B 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 compressible fluid 206' and the non-compressible fluid 205' which may have changed volume in the container.

Figs. 208A,B,C deal with the construction of the piston which may be identical with that of Figs. 207A,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. 208A 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. 208B 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. 208C 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. 208D shows a top view of the piston 228 and 228', respectively with the reinforcement means 223, and 223" respectively at the first and second longitudinal position of the chamber 186 respectively.

Fig. 208E 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 lie in planes through the central axis 184 in the longitudinal direction of the chamber 186. Fig. 208F 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. 208G shows schematically how fibers 402 may be mounted in caves 431 of the cap 430. This may be achieved by rotating the cap and the fibers around the central axis 433, each may have its own velocity, while the fibers 432 are being pushed towards and in the caves 431.

Fig. 209A 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. 209B 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. 209C shows the longitudinal cross-section of the piston 258'. The contact area 253'.

Figs. 210-212 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. 211E with means so that the piston opens the channel 297 when a certain pressure has been reached (not shown).

Fig. 210A 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. 206A-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. 210B 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. 210C 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. 210D shows details of the flexible piston 126 of the check valve 242. The spring 248 keeps the pressure on the piston 126.

Fig. 210E shows the pressure source 451 which may have a pressure which exceeds the pressure level of the container. Inlet valve 452 with e.g. a valve actuator 453 (the configuration 459 shown is analogeous to the one of Fig. 211E (292,297)), and outlet valve 454 with e.g. a valve actuator 455 (the configuration 451 shown is analogeous to the one of Fig. 211E (292,297)). The space 460 is connected to the chamber 457, while the space 462 is connected to the chamber 458. The valves 452 and 454 may be mounted in the piston rod 456, which may be updivided in two chambers 457 and 458.

Fig. 210F shows the construction of Fig. 210E where two black boxes are shown comprising each a valve arrangement which may be steerable by external signals. The steering 415 may receive pressure signal 416 and 417, respectively from the inside of the piston at different longitudinal positions of the chamber. The steering 415 may send signals 418 and 419, respectively to the actuator 422 of the outlet valve arrangement 420 and to the actuator 423 of the inlet valve arrangenment 421. This valve and valve steering arrangement may be analogeously to the one shown in Fig.211F.

Fig. 211A 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. 206A-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. 210A,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. 211B 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. 211C 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. 211D 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. 211E 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. 211A) or to other actuators (schematically shown in Fig. 211E).

Fig. 211F shows the piston 248' and the inflation arrangement 368 of Fig. 211D, besides the arrangement 369 to control the outlet valve of Fig. 211E. The inflation arrangement 368 comprises now also the arrangement 370 to control the valve of Fig. 211E. 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. 211G 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 tightly closed. The contact area 313

of the cap 312 with the cylinder 282 (fig. 211D). 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. 212 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.

Figs. 213A,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 inflatable 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-compressible 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 equipped with all the already shown loading regulating means the one showed on Fig. 212B, and if necessary with the shape regulating means. The velocity of the piston in the chamber may have an effect on the sealing.

Fig. 213A 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 different from the one shown.

Fig. 213B 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. 213C 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. 213D 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. 214 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. 213A now with only a non-compressible medium 237 and piston 385 at the beginning of a stroke, while the piston 385' 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. 215A-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. 208D approximately paralell with the central axis of the chamber, and when the reinforcement is made of e.g. elastical threads (Figs. 206D, 206E), or those shown in Figs. 206F, 206G allowing each an individual size. The one showed in Figs. 209A,

209B 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

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

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

$$0 \le x \le 2\pi,\ x \in \mathbb{N}$$

$$p \ge 0,\ p \in \mathbb{R}$$

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. 215A, 215E 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. 215F 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 215A, 215E, 215F 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

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

$$0 \le x \le 2\pi,\ x \in \mathbb{N}$$

$$p \ge 0,\ p \in \mathbb{R}$$

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

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

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

$$0 \le x \le 2\pi,\ x \in \mathbb{N}$$

$$p \ge 0,\ p \in \mathbb{R}$$

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:

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

where

$r_0 \ge 0$,
$a \ge 0$,
$m \ge 0, m \in$,
$n \ge 0, n \in$,
$0 \le \varphi \le 2\pi$,

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"*

φ = *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. 215A 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. 215B 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 circleround cross-section, while cross-section H-H 152 has approximately an area between 90-70% of the one of cross-section G-G.

Fig. 215C shows transversal cross-section H-H 152 of Fig. 207G 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. 215D shows a transversal cross-section I-I of Fig. 207G 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. 215E 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. 215F 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:

$$r = \frac{1}{2}\pi(L - \sqrt{L^2 - (4\pi A_1)}$$

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 from Fig. 203D: 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:

$r = 1.54$

$= 1/r = 0.65$

$x = 89.4$

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. 216 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. 217A shows a convex chamber 380 witin a wall 381. "s" means stroke.

Fig. 217B shows the Force-Stroke diagram in the direction shown in Fig. 217A.

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. 218A shows an example of a Movable Power Unit 390, shown movable by parachute 391, and by wheels 392.

Fig. 218B shows the Movable Power Unit 390, with a power unit comprising a set of solar cells 393 on top and a motor 394. Moreover a water pump 395, and a compressor 396. The steering unit 397.

653 SPECIFICALLY PREFERRED EMBODIEMENTS

According to an embodiment of the invention, there is provided 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, wherein: 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 (162,186,231) 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.

Preferably is the container inflatable and said container being elastically deformable and being inflatable to provide for different cross-sectional areas and circumferential lengths of the piston.

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

Preferably is the cross-sectional area of said chamber at the second longitudinal position thereof 95 - 15 % of the cross-sectional area of said chamber at the first longitudinal position thereof.

Preferably is the cross-sectional area of said chamber at the second longitudinal position thereof approximately 50% of the cross-sectional area of said chamber at the first longitudinal position thereof.

Preferably is the container containing a deformable material.

Preferably is the deformable material a fluid or a mixture of fluids, such as water, steam and/or gas, or a foam.

Preferably is the deformable material comprising spring-force operated devices, such as springs.

Preferably has in a cross-section through the longitudinal direction, the container, when being positioned at the first longitudinal position of the chamber, a first shape which is different from a second shape of the container when being positioned at the second longitudinal position of said chamber.

Preferably is at least part of the deformable material compressible and wherein the first shape has an area being larger than an area of the second shape.

Preferably is the deformable material is at least substantially incompressible.

Preferably is the container inflatable, to a certain pre-determined pressure value.

Preferably is the pressure remaining constant during the stroke.

Preferably is the piston comprising an enclosed space communicating with the deformable container, the enclosed space having a variable volume.

Preferably is the volume of the enclosed space adjustable.

Preferably is the first enclosed space comprising a spring-biased pressure tuning piston.

Preferably further comprising means for defining the volume of the first enclosed space so that the pressure of fluid in the first enclosed space relates to the pressure in the second enclosed space.

Preferably the defining means are adapted to define the pressure in the first enclosed space during the stroke.

Preferably are the defining means adapted to define the pressure in the first enclosed space at least substantially constant during the stroke.

Preferably is the spring-biased pressure tuning piston a check valve through which fluid of an external pressure source can flow into the first enclosed space.

Preferably can the fluid from an external pressure source enter the second enclosed space through an inflation valve, preferably a valve with a core pin biased by a spring, such as a Schrader valve from an external pressure source.

Preferably is the piston communicating with at least one valve.

Preferably is the piston comprising a pressure source.

Preferably is the valve an inflation valve, preferably a valve with a core pin biased by a spring, such as a Schrader valve.

Preferably is the valve a check valve.

Preferably is the foot of the chamber connected to at least one valve.

Preferably is the outlet valve an 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 chamber when closing the valve.

Preferably is the core pin of the valve connected to an actuator which opens or close the valve.

Preferab ly is the actuator 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.

Preferably is 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 predermined 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.

Preferably is the activator 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.

Preferably is the activator 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.

Preferably is 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.

Preferably is the valve actuator 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.

Preferably is the piston comprising means to obtain a pre-determined pressure level.

Preferably is the valve a release valve.

Preferably is a spring-force operated cap which closes the channel above the valve actuator when the pressure comes above a certain pre-determined pressure value.

Preferably is a channel be opened or closed, the channel connects the chamber and the space between the valve actuator and the core pin, a piston is movable between an opening position and a closing position of said channel, and the movement of the piston is controlled by an actuator which is steered as a result of a measurement of the pressure in the piston.

Preferably is a channel be opened or closed, which connects the chamber and the space between the valve actuator and the core pin.

Preferably is a piston movable between an opening position and a closing position of said channel.

Preferably is the piston operated by a operator controlled pedal, which is turning around an axle from a inactive position to an activated position and vice versa.

Preferably is the piston controlled by an actuator which is steered as a result of a measurement of the pressure in the piston.

Preferably is the combination further comprising means for defining the volume of the enclosed space so that the pressure of fluid in the enclosed space relates to the pressure acting on the piston during the stroke.

Preferably is the foam or fluid adapted to provide, within the container, a pressure higher than the highest pressure of the surrounding atmosphere during translation of the piston from the second longitudi-nal position of the chamber to the first longitudinal position thereof or vice versa.

Preferably is the combination comprising a pressure source.

Preferably has the pressure source a higher pressure level than the pressure level of the container.

Preferably is the pressure source communicating with the container by an outlet valve and an inlet valve

Preferably is the outlet valve an 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 when closing the valve.

Preferably is the inlet valve an 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 when closing the valve.

Preferably is a channel be opened or closed, which connects the chamber and the space between the valve actuator and the core pin.

Preferably is a channel be opened or closed, which connects the chamber and the space between the valve actuator and the core pin.

Preferably is a piston movable between an opening position and a closing position of said channel.

Preferably is a channel be opened or closed, the channel connects via the space the chamber and the space between the valve actuator and the core pin, a piston is movable between an opening position and a closing position of said channel, and the movement of the piston is controlled by an actuator which is steered as a result of the measurement of the pressure level in the piston and that of the pressure source.

Preferably is a channel be opened or closed, the channel connects via the space the chamber and the space between the valve actuator and the core pin, a piston is movable between an opening position and a closing position of said channel, and the movement of the piston is controlled by an actuator which is steered as a result of the measurement of the pressure level of the pressure in the and that of the pressure source.

Preferably is the wall of the container comprising an elastically deformable material comprising reinforcement means.

Preferably have the reinforcement windings a braid angle which is different from 54°44'.

Preferably is the reinforcement means comprising 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.

Preferably is the piston produced by a production system with multiple vulcanisation caves.

Preferably is the reinforcement means comprising 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.

Preferably is the piston produced by a production system with multiple vulcanisation caves and where the fibers are being mounted in the caves of the caps by rotation of the fibers and the cabs at different speeds, while the fibers are being pushed onto the inside of the caps.

Preferably are the fibers arrangend as to the Trellis Effect.

Preferably is the reinforcement means comprising 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.

Preferably are said members and/or the common member inflatable.

Preferably is the pressure on the wall of the container build up by spring-force operated devices.

Preferably is the piston comprising a reinforcement which is positioned outside the container.

Preferably is the container moving in a cylinder around a tapered wall.

Preferably is the chamber convex and the operating force tangents a set maximum force during the stroke.

According to an embodiment of the invention, there is also provided a combination according to any of the preceeding statements 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 being at least substantially continuous between the first and second longitudinal positions of the chamber, wherein the piston is further designed to adapt itself and the sealing means to the different cross-sectional shapes.

Preferably is the cross-sectional shape of the chamber at the first longitudinal position thereof at least substantially circular and wherein the cross-sectional shape of the chamber 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.

Preferably is the cross-sectional shape of the chamber at the first longitudinal position thereof at least substantially circular and wherein the cross-sectional shape of the chamber at the second longitudinal position thereof comprises two or more at least substantially elongate, such as lobe-shaped, parts.

Preferably is a first circumferential length of the cross-sectional shape of the cylinder at the first longitudinal position thereof amounting 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 at the second longitudinal position thereof.

Preferably are the first and second circumferential lengths at least substantially identical.

According to an embodiment of the invention, there is also provided a piston-chamber combination comprising an elongate chamber bounded by an inner chamber wall and comprising a piston in the chamber to be sealingly movable in the chamber, the piston being movable in the chamber at least from a second second longitudinal position thereof to a first longitudinal position thereof, the chamber comprising an elastically deformable inner wall along at least part of the length of the chamber wall between the first and second longitudinal positions, the chamber having, at the first longitudinal position thereof when the piston 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 when the piston is positioned at that position, the change in cross-sections 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 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.

Preferably is the piston made of an at least substantially incompressible material.

Preferably has the piston, in a cross section along the longitudinal axis, a shape tapering in a direction from the first longitudinal position of the chamber to the second longitudinal position thereof.

Preferably is the angle between the wall and the central axis of the cylinder at least smaller than the angle between the wall of the taper of the piston and the central axis of the chamber.

Preferably is the chamber comprising 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.

Preferably is the space defined by the outer structure and the inner wall inflatable.

Preferably is the piston comprises an elastically deformable container comprising a deformable material and designed according to statements 7 to 17.

According to an embodiment of the invention, there is provided a pump for pumping a fluid, the pump comprising a combination according to any of the earlier mentioned statements, 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.

Preferably have the engaging means 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.

Preferably have the engaging means an outer position where the piston is at the second longitudinal position of the chamber, and an inner position where the piston is at the first longitudinal position of the chamber.

According to an embodiment of the invention, there is provided a shock absorber comprising: a combination according to any of the preceeding statements 1-80, means for engaging the piston from a position outside the chamber, wherein the engaging means have an outer position where the piston is at the first longitudinal position of the chamber, and an inner position where the piston is at the second longitudinal position.

Preferably is the shock absorber comprising a fluid entrance connected to the chamber and comprising a valve means.

Preferably is the shock absorber further comprising a fluid exit connected to the chamber and comprising a valve means.

Preferably form the chamber and the piston an at least substantially sealed cavity comprising a fluid, the fluid being compressed when the piston moves from the first to the second longitudinal positions of the chamber.

Preferably a shock absorber further comprising means for biasing the piston toward the first longitudinal position of the chamber.

According to an embodiment of the invention, there is provided an actuator comprising: a combination according to any of preceeding the statements 1-80, 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 of the chamber.

Preferably an actuator further comprising a fluid entrance connected to the chamber and comprising a valve means.

Preferably an actuator further comprising a fluid exit connected to the chamber and comprising a valve means.

Preferably an actuator further comprising means for biasing the piston toward the first or second longitudinal position of the chamber.

Preferably the introducing means comprise means for introducing pressurised fluid into the chamber.

Preferably are the introducing means adapted to introduce a combustible fluid, such as gasoline or diesel, into the chamber, and wherein the actuator further comprises means for combusting the combustible fluid.

Preferably are the introducing means adapted to introduce an expandable fluid to the chamber, and wherein the actuator further comprises means for expand the expandable fluid.

Preferably is the actuator further comprising a crank adapted to translate the translation of the piston into a rotation of the crank.

Preferably a motor wherein comprising a combination according to any of the foregoing statements.

Preferably a power unit comprising a combination according to any of the foregoing statements, a power source, and a power device.

Preferably is the power unit movable.

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507 DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 301 shows a valve actuator in a clip-on valve connector to be coupled to e.g. a Schrader valve. The piston 477 is very near the first end 492 of the cylinder 470. The connector has a housing 500 and the sealing means comprises one annular portion 475. The securing means comprises temporary thread 476. The housing also has a center axis 479 and a coupling section 510.

Figure 301A shows an enlarged detail of Figure 301. The cylinder 470 has a cylinder wall portion 511 with a diameter which fits the piston ring 508 of the piston 477. Near its first end 492, the cylinder wall comprises enlargement wall portions 475a, 475b, 476a with an enlarged diameter, comprising flow channel portions 471,472,473 around the piston means 477,508 when the activating pin has enough opened the core of the valve. The flow from the pressure source to the valve can now be established. The first end 492 of the cylinder 470 functions here as a stop for the movement of the activating pin. The channel portions 473 and 474 are parts of the piston control means 476c. These parts can have several shapes which depend on the chosen production technique: e.g., channel portions 473,474 as sector parts of a circle and (507) as cylinders made by injection moulding, while alternatively channel portions (507) could also be drilled holes. Channel portions 473,474 could be considered 'flow shaped', and are constructed to reduce aerodynamic drag. The inclined enlargement wall portion 475a has an angle τ with the center axis 479, which is larger than 0° and smaller than 20°, normally in the interval $1° < \tau < 12°$ with respect to the direction of the gaseous and/or liquid medium or media, respectively coming from the pressure source. The piston control means 476c has three grooves with walls 476a and 476b, respectively. The wall 476a has an angle ω which is larger than 0° and smaller than 20° (usually in the interval between 6° and 12°) with respect to the direction of the gaseous and/or liquid medium or media coming from the pressure source. The alternative for the forementioned channel portions 473 and 474 are channels (507) where the piston control has no grooves. In this alternative, a hole (507) parallel to the center axis 479 and beside the piston control connects channel portion 475b (shown as three holes with dotted lines) and the coupling hole.

Figure 301B shows section G-G from Figure 301A, with the channel portions 473 and 474 and the stopper 492. The alternative channel portion (507) is sketched by dotted lines.

Figure 302 shows a valve actuator in a universal clip-on valve connector with the housing 504 and with a sealing means comprising a first annular portion 482 and a second annular sealing

portion 483 situated coaxially with the center axis 486 of the coupling section, in the direction of the center axis 486 of the coupling section 503. The first annular sealing portion 482 is closer to the opening 502 of the coupling section than the second annular sealing portion 483, and the diameter of the first annular sealing portion 482 is larger than the diameter of the second annular sealing portion 483. The coupled valves can be secured by at least one 'clip' (= i.e. temporary thread) 476. However, two clips 493 opposite each other are preferable. A taper cone 501 near the sealing surface 482 helps center the valve. The taper cone has an angle ω with the center axis 486, and normally this angle is > 45°. A separate cylinder sleeve 496 with cylinder wall portion 509 is shown which is sealed. It is fastened by for example a snap-lock 497 in the wall of the housing 504. This is an economical way of making the negative slip angle of the inclined enlargement wall portion 512 possible. The cylinder sleeve 496 has distant from the piston stop 495 an angle ς, so that the piston ring 508 is non-sealing there.

Figure 302A shows the channel portions 480 and 481 respectively defined by the enlargement wall portions 487 and 488 of the piston control means, respectively. The activating pin is streamlined with the piston 484 and the piston rod 485. The wall portion 487 has an angle κ with the center axis 486 seen in the direction of the medium coming from the pressure source, which is larger than 0° and smaller than 20° (usually in the interval between 6° and 12°). The stepped surface 498 of wall of housing 504 makes an air tight connection from the wall of the cylinder sleeve 496 to the cylinder 499. It is of course also possible to make the air tight connection on the other side of the cylinder. In the bottom of the cylinder sleeve 496 is the inclined enlargement wall portion 512 shown which together with the piston ring 515 forms channel portion 471.

Figure 302B shows section H-H of Figure 302A and the stopper 495 for the movement of the activating pin. Also shown is the wall portion 488 and the channel portion 481.

Figure 303 shows an activating pin which is comparable of the one from Figure 301. The piston 529 is also shown. The piston rod 531 need not to be sealed against the piston control. The cylinder 536 of the valve actuator is within housing 532 of the valve connector. The coupling section 530 is also shown.

Figure 303A shows a channel portion 533 with an expansion 535 and a channel portion 534 formed as a radial drilling 534. The piston ring 539 opens and closes this conducting channel at its orifice 537, depending on the position of the activating pin. The direction of the channel portion 534 in

relation to the center axis is comparable with the angle τ of channel portion 471 of Fig. 301A. The wall of expansion 535 has an angle comparable to angle ω of the wall 476a Fig. 1A. Also shown is the cylinder wall portion 538 of the cylinder 536.

Figure 304 shows an activating pin and its cylinder, which was shown in Figure 301. This is built in an assembled pipeline housing means 520,521 or the like, in which a valve 522 with a spring-force operated core pin 523 is situated, e.g. a Schrader valve. The activating pin is engaging with the core pin 523 of the valve.

Figure 305 shows a valve actuator in a universal valve connector. It is comparable with the one of Figure 301. However, two sealing means 540, 541 with an in-between distance A can seal two valves of different sizes. Two enlargements 1 and 2 of the diameter of the cylinder 542 in the cylinder wall 550 are shown, with the in-between distance B. An activating pin 543 is also shown, with two engaging levels on a distance B. The in-between distances can be equal or different if for example the valves are of a different type, so that the distance from the core pin to the sealing is not the same. Between the two enlargements 1 and 2 is a cylindrical wall portion 544, with cylinder portion 545, which fits the piston ring 508. Also is shown the center axis 546, the coupling section 547 and its opening 548 from the housing 549.

507 SPECIFICALLY PREFERRED EMBODIMENTS

According to an embodiment of the invention, there is provided 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.

Preferably is said first predetermined distance greater than zero.

Preferably is said first predetermined distance approximately zero.

Preferably it is comprising a stopper to limit the movement of the piston in the first piston position.

Preferably it is comprising a tapered portion at the first end of the cylinder and a conical portion of the piston to coincide with said tapered portion when the piston is in the first piston position.

Preferably is the conducting channel formed by an enlargement of the cylinder wall diameter which is arranged to be radially around the piston when being in its first piston position so that the pressure medium can freely flow around the edge of the piston ring when the piston is in its first piston position.

Preferably is the enlargement of the cylinder diameter formed at one or several sections of the circumference of the cylinder wall.

Preferably is the wall of the enlargement comprising a cylindrical enlargement wall portion and an inclined enlargement wall portion forming an angle with the cylinder axis which is larger than 0° and smaller than 20°, wherein the inclined enlargement wall portion is situated between the cylindrical enlargement wall portion and the cylinder wall portion having the predetermined cylinder wall diameter.

Preferably is a channel portion of the conducting channel between the cylindrical enlargement wall portion and the coupling section designed as a tapered channel portion shaped as a groove or is designed as a hole (107) which is parallel to the center axis of the cylinder.

Preferably is the coupling section connected by the conducting channel to an orifice in the cylinder wall portion , said orifice being situated at a distance from the first cylinder end so that the orifice is situated between the piston and the second end of the cylinder when the piston is in the first piston position.

Preferably is the piston further movable within the cylinder to a third position and a fourth position, corresponding to a third predetermined distance and a fourth predetermined distance from the first end of the cylinder, respectively, where said third predetermined distance is larger than said second predetermined distance and said fourth predetermined distance is larger than said third predetermined distance; and - the cylinder comprises a second channel for allowing the conduction of gaseous and/or liquid media between the cylinder and the coupling section when the piston is in said third position and inhibiting the conduction of gaseous and/or liquid media between the cylinder and the coupling section when the piston is in said fourth position.

Preferably is the embodiment comprising within the coupling section sealing means for sealing the valve actuator onto valves of different types and/or sizes, and the sealing means comprise a first annular sealing portion and a second annular portion situated coaxially with the centre axis of the coupling section and being displaced in the direction of the centre axis of the coupling section , said first annular portion is closer to the opening of the coupling section than said second annular portion and the diameter of said first annular portion is larger than the diameter of said second annular portion

Preferably is the embodiment comprising within the coupling section a securing thread for securing the valve actuator onto the inflation valve.

Preferably is said securing thread a temporary securing thread .

Preferably is the cylinder wall formed as a cylinder sleeve, fastened and sealed in the housing and formed with said inclined enlargement wall portion , the cylinder sleeve having distant from the first cylinder end a wall portion an angle so that the piston ring is not sealing there.

Preferably is said cylinder sleeve fastened and sealed by a snap-lock in the wall of the housing .

Preferaby is the embodiment provided within the coupling section a sealing means for sealing the valve actuator onto a valve with a spring-force operated valve core pin.

According to an embodiment of the invention there is also provided a valve connector, coupled to a handpump, a foot pump, a car pump, a pressure vessel or a compressor, for inflating vehicle tires, comprising a valve actuator of any of claims 1 to 16.

According to an embodiment of the invention there is also provided a pressure vessel or a hand pump for inflating a vehicle tire, wherein: an integrated valve actuator.

According to an embodiment of the invention there is also provided a valve actuator in a stationary construction, such as a chemical plant.

19597 DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 401A shows line XX between two of the three engaging surfaces 1,2 of the basis 4 with a rigid surface 5, around which the combination 6 may move. The line Y-Y between two of the three engaging surfaces 2,3 of the basis 4 with a rigid surface 5, around which the combination 6 may move. The line Z-Z between two of the three contact points 1,2 of the basis 4 with a rigid surface 5, around which the combination 6 may move.

Fig. 401B shows the combination 6, comprising a chamber 7, a guiding 8 for the piston rod 9, a handle 10. The basis 4 with contact points 1, 2 and 3, which are rounded off towards the rigid surface. The chamber 7 is rigidly connected to the basis 4 by means of reinforcement 11.

Fig. 402A shows the handle 10 of the combination 6 when the combination 6 is in its rest position 12.

Fig. 402B shows the combination 6 in its rest position 12, when the transition 13 between the combination 6 and the reinforcement 14 of the basis 40 is in its rest position. The transition 13 may be made of a flexible material, and is positioned around the chamber 7.

Fig. 402C shows the activated position 14 of the handle 10, when the handle 10 has been moved from its rest position 12 at the front side of the said rest position.

Fig. 402D shows the activated position 15 of the handle 10, when the handle has been moved from its rest position 12 at the back side of the said rest position.

Fig. 402E shows the activated position 16 of the handle 10, when the handle has been moved from its rest position 12 at the left front side of the said rest position.

Fig. 402F shows the activated position 17 of the handle 10, when the handle has been moved from its rest position 12 at the left back side of the said rest position.

Fig. 402G shows the activated position 18 of the handle 10, when the handle has been moved from its rest position 12 at the right front side of the said rest position.

Fig. 402H shows the activated position 19 of the handle 10, when the handle has been moved from its rest position 12 at the right back side of the said rest position.

Fig. 403A shows a floor pump where the transtion between the chamber 7 and the basis 4 is an elastically deformable bushing 20.

Fig. 403B shows an enlargement of the transition between the chamber 7 and the basis 40. The chamber 7 has a protrusion 21 which complies with a groove 22 in the bushing 20, enabling a simple mounting of the chamber 7 in the base 40. The protrusion 41 on top of the reinfoircement 42 of the

basis 40.

Fig. 403C shows a floor pump where the transtion between the chamber 7 and the basis 4 is an elastically deformable bushing 23.

Fig. 403D shows an enlargement of the transition between the chamber 7 and the 40. The chamber 7 has a groove 25 which complies with a protrusion 24 in the bushing 23, enabling a simple mounting of the chamber 7 in the basis 40.

Fig. 404A shows the combination 6 in the form of a floor pump with a cab 25 which allows a transversal translation and/or deflection of the piston rod in relation to the rest of the combination 6 and the basis 43. The basis 43 may be directly, by means of the reinforcement 42, or indirectly e.g. by means of a flexible bushing be connected to the basis 41.

Fig. 404B shows an enlargment of the cap 25 of Fig. 404A, when the piston 44 is at the end of a stroke farthest from the basis 43. The piston rod 9 is moving in a guiding means 26, of which the convex contact inner surface 31 is in line contact at its centre line 27 with the piston rod 9. The guiding means 26 is being held within the cap 9 by surfaces 36 and 37, and by a flexible O-ring 28. The cross-sectional area of the space 29 between surfaces 36 and 37 of the cap 9 and the guiding means 26 is shown bigger than the cross-sectional area of the ring 28 itself, so as to make a substantial compression of the ring 28 possible (see e.g. Fig. 404C). The distance a between the outside of the piston rod 9 and the wall 38 of the spaces 33 and 34 of the cab 9. Said distance a may be approximately the same distance b between the piston rod and the wall 38 of the cab 9 in the top of the cab.

Fig. 404C shows Fig. 4B where the centre axis 32 of the piston rod 9' is deflected angle αin relation to the centre axis 30 of the rest of the combination. The space 29' is almost being filled up by the compressed ring 28', which is compressed by the translated guiding means 26'. The space 34'. The space 33'. The contact surface 35 between the guiding means 26' and the piston rod 9'. Distance a' is smaller than distance a of Fig. 404B.

Distance b' is smaller than ditance b of Fig. 404B, and more than the diufference between distances a and a'.

Fig. 404D shows an enlargement of the cap 25 of Fig. 404A, when the piston 44 may be at the end of a stroke closest to the basis 43. The centre line 30 of the combination. The spaces 33 and 34 between the inner walls 38 of the cab 25 and the piston rod 9.

Fig. 404E shows Fig. 404D when the piston rod 9' is translated to teh left, to a distancea'' between the outside of the piston rod 9' abd the inner wall 38 of the cab 25. The guiding means 26'' is

moved to the left, compressing the ring 28'' – shown is that the space 29'' has been filled up in this cross-section by the compressed ring 28''. The space33'' is approximately equal the space 34'' with a distance a'' which is equal distance b'' which is smaller than distance a.

Fig. 405A shows the left portion 51 of the handle 52 and the right portion 53 of the handle 52, in relation to the centre axis 54 of the combination 55. The angle α between the centre axis 56 of the left portion 51 of the handle 52 and the centre axis 57 of the right portion 53 of the handle 52 is less than 180°, when viewing from the position X of the user. The center point 61 of the left portion 51 and center point 62 of right portion 53.

Fig. 405B shows the a front view of the floor pump of Fig. 5A, comprising the handle 52 and the combination 55. Handle 52 with the left 51 portion and the right 53 portion. The centre axis 54 of the combination 55.

Fig. 406A shows the left portion 58 of the handle 59 and the right portion 60 of the handle 59, in relation to the centre axis 54 of the combination 55. The angle β between the centre axis 56 of the left portion 58 of the handle 59 and the centre axis 61 of the right portion 60 of the handle 59 is more than 180°, when viewing from the position X of the user.

Fig. 406B shows the a front view of the floor pump of Fig. 406A, comprising the handle 59 and the combination 55. The handle 59 with the left 58 portion (= turned around right portion 53) and the right portion 60 (= turned around left portion 51).

19597-2 SPECIFICALLY PREFERRED EMBODIMENTS

According to an embodiment of the invention, there is provided a piston-chamber combination comprising an elongate chamber which is bounded by an inner chamber wall, and which comprises a piston means in said chamber to be sealingly movable relative to said chamber wall at least between a first longitudinal position and a second longitudinal position of the chamber, said combination engaging a rigid surface, where the combination comprises a piston rod running through a cap capping the chamber, wherein the piston rod is guided by a guiding means movably connected to the cap.

Preferably is the guiding means a washer with an opening fitting around the piston rod, the washer being held within the cap between two surfaces and wherein a flexible O-ring is held within the cap in a space between the surfaces and the guiding means, wherein the cross sectional area of the space is bigger than the cross-sectional area of the O-ring.

Preferably comprises said guiding means a convex guiding surface guiding the piston rod.

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

Preferably is the connection of the piston rod to the piston (44) flexible.

Preferably is the piston-chamber combination is a pump, comprising a means for engaging the piston from a position outside the chamber, and wherein a fluid exit and a fluid entrance comprising a valve means are connected to the chamber.

Preferably is the piston-chamber combination a shock absorber comprising means for engaging the piston from a position outside the chamber, wherein the engaging means have an outer position where the piston is at the first longitudinal position of the chamber, and an inner position where the piston is at the second longitudinal position, wherein the chamber and piston form a sealed cavity comprising a fluid, which is compressed when the piston moves from the first to the second longitudinal position.

Preferably is the piston-chamber combination an actuator comprising means for engaging the piston from a position outside the chamber, and means for introducing fluid into the chamber in order to displace the piston between the first and second longitudinal position.

Preferably has the chamber cross-sections of different cross-sectional areas and different circumferential lengths at the first and second longitudinal positions, and continuously differing cross-sectional areas and circumferential lengths at intermediate longitudinal positions between the first and second longitudinal positions, the cross-sectional area and circumferential length at said second longitudinal position being smaller than the cross-sectional area and circumferential length at said first longitudinal position, wherein the piston means can change dimensions thereby providing for different cross-sectional areas and circumferential lengths of the piston means adapting the same to said different cross-sectional areas and different circumferential lengths of the chamber during the relative movements of the piston means between the first and second longitudinal positions through said intermediate longitudinal positions of the chamber.

Preferably has the chamber cross-sections of different cross-sectional areas and equal circumferential lengths at the first and second longitudinal positions, and at least substantially continuously differing cross-sectional areas and circumferential lengths at intermediate longitudinal positions between the first and second longitudinal positions, the cross-sectional area and circumferential length at said second longitudinal position being smaller than the cross-sectional area and circumferential length at said first longitudinal position, wherein the piston can change dimensions thereby providing for different cross-sectional areas and circumferential lengths of the piston adapting the same to said different cross-sectional areas and equal circumferential lengths of the chamber during the relative movements of the piston means between the first and second longitudinal positions through said intermediate longitudinal positions of the chamber.

CLAIMS

1. A piston-chamber combination comprising a chamber (162,186,231) which is bounded by an inner chamber wall (156,185,238), and comprising an actuator piston inside said chamber to be engagingly 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 actuator piston comprising a container (208,208',217,217',228,228',258,258', 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,

the actuator piston is produced to have a production-size of the container (208,208',217,217',228,228',258,258',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) 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 actuator piston from said second longitudinal position to said first longitudinal position,

the container (208,208',217,217',228,228',258,258',450, 450') being elastically deformable to provide for different cross-sectional areas and circumferential lengths of the actuator piston,

characterized by the fact that

- the combination comprises means for introducing fluid from a position outside said container into said container, thereby enabling pressurization of said container, and thereby expanding said container,
- a smooth surface of the wall of the actuator piston, at least on and contineously until nearby its contact area with the wall of the chamber,

thereby displacing said container from a second and a first longitudinal position of the chamber,

- the combination comprises means for reducing the volume of said container from a position outside said container by exiting fluid from said container, thereby depressurizing said container when moving from a first to a second longitudinal position.

(CT)

2. A piston-chamber combination comprising a chamber (162,186,231) which is bounded by an inner chamber wall (156,185,238), and comprising an actuator piston inside said chamber to be engagingly 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 actuator piston comprising a container (208,208',217,217',228,228',258,258', 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,

the actuator piston is produced to have a production-size of the container (208,208',217,217',228,228',258,258',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) 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 actuator piston from said second longitudinal position to said first longitudinal position,

the container (208,208',217,217',228,228',258,258',450, 450') being elastically deformable to provide for different cross-sectional areas and circumferential lengths of the actuator piston, and communicating with an enclosed space,

characterized by the fact that

- the combination comprises means for changing the volume of the enclosed space communicating with said actuator piston of said container from a position outside said container, thereby expanding said container,
- a smooth surface of the wall of the actuator piston, at least on and contineously until nearby its contact area with the wall of the chamber,

and thereby displacing said container from a second and a first longitudinal position of the chamber,

- the combination comprises means for changing the volume of the enclosed space communicating with said actuator piston from a position outside said container, thereby reducing the size of said container when moving from a first to a second longitudinal position.

(ESVT)

3. A piston-chamber combination according to claim 1 or 2, wherein said actuator piston inside or outside said chamber to be sealingly movable relative to said chamber wall.

4. A piston-chamber combination according to claim 1, 2 or 3, wherein a part of said chamber, positioned adjacent to said actuator piston are communicating with each other through a channel or through the atmosphere.

5. A piston-chamber combination according to any of claims 1- 4, wherein the chamber is elongate.

6. A piston-chamber combination according to any of claims 1-4, wherein the chamber is circular.

7. A piston-chamber combination according to claim 6, wherein the chamber is formed around a circleround centre axis.

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8. A piston-chamber combination according to claims 1-7, wherein the actuator piston is not engaging with the wall of the chamber.

9. A piston-chamber combination according to claim 8, wherein the piston is moving from a first to a second longitudinal position.

10. A piston chamber combination according to claims 1-7, wherein a part of the lengh of the wall of the chamber is parallel to the centre axis of said chamber.

11. A piston chamber combination according to claim 10, wherein said wall of the chamber is positioned at an end of a stroke of the actuator piston.

12. A piston-chamber combination according to claims 1-7, wherein the container (208,208',217, 217',228,228',258,258',450,450') is comprising a deformable material (205,206).

13. A piston-chamber combination according to claim 12, wherein the deformable material (205,206) is a fluid or a mixture of fluids, such as water, steam and/or gas, or a foam.

14. A piston-chamber combination according to claims 12 or 13, wherein in a cross-section through the longitudinal direction, the container, when being positioned at the first longitudinal position of the

chamber (186,231), 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.

15. A piston-chamber combination according to claim 14, 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.

16. A piston-chamber combination according to claim 14, wherein the deformable material (206) is at least substantially incompressible.

17. A piston-chamber combination according to claims 1-7, wherein the container is inflatable.

18. A piston-chamber combination according to claims 1-7, wherein the container (208,208', 217,217',228,228',258,258',450, 450') additionally comprises an enclosed space (210,243) communicating with the deformable container.

19. A piston-chamber combination according to claim 18, wherein said introduction of the fluid from a position outside said container into said container is done through a first enclosed space, which is communicating with said enclosed space.

20. A piston-chamber combination according to claims 1, 3-7, further comprising means for removing fluid from said container to a position outside the piston, thereby enabling contraction of said container.

21. A piston-chamber combination according to claim 20, wherein the removal of fluid is done through a second enclosed space, which is communicating with said enclosed space.

22. A piston-chamber combination according to claim 2-7 or 18, wherein said means are

communicating with said enclosed space of said piston, by changing the volume of said enclosed space, increasing said volume and thereby depressurizing said actuator piston, thereby enabling contraction of said container.

23. A piston-chamber combination according to claim 22, wherein the piston is movable relative to said chamber wall at least from a first to a second longitudinal position of said chamber.

24. A piston-chamber combination according to claims 1-7, wherein the wall of the container (208,208',217,217',228,228',258,258',450, 450') comprises a reinforment layer,

25. A piston-chamber combination according to any of the previous claims, wherein the cross-section of the contact surface of the container and the wall of the chamber is cutting the central axis of said container in the longitudinal direction approximately just aside the middle point of said section of the elastically deformable wall of the container, at the side of a second longitudinal position.

26. A piston-chamber combination according to claim 25, wherein the cross-section of the contact surface of the container and the wall of the chamber is cutting the central axis of said container in the longitudinal direction approximately outside the middle point of said section of the elastically deformable wall of the container, at the side of a second longitudinal position.

27. A piston-chamber combination according to claims 12, 17, 20 or 22, wherein the actutor piston is comprising a piston rod, which is comprising said enclosed space.

28. A piston-chamber combination according to claim 26, wherein the piston rod is comprising engaging means outside said chamber.

29. A piston-chamber combination according to claim 28, further comprising a crank adapted to translate the motion of the piston between second and first longitudinal positions of the chamber into a rotation of the crank.

30. A piston-chamber combination according to claim 28, wherein the crank is translating its rotation into a movement of the piston from first to second longitudinal positions of the piston.

31. A piston-chamber combination according to claims 19, 21 or 28, wherein the crank is comprising said first and said second enclosed space.

32. A combination according to claims 1-7, 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.

33. A combination according to claims 1-7, 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.

34. A combination according to claims 1-7, wherein the cross-sectional area of said chamber at the second longitudinal position thereof is approximately 5% of the cross-sectional area of said chamber at the first longitudinal position thereof.

35. A combination according to claims 1-6, wherein said chamber comprising convex shaped walls of longitudinal cross-sectional sections near a first longitudinal position, said sections are updivided from each other by a common border, a distance between two following common borders defines a heigth of the walls of said longitudinal cross-sectional sections, said heigths are decreasing by an increasing overpressure rate of said actuator piston in relation to the pressure in said chamber, the transversal length of the cross-sectional common borders is determined by the maximum work force of said actuator piston, which is chosen constant for said common borders.

36. A combination according to claims 1-6, wherein said chamber comprising convex shaped walls of longitudinal cross-sectional sections near a first longitudinal position, said sections are updivided

from each other by a common border, a distance between two following common borders defines a heigth of the walls of said longitudinal cross-sectional sections, said heigths are decreasing in a direction from a first longitudinal postion to a second longitudinal position, the transversal length of the cross-sectional common borders is determined by the maximum work force of said actuator piston, which is chosen constant for said common borders.

37. A combination according to claims 35 or 36, wherein said chamber is further comprising a wall which is parallel to the centre axis of said chamber.

38. A combination according to claims 35-37, wherein said chamber is further comprising a concave shaped wall.

39. A combination according to claim 38, wherein said chamber is further comprising a transition between said convex shaped wall and said parallel wall, wherein said transition may be comprising a concave shaped wall.

40. A shock absorber comprising:

- a combination according to any of claims 1 to 39,
- means for engaging the piston from a position outside the chamber, wherein the engaging means have an outer position where the piston is at the first longitudinal position of the chamber, and an inner position where the piston is at the second longitudinal position.

41. A shock absorber according to claim 40, further comprising an enclosed space, communicating with the container.

42. A shock absorber according to claim 41, wherein the enclosed space has a variable volume.

43. A shock absorber according to claim 41, wherein the enclosed space has a constant volume.

44. A shock absorber according to claim 41, wherein the enclosed space is adjustible.

45. A shock absorber according to claims 41 - 44, wherein the container and the enclosed space form an at least substantially sealed cavity comprising a fluid, the fluid being compressed when the piston moves from the first to the second longitudinal positions of the chamber.

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

- a combination according to claims 1-39,
- means for engaging a second piston in a second chamber from a position outside the chamber,
- a fluid entrance connected to the second chamber and comprising a valve means, and
- a fluid exit connected to the second chamber.

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

- a combination according to claims 1-39,
- means for engaging a piston in the chamber 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.

48. A pump according to claim 46 or 47, 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.

49. A pump according to claim 46 or 47, wherein the engaging means have an outer position where the piston is at the second longitudinal position of the chamber, and an inner position where the piston is at the first longitudinal position of the chamber.

50. The use of a piston-chamber combination according to claim 1 or 2 in a motor, specifically a car motor.

51. A motor, **characterized by the fact that** it comprises attached hereto a piston-chamber combination according to claim 1.

52. A motor, **characterized by the fact that** it comprises attached hereto a piston-chamber combination according to claim 2.

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53. A motor according to claims 1, 3 - 39, 46 - 51 wherein the crankshaft is comprising a second enclosed space, communicating at one end with an external pressure source, and at the other end with the enclosed space of said actuator piston.

54. A motor according to claim 53 wherein the crankshaft is comprising a third enclosed space, communicating the enclosed space of the actuator piston, and and at the other end communicating with a repressuration pump, which is communicating with an electric motor, said motor gets it energy from a battery which is charged by an energy source, such as solar power, ór a fuel cell, such as a H_2 -fuel cell, ór an alternator which is communicating with said main axle.

55. A motor according to claim 54, wherein said alternator is communicating with the axle of an auxiliarly power source, such as a combustion motor which is burning H_2 derived from electrolysis of conductive water, and O_2 of the air, the water coming from a tank which can be filled up externally.

56. A motor according to claim 54, wherein the last mentioned pump is communicating with the axle of an auxiliarly power source, such as a combustion motor which is burning H_2 derived from electrolysis of conductive water, and O_2 of the air, the water coming from a tank which can be filled up externally.

57. A motor according to claim 53, wherein the communication between the pressure source and the enclosed space of said actuator piston takes place during a part of each crankshaft turn.

58. A motor according to claim 54, wherein the communication between the enclosed space of said piston and the repressuration cascade takes place during a part of each crankshaft turn.

59. A motor according to claims 57 and 58, wherein said communications are separated in time from each other.

60. A motor according to claim 59, wherein said communications are performed by a T-valve, being controlled by a computer which is electrically communicating with the main axle of said motor.

61. A motor according to claim 60, wherein the pressure and/or volume of the supply channel to said T-valve is being controlled by a reduction valve, said reduction valve being controlled by a speeder.

62. A motor according to claim 61, wherein said reduction valve is communicating with a pressure storage vessel, which is communicating with a repressuration cascade of pumps, of which at least one pump is communicating with the main axel **[of said crankshaft, through another crankshaft,]** while at least one pump is communicating with an electric motor, said motor gets it energy from a battery which is charged by an energy source, such as solar power, ór a fuel cell, such as a H_2 -fuel cell, ór an alternator which is communicating with said main axle.

63. A motor according to claim 62, wherein said alternator is communicating with the axle of an auxiliarly power source, such as a combustion motor which is burning H_2 from electrolysis of conductive water, and O_2 of the air, the water coming from a tank which can be filled up externally.

64. A motor according to claim 63, wherein the last mentioned pump is communicating with the axle of an auxiliarly power source, such as a combustion motor which is burning H_2 from electrolysis of conductive water, and O_2 of the air, the water coming from a tank which can be filled up externally.

65. A motor according to claims 62 - 64, wherein said pumps are piston pumps or rotational pumps.

66. A motor according to claims 2 – 39, 46 – 51, wherein the enclosed space, the second enclosed space and the third enclosed space form a closed cavity.

67. A motor according to claim 66, wherein the pressure in said cavity is being controlled by a piston-chamber combination, which communicating with a bi-directional piston-chamber combination which is controlled by a reduction valve, which is controlled by a speeder.

68. A motor according to claims 67, wherein said bidirectional actuator piston-chamber combination is which is communicating with a pressure vessel, said vessel is communicating with a repressuration cascade of pumps, of which at least one is communicating with the main axel [of said crankshaft, through another crankshaft], while at least one pump is communicating with an electric motor, said motor gets it energy from a battery which is charged by an energy source, such as solar power, and/ór by electricity from a fuel cell, such as a H_2 -fuel cell, and/ór by an alternator which is communicating with said main axle.

69. A motor according to claim 68, wherein the last mentioned pump is communicating directly with the axle of the auxiliarly power source, such as a combustion motor which is burning H_2, derived from electrolysis of conductive water, and O_2 from the air, the water coming from a tank which can be filled up, and when necessary from a conductive means storage tank

70. A motor according to claim 67-69, wherein the pressure in said cavity is being additionally controlled by a piston-chamber combination, which is communicating with said pressure vessel.

71. A motor according to claim 65, wherein the pressure in the closed cavity of a piston is controlled by a piston-chamber combination, which is communicating with the main axle of said motor, electronically by a computer.

72. A motor according to claim 65, wherein the pressure in the closed cavity of a piston is controlled by a piston-chamber combination, which is communicating with the main axle of said motor through a cam wheel, which is communicating with a cam shaft.

73. A motor according to claims 61 or 70 , wherein said pumps are piston pumps or rotational pumps.

74. A motor according to claims 1 - 4, 6 - 73, wherein a piston is rotating around the centre axis of the chamber.

75. A motor according to claims 1 - 4, 6 - 73, wherein the chamber is rotating.

76. A motor according to claims 74 and 75, wherein the piston and the chamber are rotating.

77. A motor according to claim 74 -76, wherein the actuator piston-chamber combination is comprising at least two sub-chamber, which are comprising an actuator piston, said sub-chambers are positoned in continuation of each other, whereby a first circular position of sub-chamber is adjacent to a second circular postion of another adjacent sub-chamber.

78. A motor according to claim 77, wherein the sub-chambers are identical.

79. A motor according to claim 78, wherein each sub-chamber is comprising an actuator piston, said pistons are identical, where each piston is positioned at a different circular position per sub-chamber, in relation to each other.

80. A motor according to claims 74-79, wherein the shape of the piston is not changing during the stroke.

81. A motor according to claims 62 or 68, wherein the pressure vessel is being pressurized by an external pressure source, through a pluggable connection.

82. A motor according to claims 54, 62 or 68, wherein the battery is being charged by an external electrical power source through a pluggabe connection.

83. A piston-chamber combination comprising an elongate chamber (70) which is bounded by an inner chamber wall (71,73,75) and comprising a piston means (76,76',163) 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 at the first and second longitudinal positions of said chamber and at least substantially continuously differing cross-sectional areas 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 means being designed to adapt itself and said sealing means to said different cross-sectional areas of said chamber during the relative movements of said piston means from the first longitudinal position through said intermediate longitudinal positions to the second longitudinal position of said chamber,
characterized by the fact that
the piston means (76,76',163,189,189') comprises:
- a plurality of at least substantially stiff support members (81,82,184) rotatably fastened to a common member (6,23,45,180),
- said support members being provided in elastically deformable means (79), supported by
- said support members, for sealing against the inner wall (71,73,75,155,156,157,158) of the

chamber (70) said support members being rotatable between 10° and 40° relative to the longitudinal axis (19) of the chamber (70),

- the support members (81,82,184) are bendable.

84. A piston-chamber combination according to claim 83, wherein said piston inside or outside said chamber to be sealingly movable relative to said chamber wall.

85. A piston-chamber combination according to claim 83, wherein the support members having a pre-determined bending force.

86. A piston-chamber combination according to claim 83, wherein the support members (81,82,
184) are rotatable so as to be at least approximately parallel to the longitudinal axis (19).

87. A piston-chamber combination according to claim 83, wherein the elastically deformable means (79) is made of Polyurethane-foam.

88. A piston-combination according to claim 87, wherein the PU-foam is comprising a Polyurethane Memory foam and a Polyurethane foam.

89. A piston-chamber combination according to claim 88, wherein the Polyurethane foam is comprising a major part is Polyurethane Memory foam, and a minor part Polyurethane foam.

90. A piston-chamber combination according to claims 87 - 89, wherein the Polyurethane foam is provided with a flexible impervious layer.

91. A piston-chamber combination according to claim 90, wherein the impervious layer has an unstressed production size of which the circumference is approximately the circumference of the wall of the chamber at a second longitudinal or circular position.

92. A piston-chamber combination according to claims 83 or 86, wherein the common member is attached to a crankshaft.

93. A piston-chamber combination according to claims 83 or 88, wherein the common member is attached to a piston-chamber combination, which is an external bidirectional actuator.

94 A piston-chamber combination comprising an elongate chamber (70) which is bounded by an inner chamber wall (71,73,75) and comprising a piston means (76,76',163) 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 at the first and second longitudinal positions of said chamber and at least substantially continuously differing cross-sectional areas 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 means being designed to adapt itself and said sealing means to said different cross-sectional areas of said chamber during the relative movements of said piston means from the first longitudinal position through said intermediate longitudinal positions to the second longitudinal position of said chamber,

characterized by the fact that

the piston means (49, 49') comprises:

- a plurality of at least substantially stiff support members (43) rotatably fastened by an axle (44) to a piston rod (45),
- said support members being supported by a sealing means (41), said sealing means being supported by spring 42, for sealing against the inner wall (71,73,75,155,156,157,158) of the chamber (70) said support members being rotatable between $_1$° and $_2$° relative to the longitudinal axis (19) of the chamber (70),

- a flexible impervious membrane (sheet) (40) is mounted in said sealing means (O-ring) (41), and is positioned perpendicular to the centre axis (19) of said chamber (1),
- said membrane (flexible impervious sheet) is comprising a reinforment layer,
- said support members (means), said sealing means (O-ring), said flexible impervious membrane (sheet) and said (lying) spring are vulcanized on each other.

95. A piston-chamber combination according to claim 94, wherein the support members (81-,82,184) (means) are rotatable so as to be at least approximately parallel to the longitudinal axis (19).

96. A piston-chamber combination according to claim 94, wherein said flexible reinforment layer (sheet) is comprising a spiral shaped reinforcement.

97. A piston-chamber combination according to claim 94, wherein said reinforment layer (sheet) is comprising a concentrically shaped reinforcement, positioned around the centre axis of said chamber.

98. A piston-chamber combination according to claim 94, wherein said flexible impervious membrane (sheet) having a more than 90° angle with the centre axis of said centre axis of said chamber.

99. A piston-chamber combination according to claim 98, wherein said flexible impervious membrane (sheet) is mounted on said piston rod.

100. A piston-chamber combination according to claim 98, wherein said flexible impervious membrane (sheet) is vulcanized on said piston rod.

101. A piston-chamber combination according to claims 83 or 94, wherein the common member is comprised in a piston-chamber combination.

102. A piston-chamber combination according to claim 94, wherein the flexible impervious sheet is being supported by a foam.

103. A piston-chamber combination according to claim 102, wherein said foam is being reinforced with stiff member, which are rotatably fastened to the piston rod.

104. A piston-chamber combination comprising a chamber (162,186,231) which is bounded by an inner chamber wall (156,185,238), and comprising a piston means inside said chamber to be engagingly 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 means comprising a container (208,208',217,217',228,228',258,258', 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,

the piston means is produced to have a production-size of the container (208,208',217,217',228,228',258,258',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) 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 actuator piston from said second longitudinal position to said first longitudinal position,

the container (208,208',217,217',228,228',258,258',450, 450') being elastically deformable to provide for different cross-sectional areas and circumferential lengths of the actuator piston,

characterized by the fact that

the piston means (92,92',146,146',168,168', 208,208',222,222',222'') comprises an elastically deformable container comprising a deformable material (103,103',124,124',136,137,173,173', 174,174', 205,205',206,206'215,215',219,219').

105. A piston-chamber combination according to claim 104, wherein said container in said chamber to be sealingly movable relative to said chamber wall.

106. A piston-chamber combination according to claims 104 or 105, wherein the deformable material (103,103',124, 124',136,137,173,173',174,174',205,205',206,206'215, 215',219,219') is a fluid or a mixture of fluids, such as water, steam and/or gas, or a foam.

107. A piston-chamber combination according to claim 106, wherein the deformable material (124,124', 136,174,174',205,205',219,219') is at least substantially incompressible.

108. A piston-chamber combination according to claim 106 or107, wherein the container is inflatable.

109. A piston-chamber combination according to claim 104 or 105, wherein the combination additionally is comprising a piston rod, the wall of the container is comprising a flexible material, which is vulcanized on said piston rod.

110. A piston-chamber combination according to claim 109, wherein the wall of the container is

comprising at least a layer with a reinforcement, positioned nearest to the piston rod and vulcanized on that, and a layer without a reinforcement which is vulcanized upon said layer with a reinforcement.

111. A piston-chamber combination according to claim 110, wherein the reinforcement strengs are laying parallel to the centre axis of said piston, and are bendable.

112. A piston-chamber combination according to claim 108 or 109, wherein the wall of the container is comprising two reinforcement layers, where the reinforcements of said laywers are crossing each other with a very small angle.

113. A piston-chamber combination according any of the claims wherein the length of a container type piston is enlarged, so that the shape of an ellipsoide shaped piston at a second longitudinal position is remaining its shape, but not its size when being on a first longitudinal position.

114. A motor according to claim 51, wherein a pressure regulator which is communicating with a pressure vessel and a third enclosed space, is communicating with a speeder.

115. A motor according to claim 51, further comprising two cylinders, wherein the third enclosed space of each cylinder are communicating with each other through the connection of the two sub-crankshafts which are comprised in the crankshaft of said motor, and the second enclosed spaces of each cylinder are communicating with each other outside said crankshaft. (Fig. 19)

116. A motor according to claim 115, wherein the crankshaft configuration of two piston-chamber combinations the connector rods are positioned 180° from each other. (Fig. 19)

117. A motor according to claim 115 and 116, further comprising more than two cylinders, wherein a second enclosed space is connected through the connection of said sub-crankshafts of the

existing two cylinders, with the second enclosed space of the sub-crankshaft of the cylinder to be added. (Fig. 19)

118. A motor according to claim 52, further comprising two cylinders, wherein the 2nd longitudinal position of one cylinder is at the same geometrical level of the 1st longitudinal position of a second cylinder, both actuator pistons are communicating with each other through a crankshaft, said crankshaft is comprising two connected sub-crankshafts, one for each actuator piston, where the connection rods to these actuator pistons are positioned 180° from each other. (Fig. 17)

119. A motor according to claim 118, further comprsing ESVT pumps for each of the cylinders, wherein said pumps are combined for said two cylinders into one pump, through communication of the enclosed space of one of the actuator pistons with the enclosed space of the other of the actuator pistons, said enclosed spaces being comprised in said crankshaft, said enclosed spaces are communicating with each other at the connection point of said sub-crankshafts. (Fig. 17)

120.. A motor accordung to claim 119, further comprising valves, which are opening and closing the connection between said ESVT-pump and said second or third enclosed spaces, while each connection has a check valve or check valve function, said valves are controlled by either the pressure of said ESVT-pump and/or by tappets, said tappets are communicating with a camshaft, which is communicating with the main axle of an auxilliarly motor. (Fig. 17)

121. A motor according to claims 118 - 120, further comprising more than two cylinders, where each added cylinder is communicating through the enclosed spaces of the connected sub-crankshafts of the existing sub-crankshafts. (Fig. 17)

122. A motor according to claim 52, further comprising two cylinders, wherein the 1st longitudinal position of one cylinder is at the same geometrical level of the 1st longitudinal position of a second cylinder, both actuator pistons are communicating with each other through a crankshaft,

said crankshaft is comprising two connected sub-crankshafts, one for each actuator piston, where the connection rods to these actuator pistons are positioned 0° from each other. (Fig. 18)

123. A motor according to claim 122, further comprsing ESVT pumps for each of the cylinders, wherein said pumps are combined for said two cylinders into one pump, through communication of the enclosed space of one of the actuator pistons with the enclosed space of the other of the actuator pistons, said enclosed spaces being comprised in said crankshaft, said enclosed spaces are communicating with each other at the connection point of said sub-crankshafts. (Fig. 18)

124. A motor accordung to claim 123, further comprising valves, which are opening and closing the connection between said ESVT-pump and said second or third enclosed spaces, while each connection has a check valve or check valve function, said valves are controlled by either the pressure of said ESVT-pump and/or by tappets, said tappets are communicating with a camshaft, which is communicating with the main axle of an auxilliarly motor. (Fig. 18)

125. A motor according to claims 122 - 124, further comprising more than two cylinders, where the enclosed space(s) of each added (couple) cylinder(s) is(are) separated through a filler in the connection with said existing sub-crankshafts, and where the power strokes of the added cylinders are simultaneously the return strokes of the existing cylinders. (Fig. 18)

126. A motor according to claim 52, further comprising 2 cylinders wherein the connection rods are in a position of 180° from each other, while the chambers have an identical geometrical position of their 1st and 2nd longitudinal positions. (Fig. 18)

127. A motor according to claims 115 - 126, wherein the piston-chamber combinations for each of the enclosed spaces in a sub-crankshaft, which are changing the speed/pressure in a cylinder are communicating with each other through the electric pressure regulator of the 2-way actuators, which is moving the piston rod of each of said piston-chamber combinations, and is communicating with the external speeder.

128. A motor according to claims 115-127, wherein the piston rods of the pumps, pressurizing the fluid in said pistons, are being powered by a 2 way actuator piston powered by a battery, which is powered by an auxilliarly power source.

129. A motor according to claims 115-128, wherein the piston rods of the pumps, pressurizing the fluid in said pistons, are being powered by a 2 way actuator piston powered by a battery, which is powered by an auxilliarly power source.

130. A motor according to claims 115-129, wherein the piston rods of the pumps, pressurizing the fluid in said pistons, are being powered by a 2 way actuator piston powered by a crankshaft, which is powered by an auxilliarly power source.

131. A motor according to claims 115-130, wherein the piston rods of the pumps, pressurizing the fluid in said pistons, are being powered by a 2 way actuator piston powered by a cramshaft, which is powered by an auxilliarly power source.

132. A motor according to claim 52, which is comprising a circular chamber and a actuator piston, wherein the piston rod is sealingly movable in a cylinder, and the enclosed space inside said piston rod is communicating with pressure controller, which is communicating with a remotely positioned speeder, while the size of the enclosed space is regulated by a pump with a conical chamber, of which end is running over a cam profile, said cam profile is driven by an auxilliarly electric motor which is turning said cam, and turning independantly of said motor around the same main motor axle.

133. A motor according to claim 132, wherein said actuator piston having a wall a reinforcement, said wall being mounted on an end fixed on said piston rod, and on a movable end, which can sealingly slide on said piston rod.

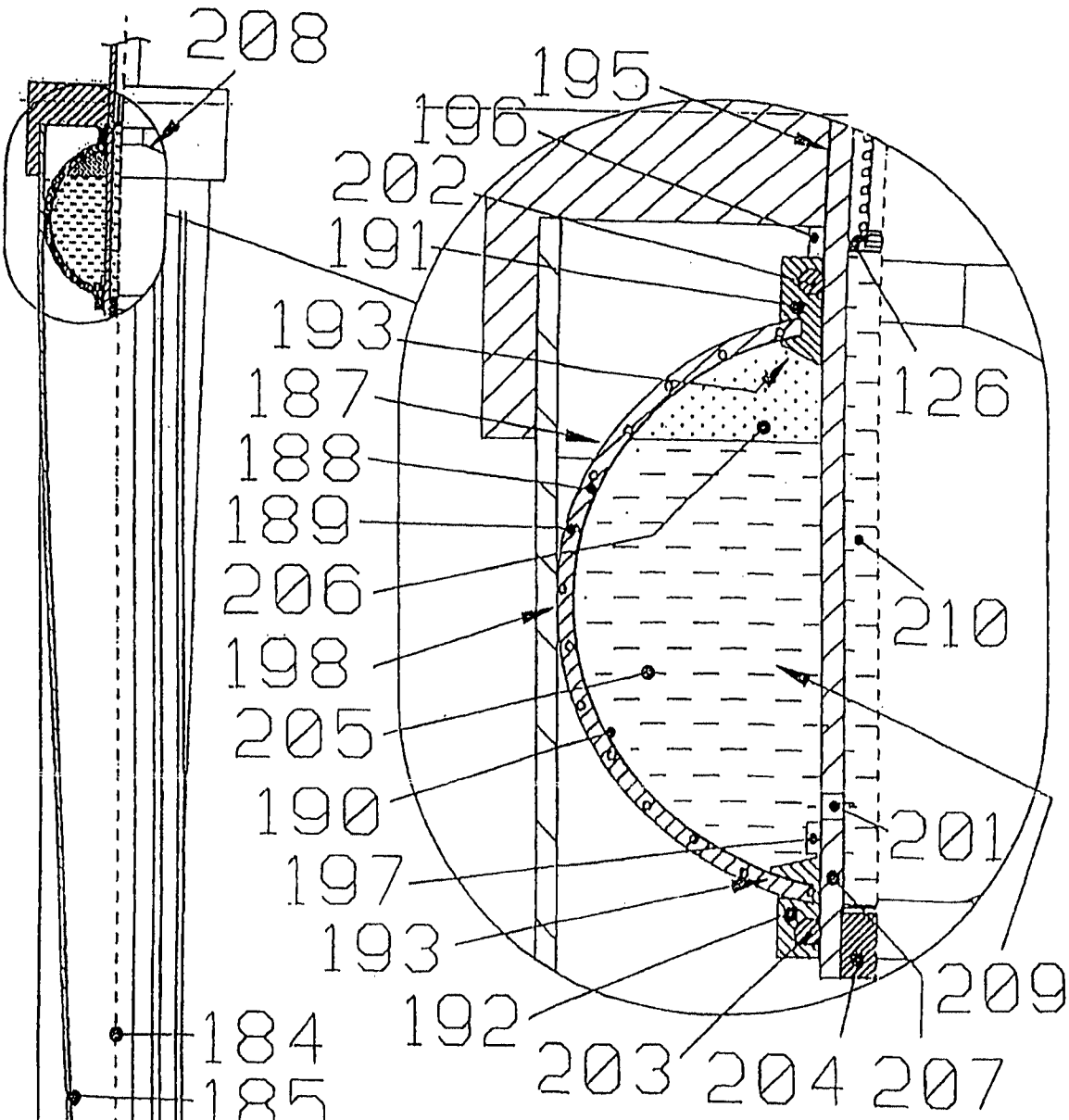


Fig.1B

FIG.1C

Fig.1A

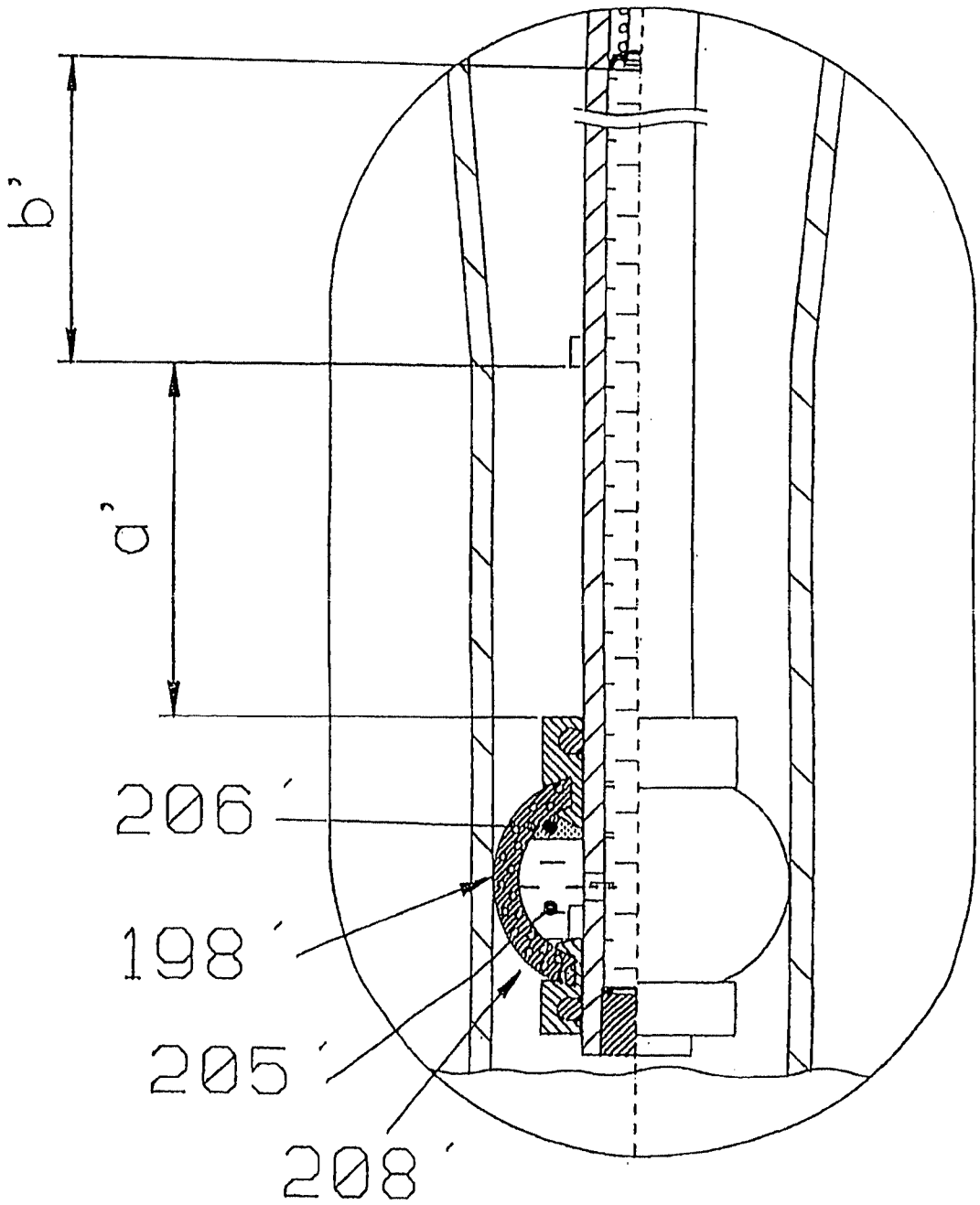


Fig.1C

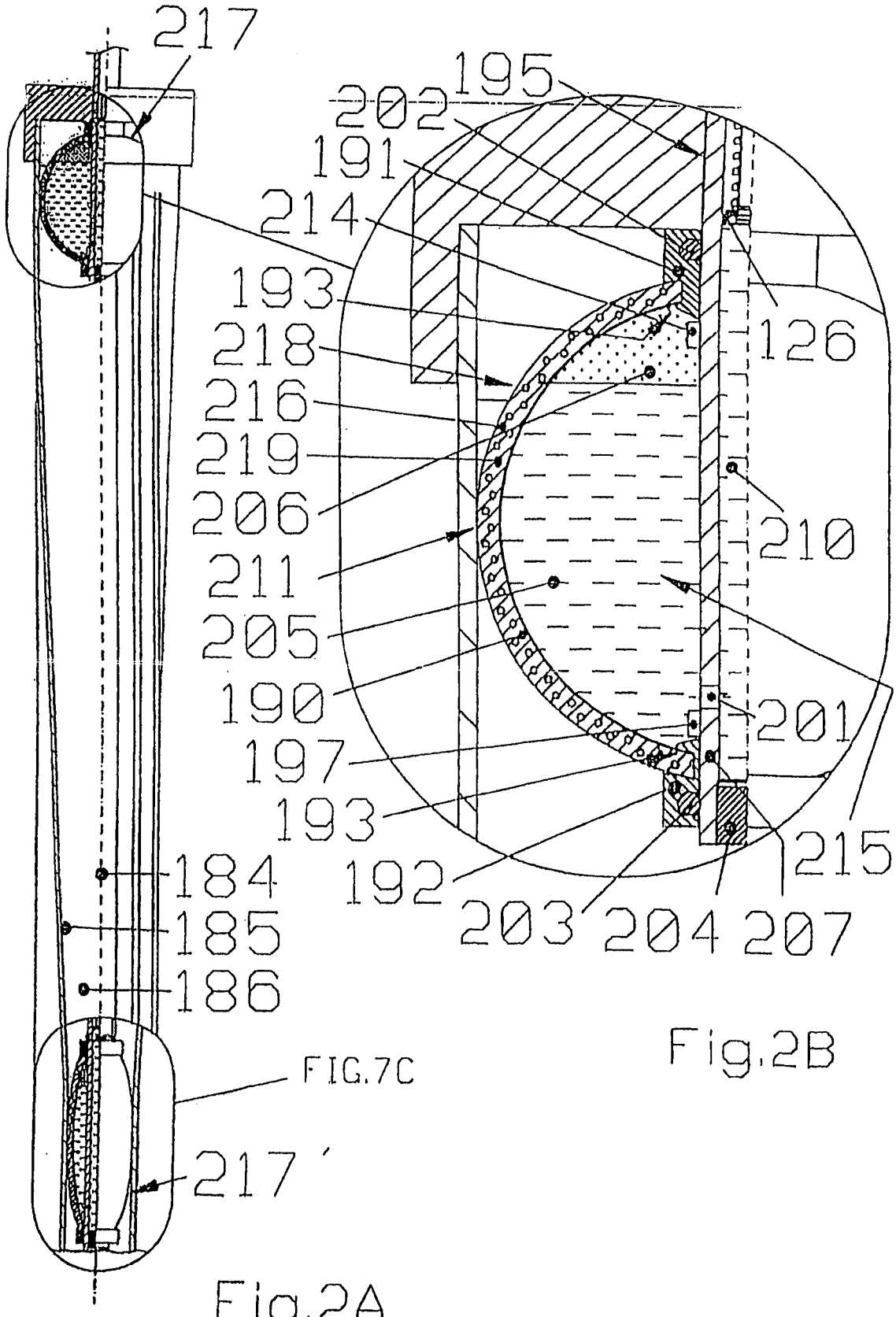

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FIG.7C
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Fig.2B

Fig.2A

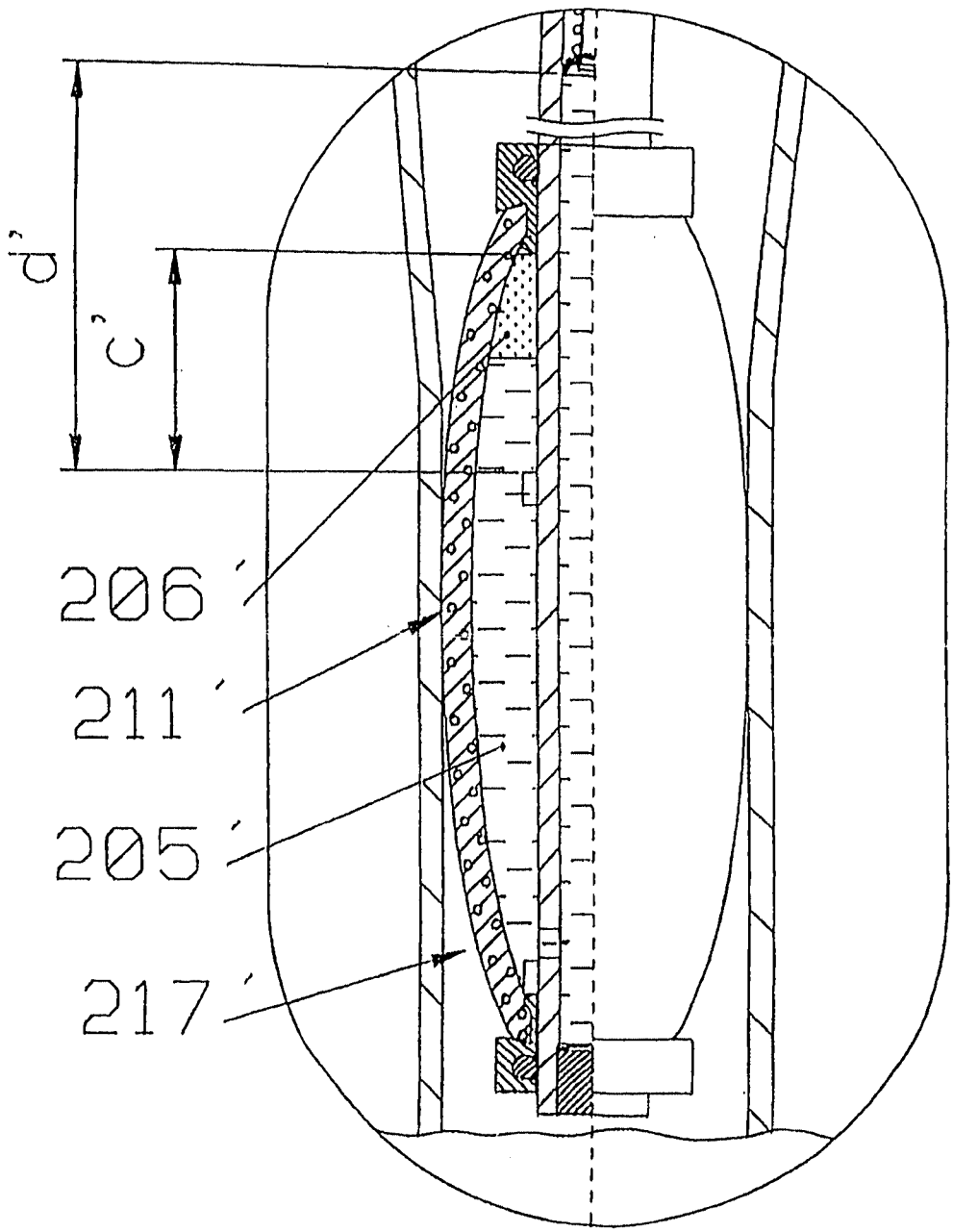


Fig.2C

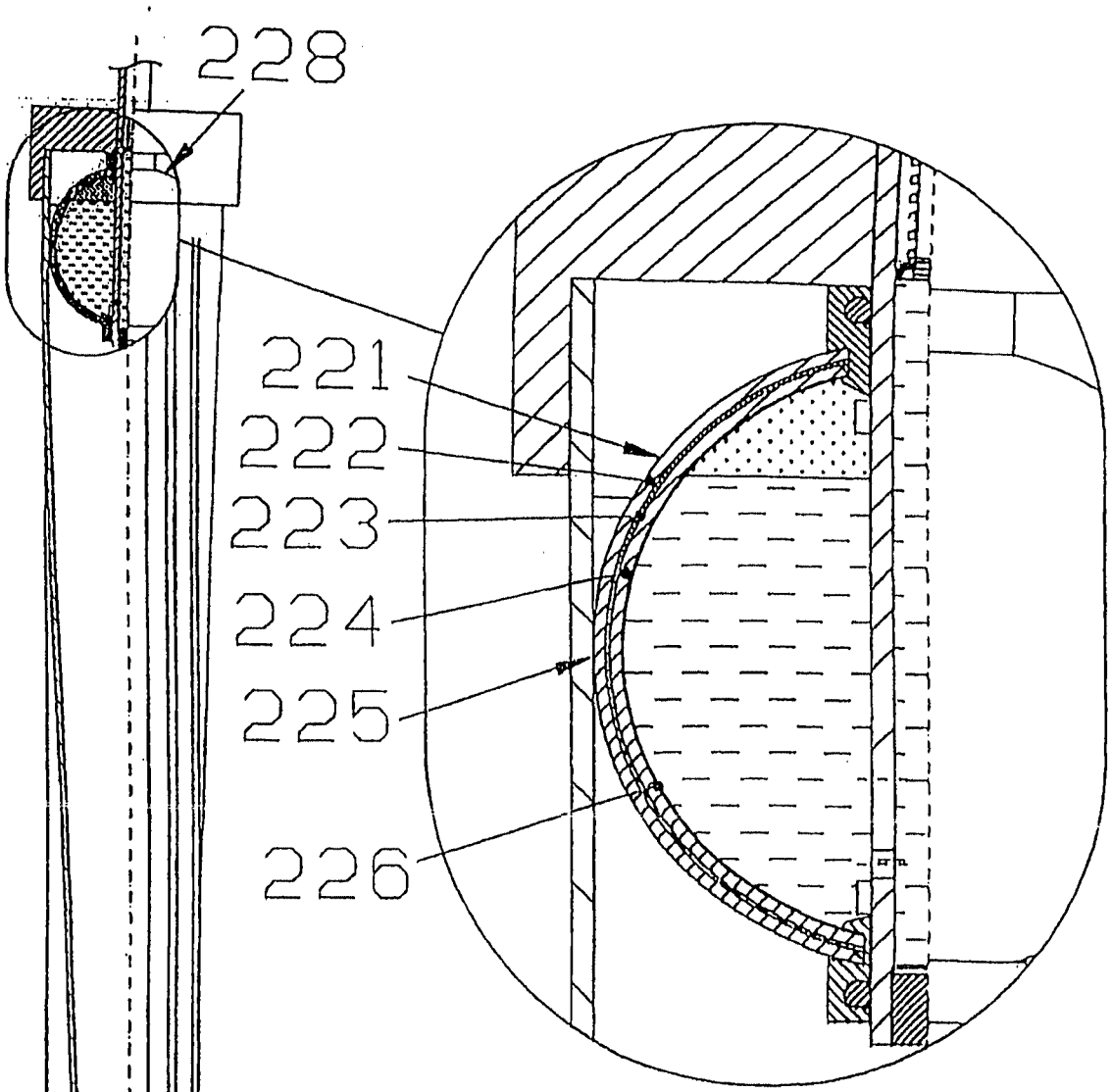


Fig.3B

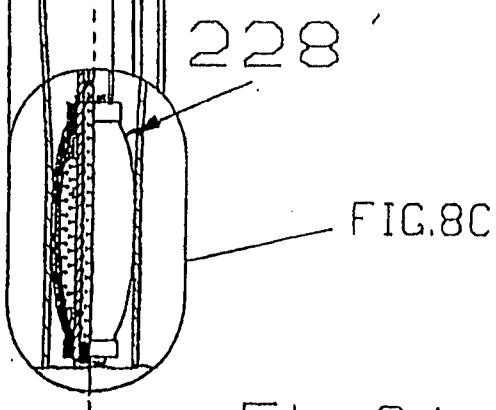


Fig.3A

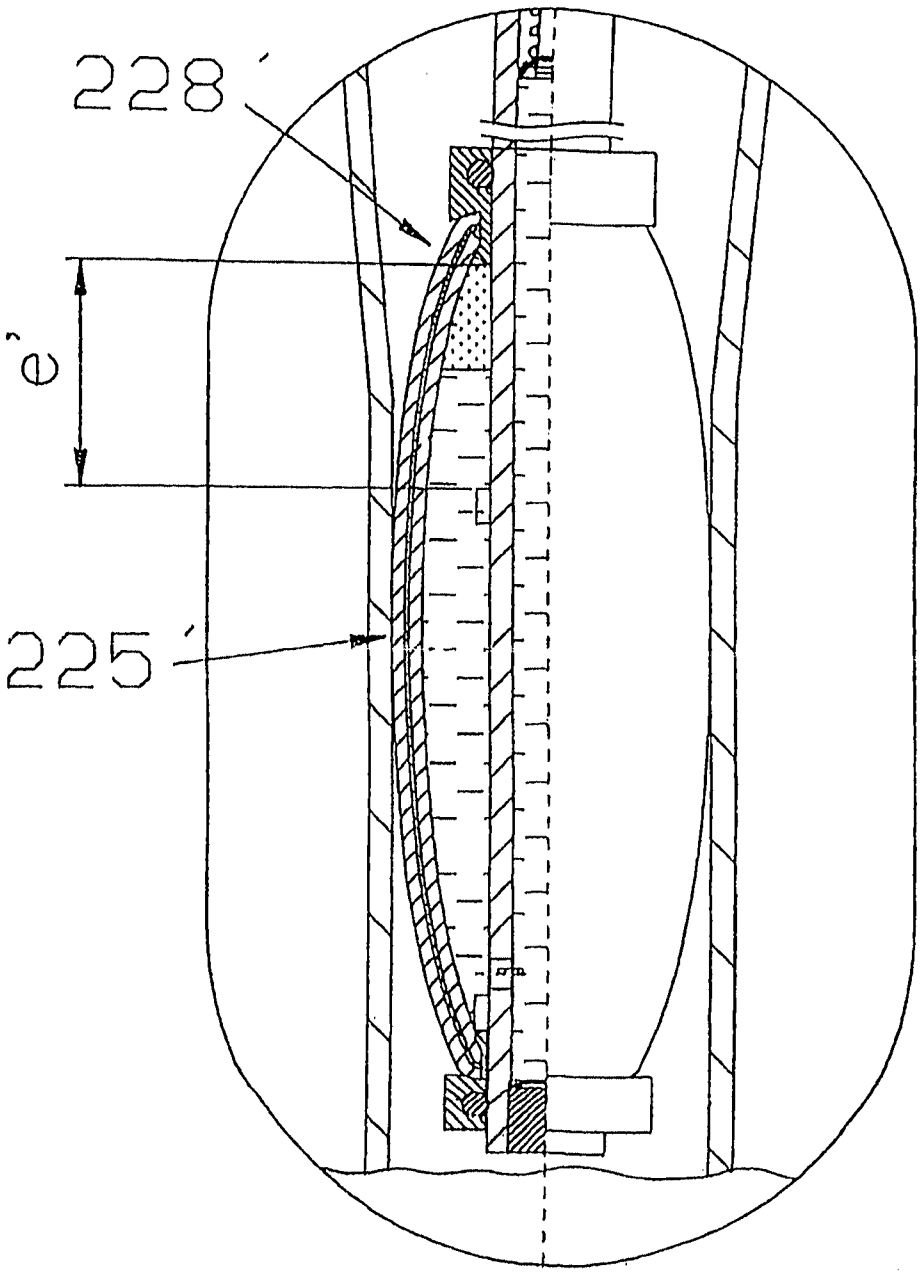


Fig.3C

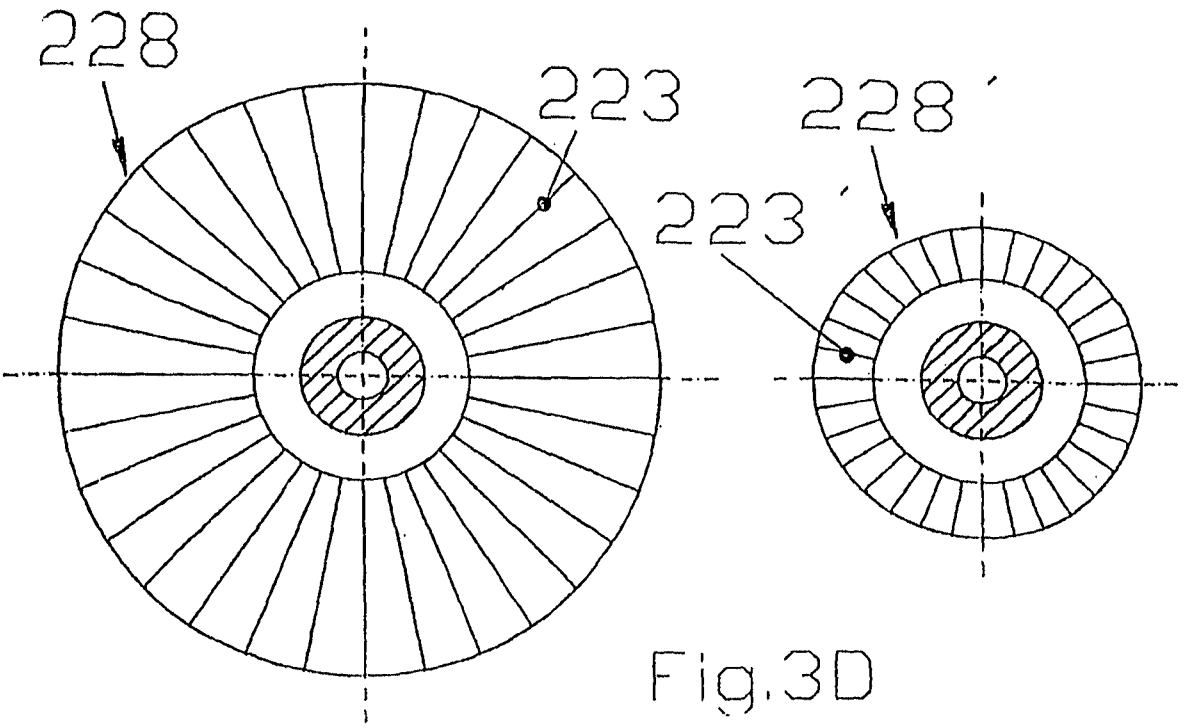


Fig.3D

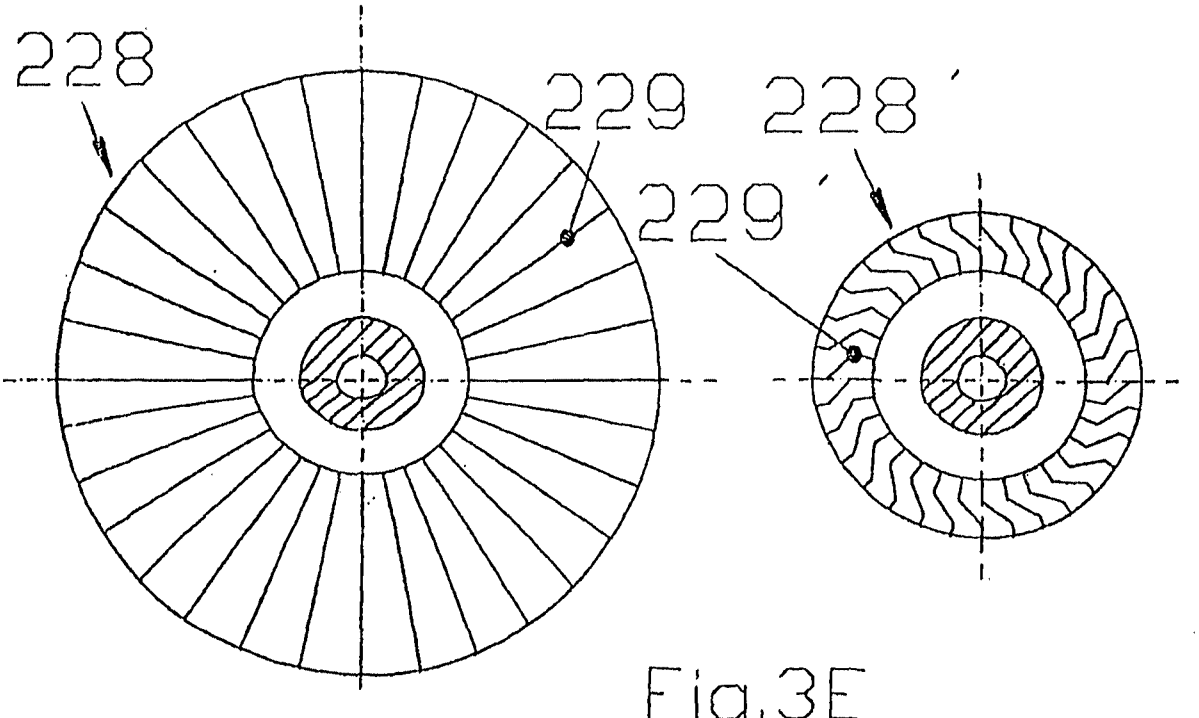


Fig.3E

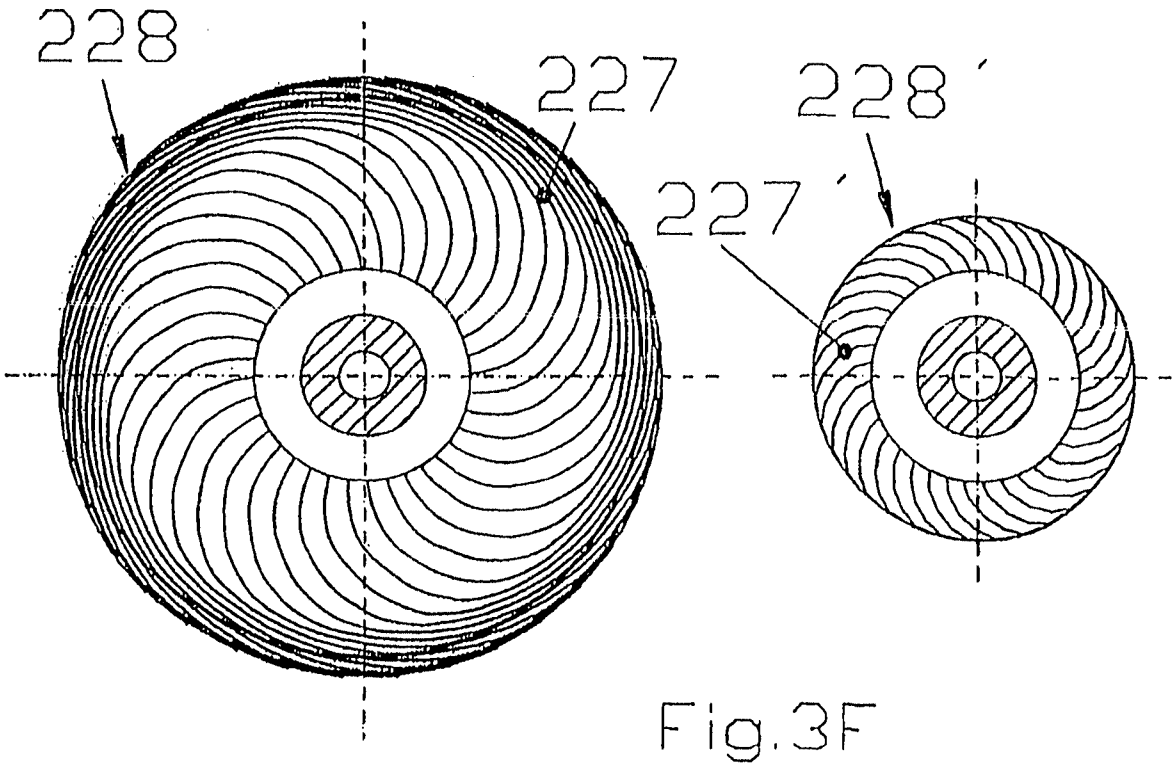


Fig.3F

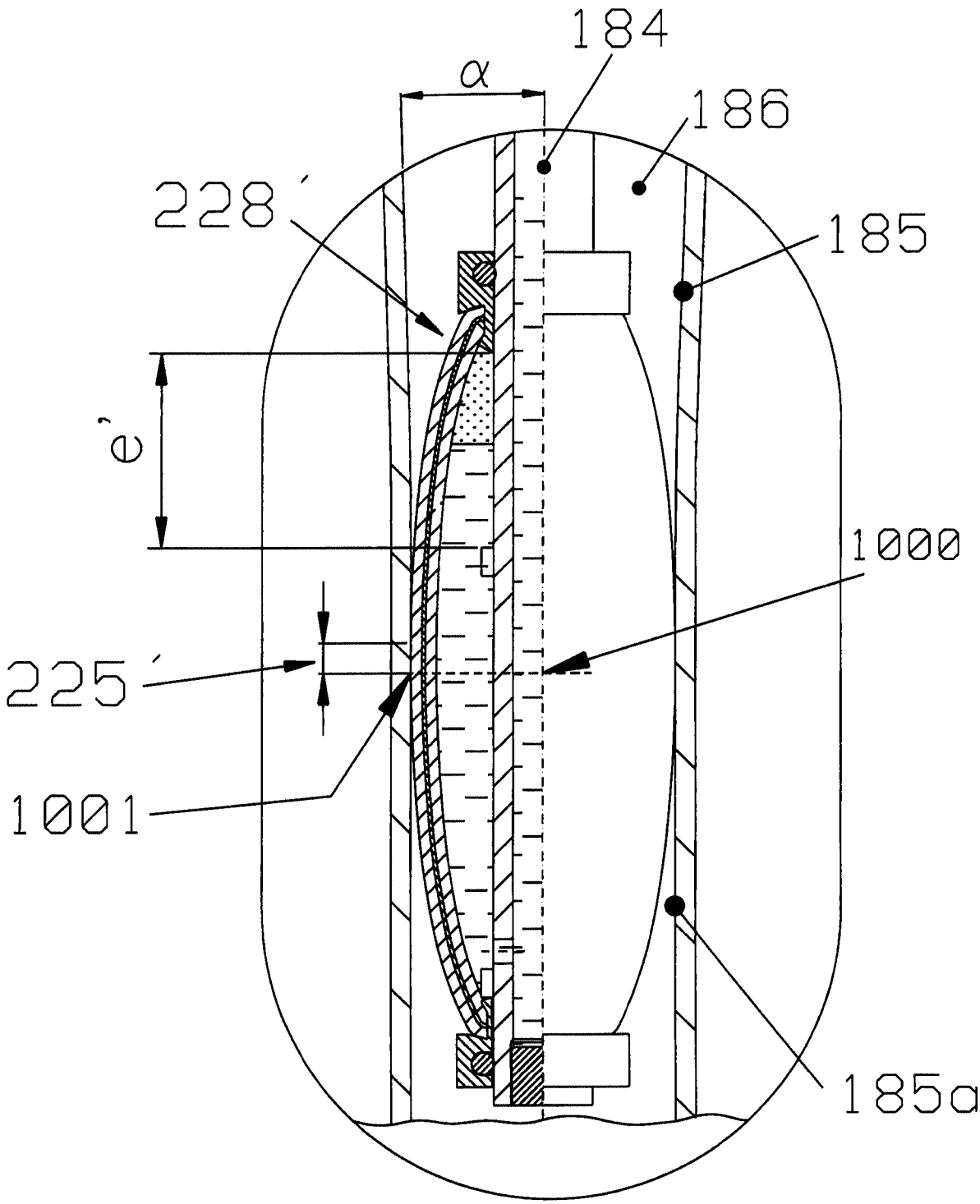


Fig.4

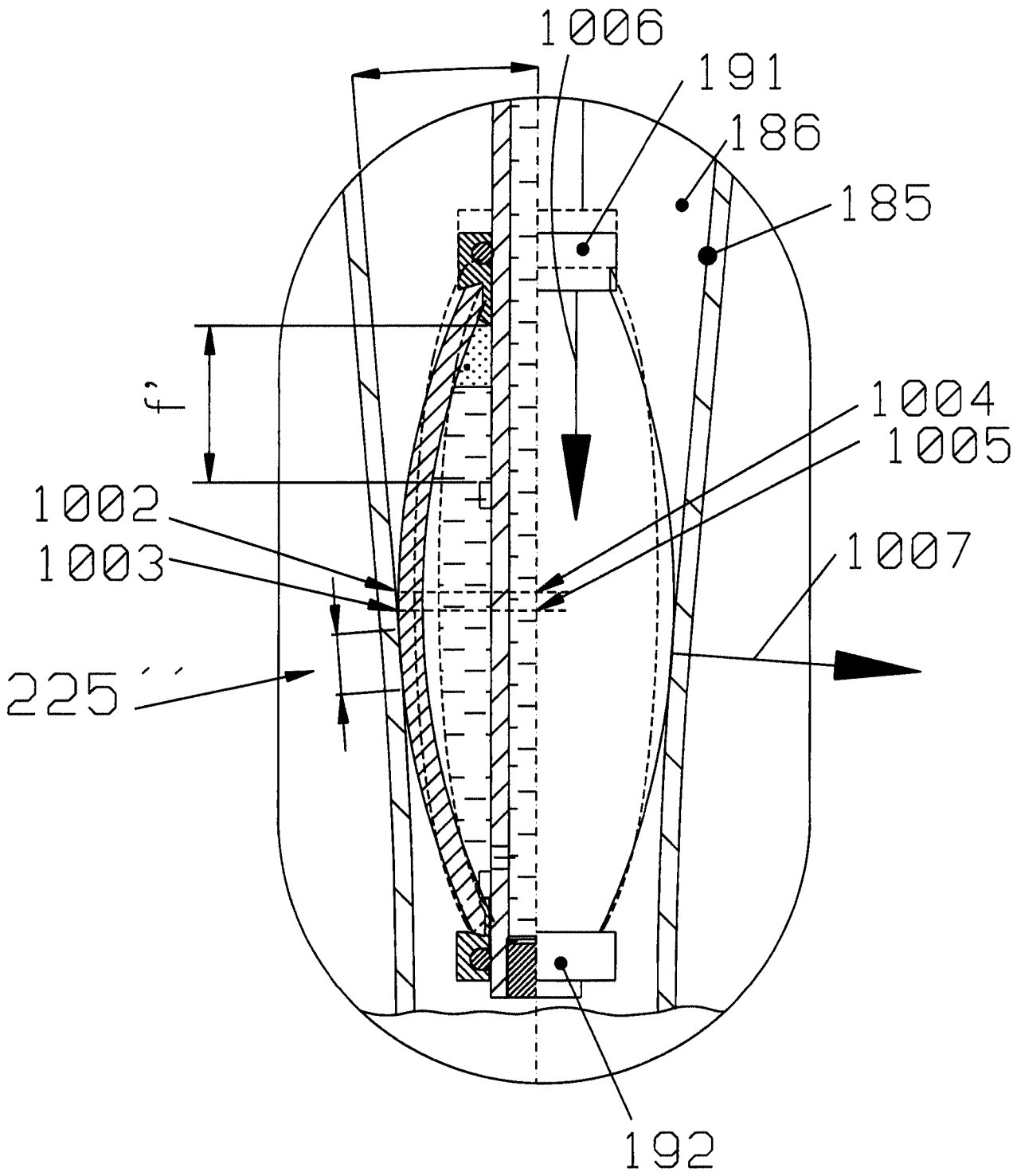


Fig.5A

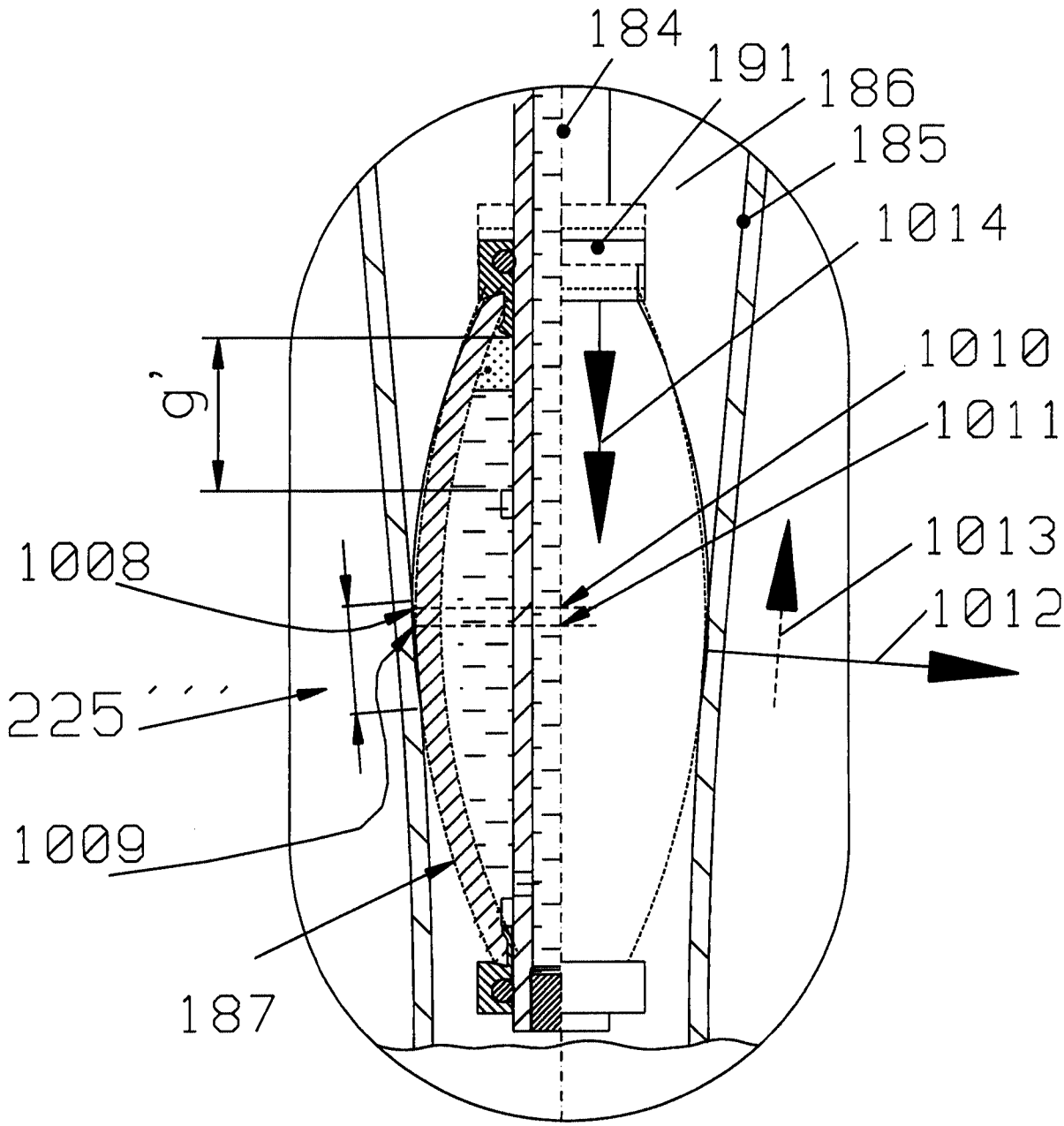


Fig.5B

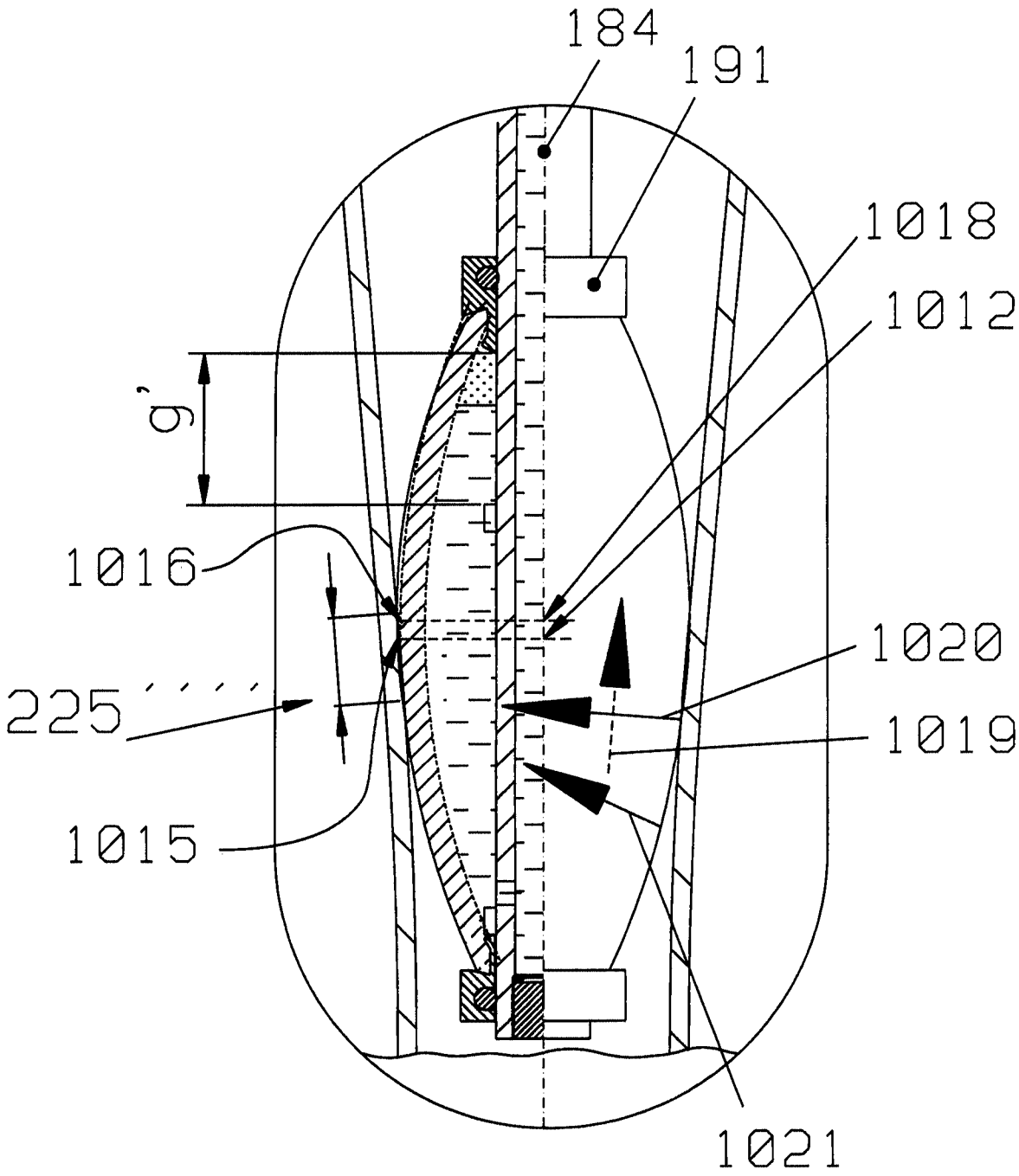


Fig.5C

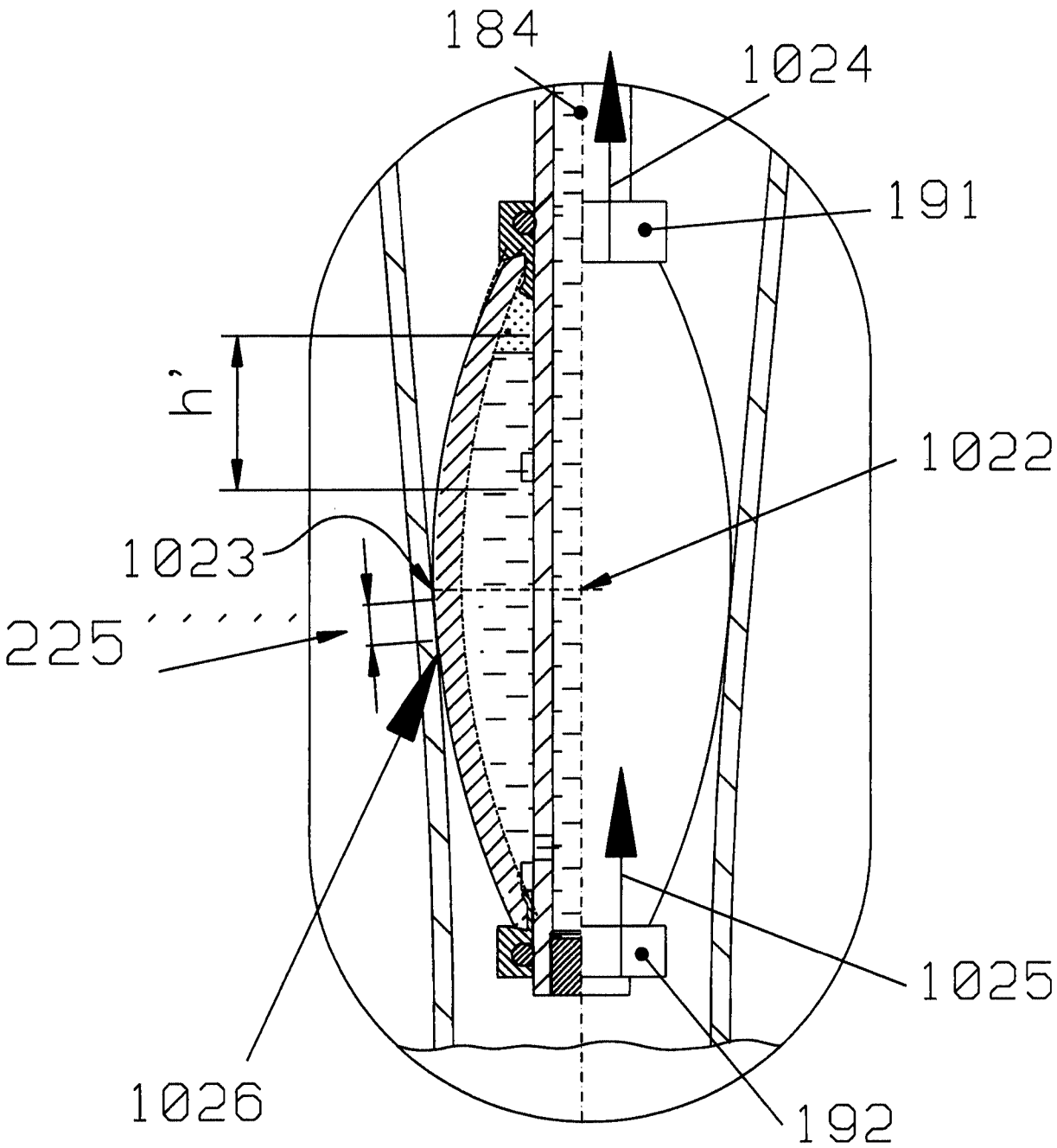


Fig.5D

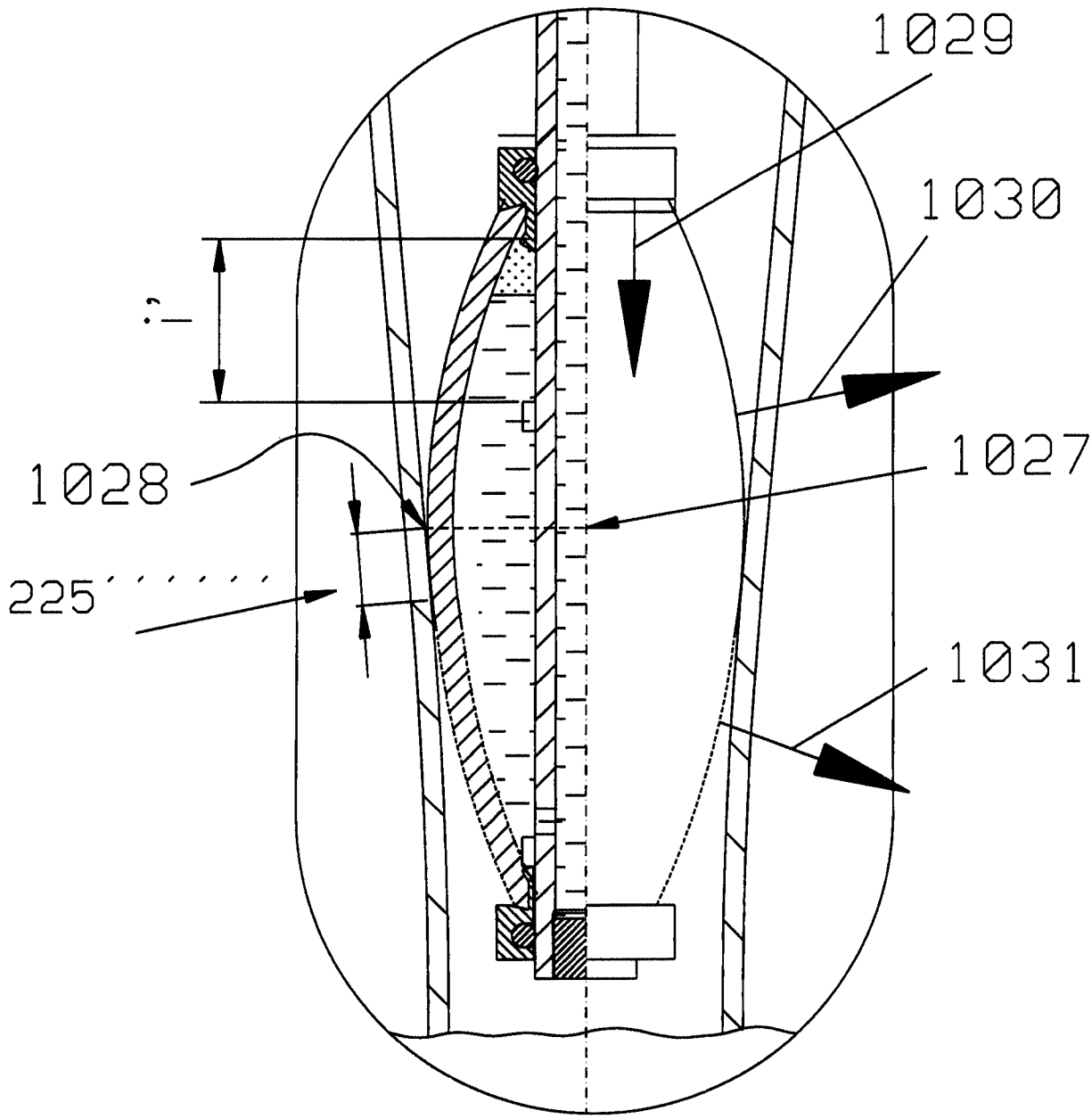


Fig.5E

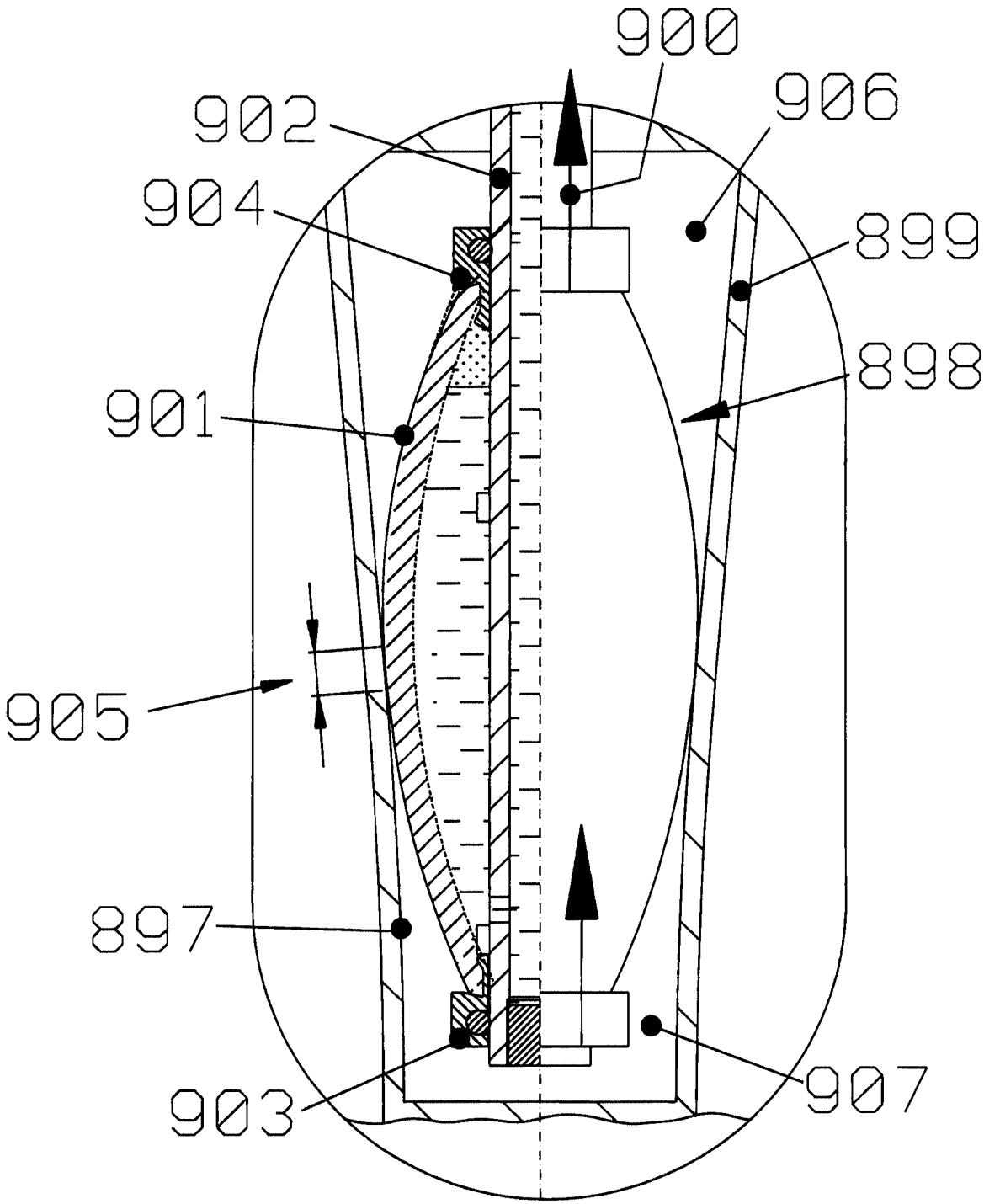


Fig.6A

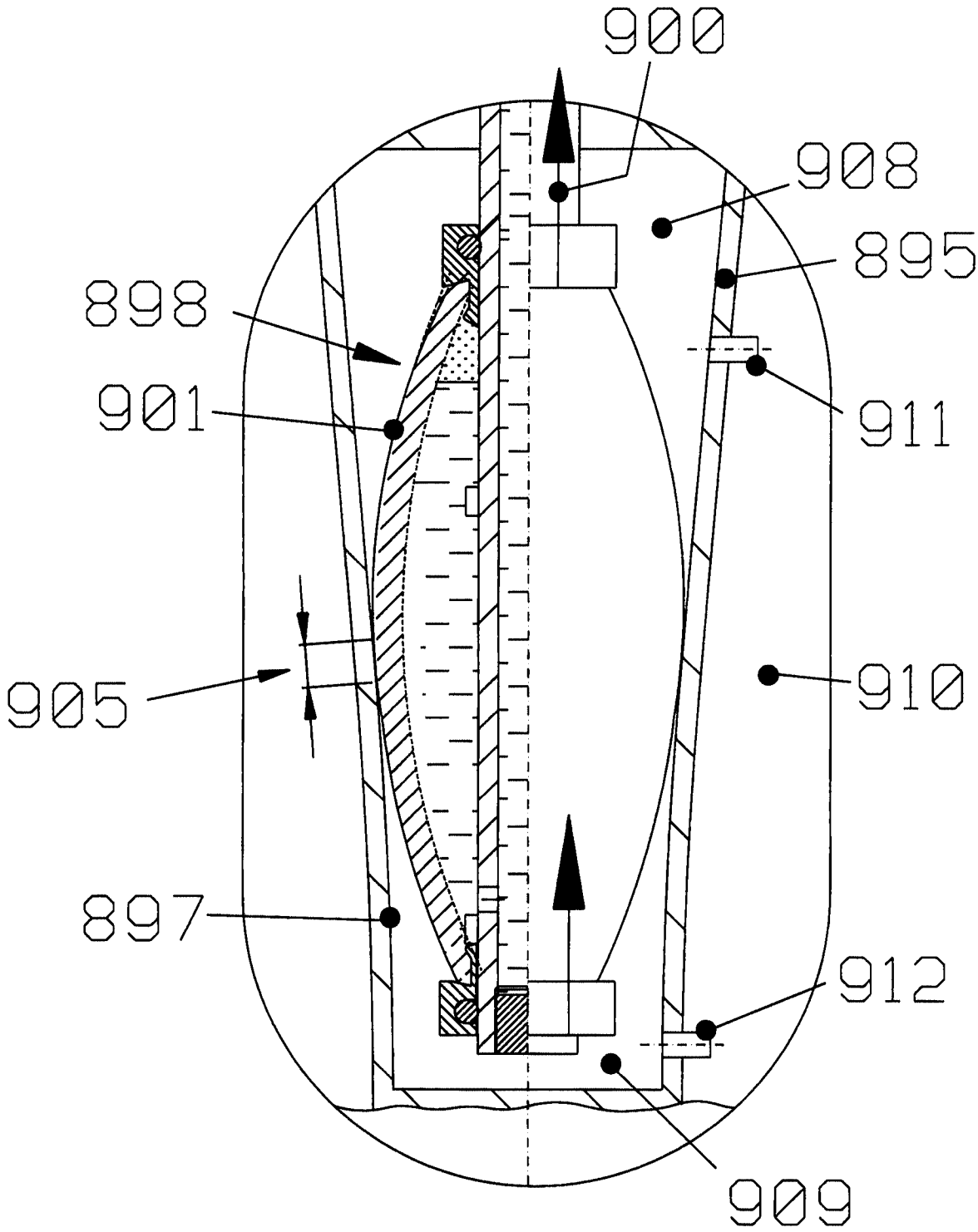


Fig.6B

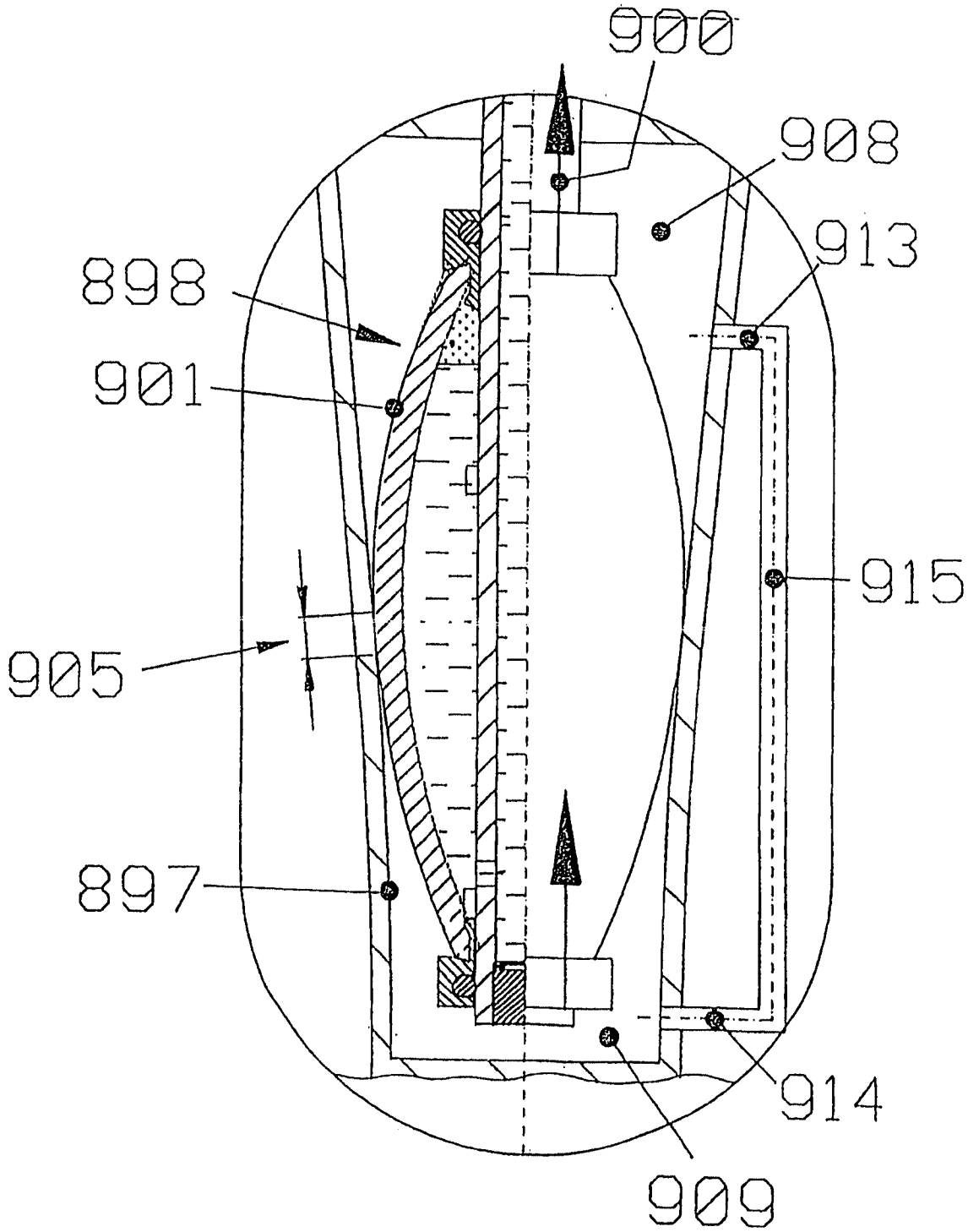


Fig.6C

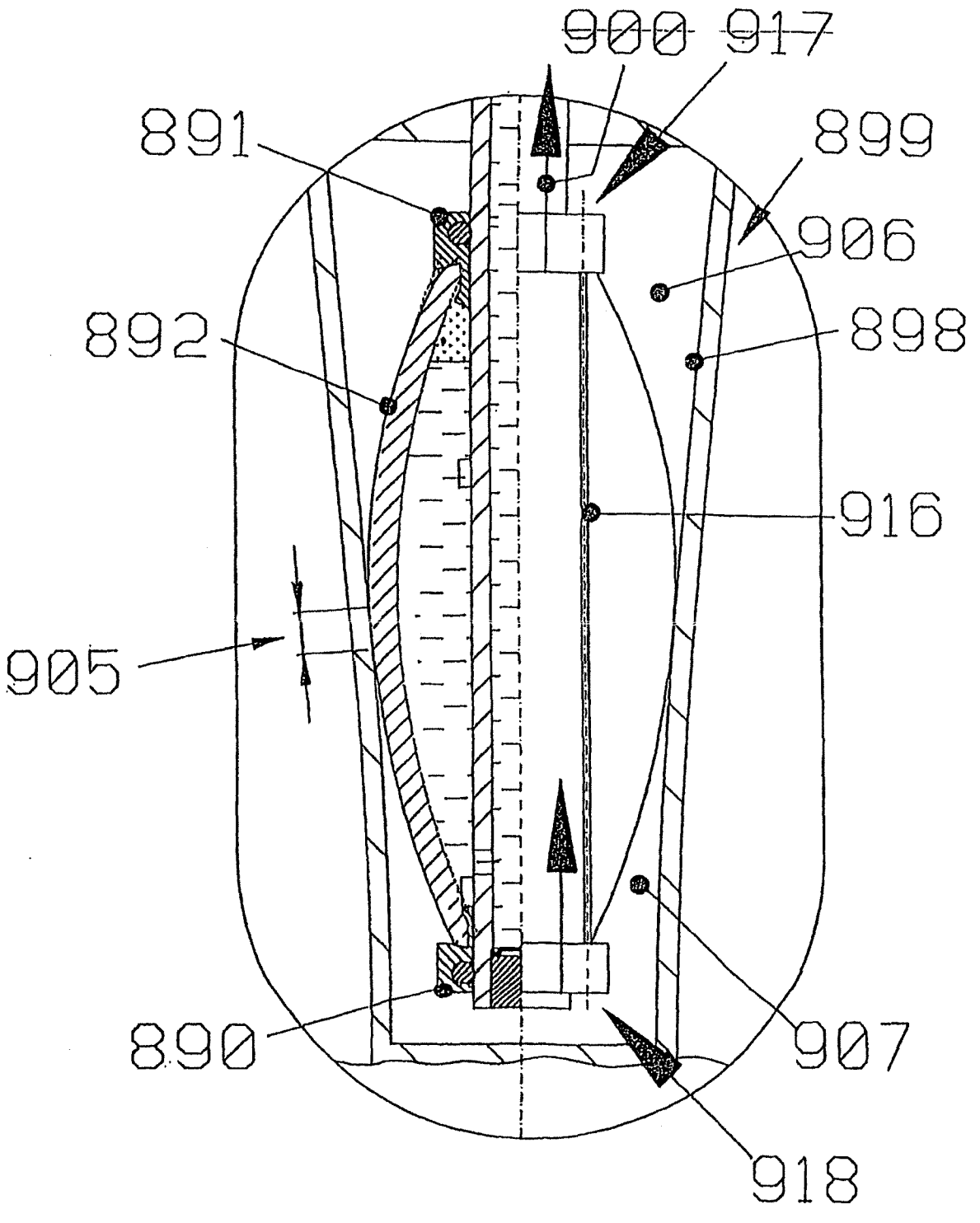


Fig.6D

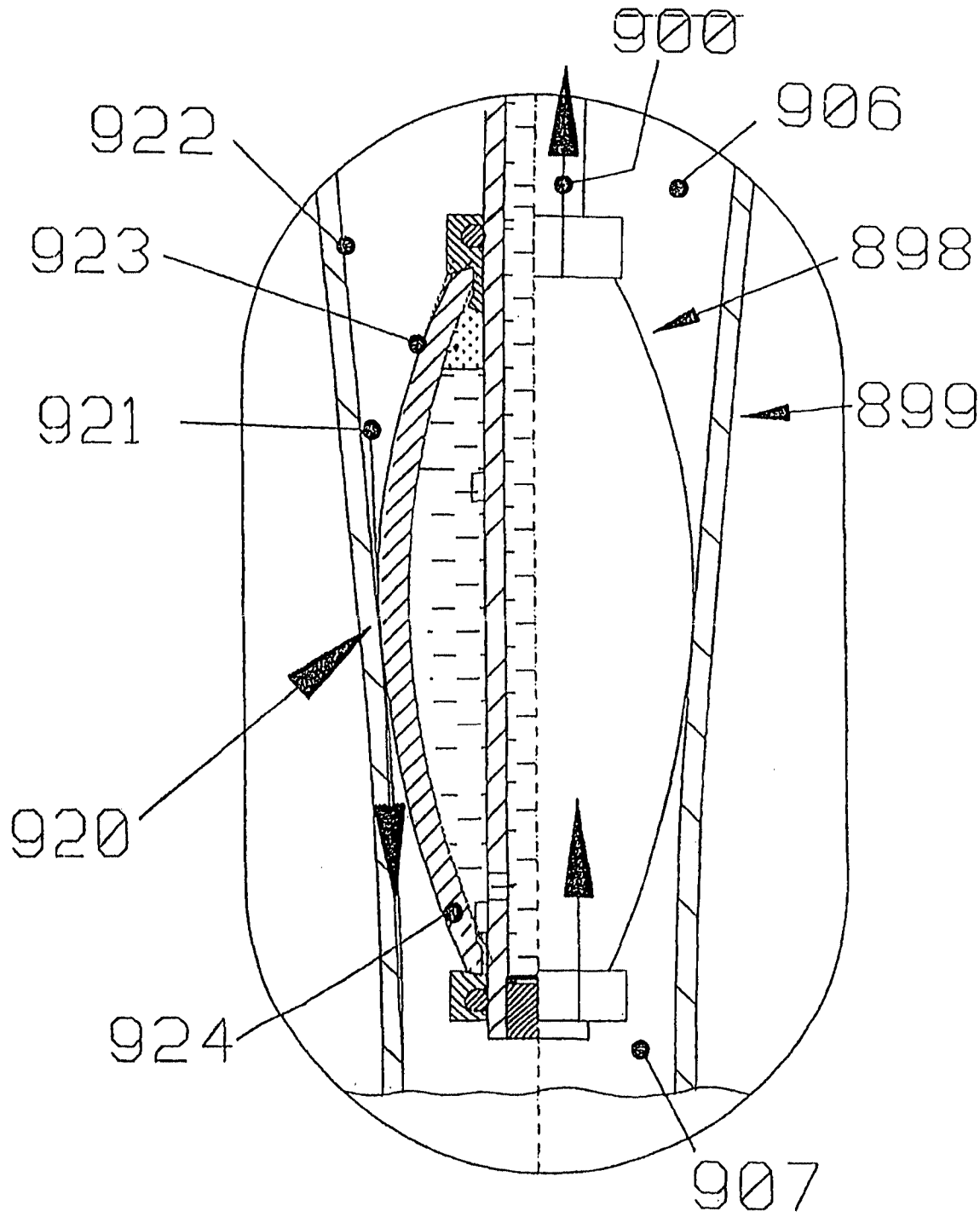


Fig.6E

ANY REFERENCE TO FIGURES 7A TO 7C
SHOULD BE CONSIDERED
AS NON-EXISTENT

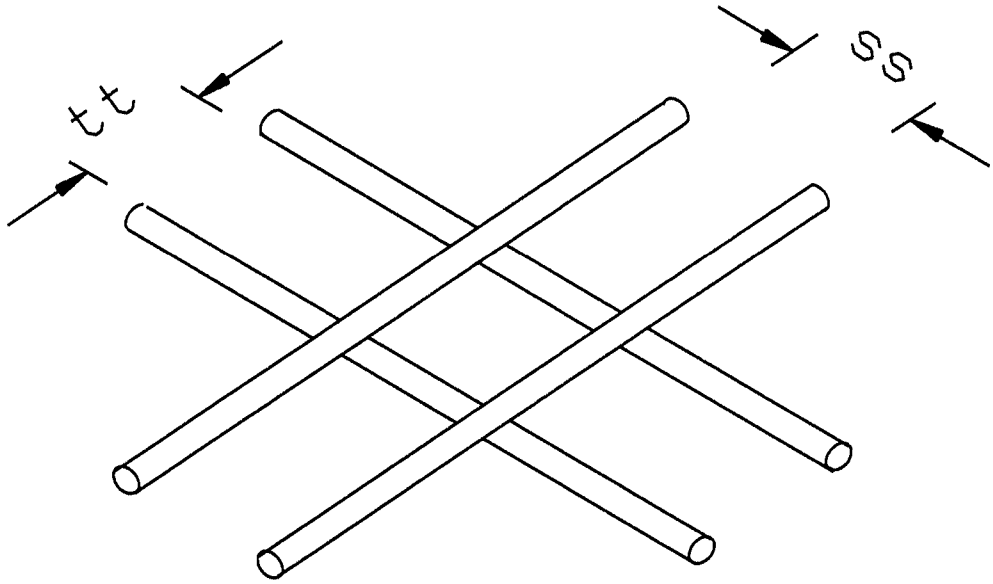


Fig.7D

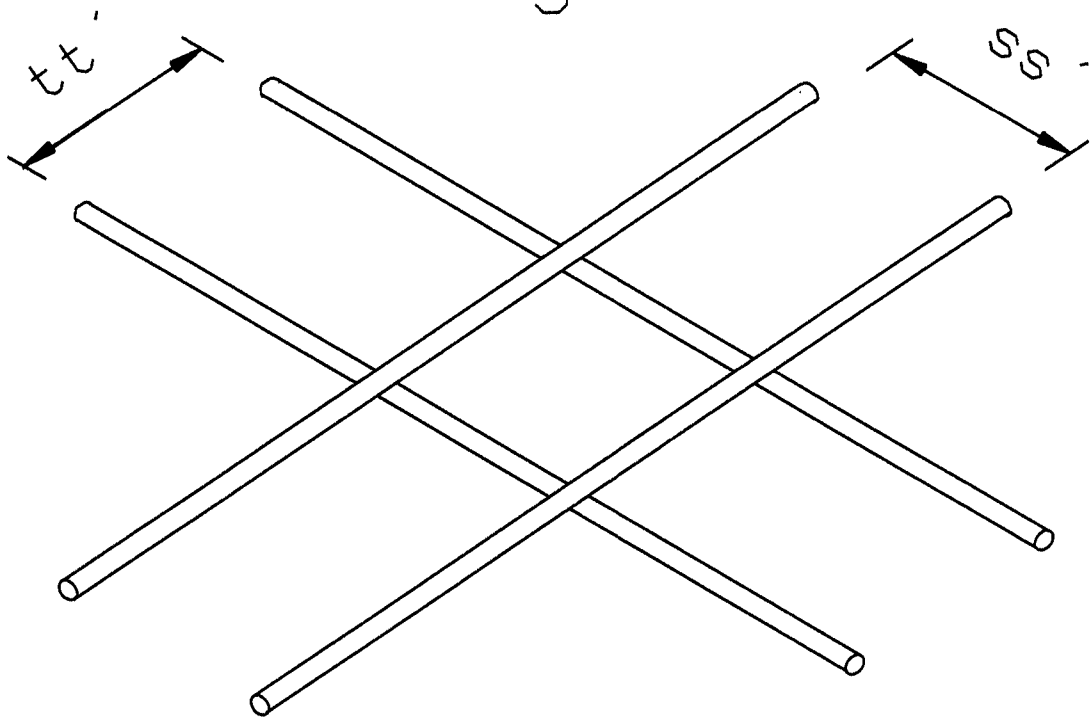


Fig.7E

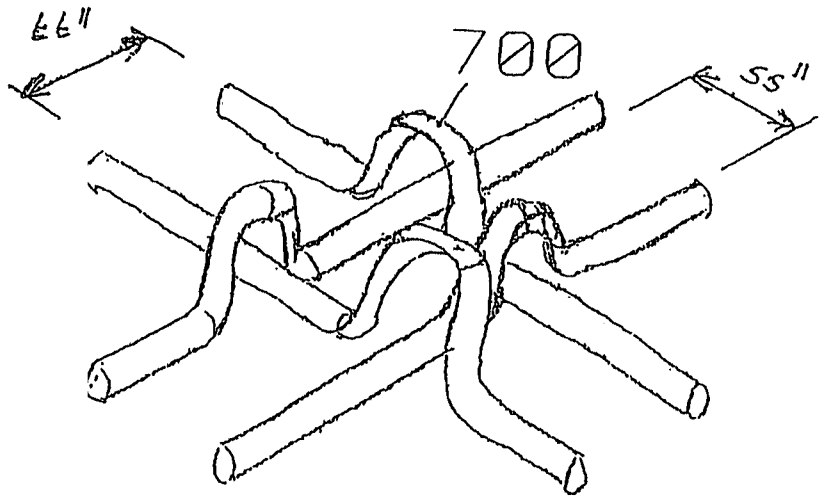


Fig.7F

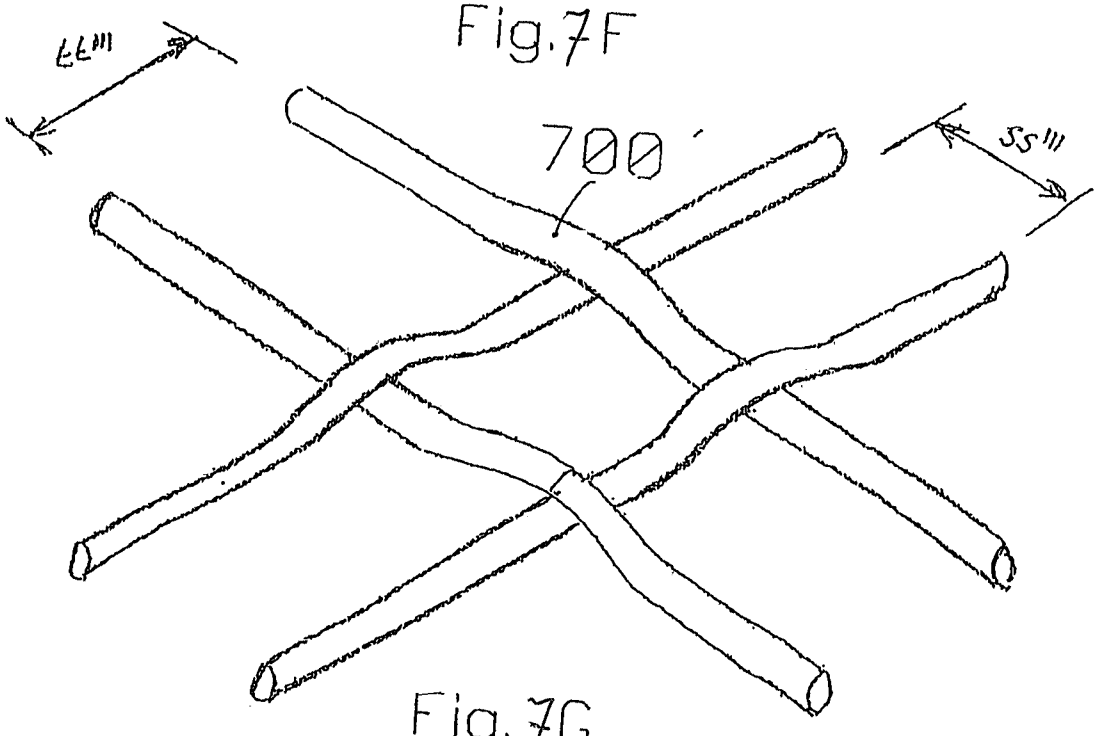


Fig.7G

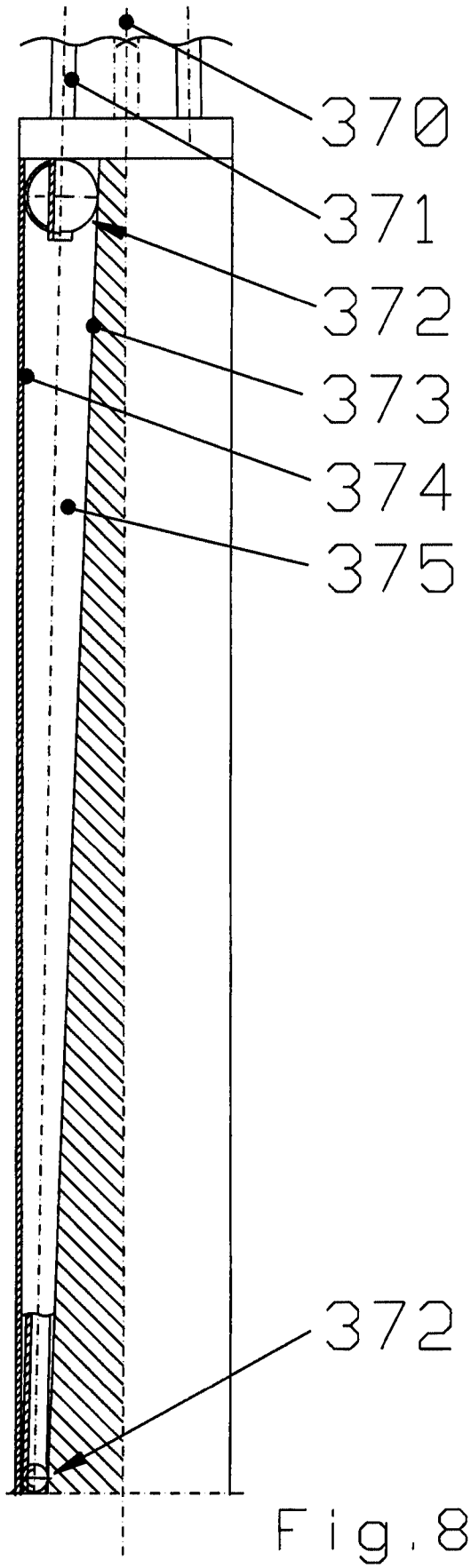


Fig. 8

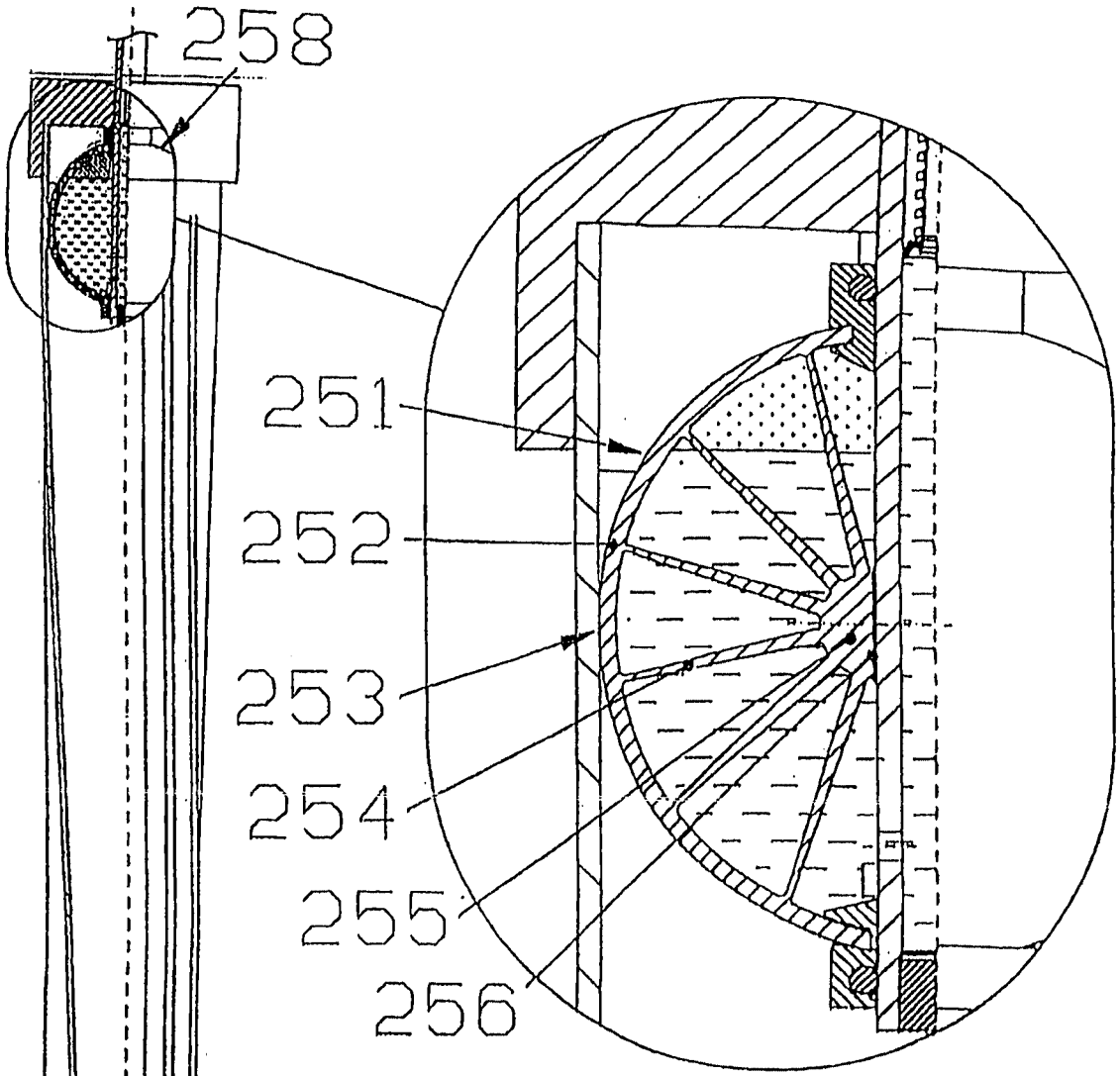


Fig.9B

FIG.9C

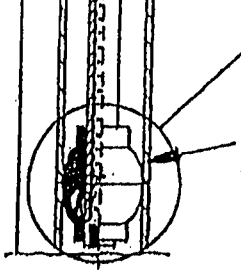


Fig.9A

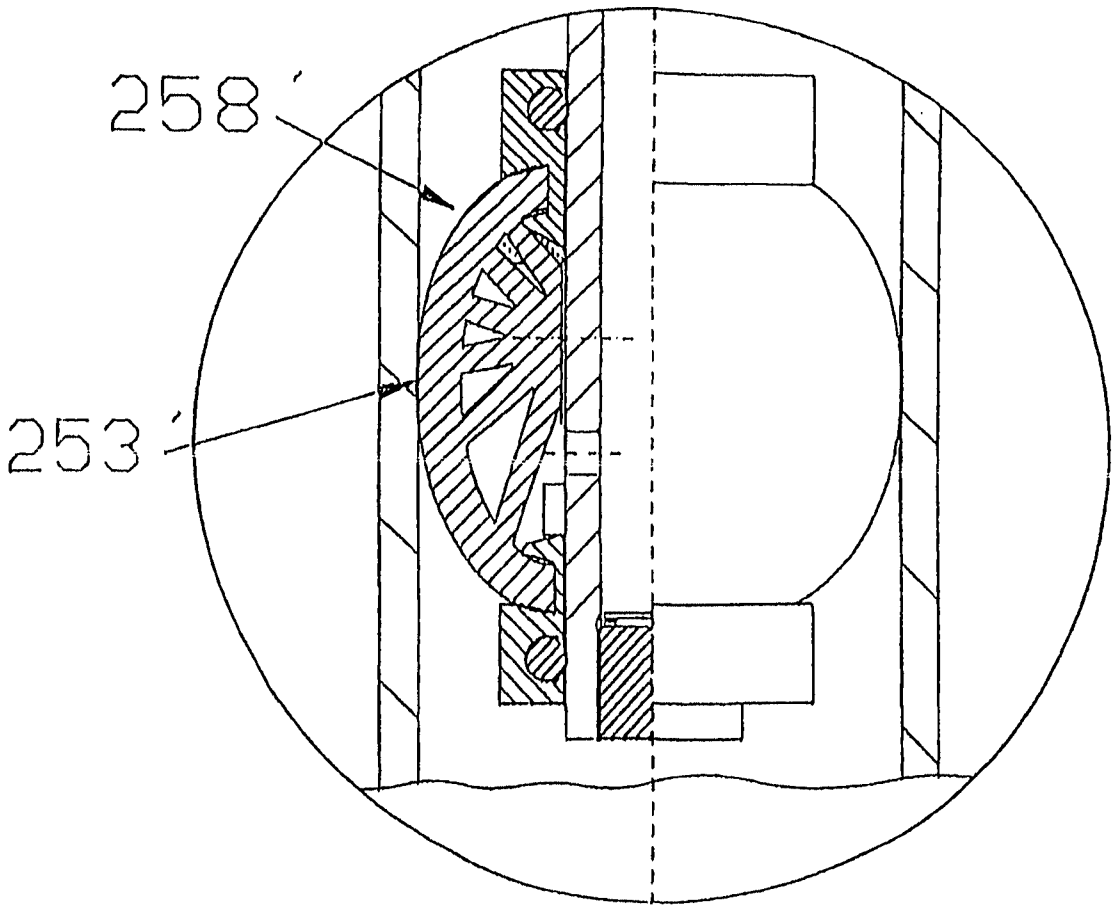


Fig.9C

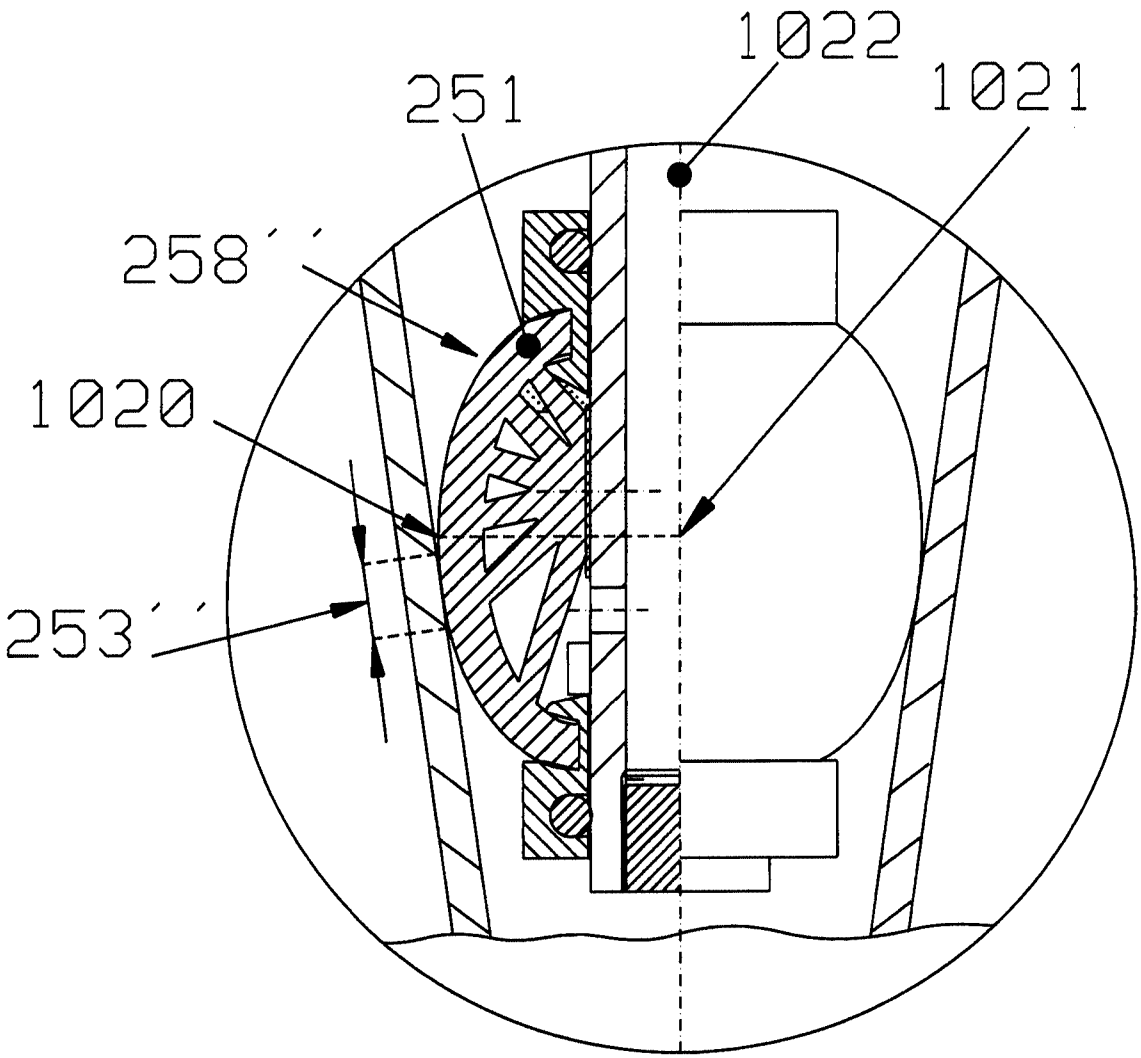


Fig.9D

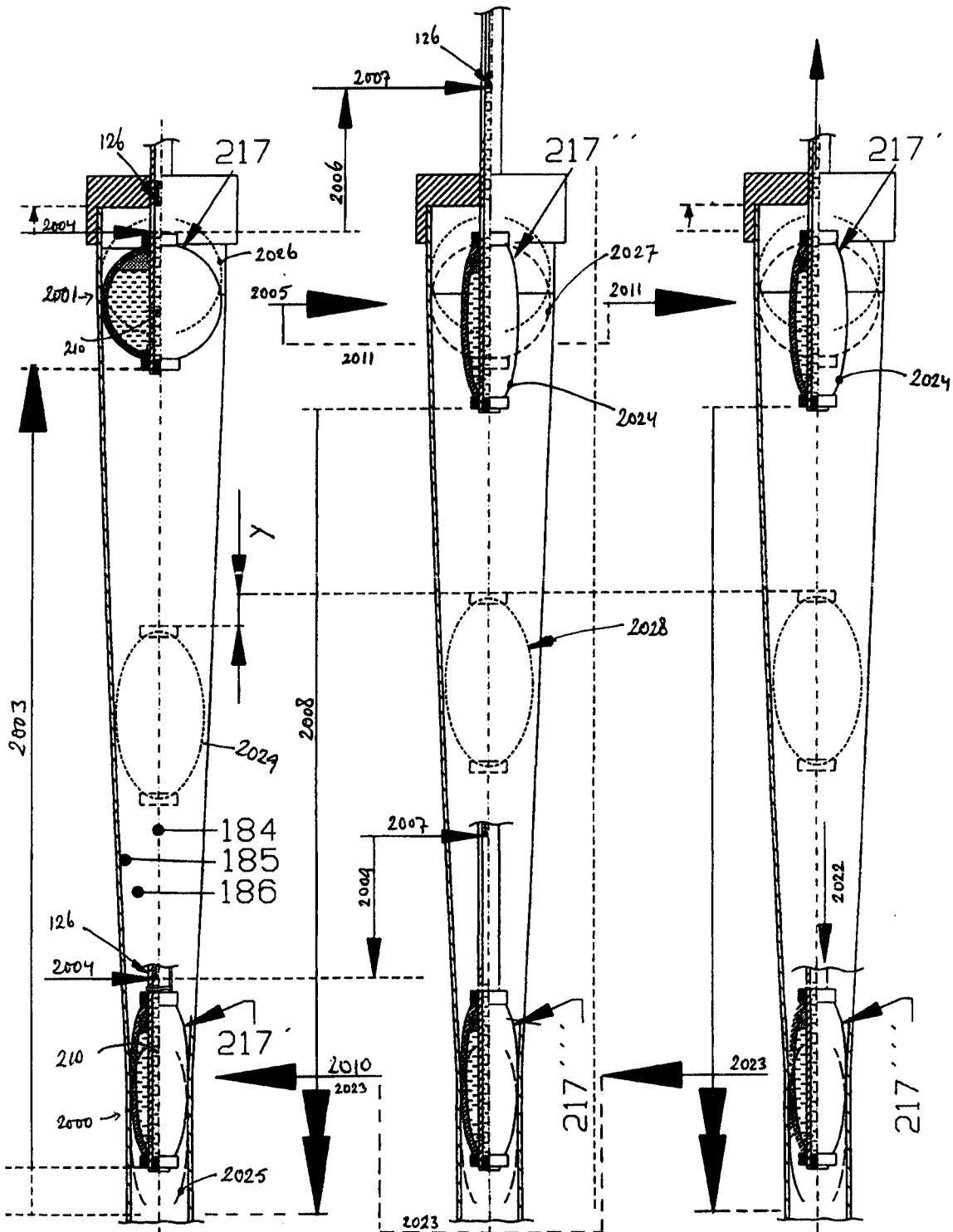


Fig.10A Fig.10B Fig.10C

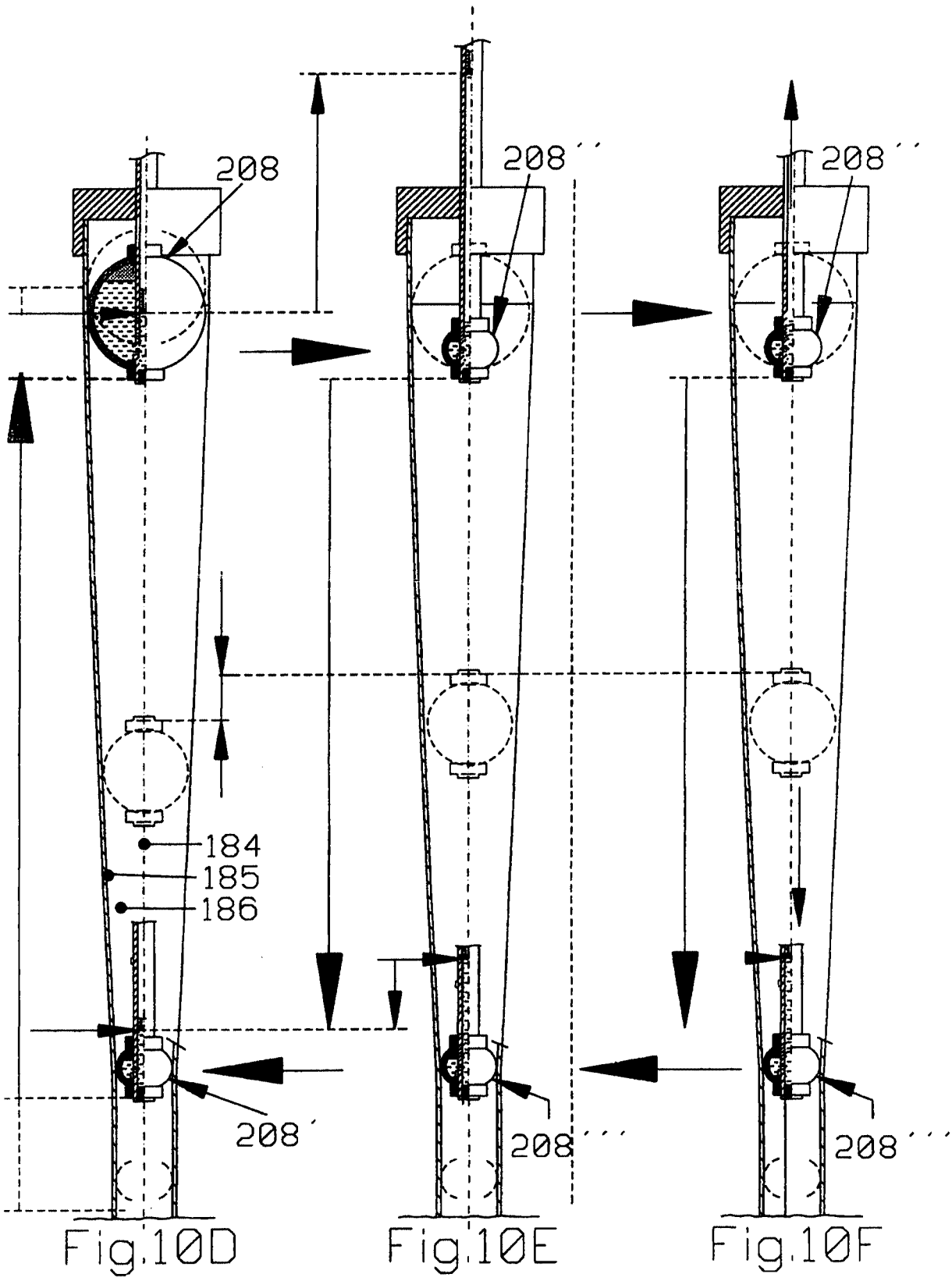


Fig.10D Fig.10E Fig.10F

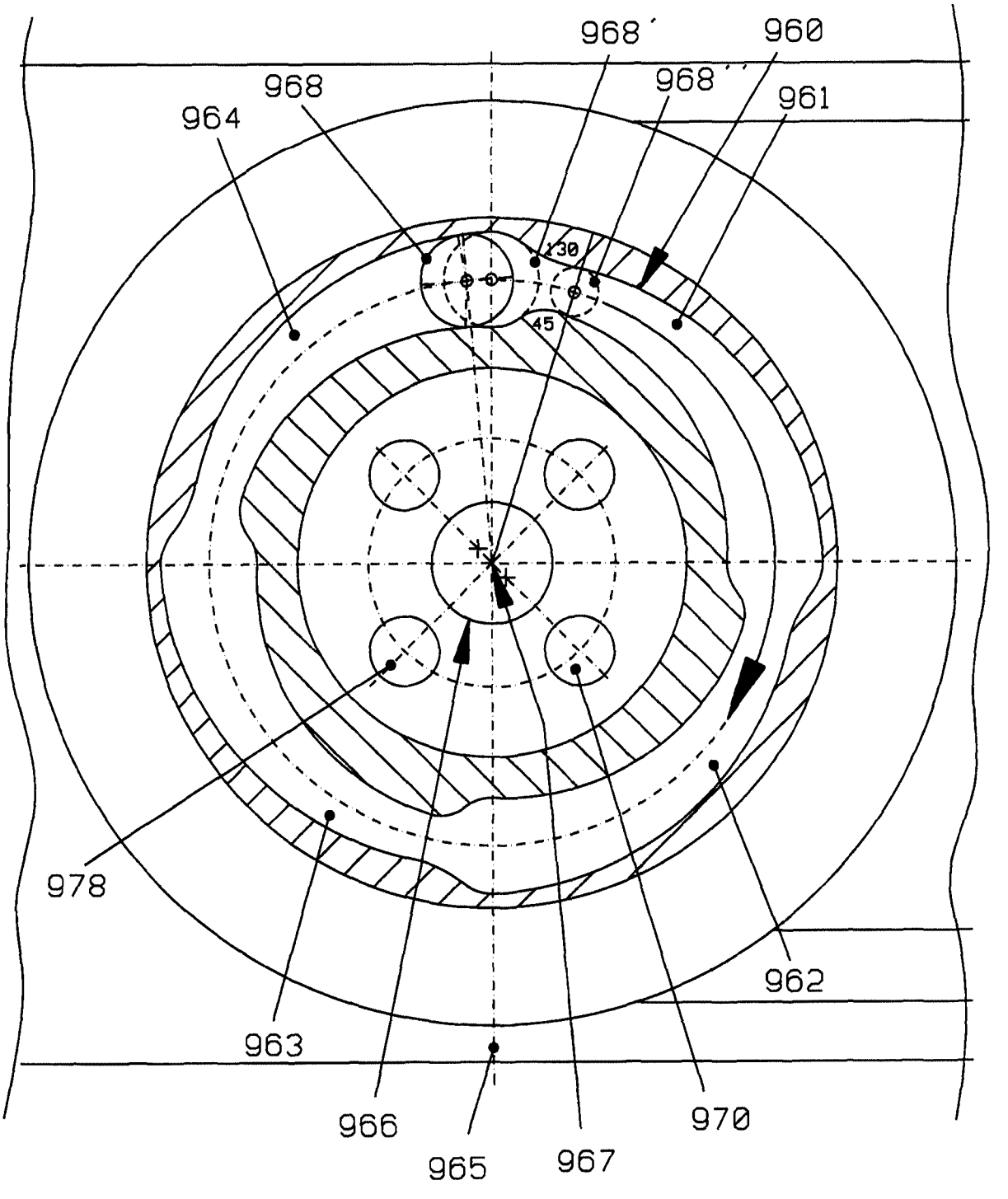


Fig.10G

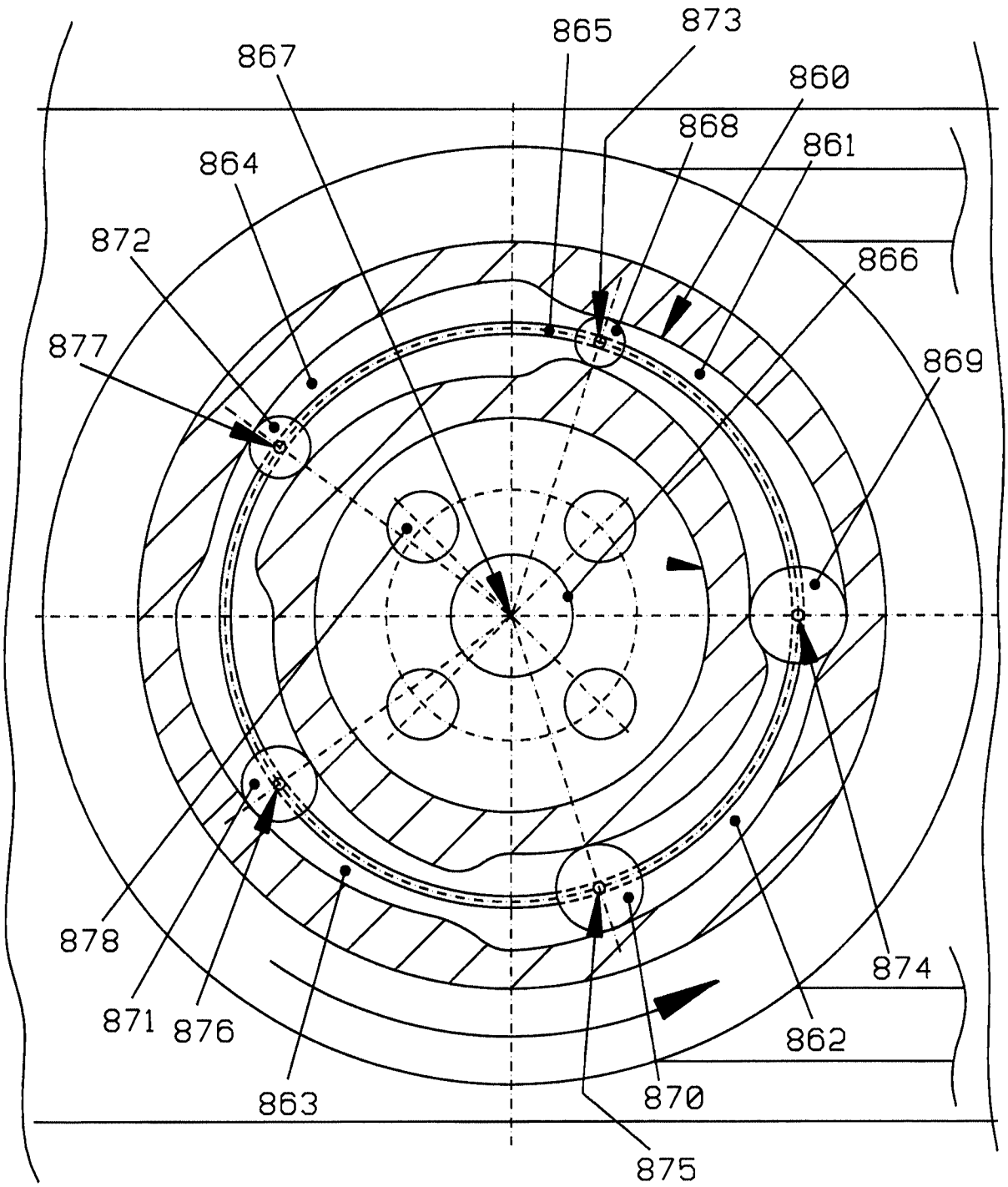

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Fig.10H

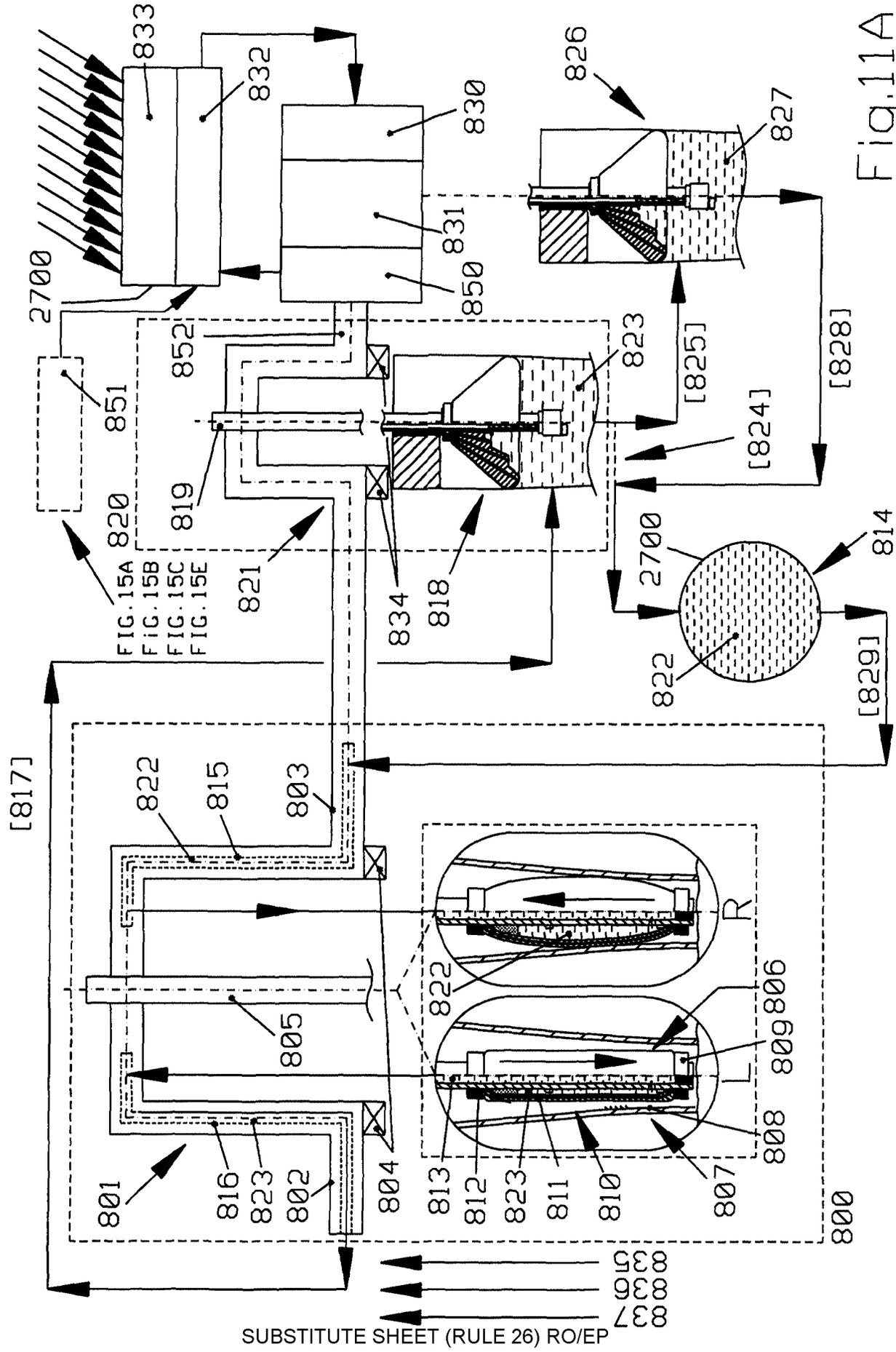

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FIG.15A
FIG.15B
FIG.15C
FIG.15E
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Fig.11A

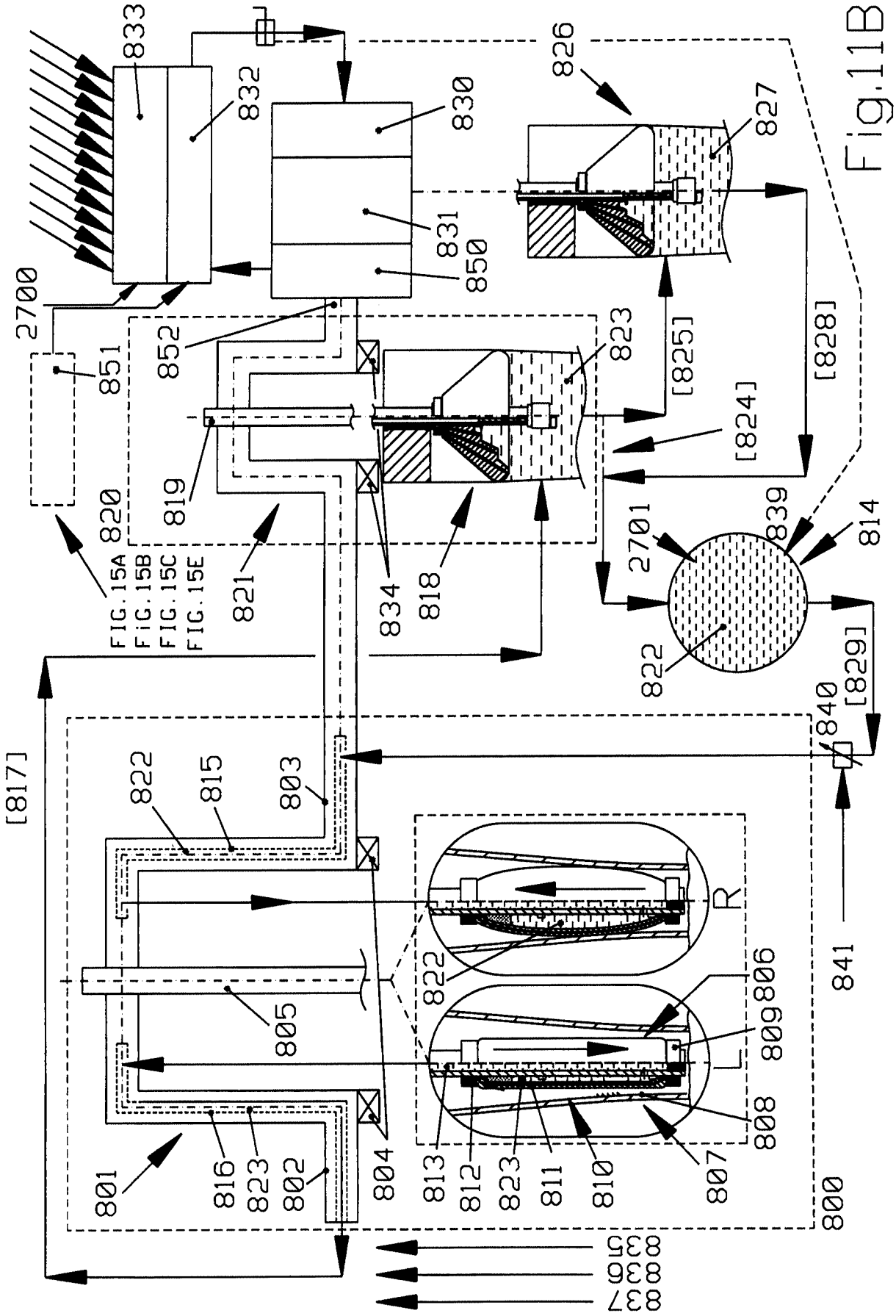
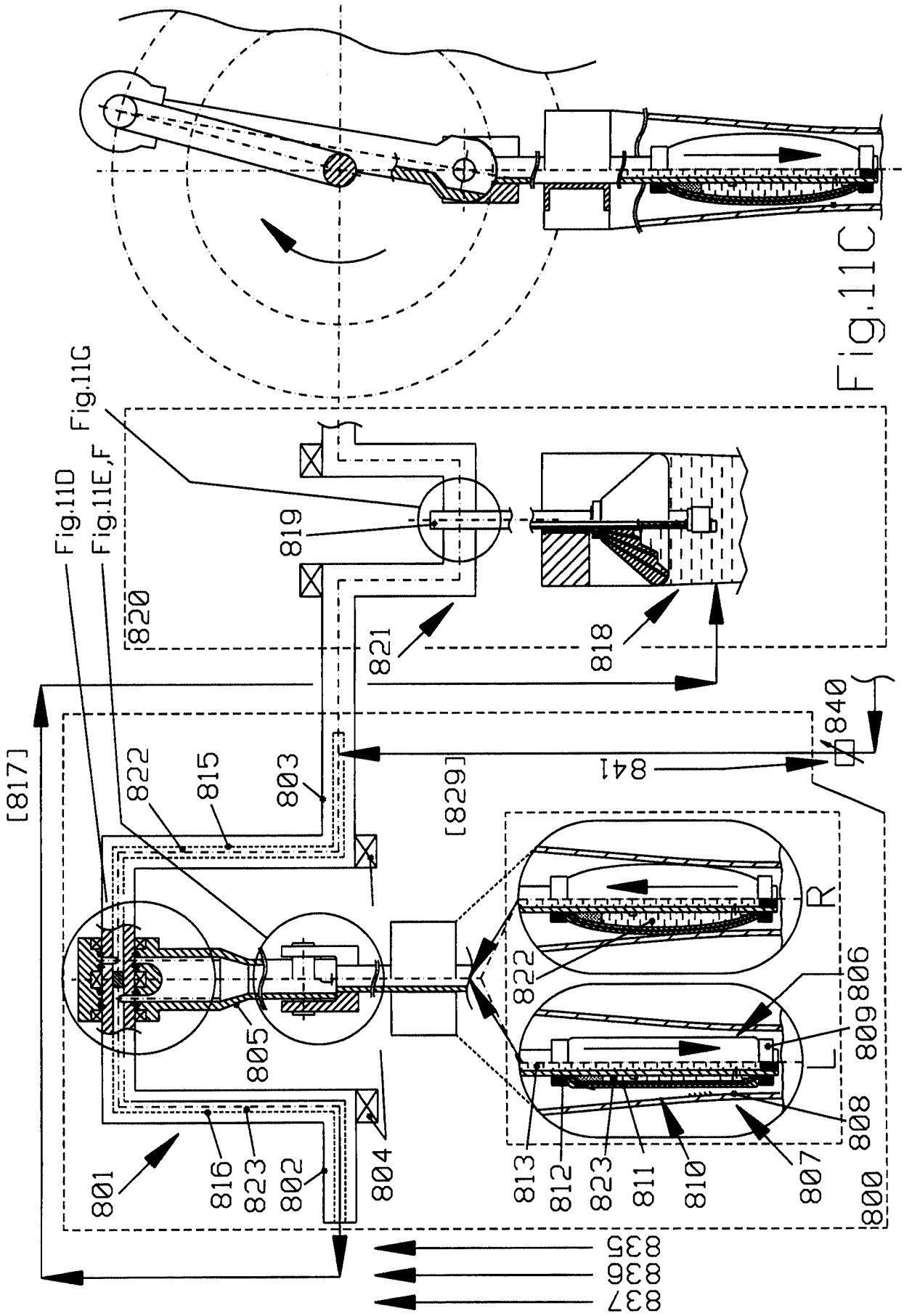

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FIG.15A
FIG.15B
FIG.15C
FIG.15E
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Fig.11B


Fig.11C
Fig.11G
Fig.11D
Fig.11E,F
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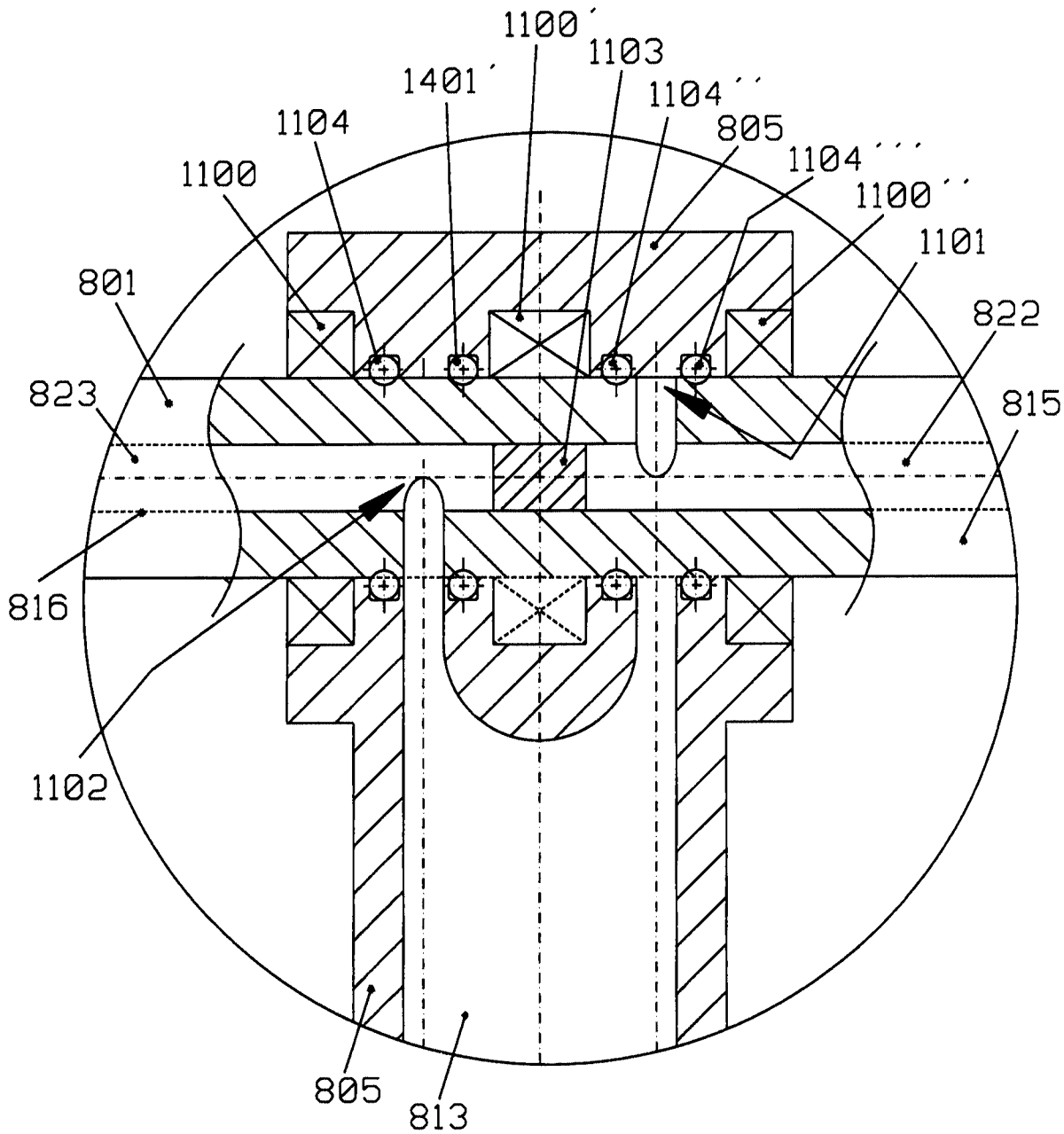

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Fig.11D

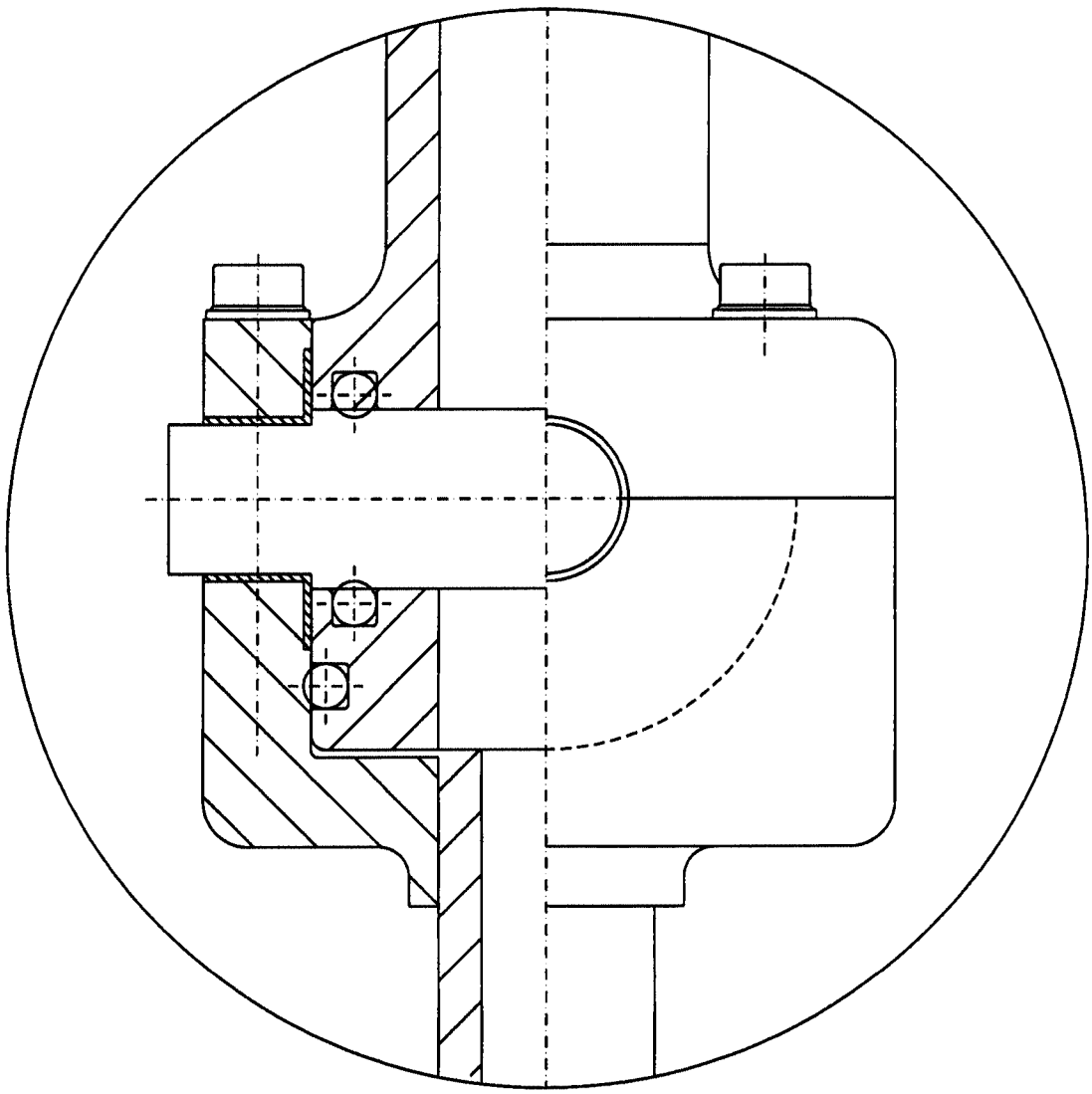


Fig.11E

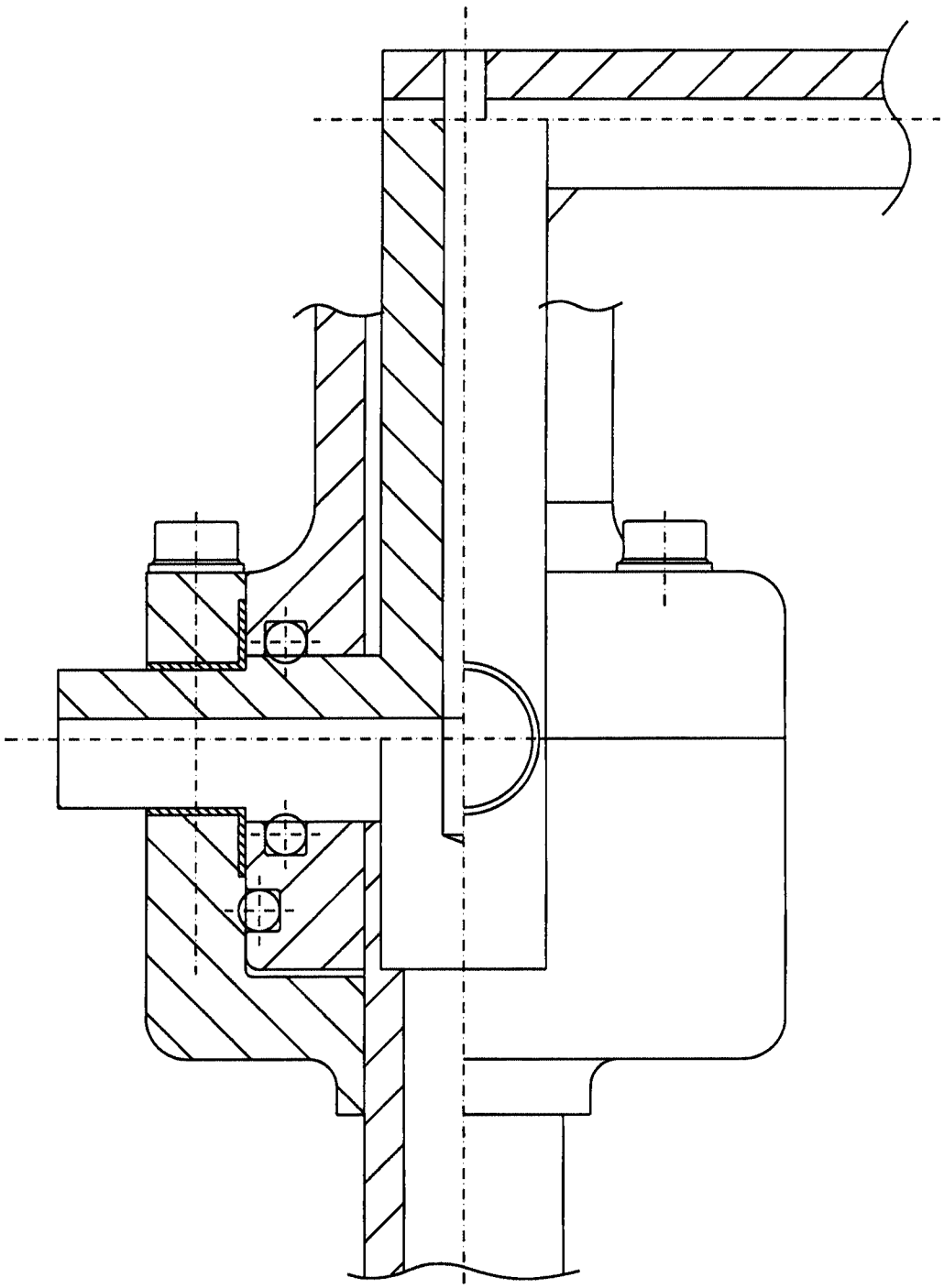
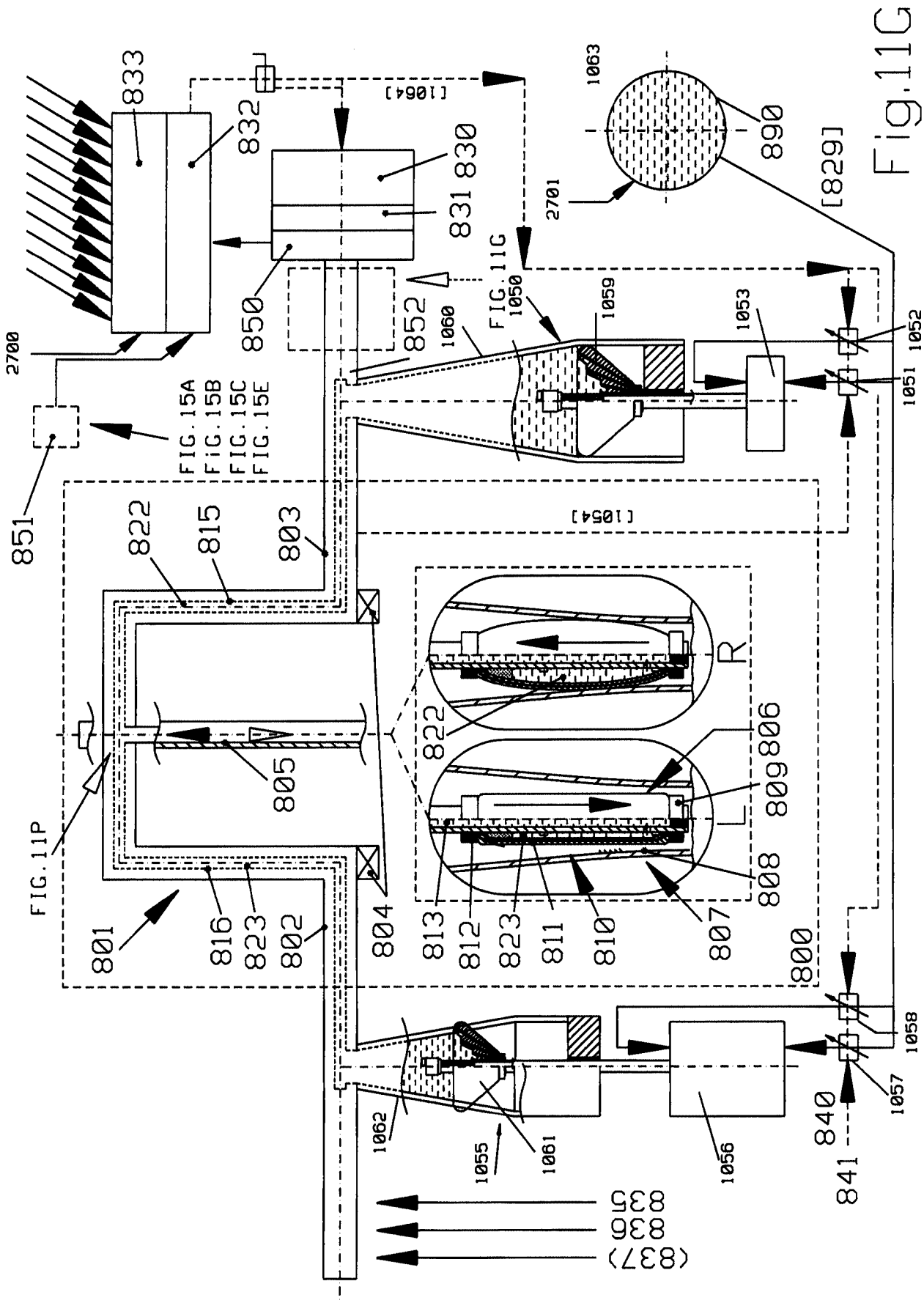


Fig.11F


Fig.11G
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FIG.11P
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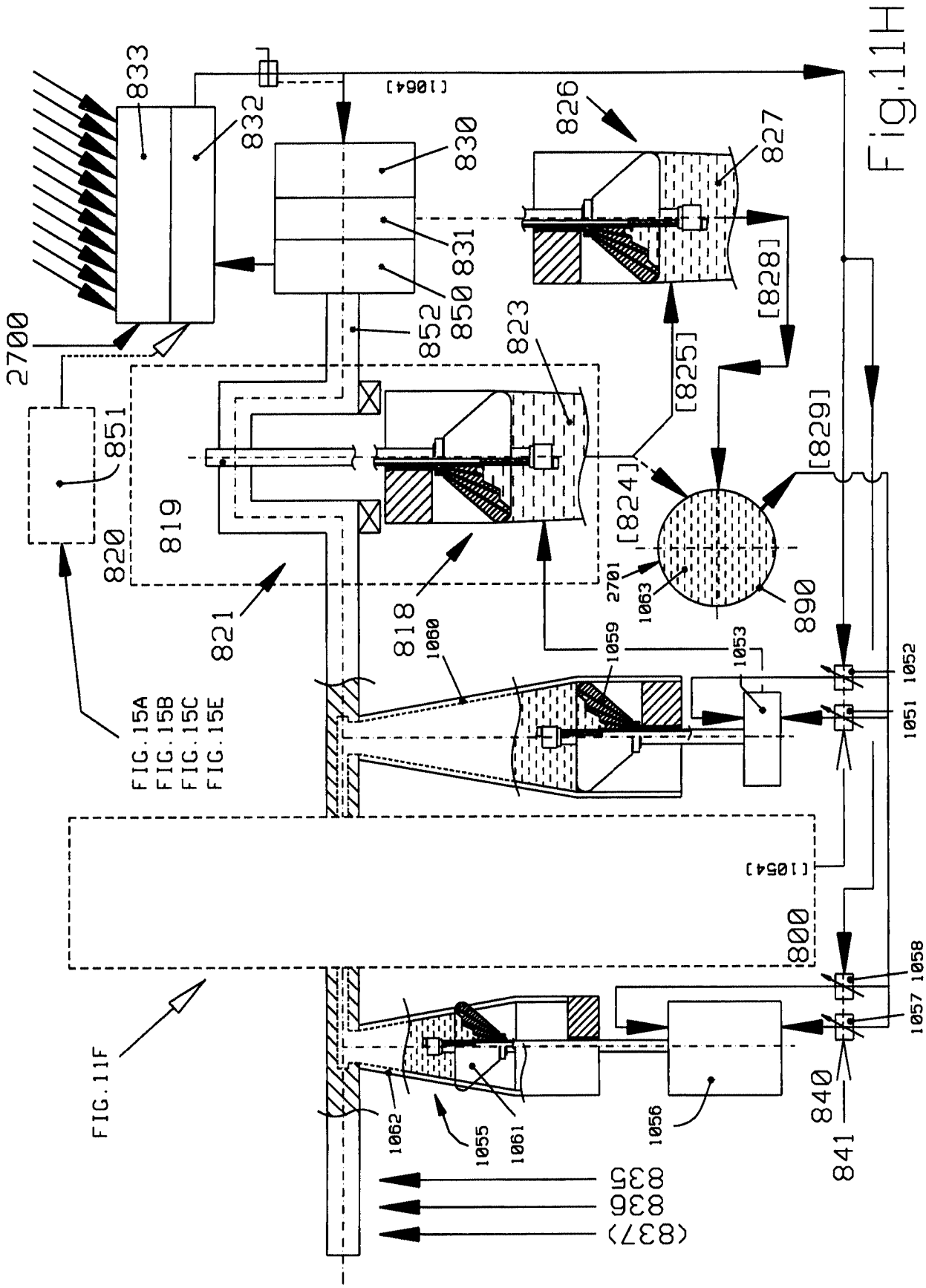

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Fig.11H

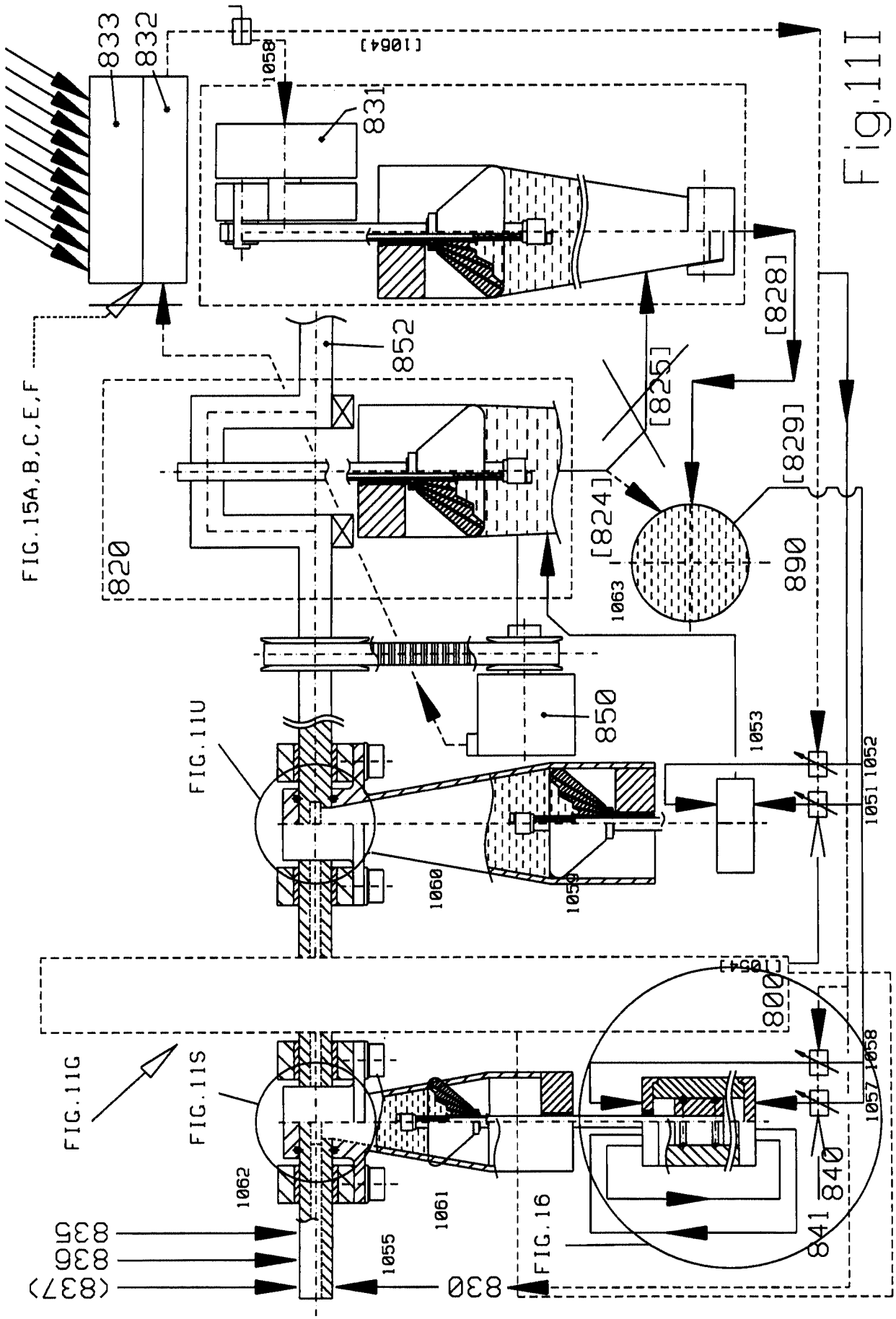
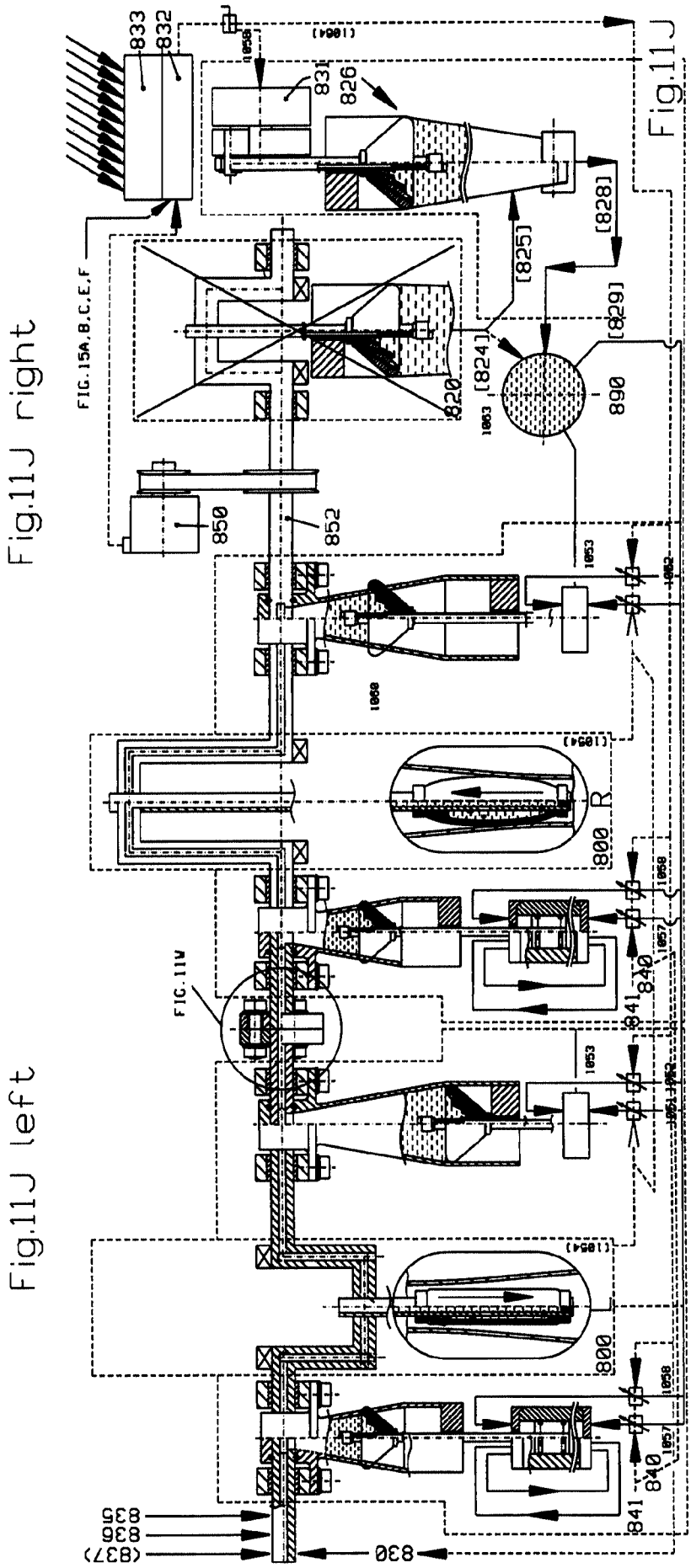

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FIG.15A,B,C,E,F
FIG.11U
FIG.11G
FIG.11S
FIG.16

Fig.11I


Fig.11J right
Fig.11J left
Fig.11J
FIG.15A,B,C,E,F
FIG.11V
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(837)
830

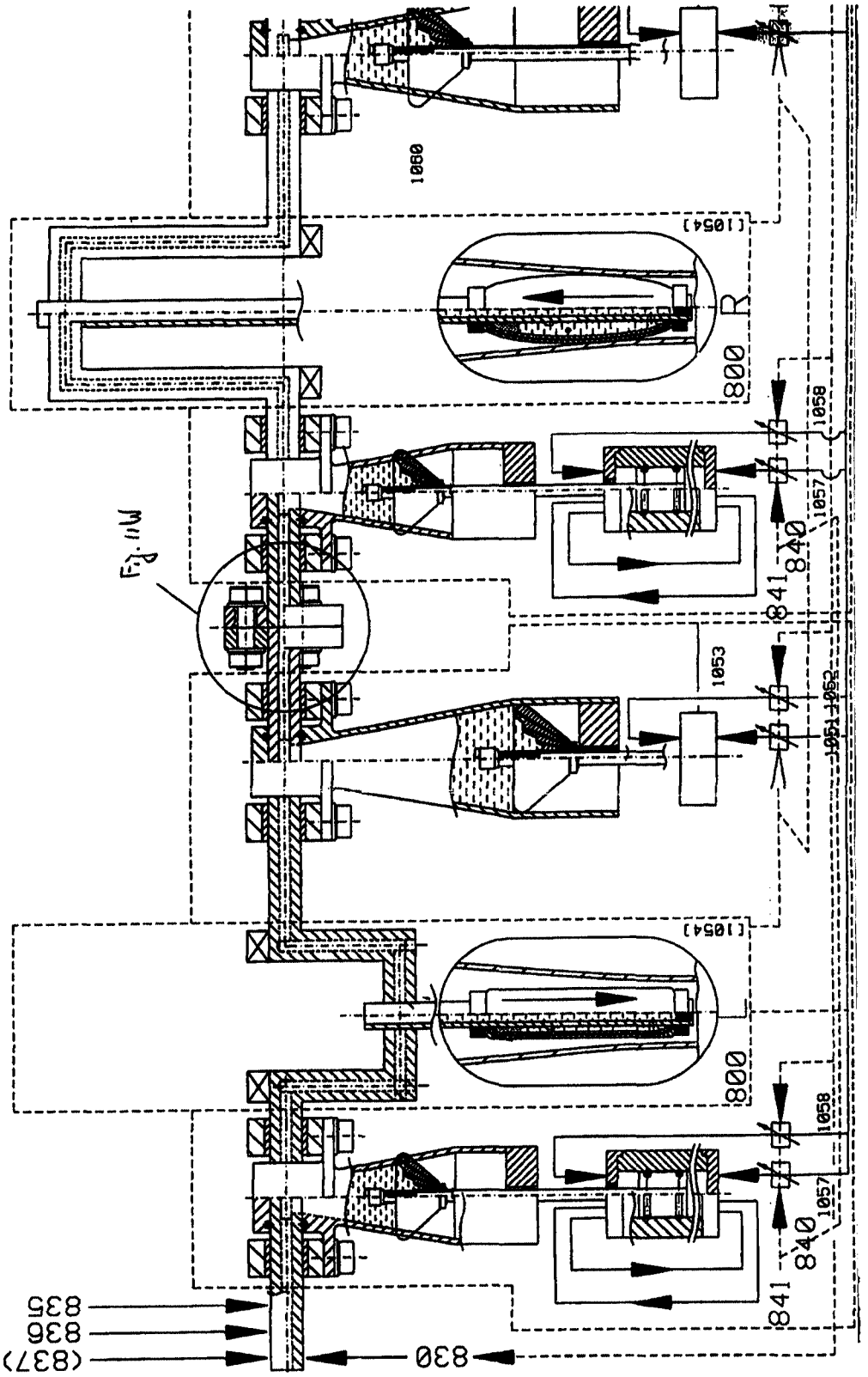
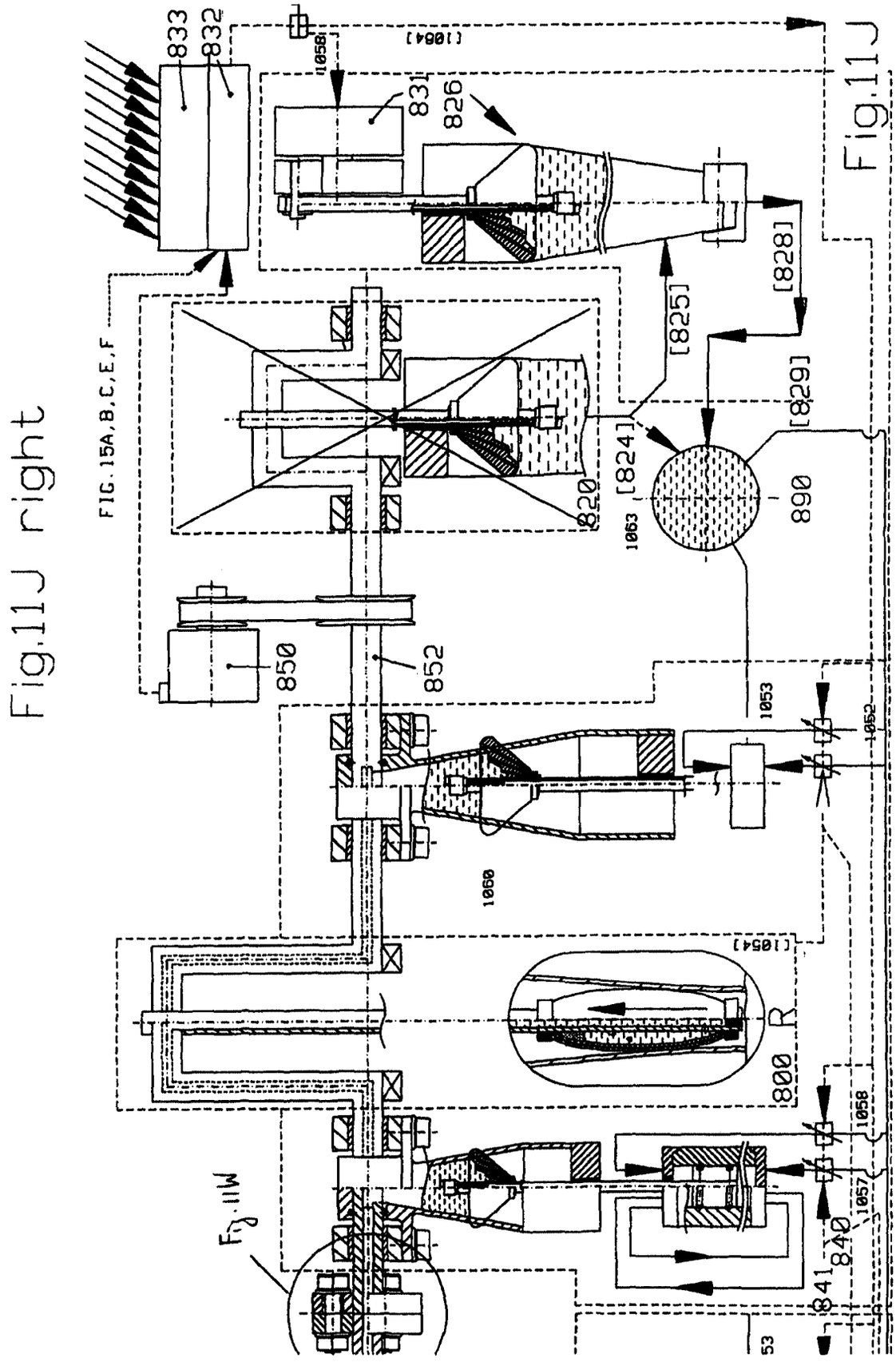

1060
1054
800
R
1058
1057
840
841
Fig.11W
1053
1052
1051
1054
800
1058
1057
840
841
835
836
(837)
830

Fig.11J left


Fig.11J right
FIG.15A,B,C,E,F
Fig.11J
833
832
831
826
[828]
[825]
[829]
[824]
820
890
850
852
1063
1053
1052
1060
1058
1057
840
841
800 R
53

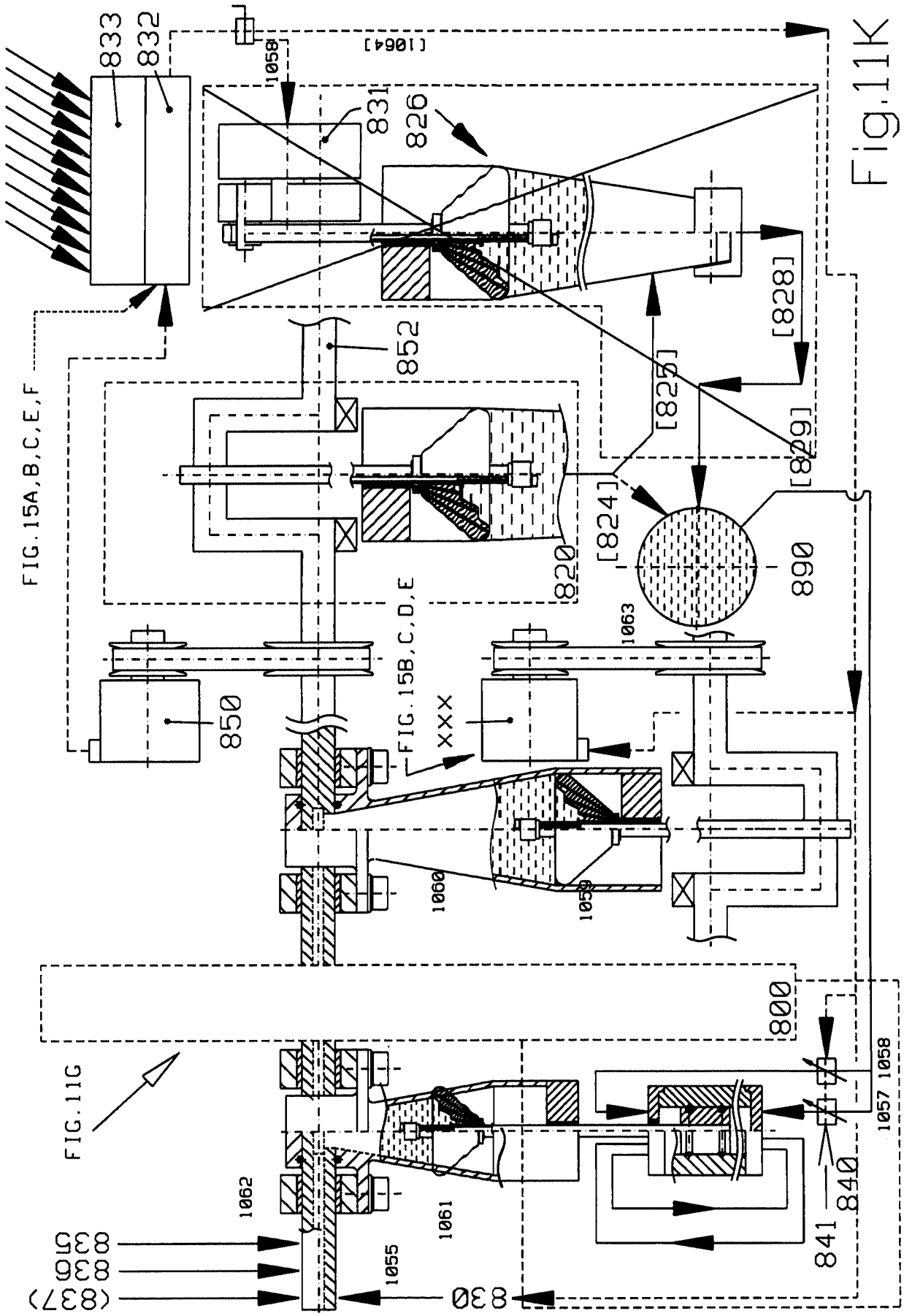
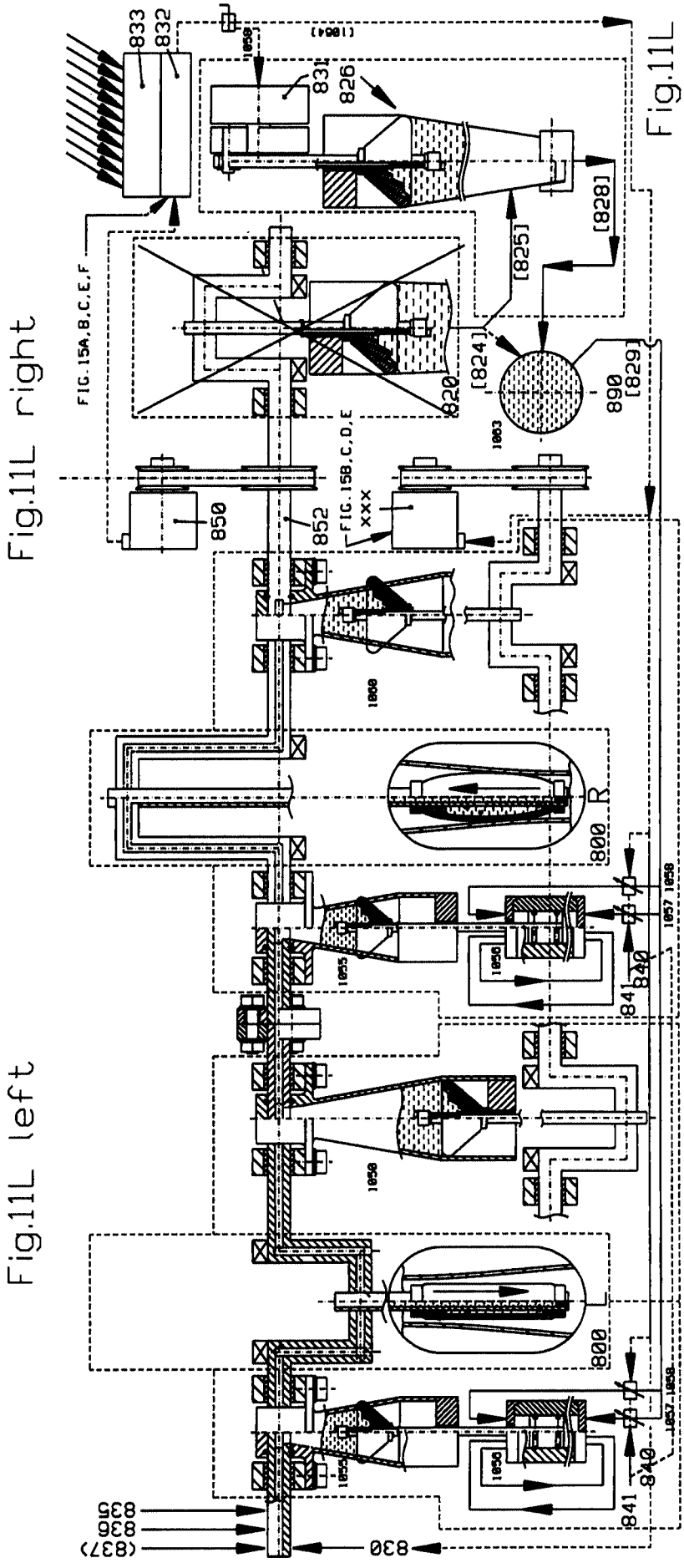

833
832
1058
[1064]
831
826
[828]
[825]
[829]
852
[824]
820
890
1063
850
FIG.15A,B,C,E,F
FIG.15B,C,D,E
XXX
1060
1059
800
FIG.11G
1062
1061
1055
835
836
837
830
1057
1058
840
841

Fig.11K


Fig.11L right
Fig.11L left
Fig.11L
833
832
831
826
[828]
[825]
[824]
820
890
[829]
FIG.15A,B,C,E,F
FIG.15B,C,D,E
850
852
XXX
800
R
840
841
835
836
837
830

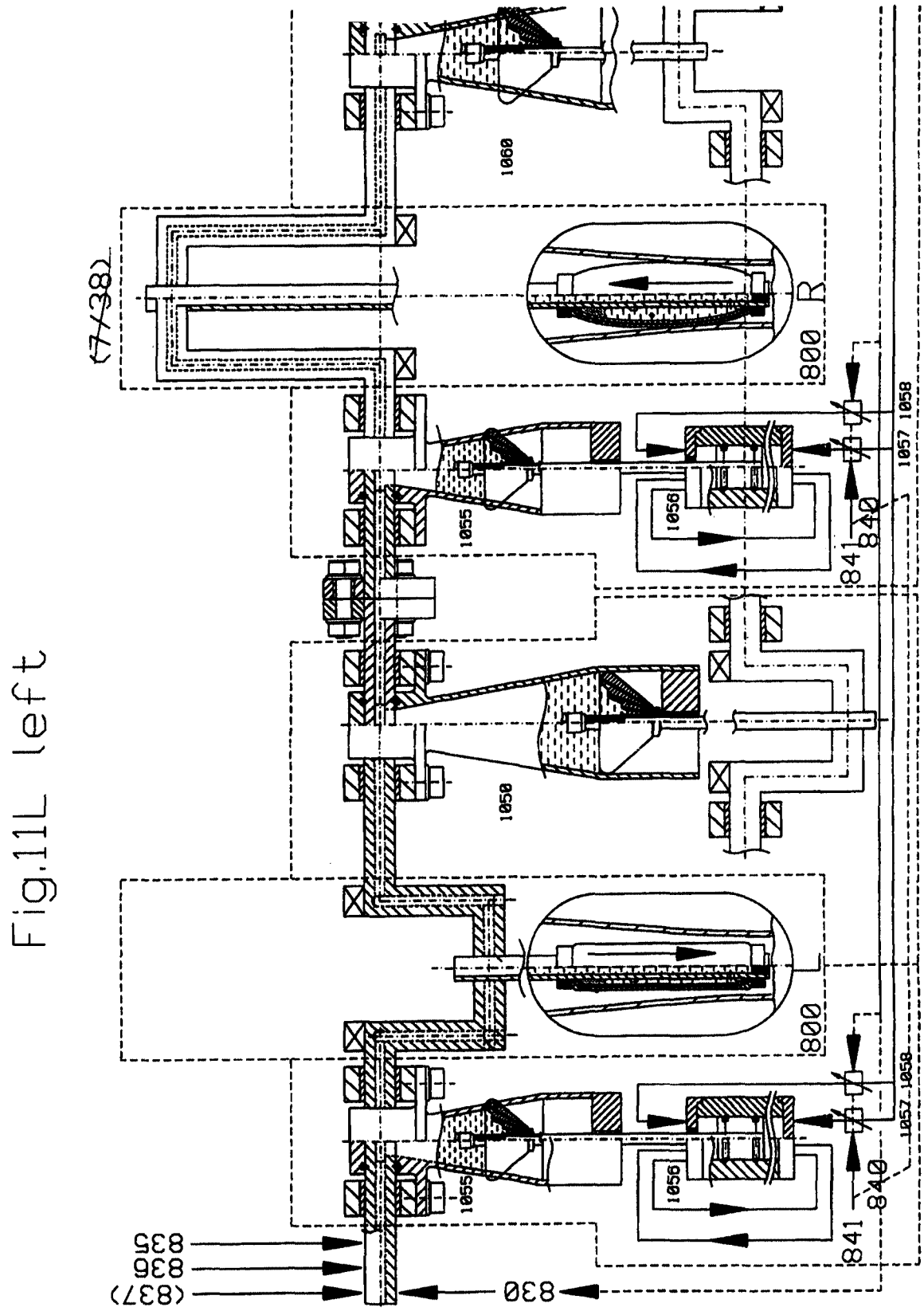

(738)
1000
800 R
1057 1058
1056
1055
840
841
1050
800
1057 1058
1056
1055
840
841
835
836
(837)
830

Fig.11L left

Fig.11L right

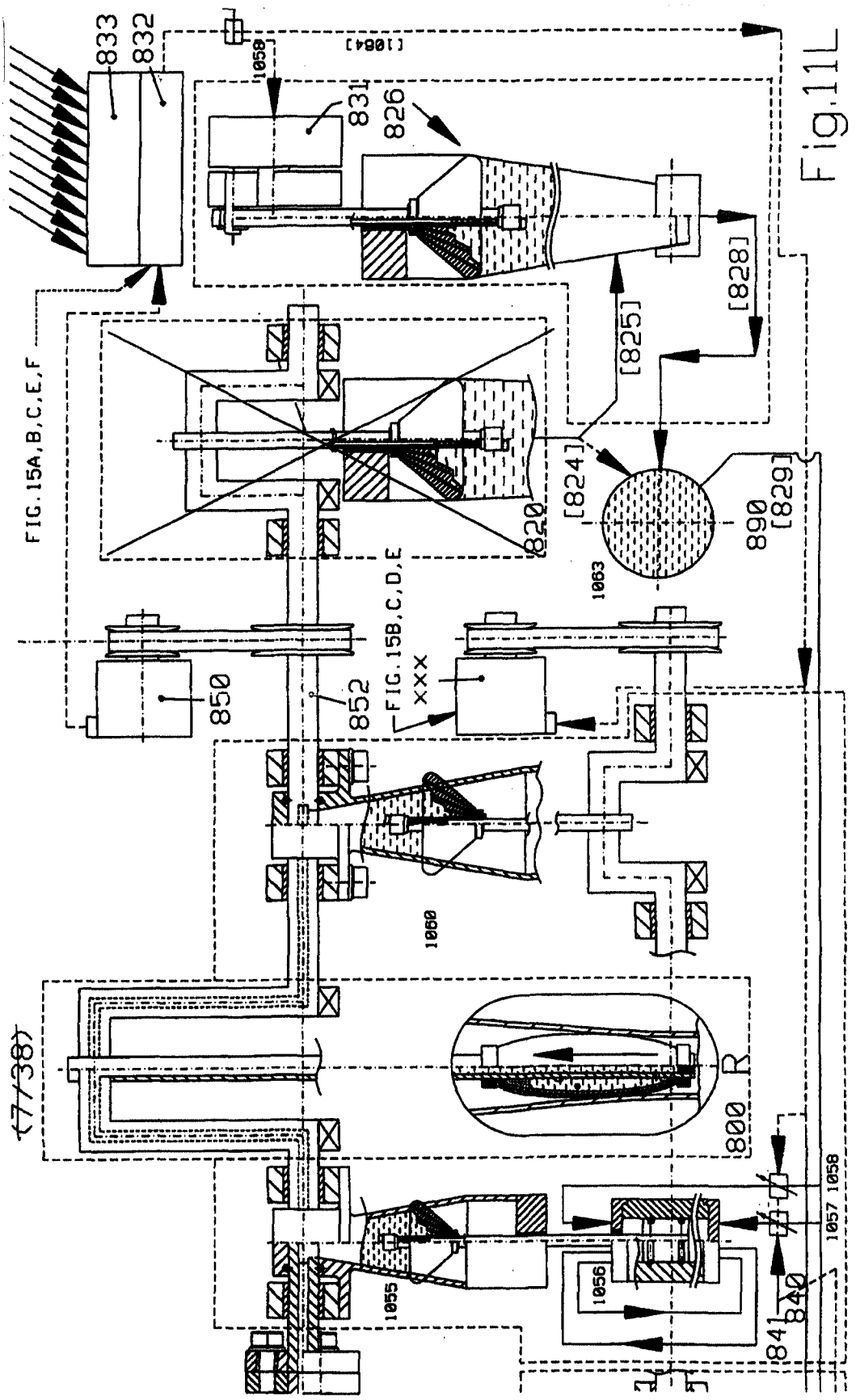


Fig.11L

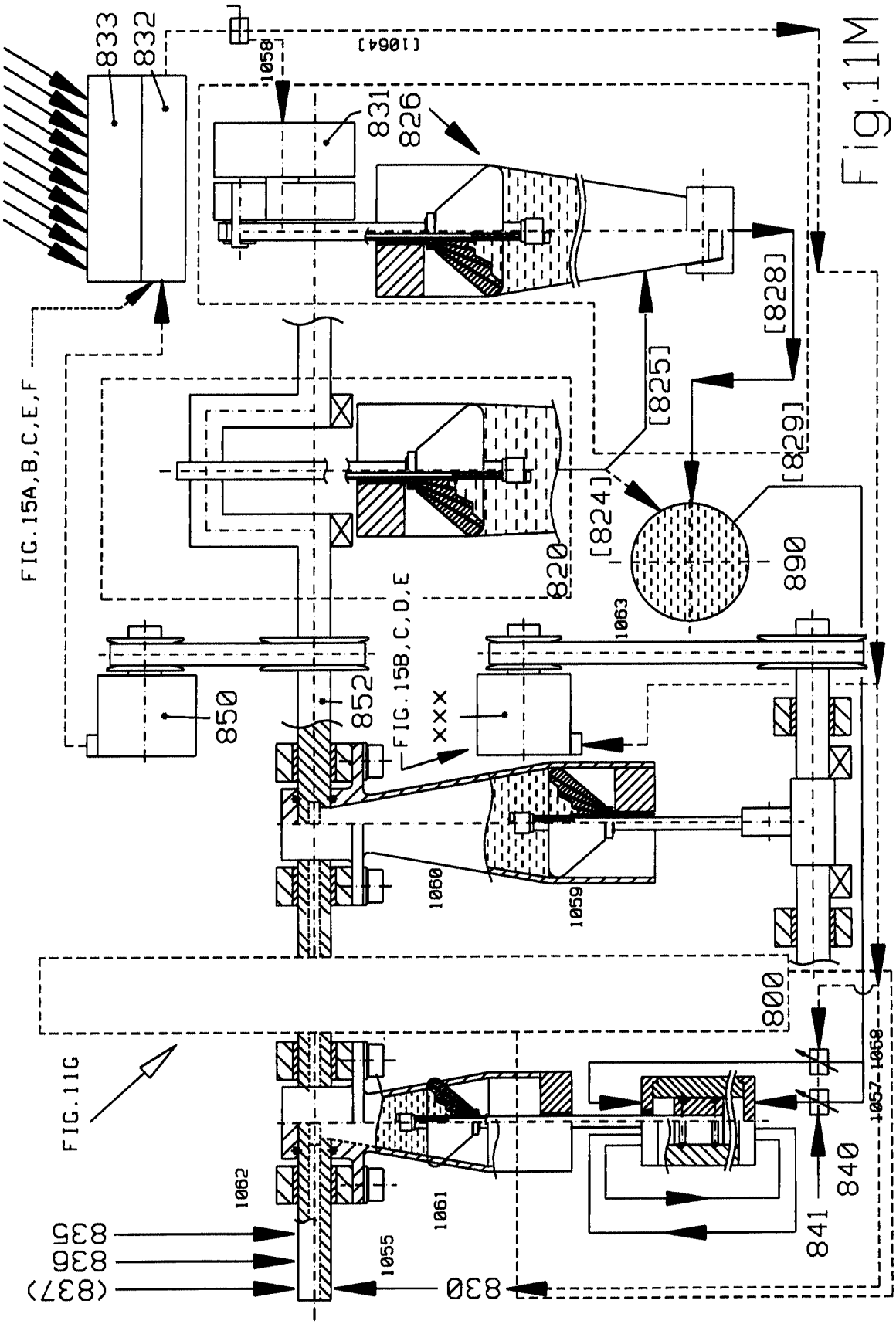

833
832
1058
[1064]
831
826
[828]
[825]
[829]
[824]
820
890
1063
FIG.15A,B,C,E,F
FIG.15B,C,D,E
850
852
XXX
1060
1059
800
FIG.11G
1062
1061
1055
837
835
833
830
840
841
1057
1058

Fig.11M

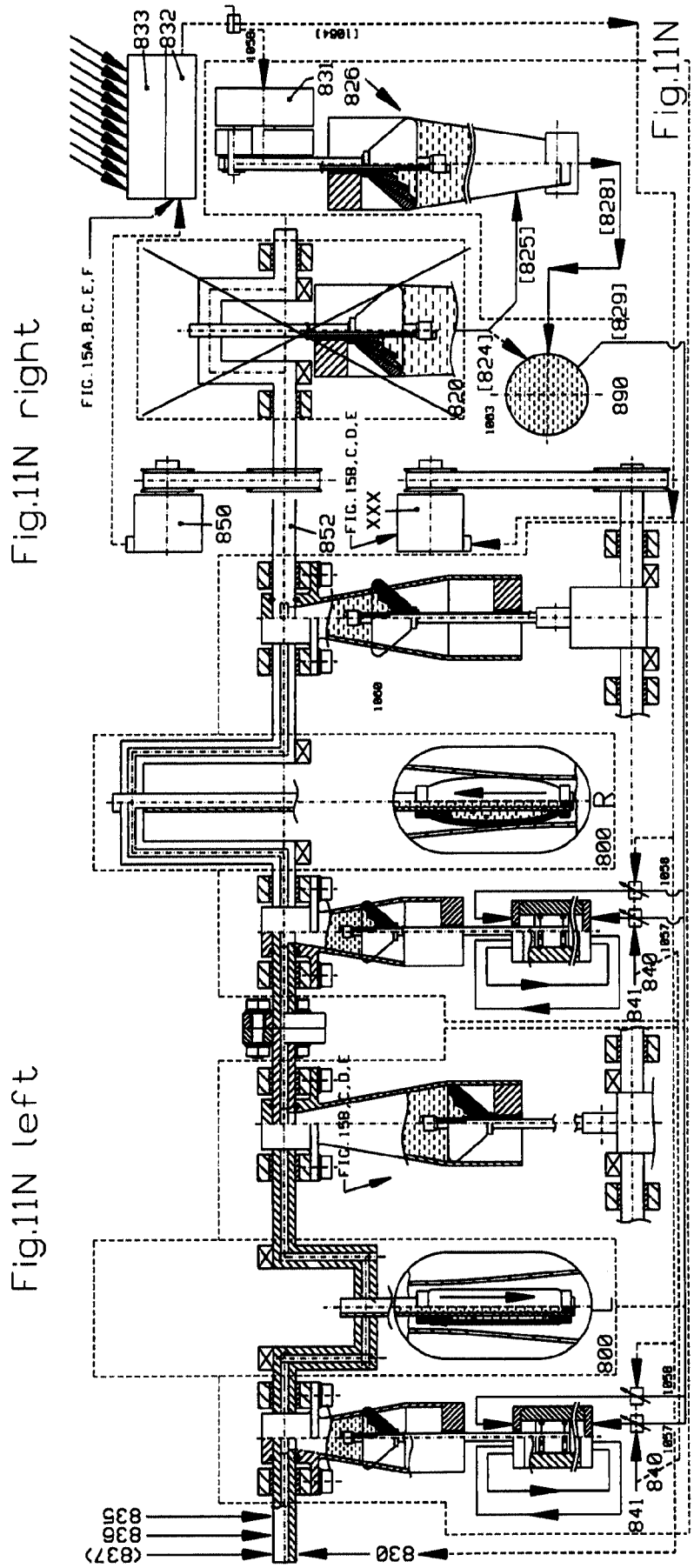

Fig.11N
Fig.11N right
Fig.11N left
833
832
831
826
[828]
[825]
[829]
[824]
820
890
850
852
XXX
800
R
840
841
835
836
(837)
830
FIG.15A,B,C,E,F
FIG.15B,C,D,E
FIG.15B,C,D,E

Fig.11N left

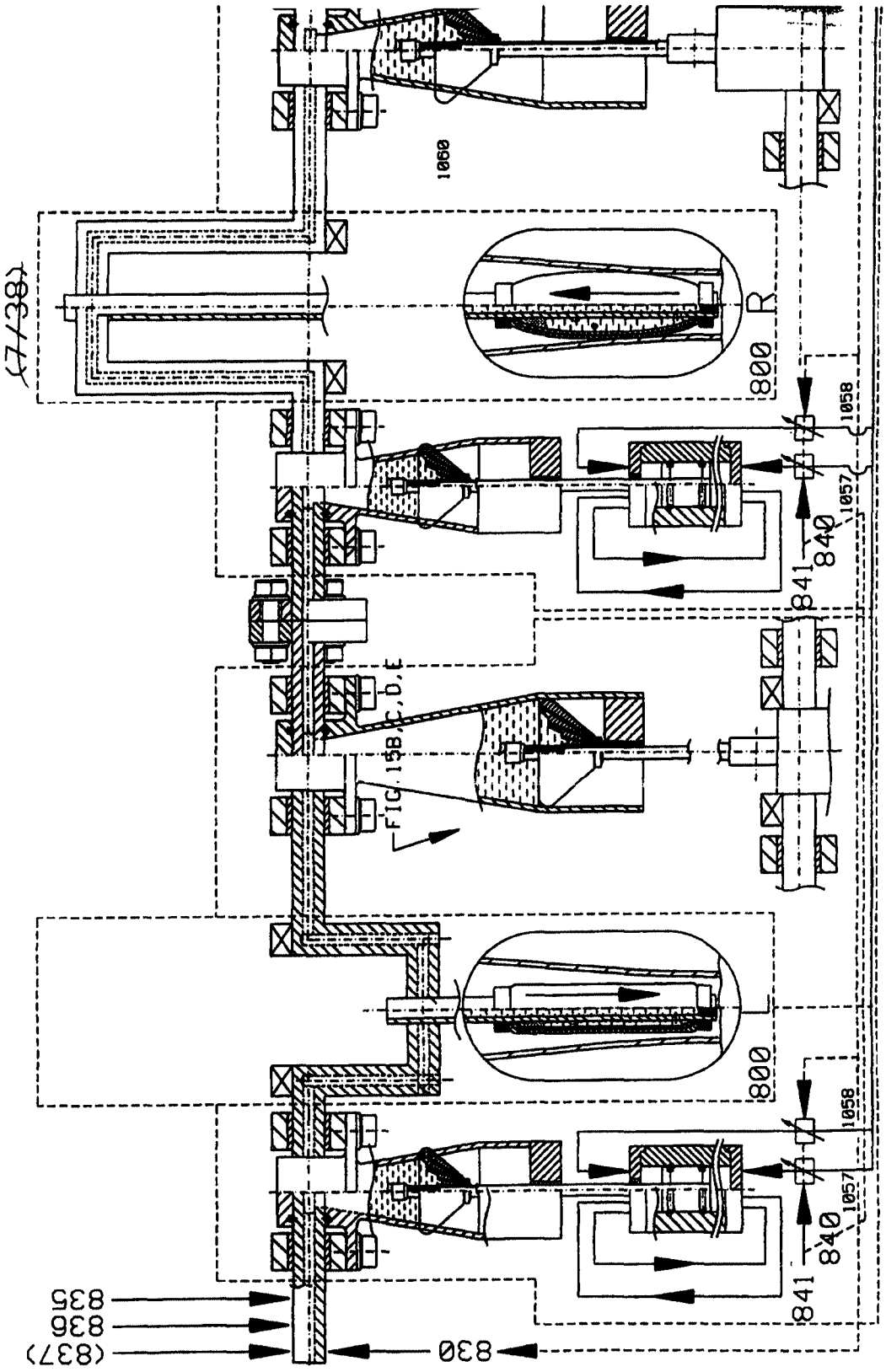

1060
800 R
1058
1057
840
841
Fig.15B,C,D,E
800
1058
1057
840
841
835
836
(837)
830
(738)

Fig.11N right

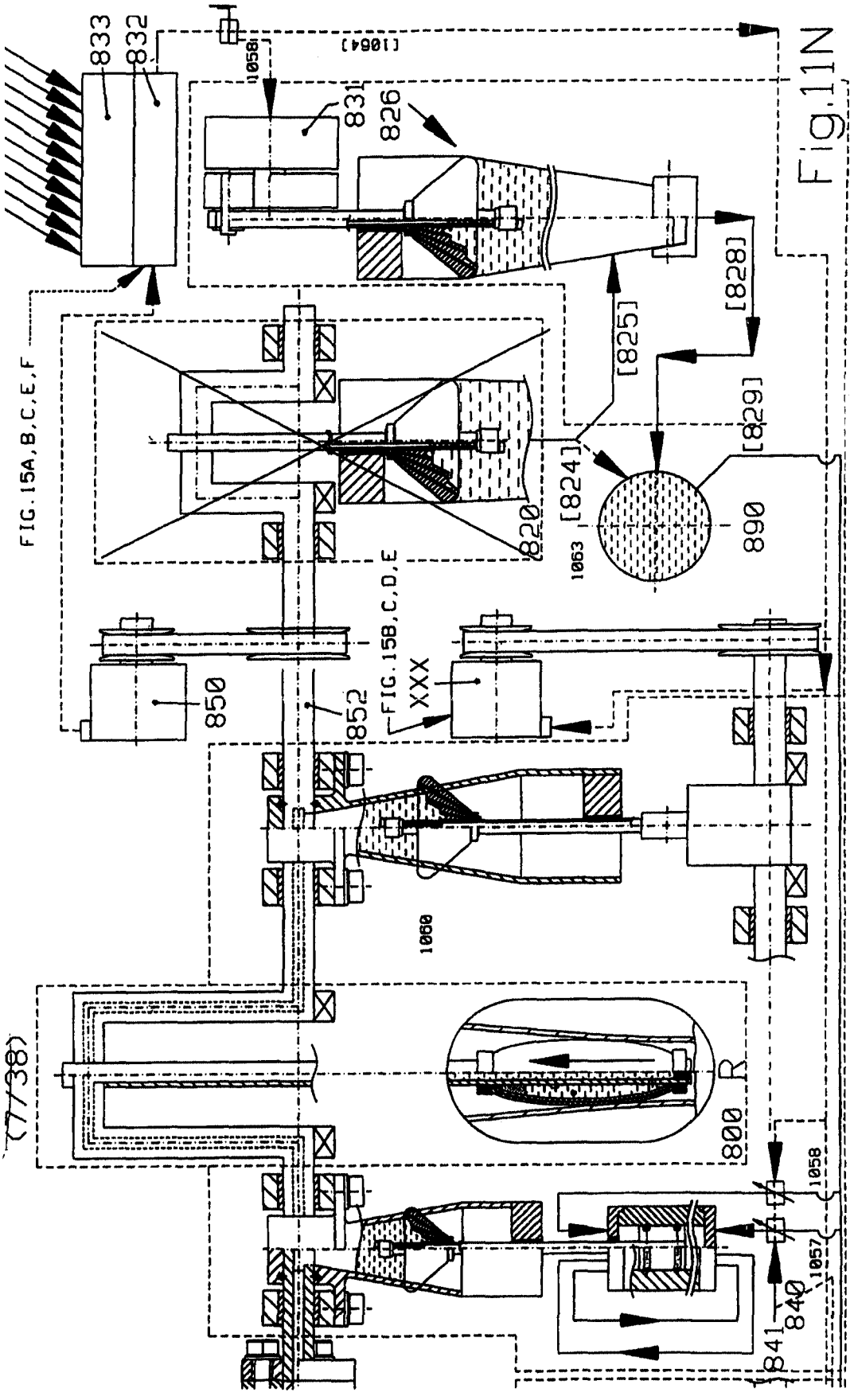


Fig.11N

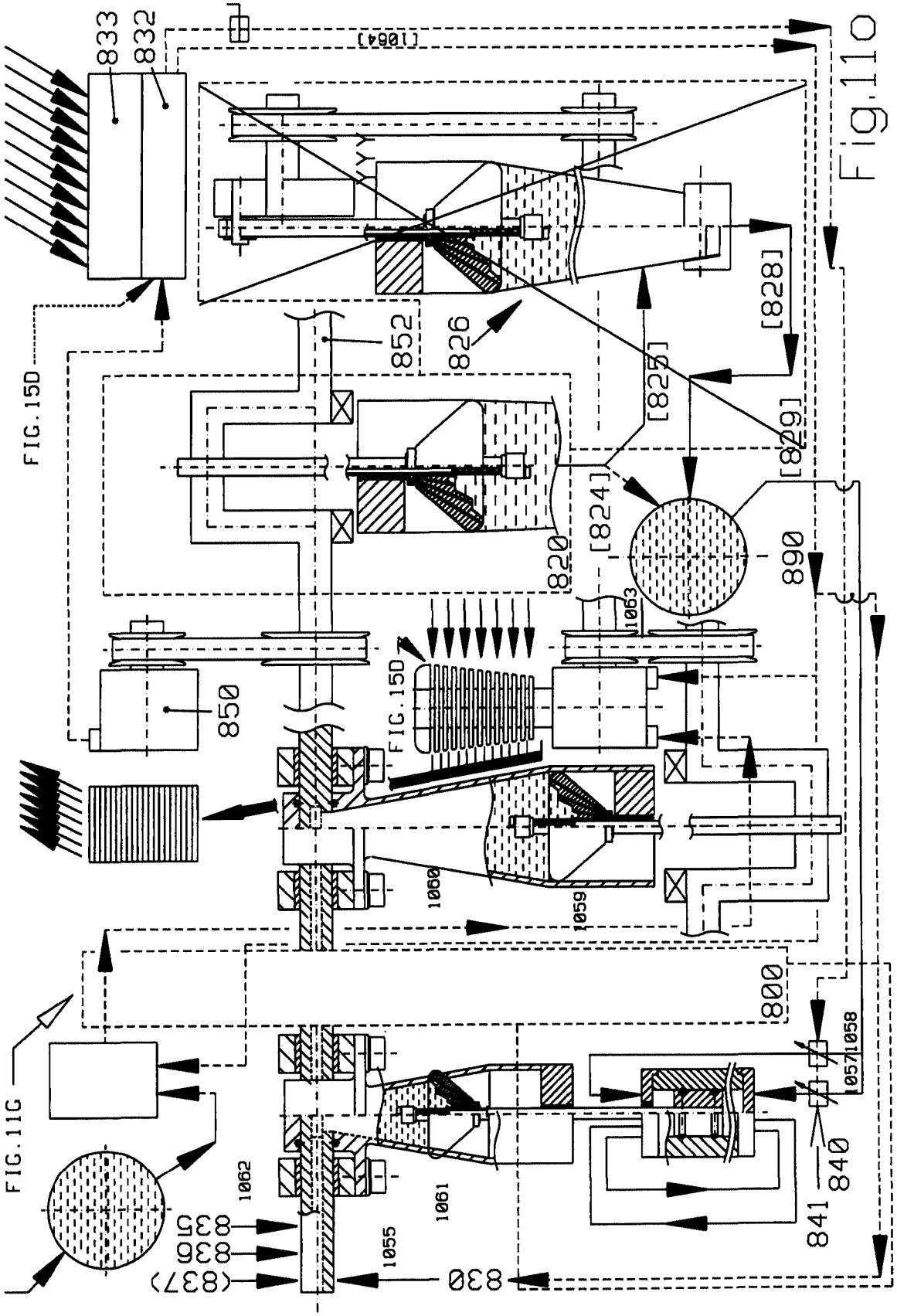

833
832
[1064]
852
826
[828]
[825]
[826]
[824]
820
890
850
FIG.15D
FIG.15D
1063
1060
1059
800
1057
1058
840
841
FIG.11G
1062
1061
1055
835
836
(837)
830

FIG.110

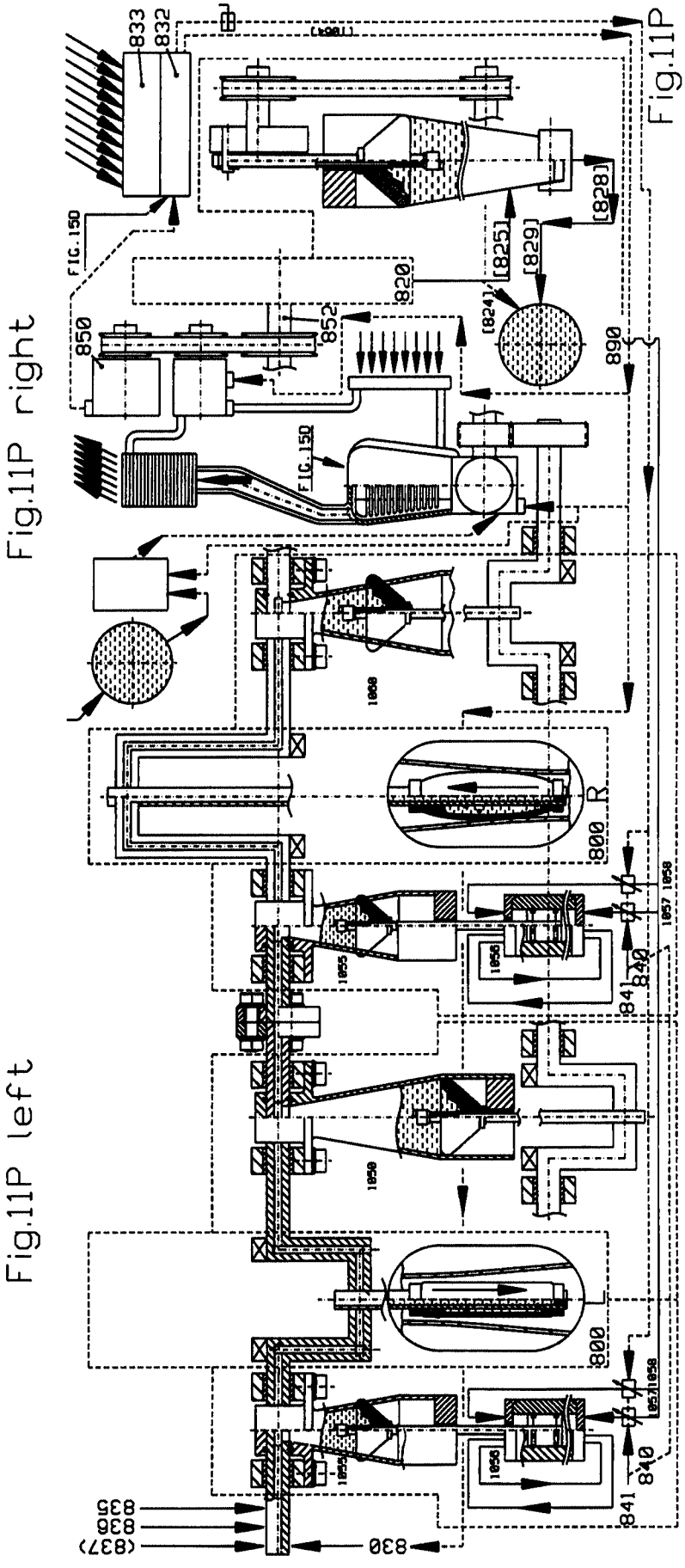

Fig.11P right
Fig.11P left
Fig.11P
833
832
FIG.150
820
850
852
[825]
[829]
[828]
[824]
890
FIG.150
800 R
800 L
840
841
1656
1657
1658
835
836
(837)
830

Fig.11P left

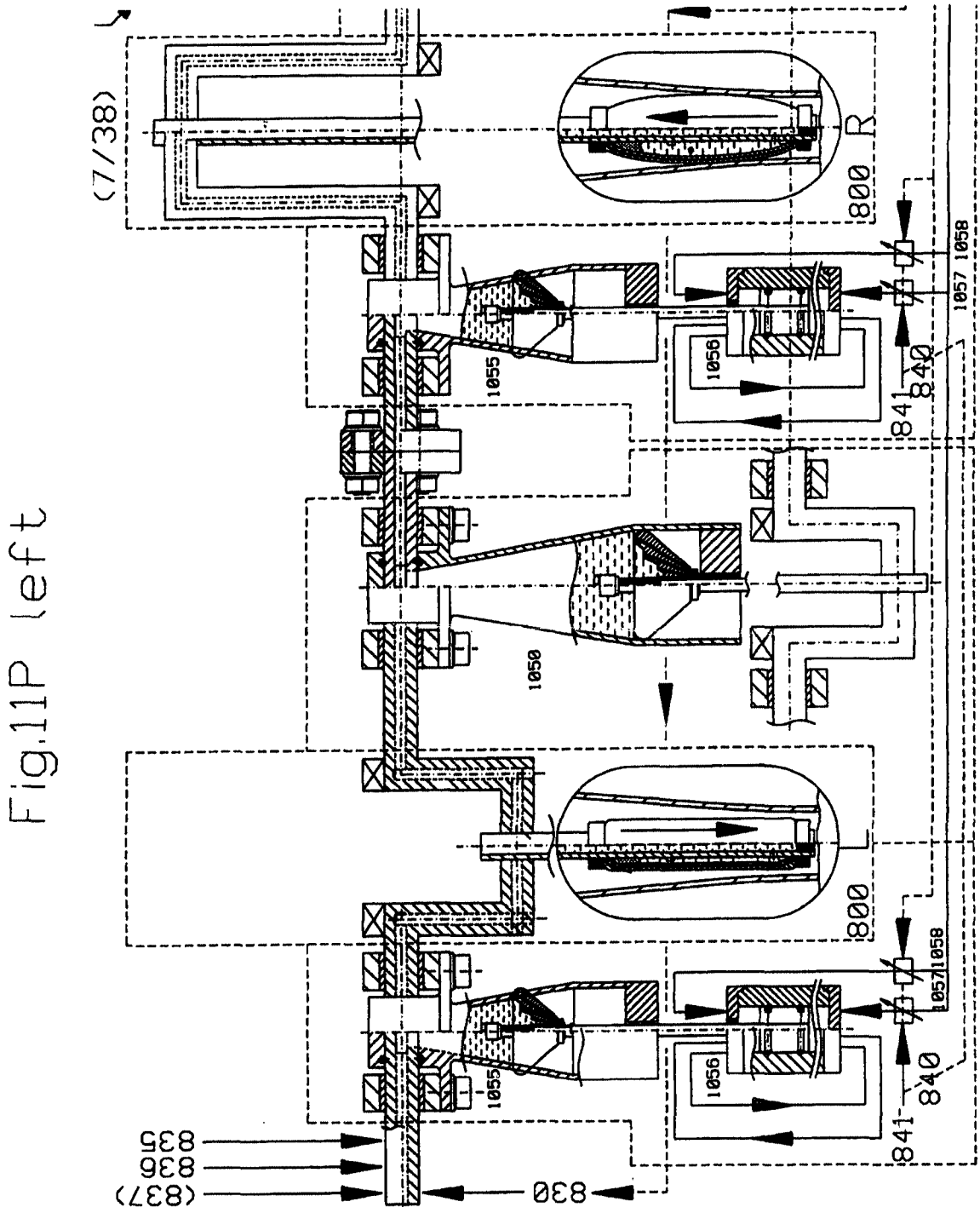


Fig.11P right

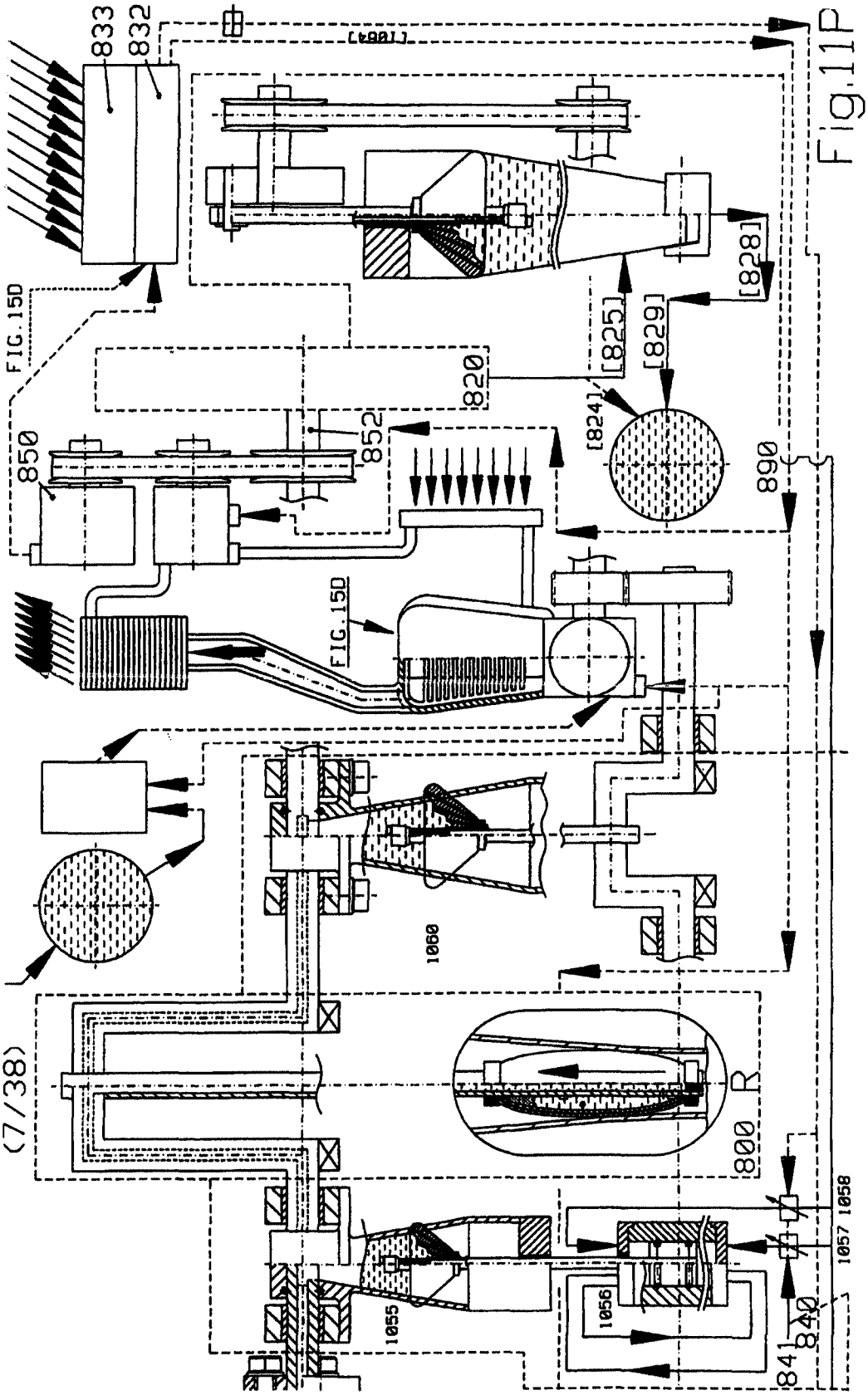


Fig.11P

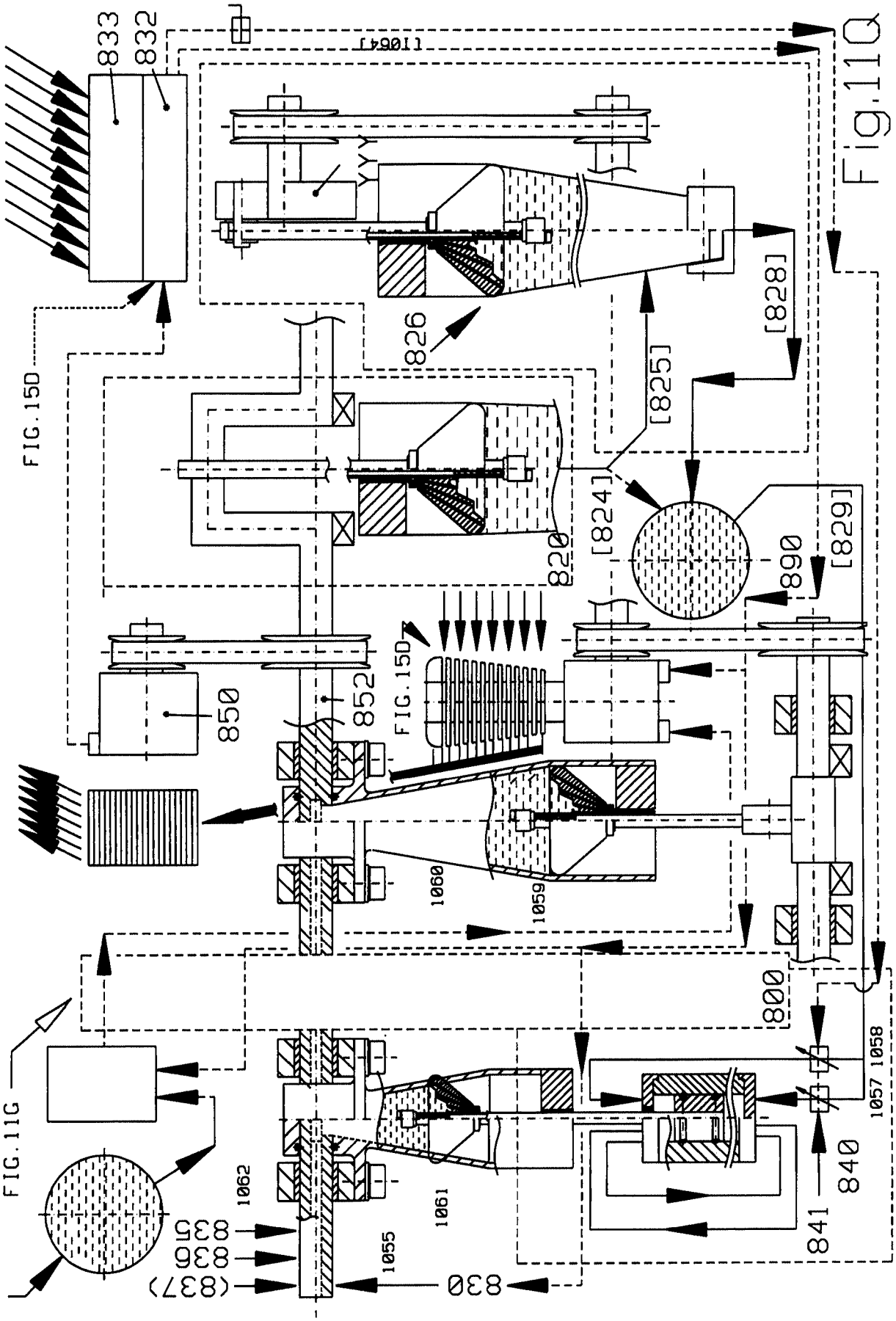

833
832
1064
826
[828]
[825]
FIG. 15D
820
[824]
890
[829]
850
852
FIG. 15D
1060
1059
800
1057
1058
840
841
FIG. 11G
1062
1061
835
836
837
1055
830

Fig.11Q

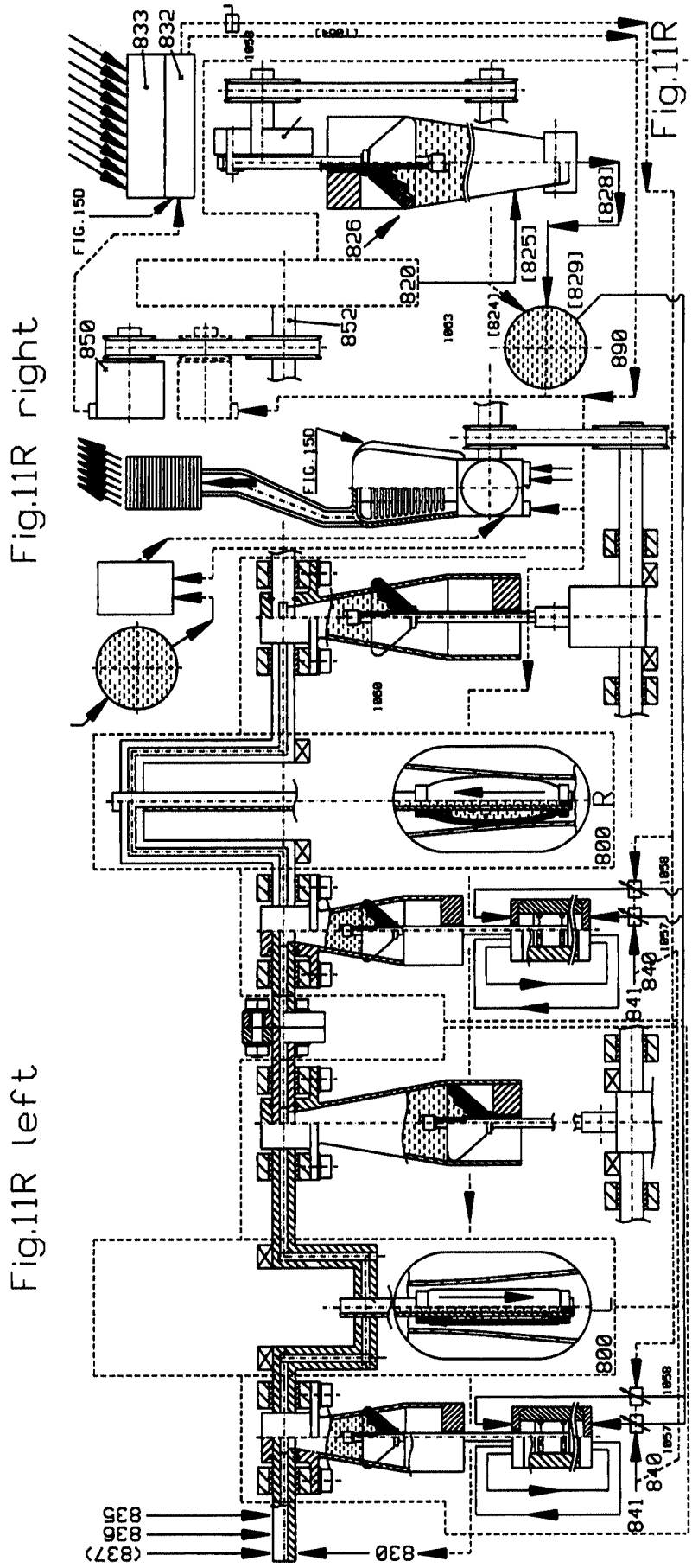

Fig.11R right
Fig.11R left
Fig.11R
833
832
826
820
[825]
[828]
[829]
[824]
850
852
890
800
840
841
835
836
(837)
830

Fig.11R left

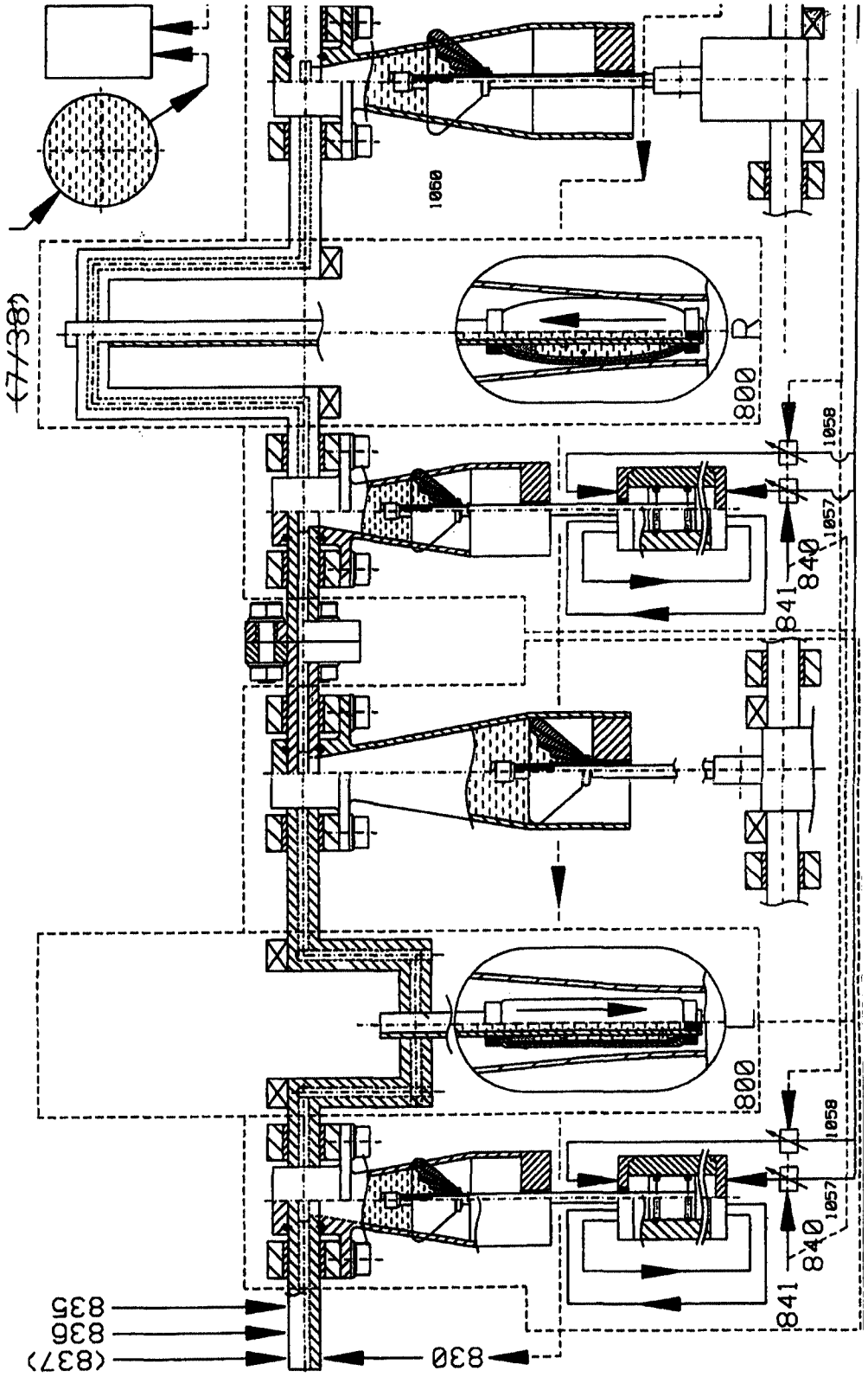

1060
(738)
800
R
1058
1057
840
841
800
1058
1057
840
841
835
836
(837)
830

Fig.11R right

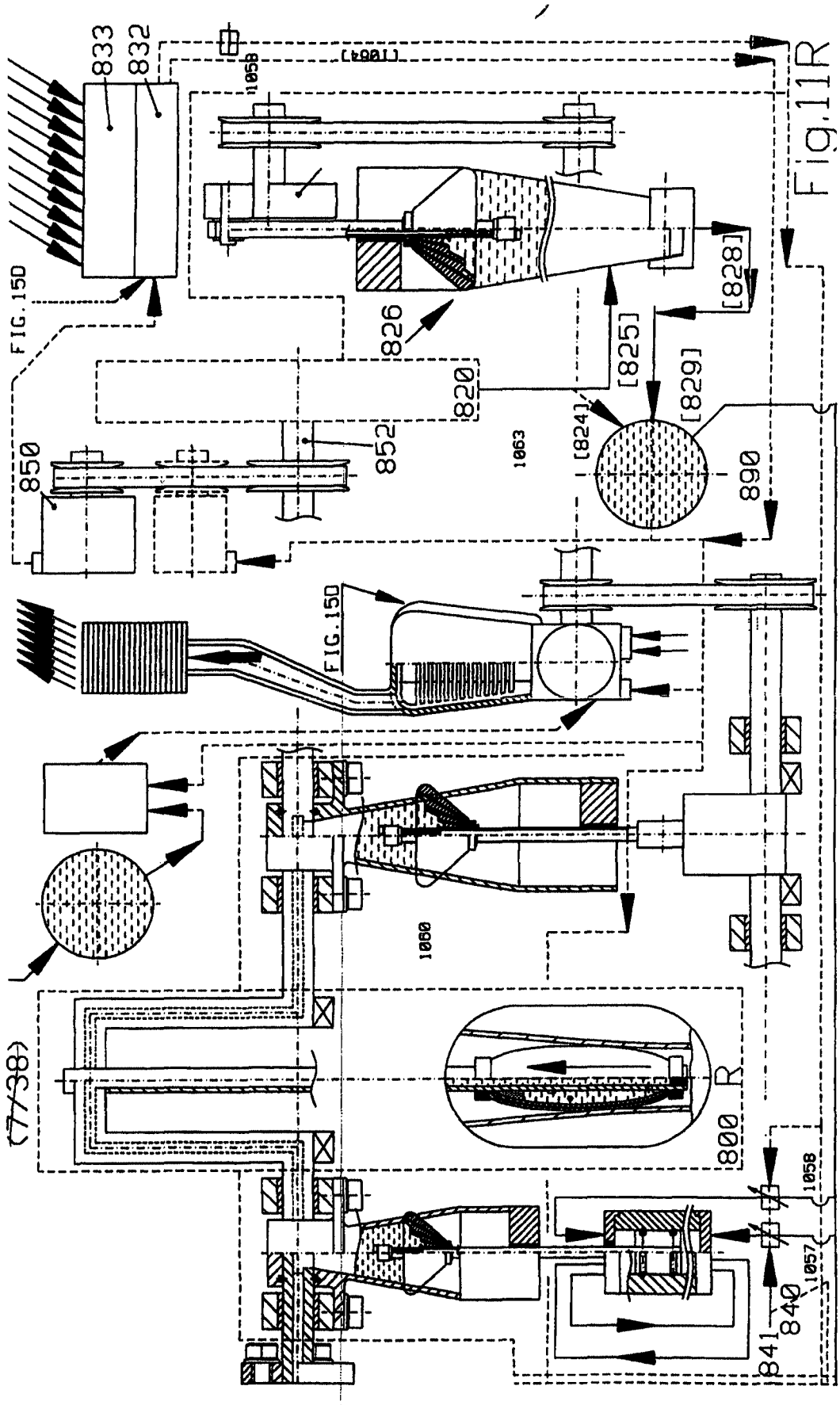


Fig.11R

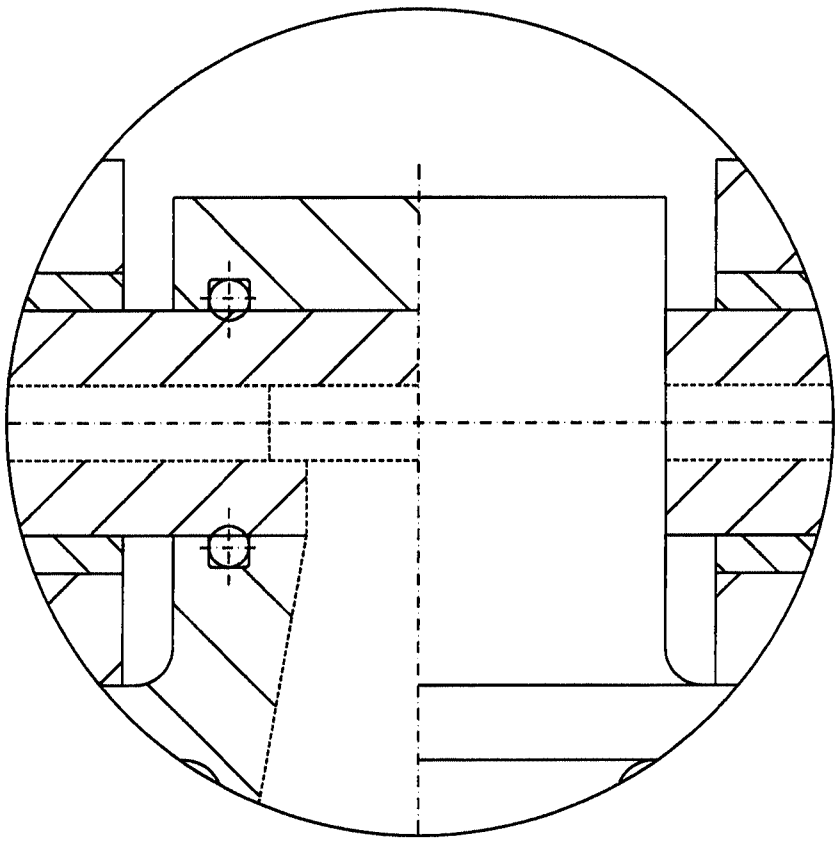


Fig.11S

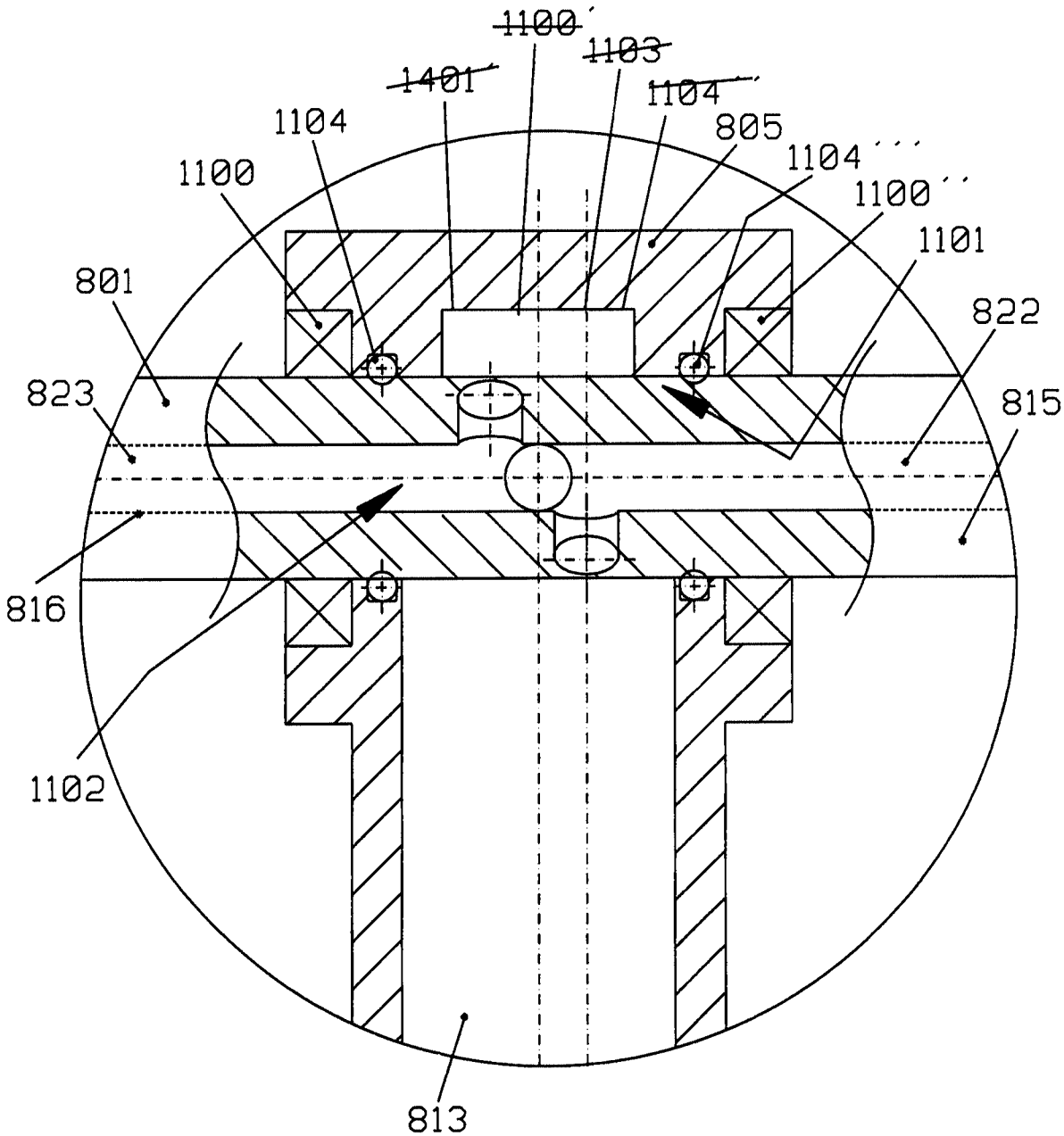

1100'
1103
1401'
1104'
1104
805
1104''
1100
1100''
1101
801
822
823
815
816
1102
813

Fig.11T

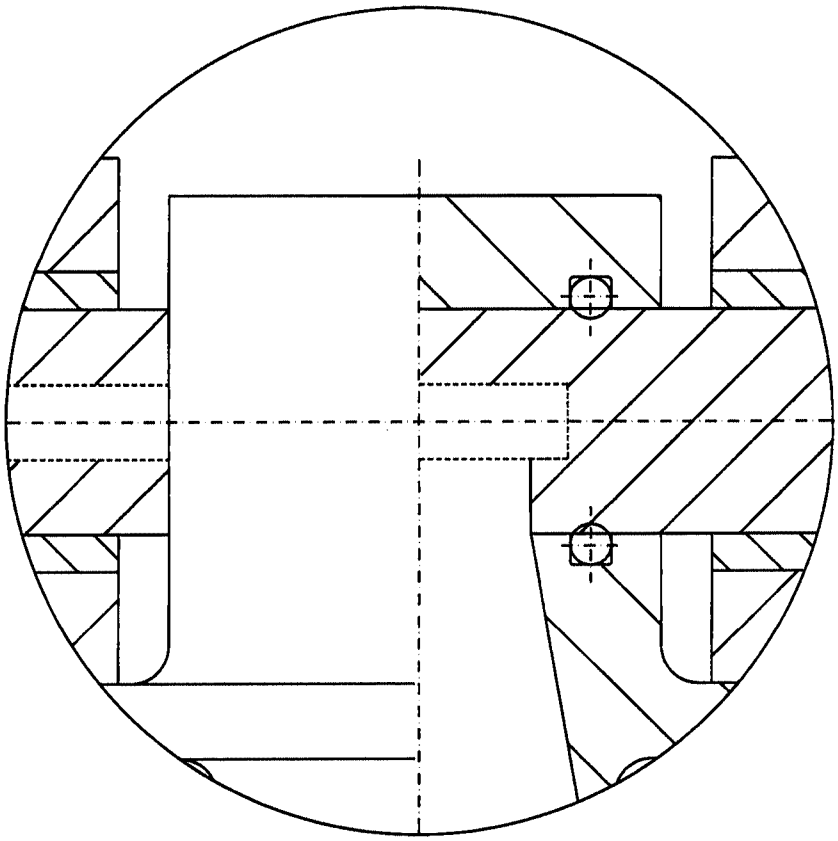


Fig.11U

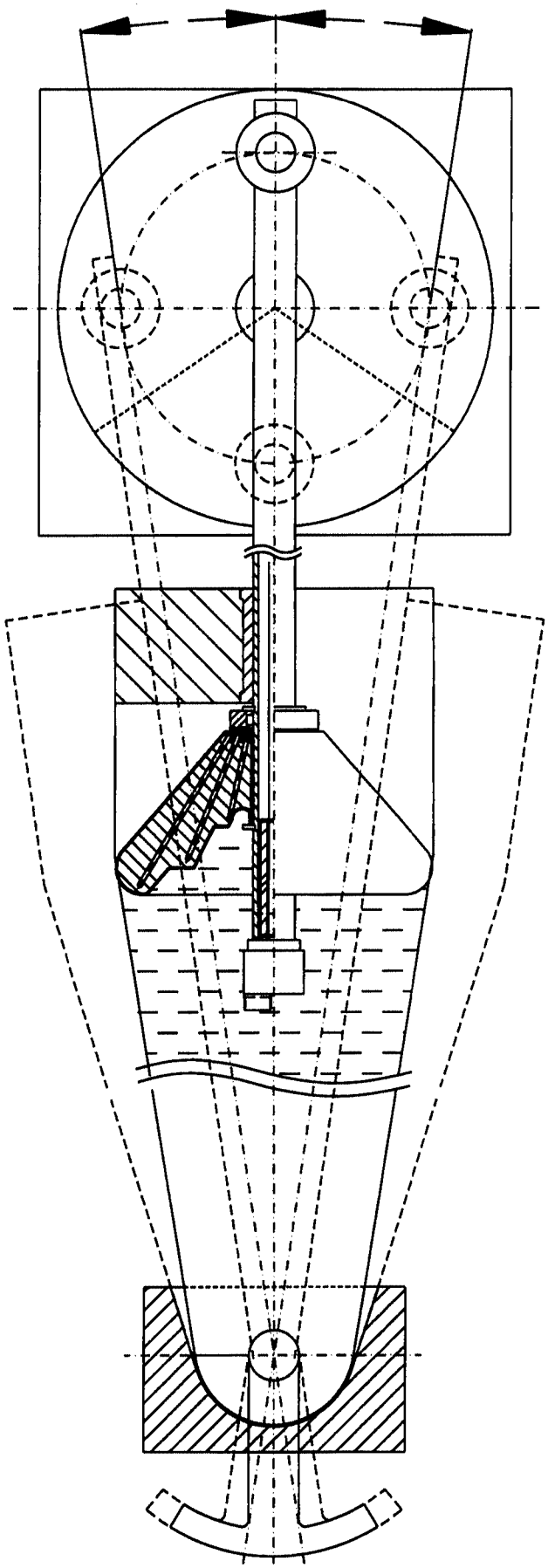


Fig.11V

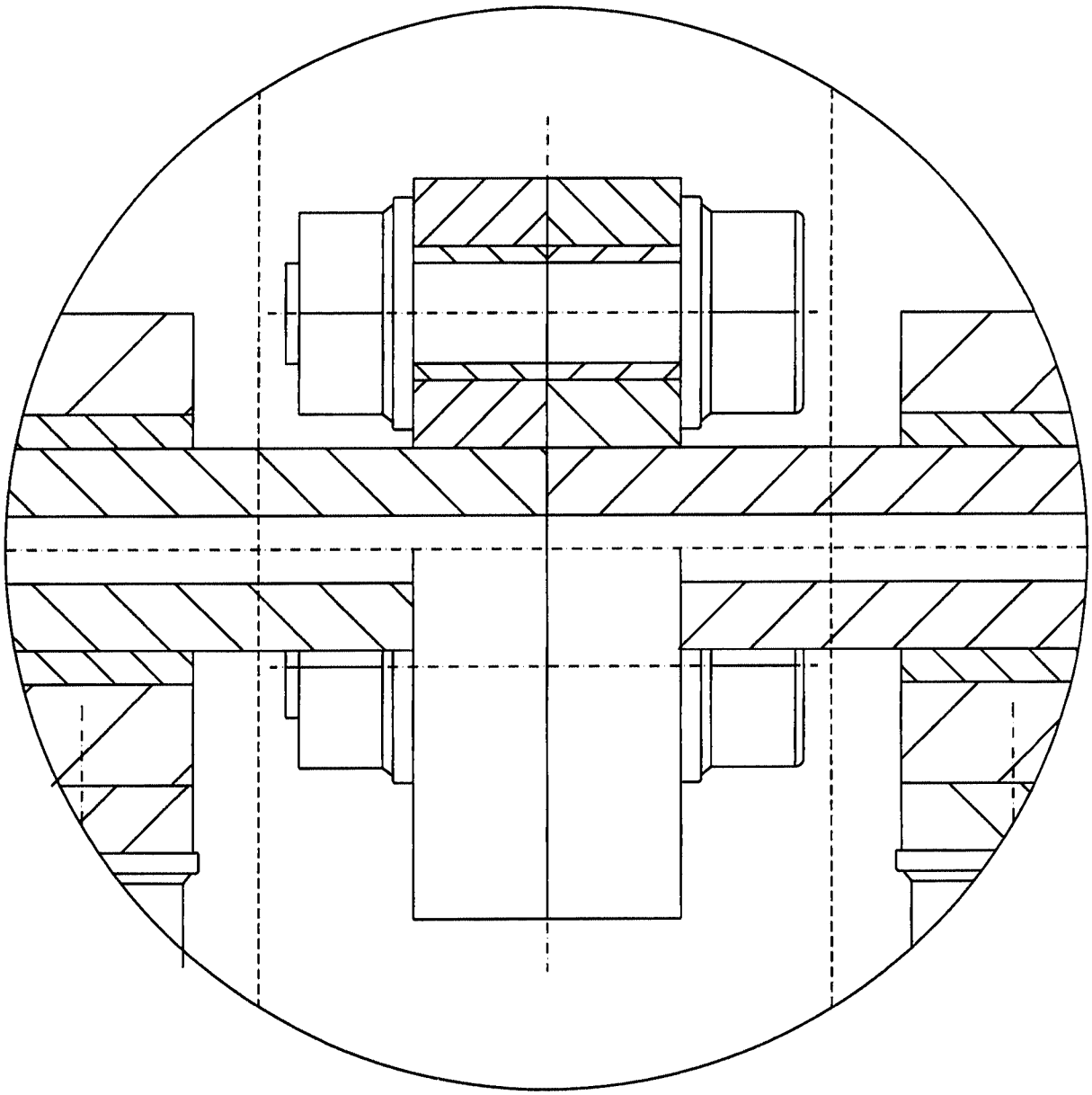


Fig.11W

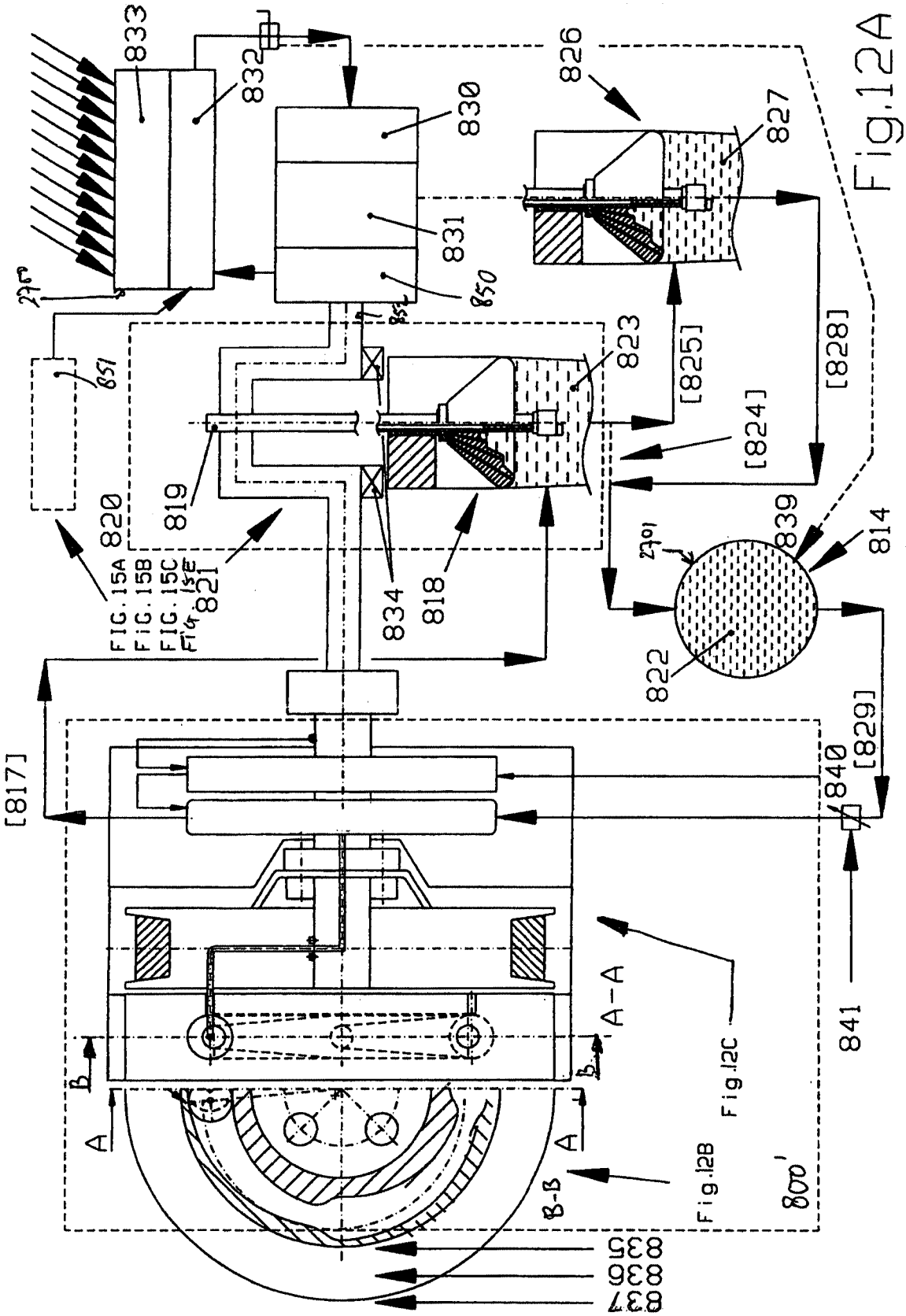

833
832
826
830
827
831
850
851
823
[825]
[828]
[824]
819
820
821
834
818
839
814
822
[817]
[829]
840
841
A-A
B-B
A
B
Fig.12B
Fig.12C
800'
835
836
837

Fig.12A

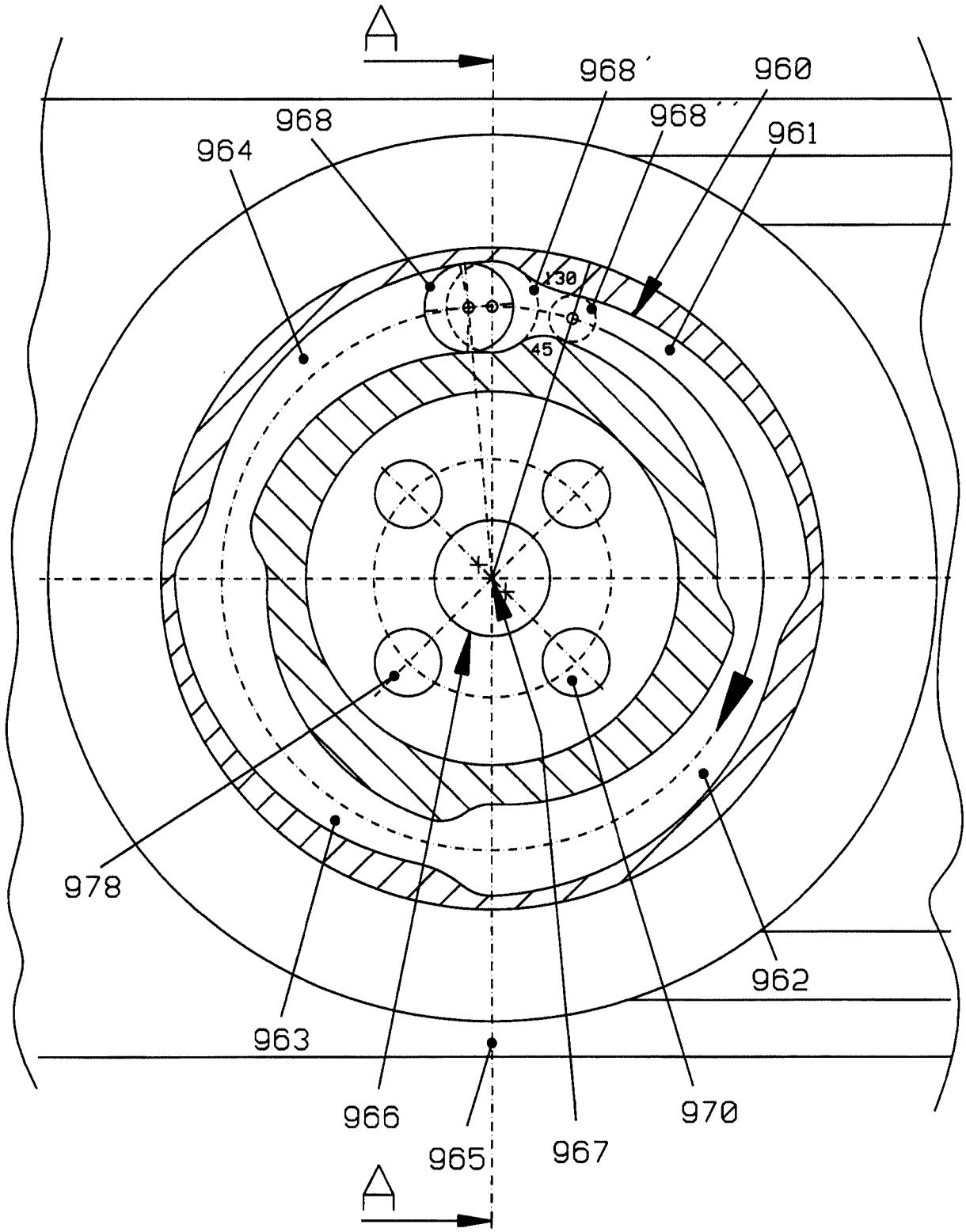


Fig.12B

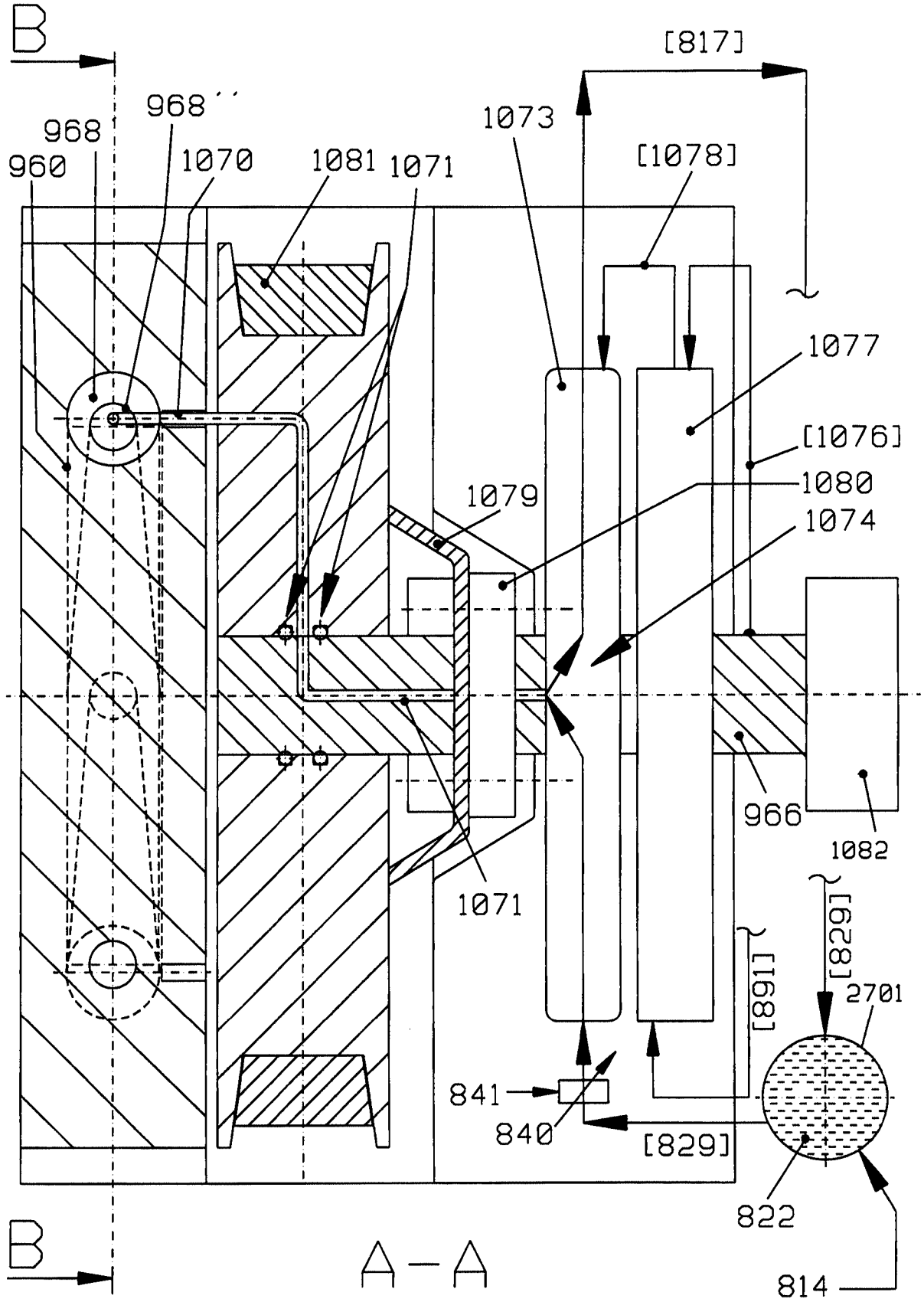

B
[817]
968''
968
960
1070
1081
1071
1073
[1078]
1077
[1076]
1080
1079
1074
966
1082
1071
[829]
[831]
2701
841
840
[829]
822
814
B
A – A

Fig.12C

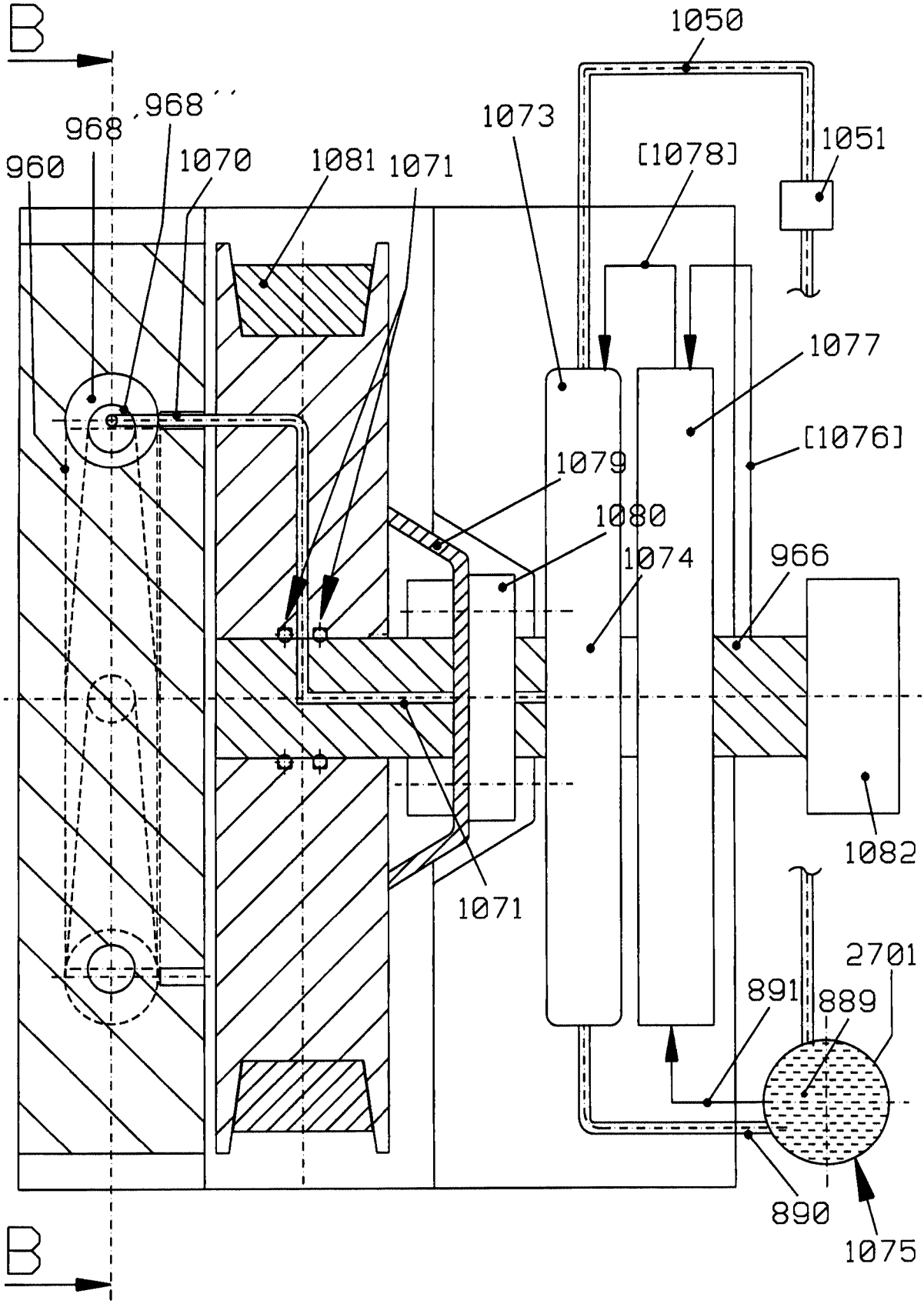

B
1050
968''
968'
960
1070
1081
1071
1073
[1078]
1051
1077
[1076]
1079
1080
1074
966
1082
1071
2701
891
889
890
1075
B

Fig.12D

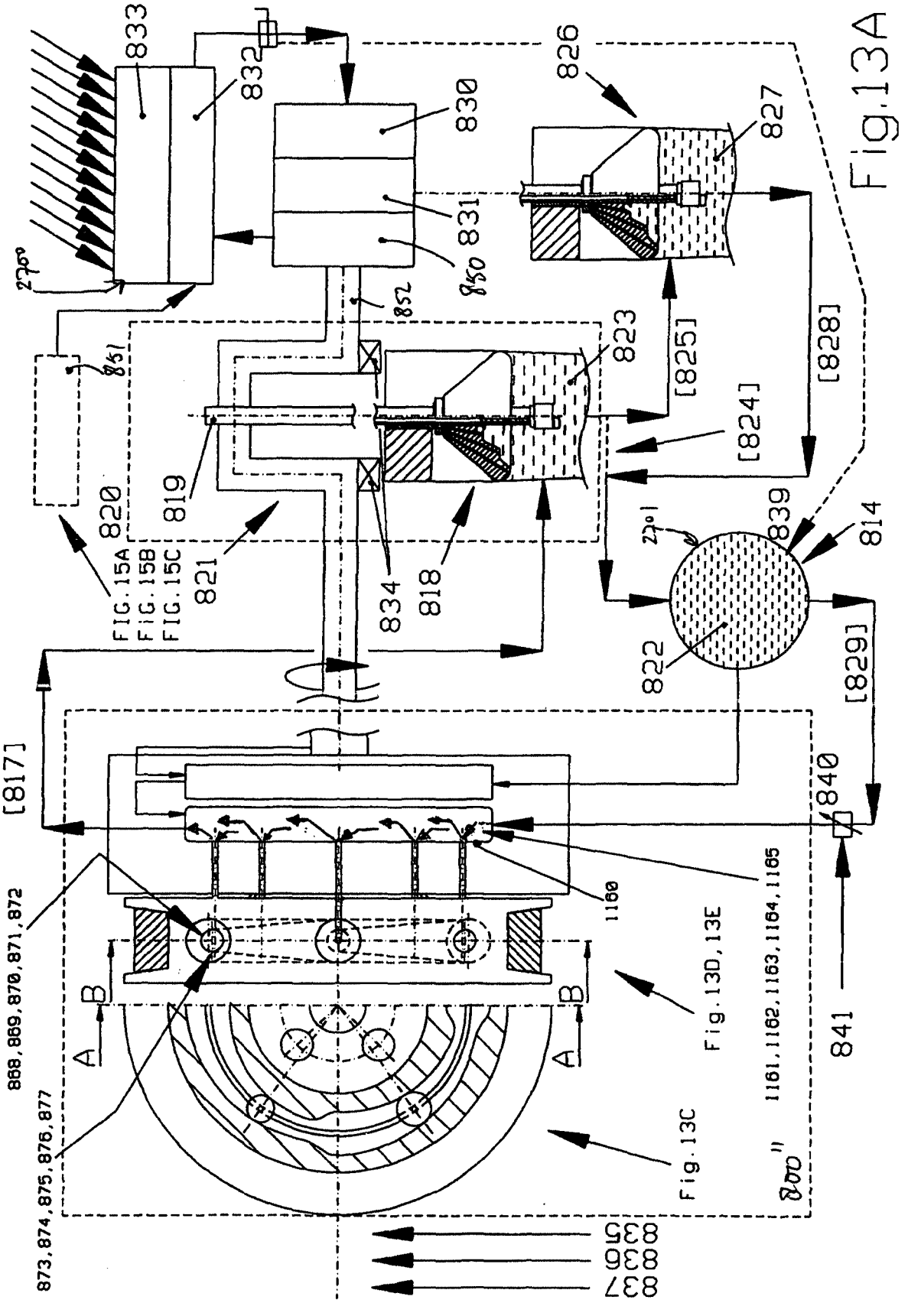

833
832
826
830
827
831
850
852
851
823
[825]
[828]
[824]
820
819
821
818
834
839
814
822
[829]
[817]
840
841
868,869,870,871,872
873,874,875,876,877
1160
1161,1162,1163,1164,1165
Fig.13D,13E
Fig.13C
835
836
837
A
B

Fig.13A

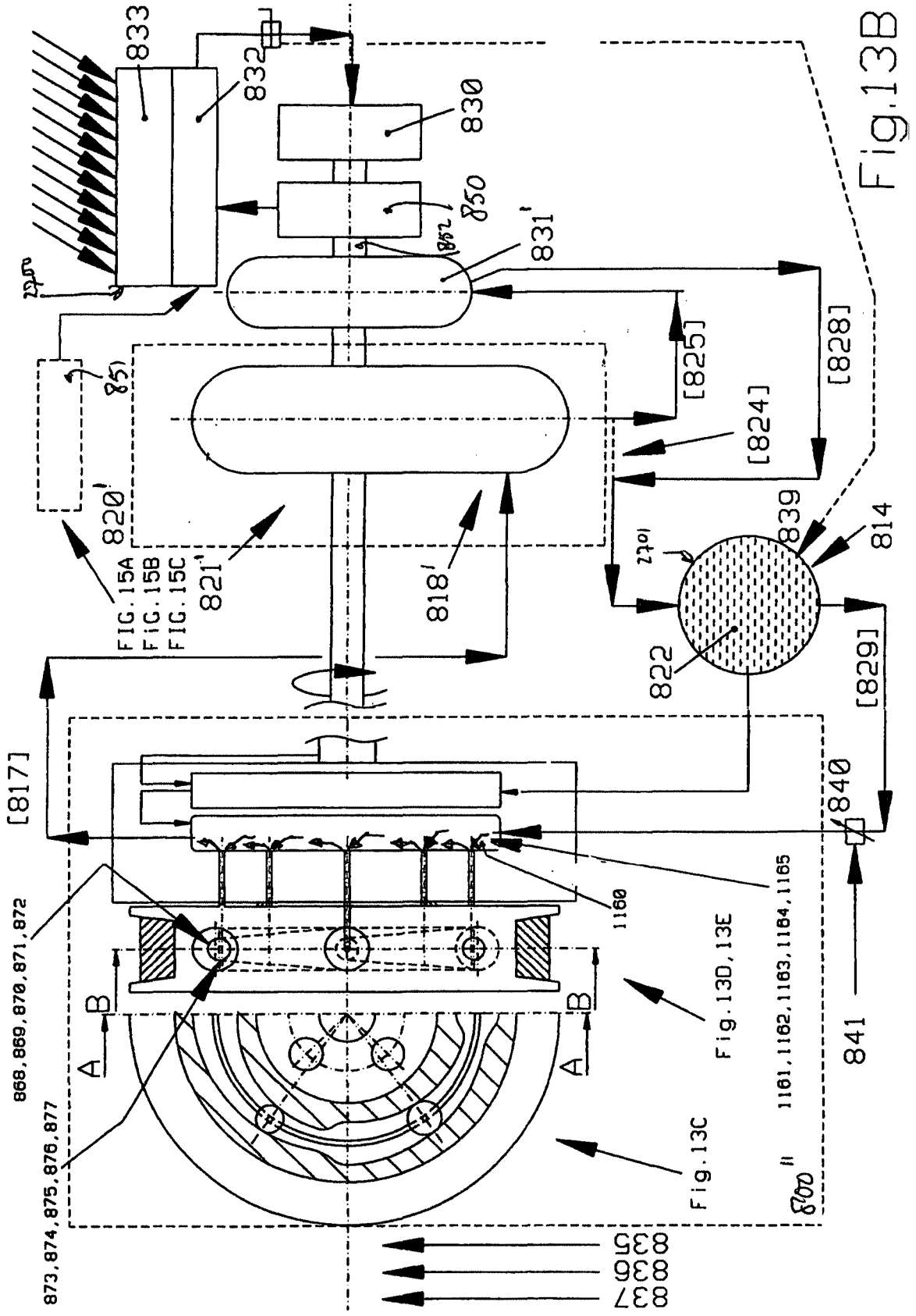
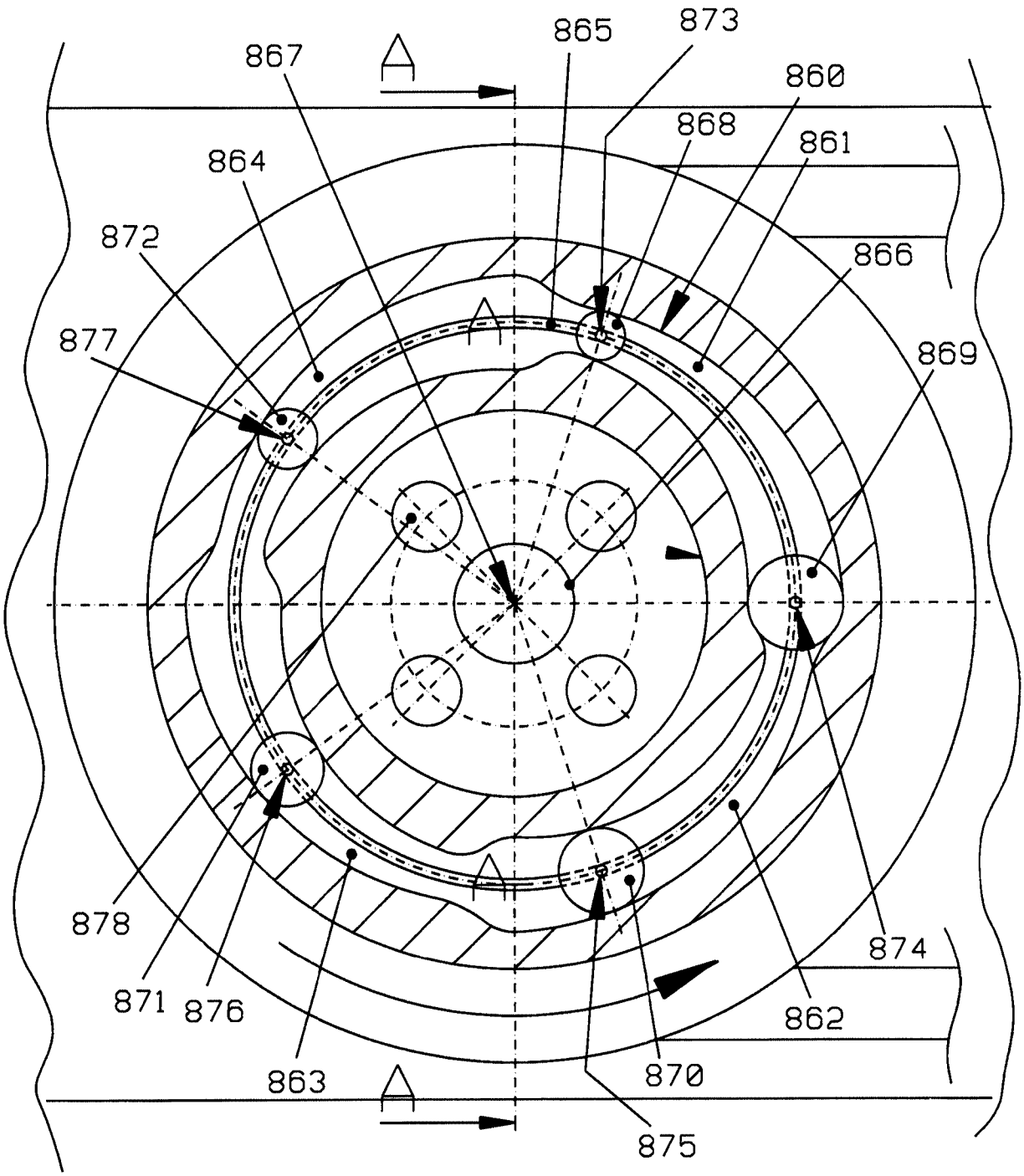

833
832
830
850
831'
[825]
[828]
[824]
820'
821'
818'
839
814
822
[829]
[817]
840
841
1160
868,869,870,871,872
873,874,875,876,877
A
B
Fig.13D,13E
Fig.13C
1161,1162,1163,1164,1165
FIG.15A
FIG.15B
FIG.15C

Fig.13B


867
A
865
873
860
868
861
864
872
866
877
869
878
874
871
876
862
863
870
875
A

B-B

Fig.13C

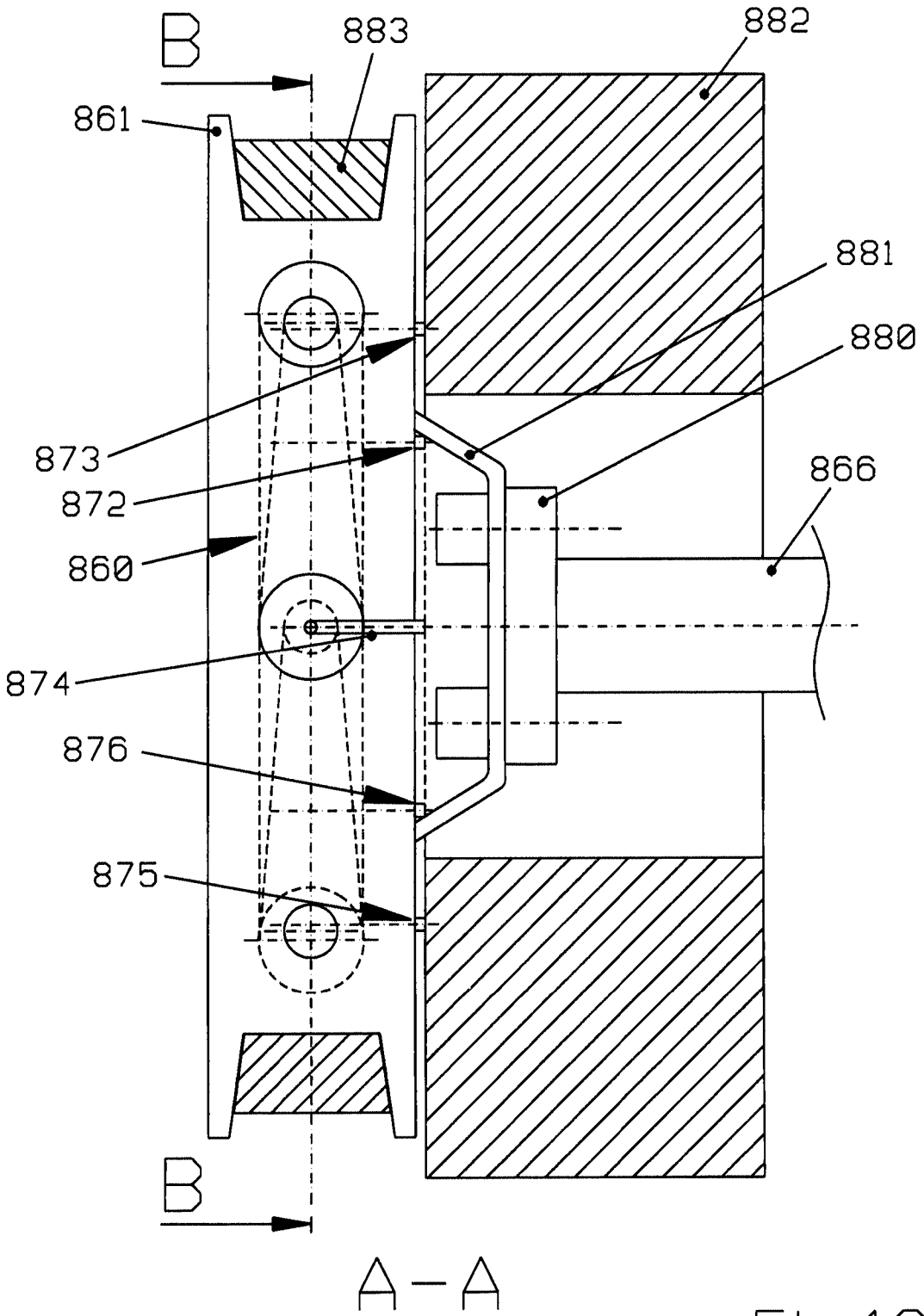


Fig.13D

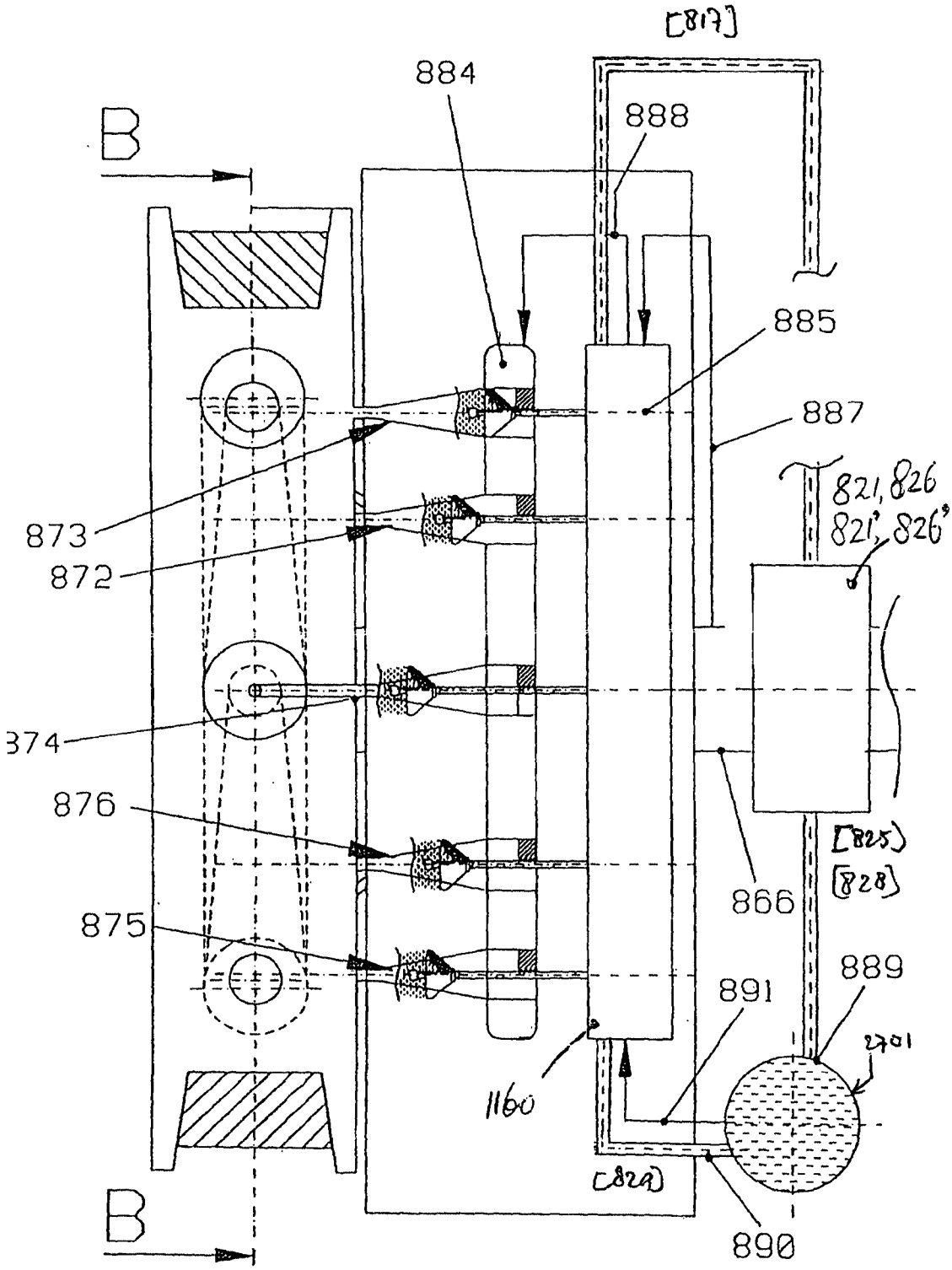

[817]
884
888
B
885
887
821, 826
821', 826'
873
872
374
876
875
866
[825]
[828]
889
891
2701
1160
[829]
890
B
C-C

Fig.13E

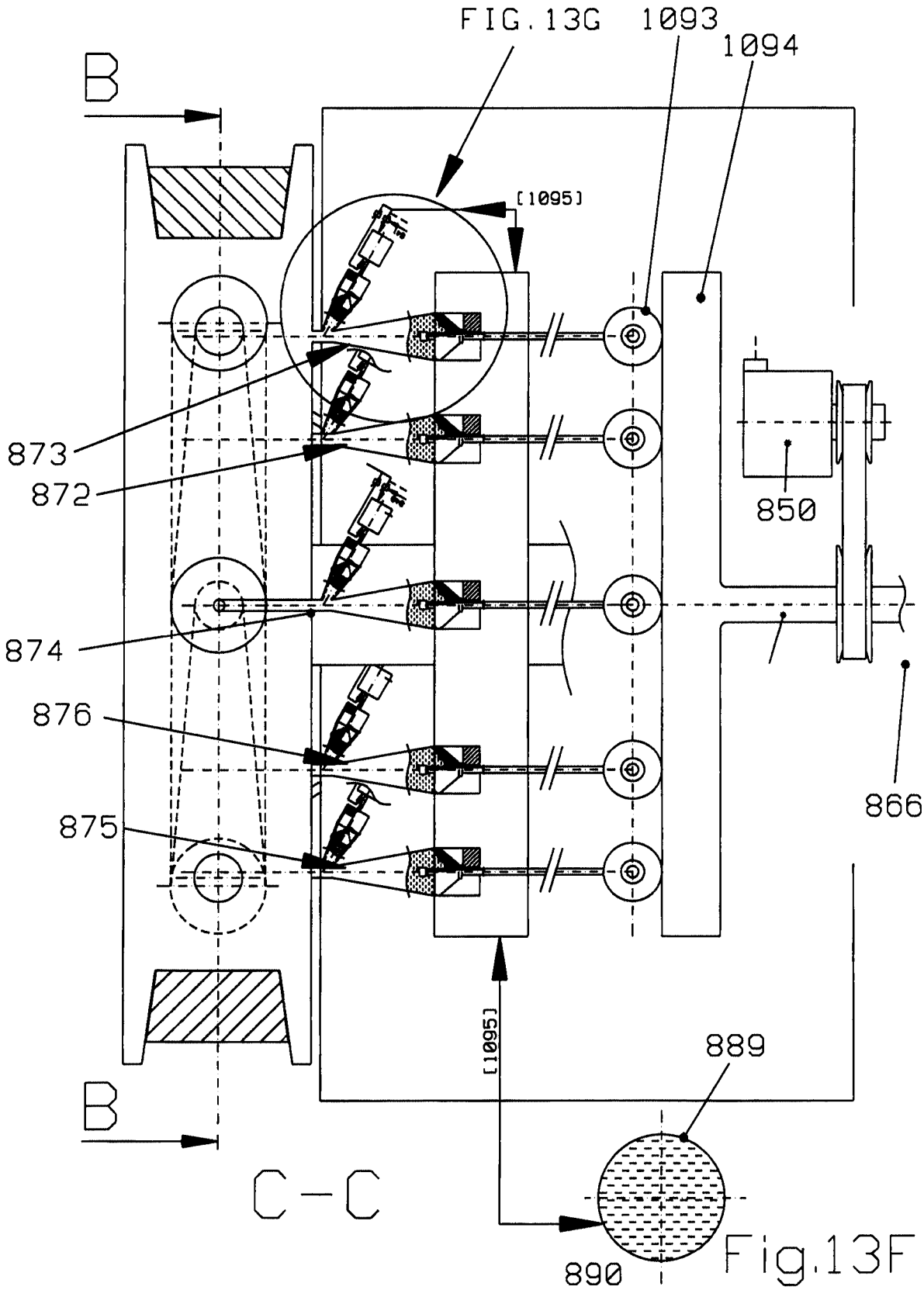

FIG.13G
1093
1094
B
[1095]
873
872
874
876
875
850
866
889
[1095]
B
C-C
890

Fig.13F

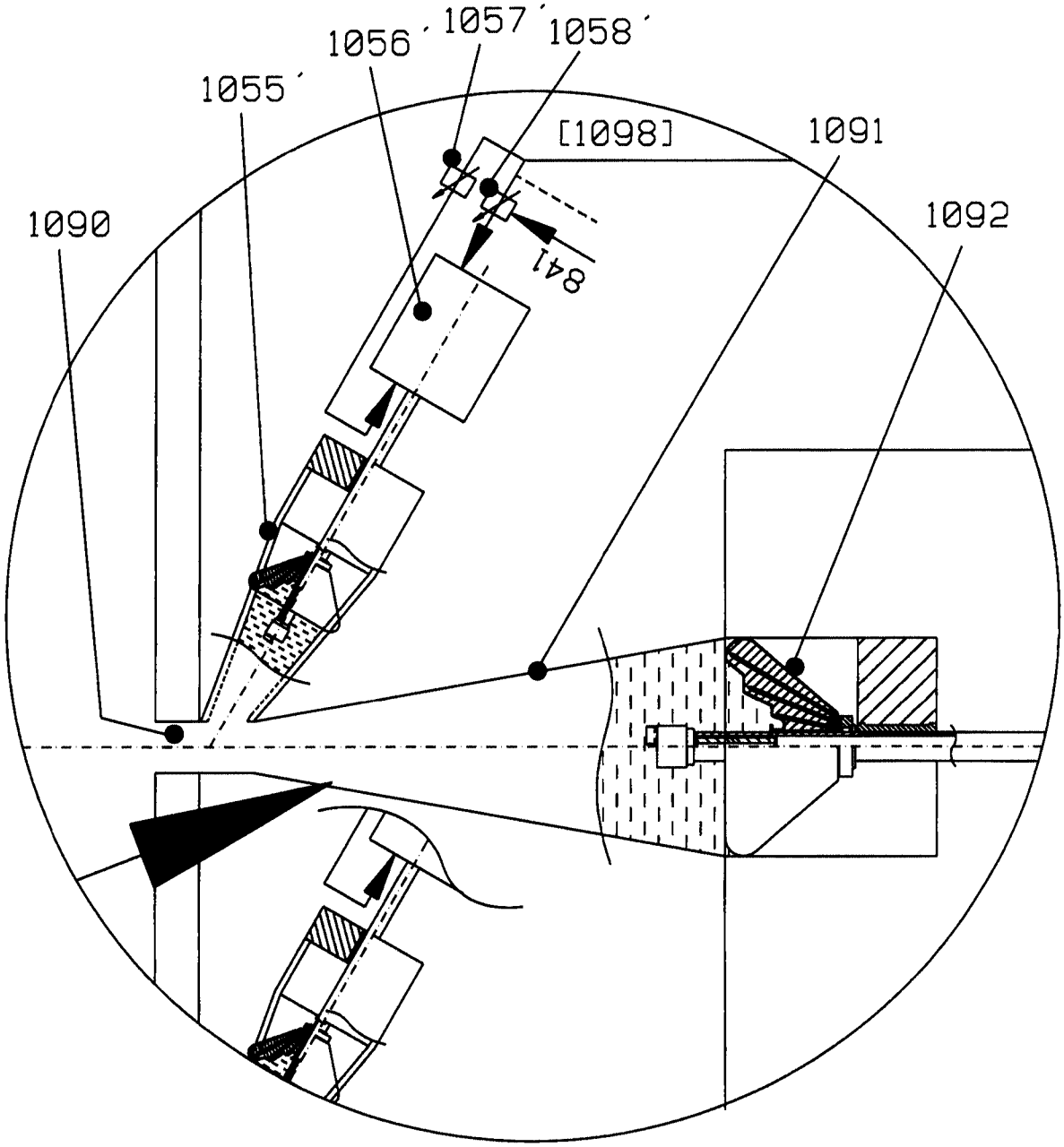


Fig.13G

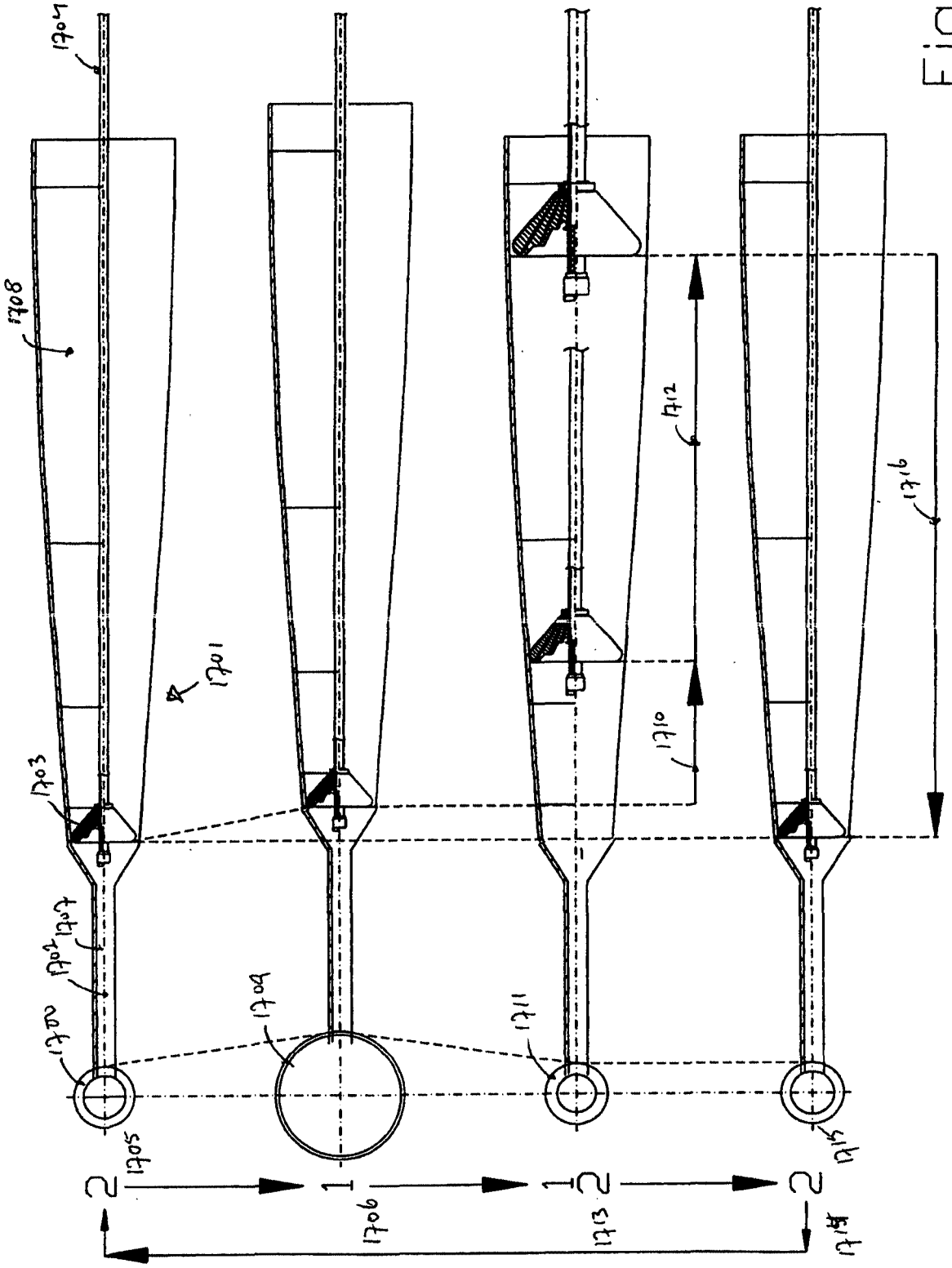

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1708
1701
1703
1702
1707
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2
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1
2
2

Fig.144

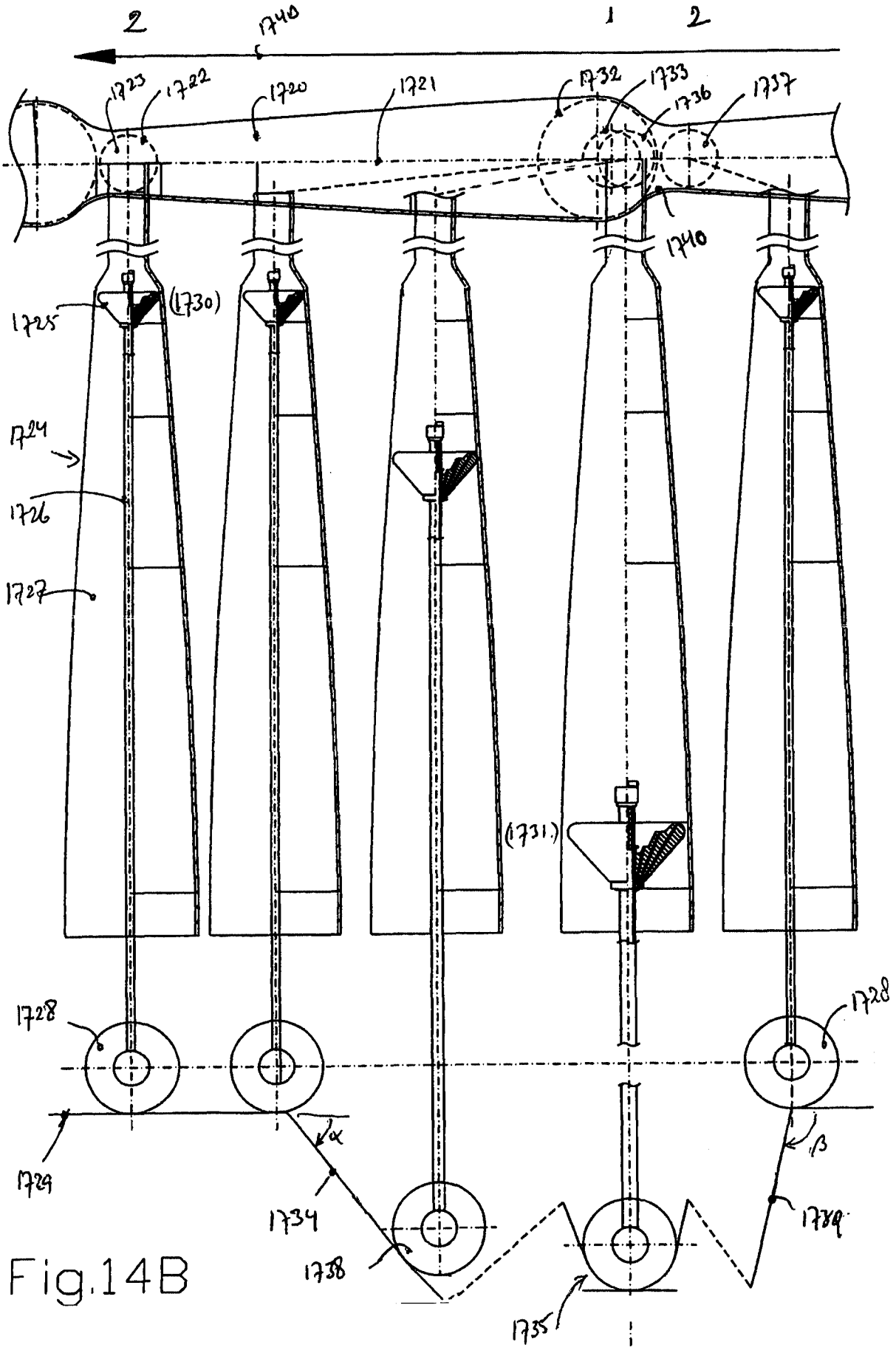

2
1740
1
2
1723
1722
1720
1721
1732
1733
1736
1737
1740
1725
(1730)
1724
1726
1727
(1731)
1728
1728
1729
α
β
1734
1738
1739
1735

Fig.14B

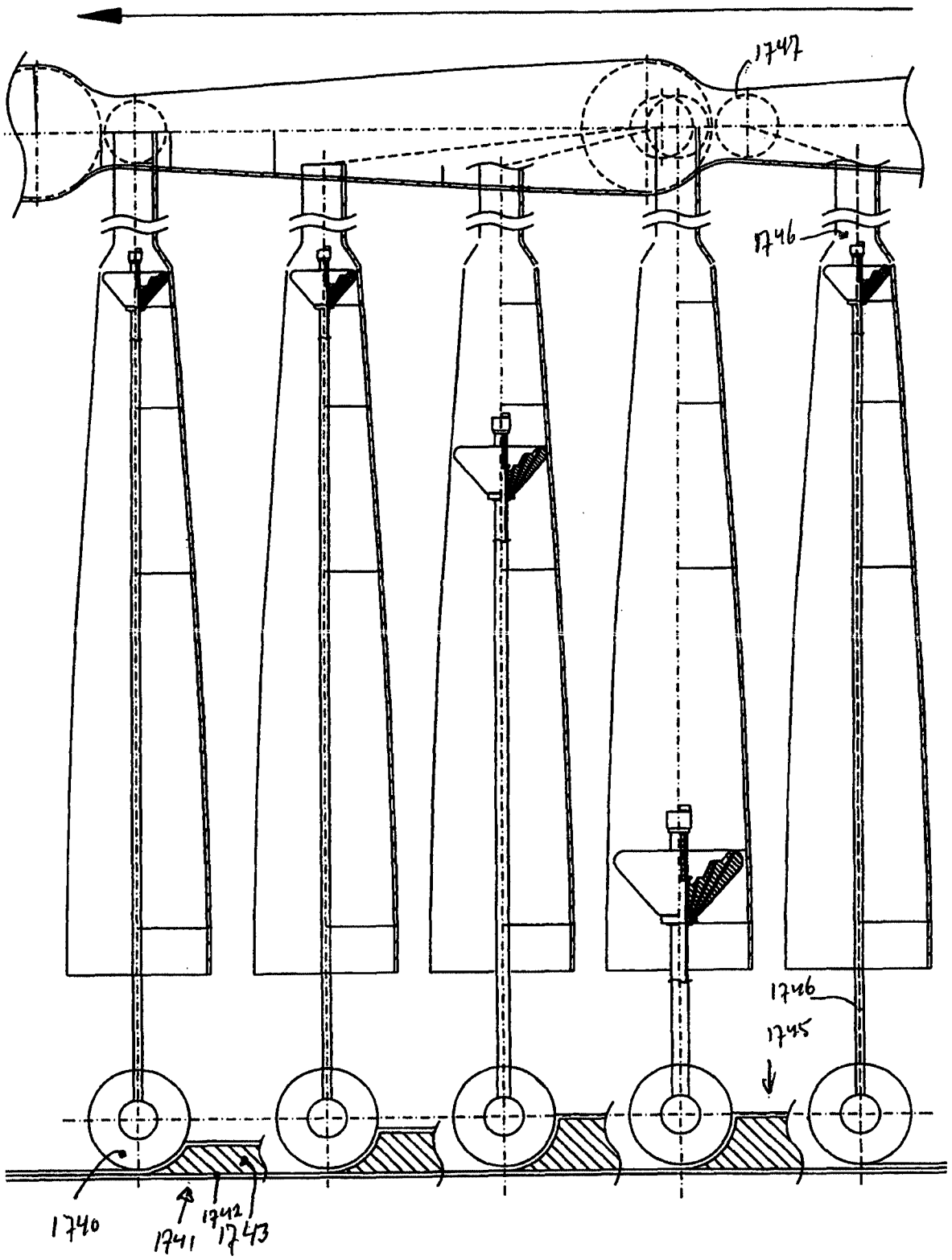


Fig.14C

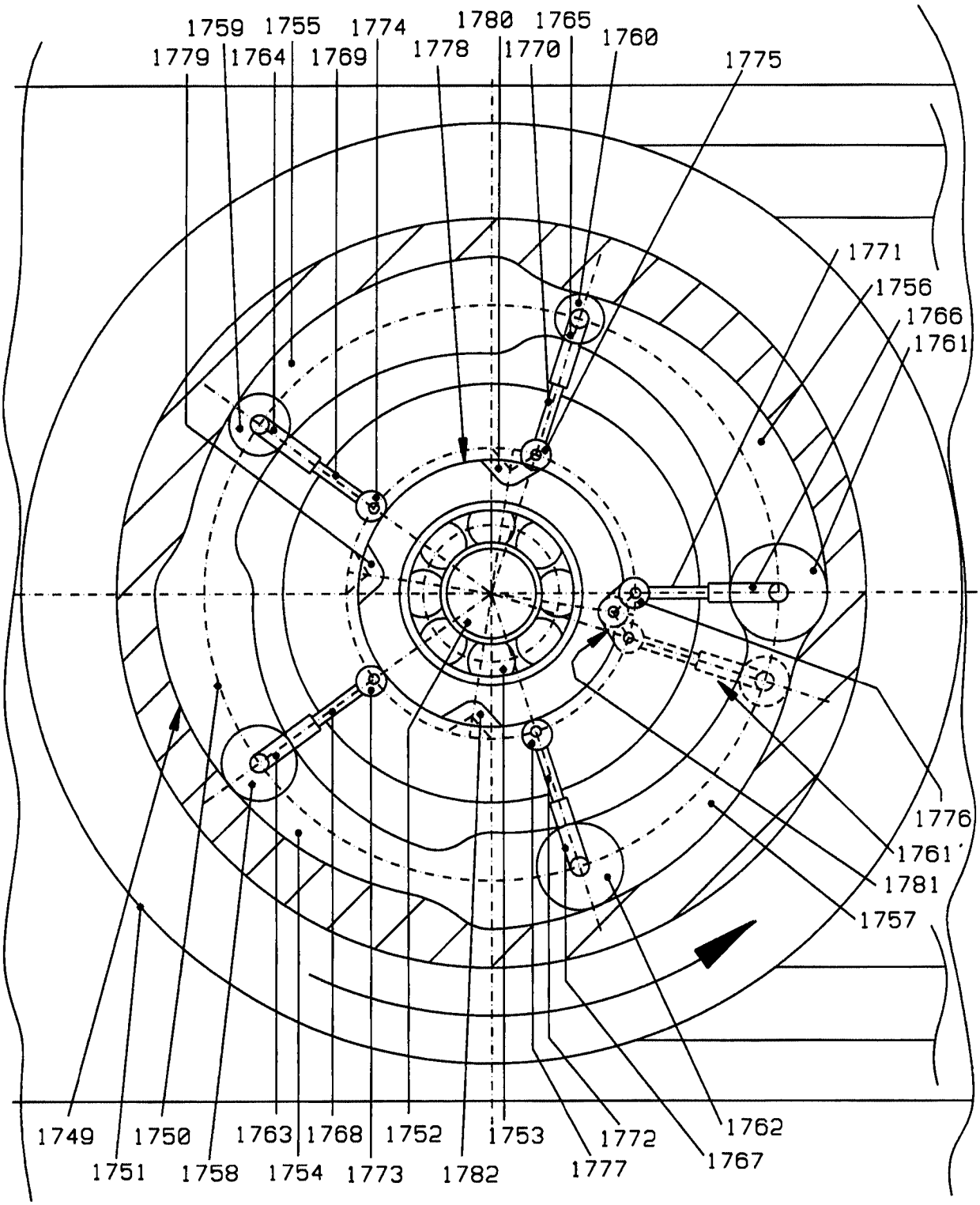

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1755
1774
1780
1765
1779
1764
1769
1778
1770
1760
1775
1771
1756
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1761
1776
1761'
1781
1757
1749
1750
1763
1768
1752
1753
1772
1762
1751
1758
1754
1773
1782
1777
1767

Fig.14D1

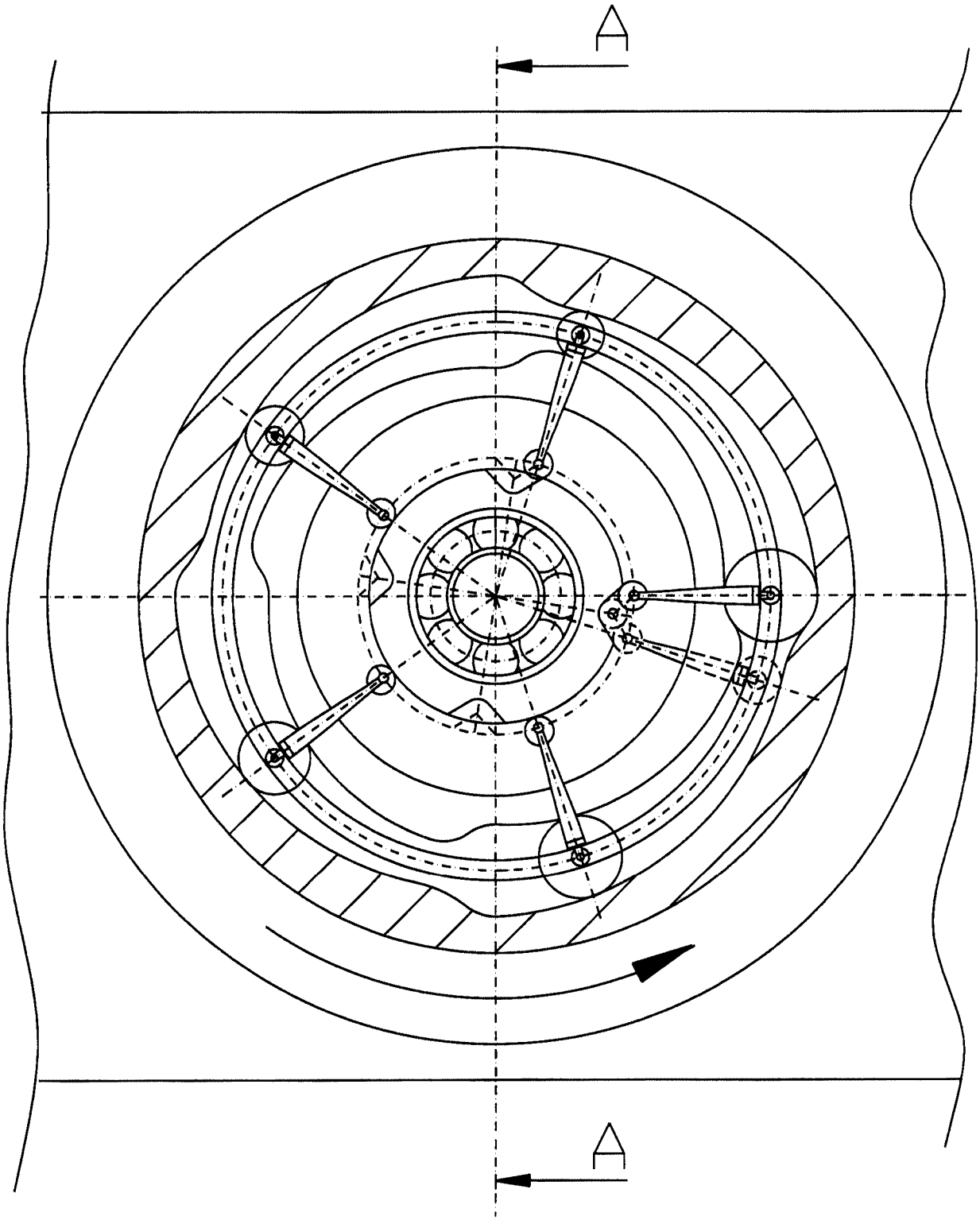


Fig.14D2

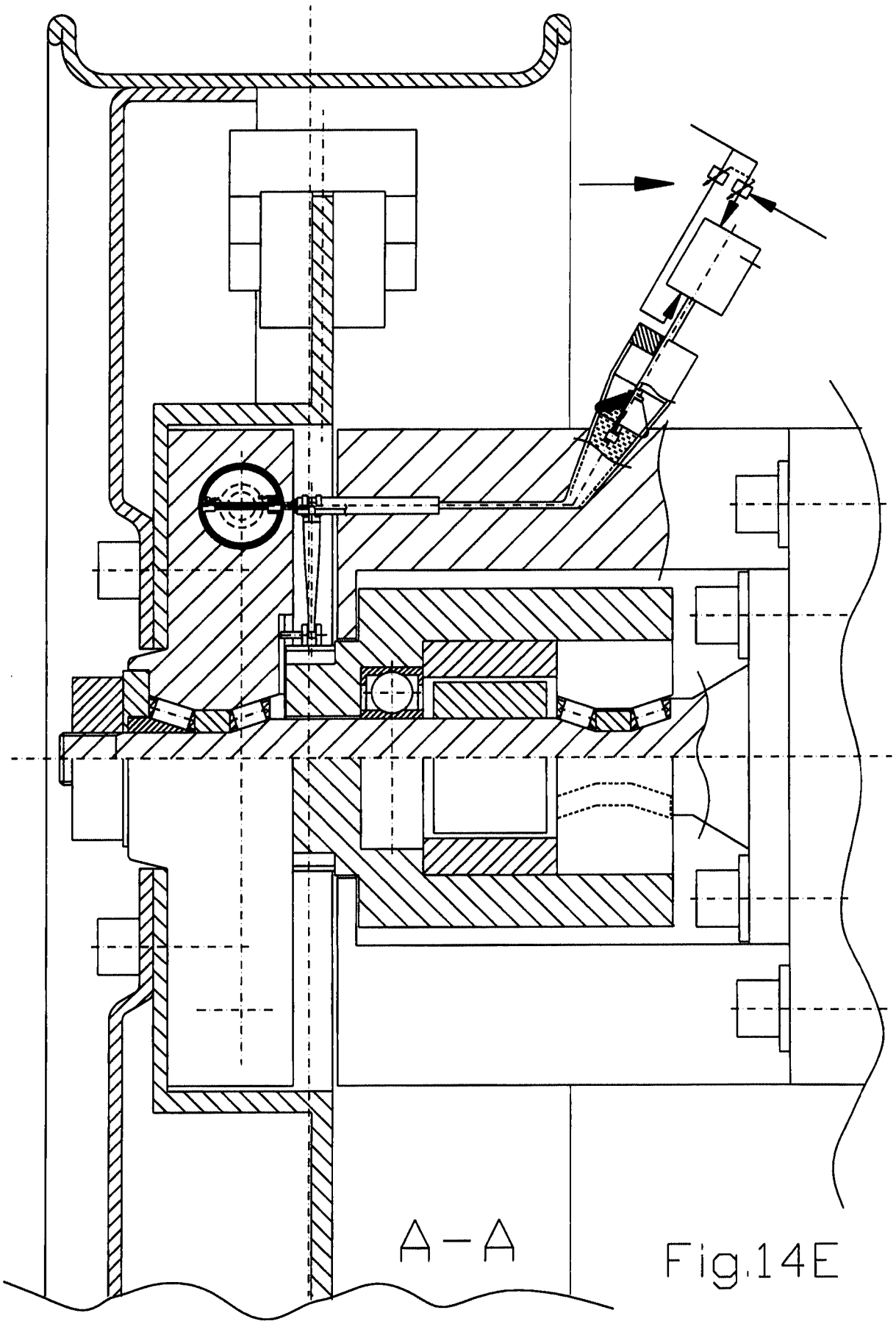


Fig.14E

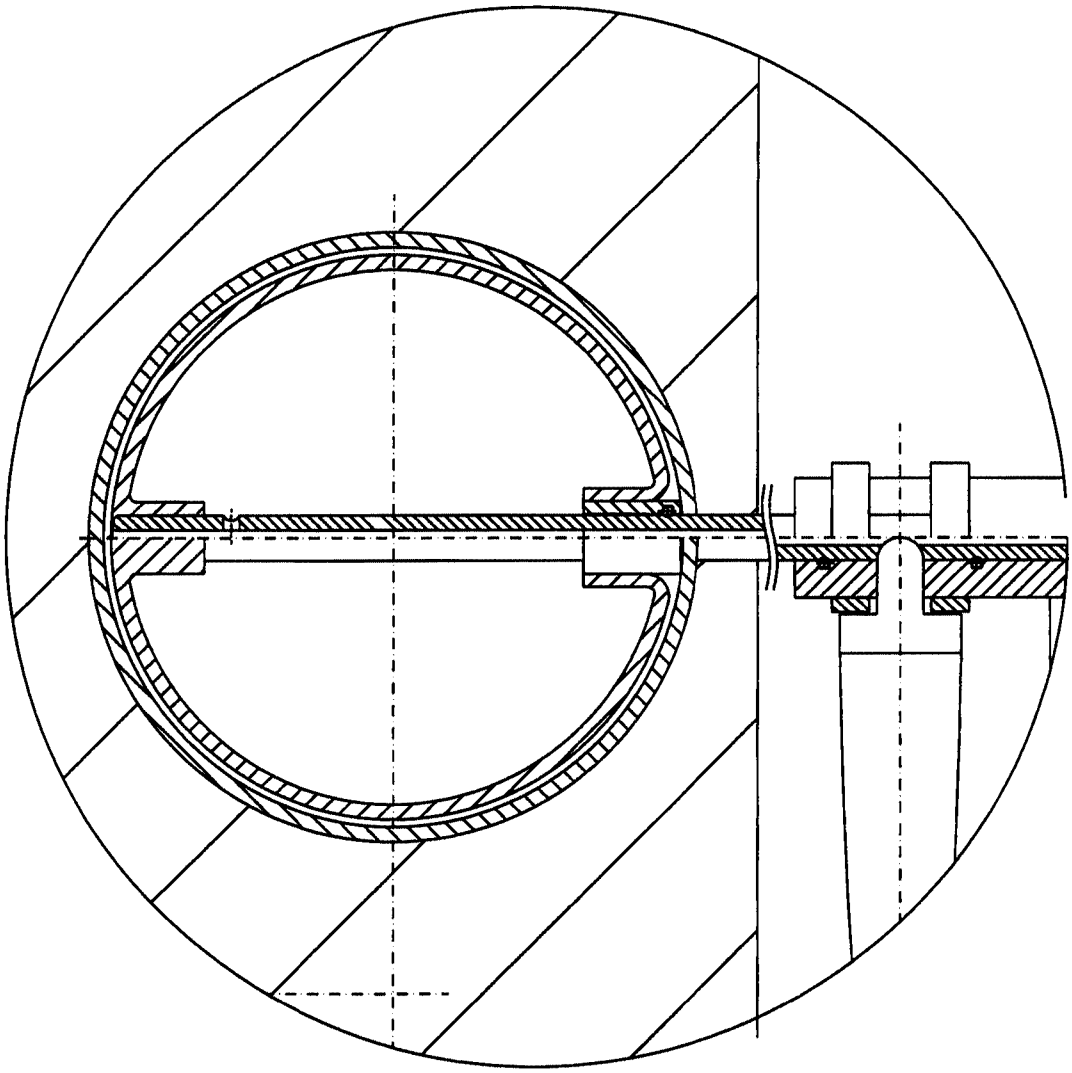


Fig.14F

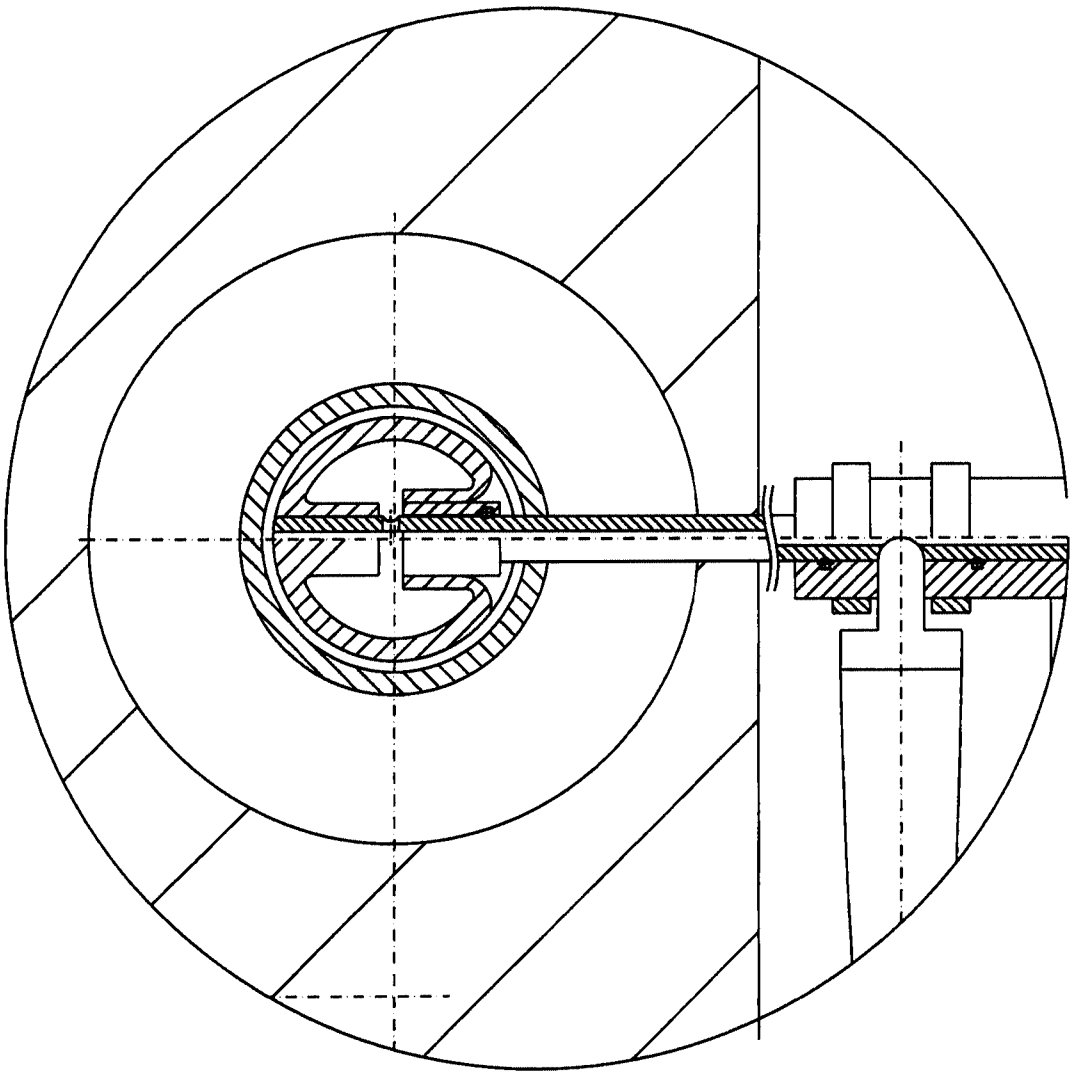


Fig.14G

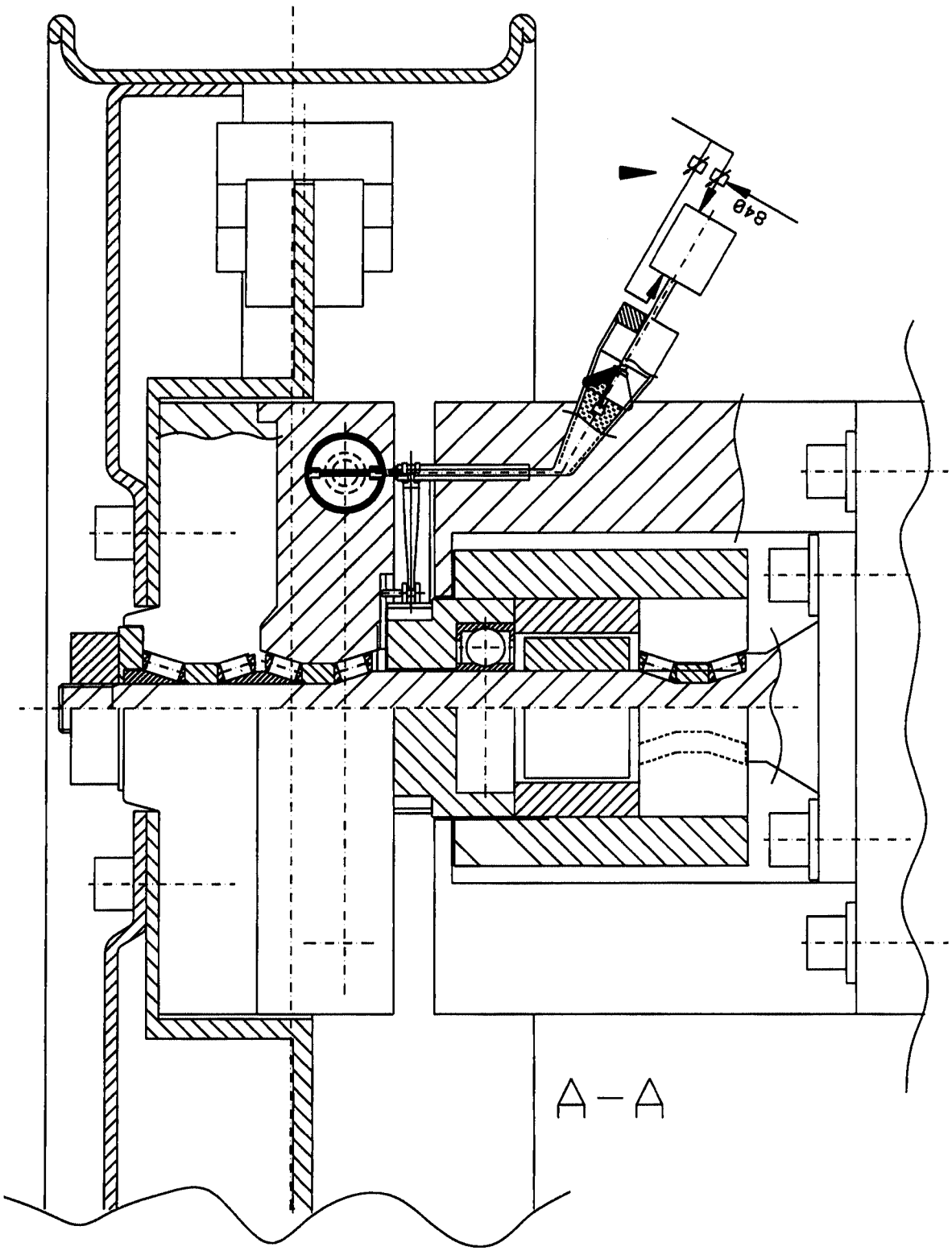


Fig.14H

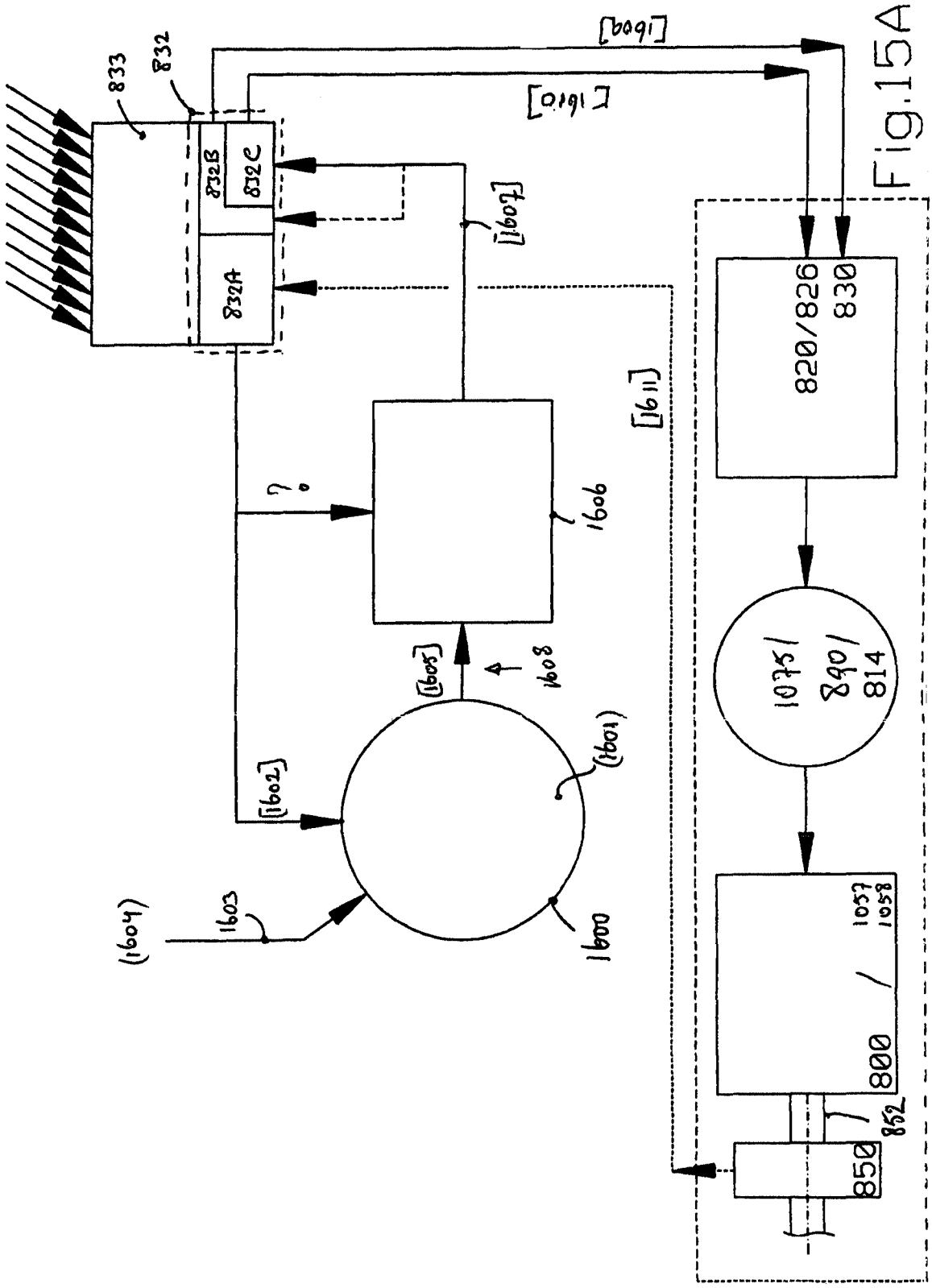

833
832
832B
832C
832A
1607
1609
1610
1611
820/826
830
1606
1608
1605
1601
1602
1603
1604
1600
1075/
840/
814
1057
1058
800
852
850

Fig.15A

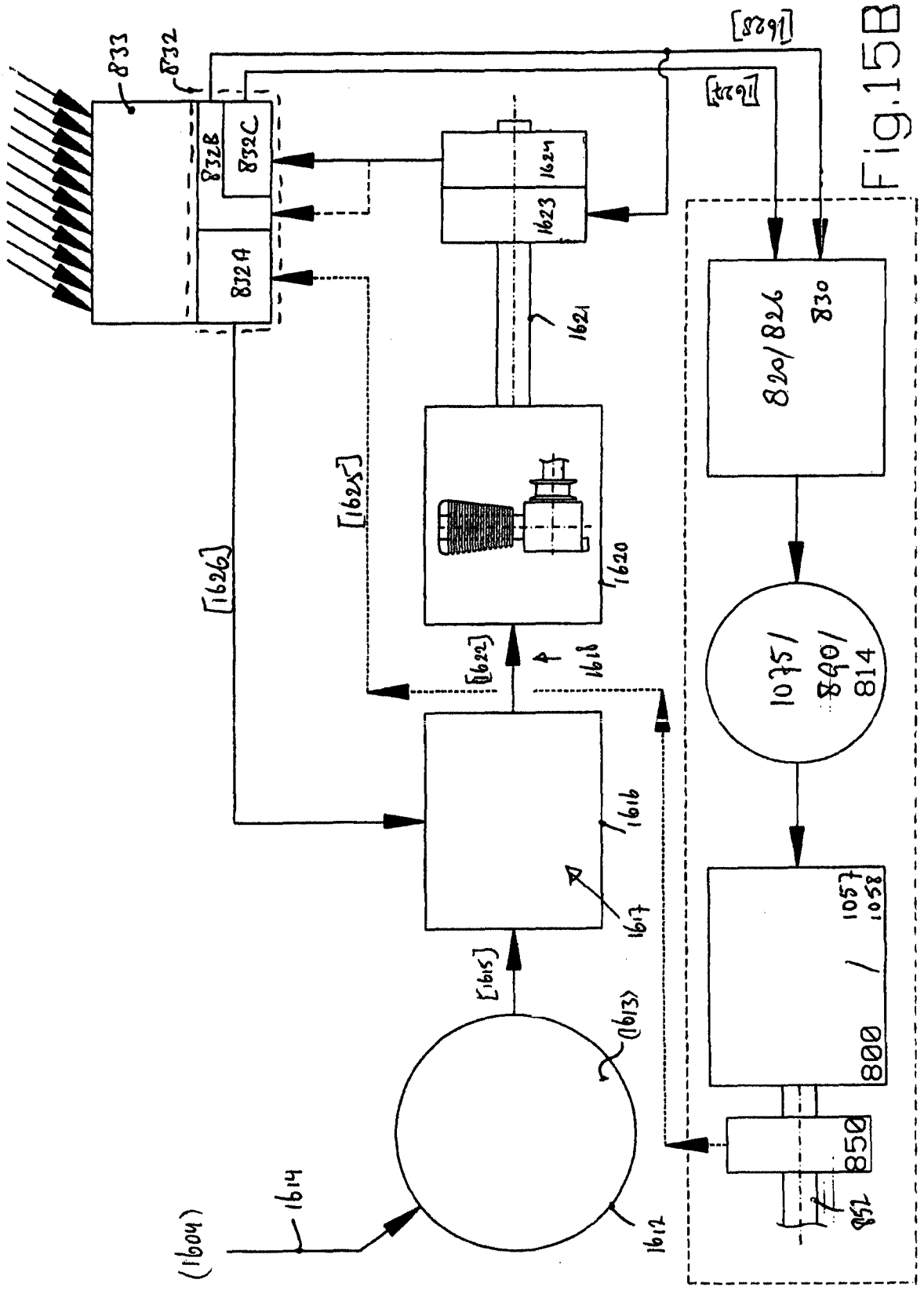

833
832
8328
832C
8329
1624
1623
1621
1620
1618
1616
1617
1615
1613
1612
1614
(1604)
[1626]
[1625]
[1622]
[1627]
[1628]
820/826
830
1075/
840/
814
1057
1058
800
850
852

Fig.15B

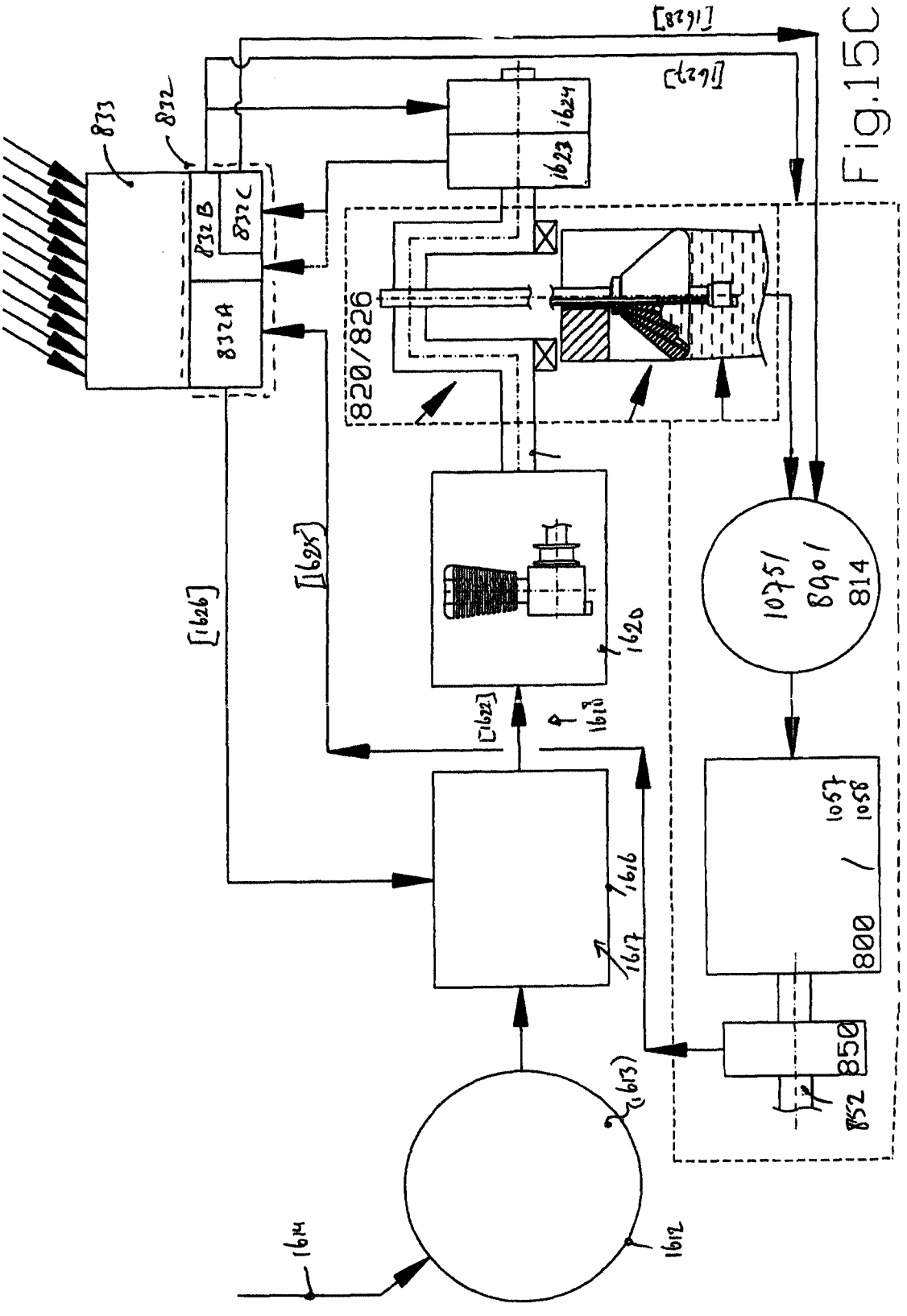

[1627]
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833
832
832B
832C
832A
1624
1623
820/826
[1628]
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1620
[1622]
1618
1616
1617
1613
1612
1614
1075/
809/
814
1057
1058
800
850
852

Fig.15C

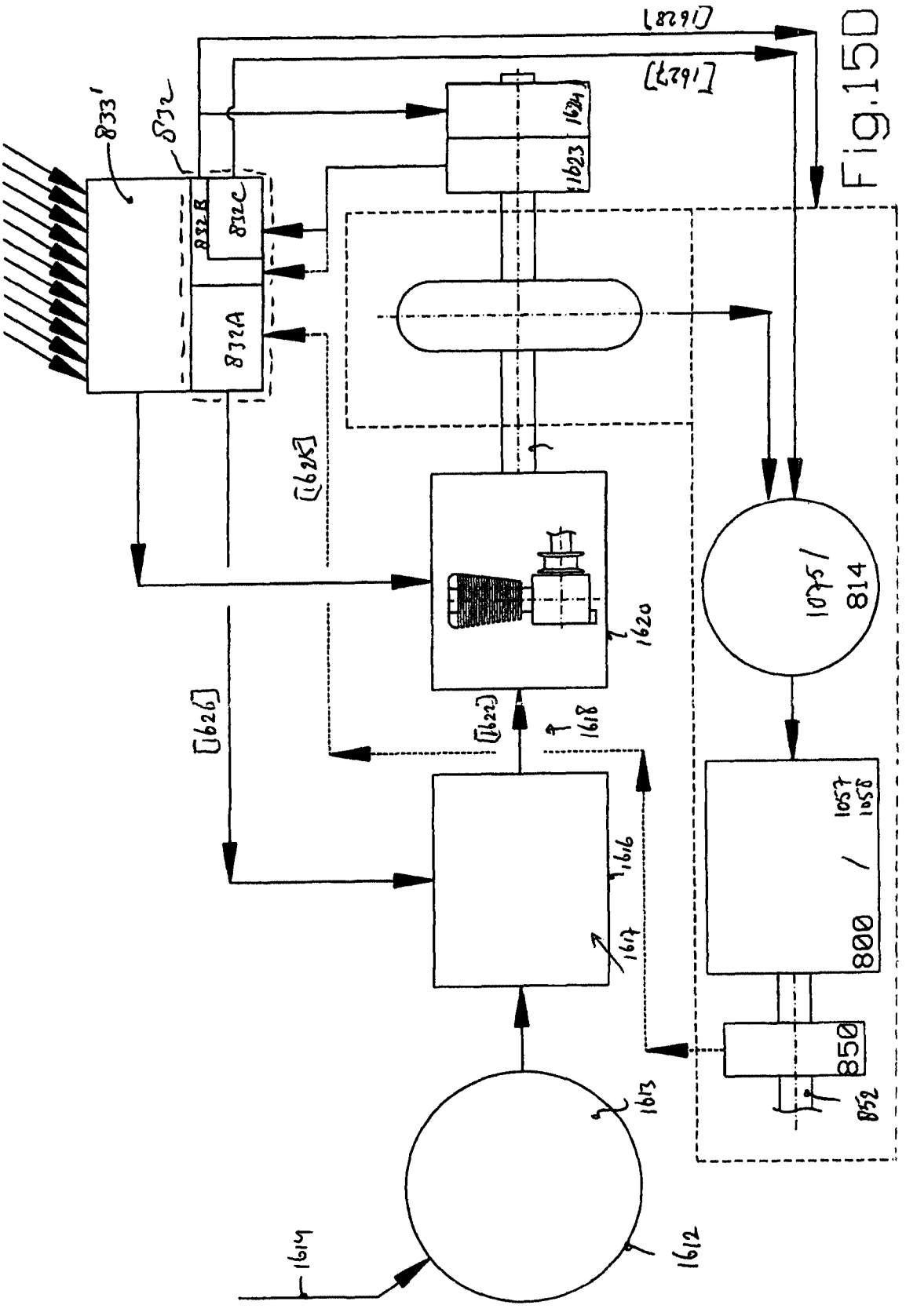
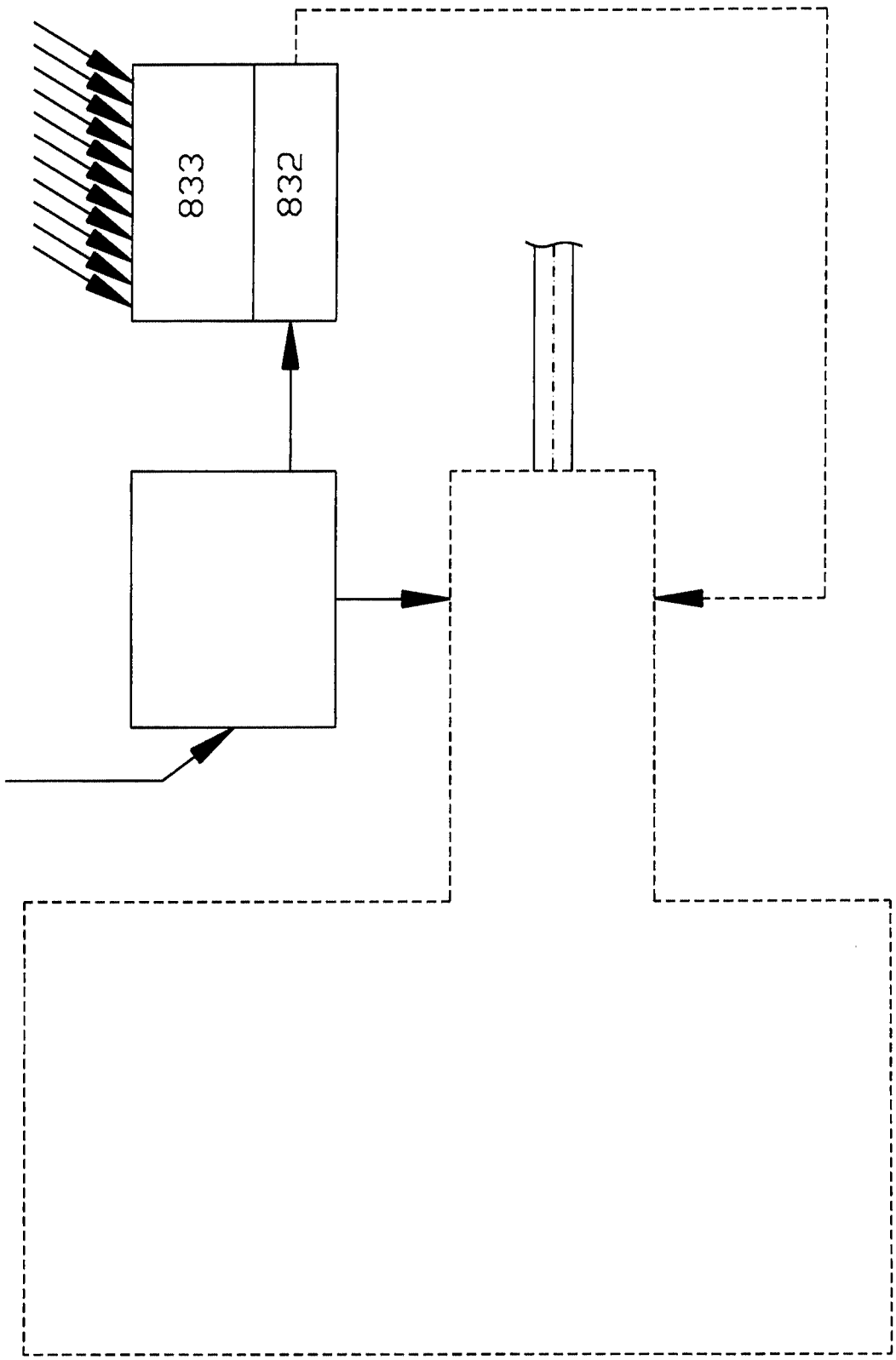

833'
832
832B
832C
832A
1623
1624
1628
1620
1618
1626
1622
1616
1617
1613
1612
1614
1075 / 814
1057
1058
800
850
852

Fig.15D

Fig.15E



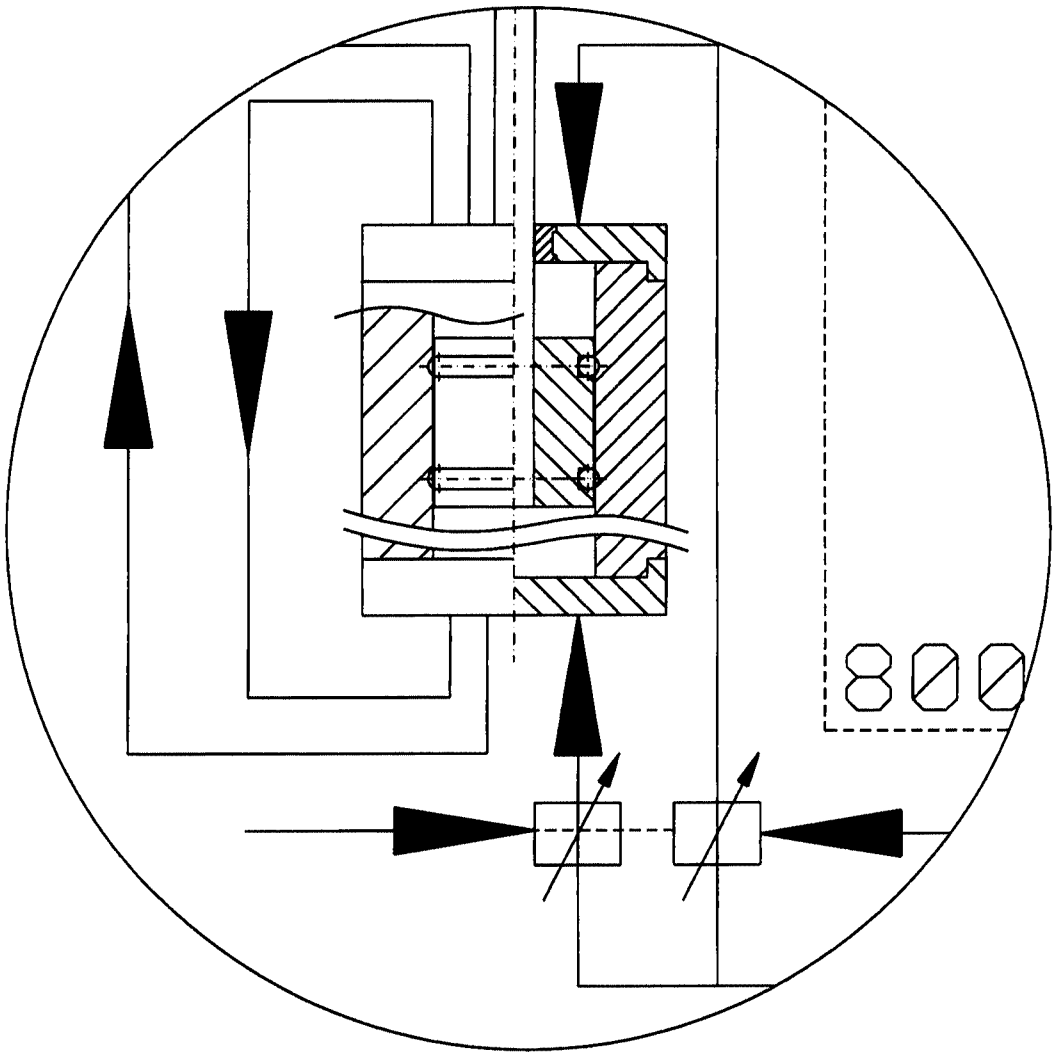


Fig.16A

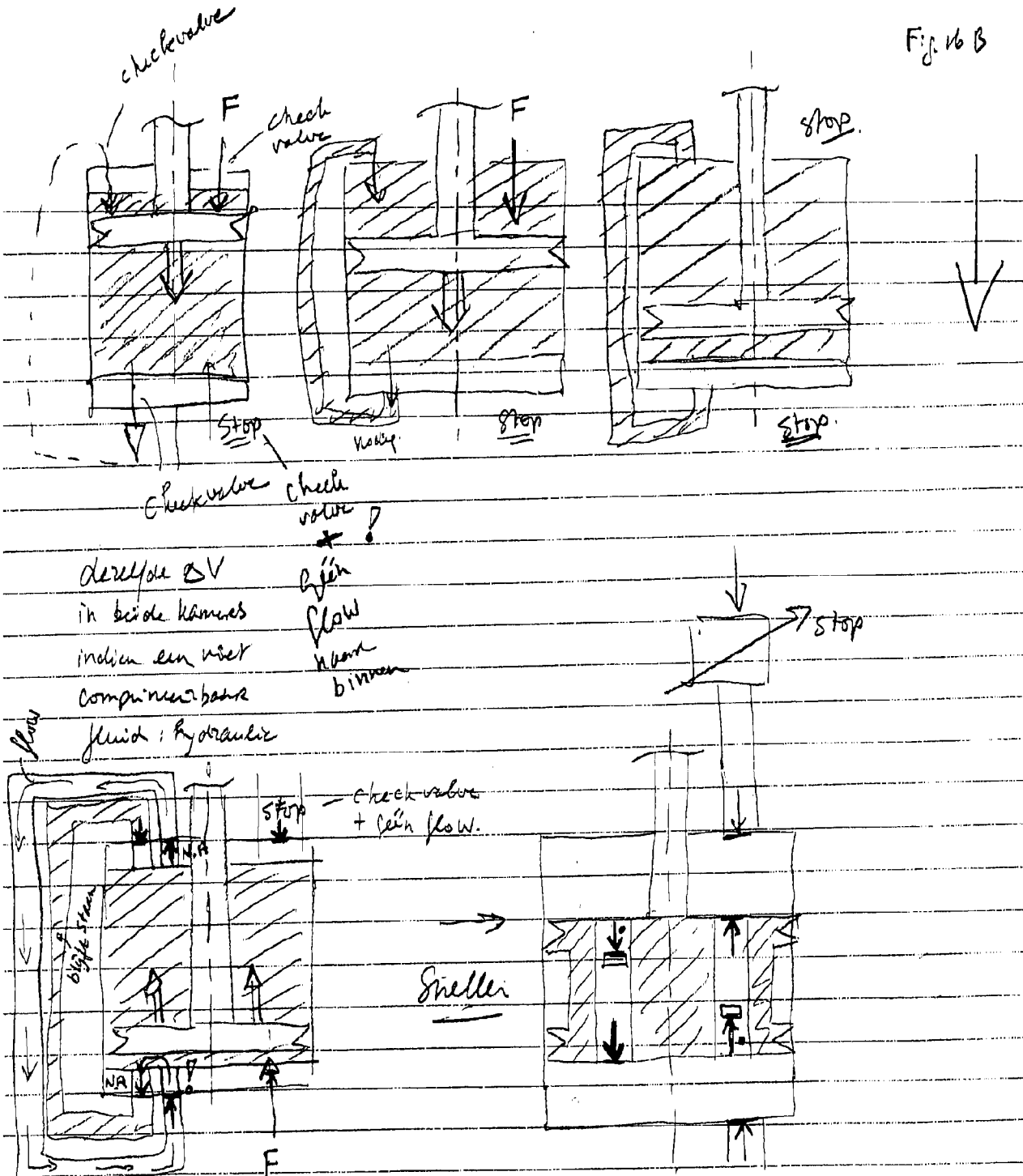


Fig. 16 B

dezelfde BV
in beide kamers
indien een niet
compenseerbare
fluid : hydraulic

Conclusions:
1. 2x buitenpijp O.K.
2. controlevalves O.K.
3. flow-stop to be developed
4. controlevalves NOT one / return pipe
5. automatic control valves not sufficient
→ non-automatic
inlet overflow pipe
6. stop in reduction valve

FIG. 16B

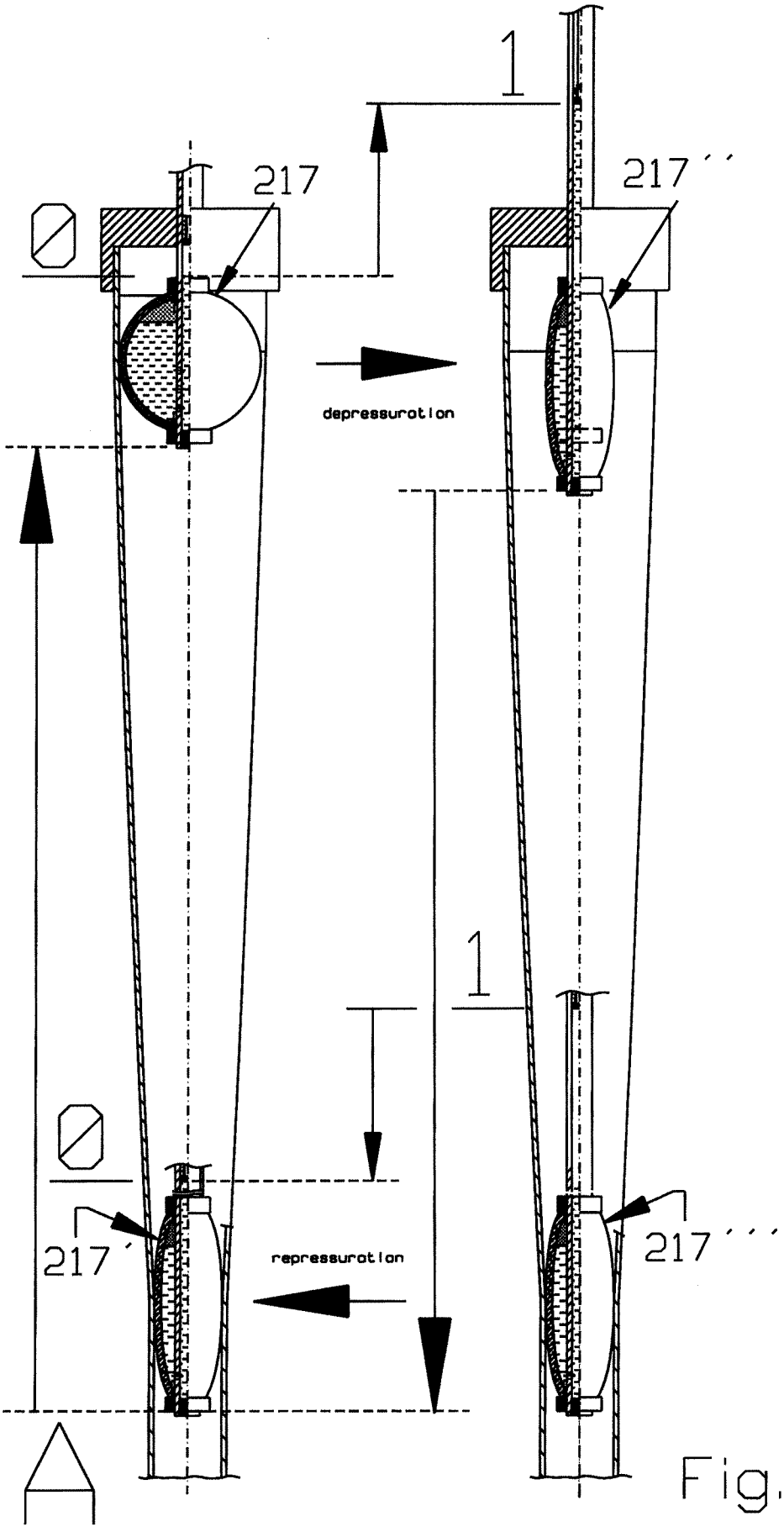
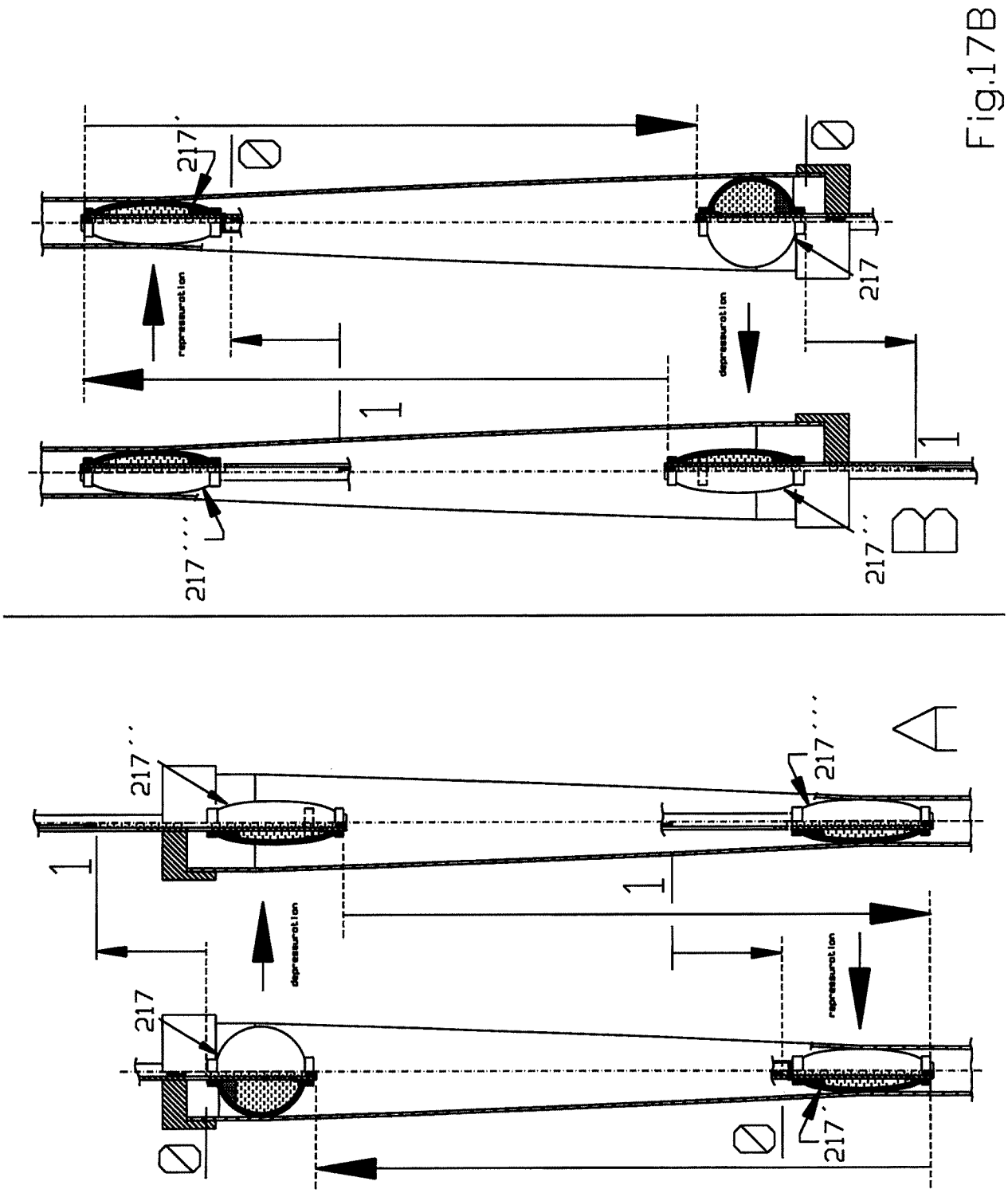


Fig.17A

Fig.17B



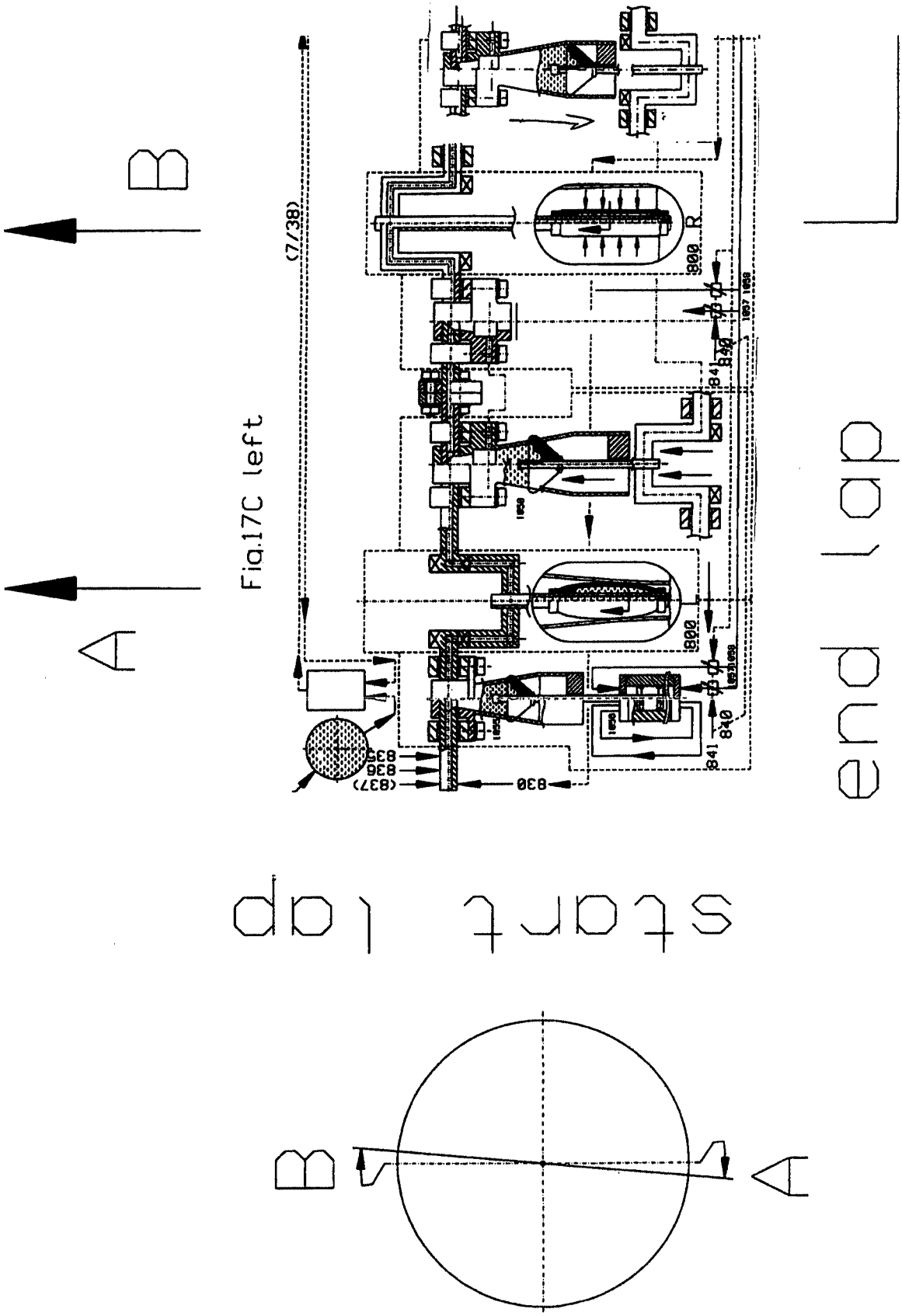

B
A
(7/38)
800 R
840
841
800
840
841
(837)
836
839
830
end lap
start lap
B
A

Fig.17C left

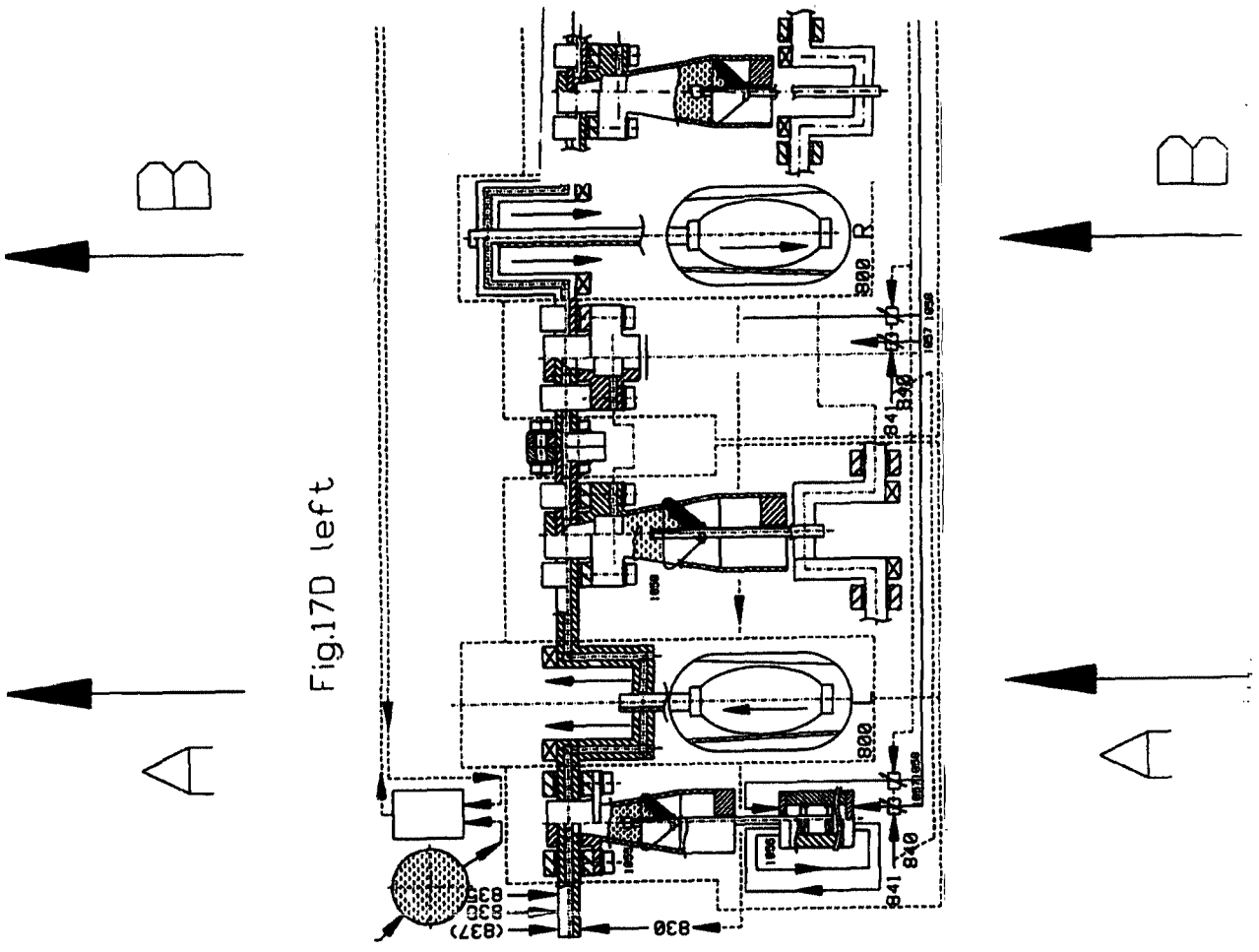
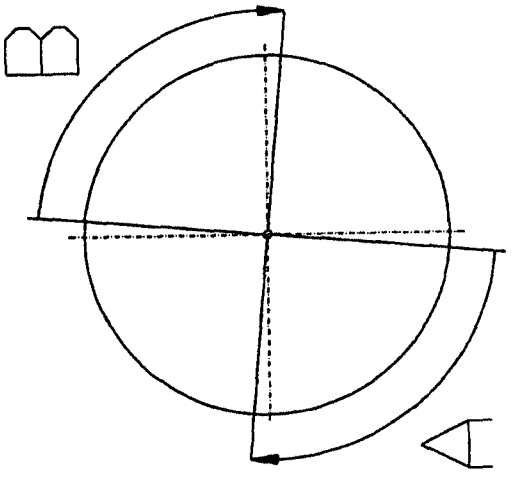
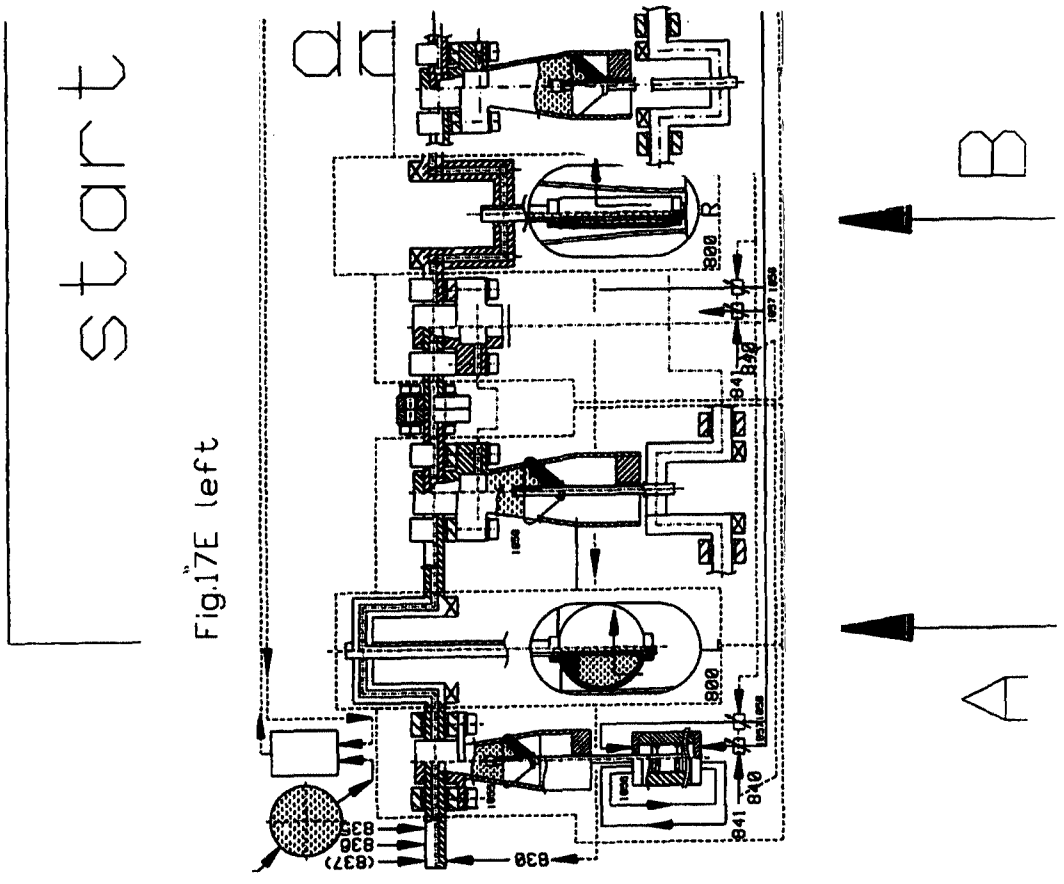


Fig.17D left




start
Fig.17E left
B
A
B
A

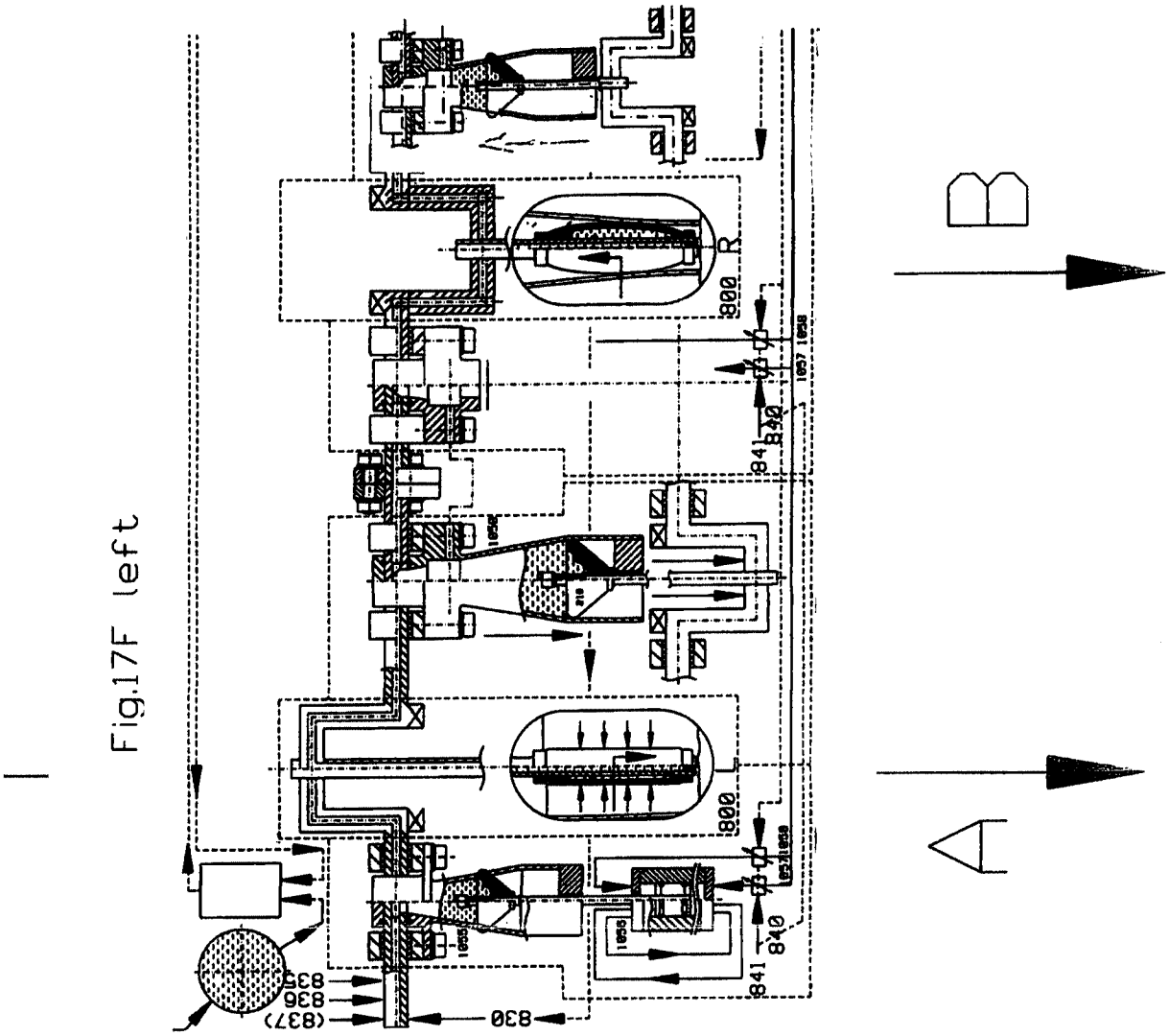
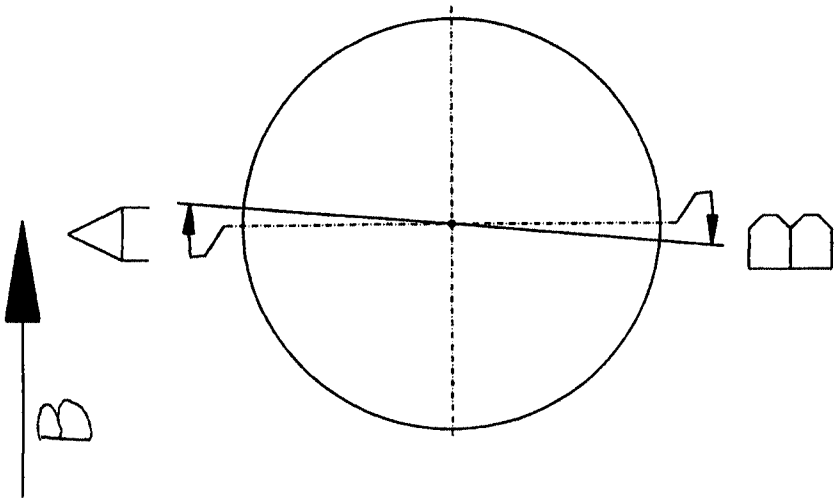


Fig.17F left



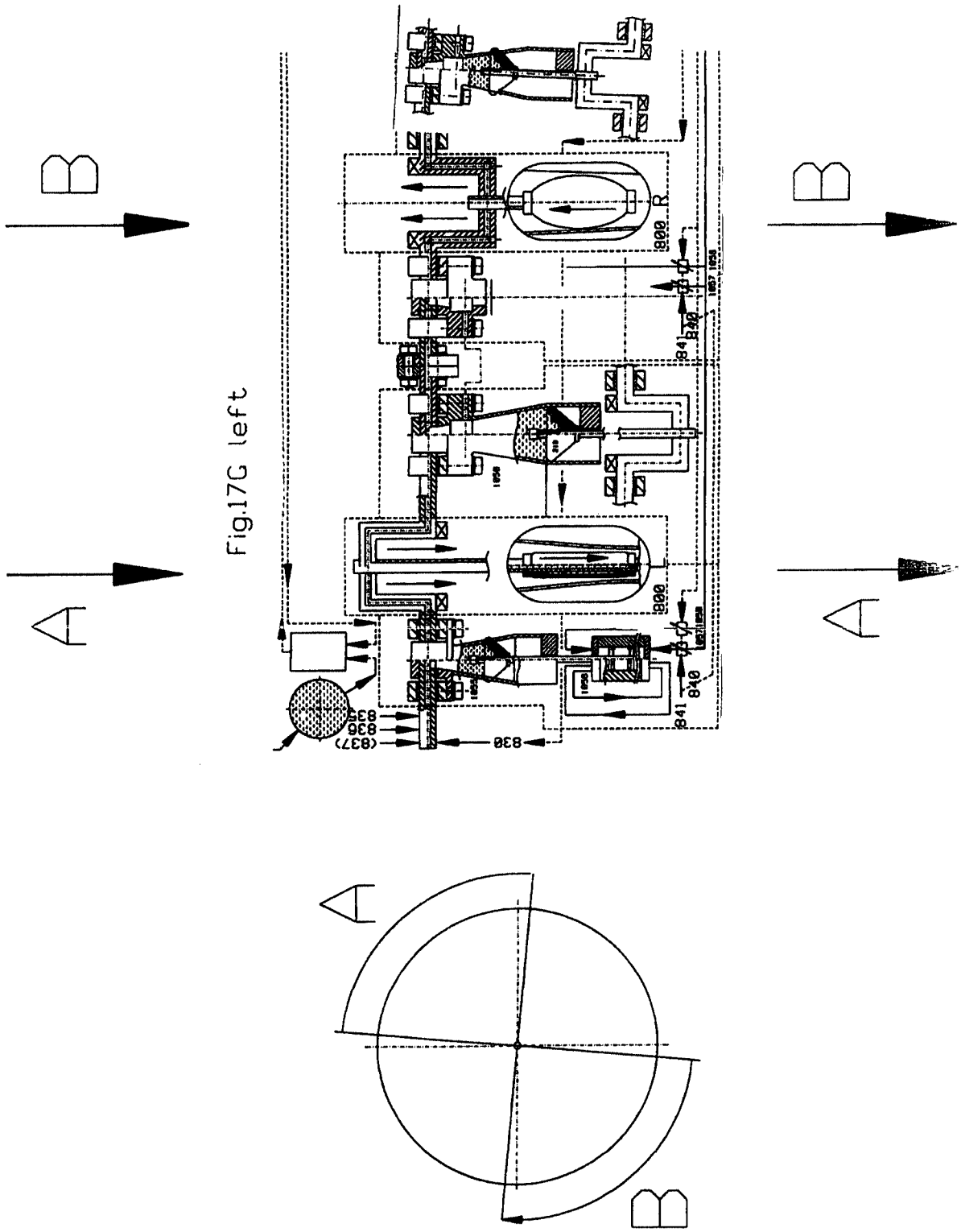


Fig.17G left

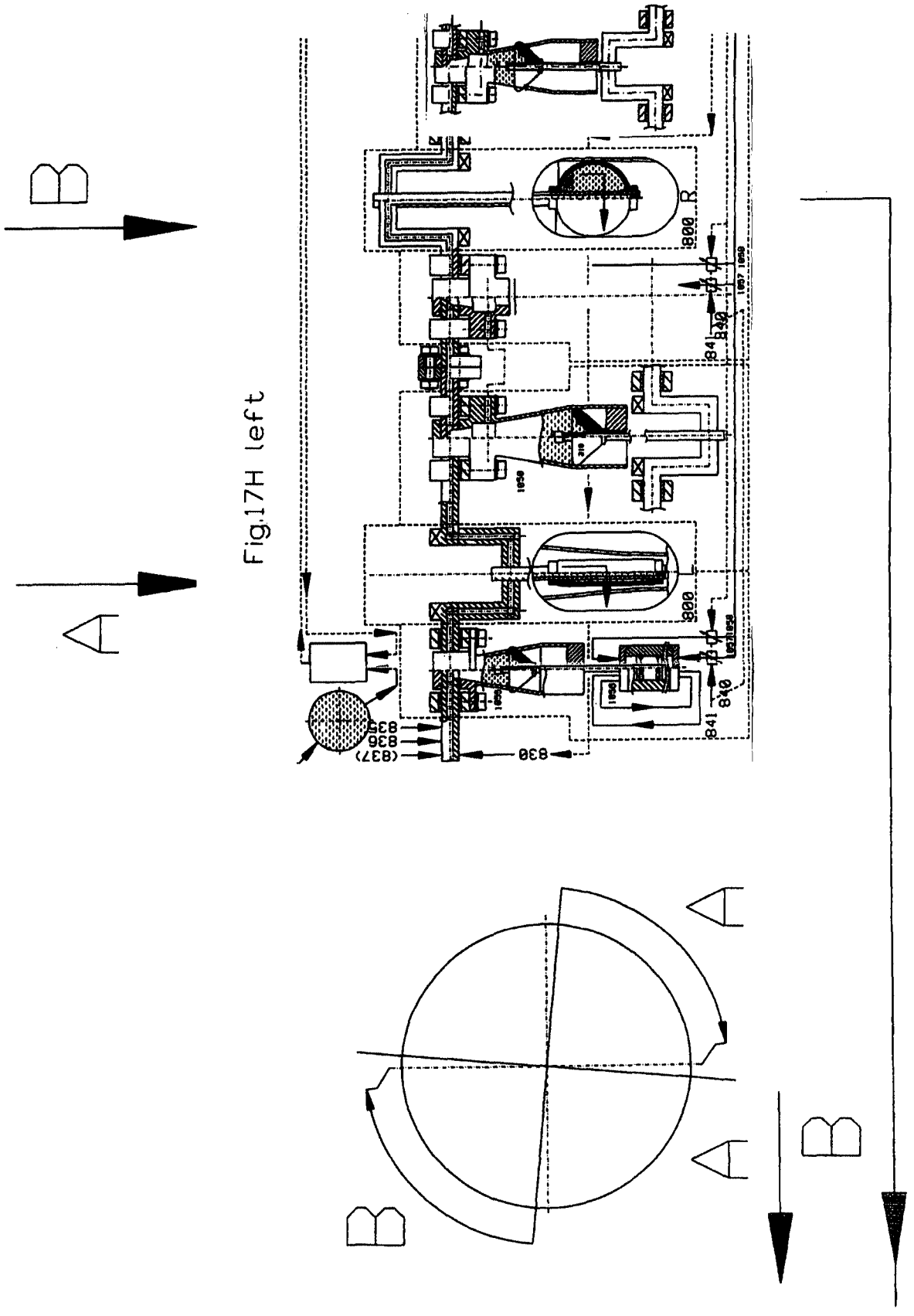
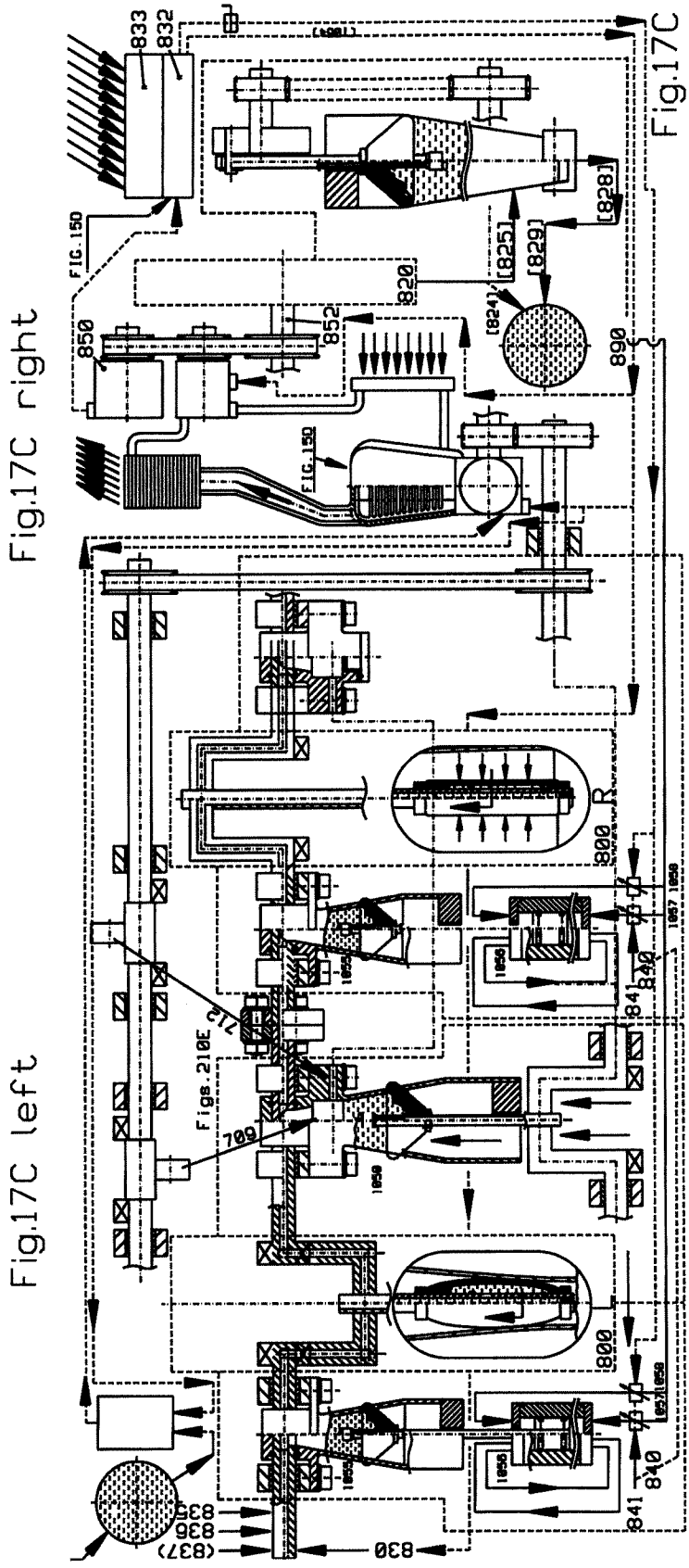


Fig.17H left


Fig.17C left
Fig.17C right
Fig.17C
833
832
FIG.150
820
[825]
[829]
[828]
[824]
850
852
890
FIG.150
800
840
841
Figs.210E
712
709
800
840
841
839
836
(837)
830

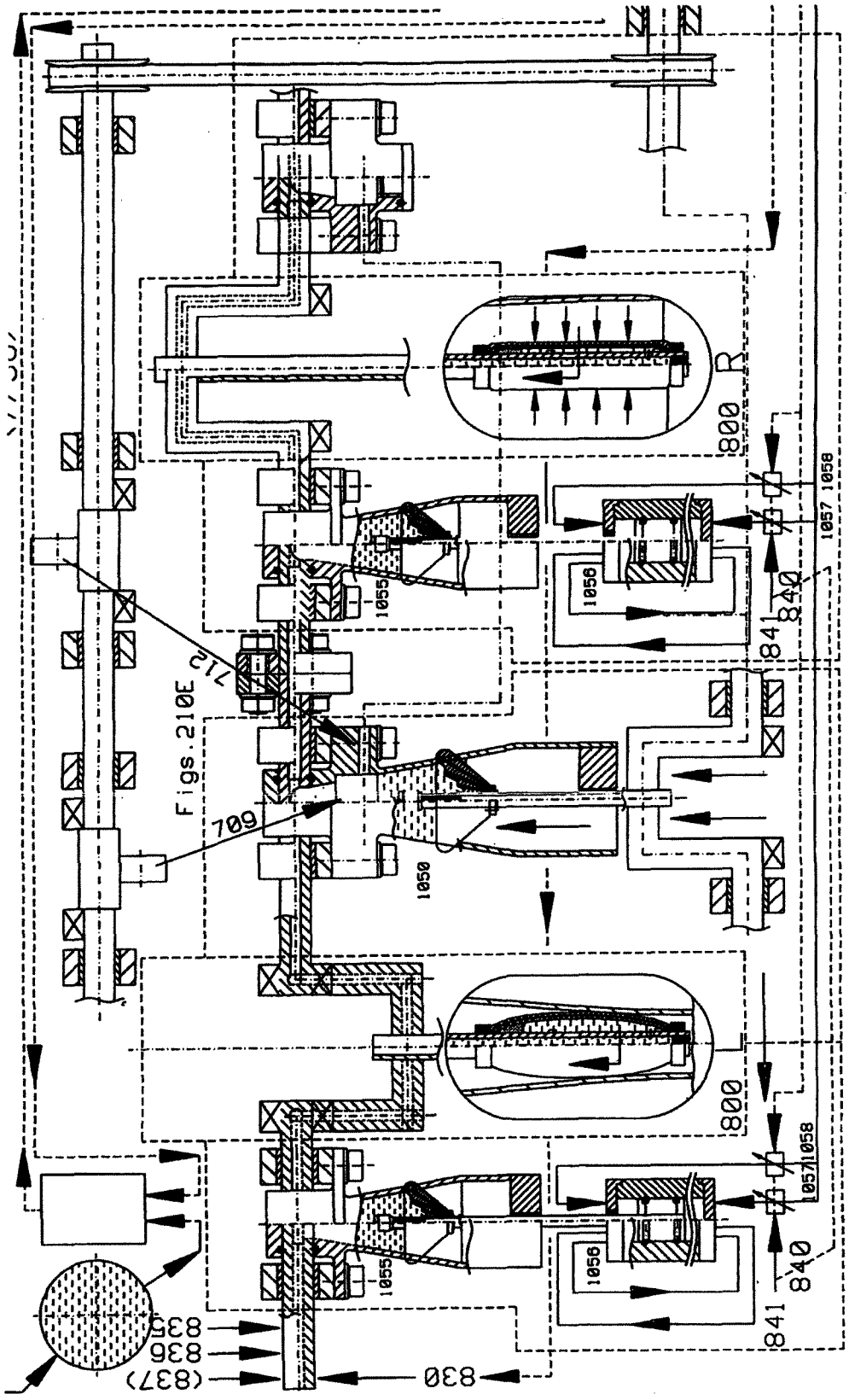

F
800
R
1057 1058
1055
1050
840
841
712
Figs.210E
709
1050
800
1057 1058
1056
1055
840
841
835
836
(837)
830

Fig.17C left

Fig.17C right

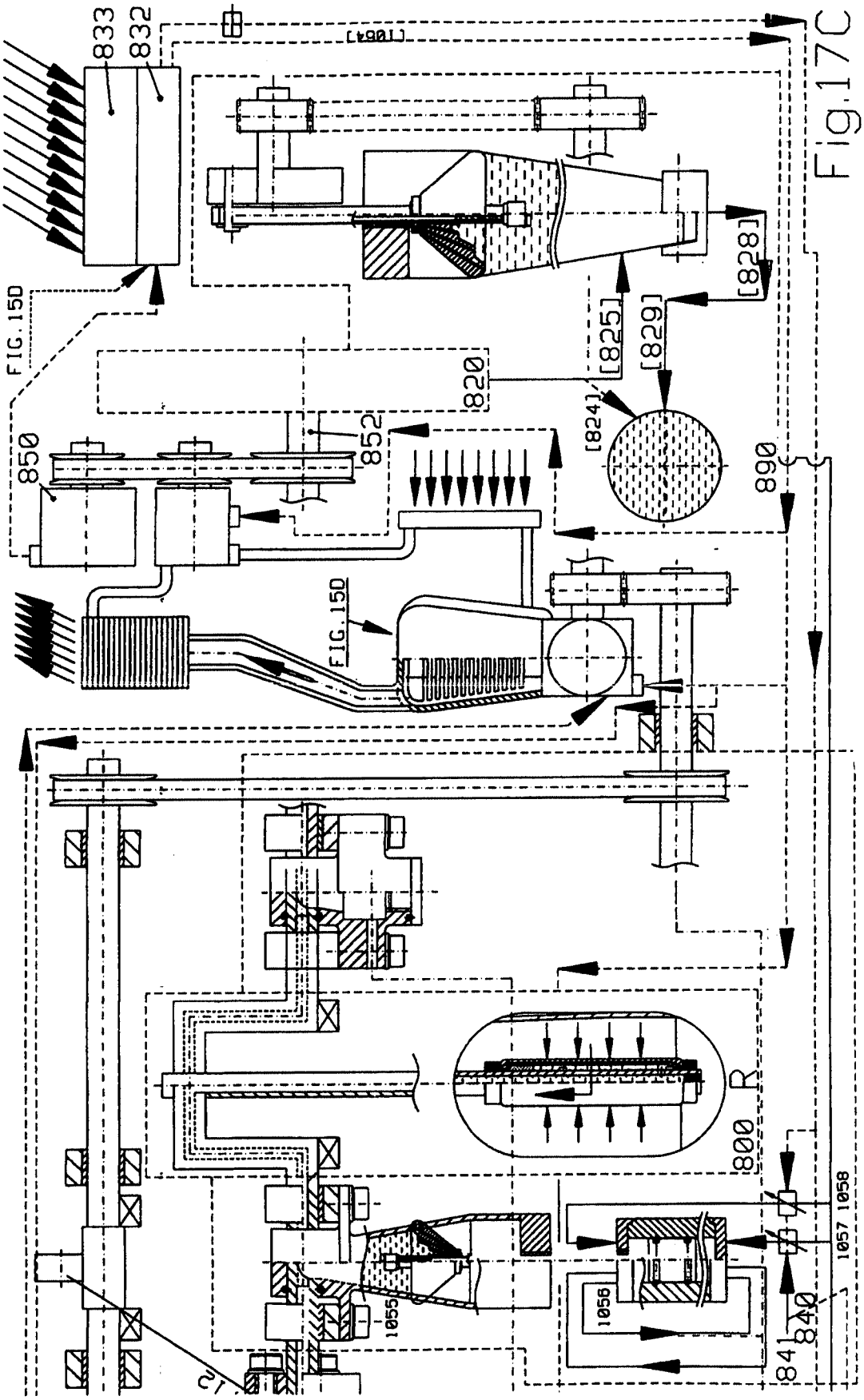
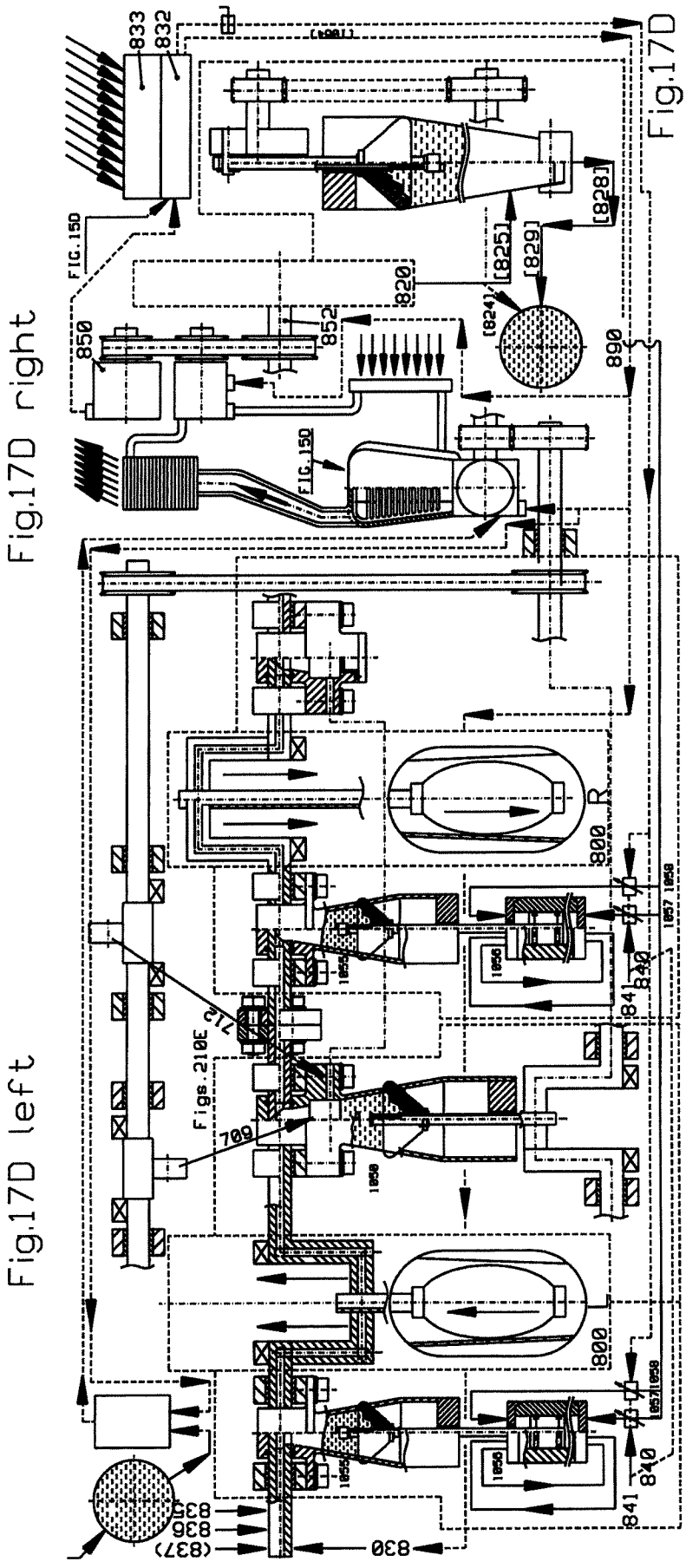


Fig.17C


Fig.17D left
Fig.17D right
Fig.17D
833
832
FIG.150
820
850
852
[824]
[825]
[828]
[829]
890
800
R
840
841
712
Figs.210E
709
1856
1857
1858
1859
835
836
(837)
830

Fi

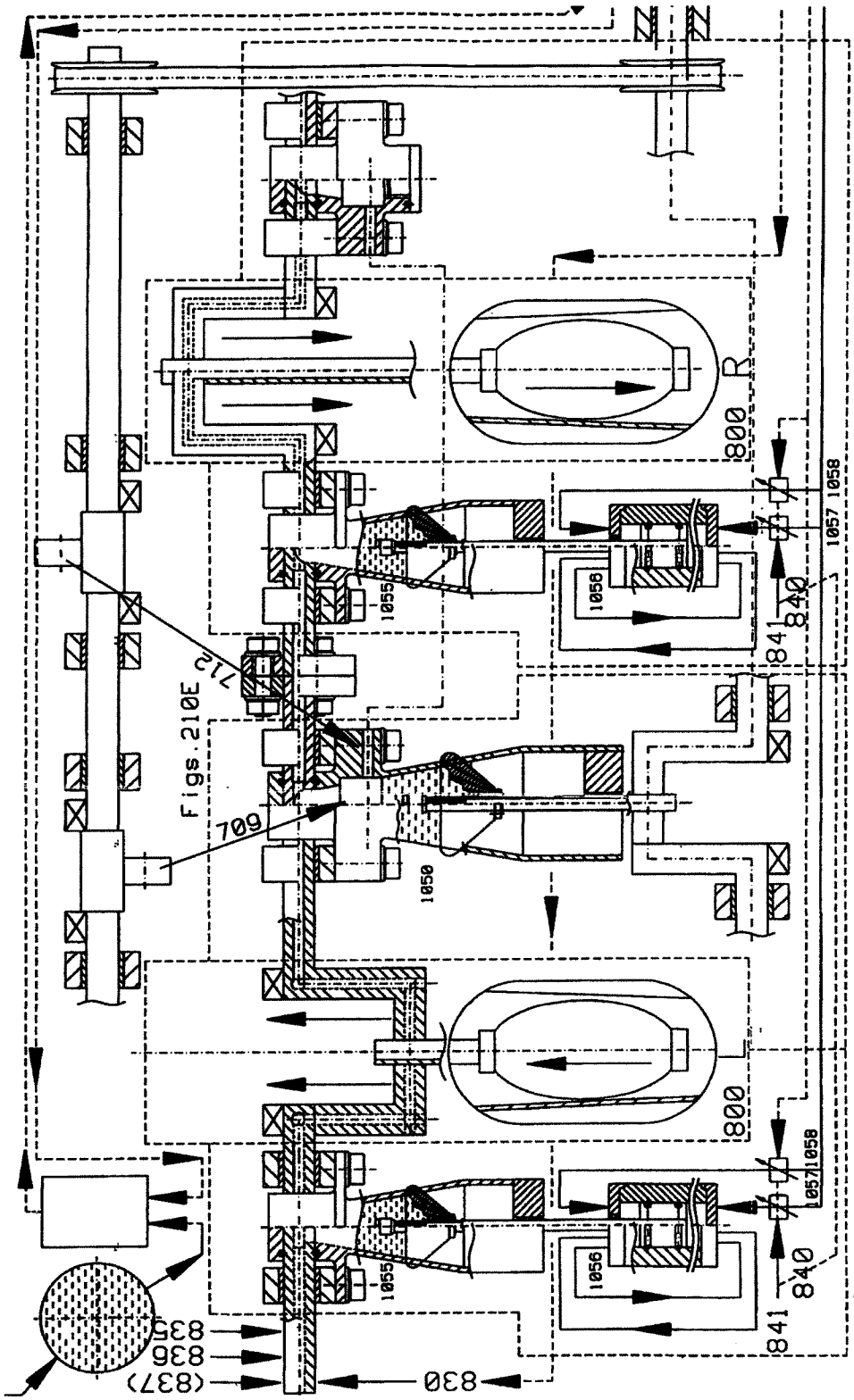


Fig.17D left

Fig.17D right

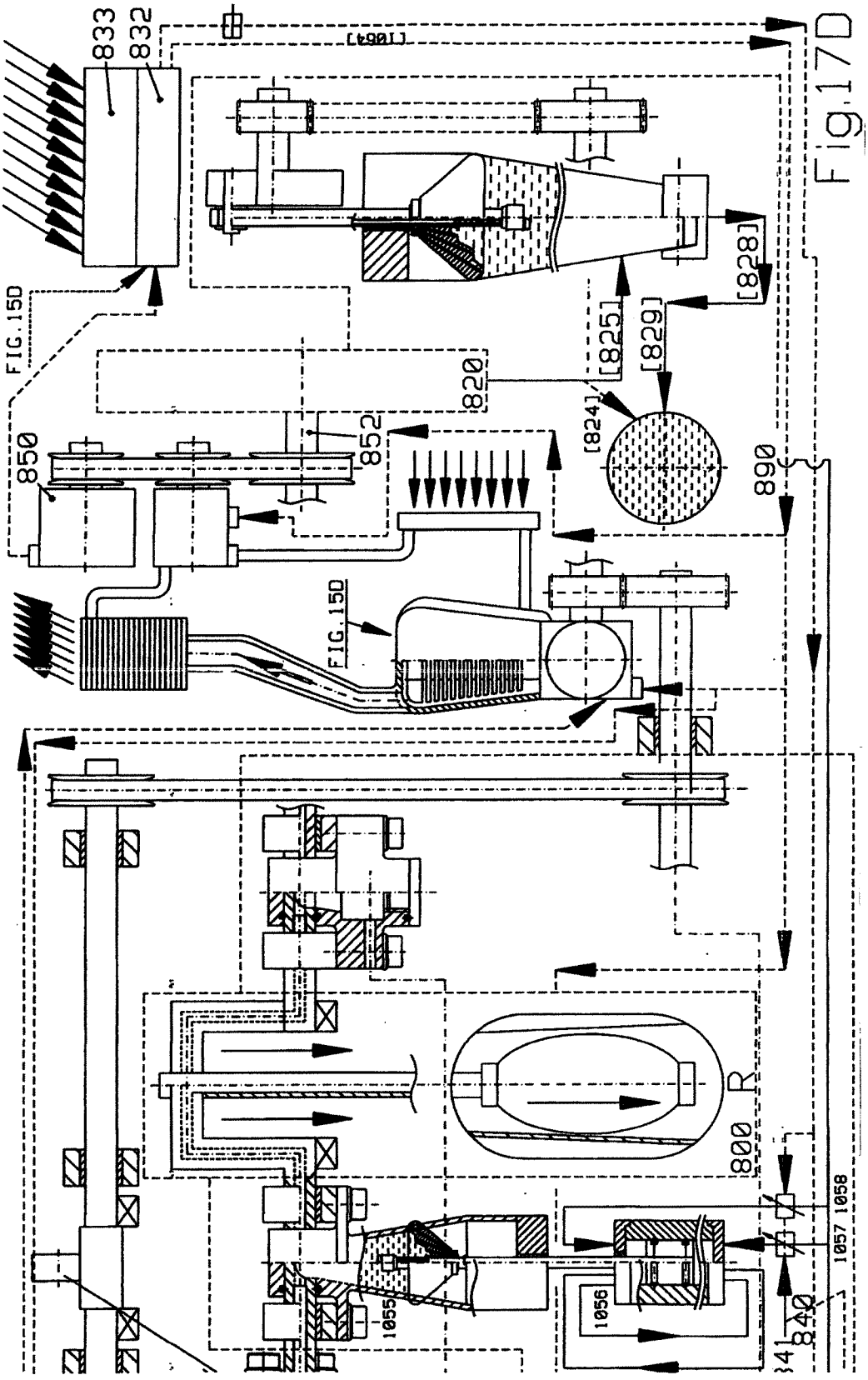


Fig.17D

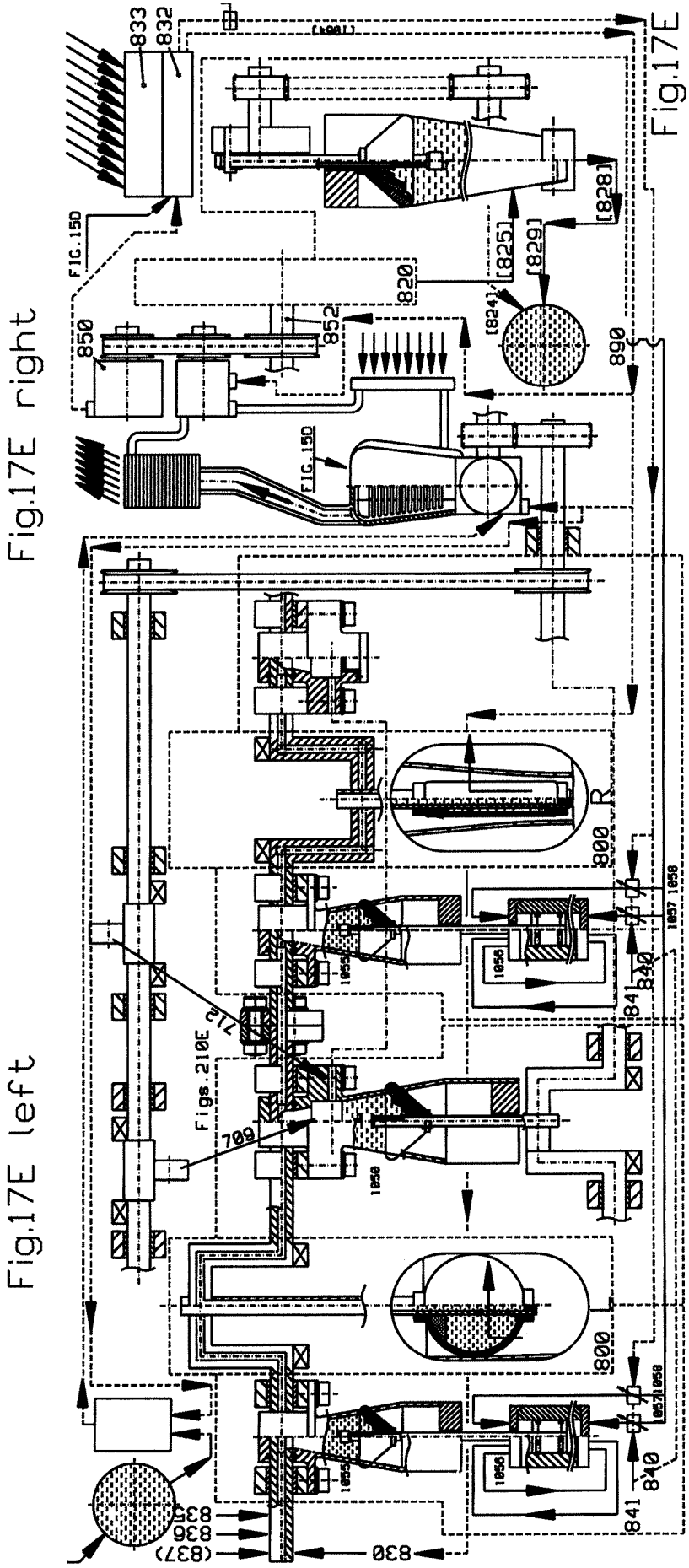

Fig.17E left
Fig.17E right
Fig.17E
833
832
FIG.15D
820
[825]
[829]
[828]
[824]
850
852
890
FIG.15D
800
R
840
841
1857 1858
1856
1858
Figs.210E
709
800
840
841
835
836
(837)
830

Fig.17E left

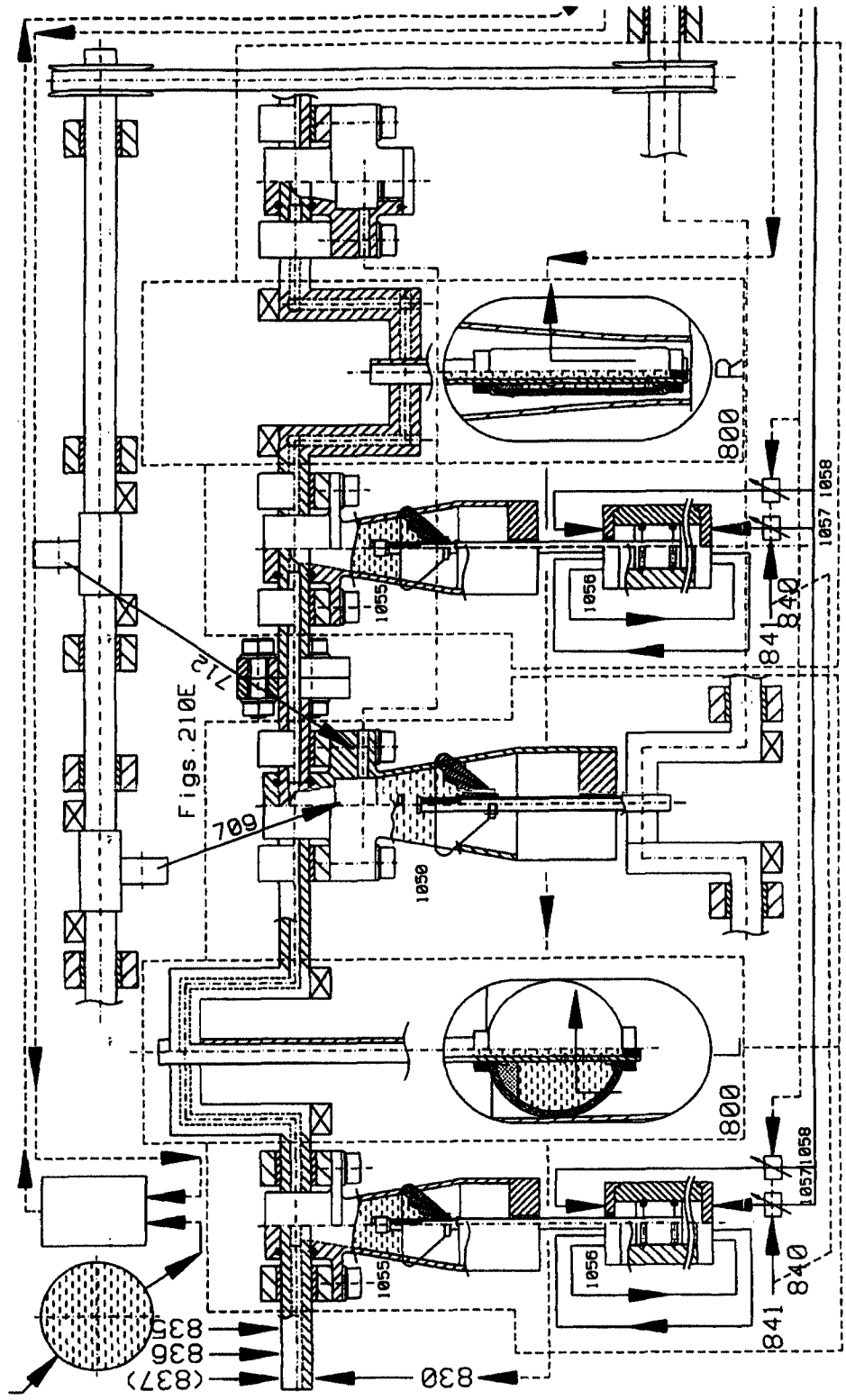

800 R
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1055
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841
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Figs.210E
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1057 1058
1056
1055
840
841
835
836
(837)
830

Fig.17E right

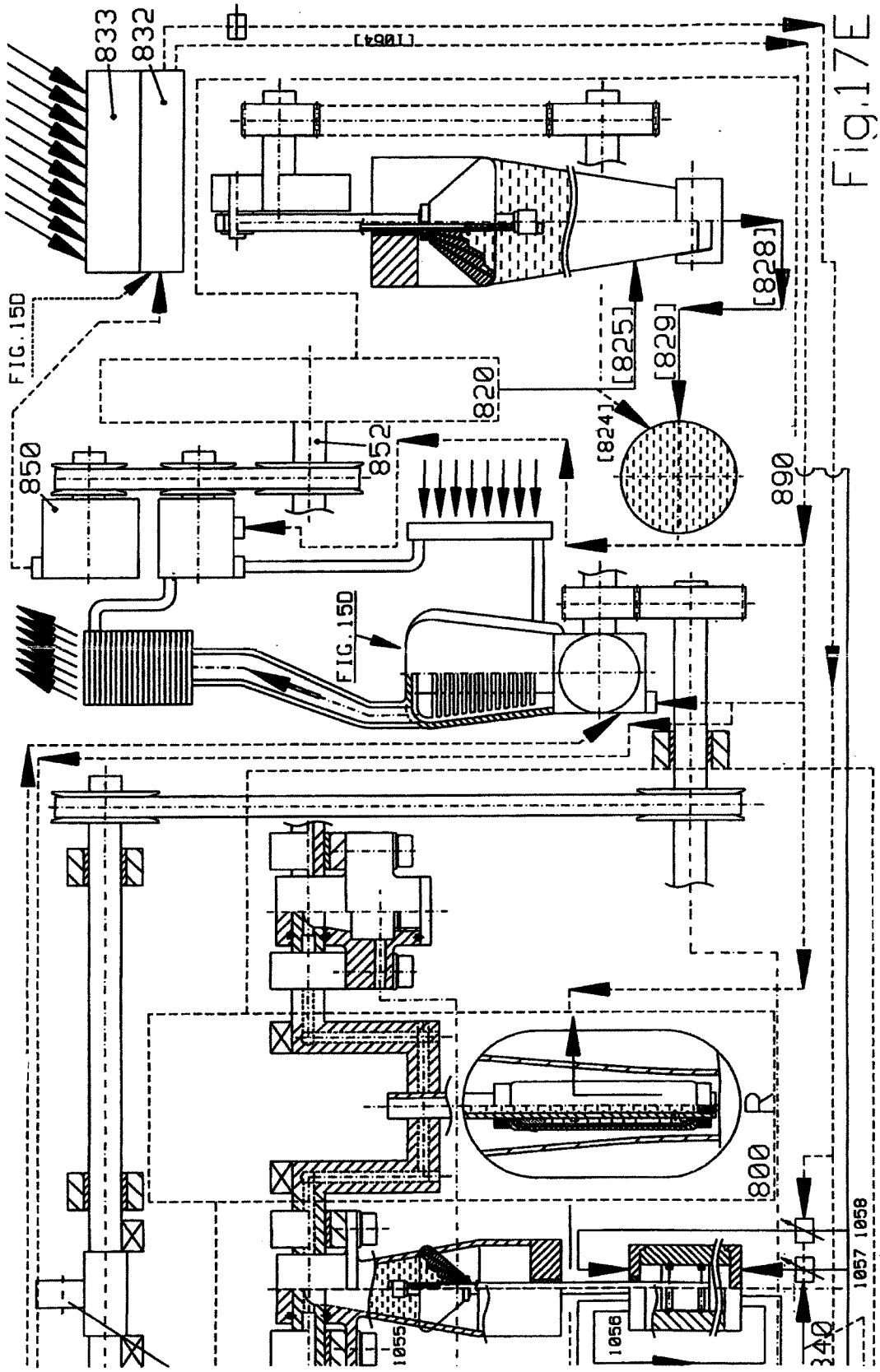


Fig.17E

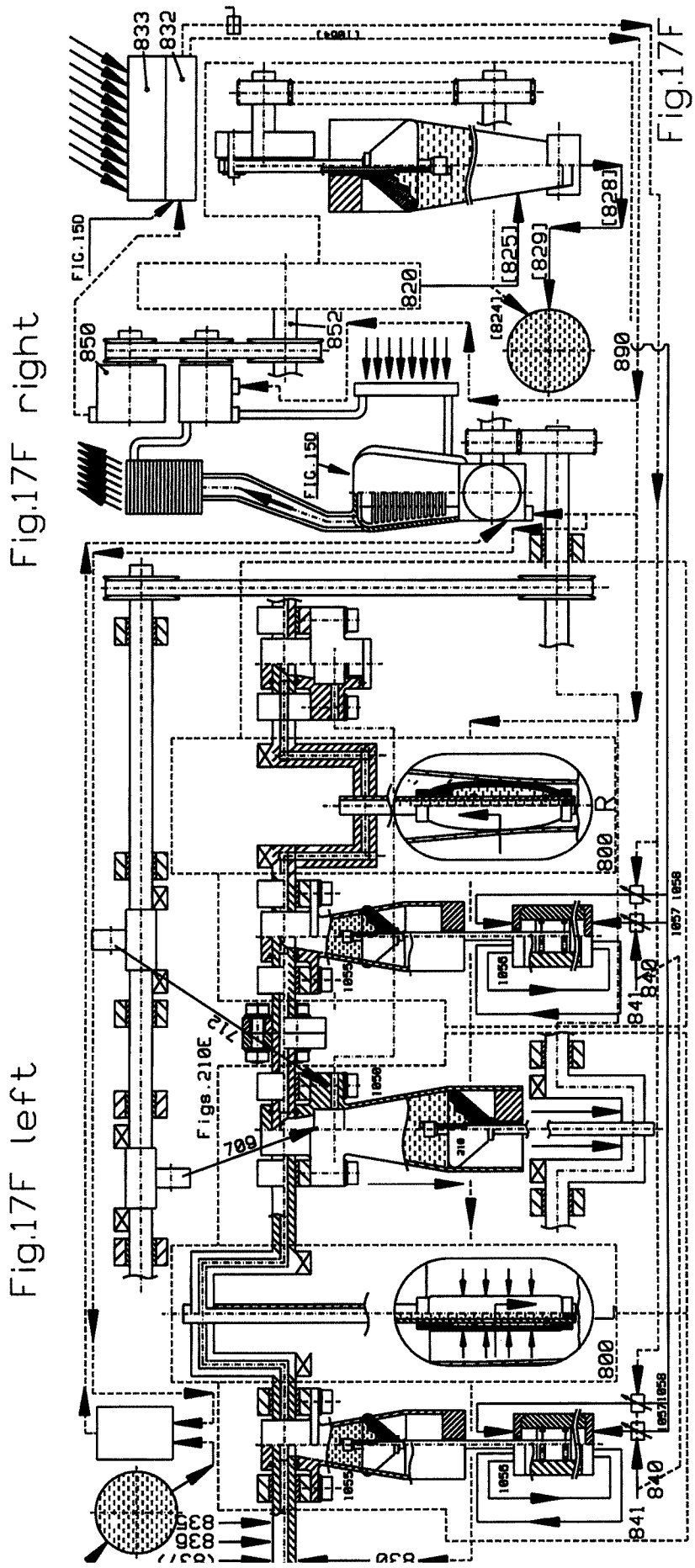

Fig.17F left
Fig.17F right
Fig.17F
833
832
FIG.15D
820
[825]
[829]
[828]
[824]
850
852
890
FIG.15D
800
R
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1857
1856
1855
Figs.210E
709
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840
841
835
836

Fig.17F left

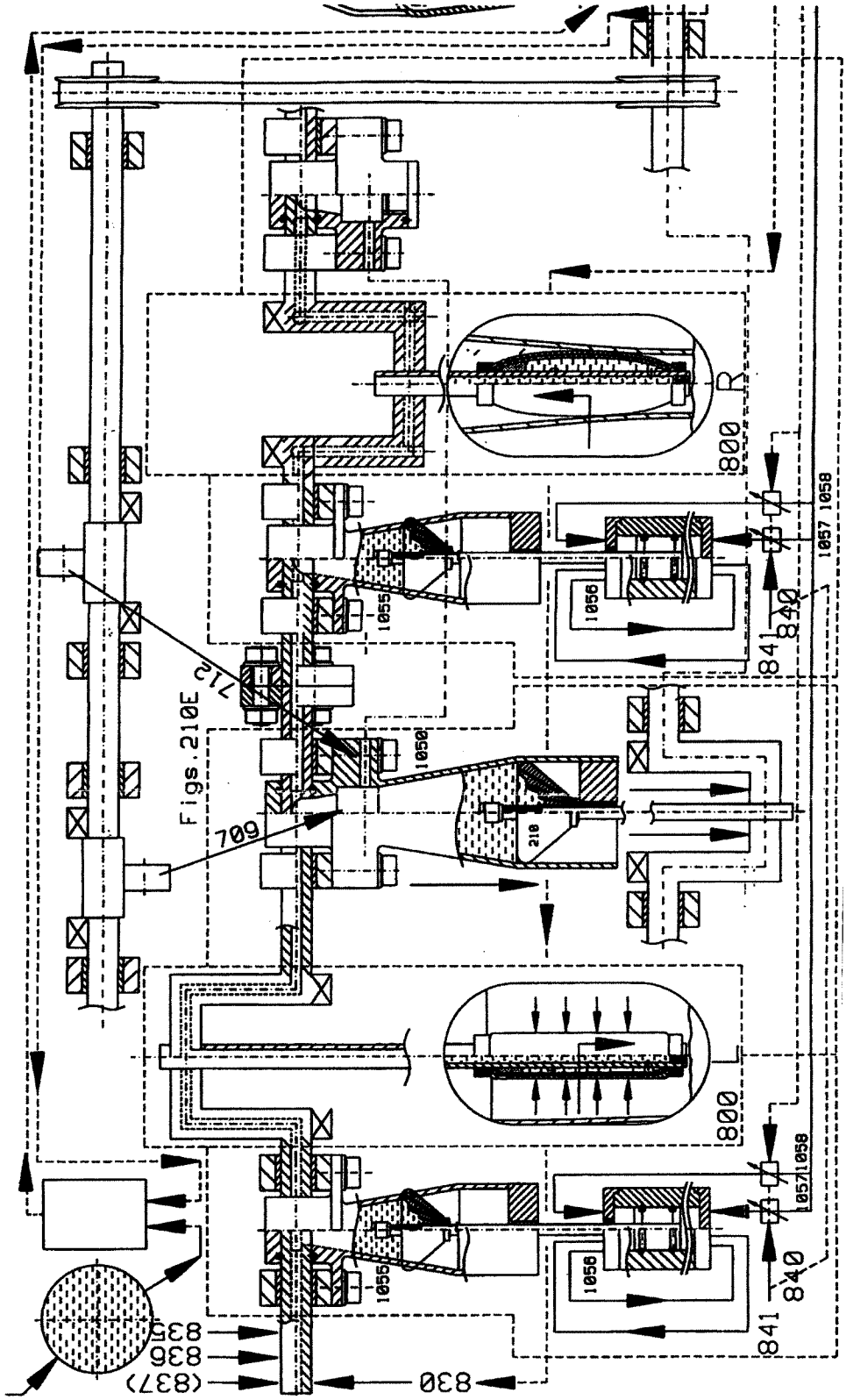

800
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1056
712
Figs.210E
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1057 1058
840
841
1055
1056
835
836
(837)
830

Fig.17F right

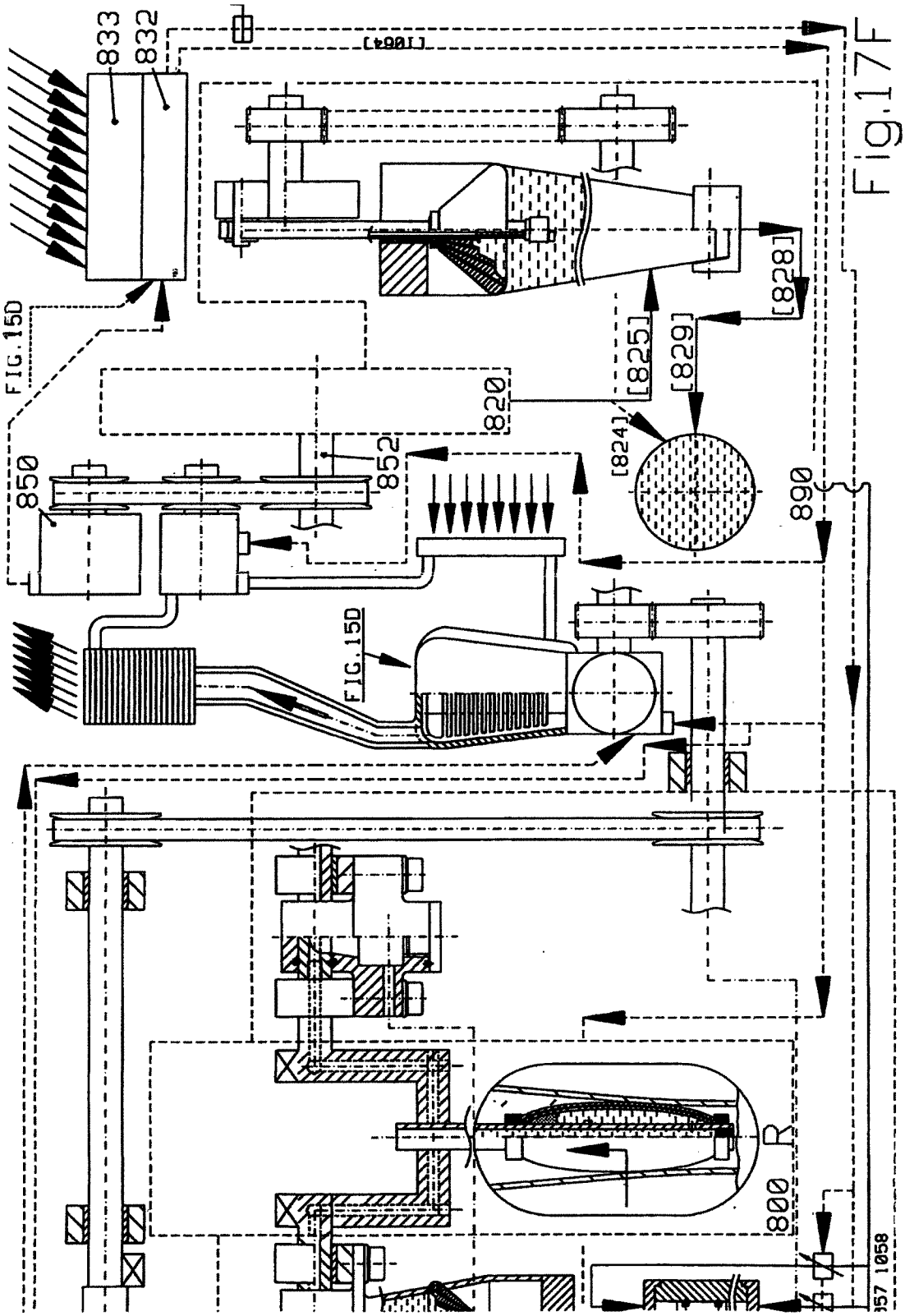
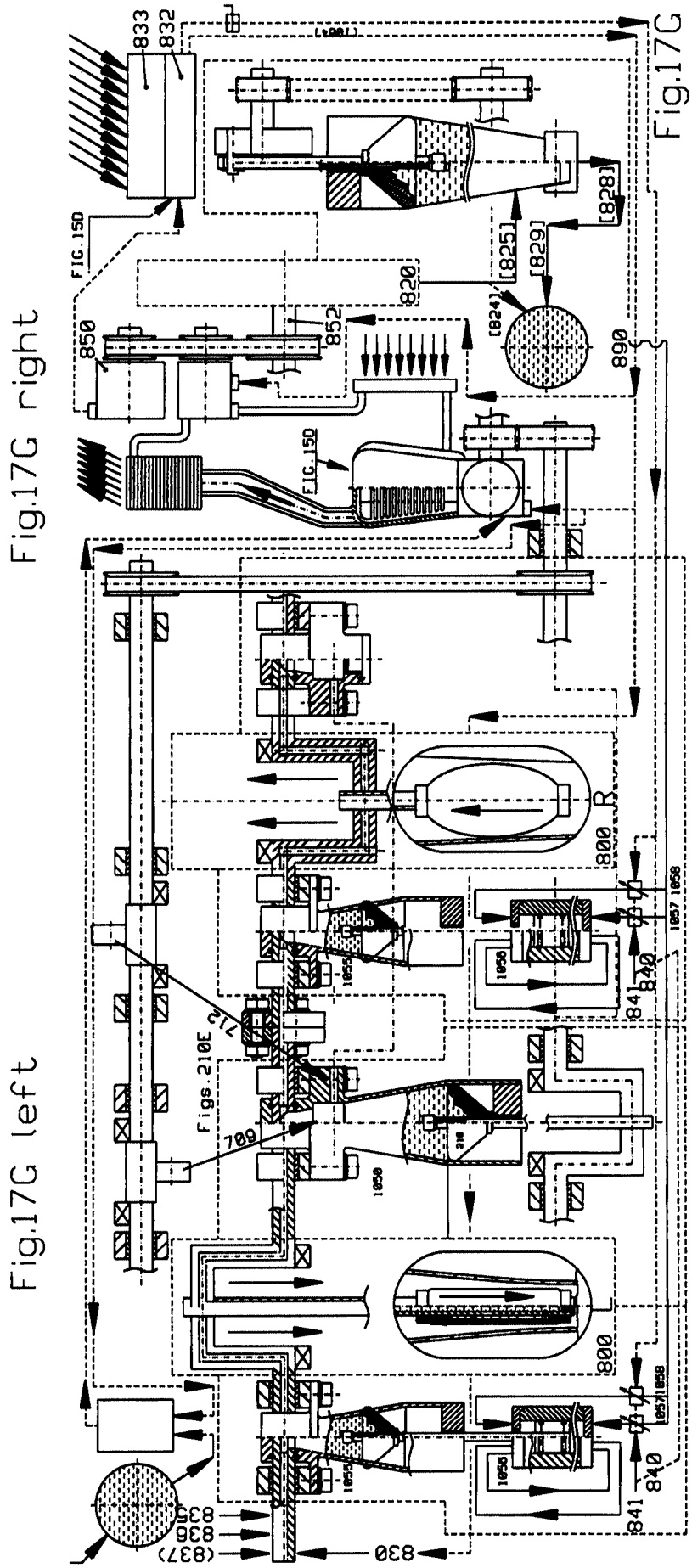


Fig.17F


Fig.17G
Fig.17G right
Fig.17G left
833
832
[828]
[825]
[829]
820
[824]
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852
890
FIG.15D
FIG.15D
800 R
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Figs.21DE
712
709
830
835
836
(837)

Fi

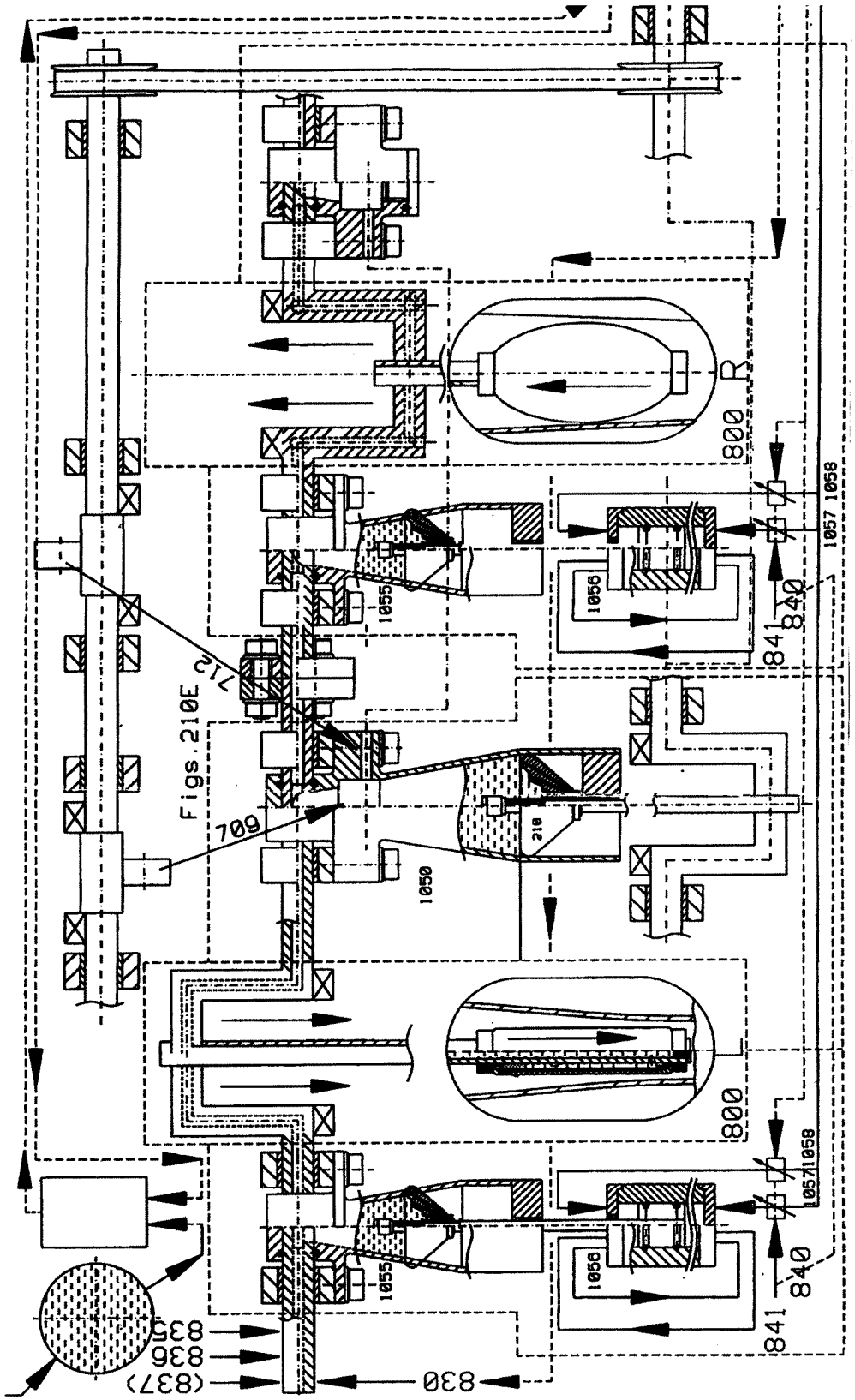


Fig.17G left

Fig.17G right

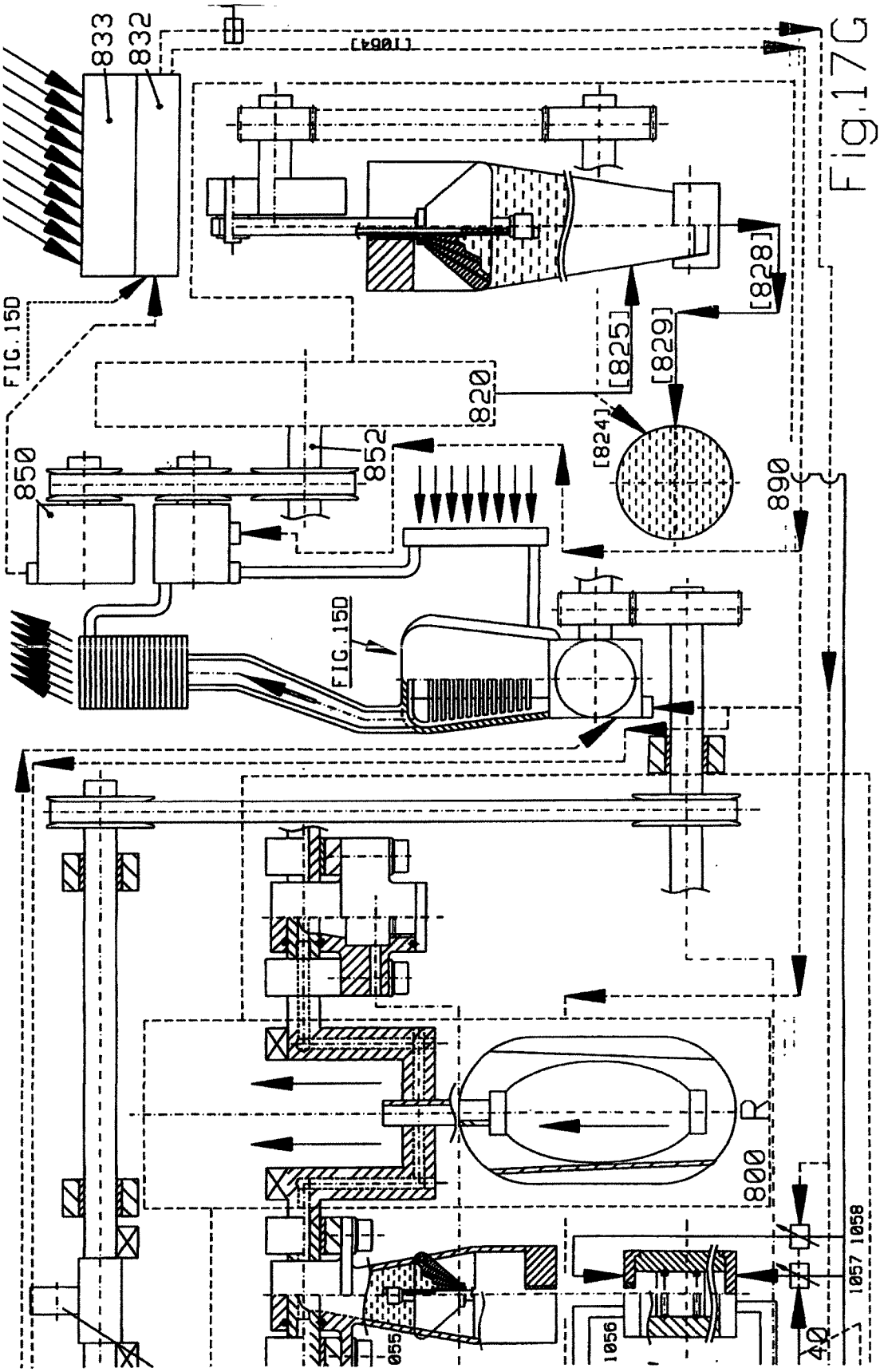
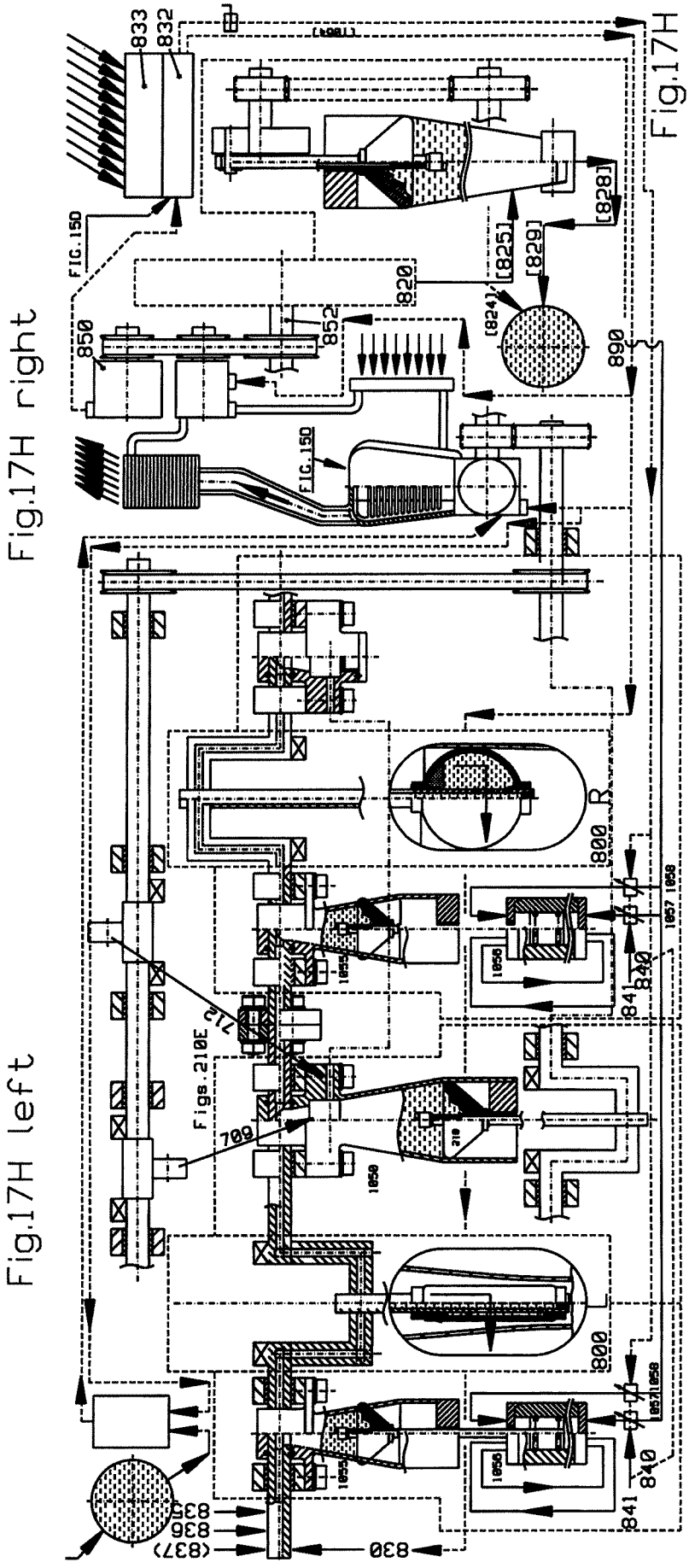


Fig.17G


Fig.17H left
Fig.17H right
Fig.17H
833
832
FIG.150
820
[825]
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[824]
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852
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800 R
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841
Figs.210E
709
712
830
836
837

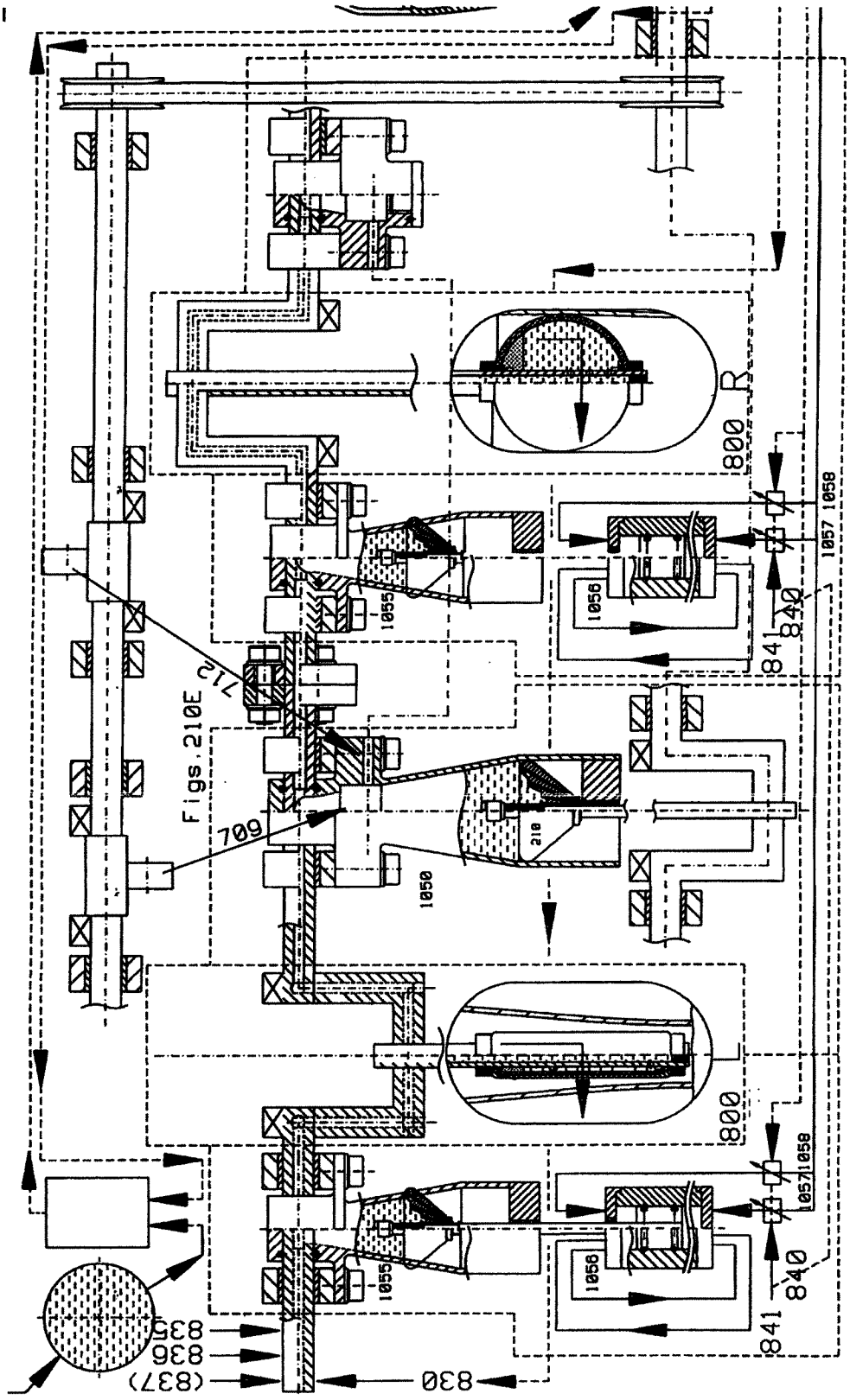

800 R
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841
1057 1058
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712
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Figs.210E
218
830
836
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835

Fig.17H left

Fig.17H right

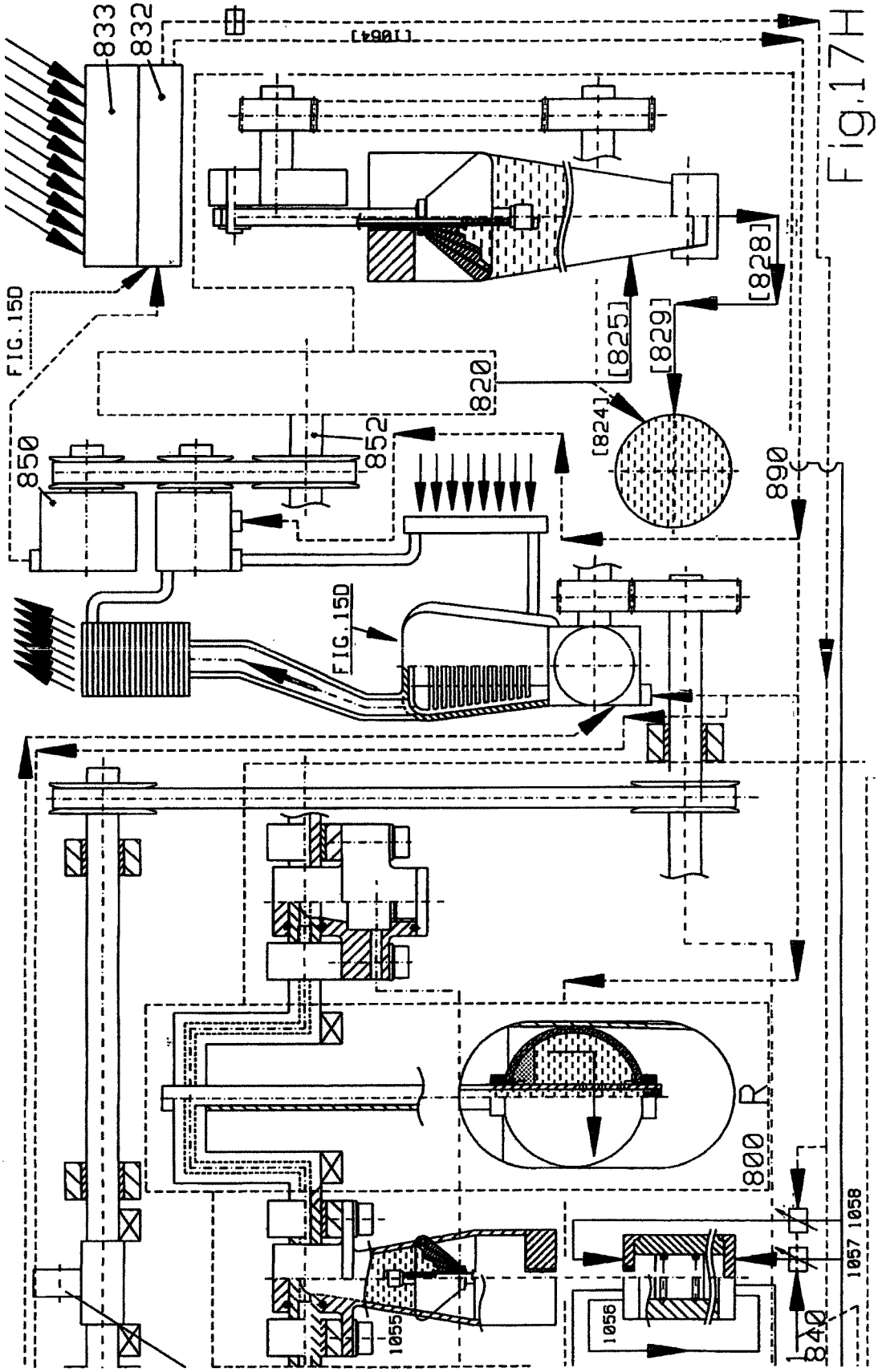


Fig.17H

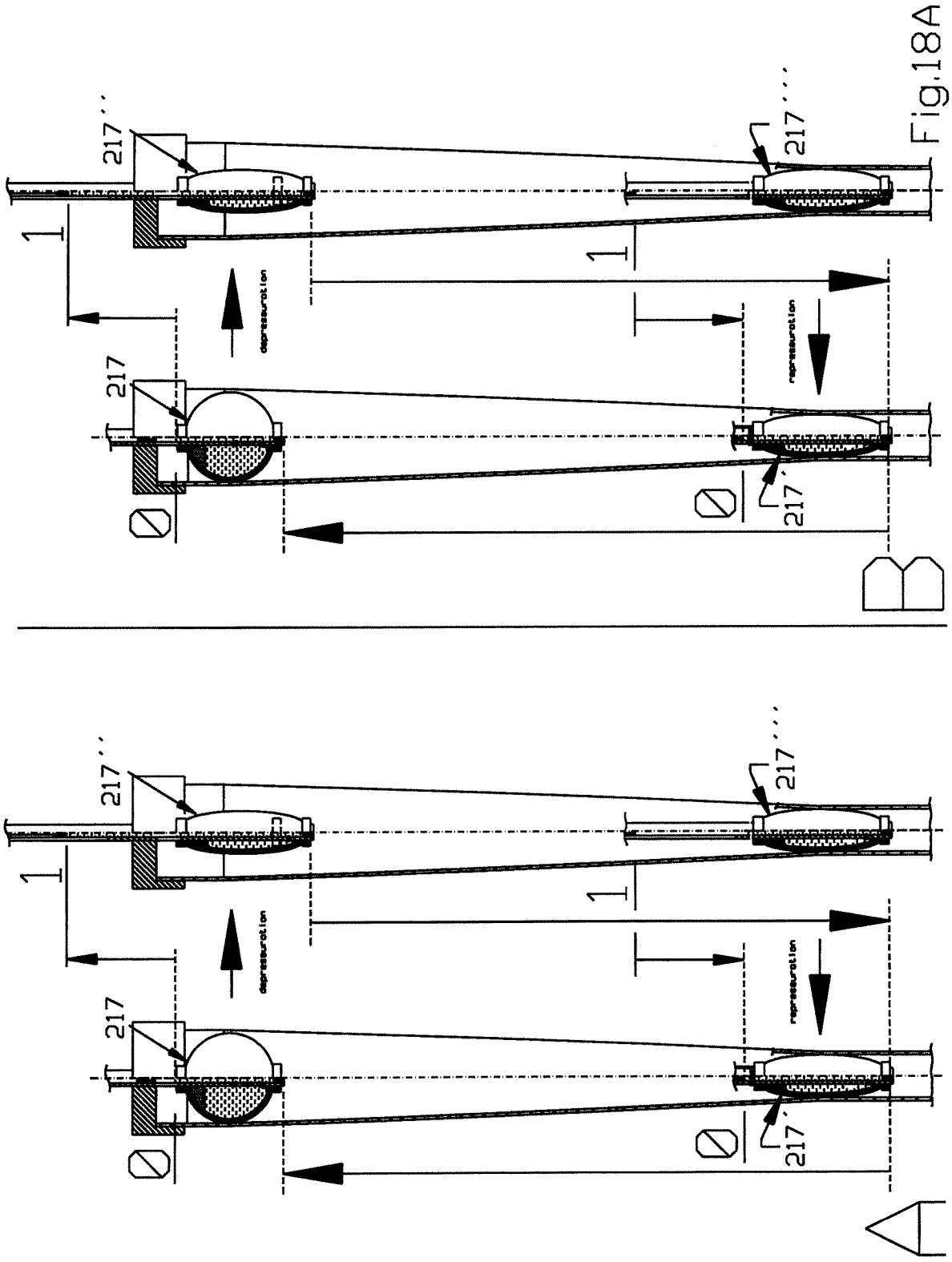
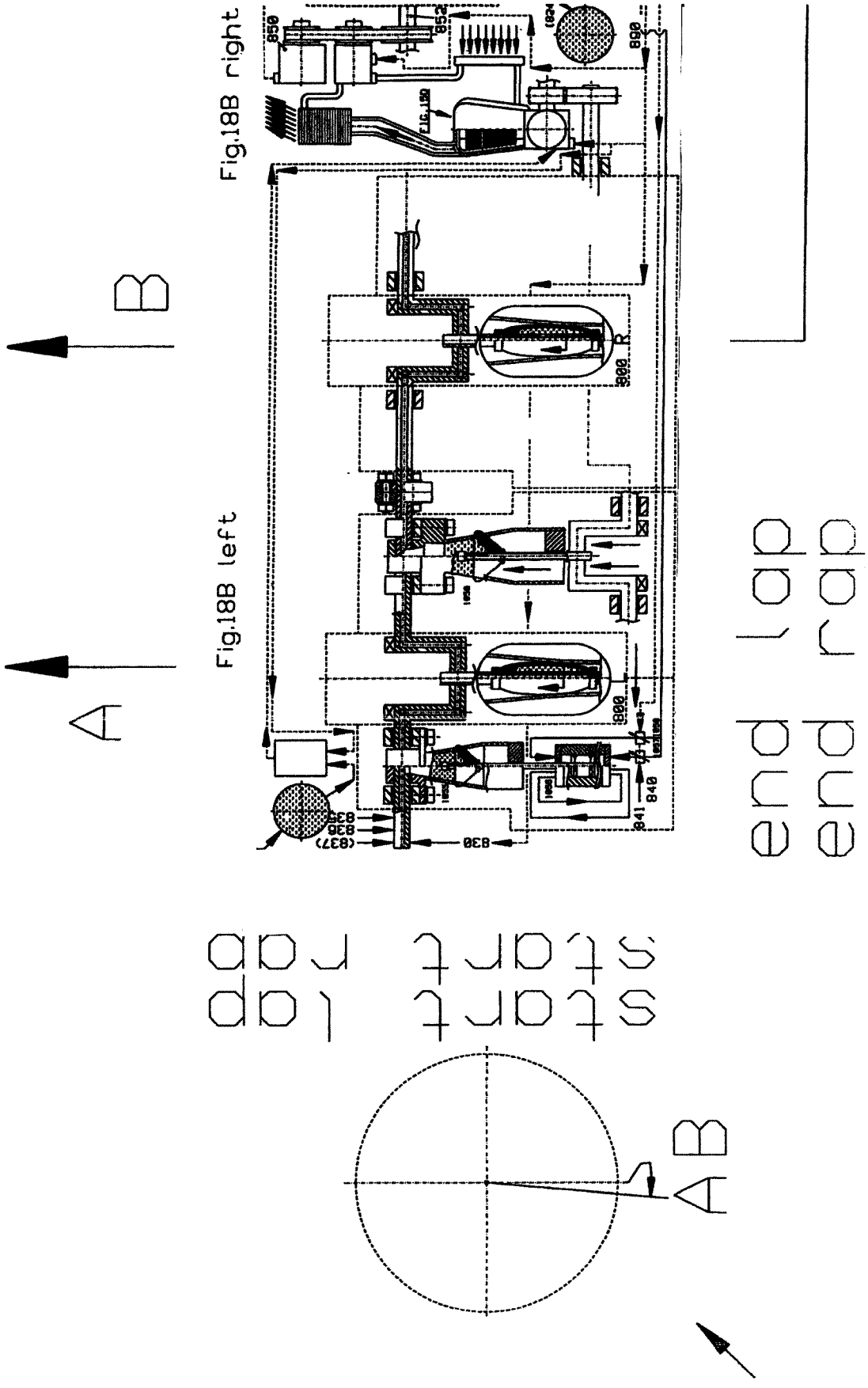
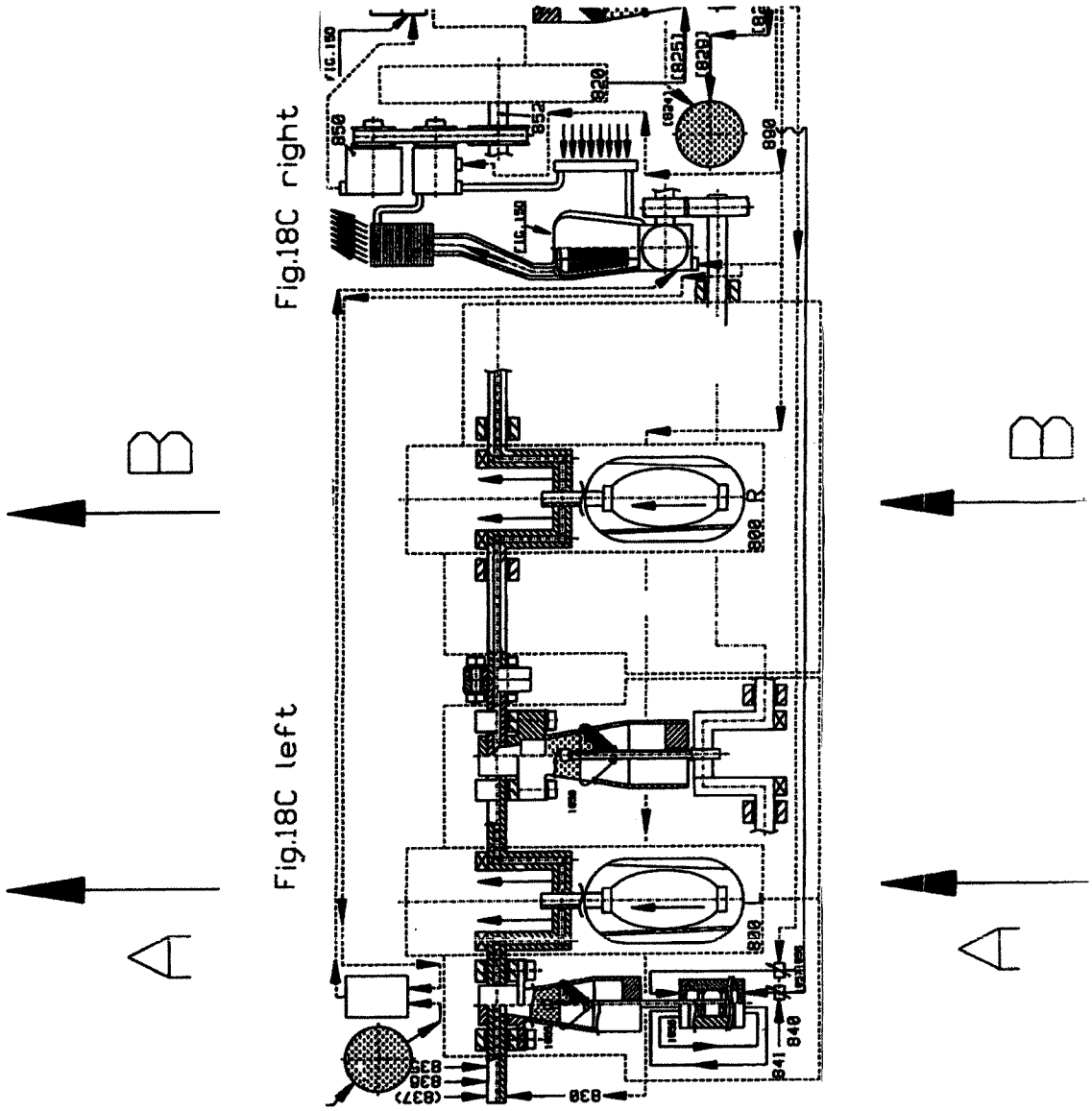
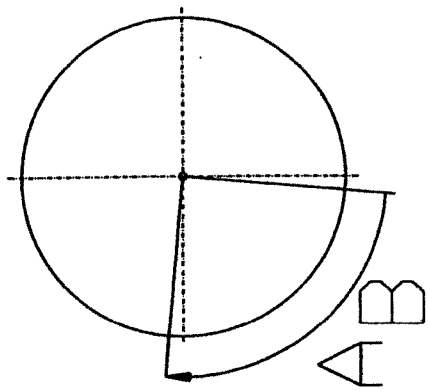
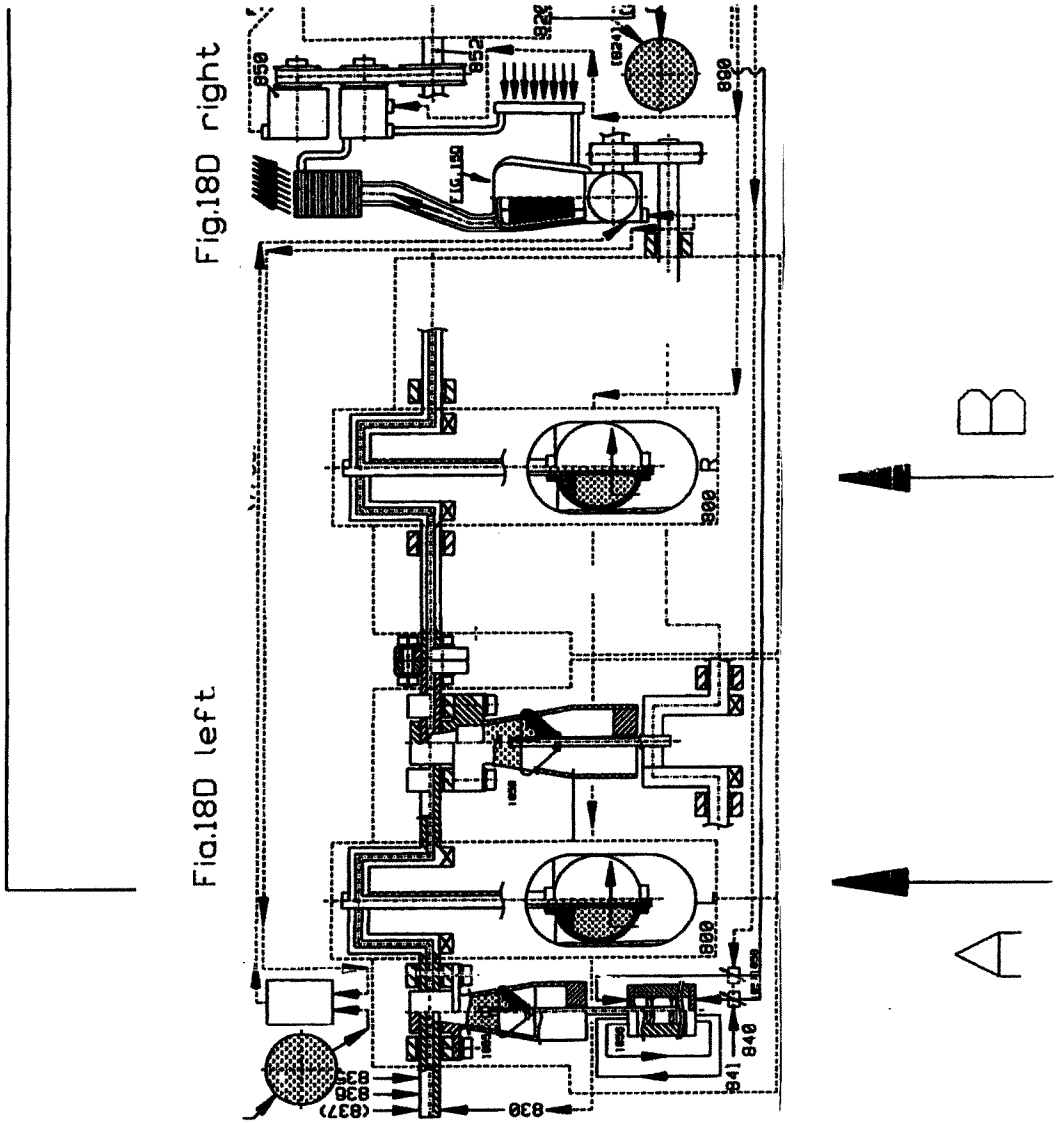

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repressurisation
217
217'
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1
depressurisation
repressurisation
217
217'

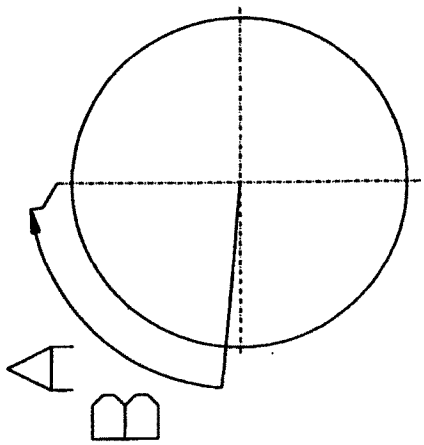
Fig.18A


Fig.18B right
Fig.18B left
B
A
end lap
end lap
start lap
start lap
B
A


Fig.18C right
Fig.18C left
B
B
A
A
FIG.150
FIG.150
850
852
820
(828)
(827)
(825)
880
808
808
840
841
837
838
(837)
830


B
A


Fig.18D right
Fig.18D left
850
852
820
890
800 R
800
840
830



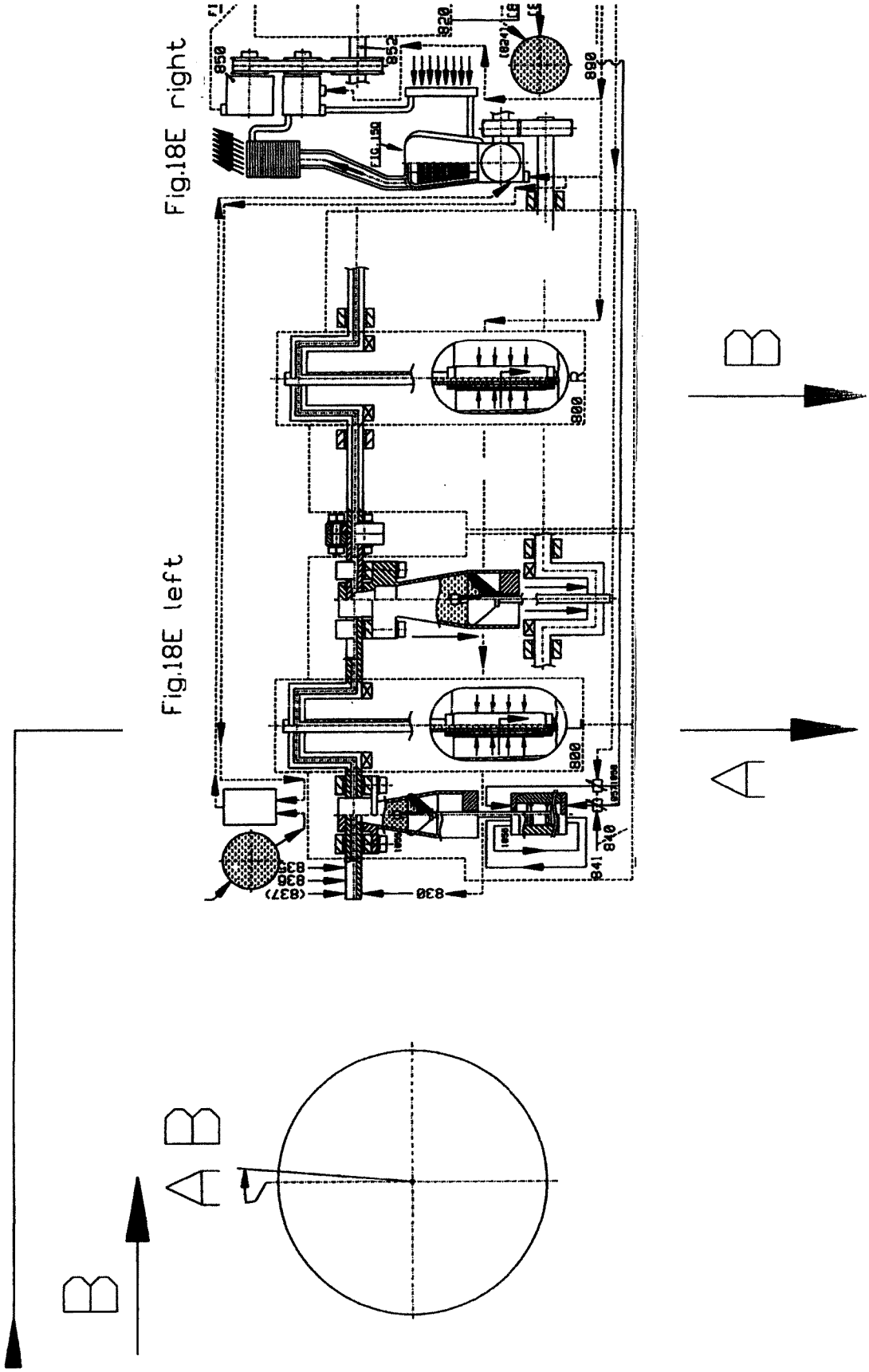
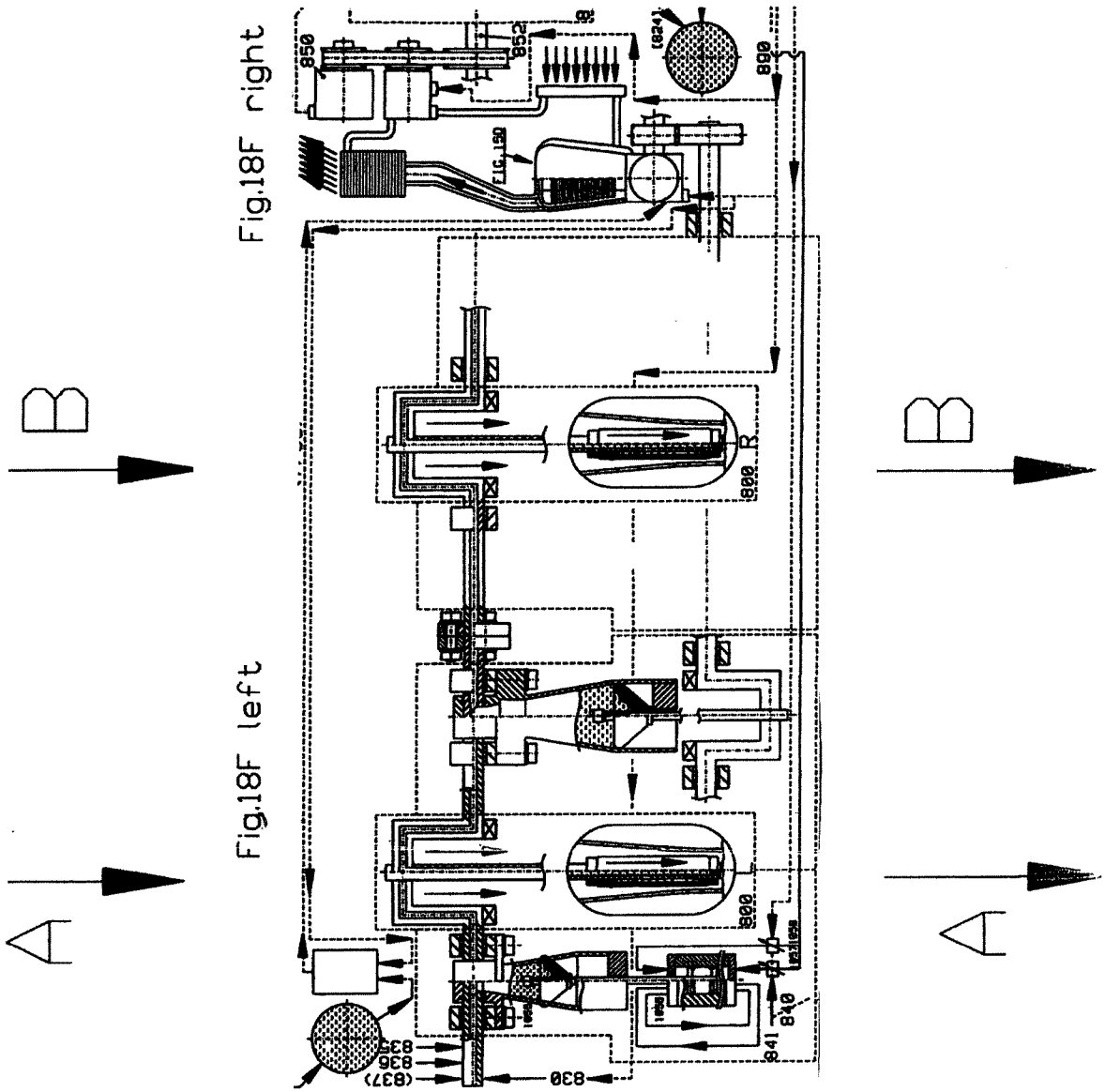
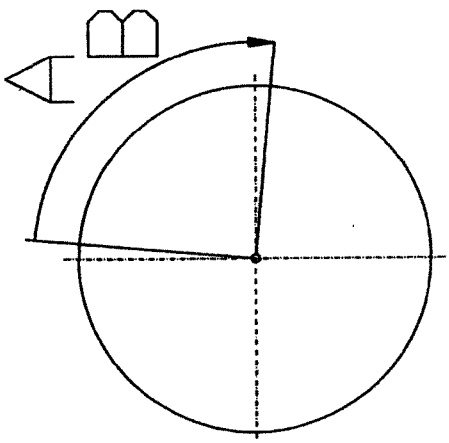
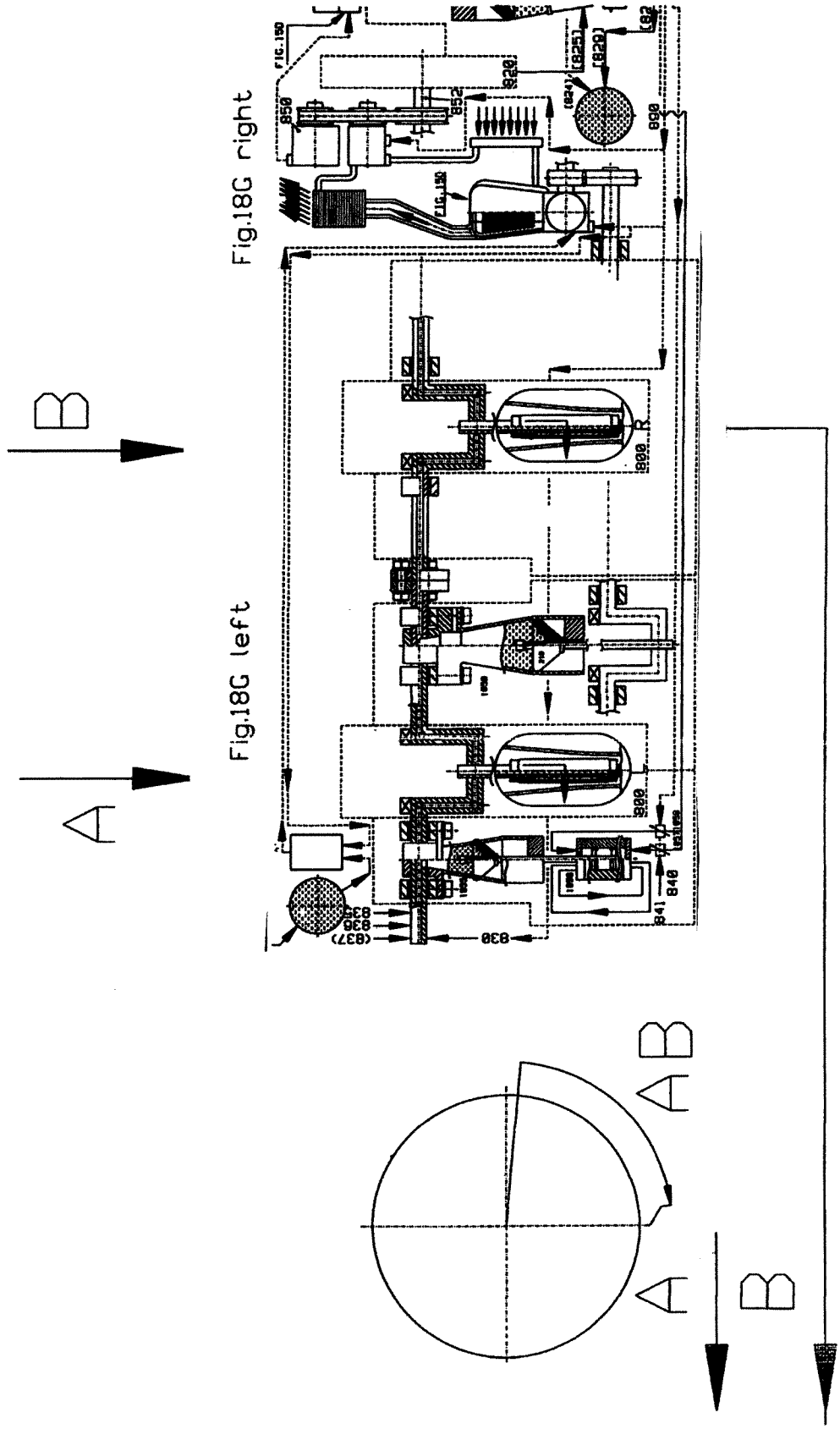

Fig.18E right
Fig.18E left
B
B

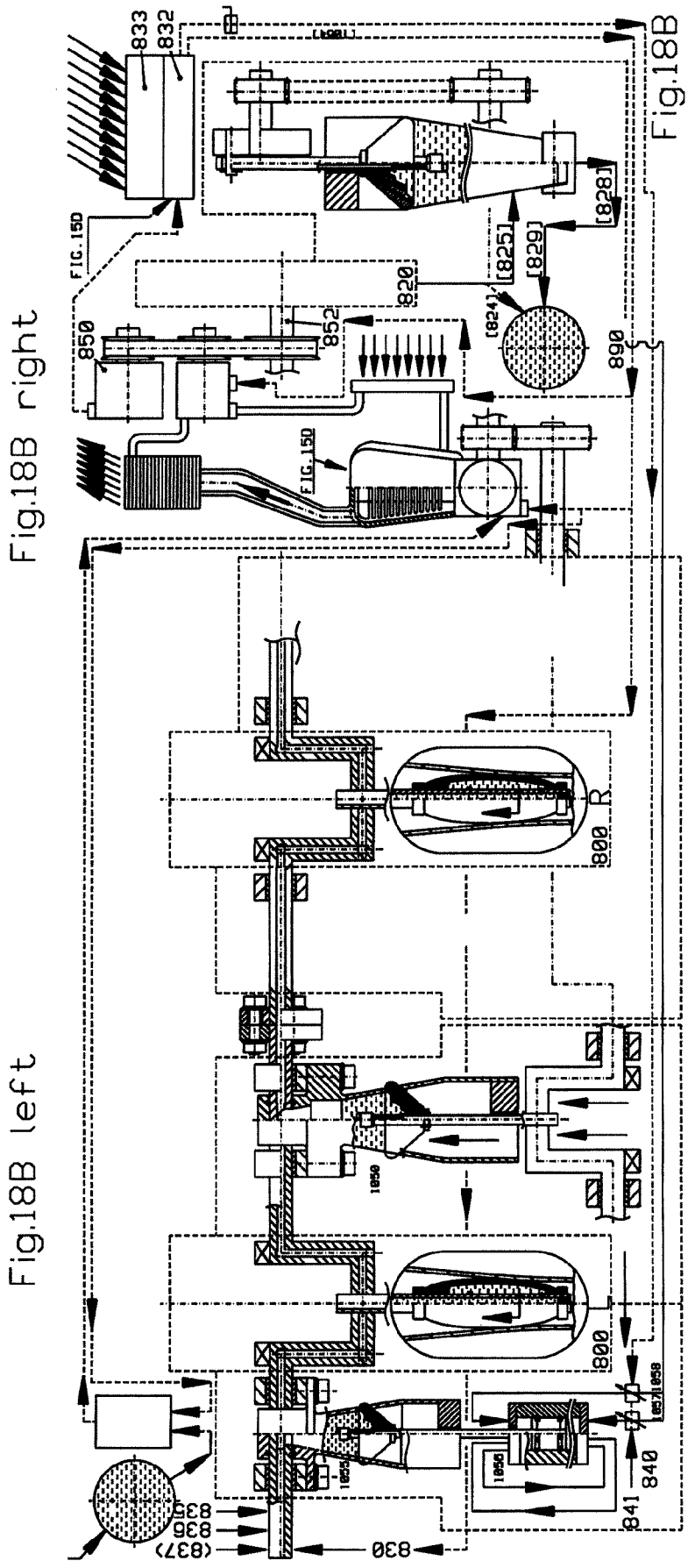
Fig.18F right

Fig.18F left






Fig.18G right
Fig.18G left
A
B
A
B
A
B


Fig.18B left
Fig.18B right
Fig.18B
833
832
FIG. 15D
820
850
858
890
FIG. 15C
800
R
1850
840
841
835
836
(837)
830

Fi

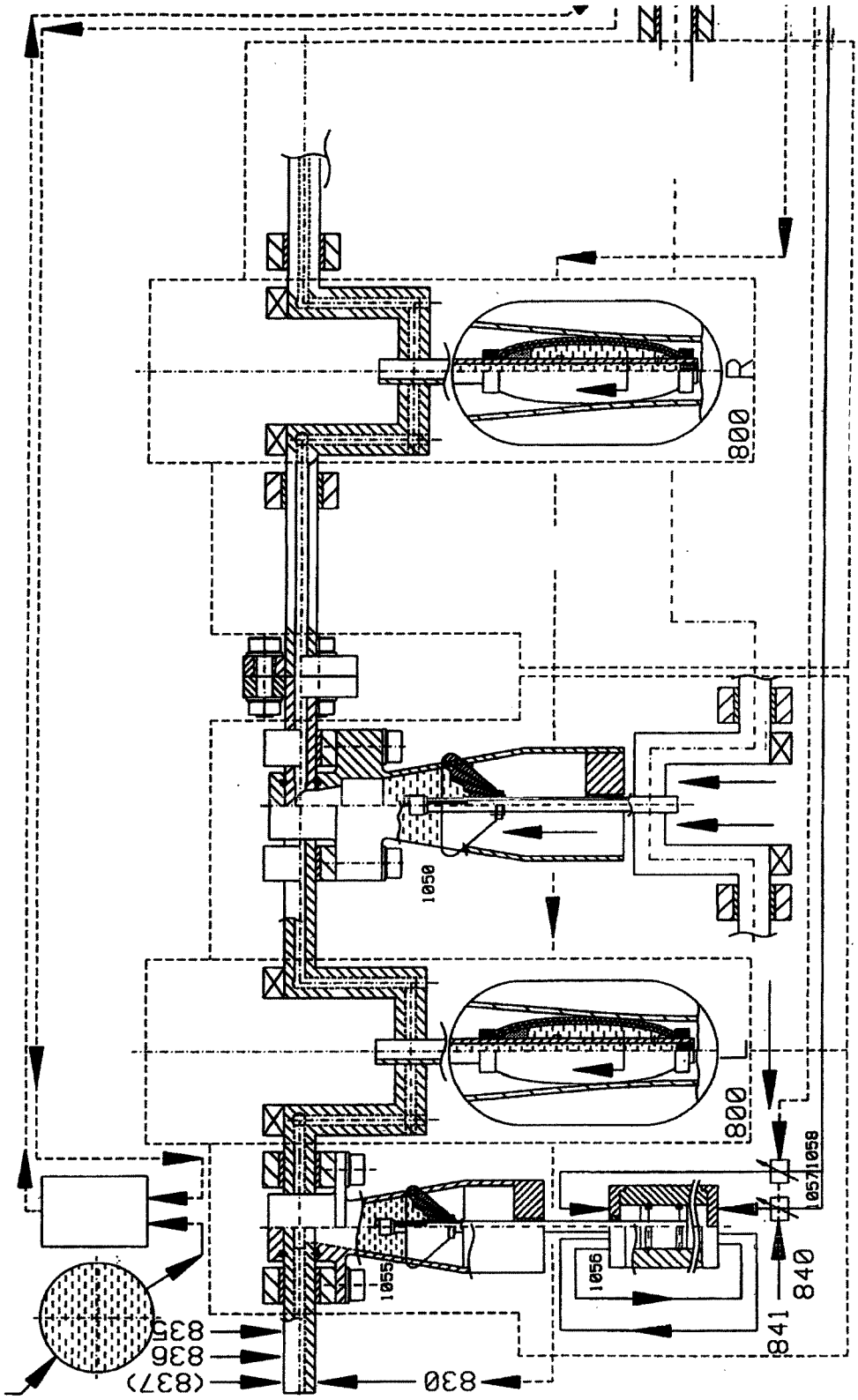


Fig.18B left

Fig.18B right

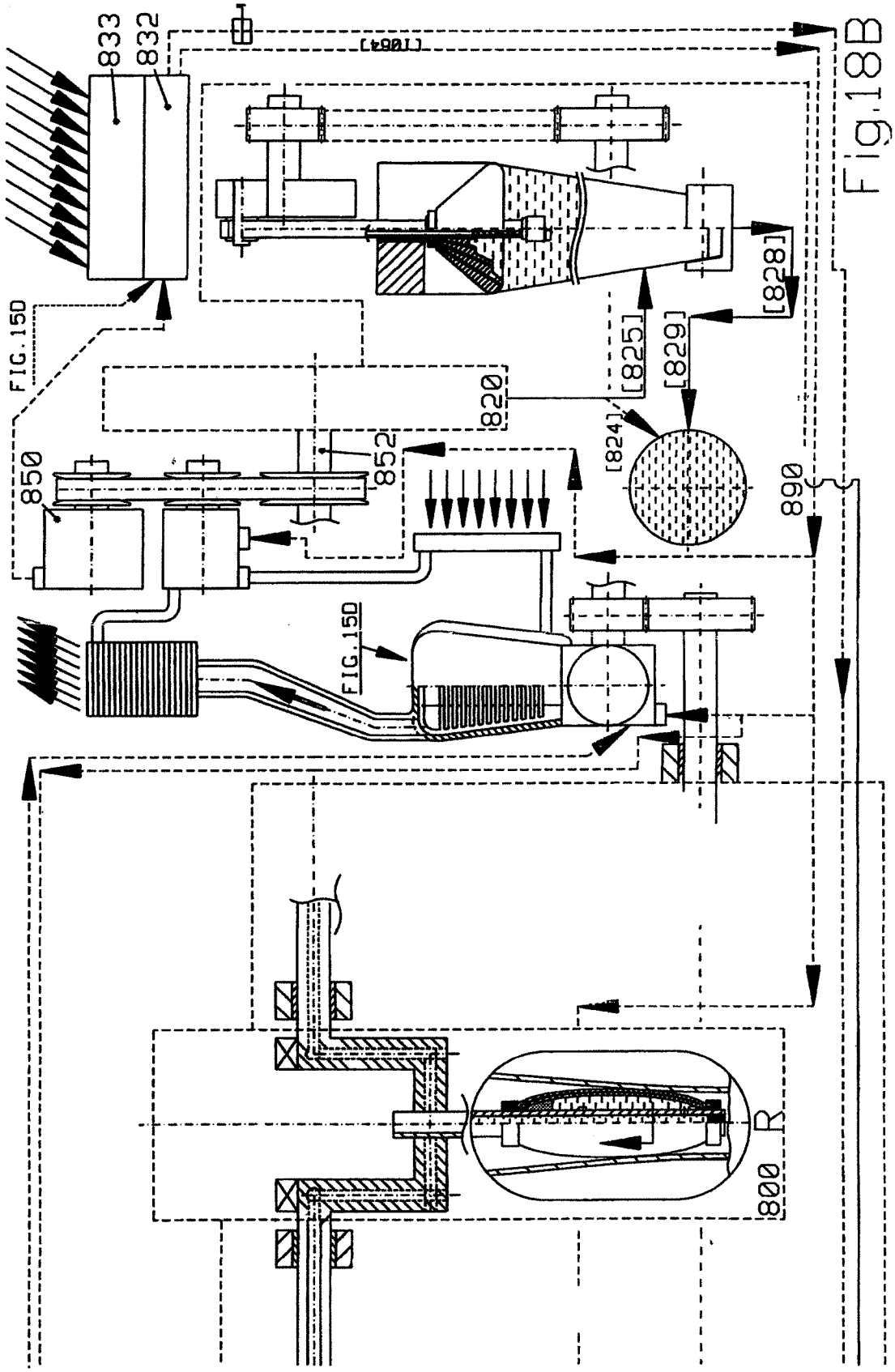


Fig.18B

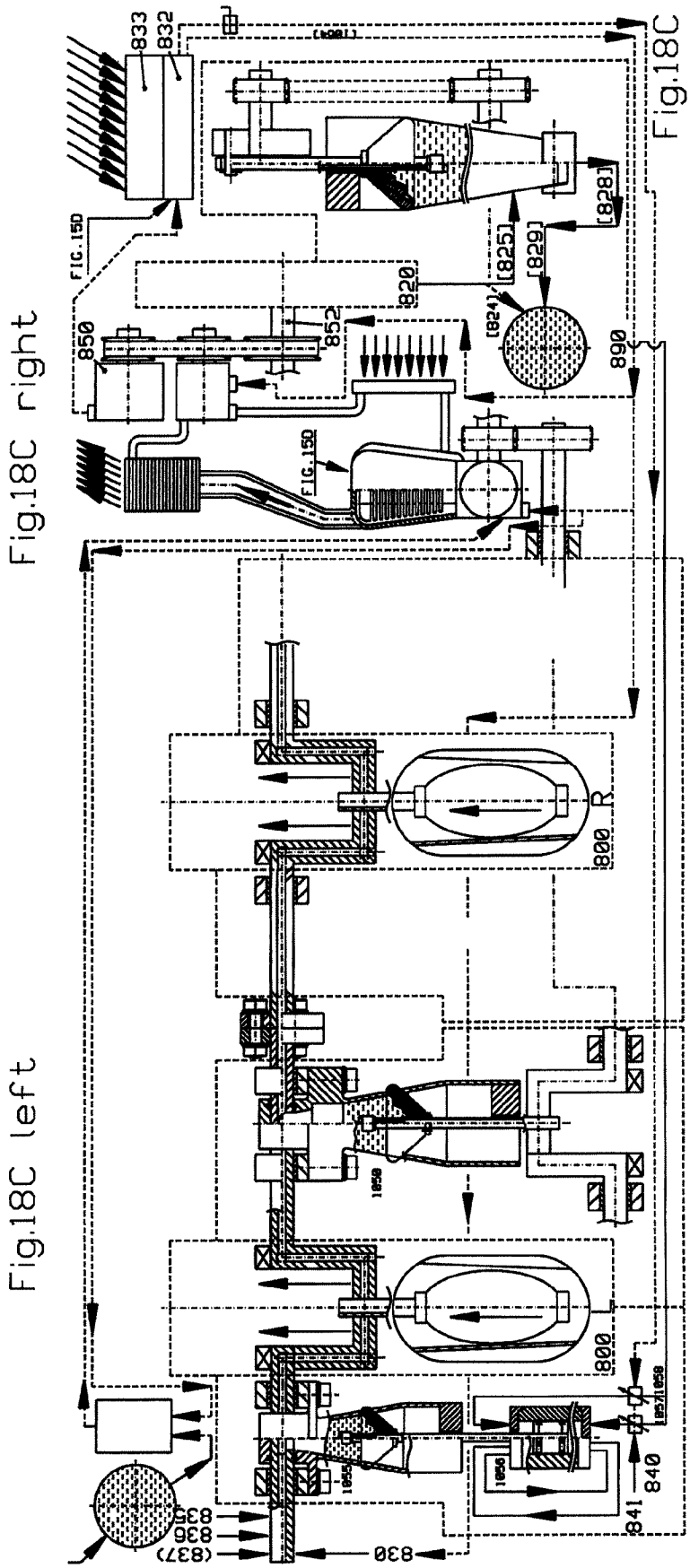
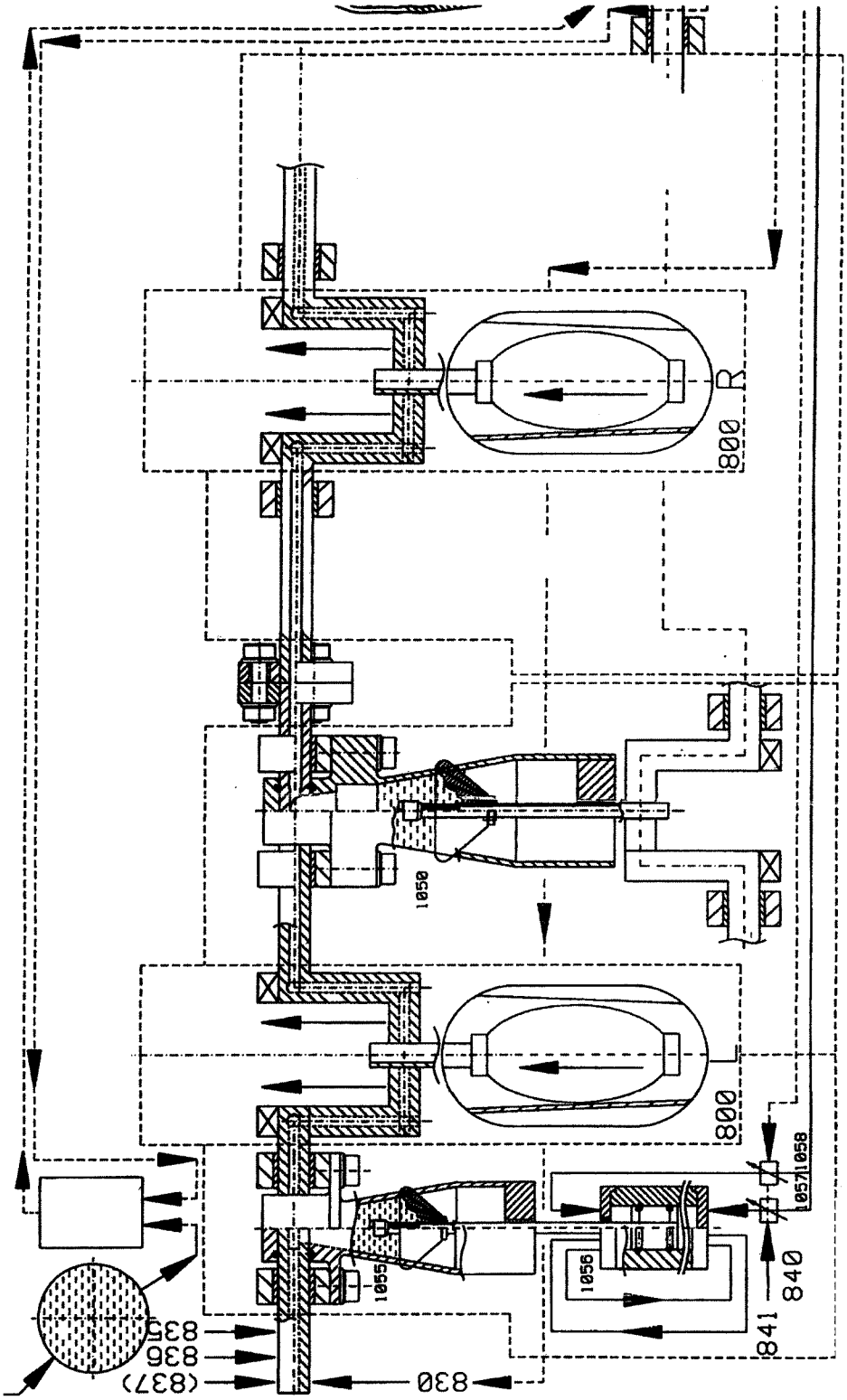
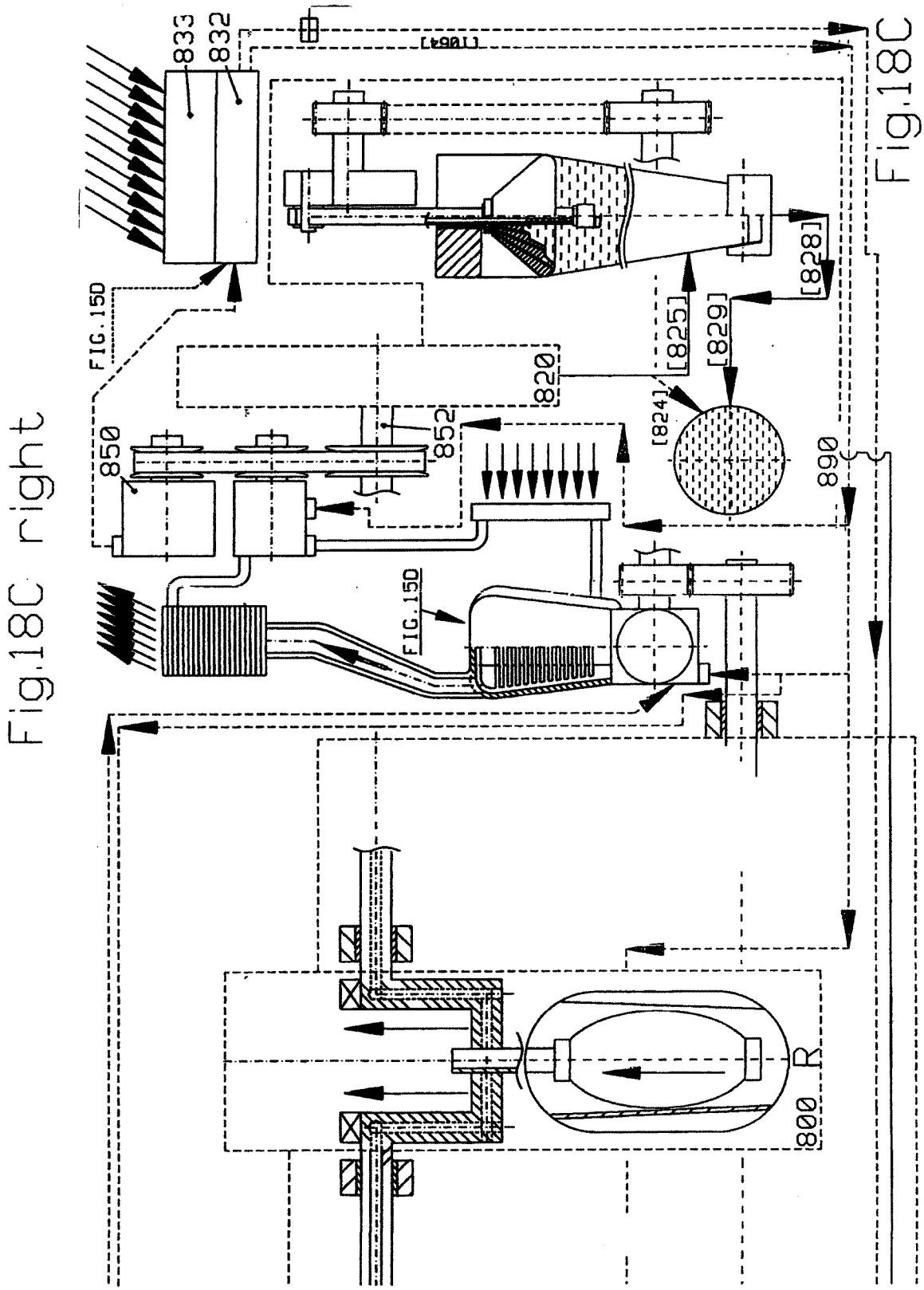

Fig.18C
Fig.18C right
Fig.18C left
833
832
820
850
852
890
800
840
841
830
835
836
(837)

Fig.18C left




Fig.18C right
833
832
[1064]
[828]
[825]
[829]
820
[824]
852
850
860
FIG.15D
FIG.15D
800R
Fig.18C

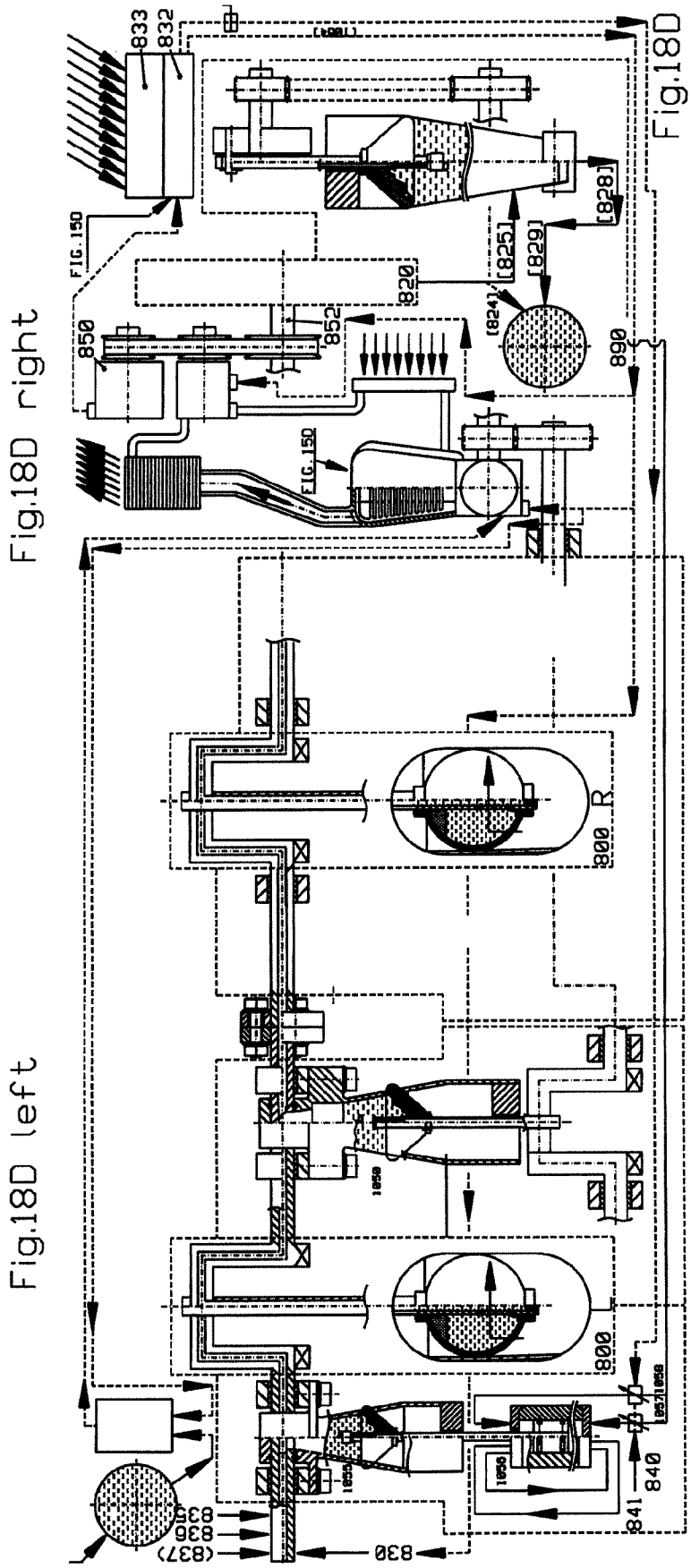

Fig.18D
Fig.18D right
Fig.18D left
833
832
FIG. 15D
820
[825]
[828]
[824]
850
852
890
800 R
800
840
841
830
836
(837)

Fig.18D left

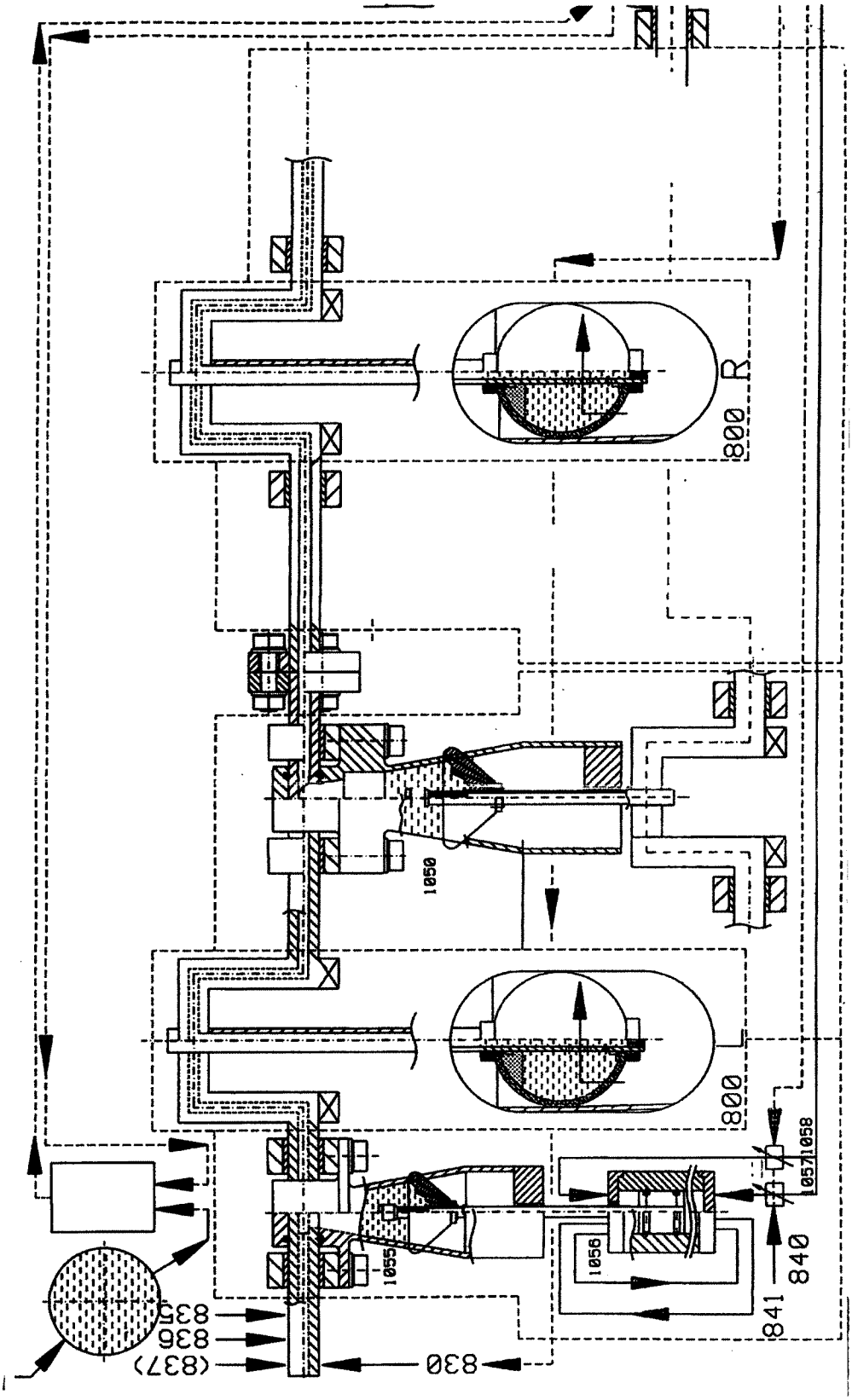


Fig.18D right

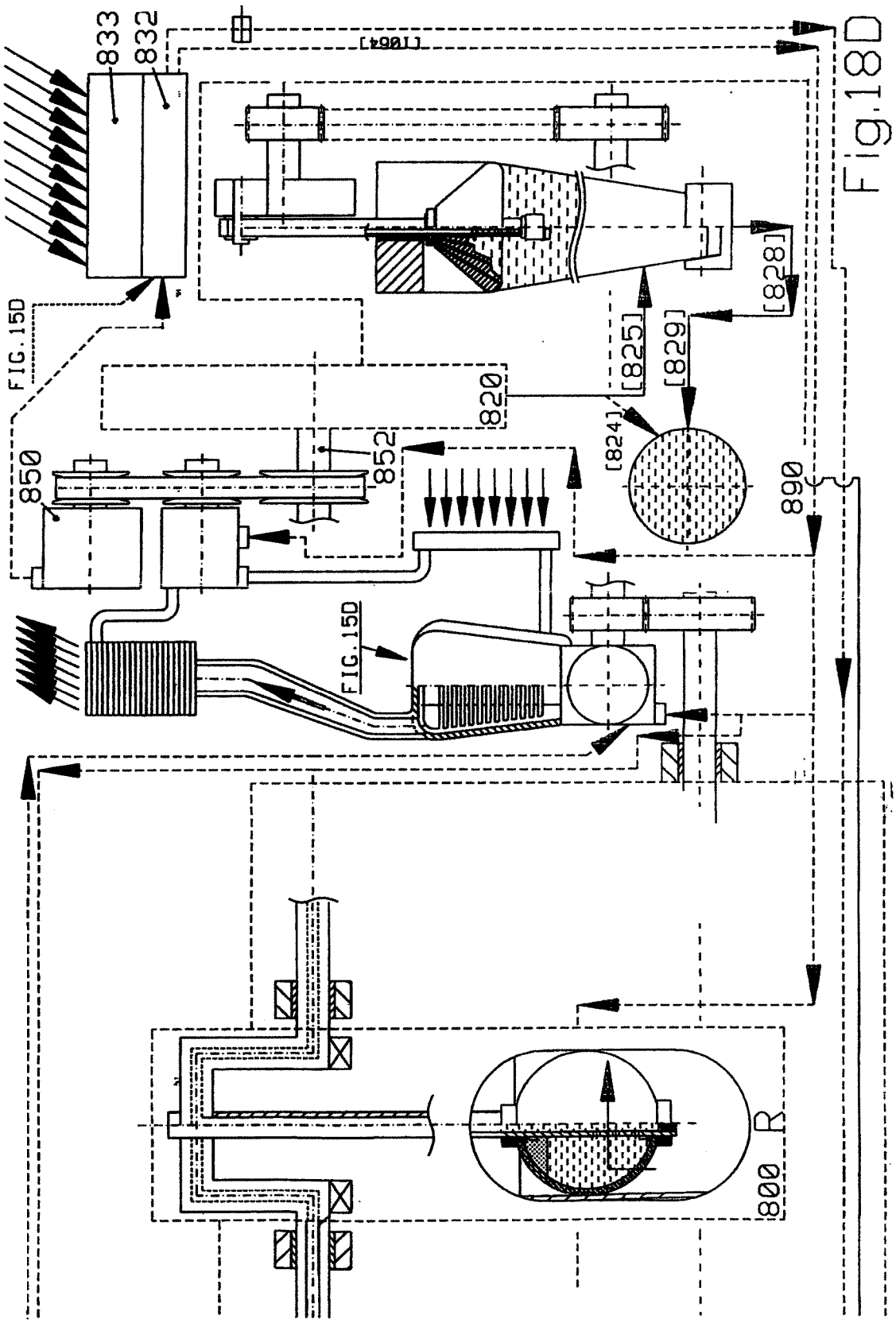


Fig.18D

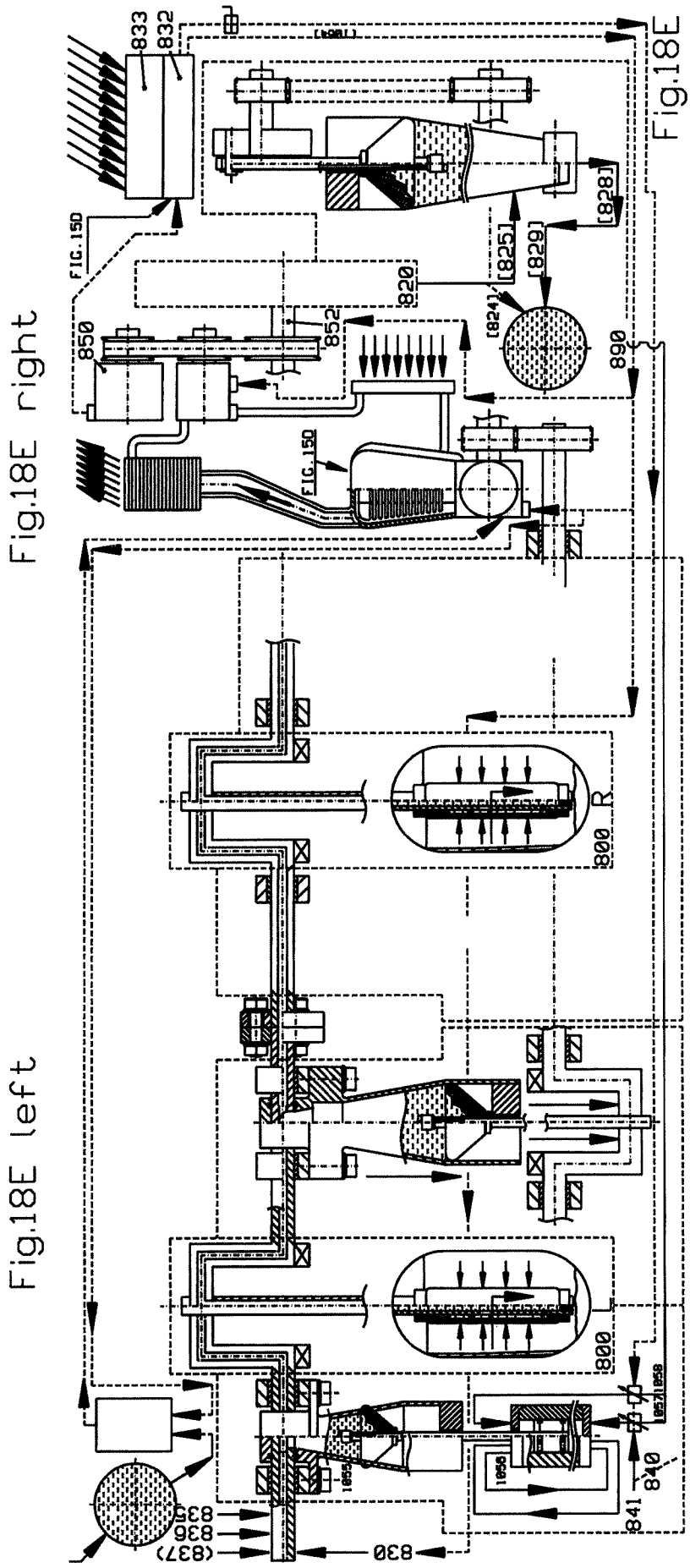
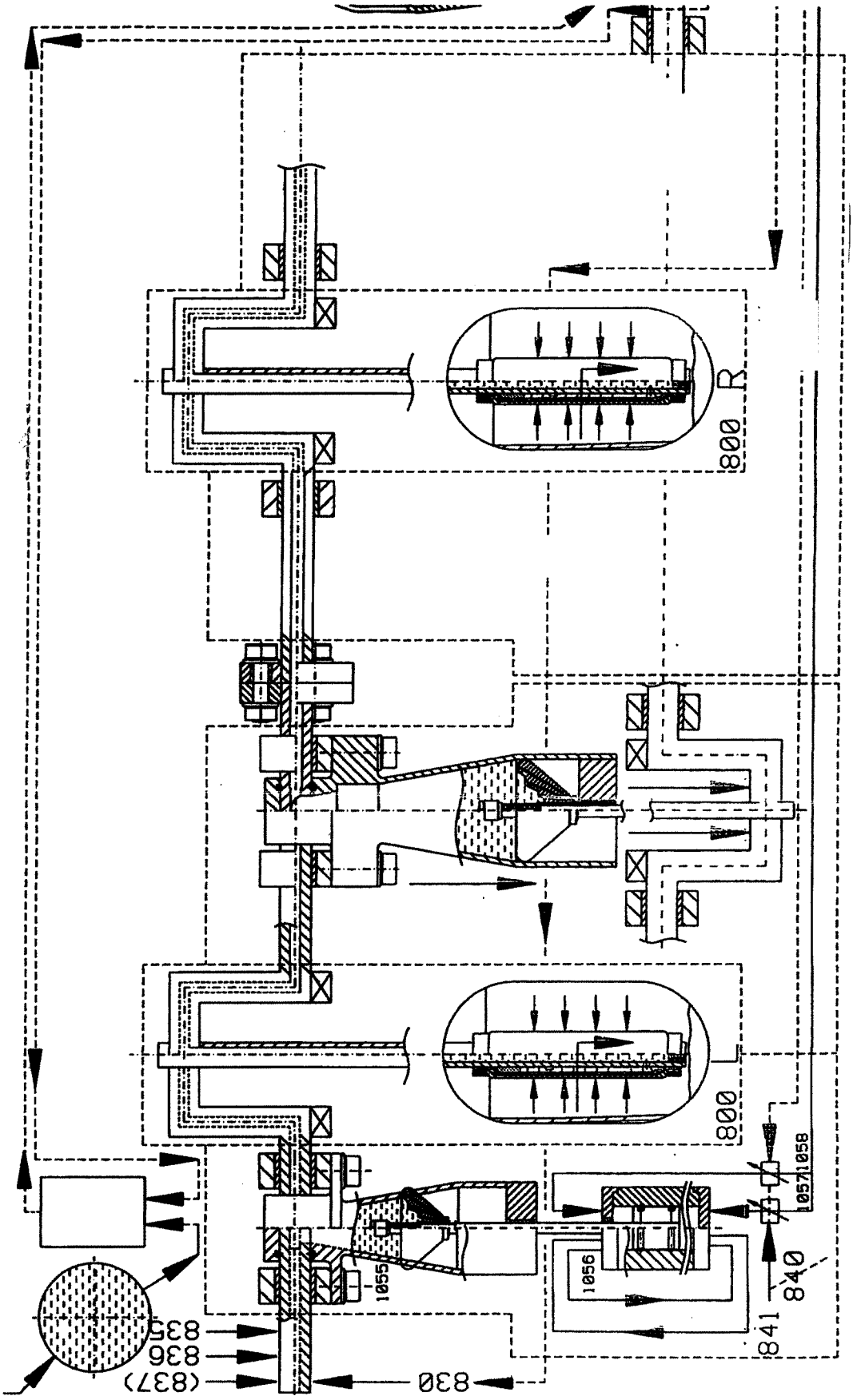
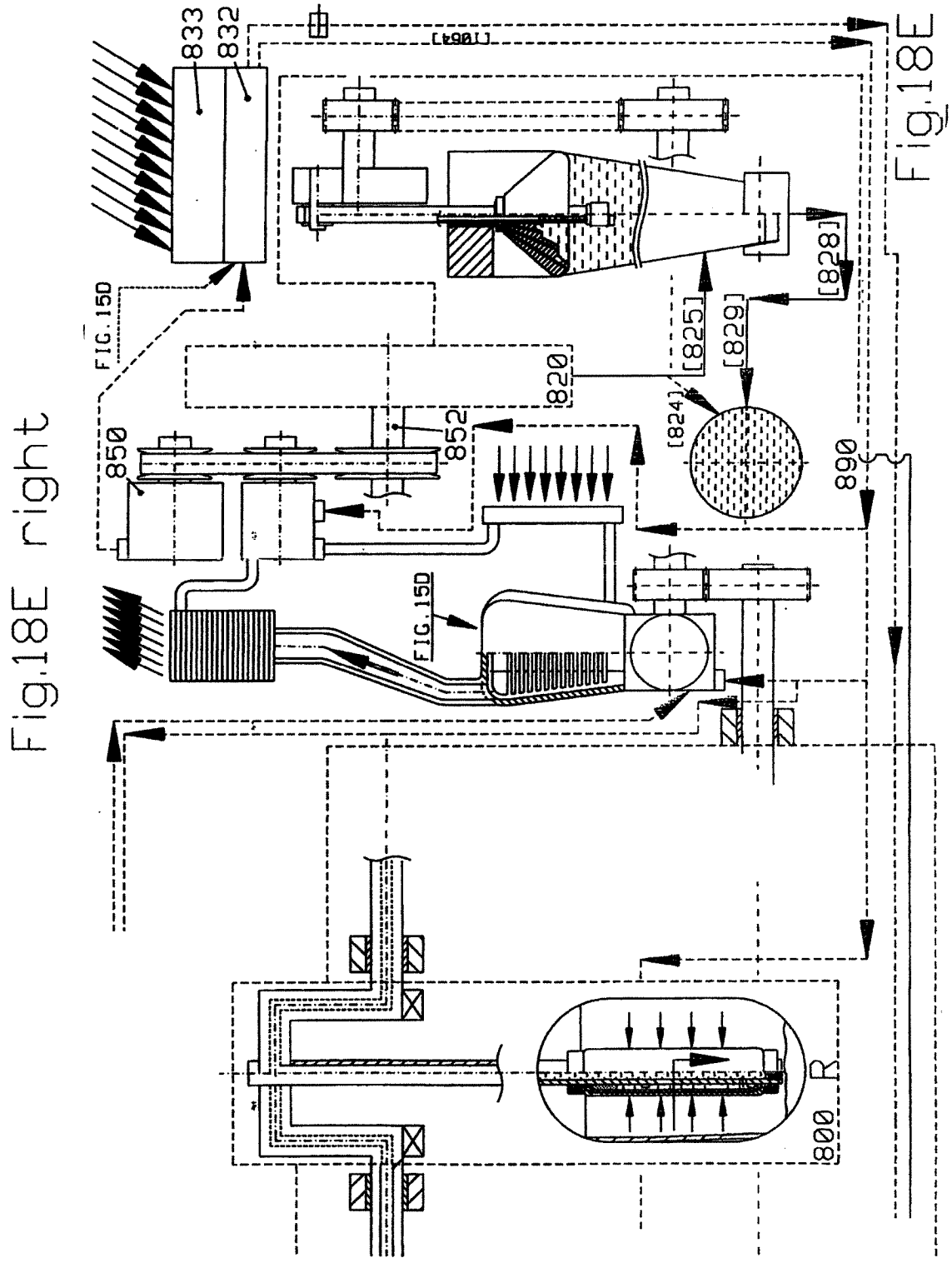
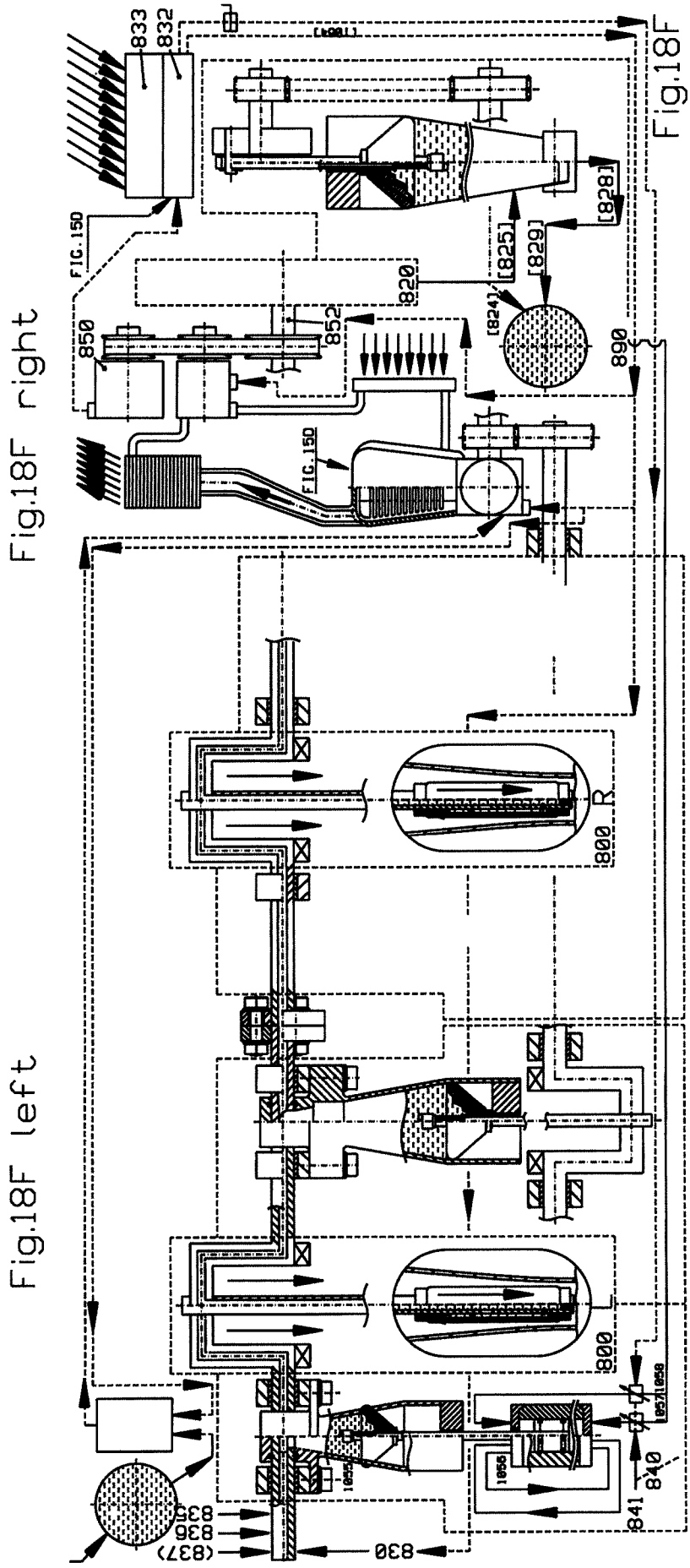

Fig.18E right
Fig.18E left
Fig.18E
833
832
828
825
829
820
824
850
852
890
FIG.15D
FIG.15D
800 R
800 L
840
841
835
836
837
830

Fig.18E left




Fig.18E right
Fig.18E
833
832
[828]
[825]
[829]
[824]
820
852
850
890
FIG.15D
FIG.15D
800
R


Fig.18F left
Fig.18F right
Fig.18F
833
832
FIG.150
820
[824]
[825]
[828]
[829]
850
852
890
800
R
840
841
835
836
(837)
830

F

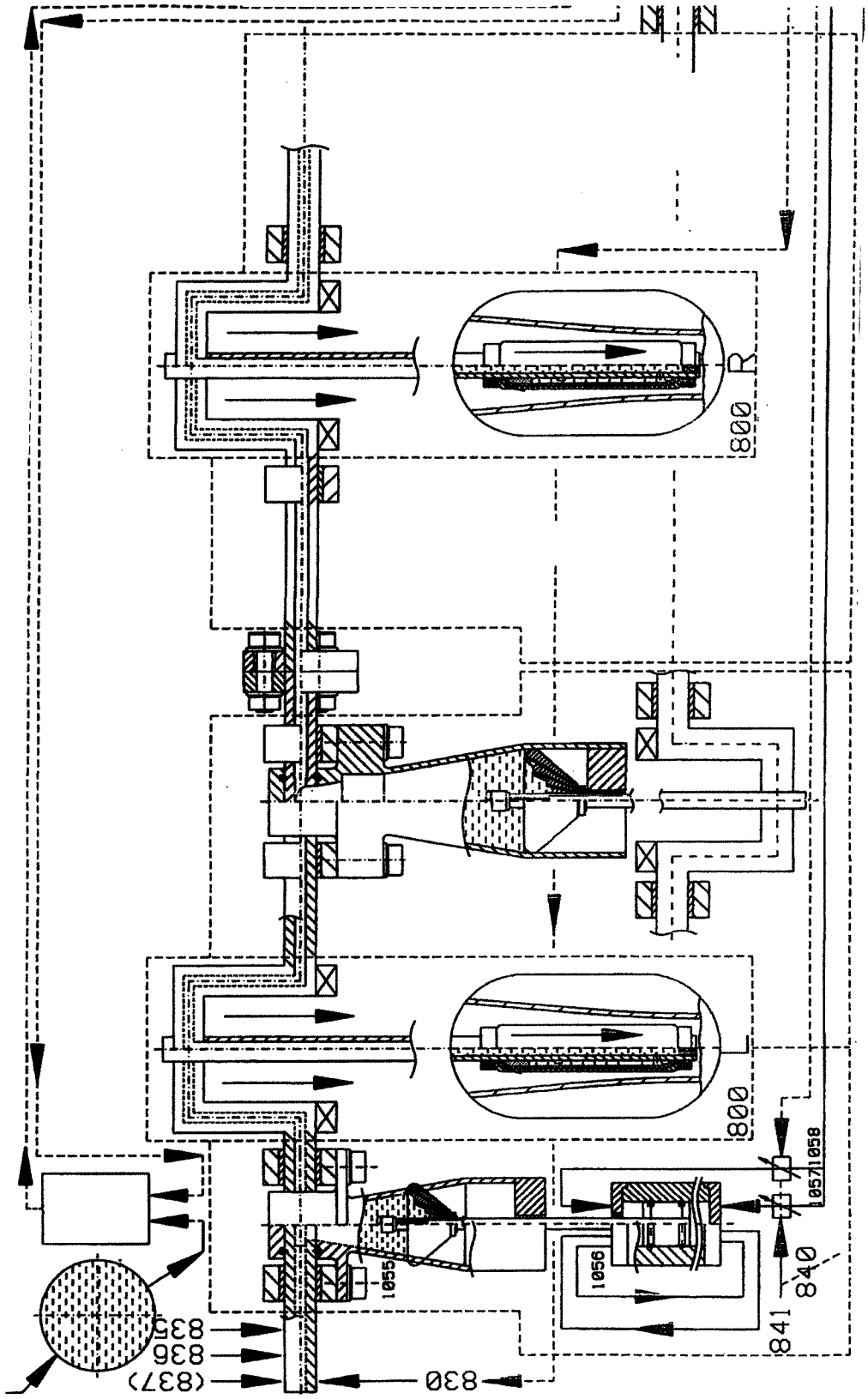


Fig.18F left

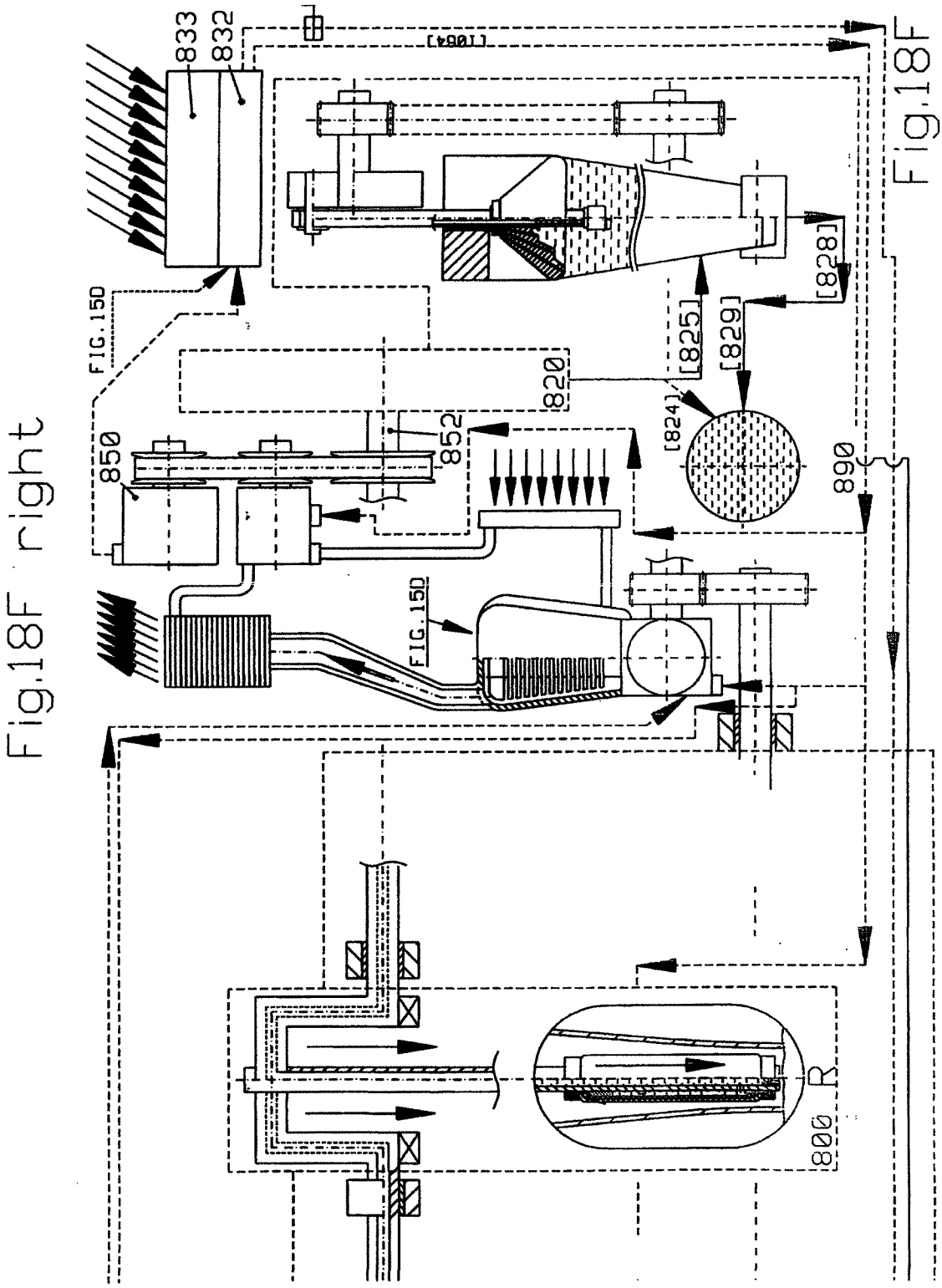


Fig.18F right

Fig.18F

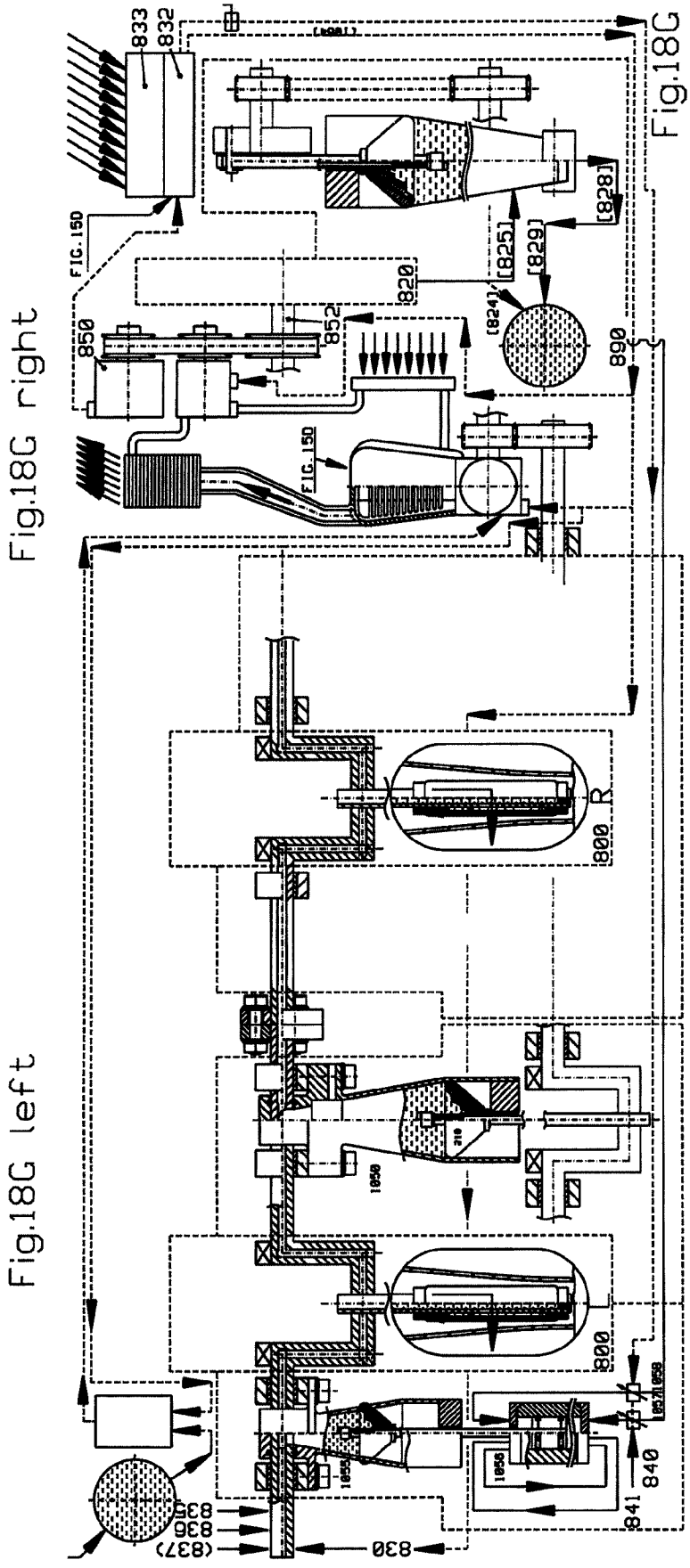

Fig.18G left
Fig.18G right
Fig.18G
833
832
FIG.15D
820
850
852
828
825
829
824
890
800
R
1850
840
841
835
836
837
830

Fig.18G left

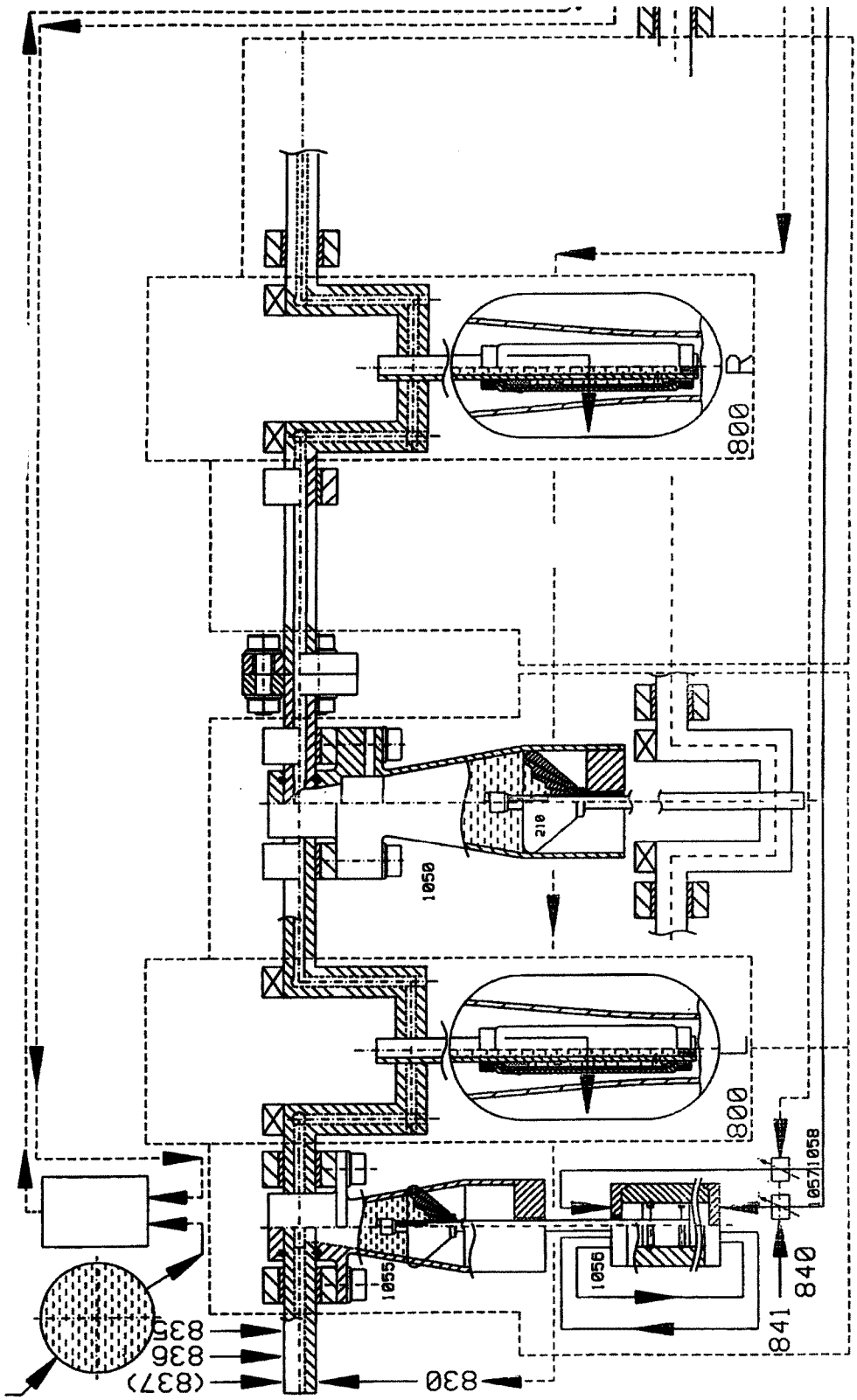

F
800 R
800 L
210
1050
1055
1056
1057
1058
840
841
830
836
835
(837)

Fig.18G right

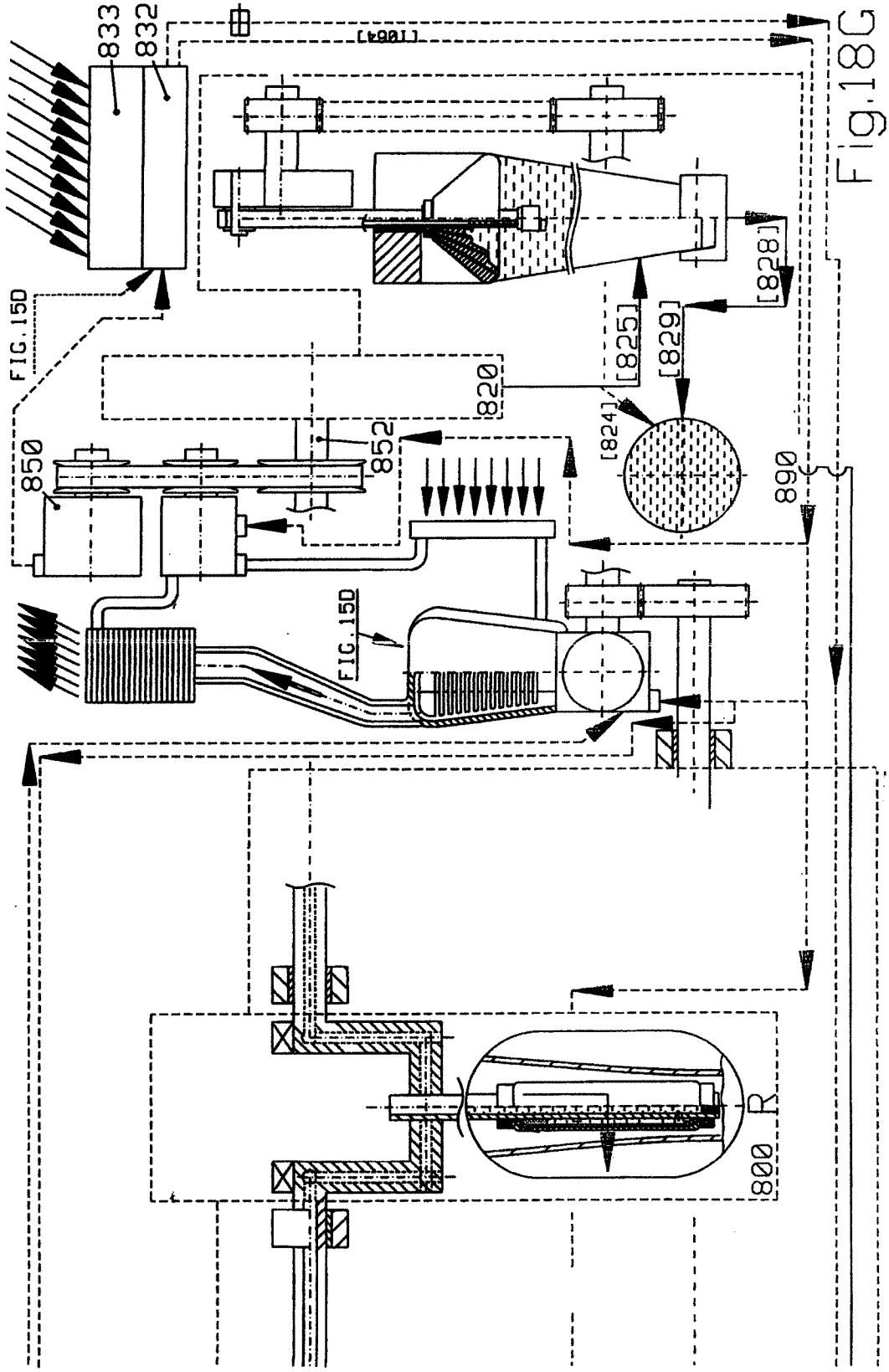


Fig.18G

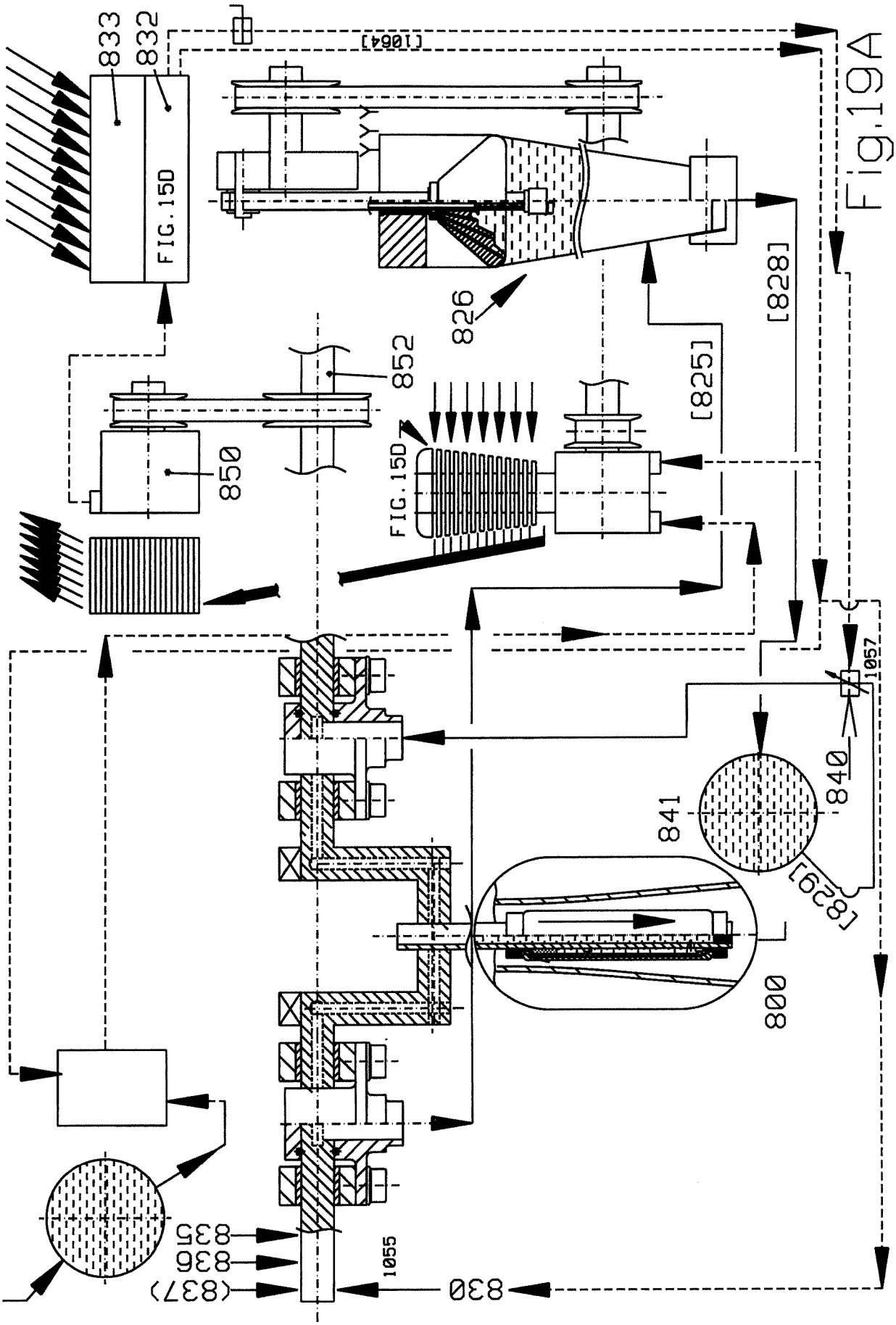
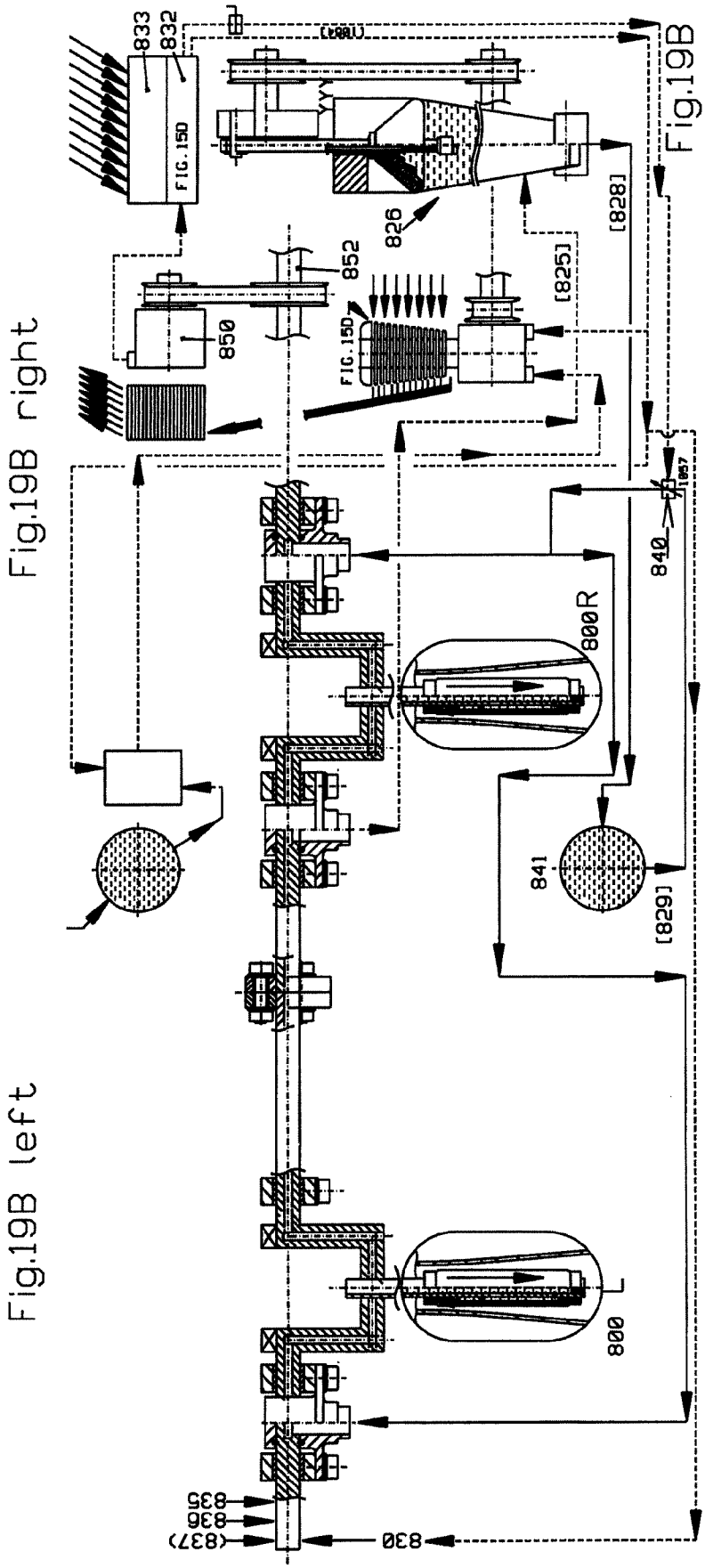
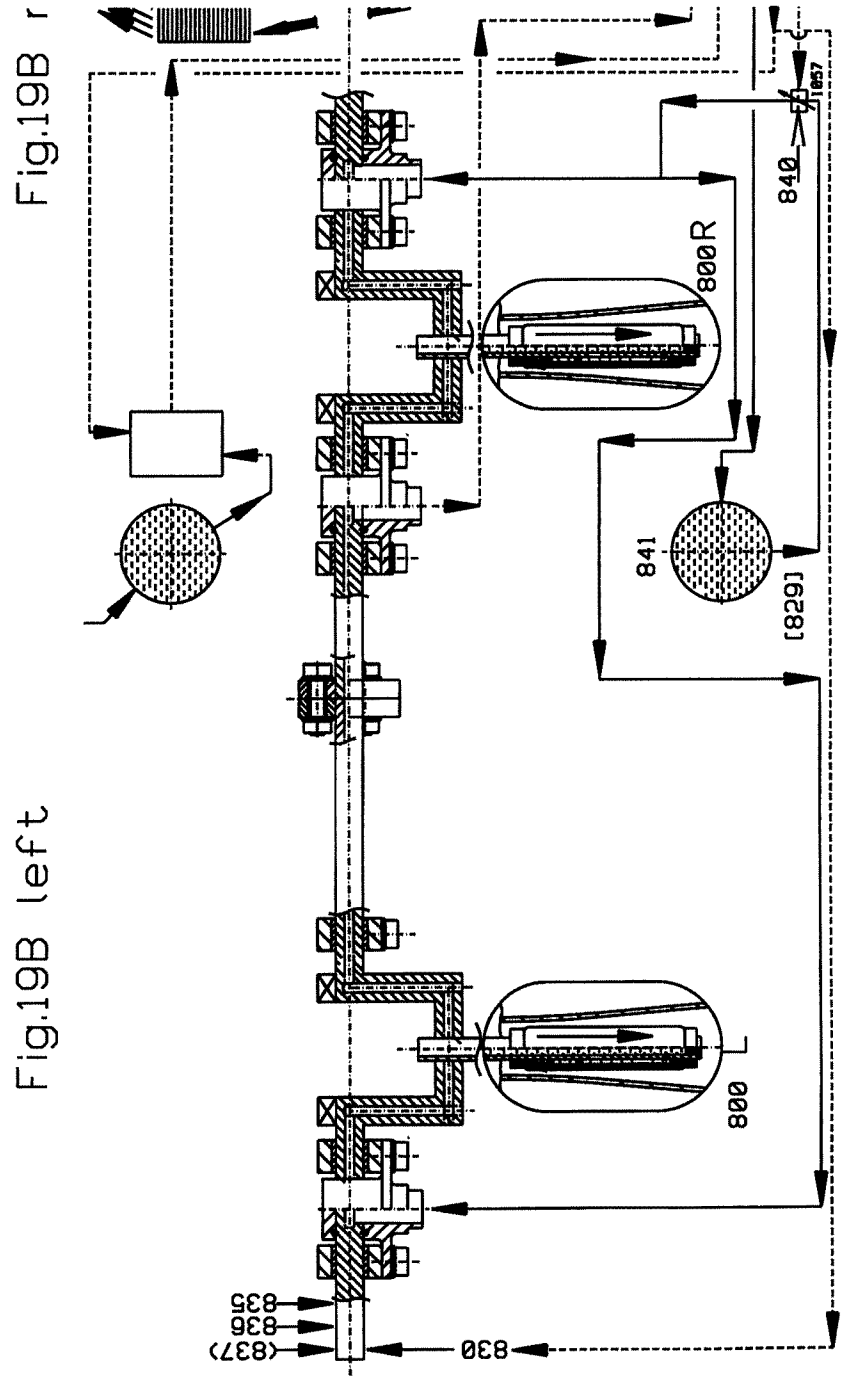
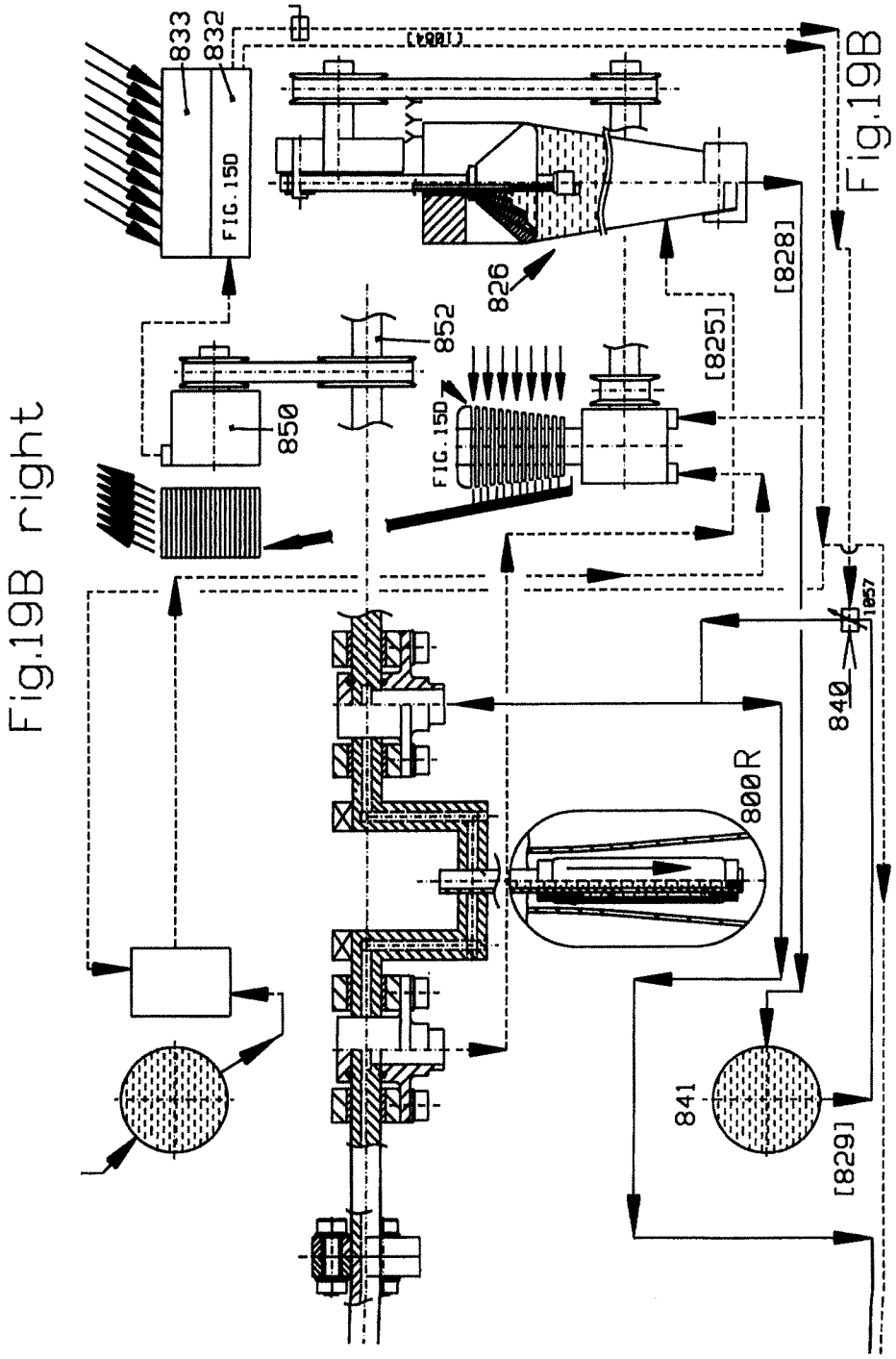
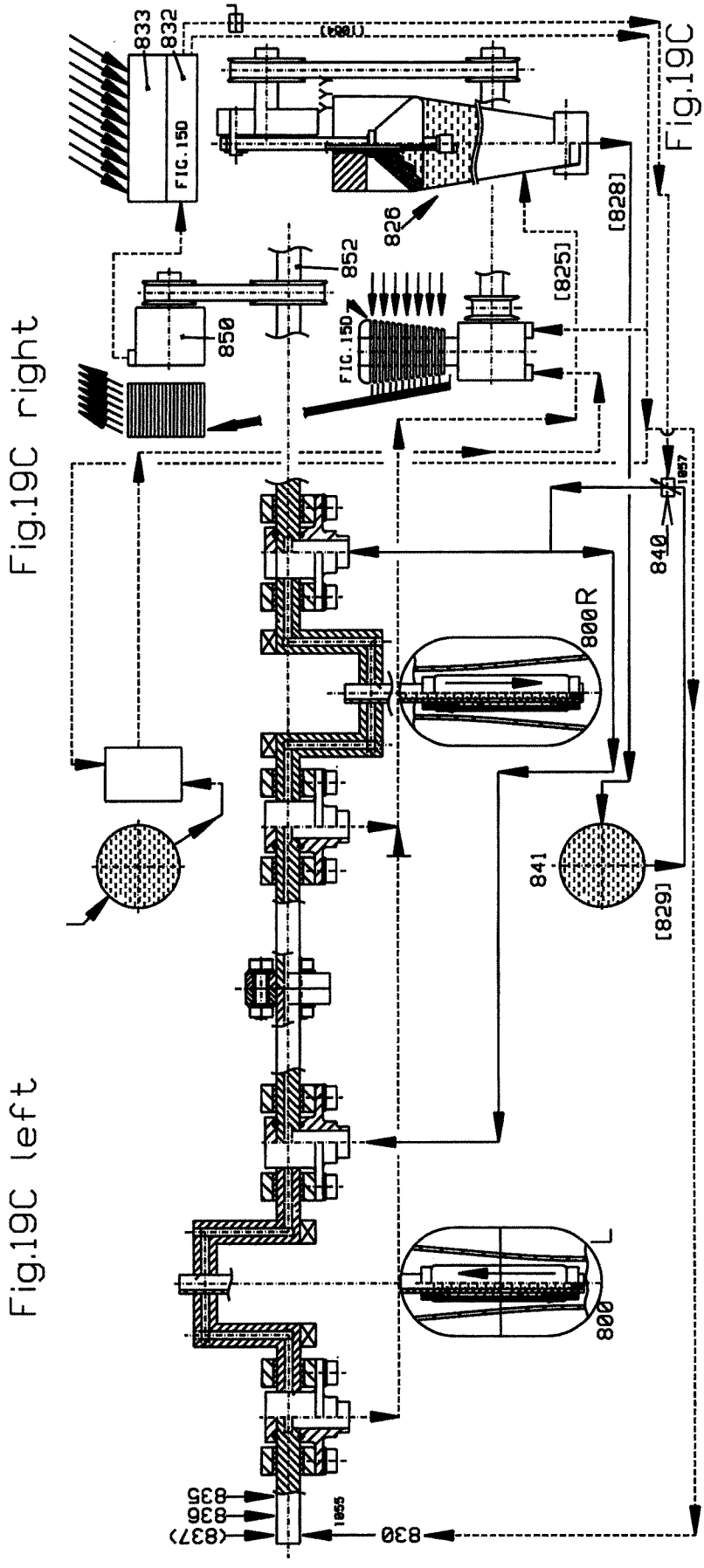

833
832
FIG.15D
[1064]
YYY
826
[828]
[825]
852
850
FIG.15D
1057
840
841
[829]
800
830
1055
835
836
(837)

Fig.19A


Fig.19B right
Fig.19B left
Fig.19B
833
832
FIG.15D
826
[828]
[825]
852
850
FIG.15D
840
800R
841
[829]
800 L
835
836
(837)
830


Fig.19B r
Fig.19B left
840
800R
841
[829]
800 L
835
836
(837)
830


Fig.19B right
Fig.19B
833
832
FIG.15D
826
852
850
[825]
[828]
840
800R
841
[829]


Fig.19C right
Fig.19C left
Fig.19C
833
832
FIG.15D
826
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850
[825]
[828]
840
800R
841
[829]
800L
835
836
(837)
830

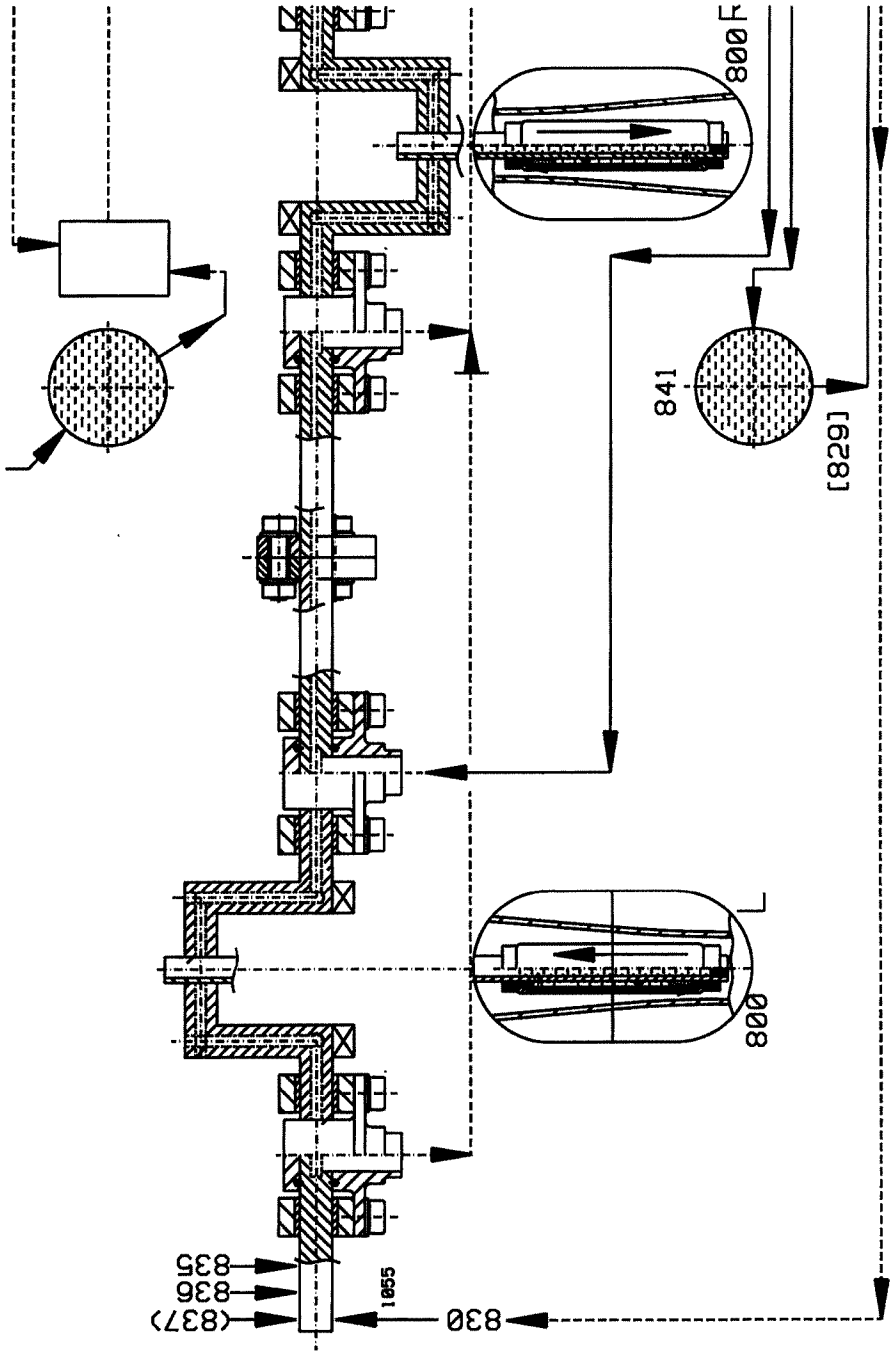
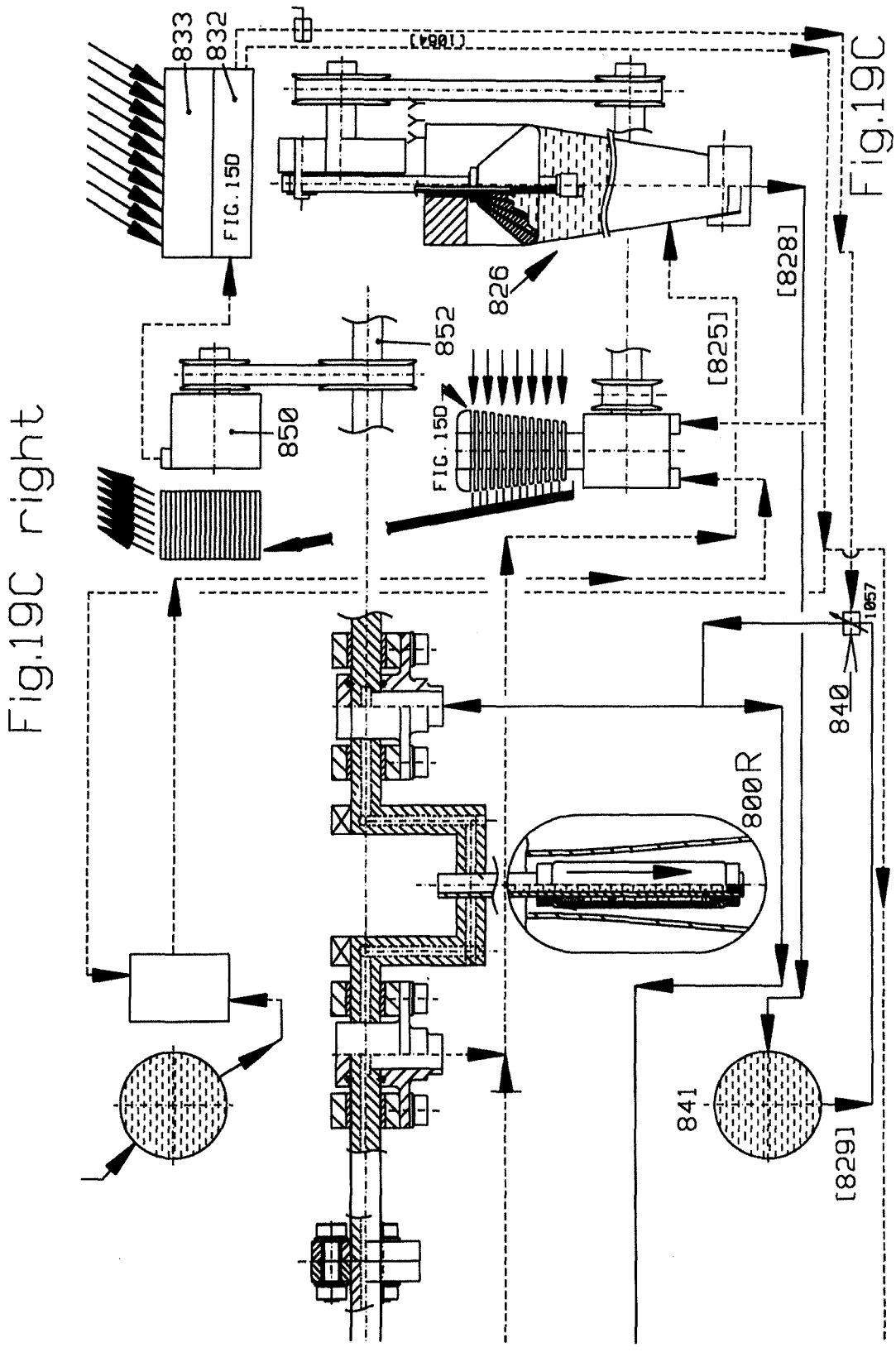


Fig.19C left


Fig.19C right
Fig.19C
833
832
FIG. 15D
YY
826
[828]
852
850
[825]
FIG. 15D
840
1057
800R
841
[829]

ANY REFERENCE TO FIGURE 20
SHOULD BE CONSIDERED
AS NON-EXISTENT

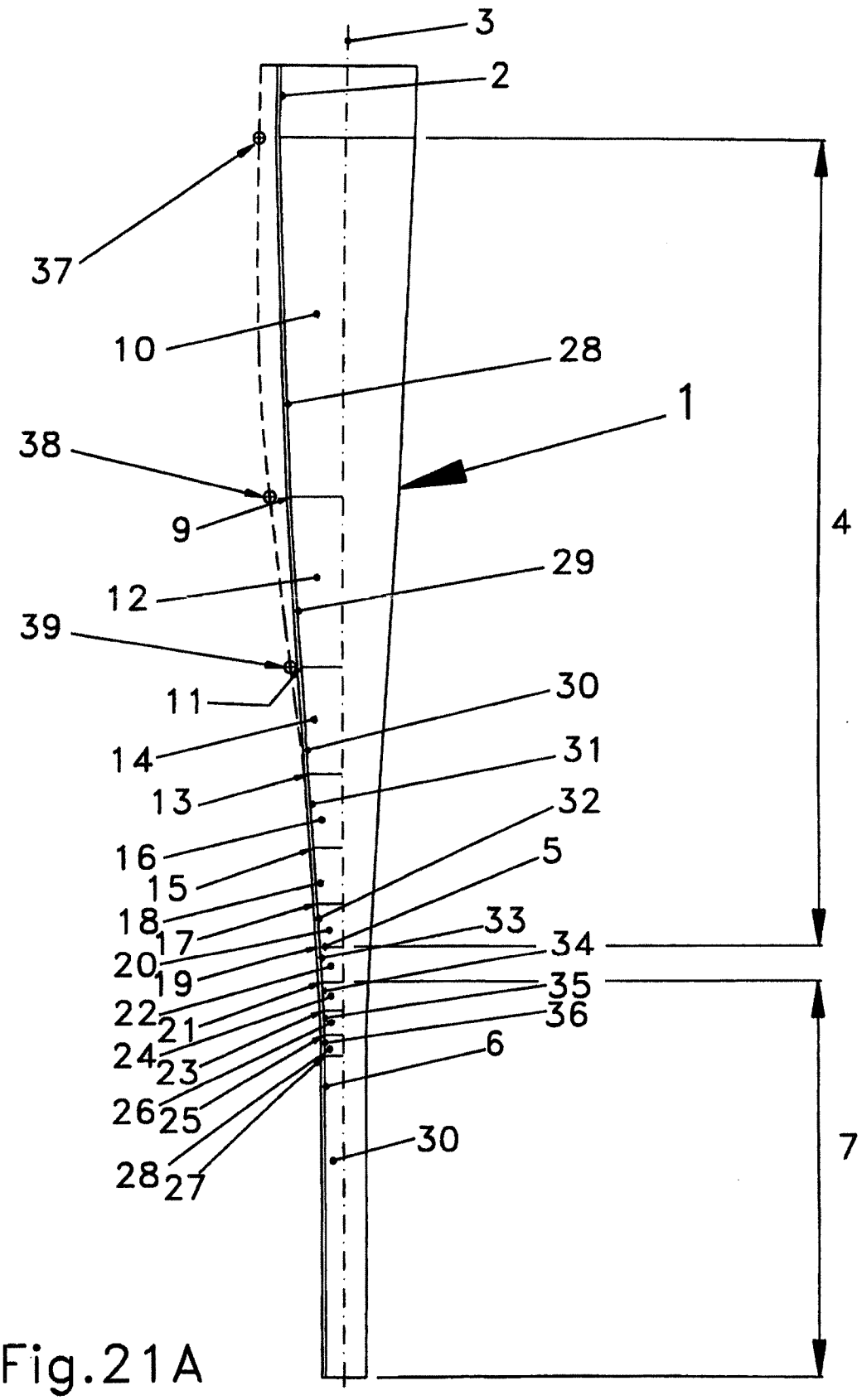

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Fig.21A

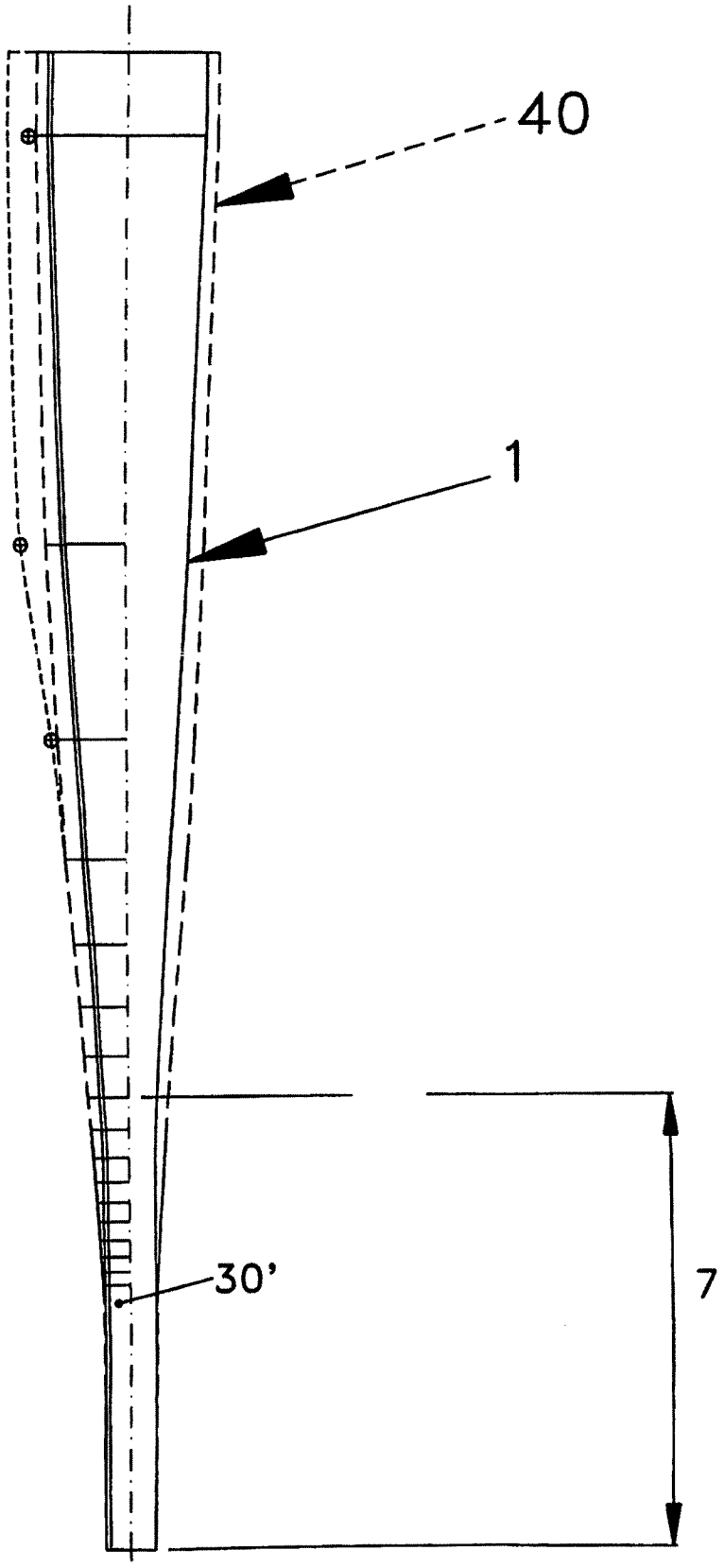


Fig.21B

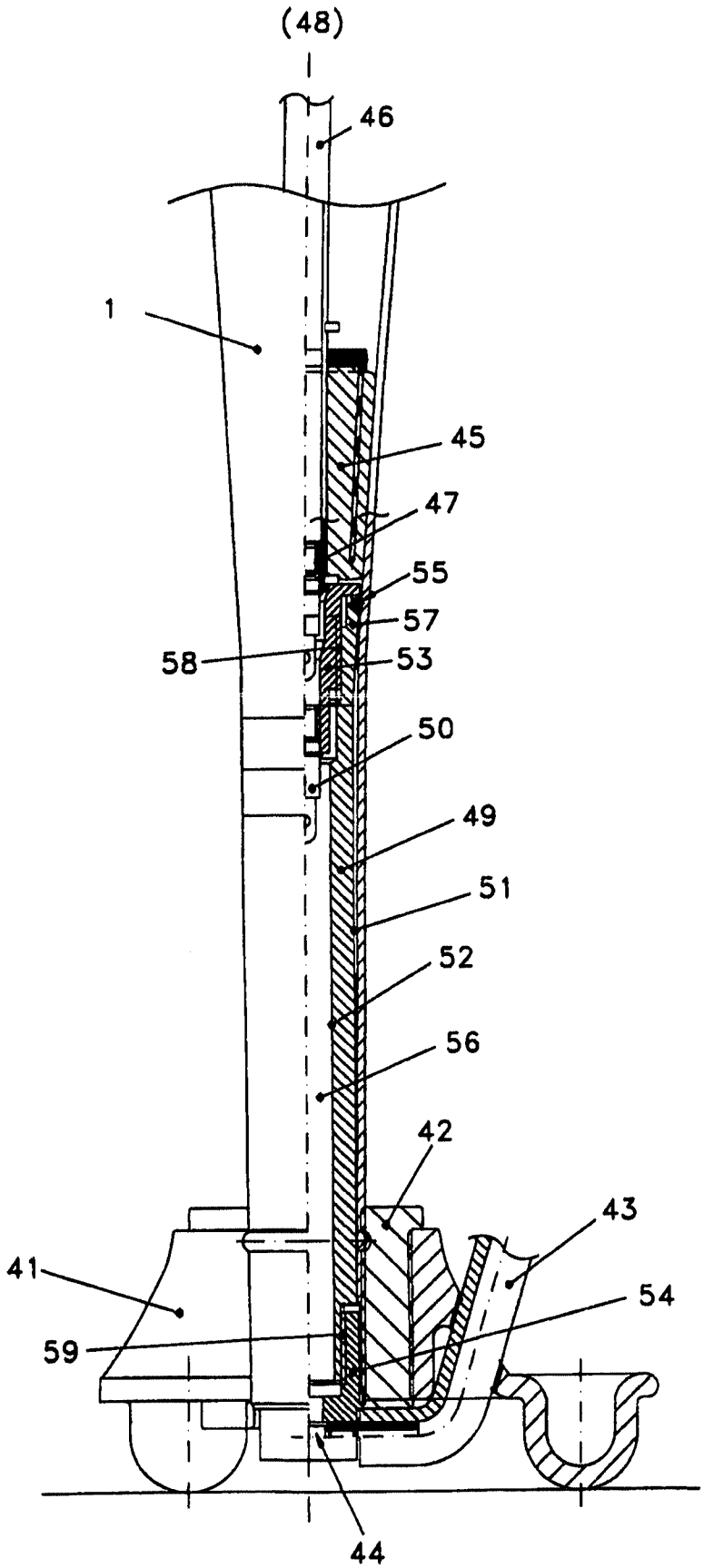


Fig.22

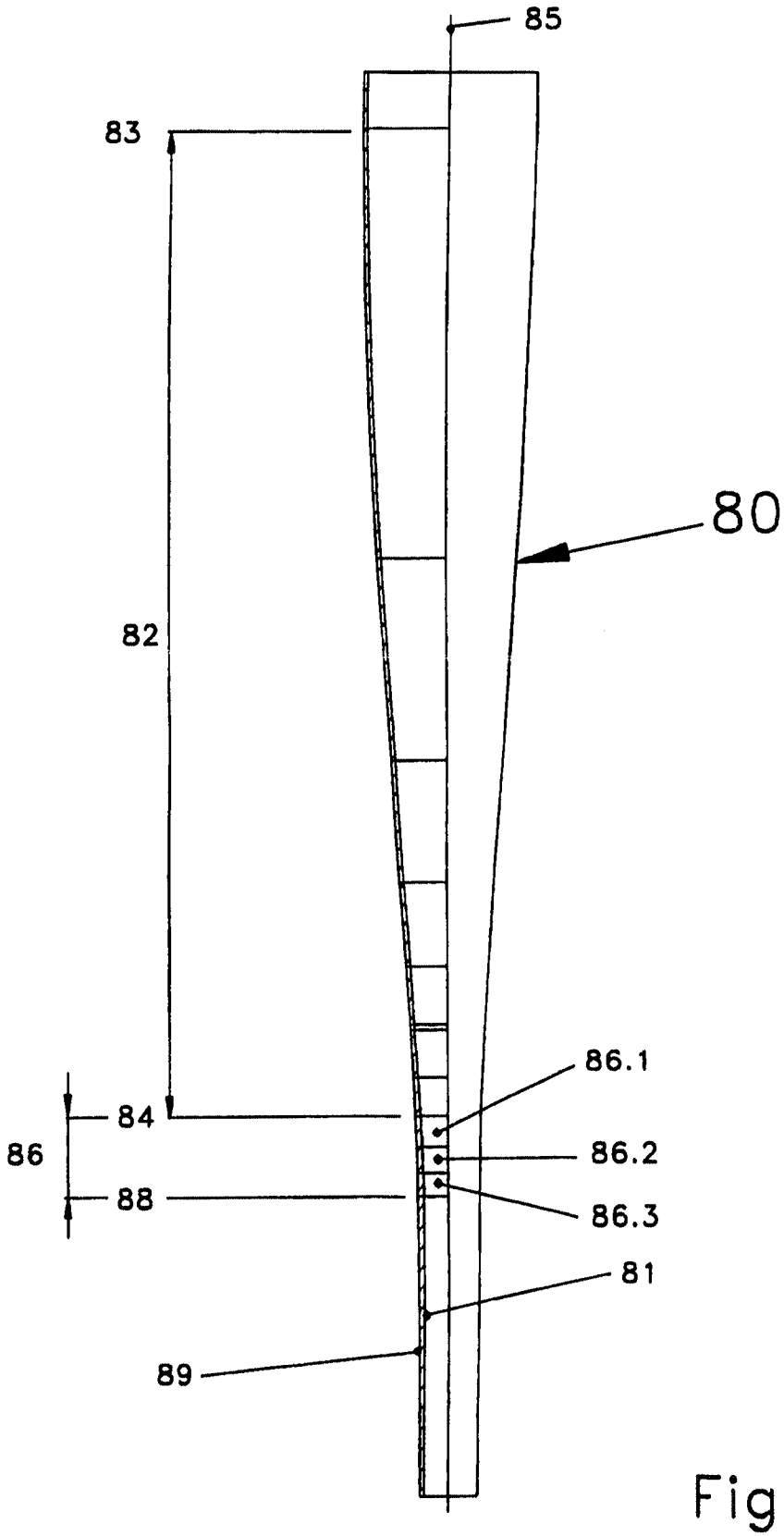


Fig.23

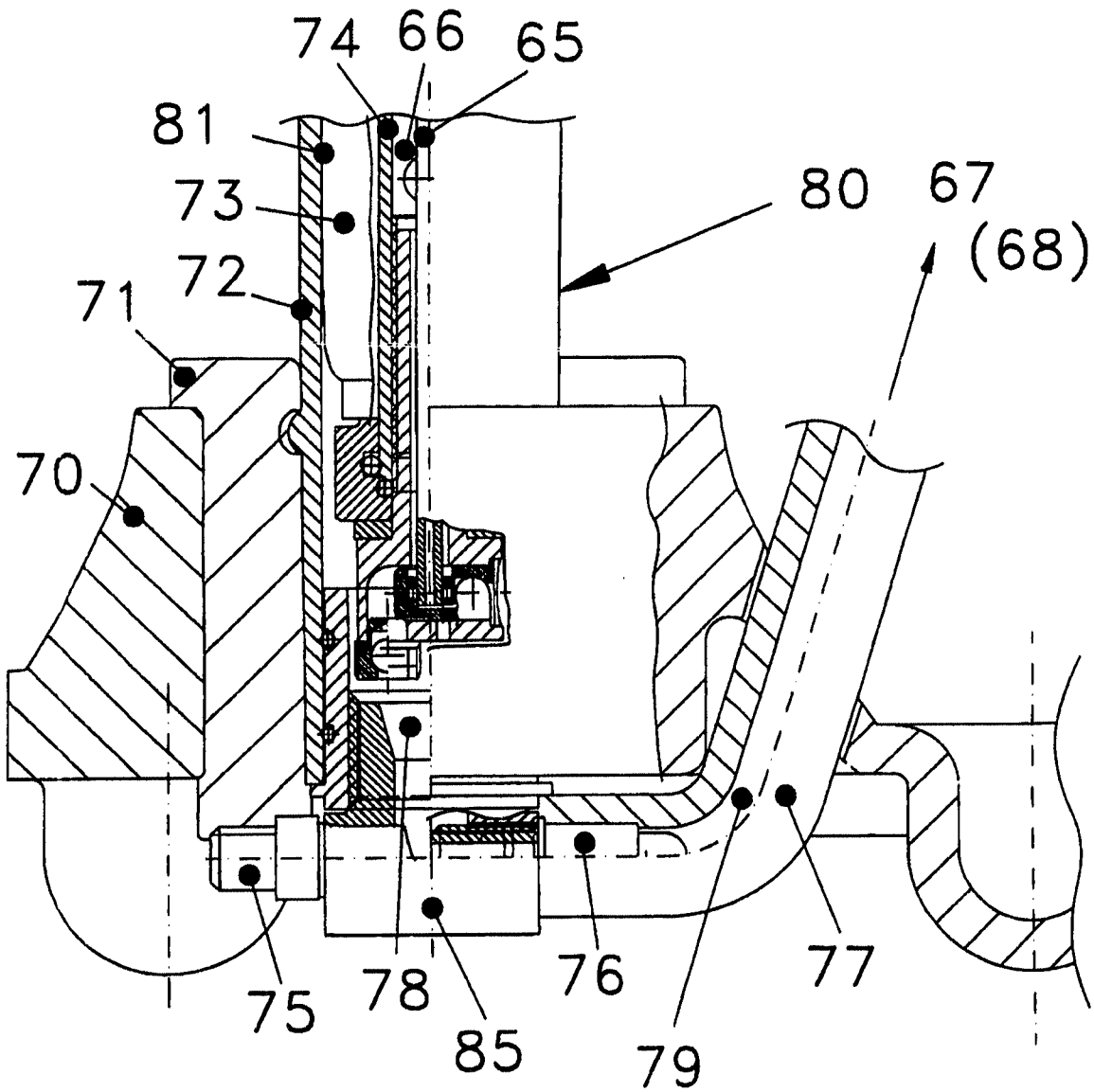


Fig.24

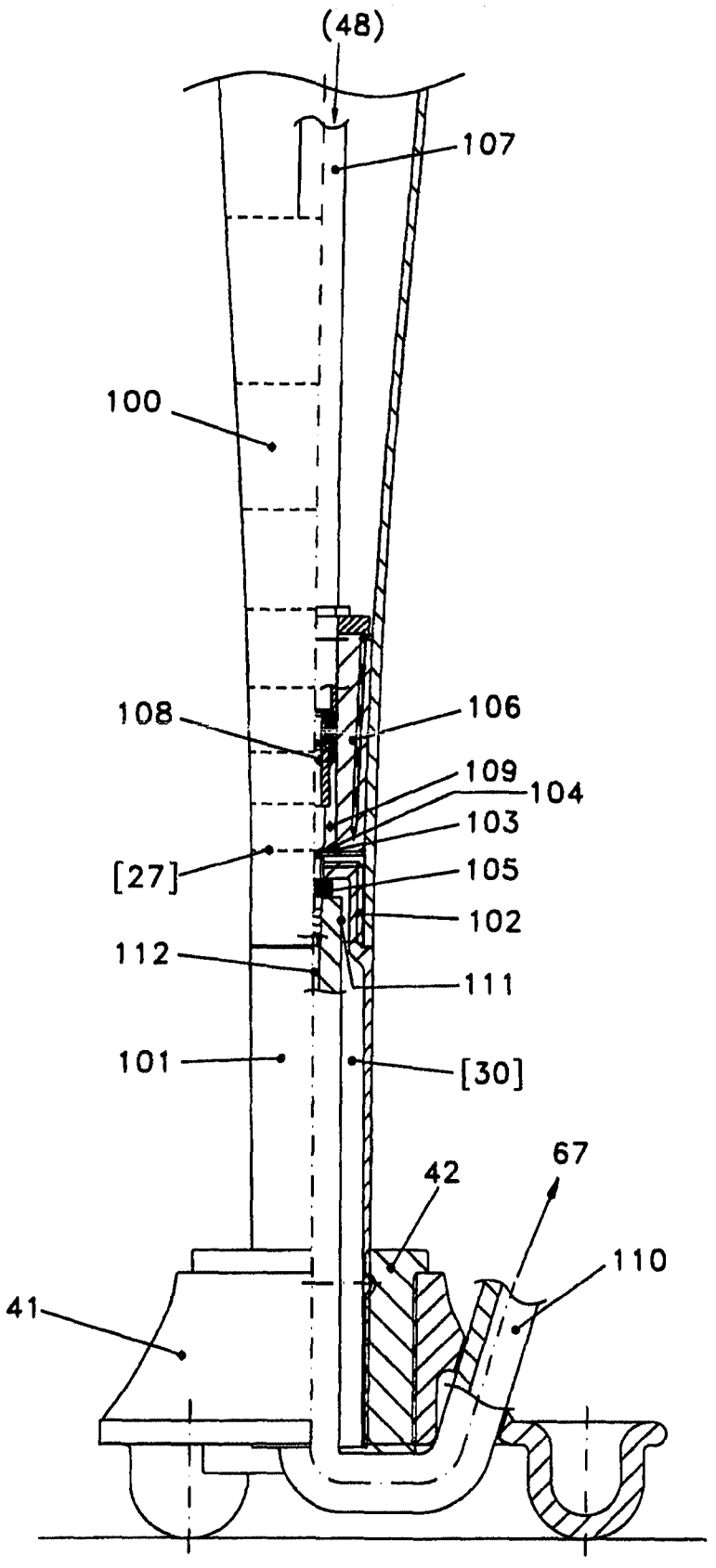

(48)
107
100
108
106
109
104
103
[27]
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102
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111
101
[30]
67
42
110
41

Fig.25

ANY REFERENCE TO FIGURES 26 TO 29
SHOULD BE CONSIDERED
AS NON-EXISTENT

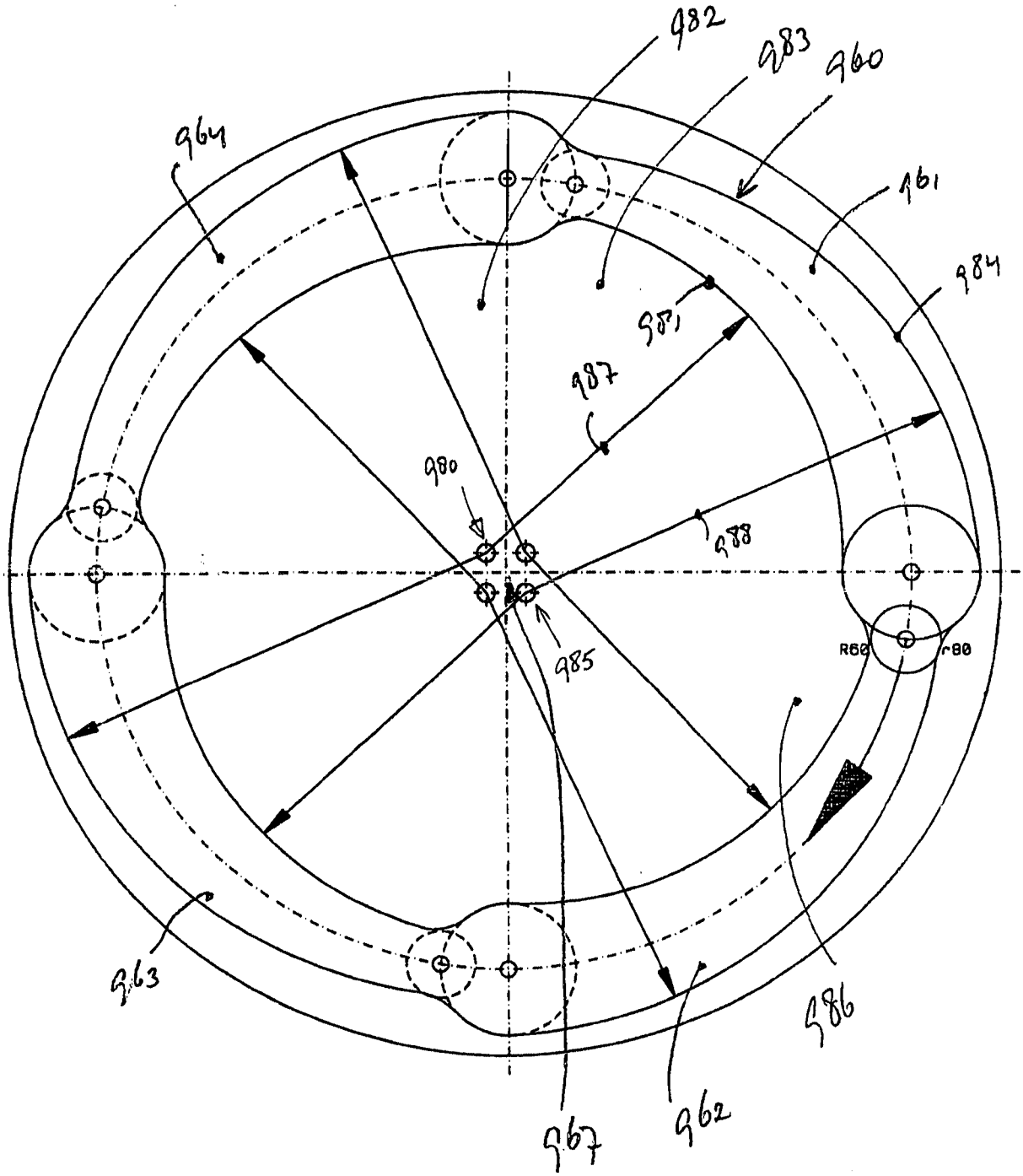

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983
960
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980
988
985
R60
r80
963
986
967
962

Fig.30A

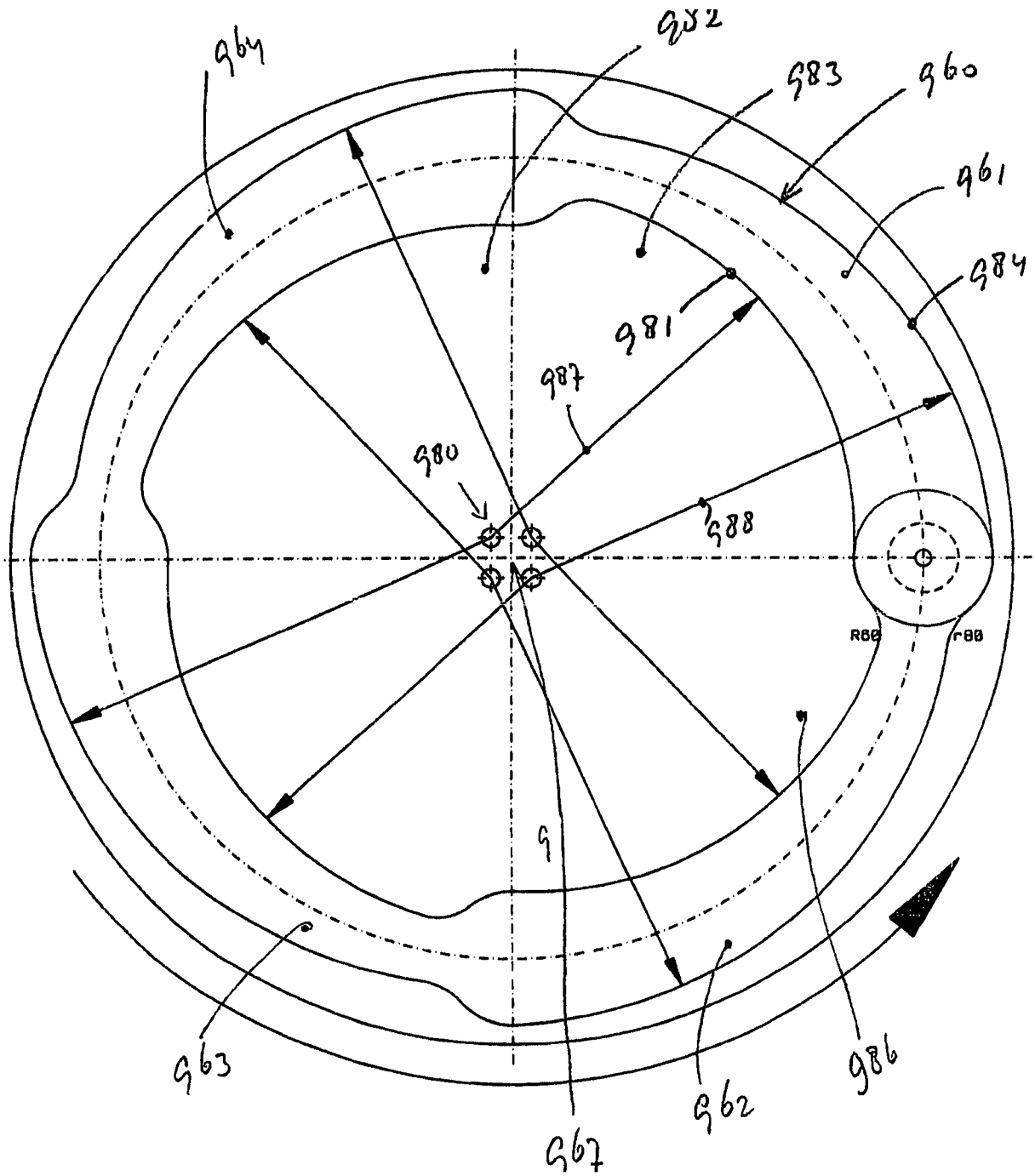


Fig.30B

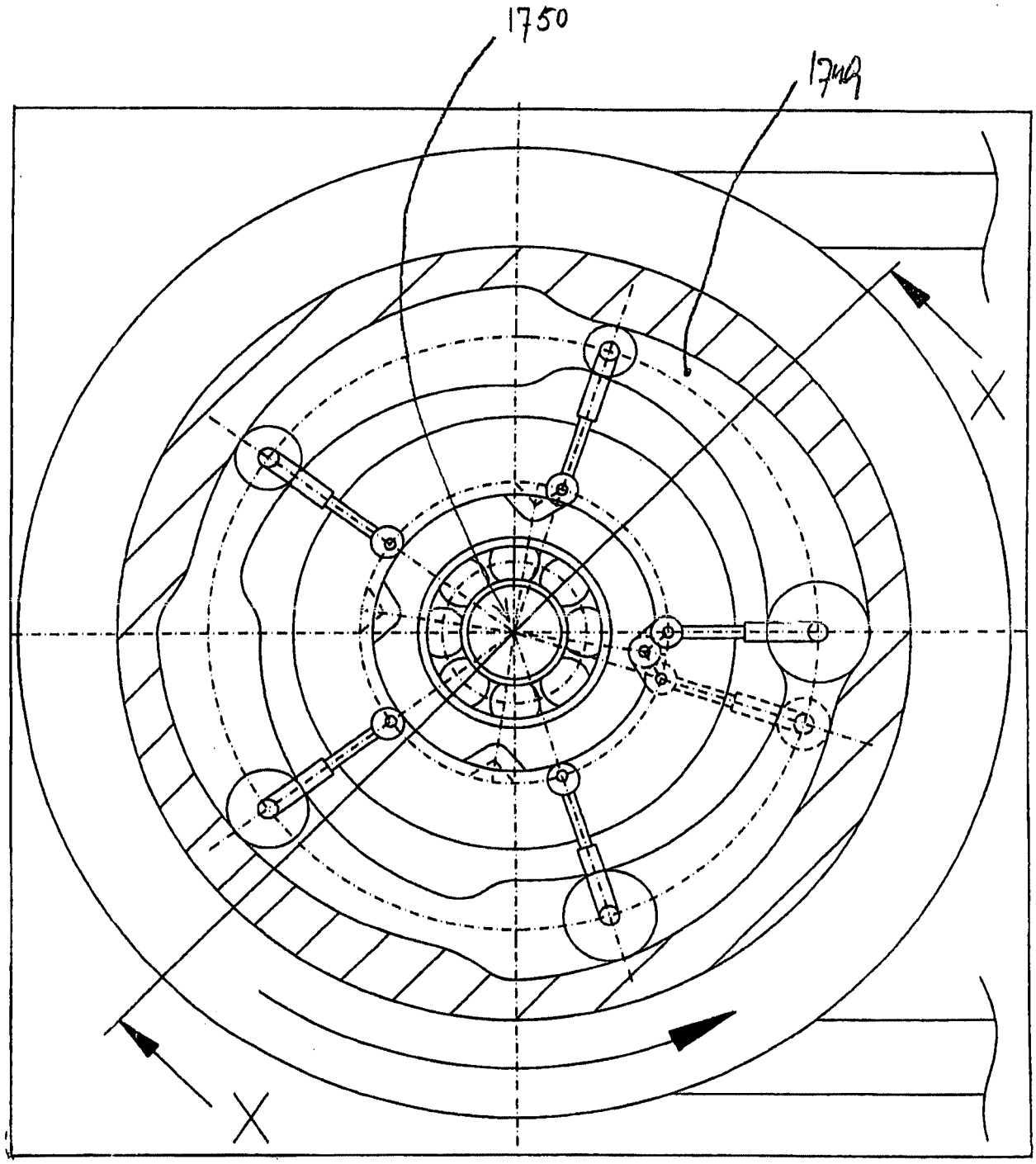


Fig. 31A

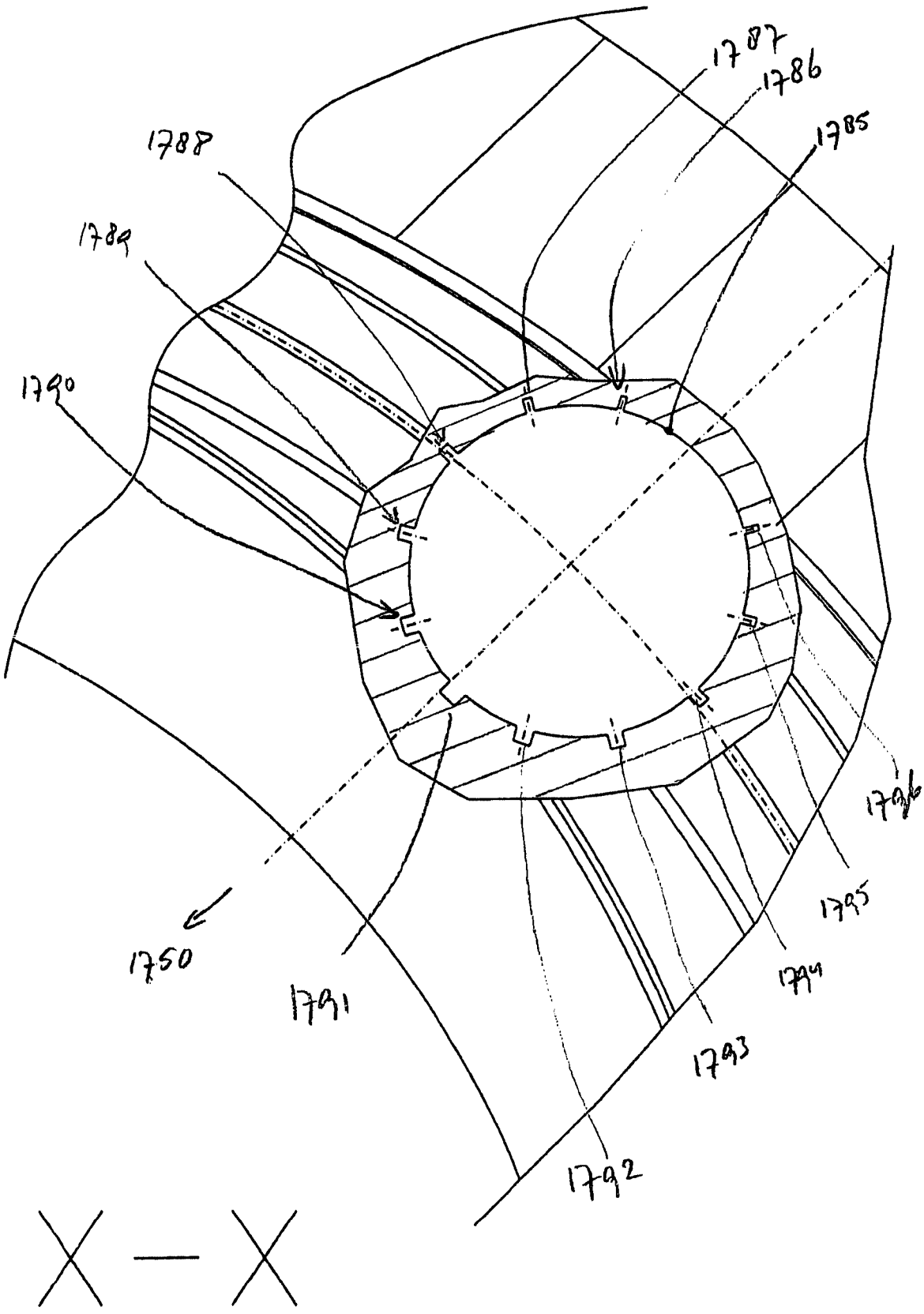

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1794
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1792
1791
1750
X — X

Fig. 31B

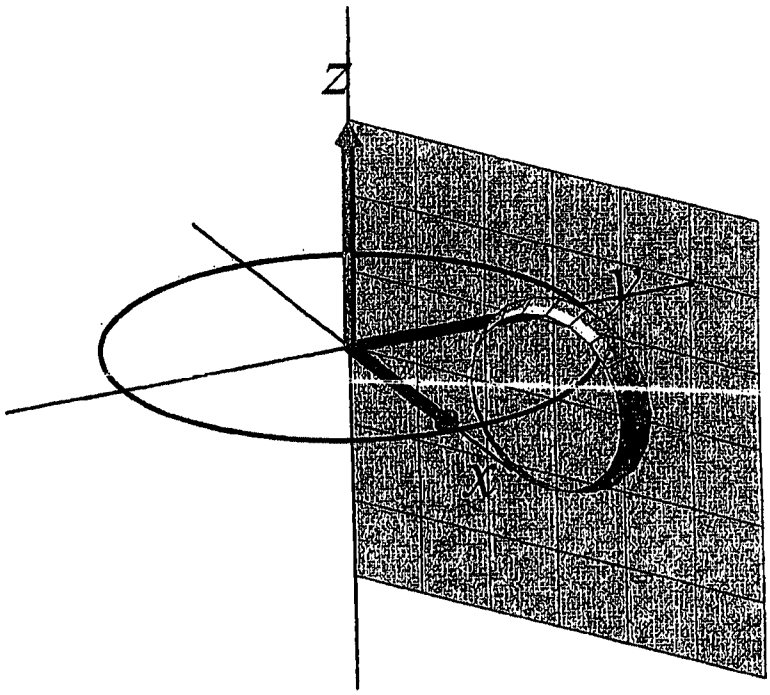


Fig. 32A

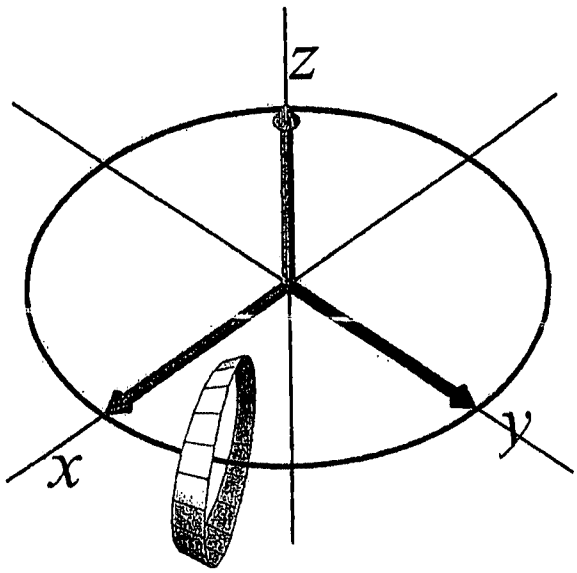


Fig. 32B

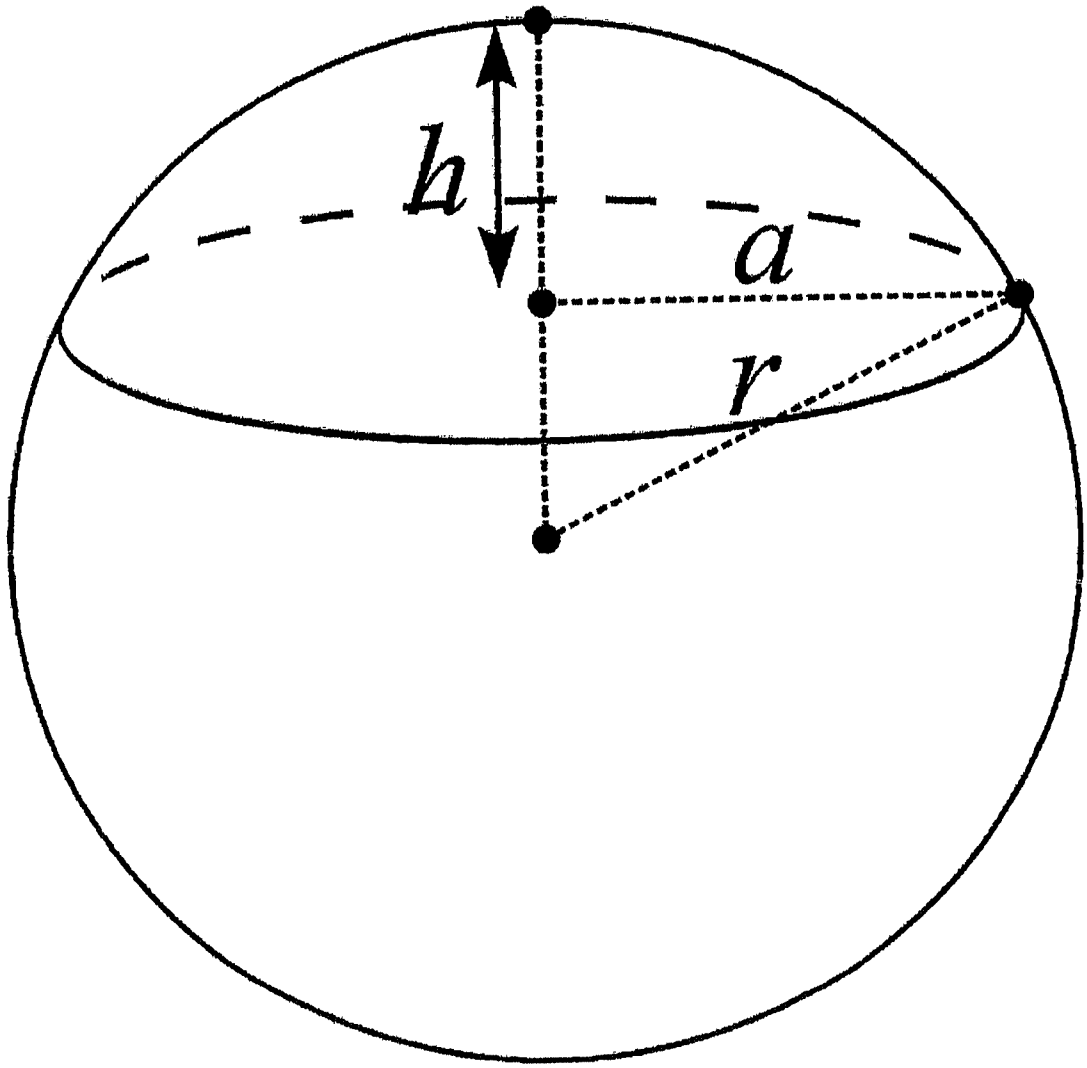


Fig. 31C

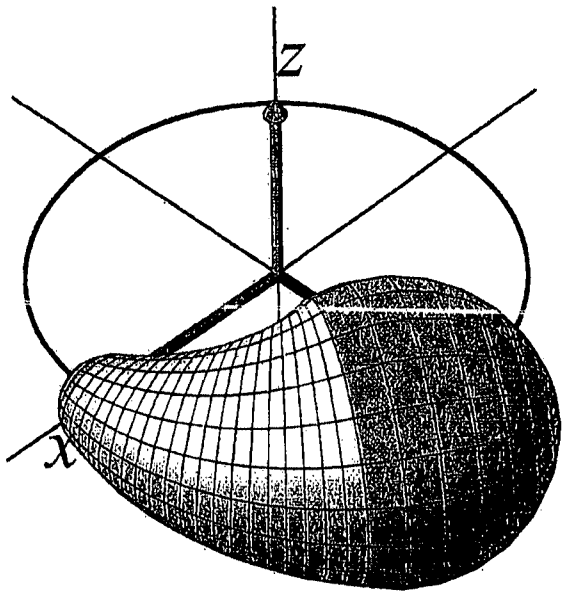


Fig. 32D

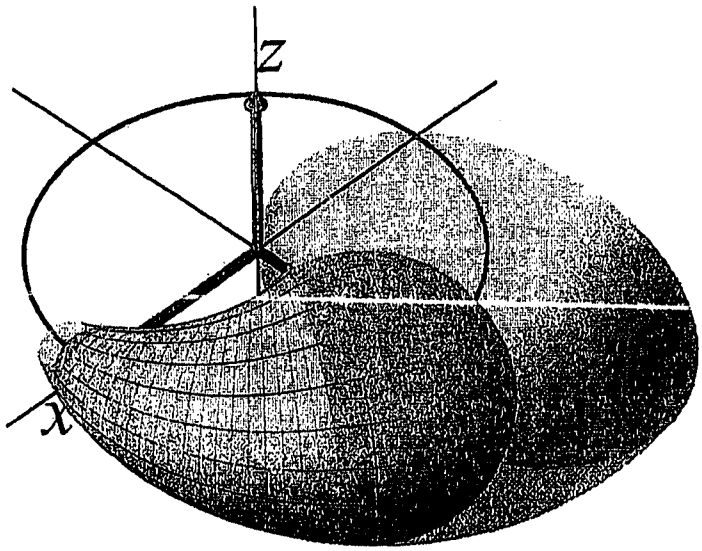


Fig. 32E

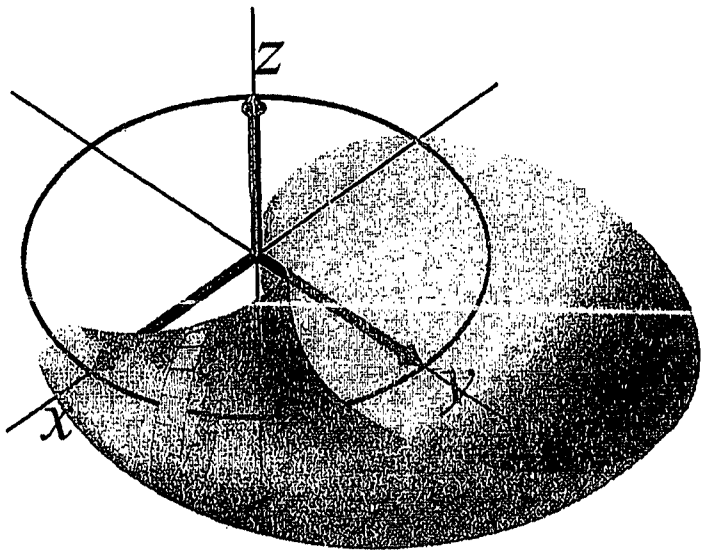


Fig. 32F

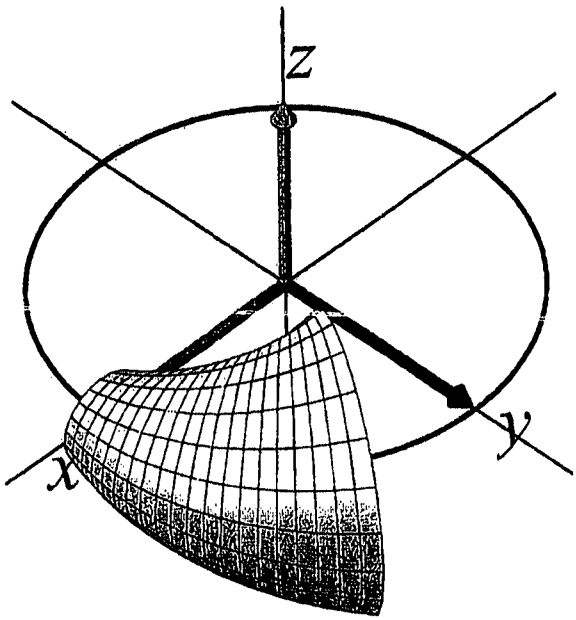


Fig 32G

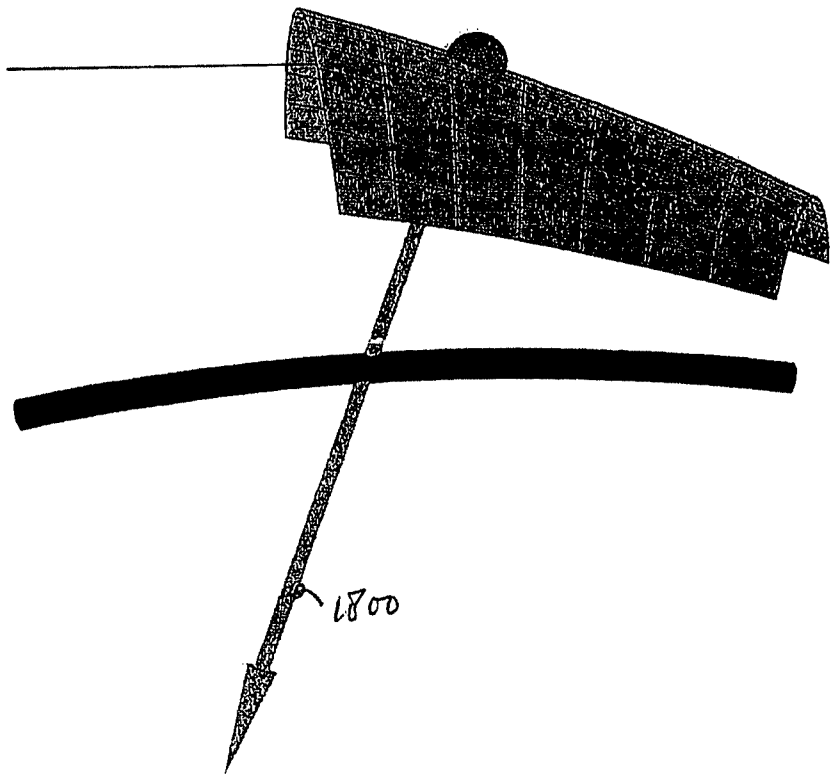


Fig. 32H

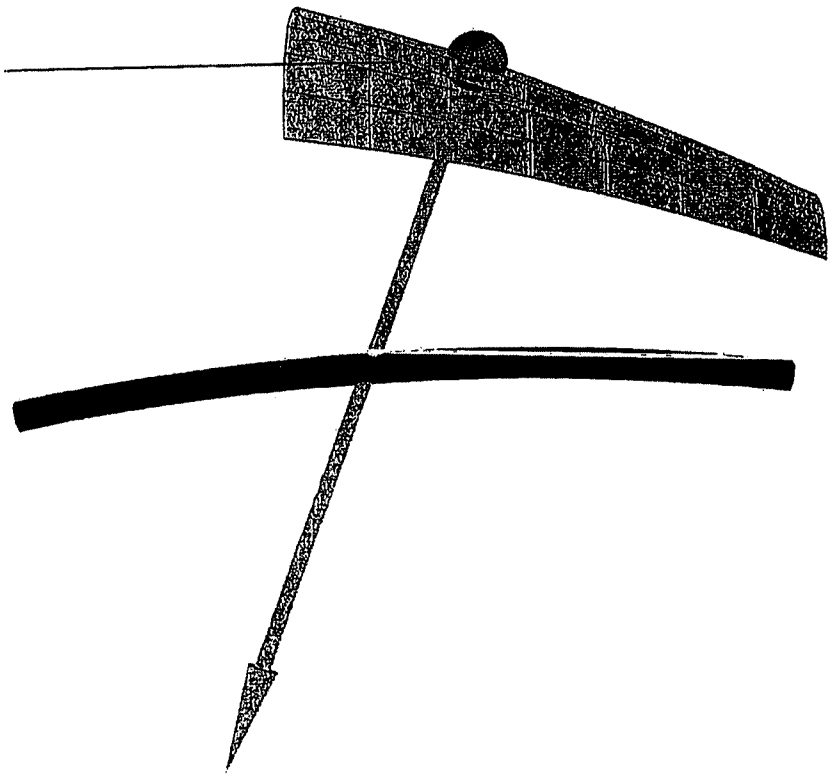


Fig. 32 I

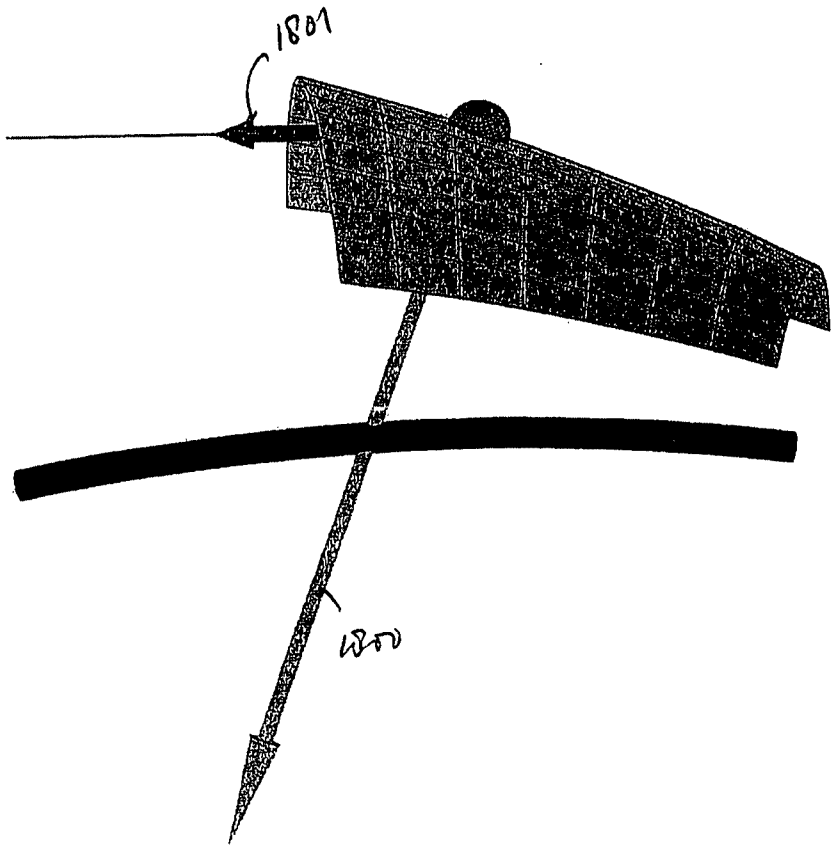


Fig. 32J

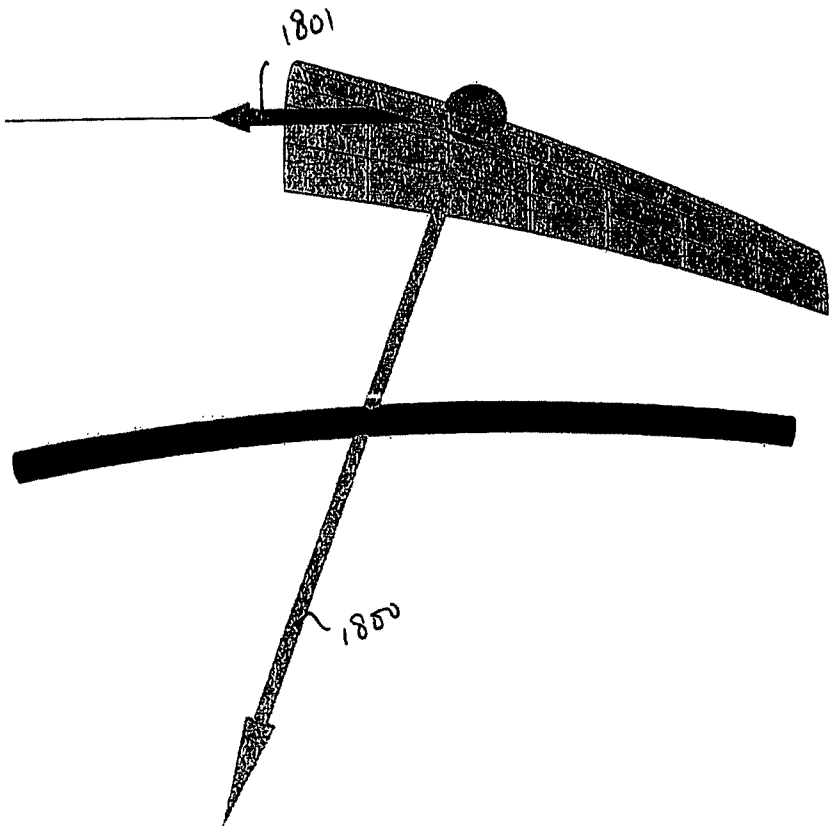


Fig. 32K

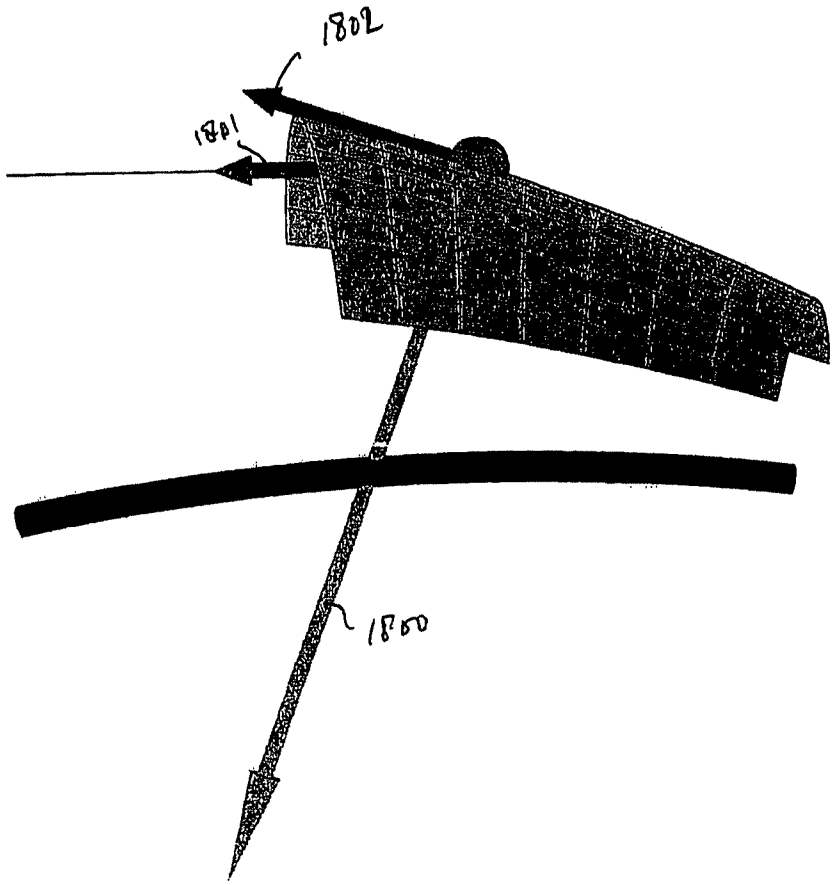


Fig. 32L

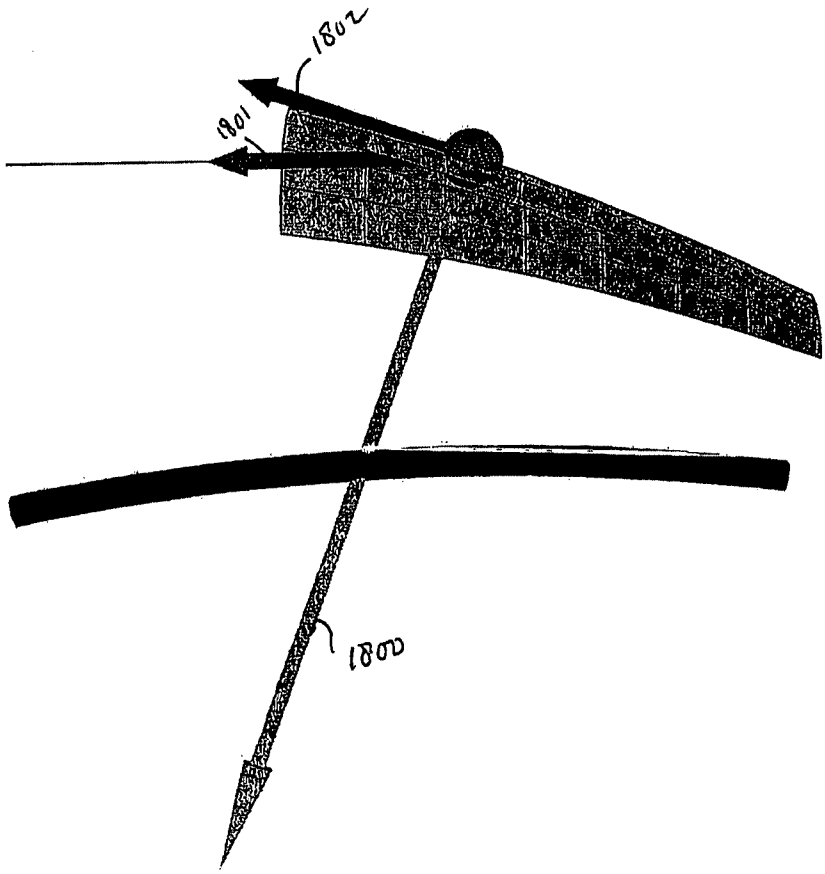


Fig. 32M

ANY REFERENCE TO FIGURES 33 TO 39
SHOULD BE CONSIDERED
AS NON-EXISTENT

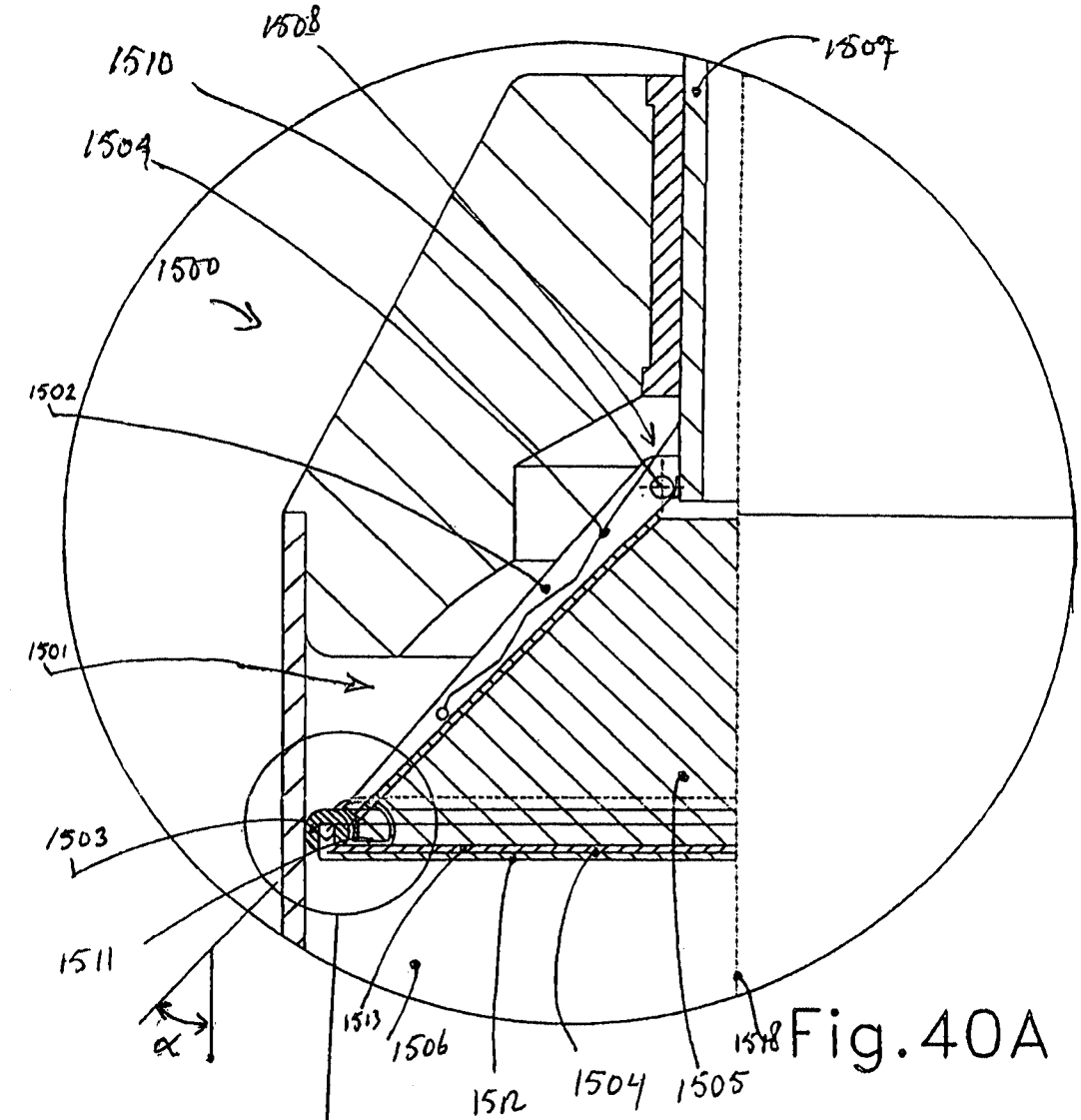


Fig.40A

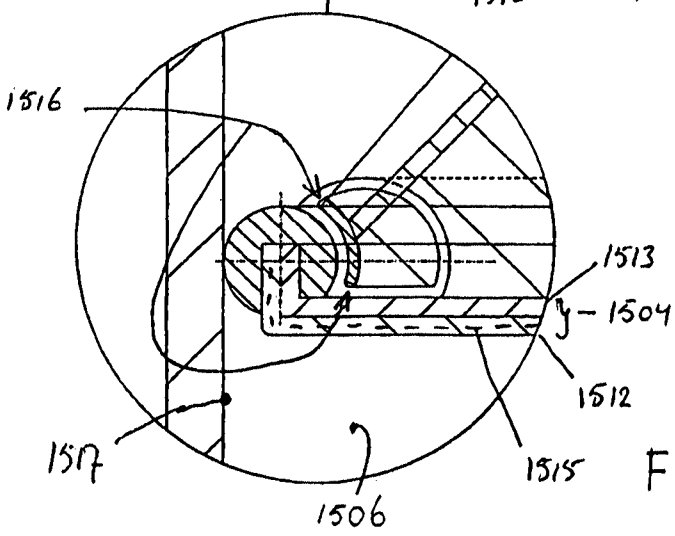


Fig.40B

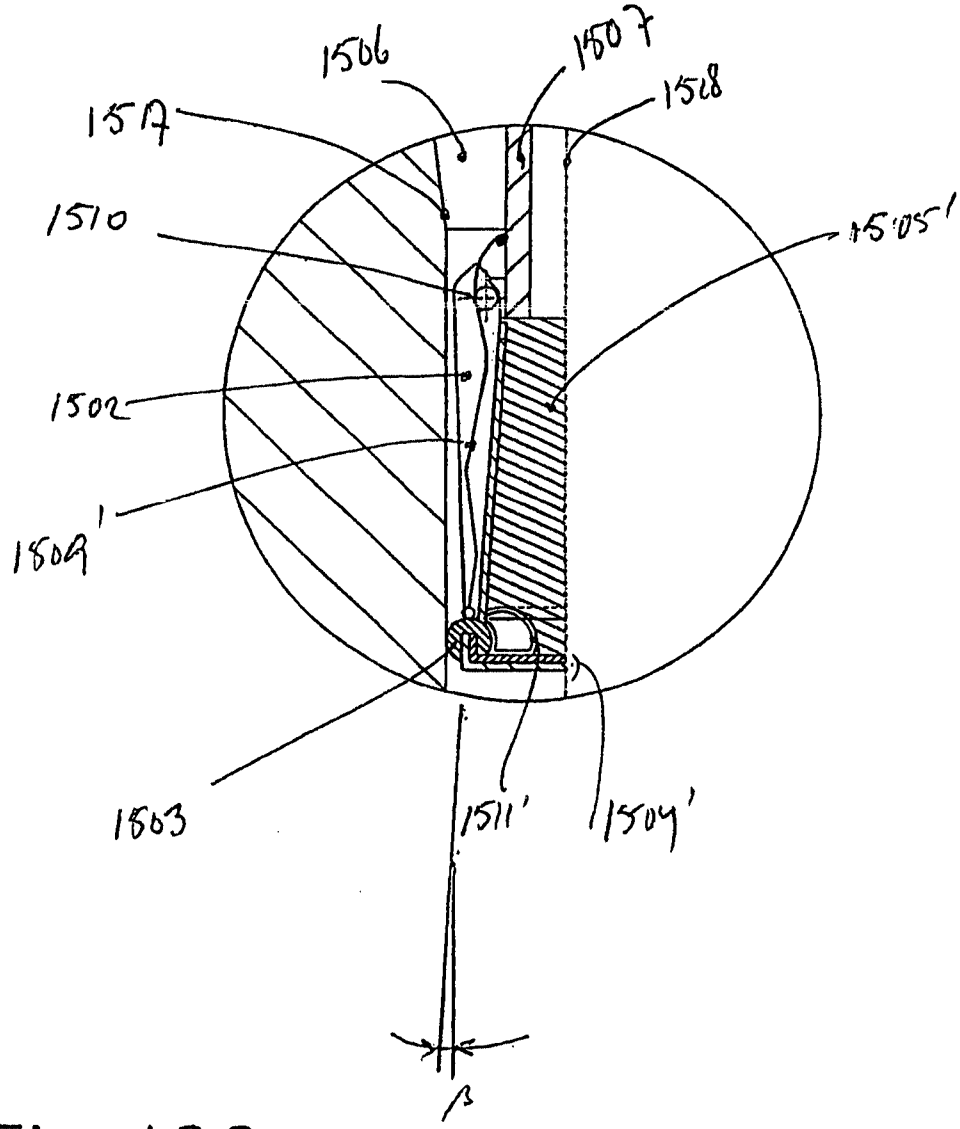


Fig.40C

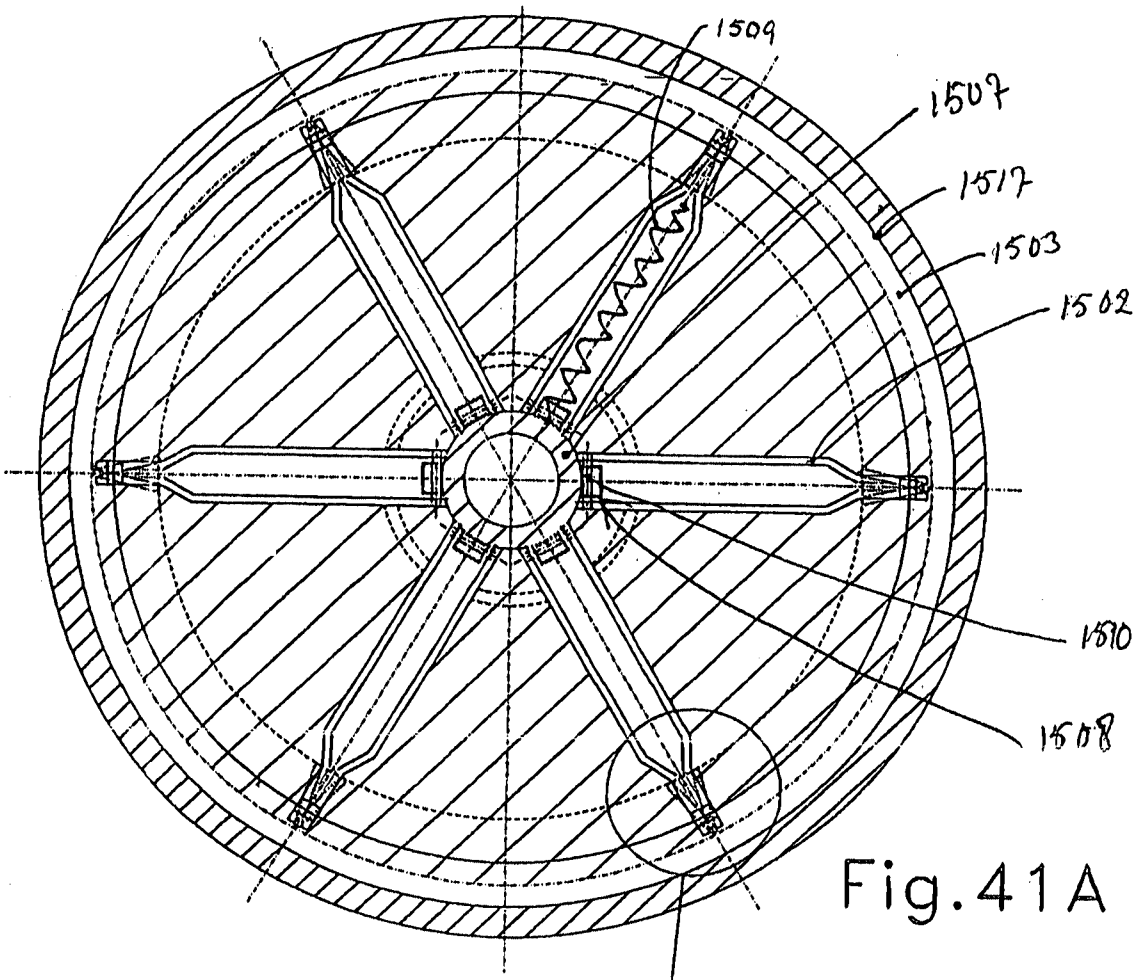
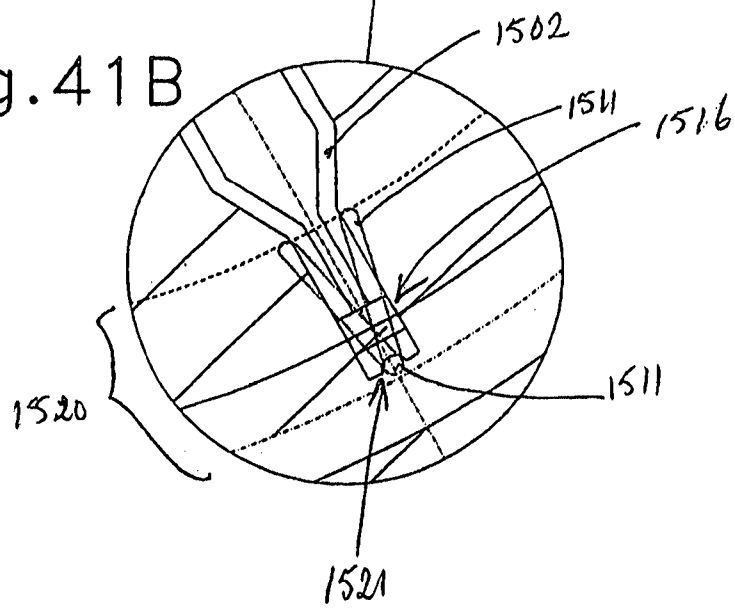


Fig.41A

Fig.41B



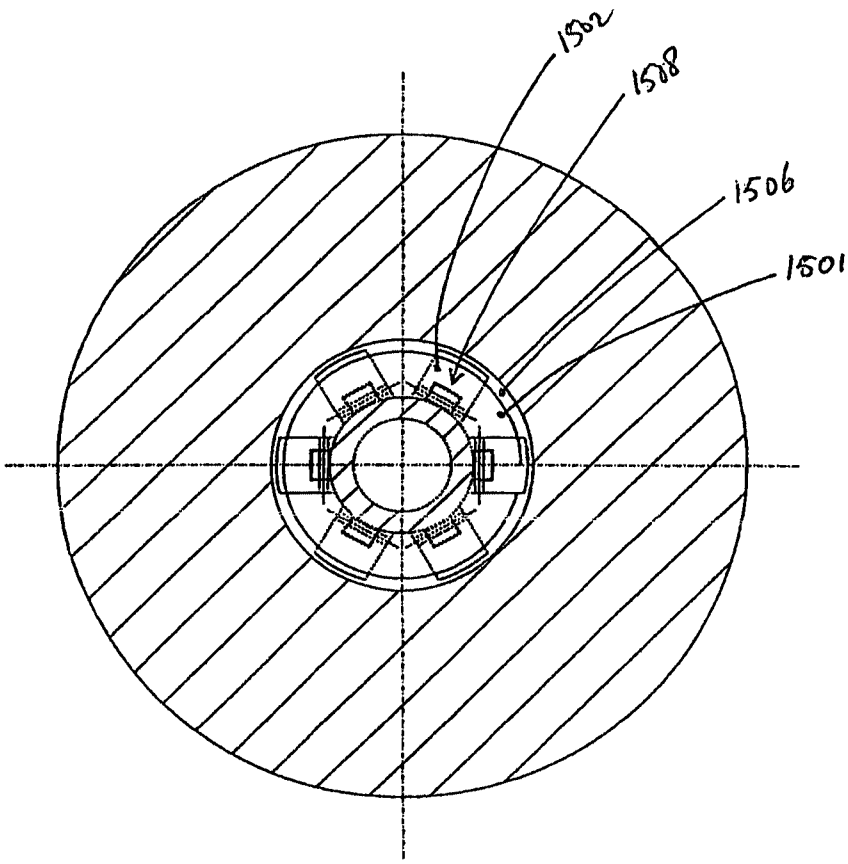


Fig.41C

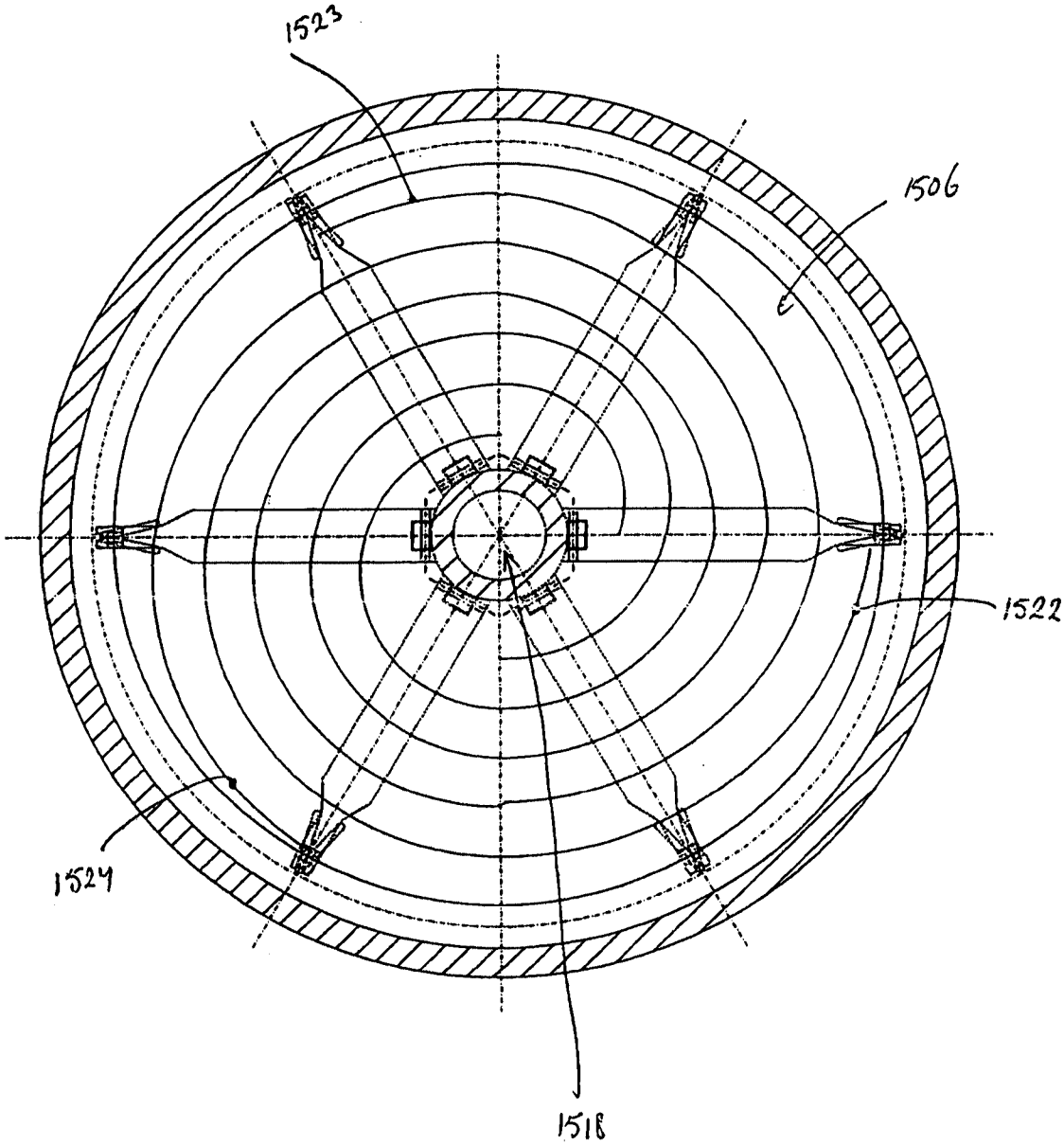


Fig.41D

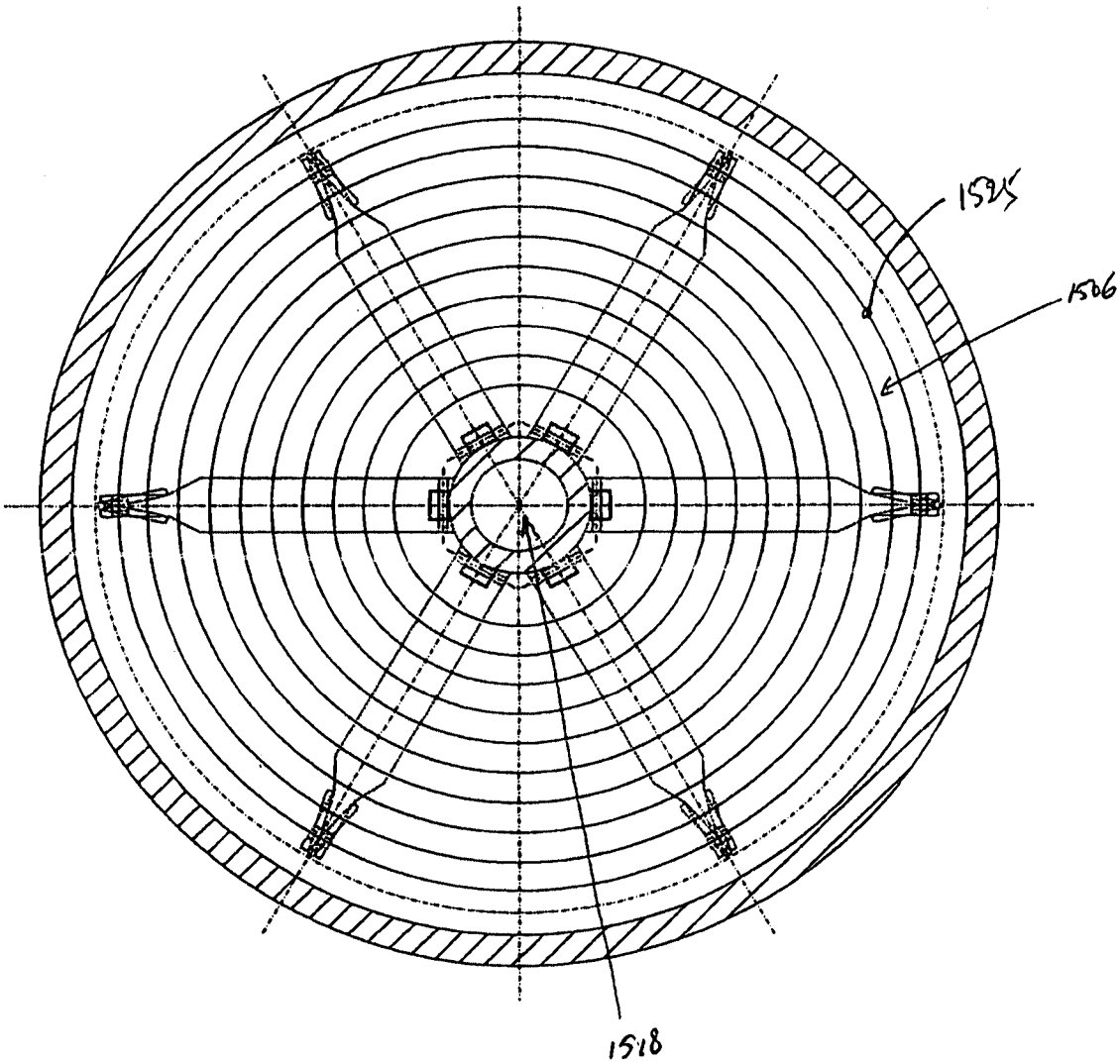


Fig.41E

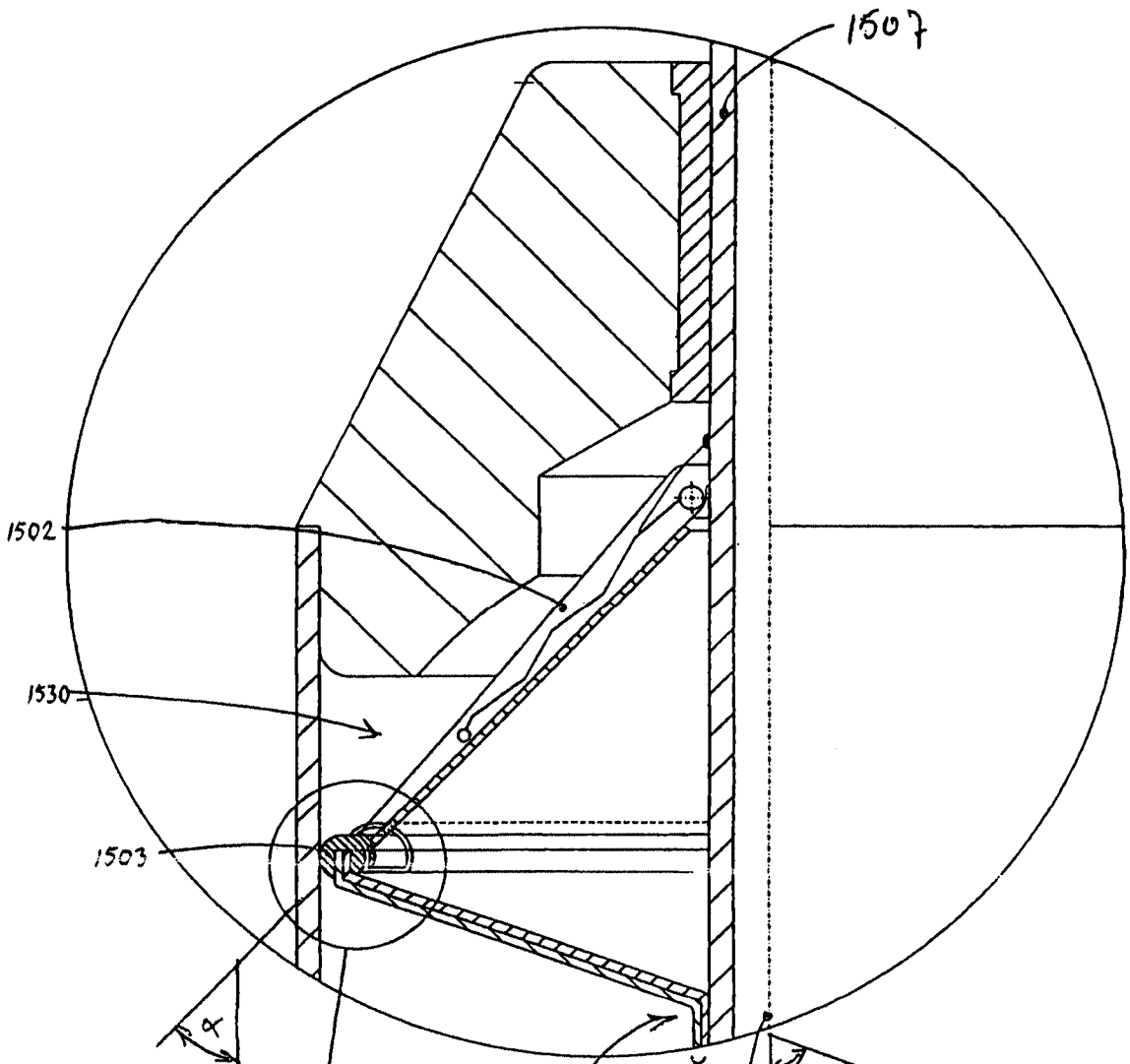


Fig.42A

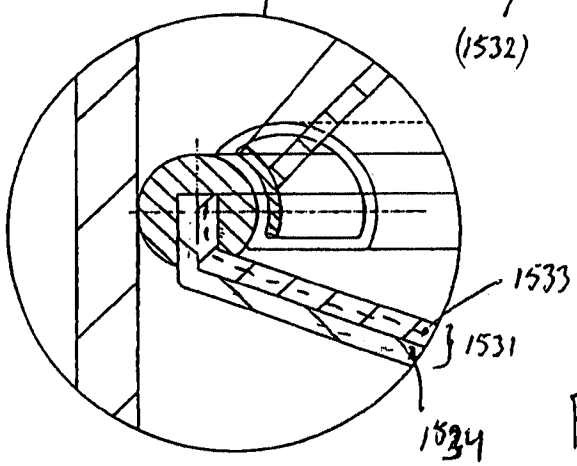


Fig.42B

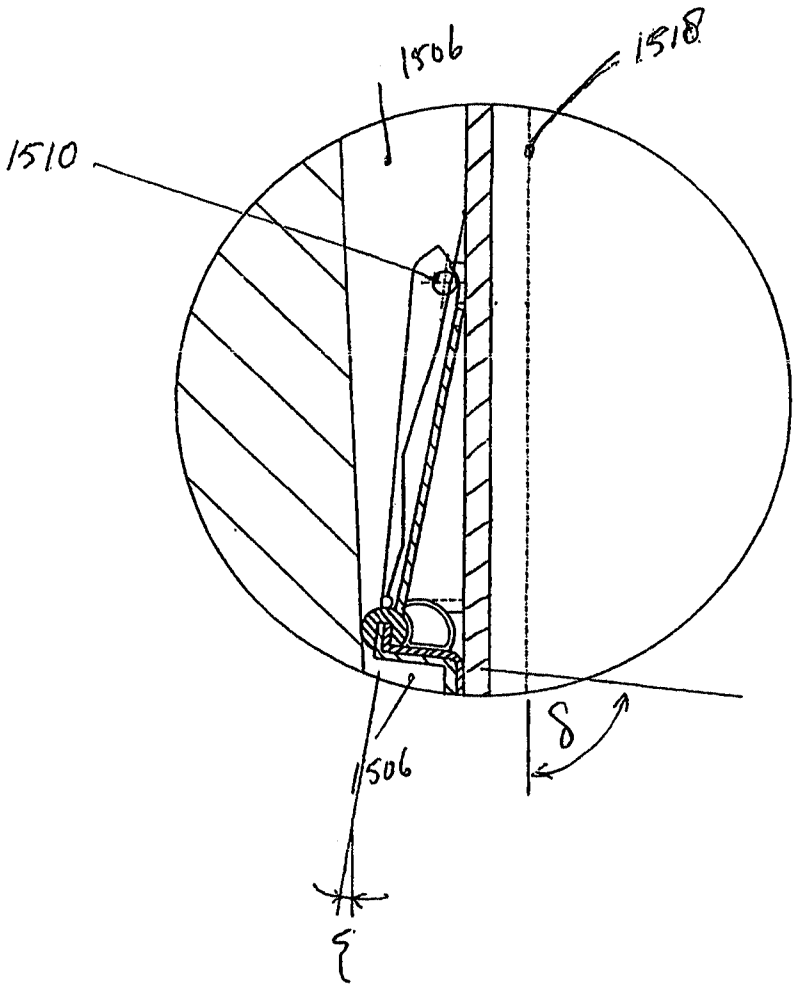


Fig.42C

ANY REFERENCE TO FIGURES 43 TO 49
SHOULD BE CONSIDERED
AS NON-EXISTENT

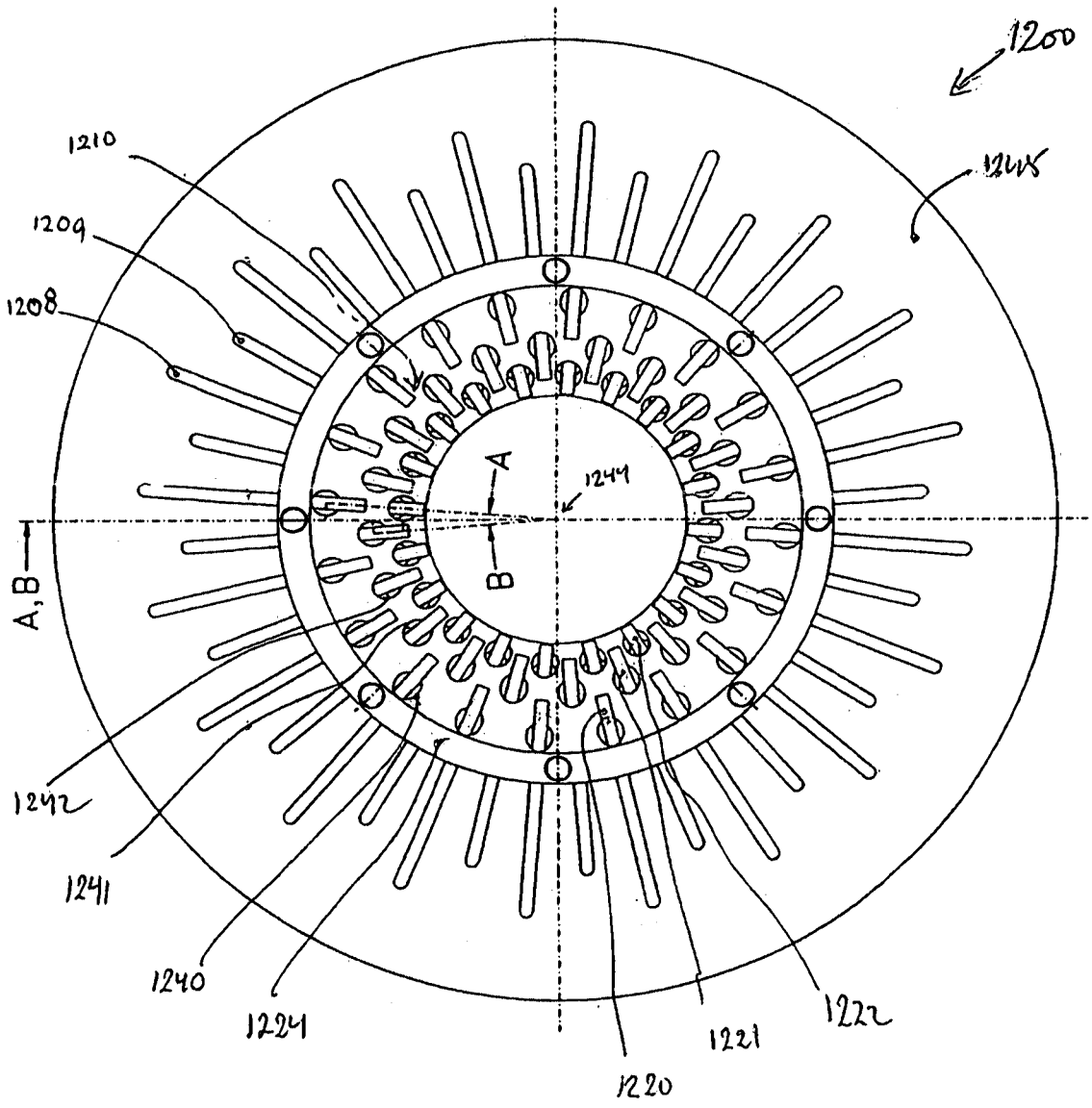

1200
1210
1209
1208
1245
1244
A
B
A,B
1242
1241
1240
1224
1220
1221
1222

Fig. 50

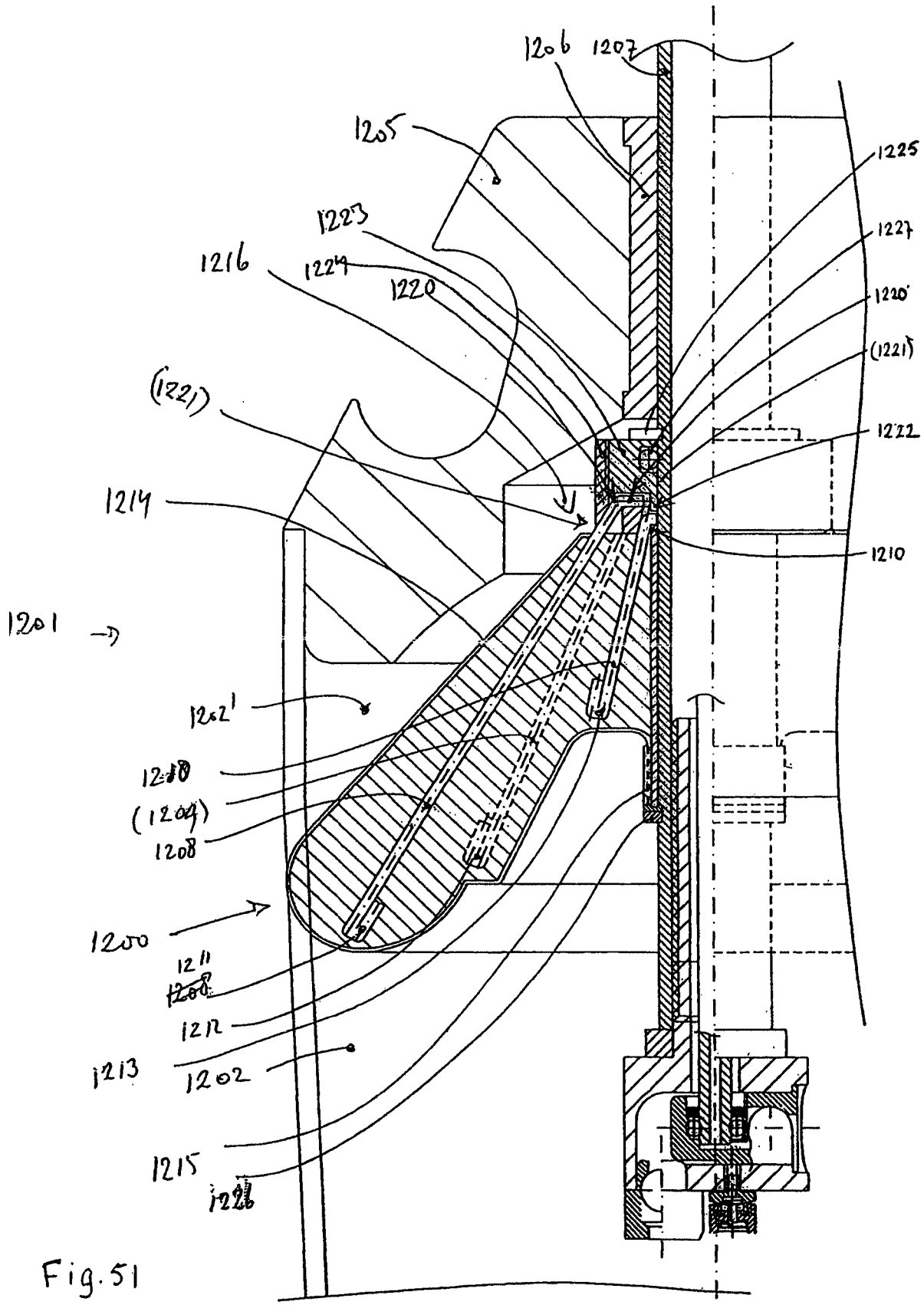

1206
1207
1205
1225
1223
1227
1216
1224
1220
1220'
(1221')
(1221)
1222
1214
1210
1201
1202'
1218
(1209)
1208
1200
1211
1212
1213
1202
1215
1226

Fig. 51

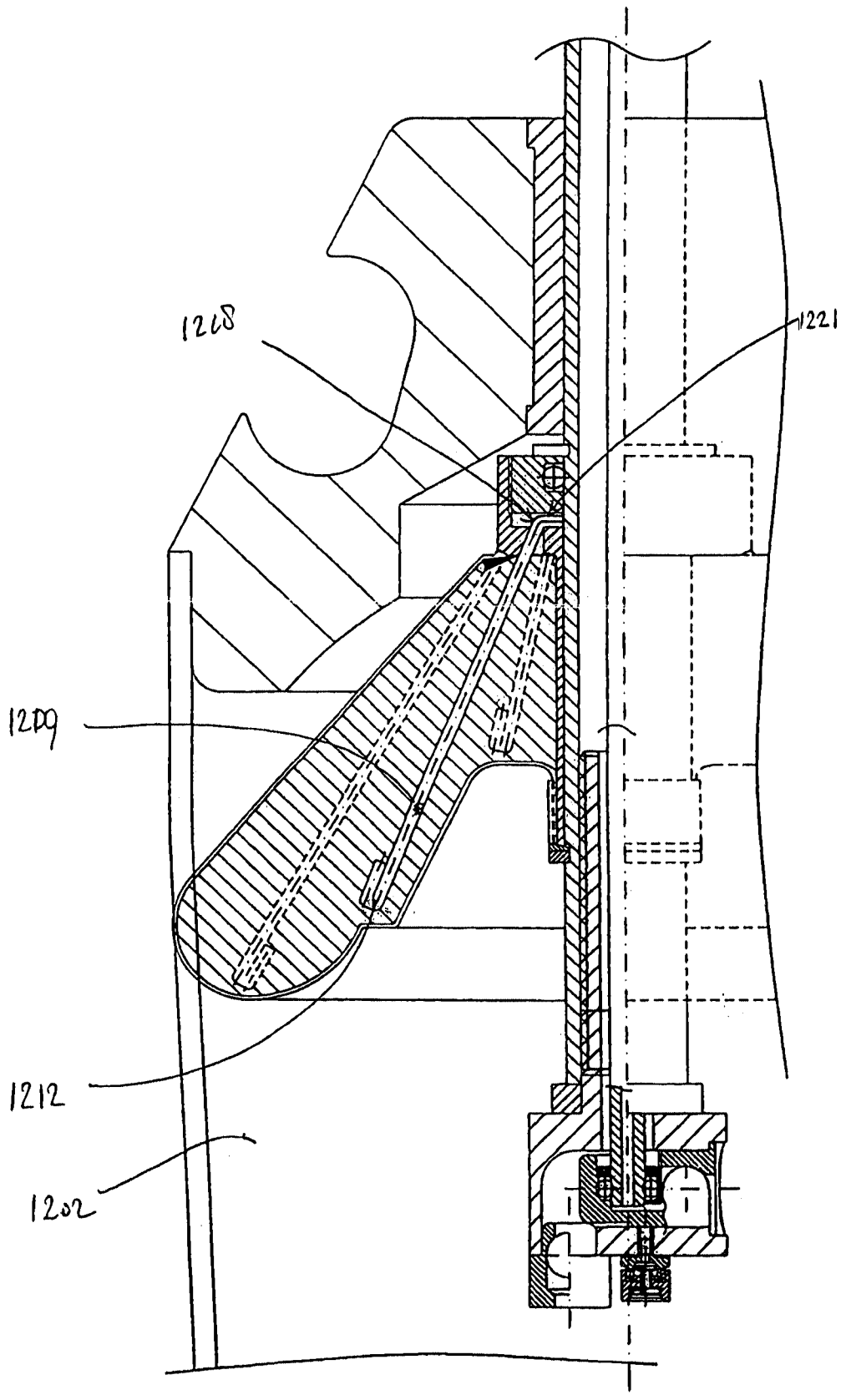


Fig. 52

ANY REFERENCE TO FIGURES 53 TO 59
SHOULD BE CONSIDERED
AS NON-EXISTENT

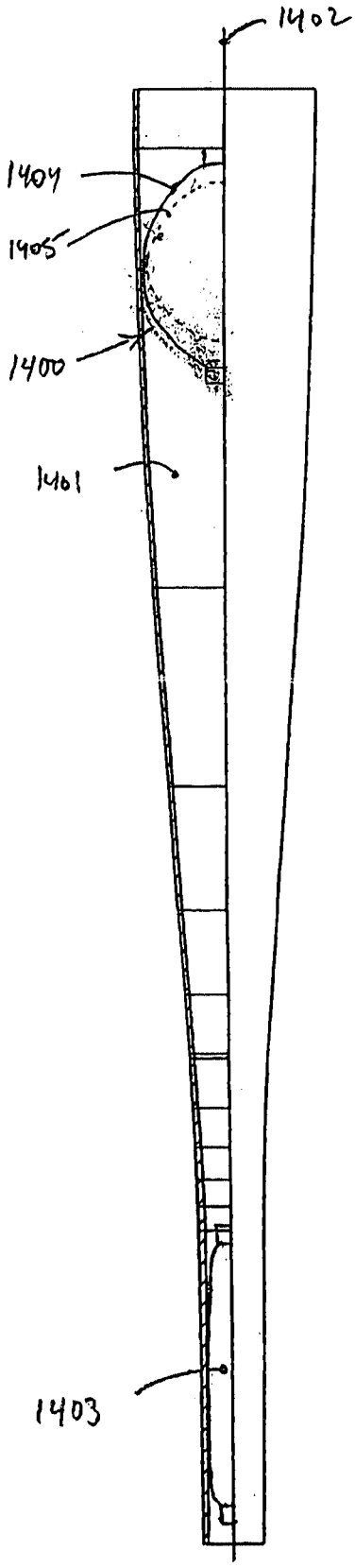


Fig.60

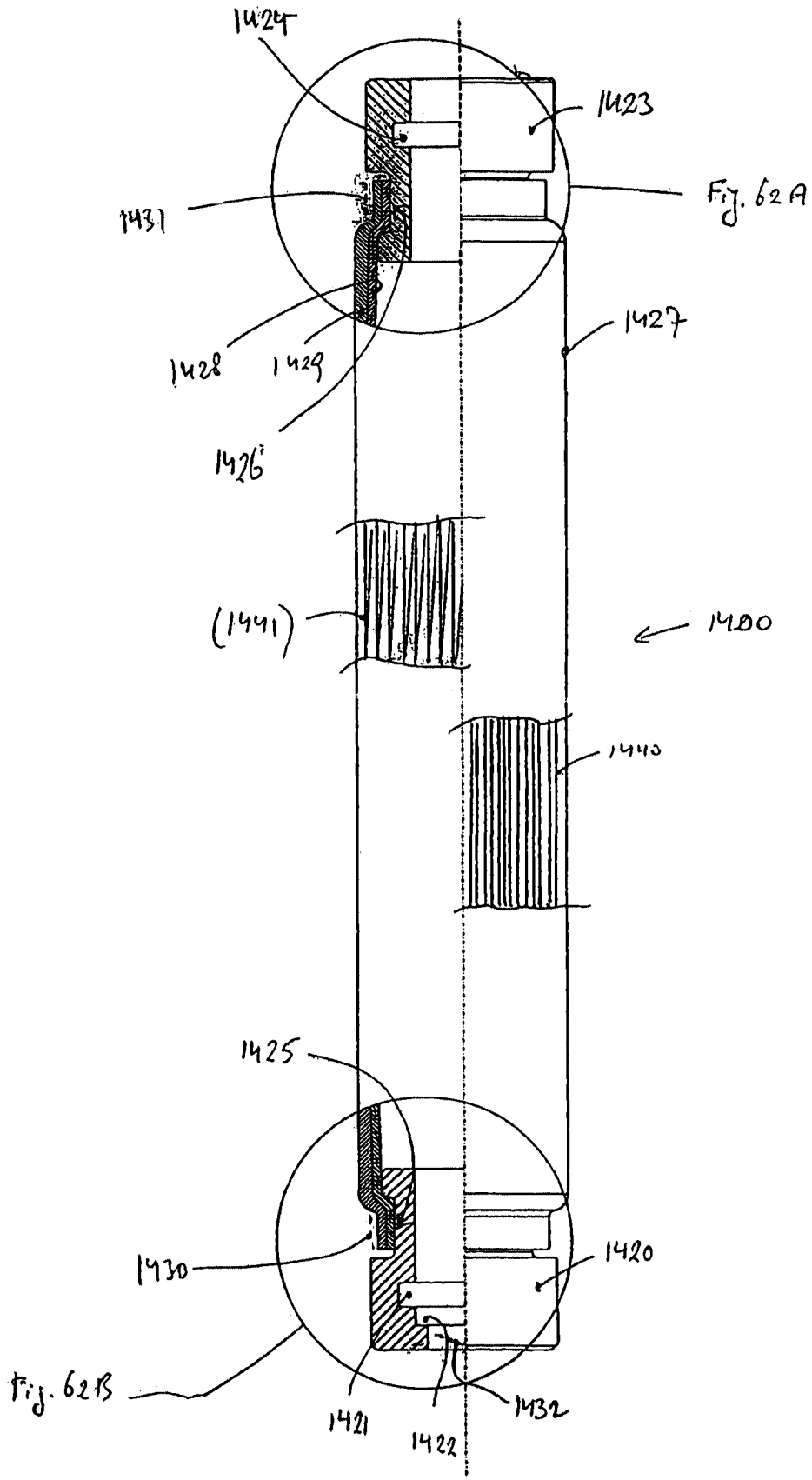

1424
1423
1431
Fig. 62A
1427
1428
1429
1426
(1441)
1400
1440
1425
1430
1420
Fig. 62B
1421
1422
1432

Fig. 61

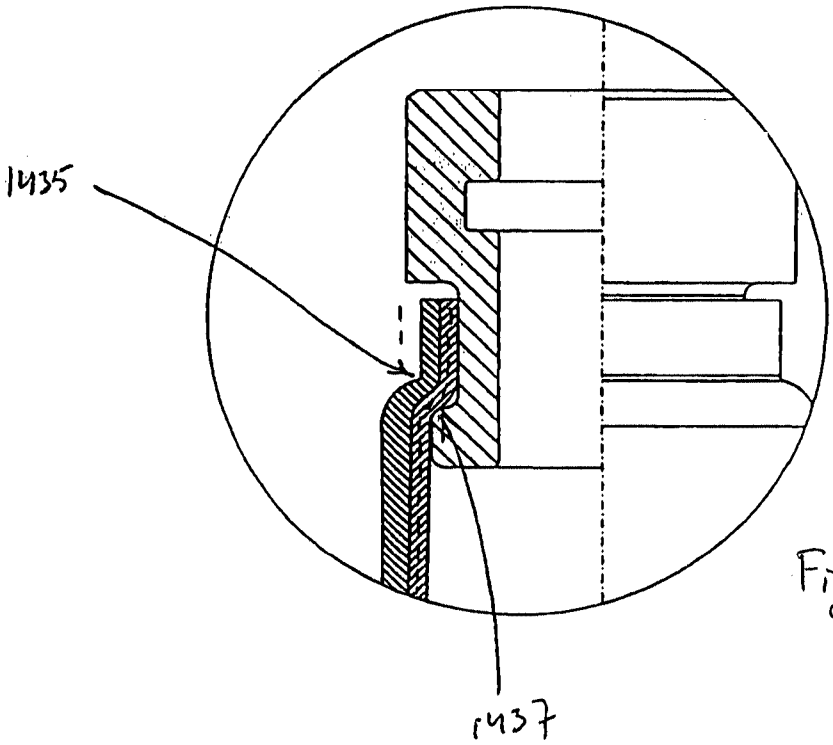


Fig. 62A

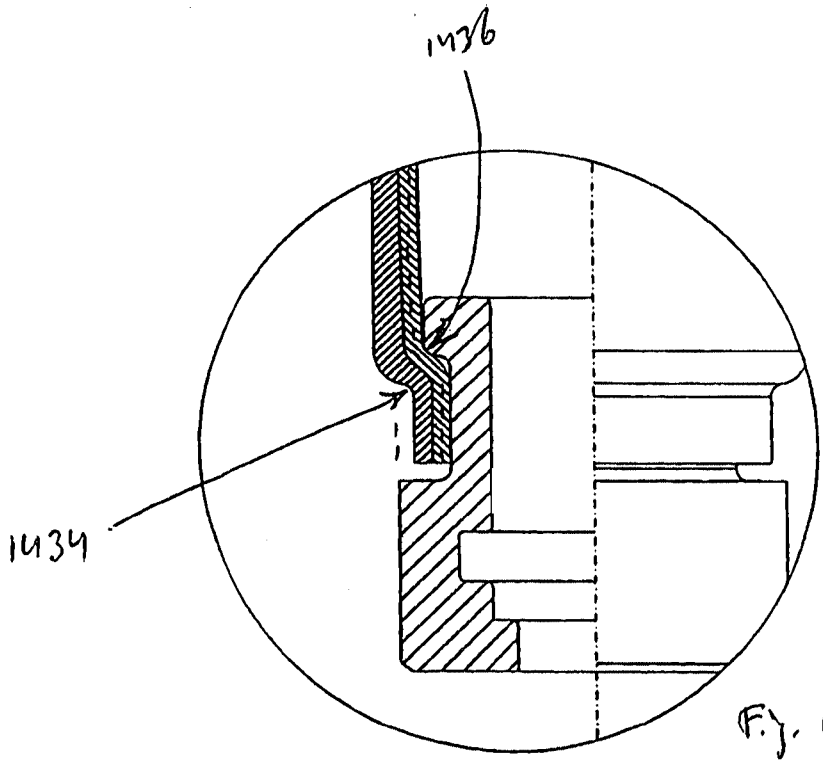


Fig. 62B

ANY REFERENCE TO FIGURES 63 TO 99
SHOULD BE CONSIDERED
AS NON-EXISTENT

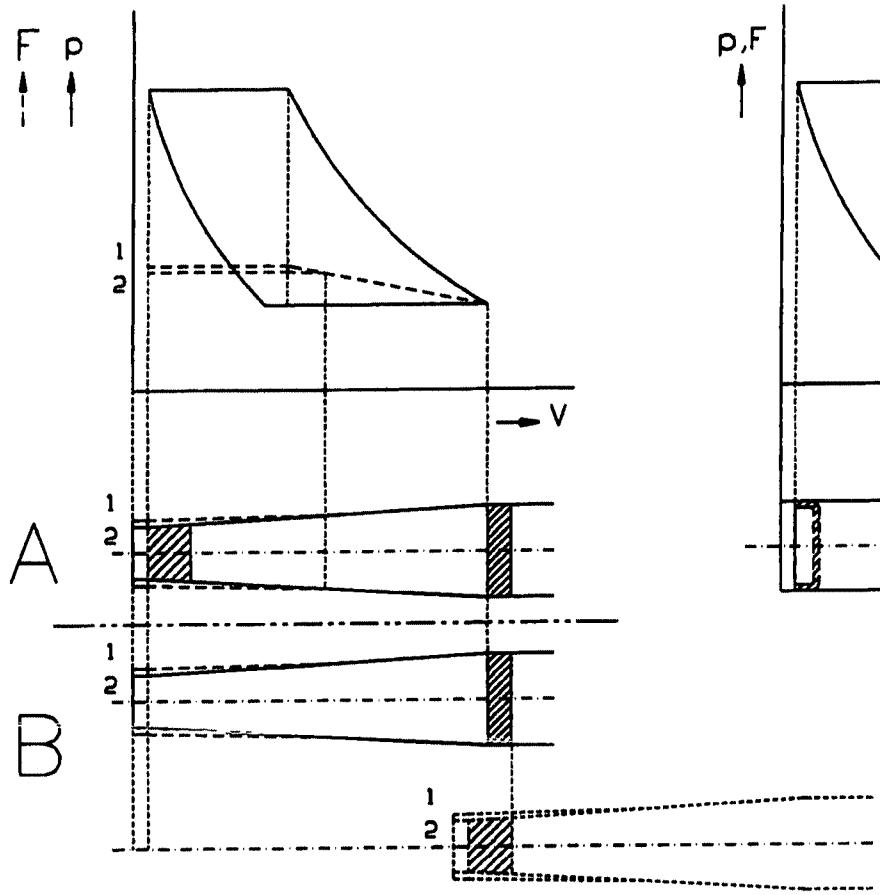


Fig. 102A

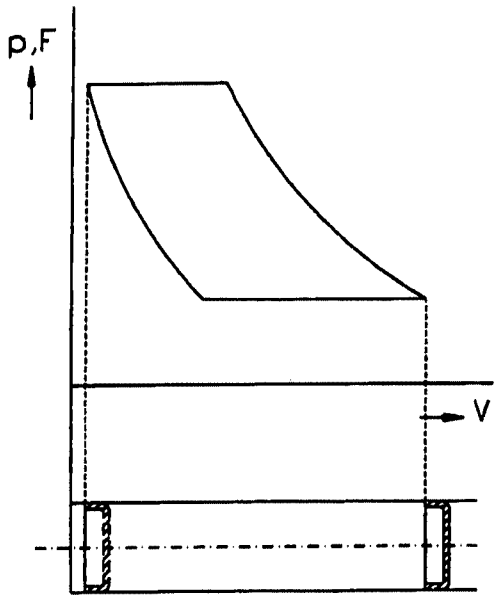


Fig. 100

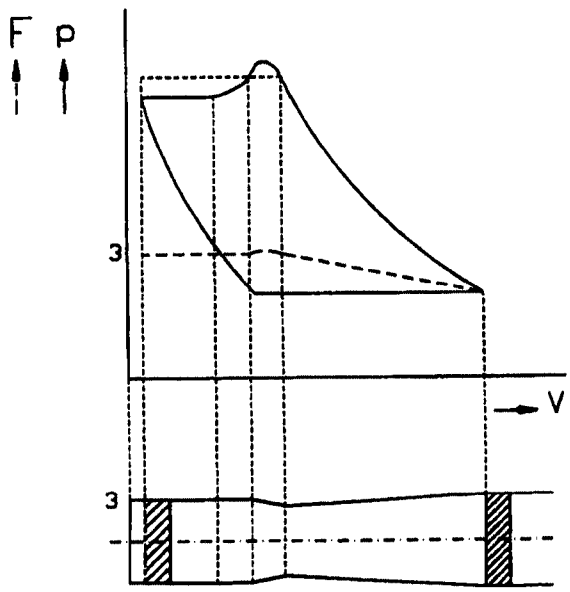


Fig. 102B

ANY REFERENCE TO FIGURE 101
SHOULD BE CONSIDERED
AS NON-EXISTENT

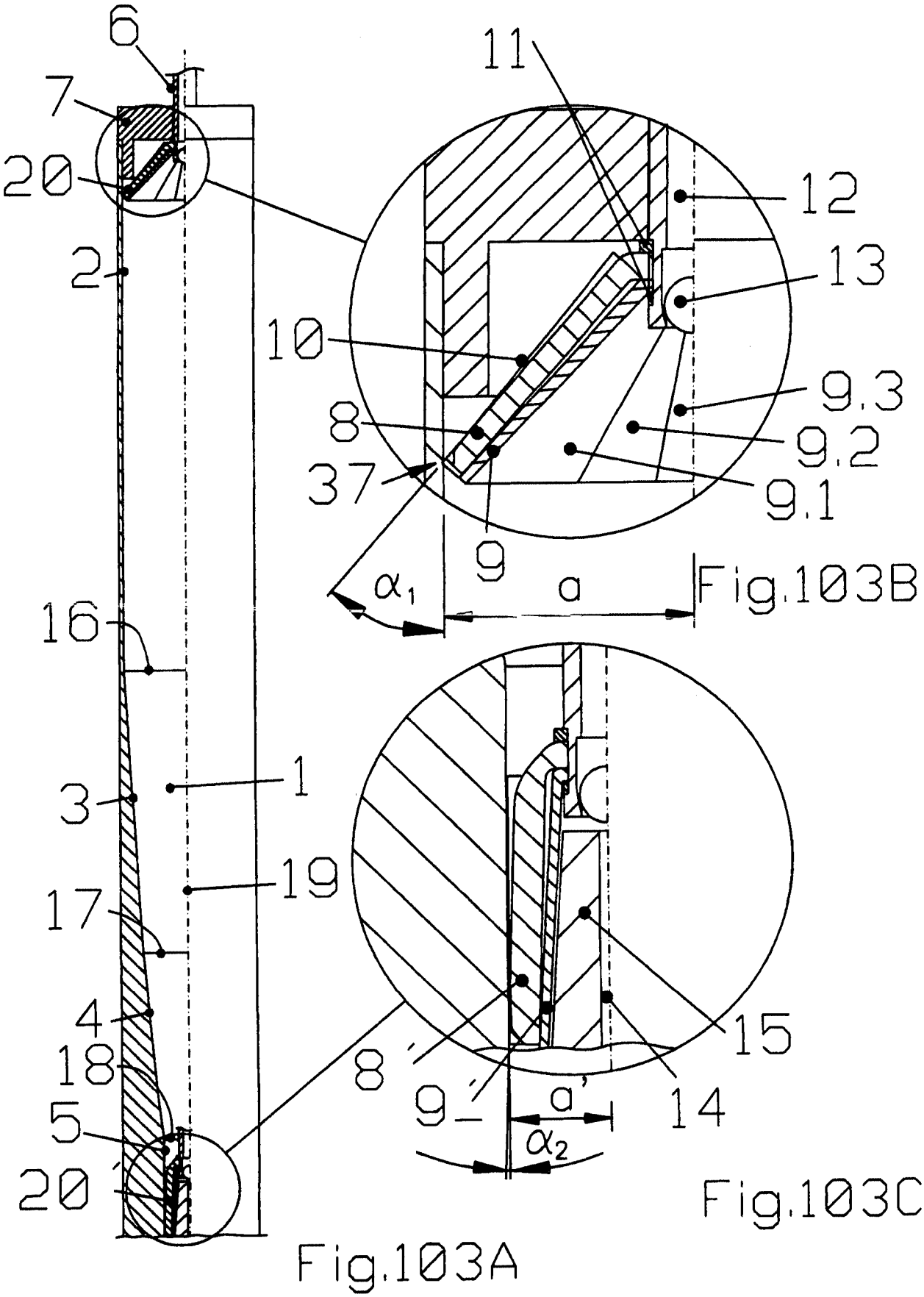


Fig.103A

Fig.103B

Fig.103C

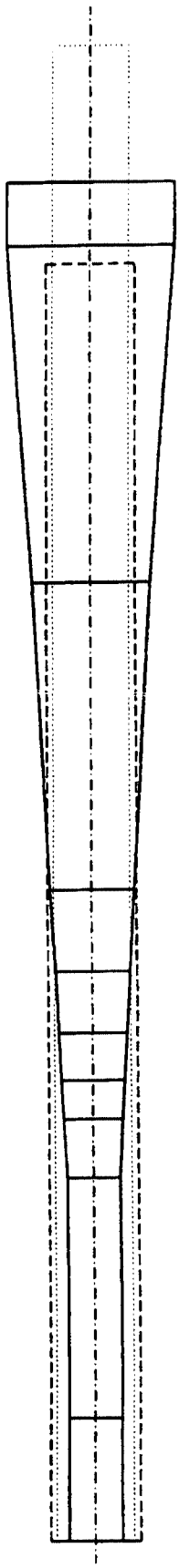


Fig.103D

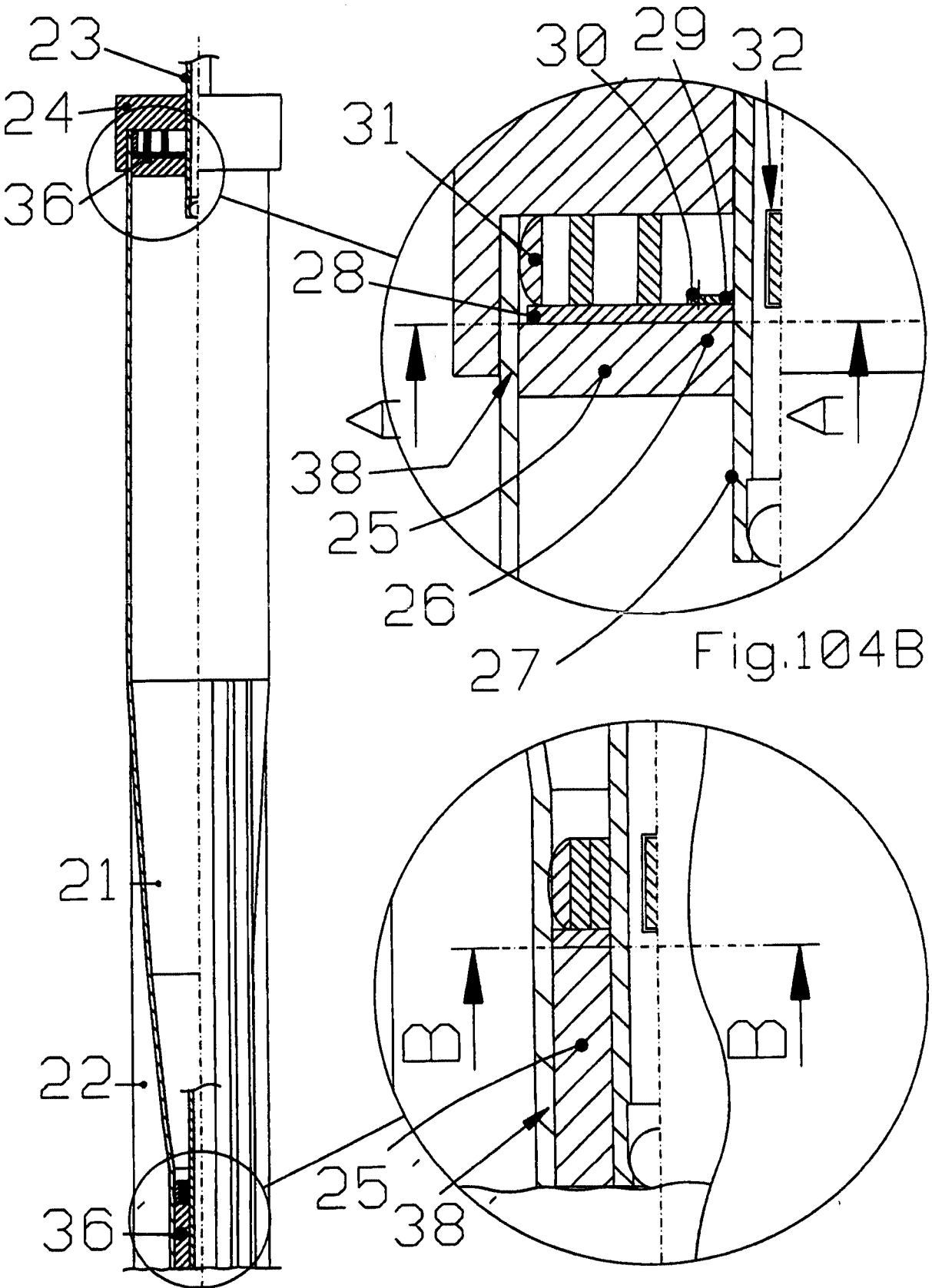


Fig.104A

Fig.104B

Fig.104C

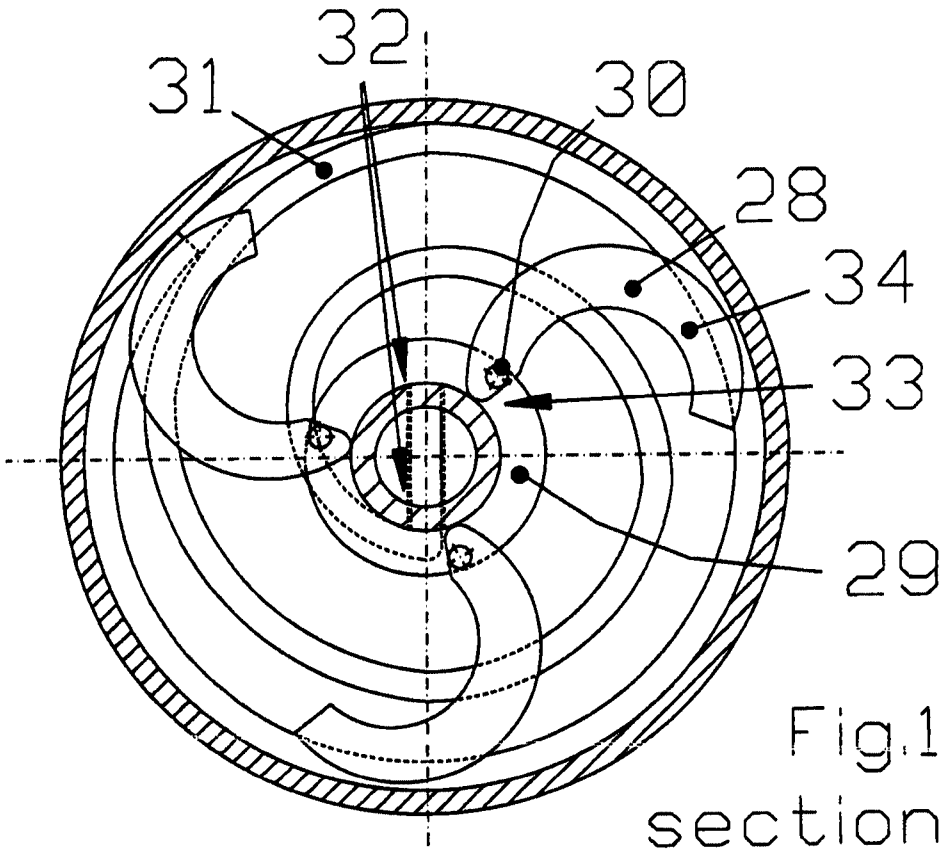


Fig.104D
section A-A

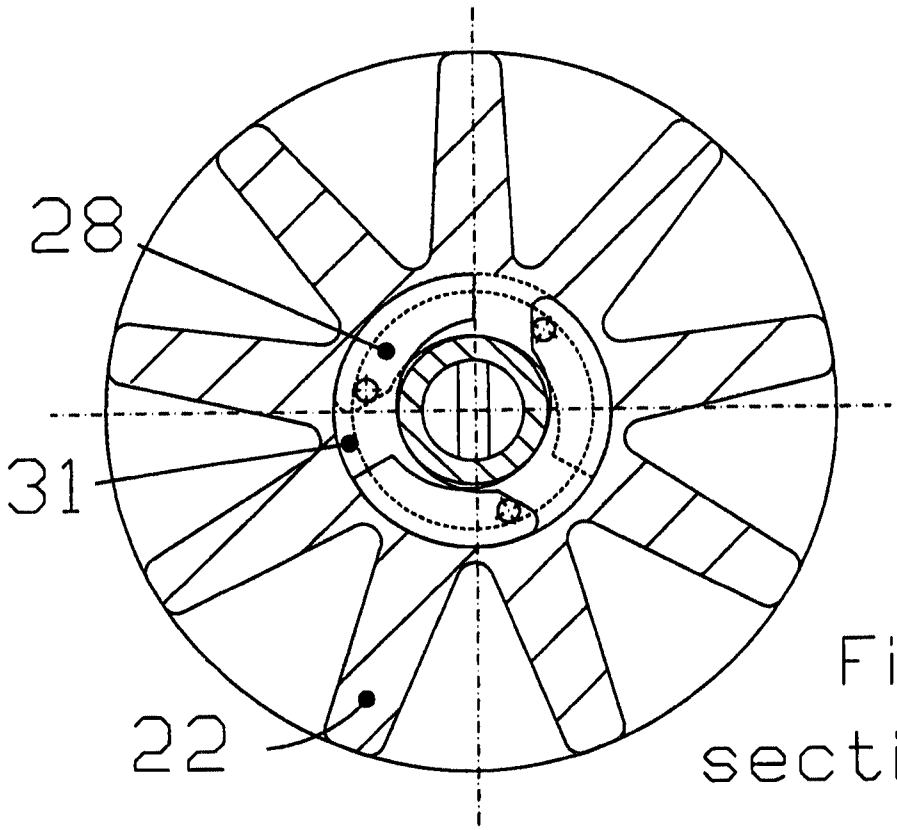


Fig.104E
section B-B

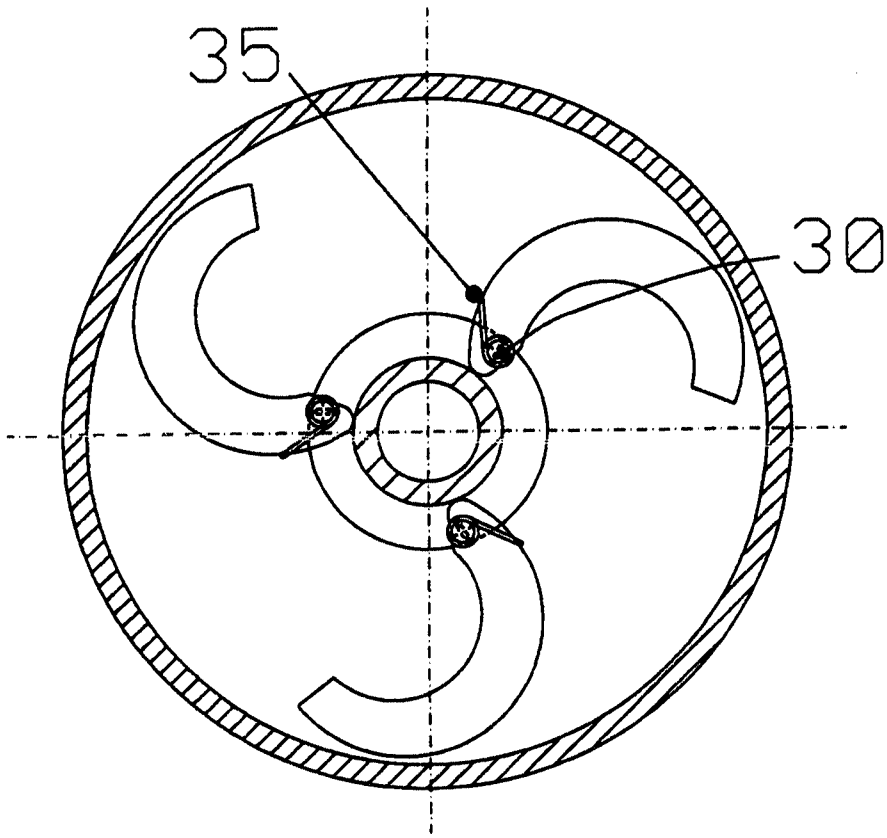
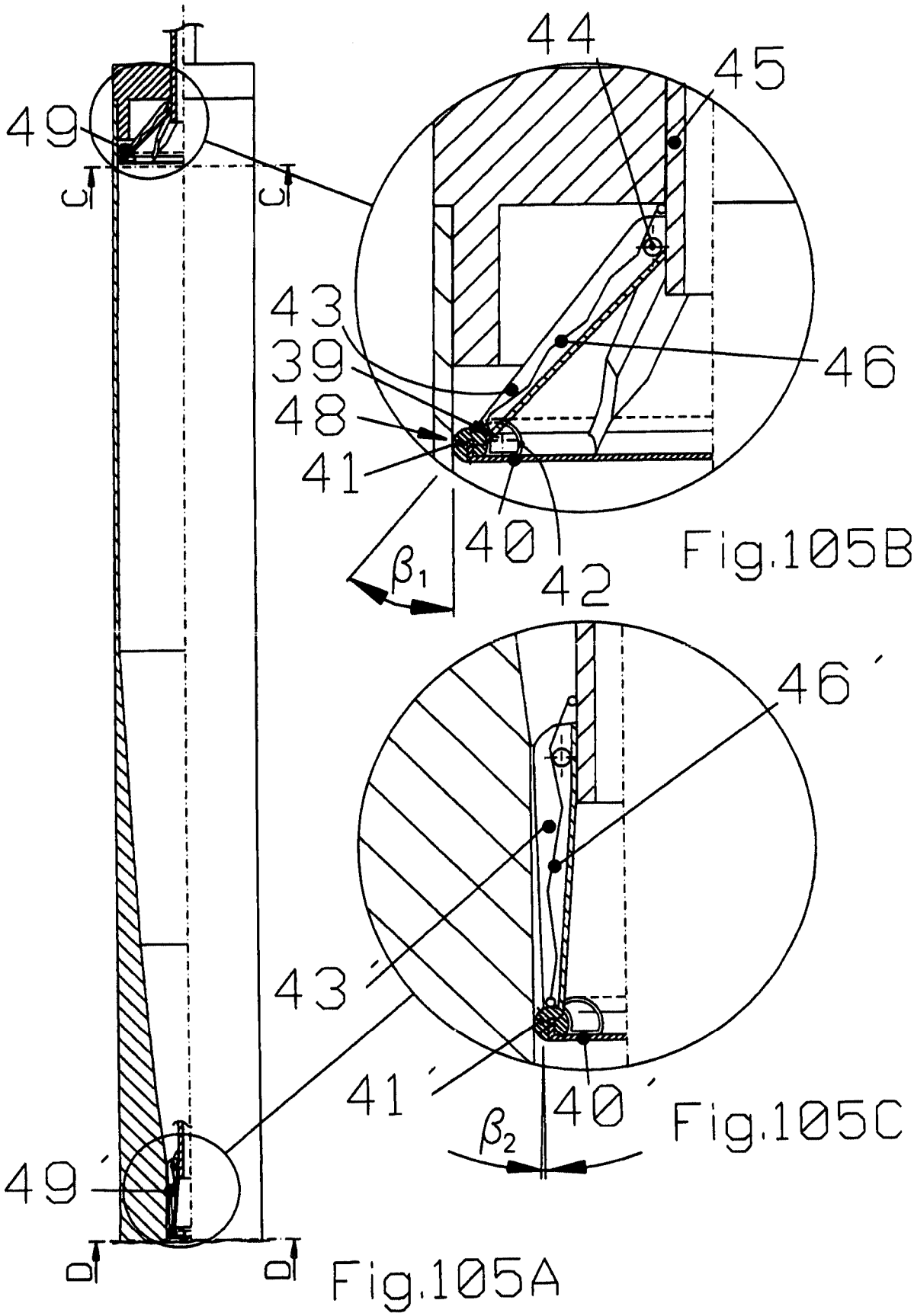


Fig.104F
section A-A


49
d
d
44
45
43
39
48
41
46
40
42
β1
Fig.105B
46´
43´
41´
40´
β2
Fig.105C
49´
d
d
Fig.105A

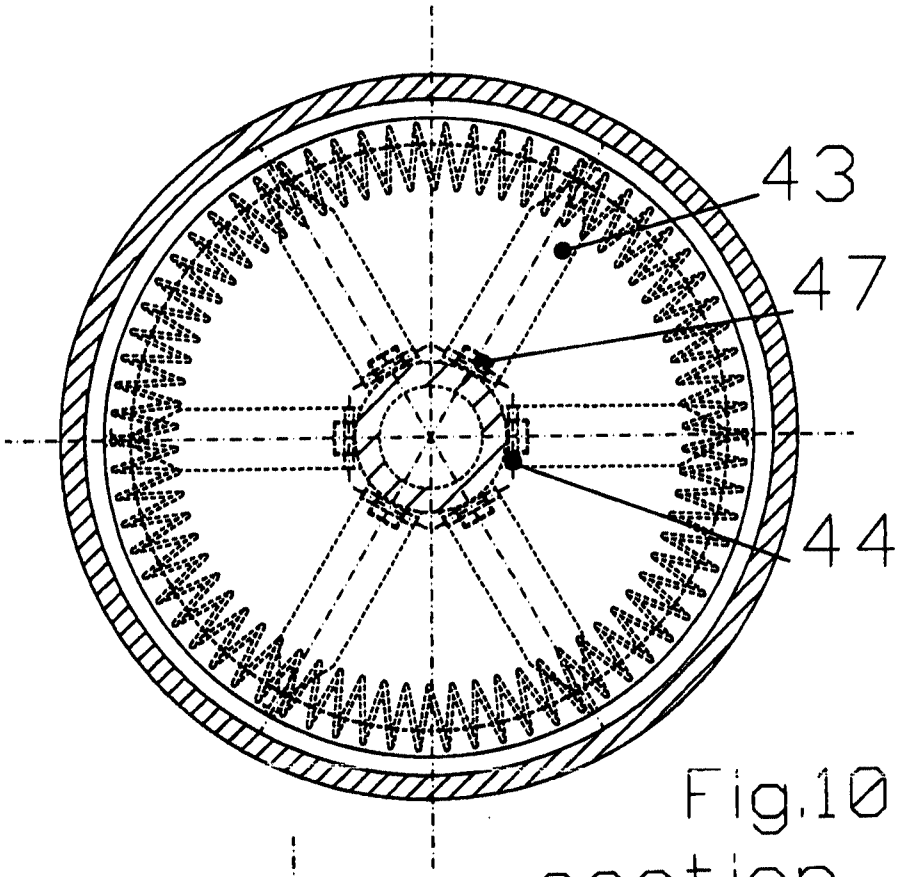


Fig.105D
section C-C

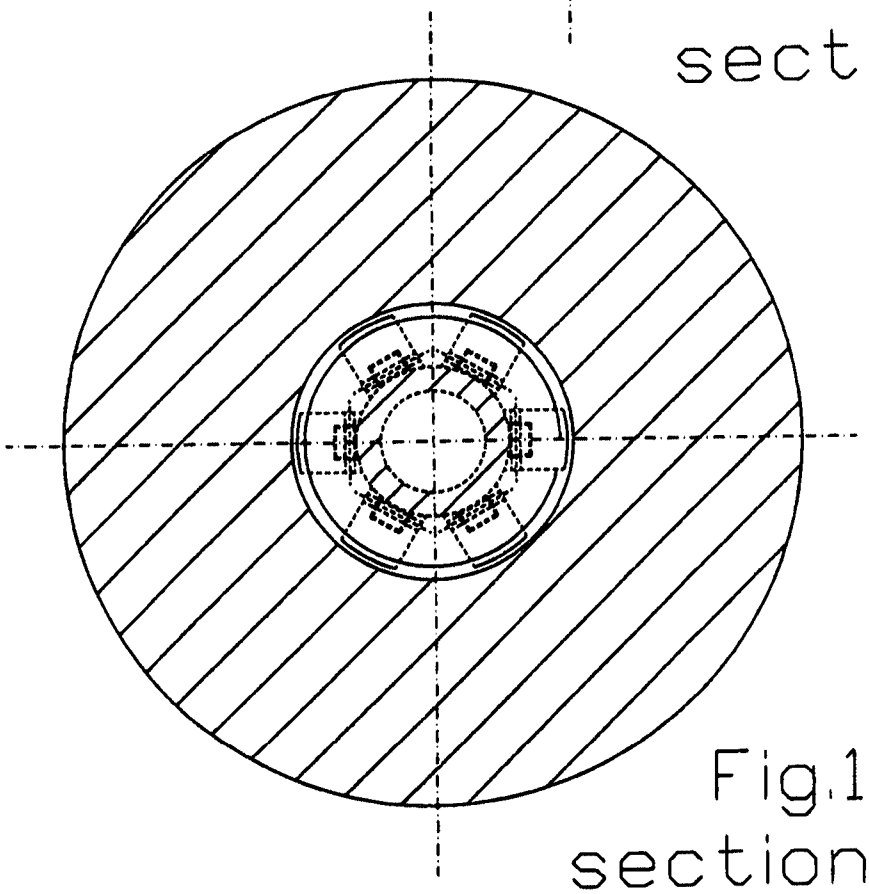


Fig.105E
section D-D

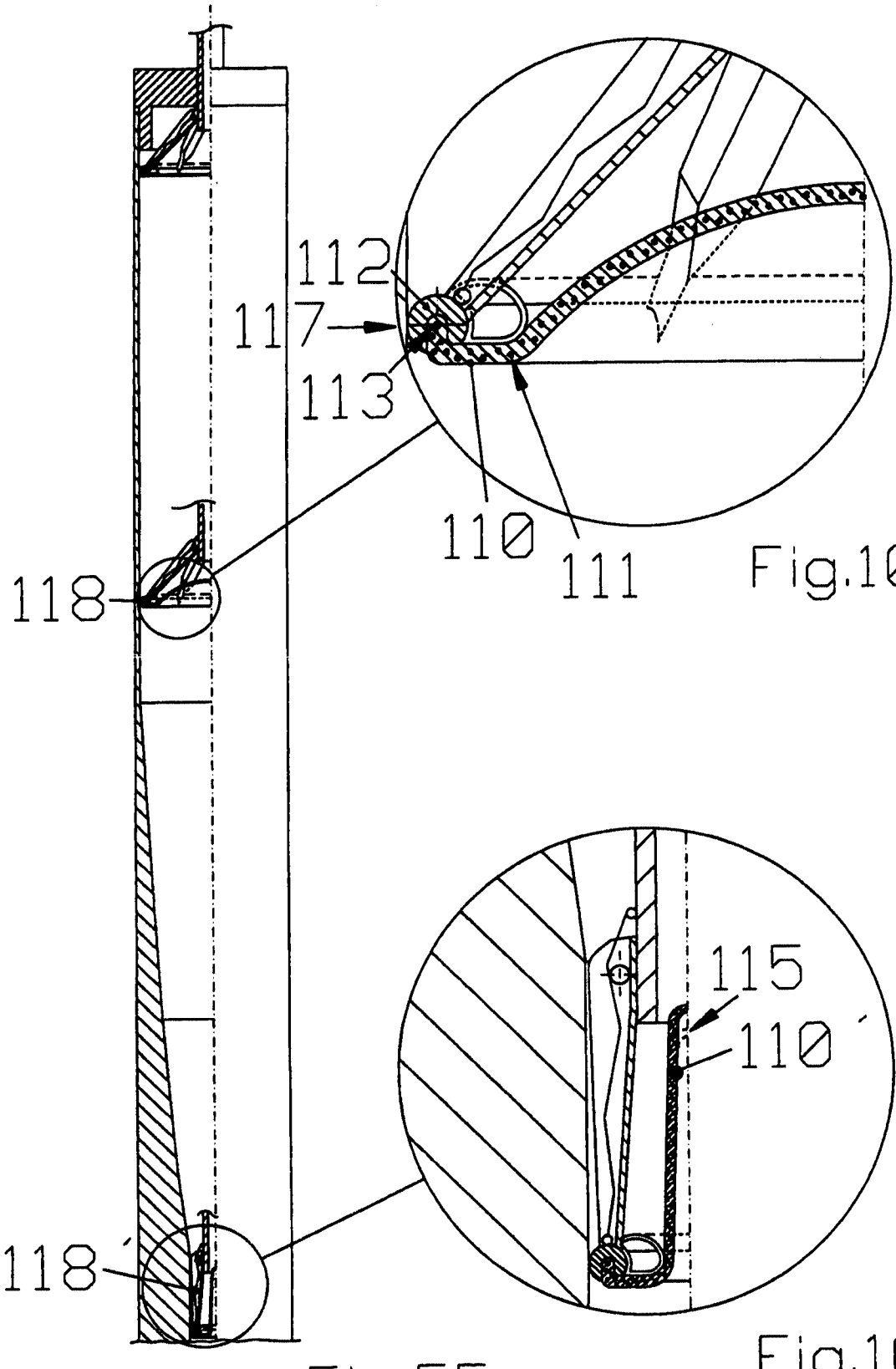


Fig.105G

Fig.5F

Fig.105H

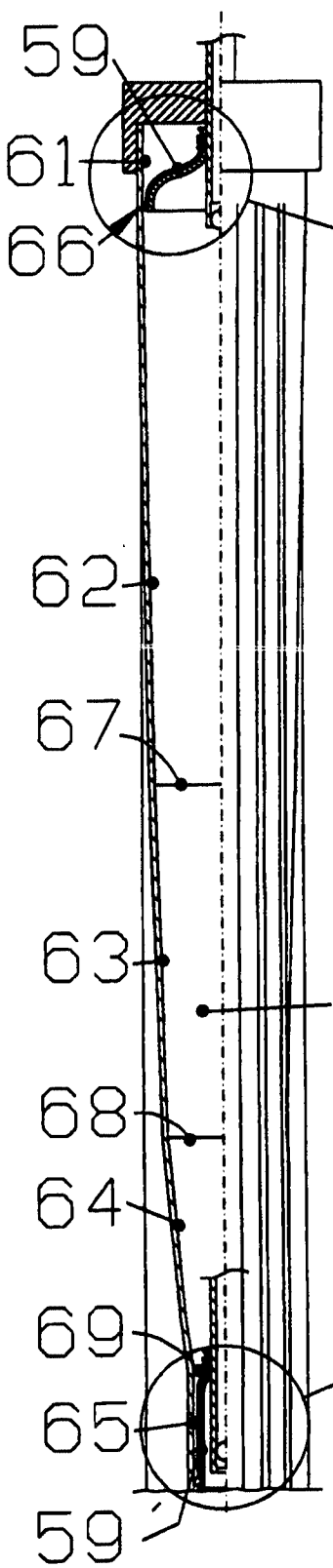


Fig.6A

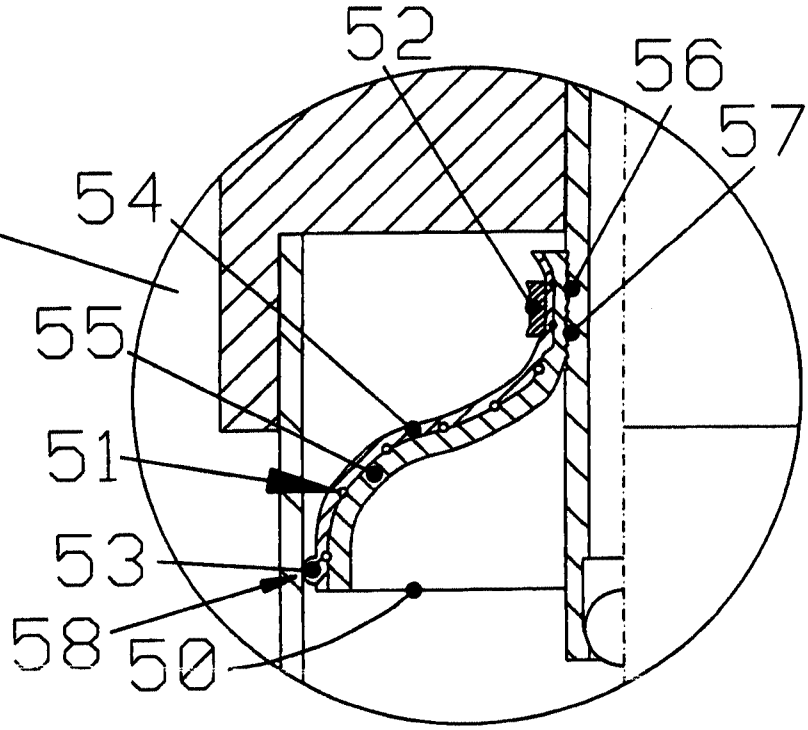


Fig.106B

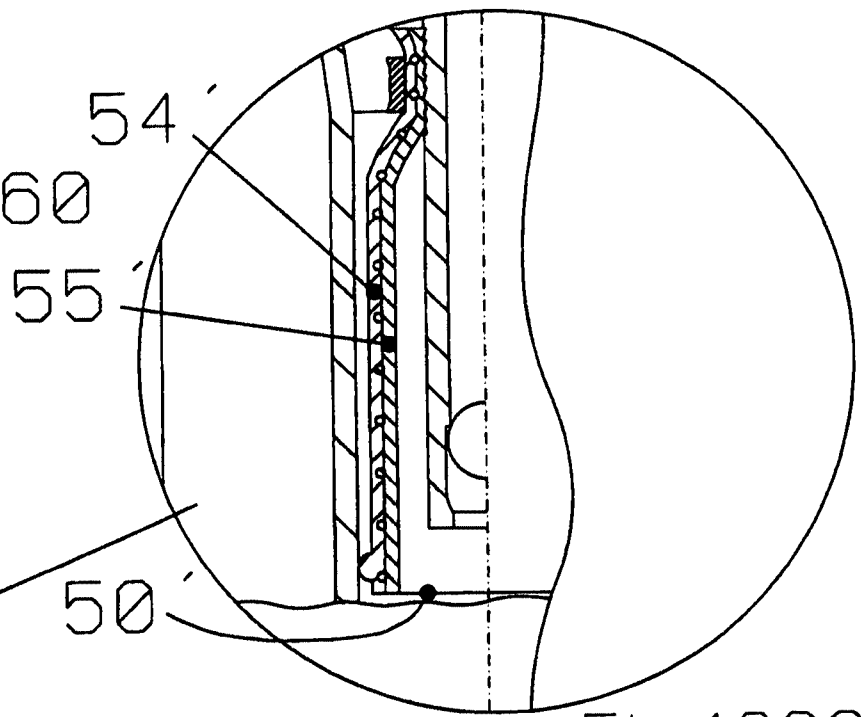


Fig.106C

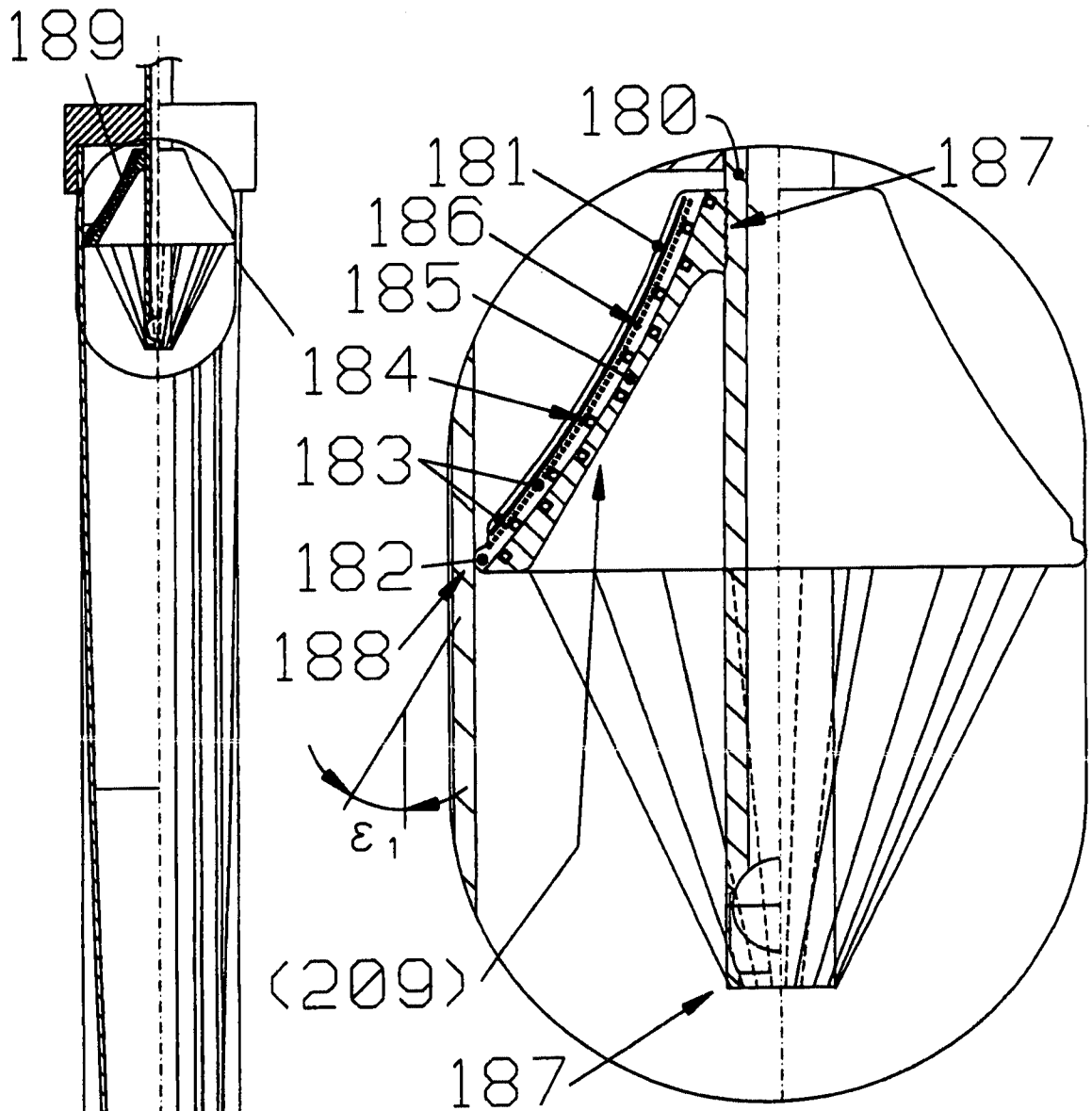


Fig.106E

Fig.6F

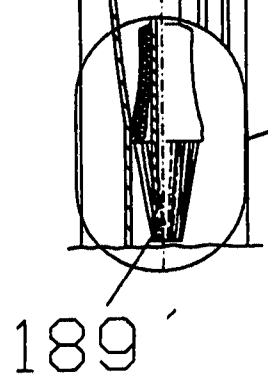


Fig.106D

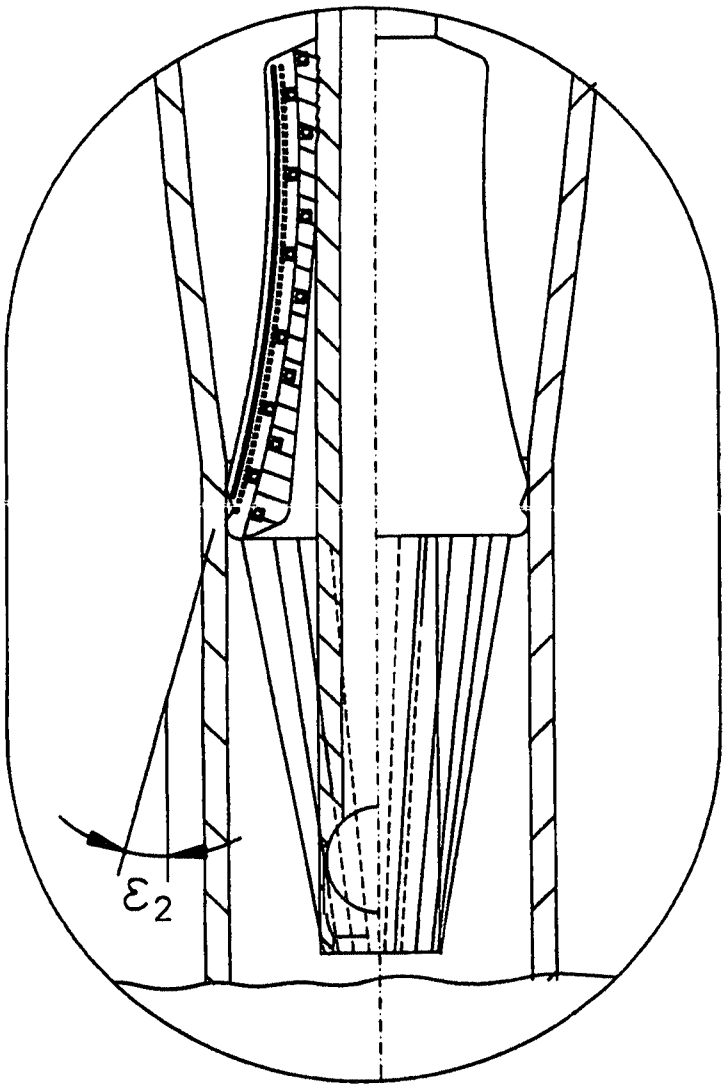


Fig.106F

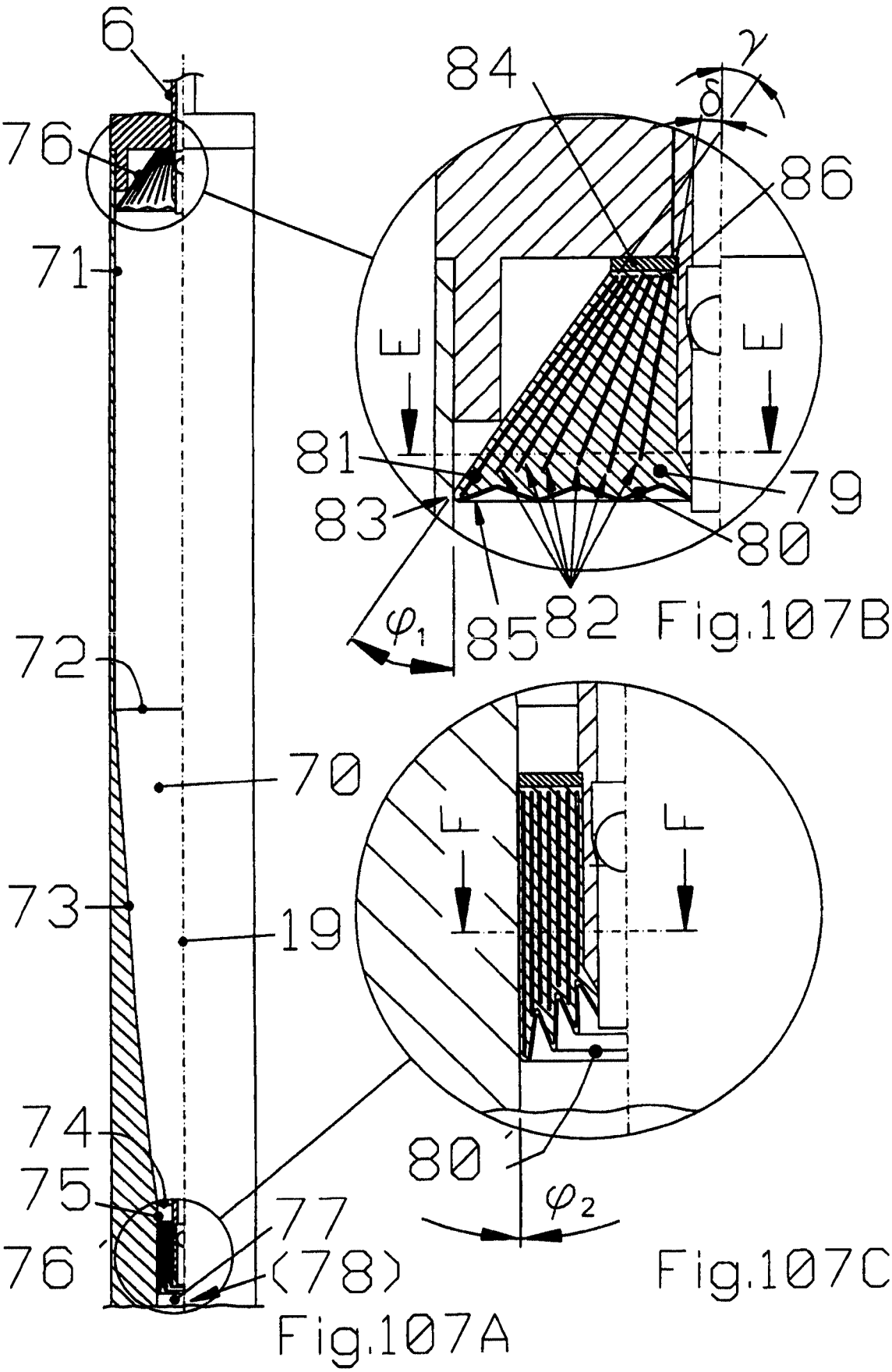


Fig.107B

Fig.107C

Fig.107A

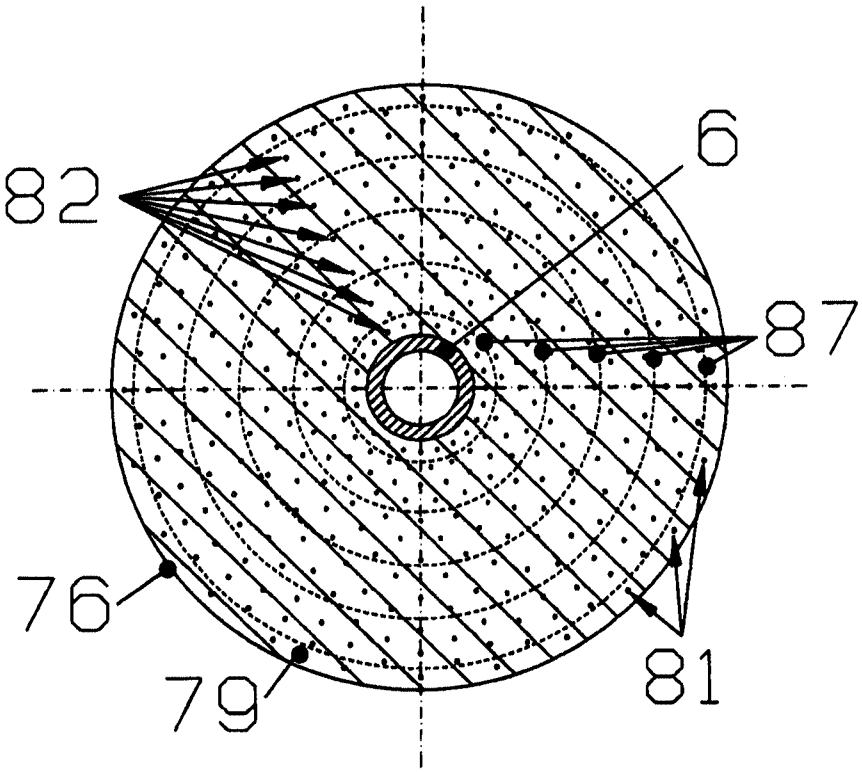


Fig.107D
section E-E

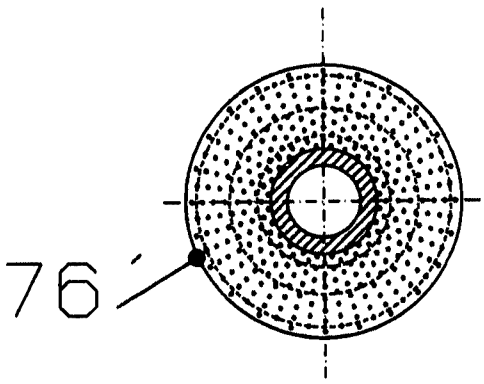
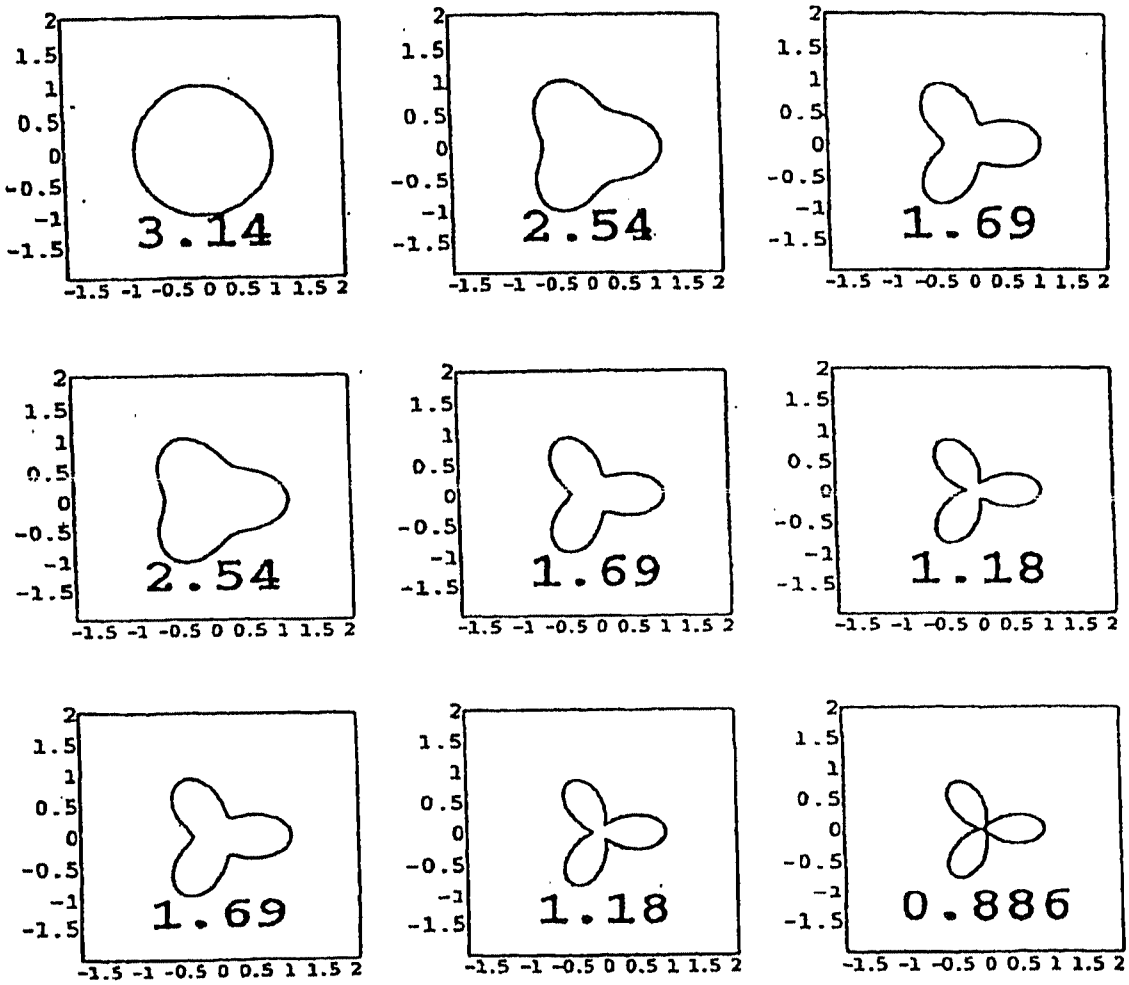


Fig.107E
section F-F



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

$c_1=0$

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

$c_3=p+q$

Fig.107F

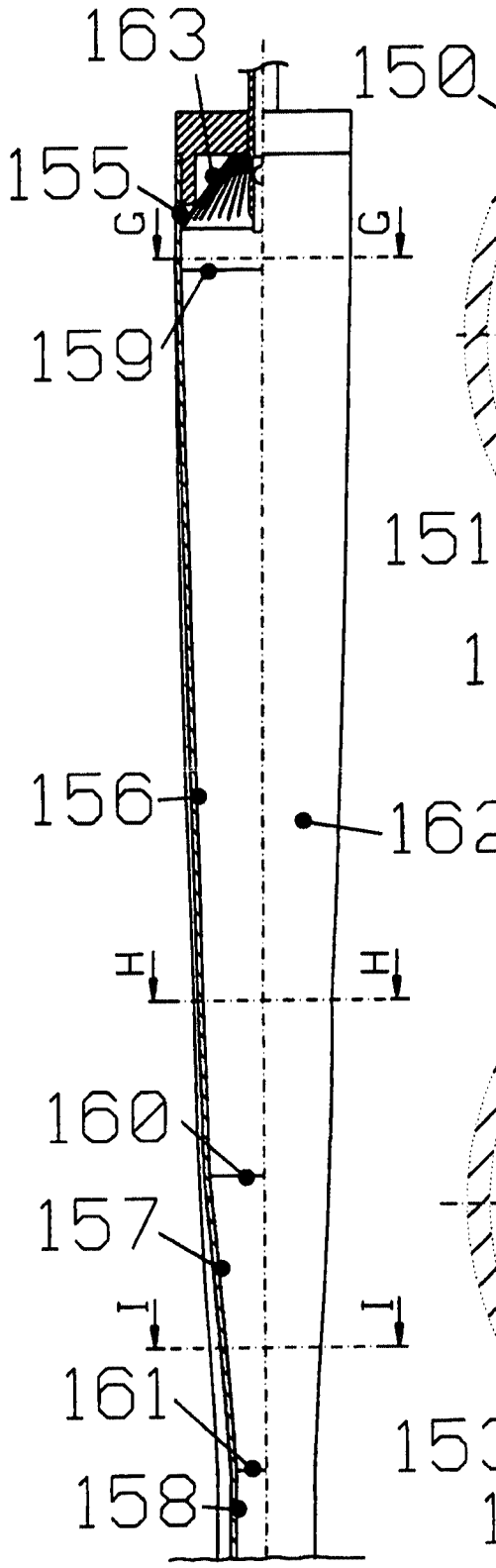


Fig.107G

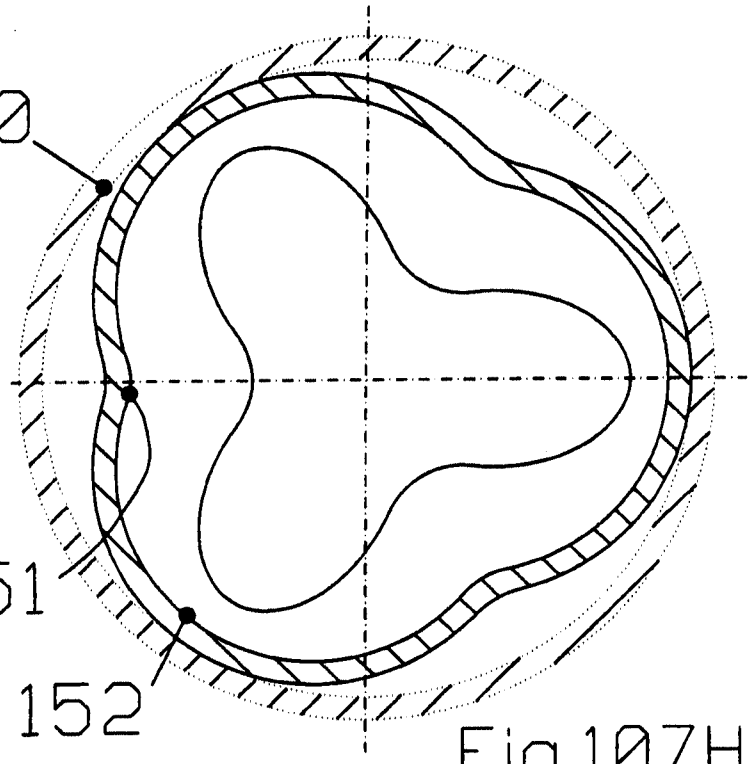


Fig.107H
section H-H (G-G)

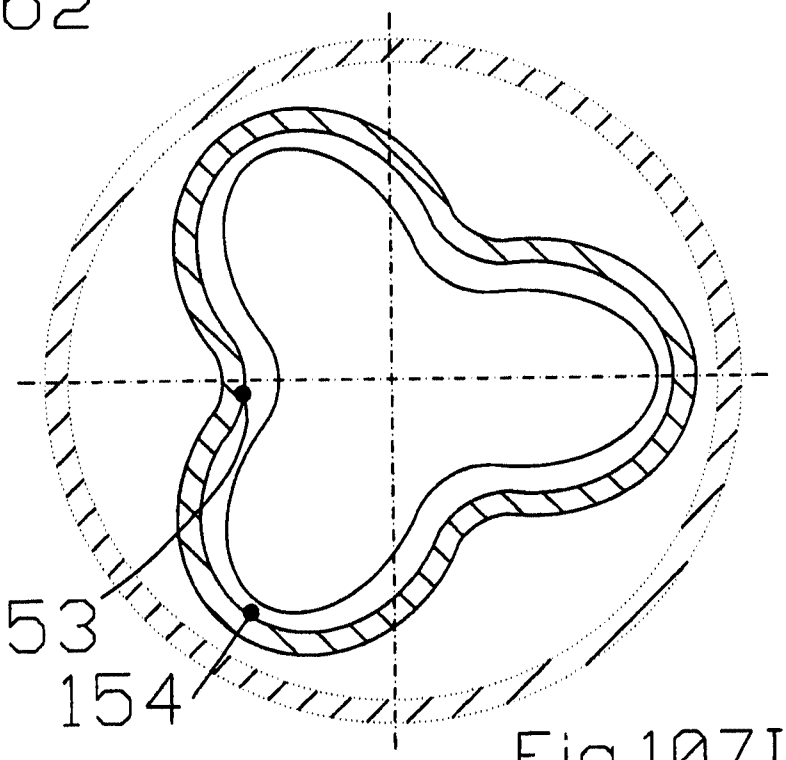


Fig.107I
section I-I (G-G)

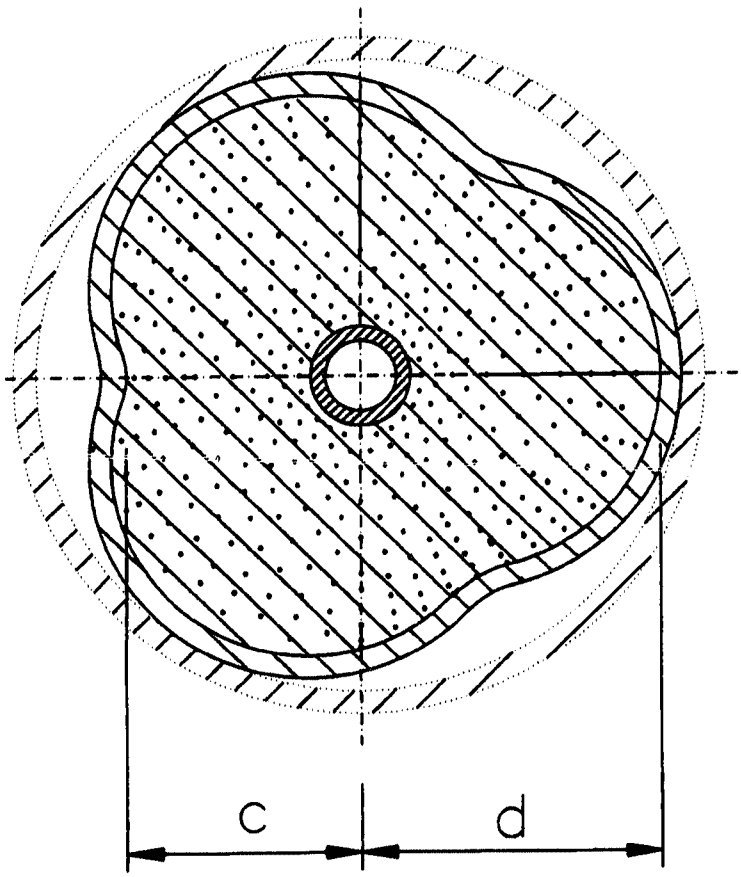
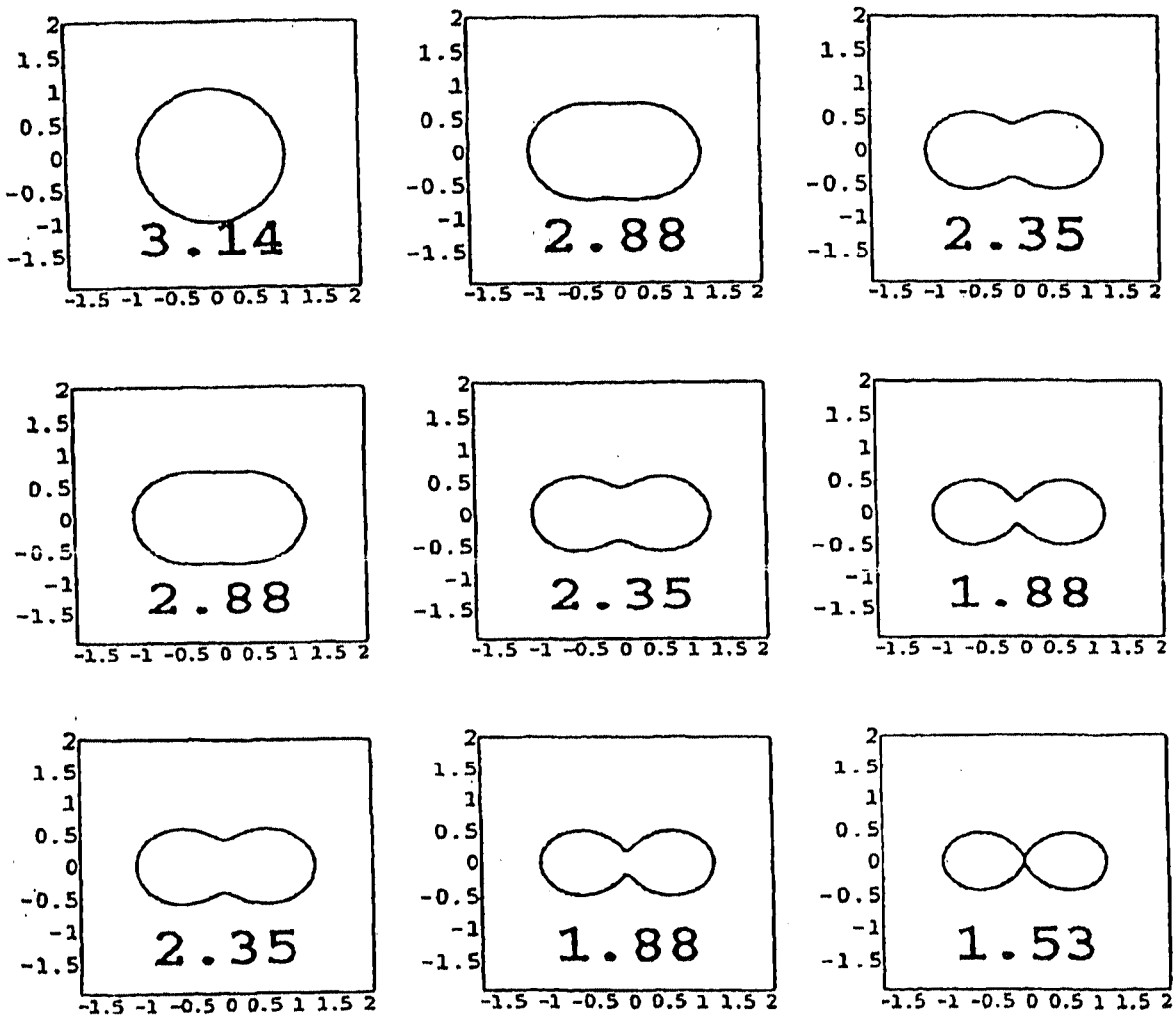


Fig.107J
section H-H (G-G)



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

$c_1=0$

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

Fig.107K

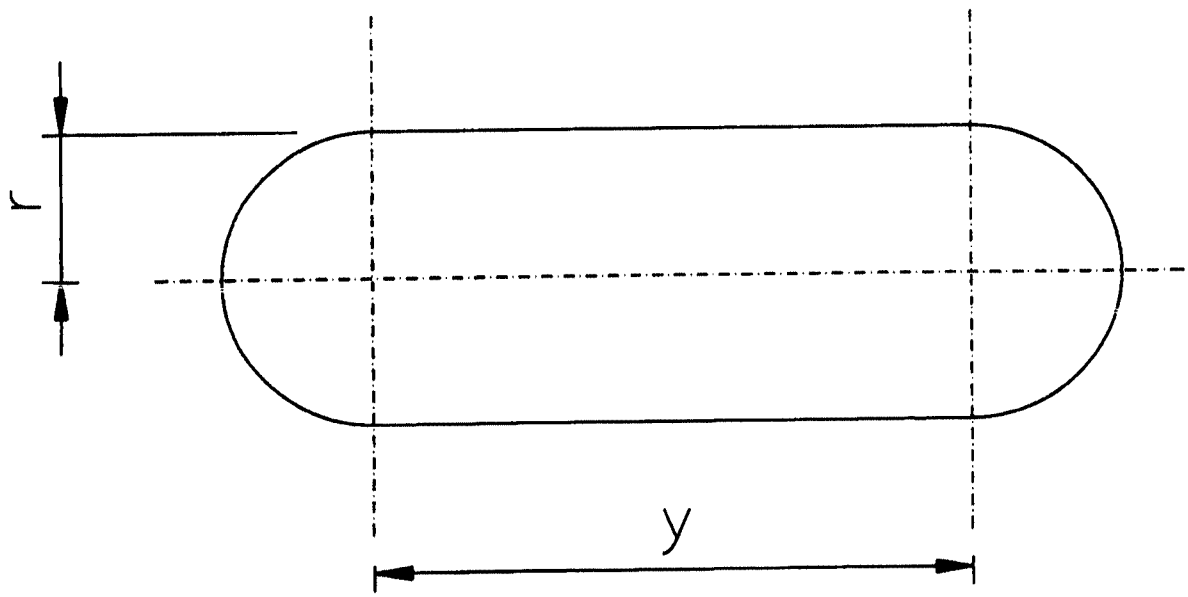


Fig.107L

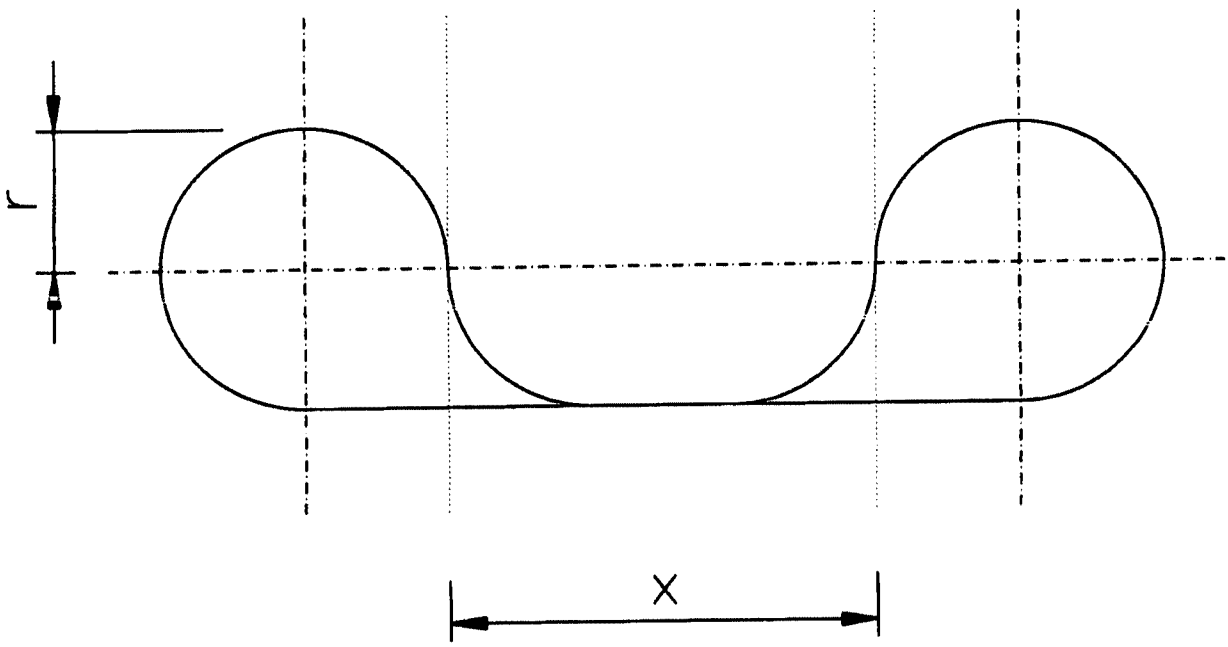


Fig.107M

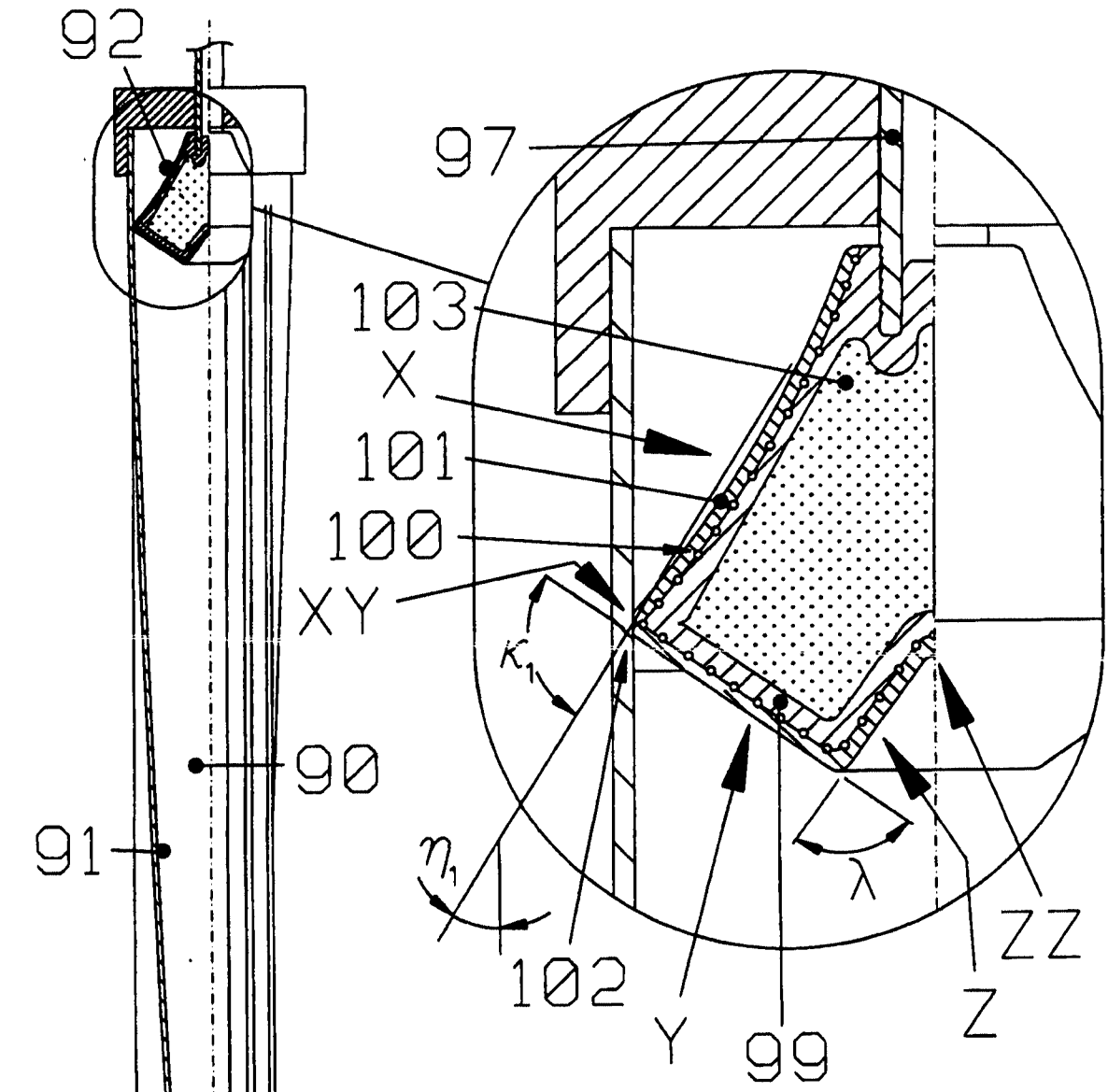


Fig.108B

FIG.108C

(93,94,95,96)

92'

Fig.108A

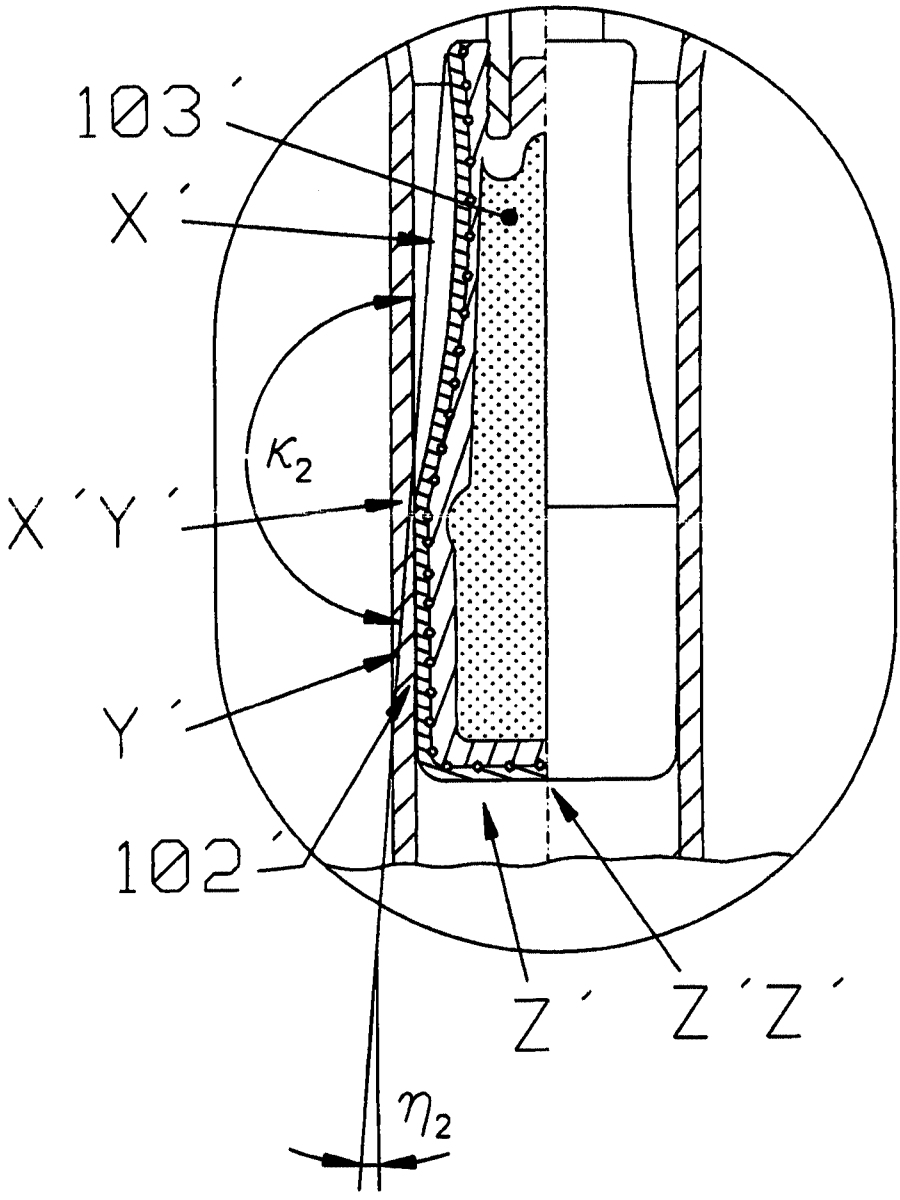


Fig.108C

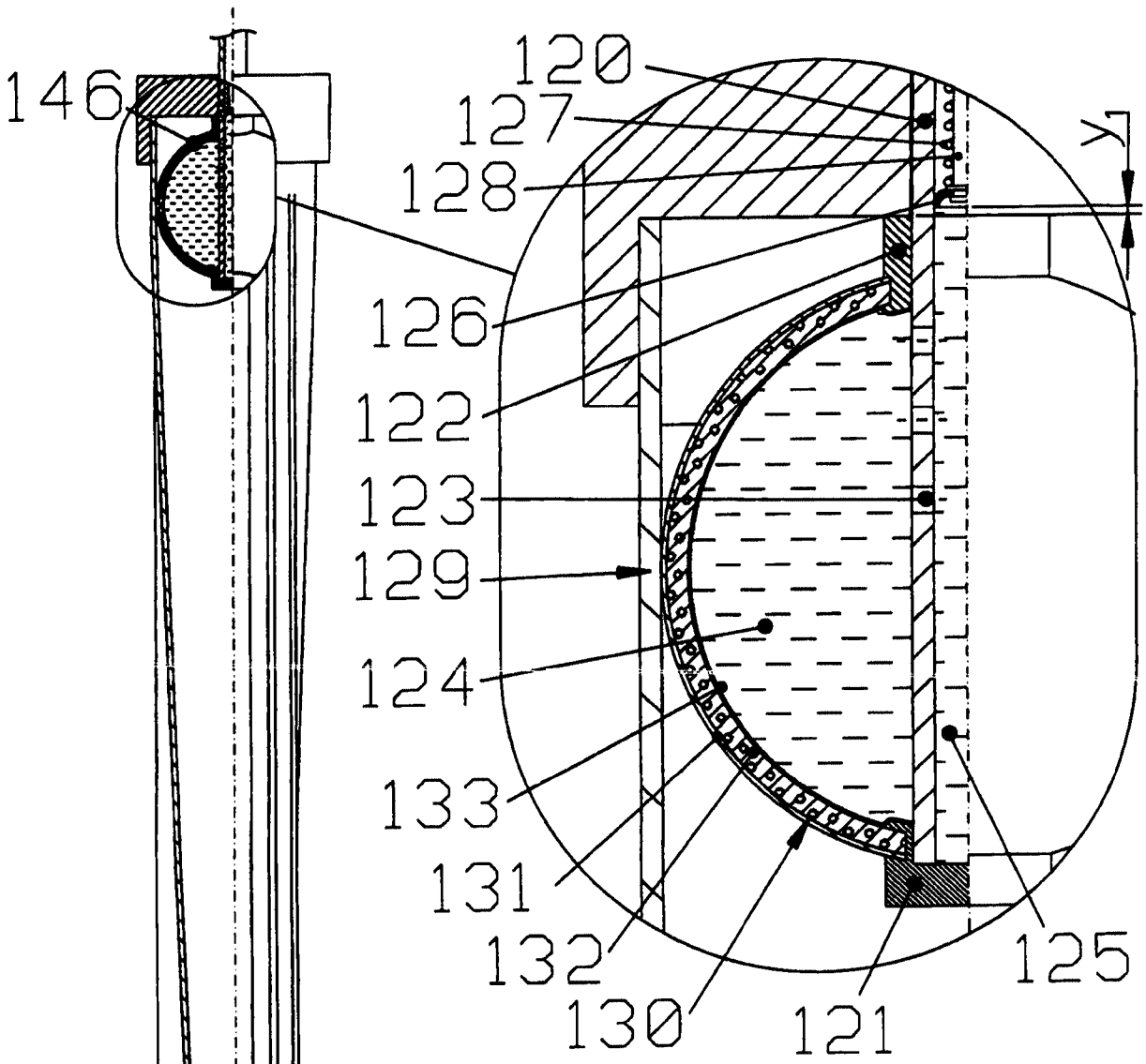


Fig.109B

FIG.109C

Fig.109A

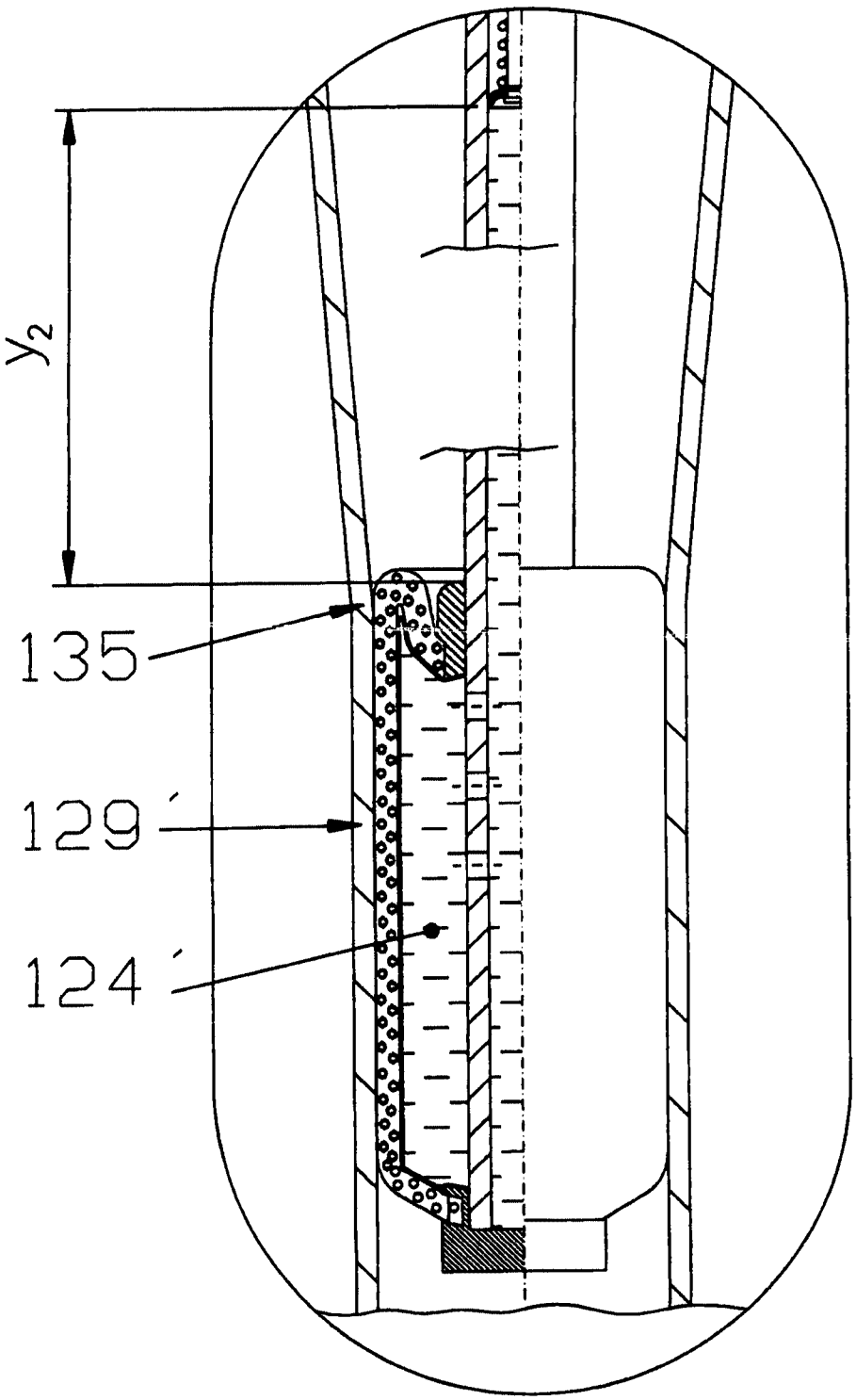


Fig.109C

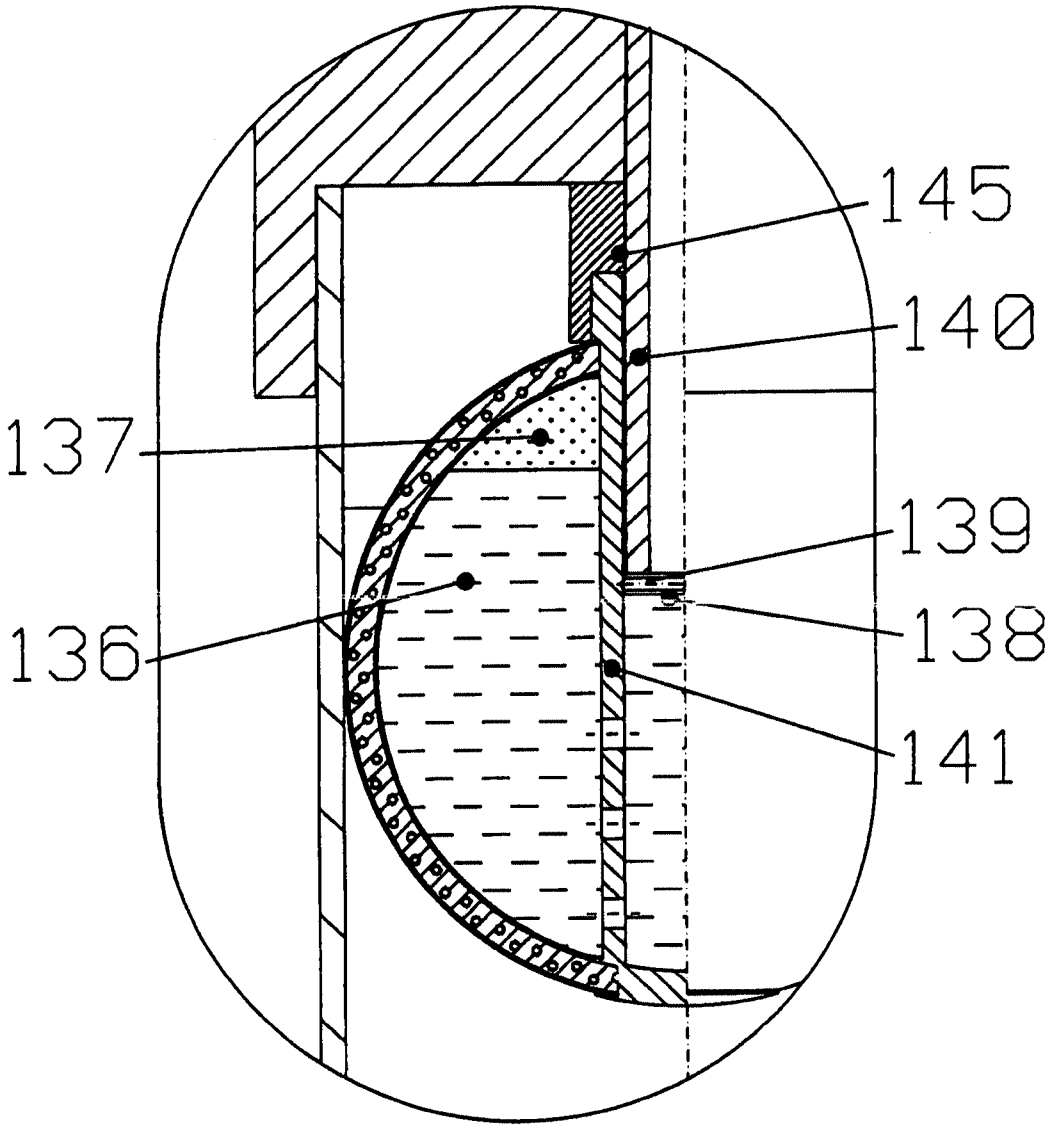


Fig.109D

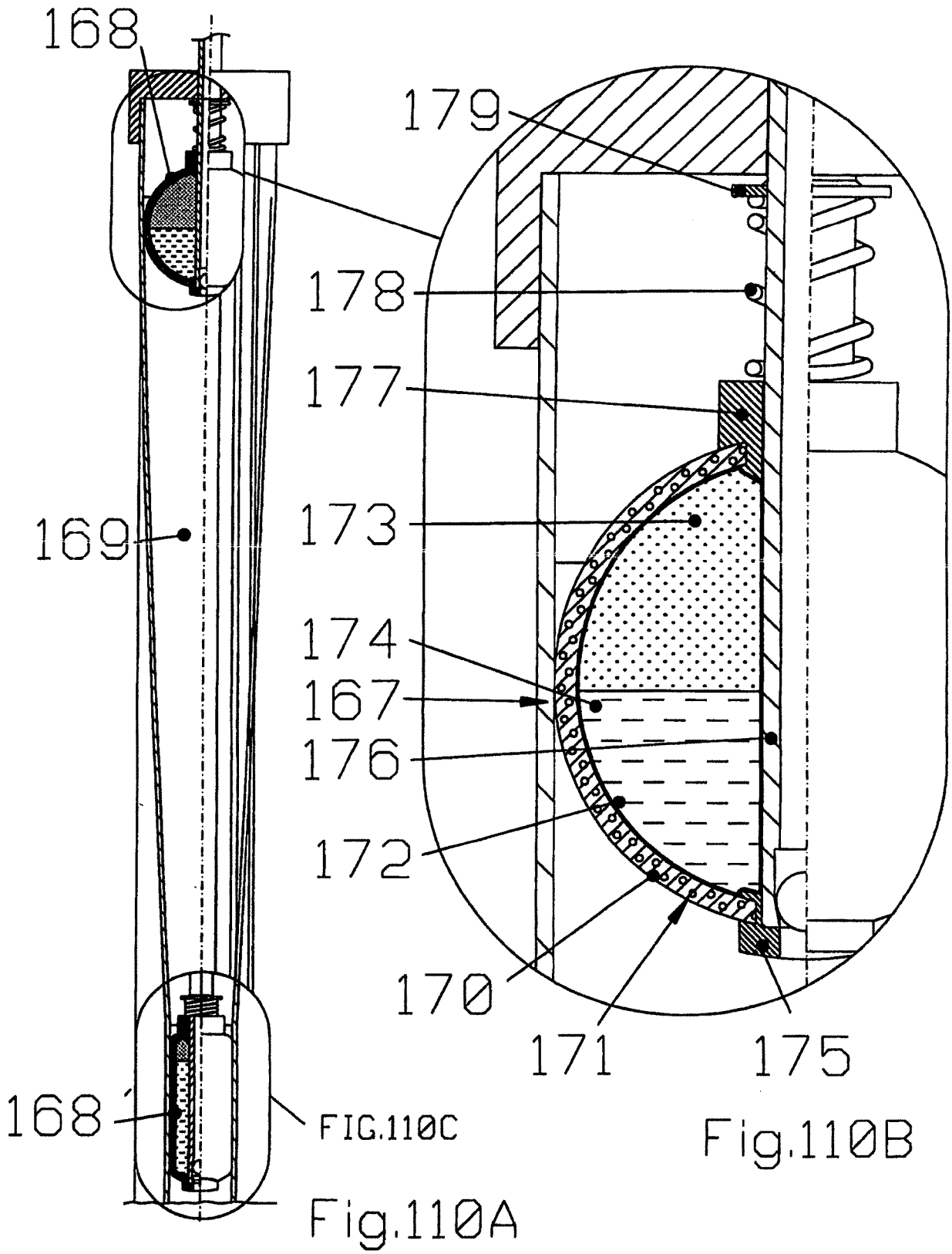


FIG.110C

Fig.110A

Fig.110B

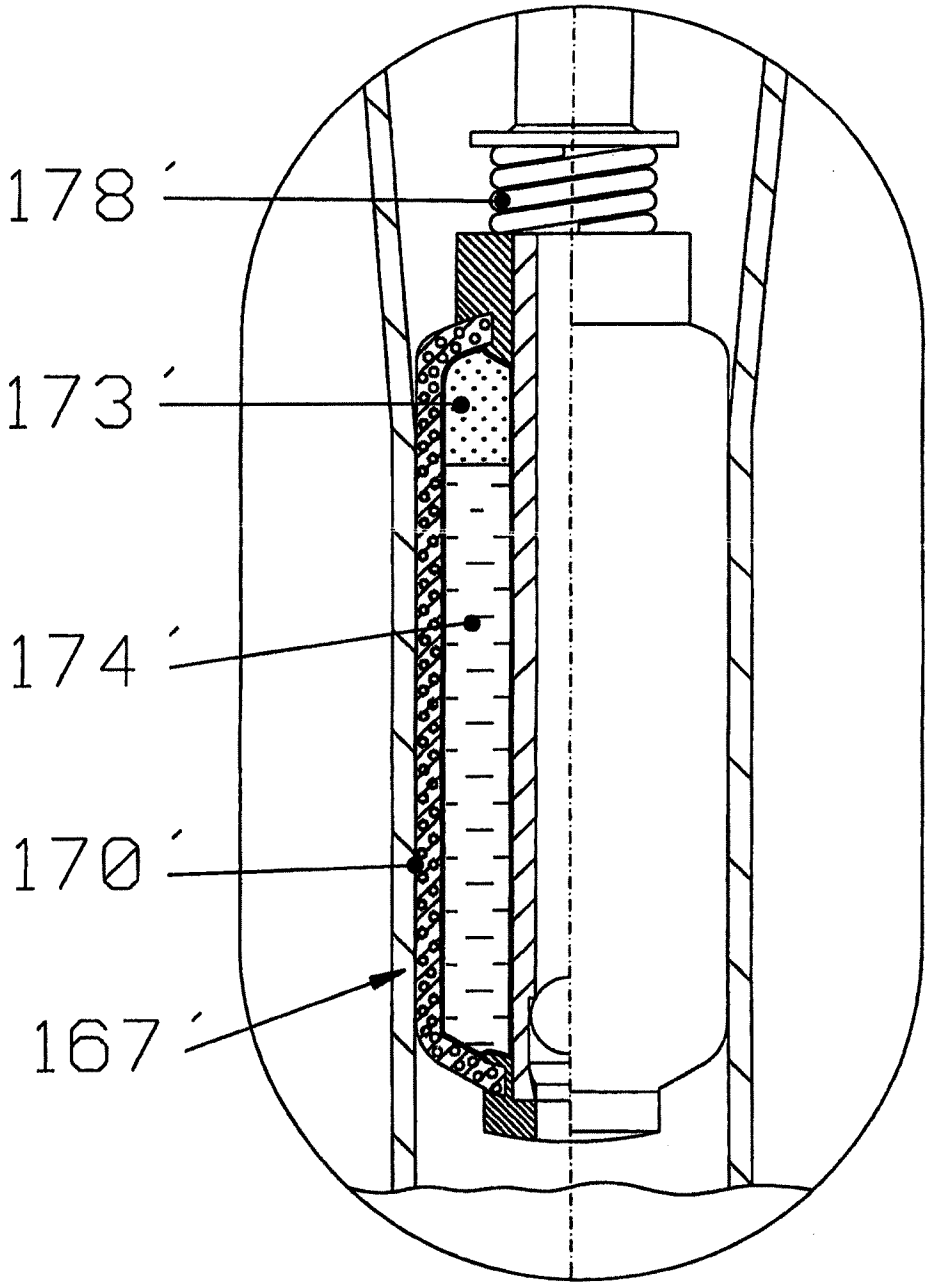


Fig.110C

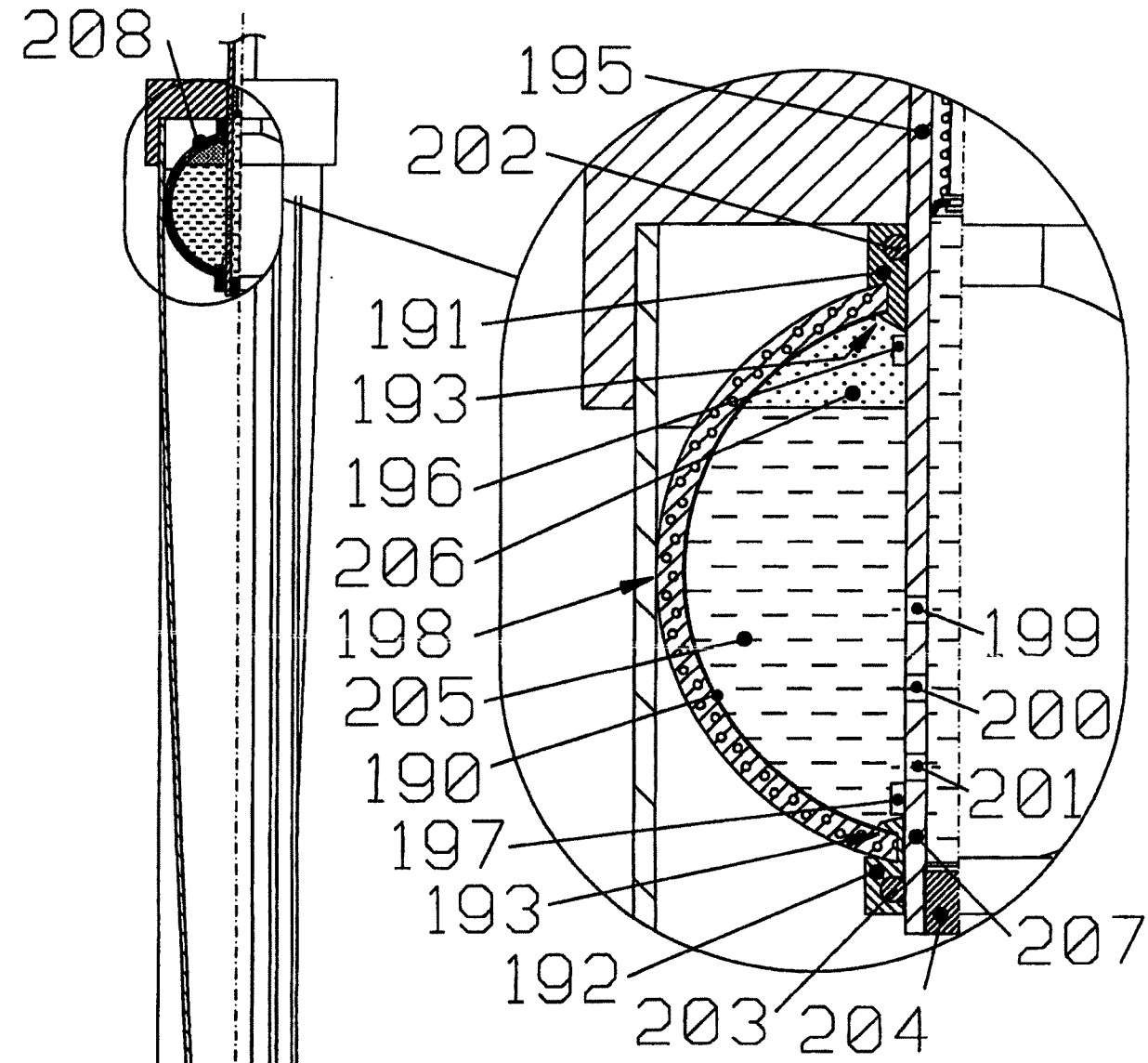


Fig.11B

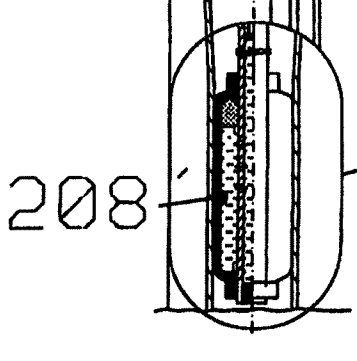


Fig.111A

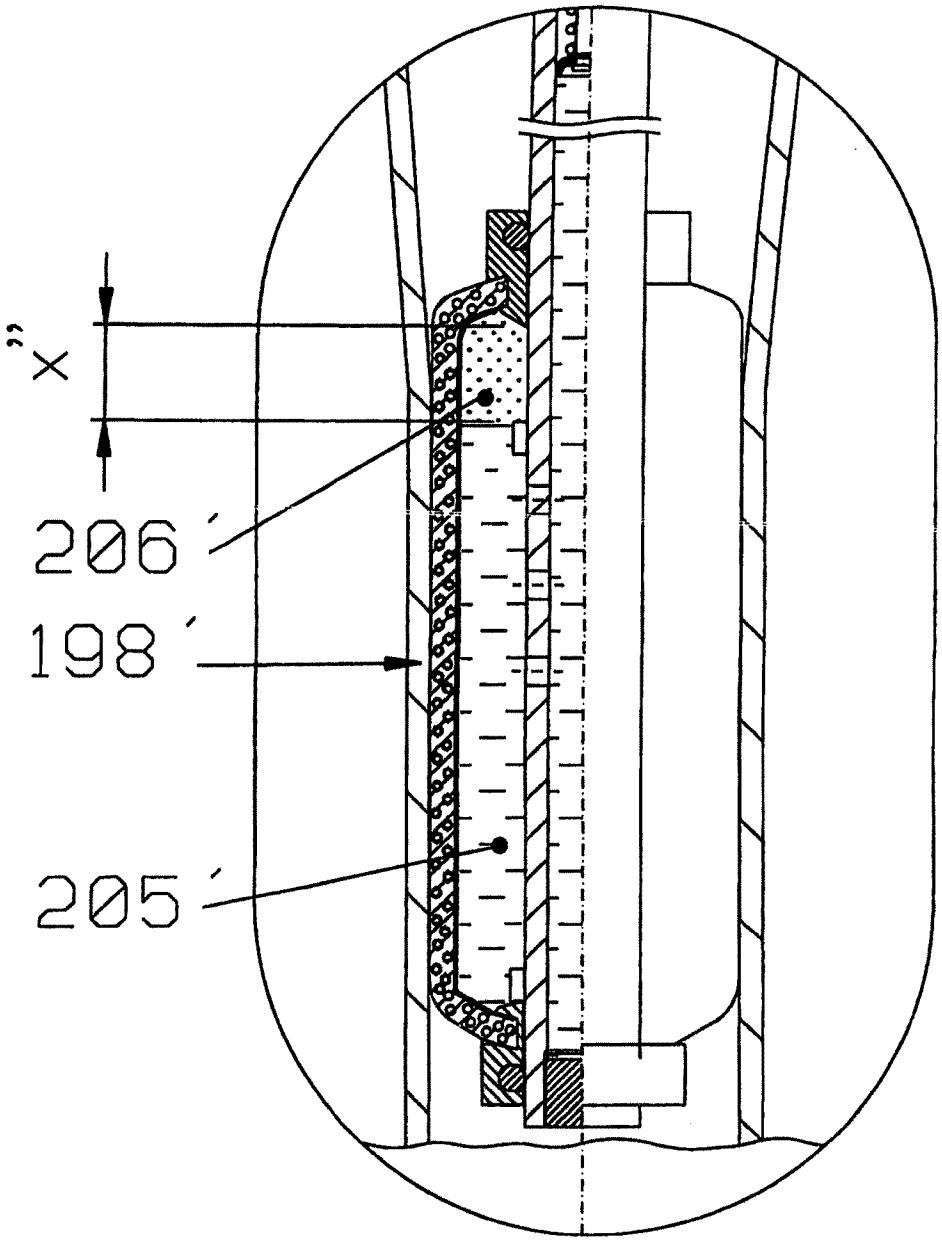


Fig.111C

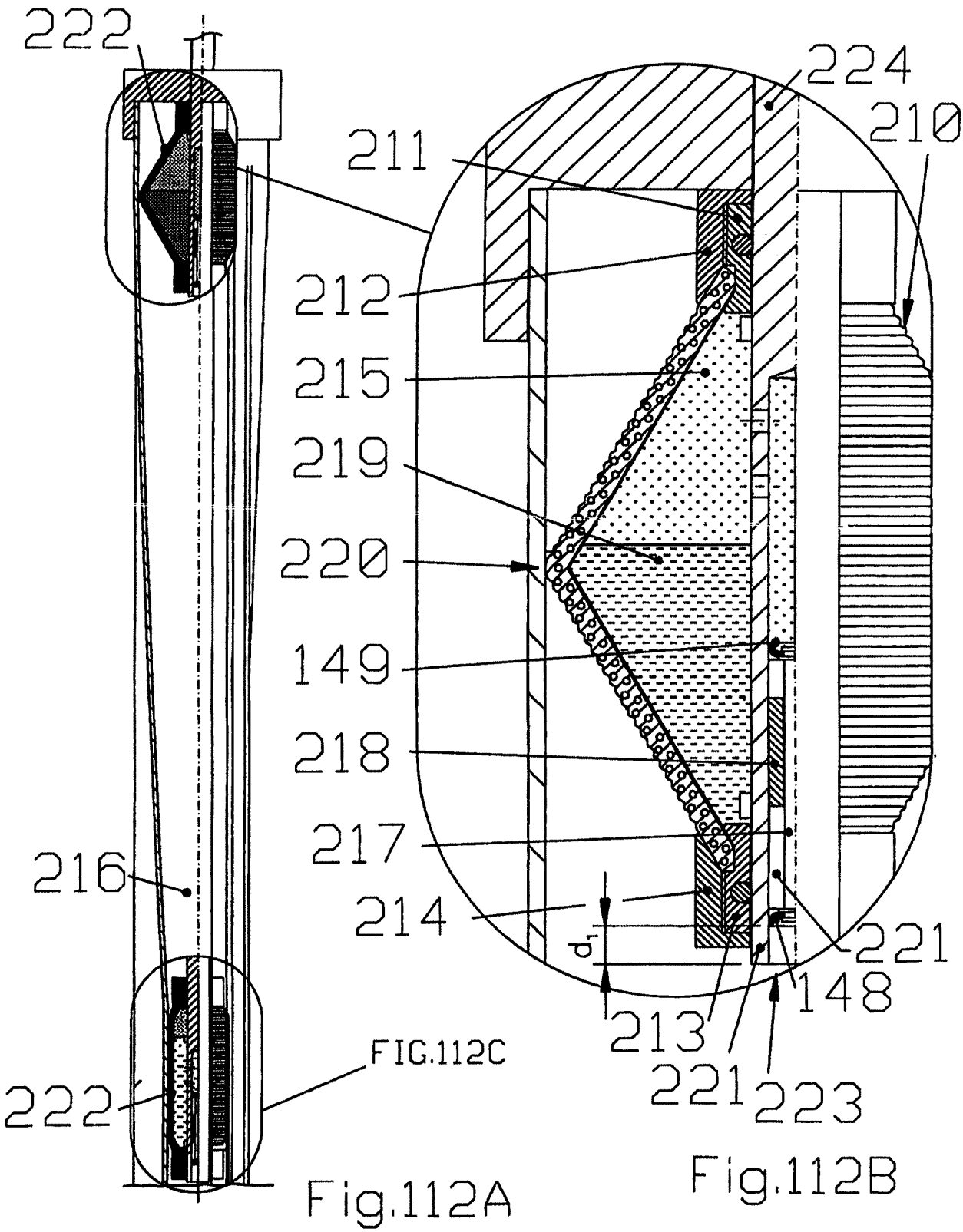


FIG.112C

Fig.112A

Fig.112B

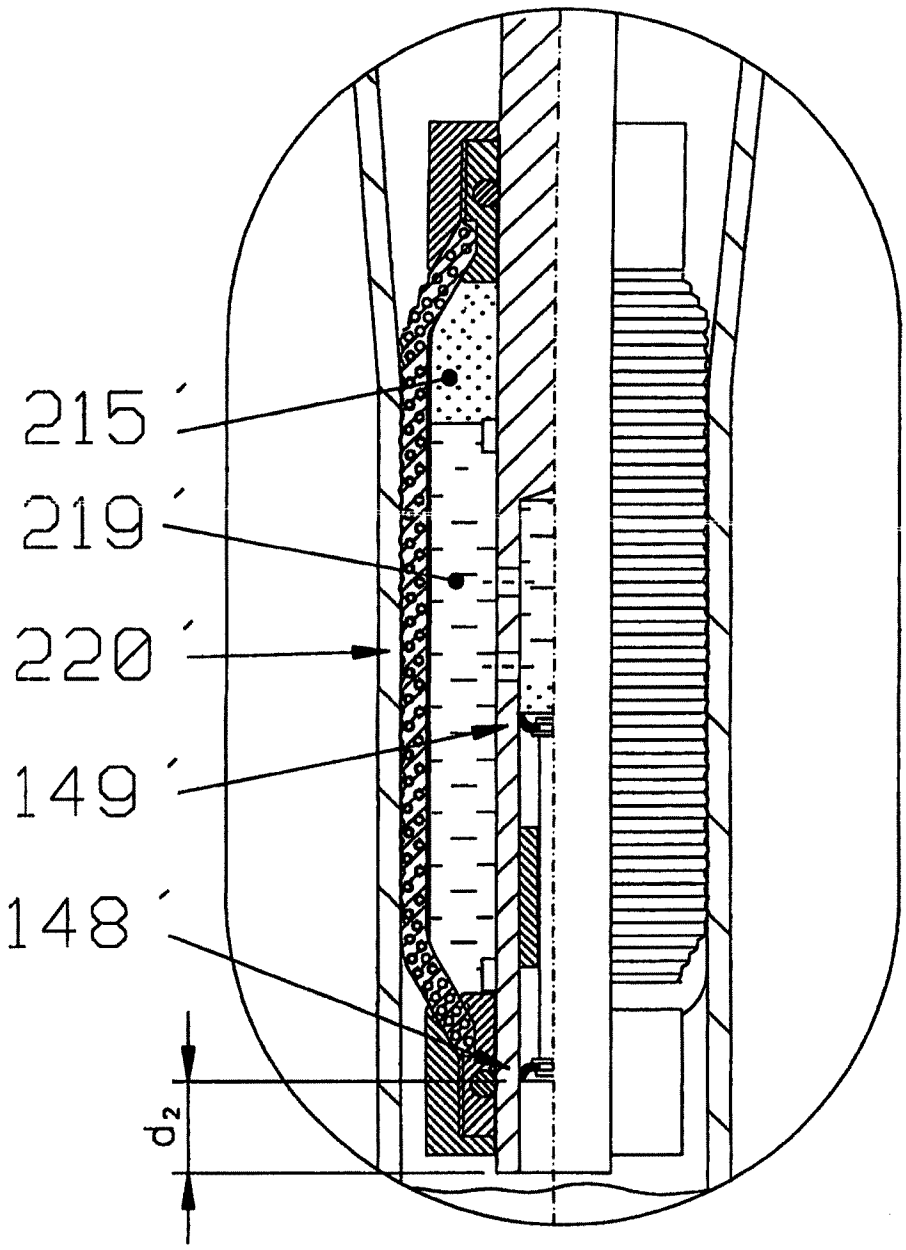


Fig.112C

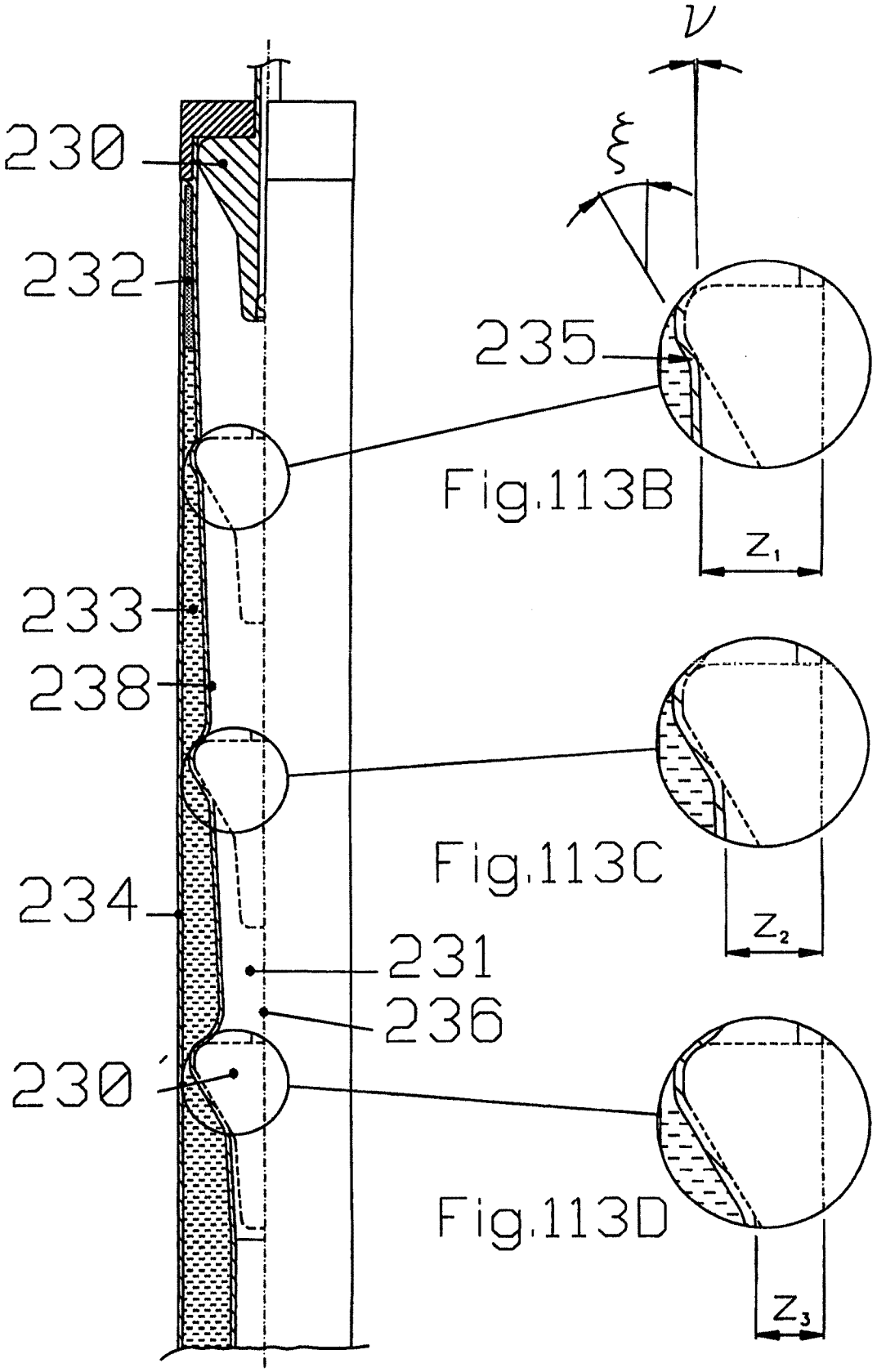


Fig.113B

Fig.113C

Fig.113D

Fig.113A

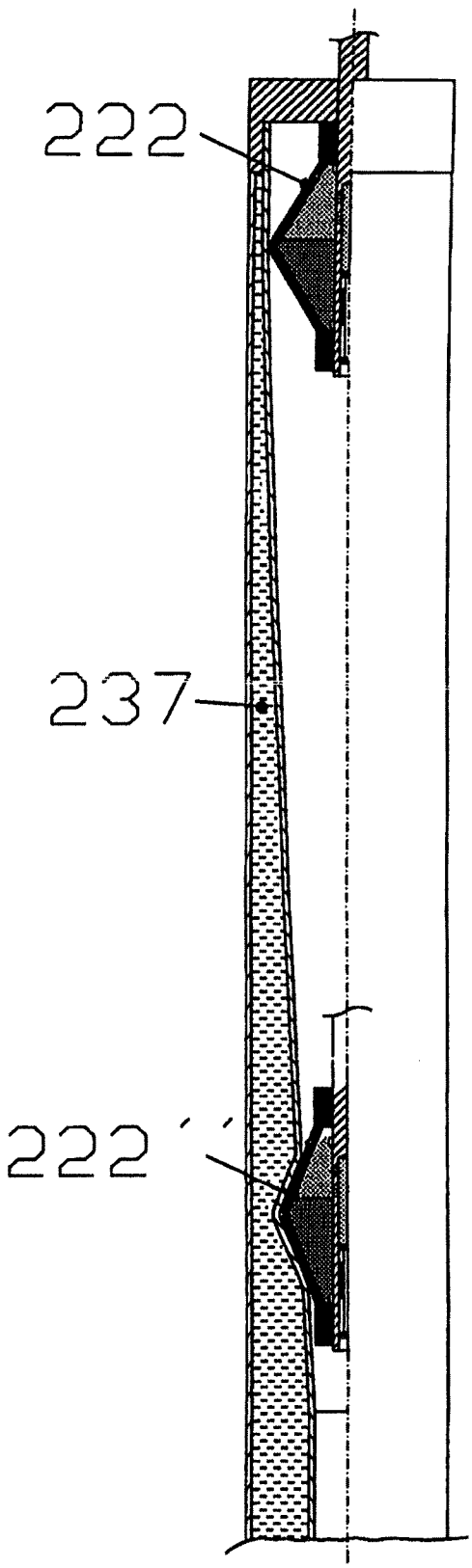


Fig.114

ANY REFERENCE TO FIGURES 115 TO 200
SHOULD BE CONSIDERED
AS NON-EXISTENT

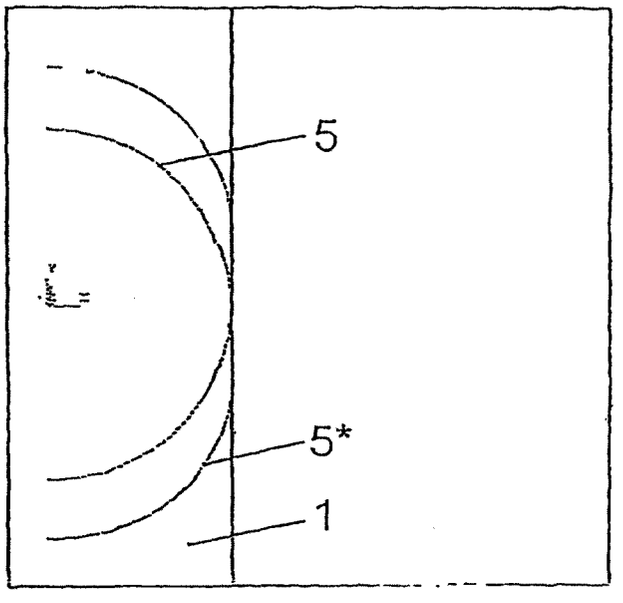


Fig.201A

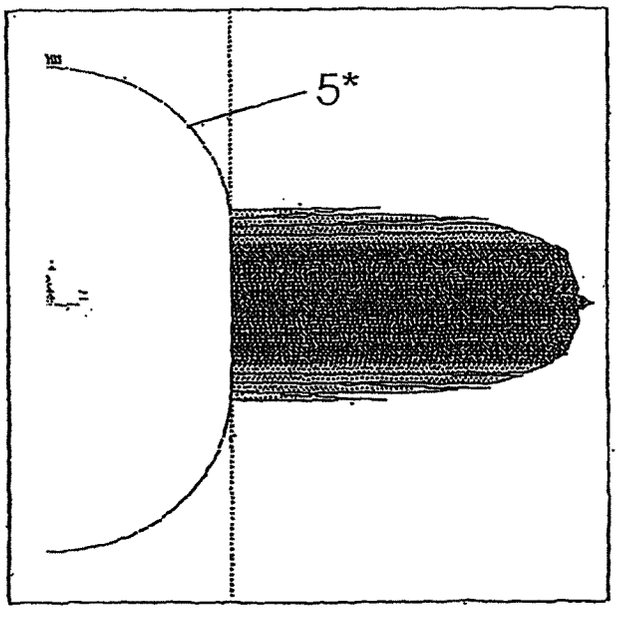


Fig.201B

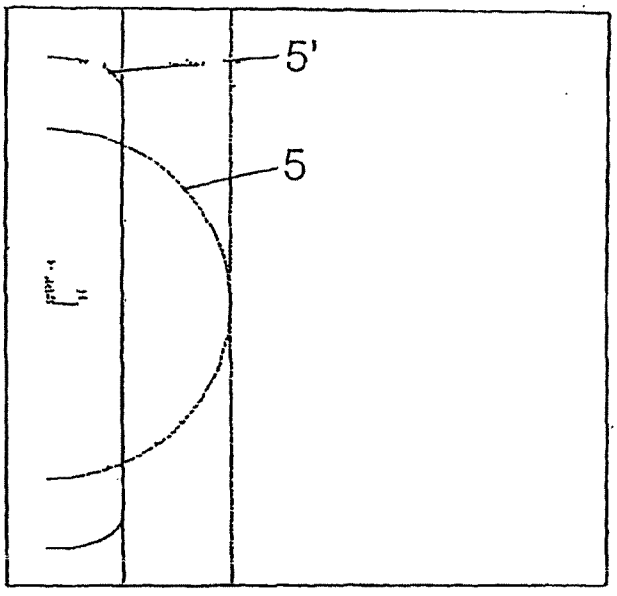


Fig.202A

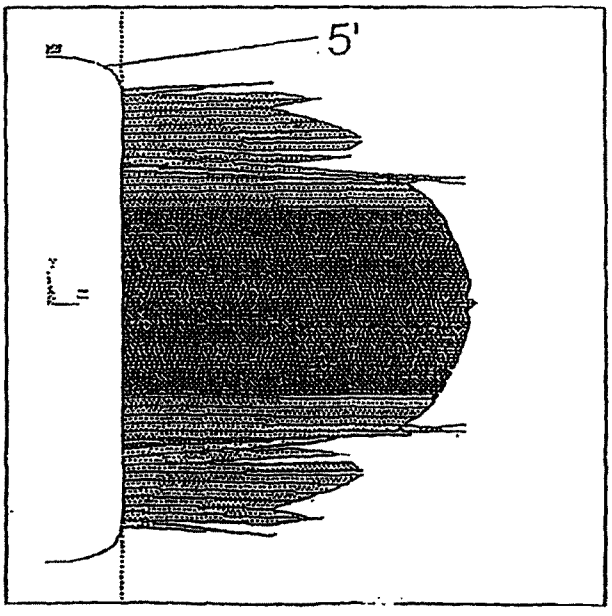


Fig.202B

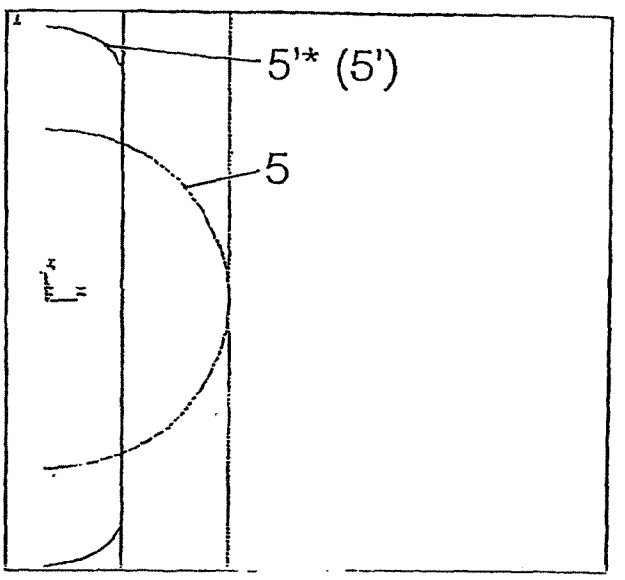


Fig.202C

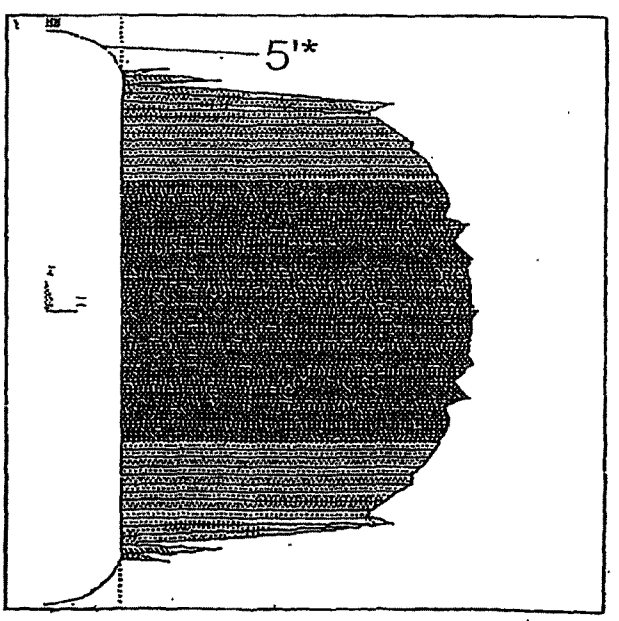


Fig.202D

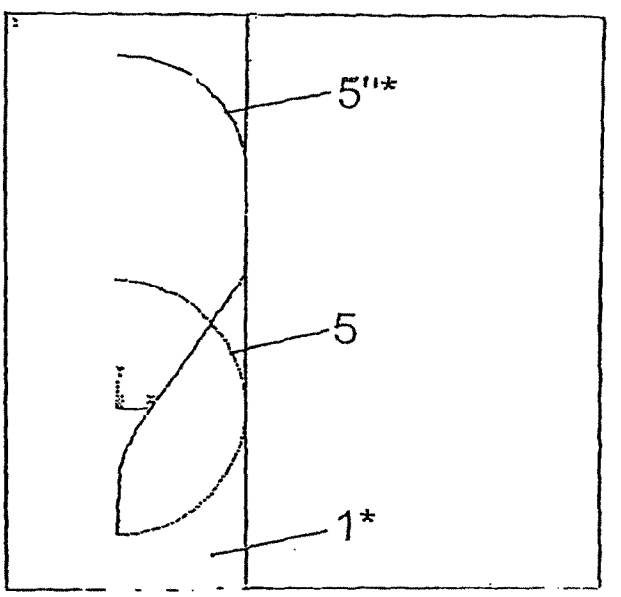


Fig.203A

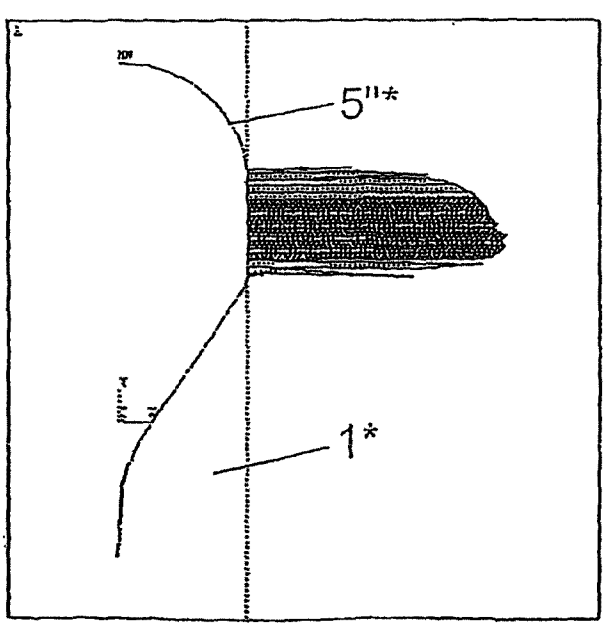


Fig.203B

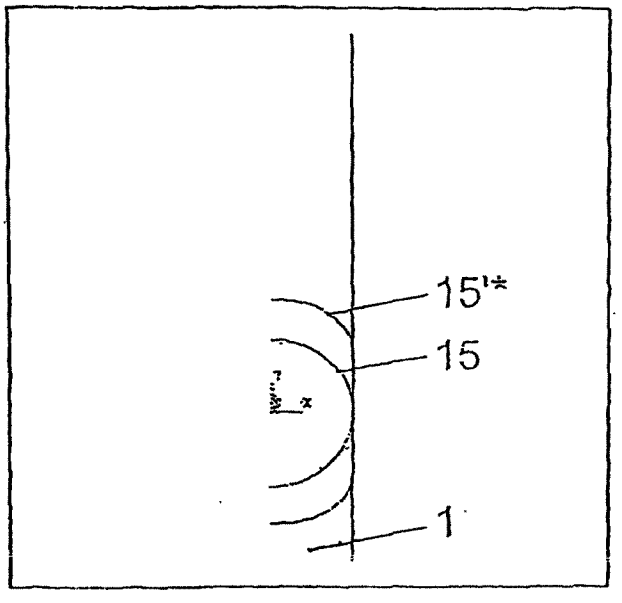


Fig.204A

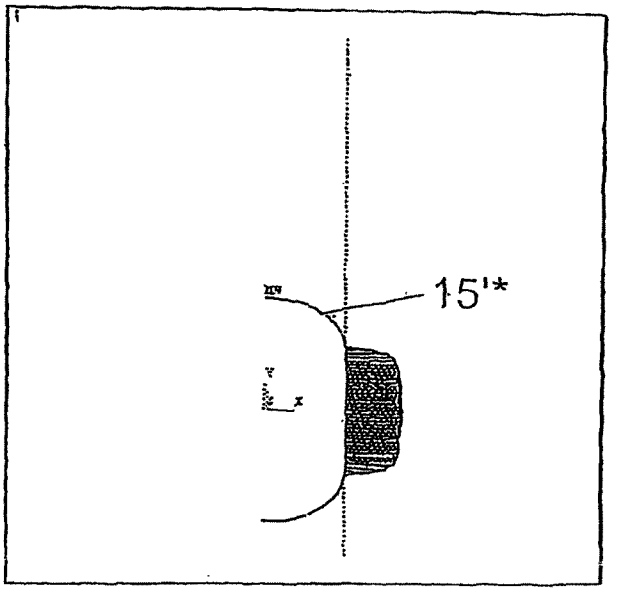


Fig.204B

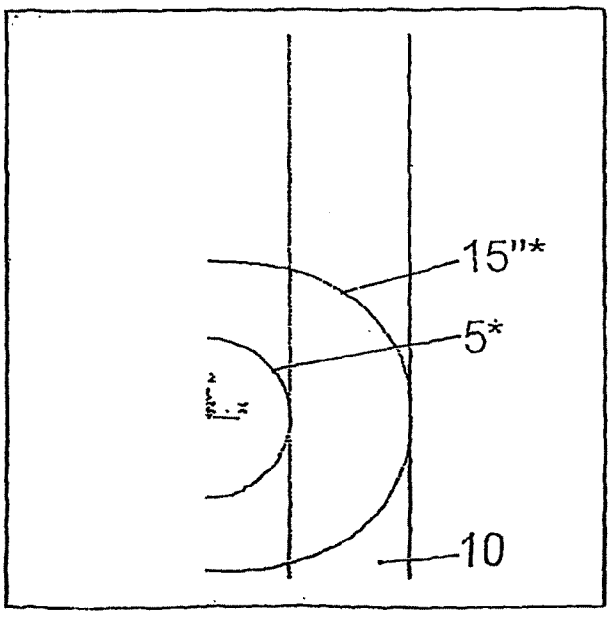


Fig.204C

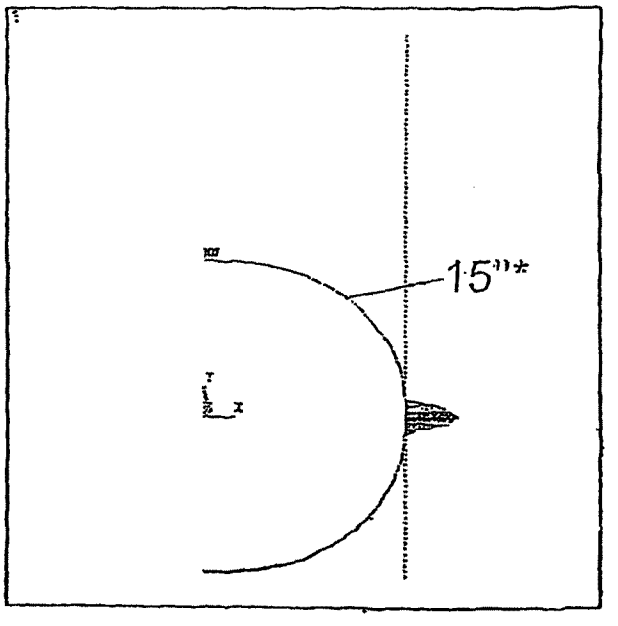


Fig.204D

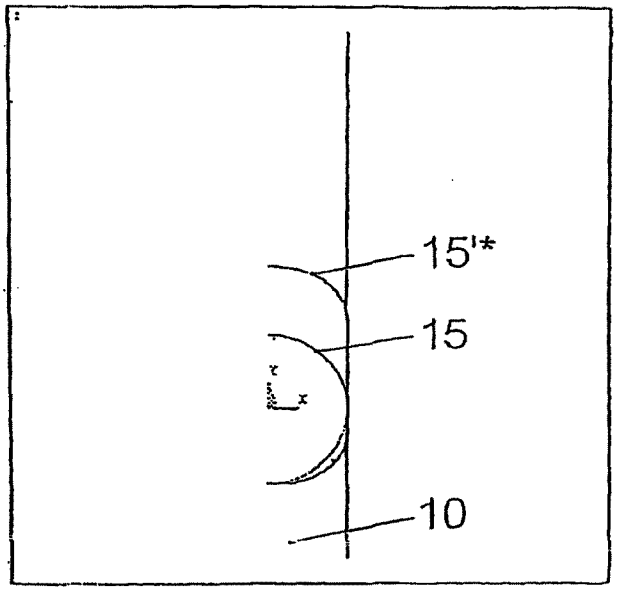


Fig.205A

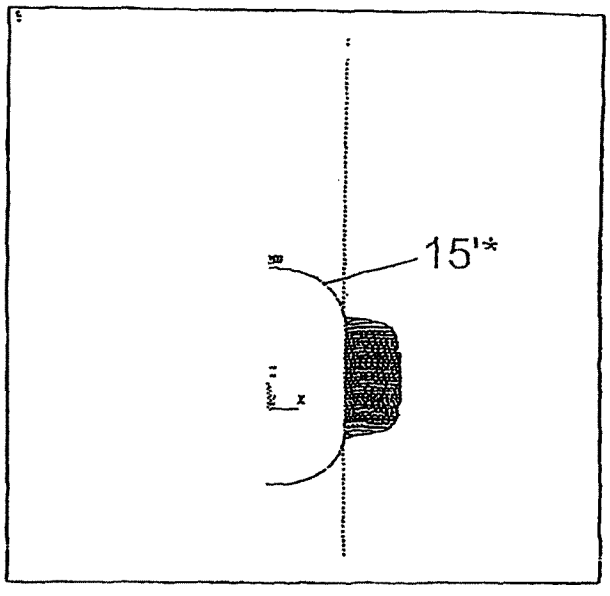


Fig.205B

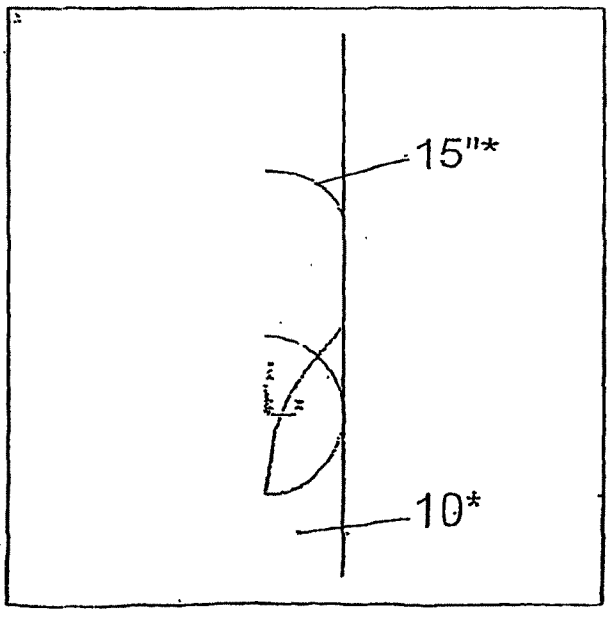


Fig.205C

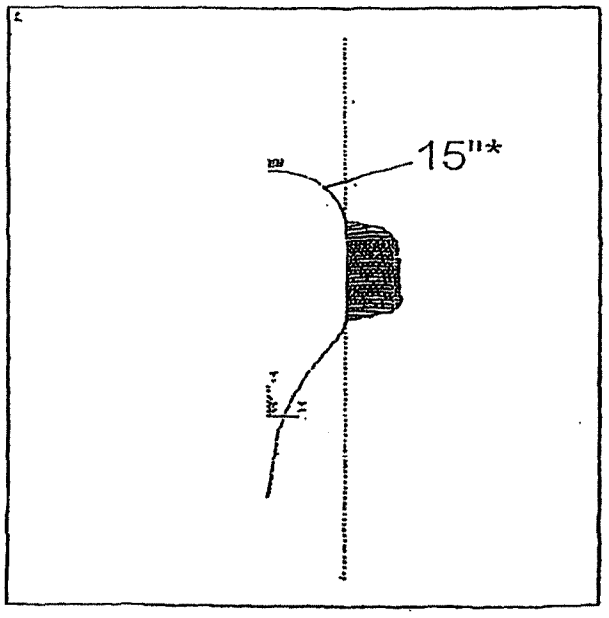


Fig.205D

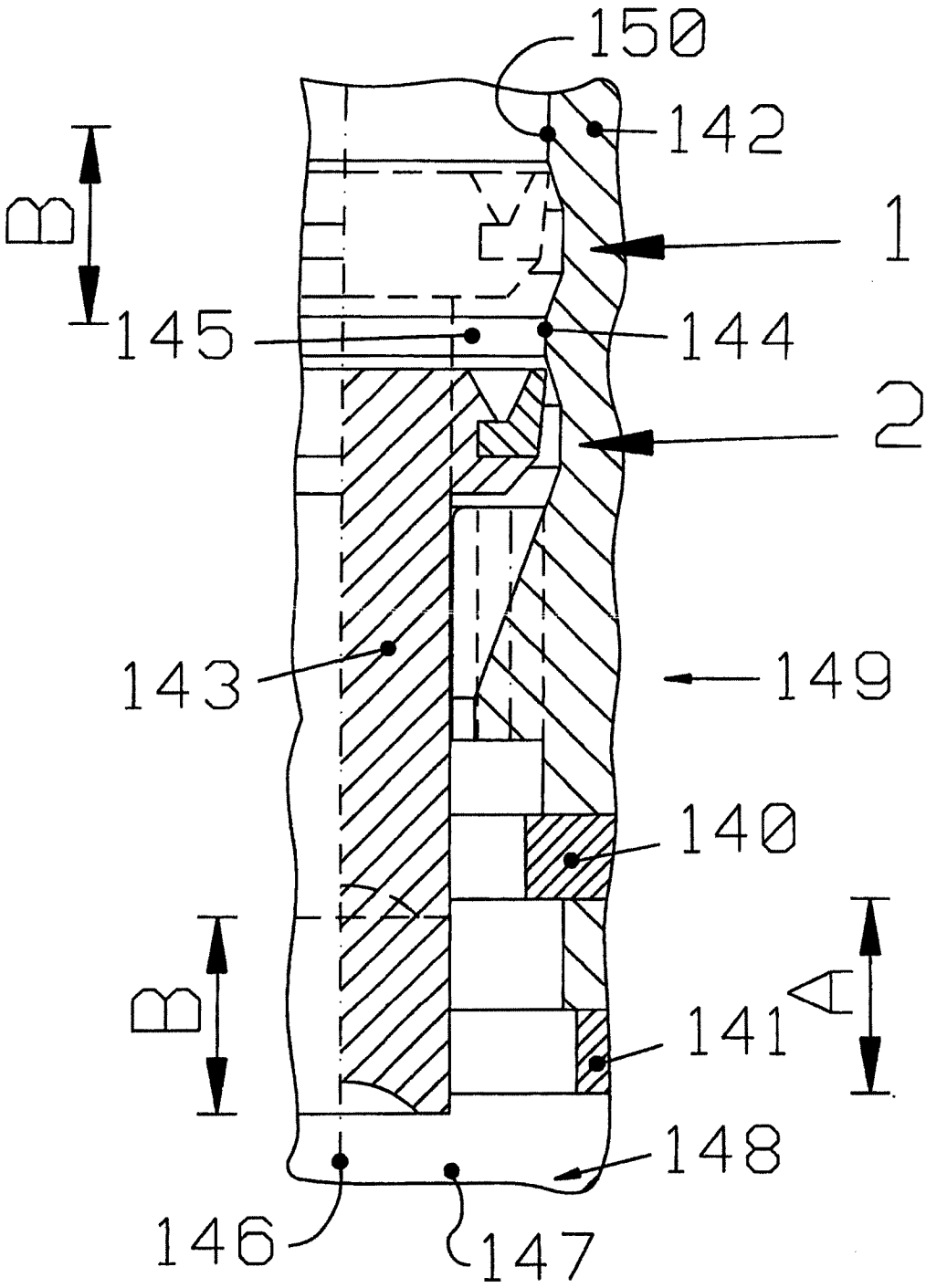


Fig.305

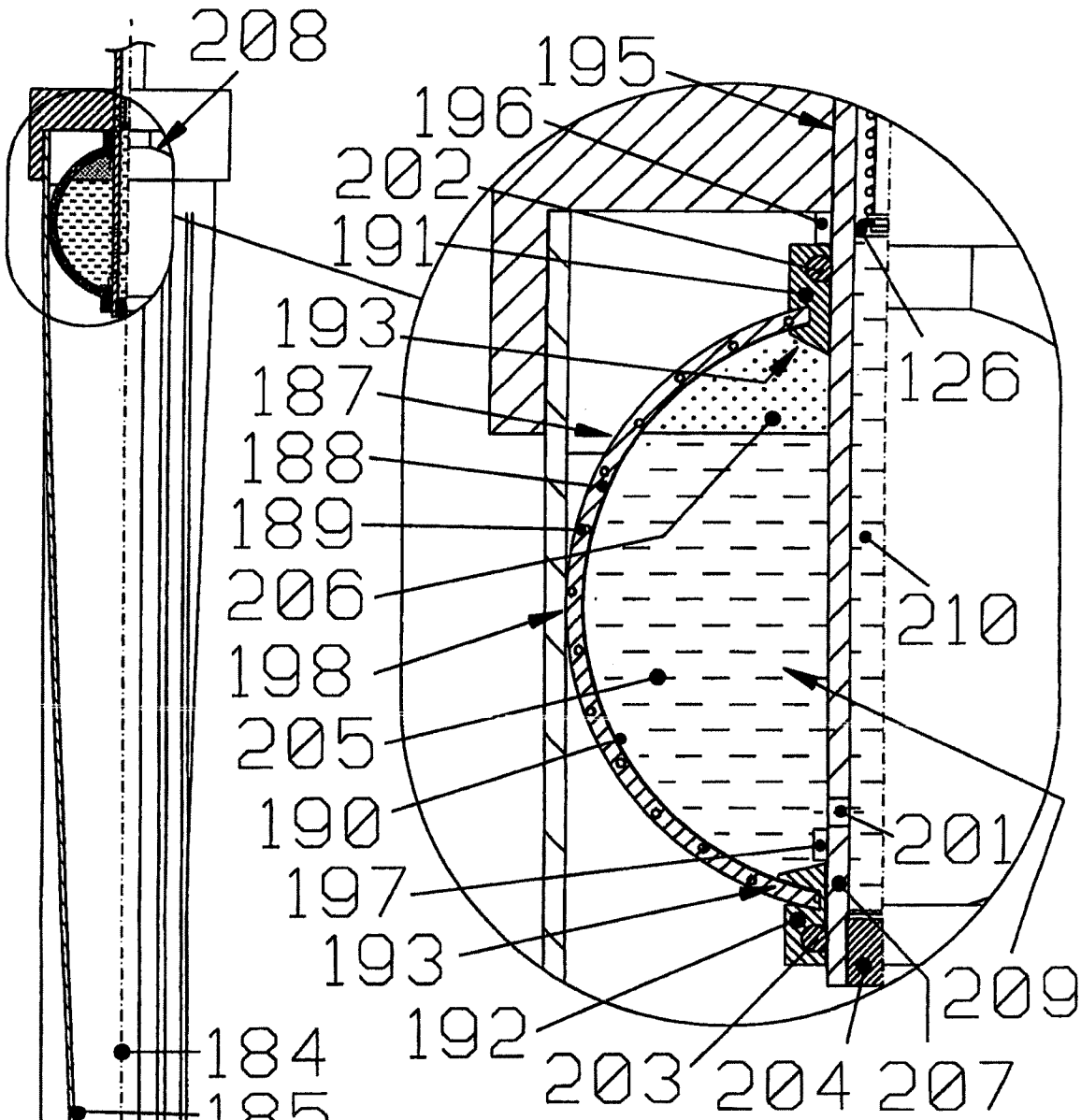


Fig.206B

FIG.206C

Fig.206A

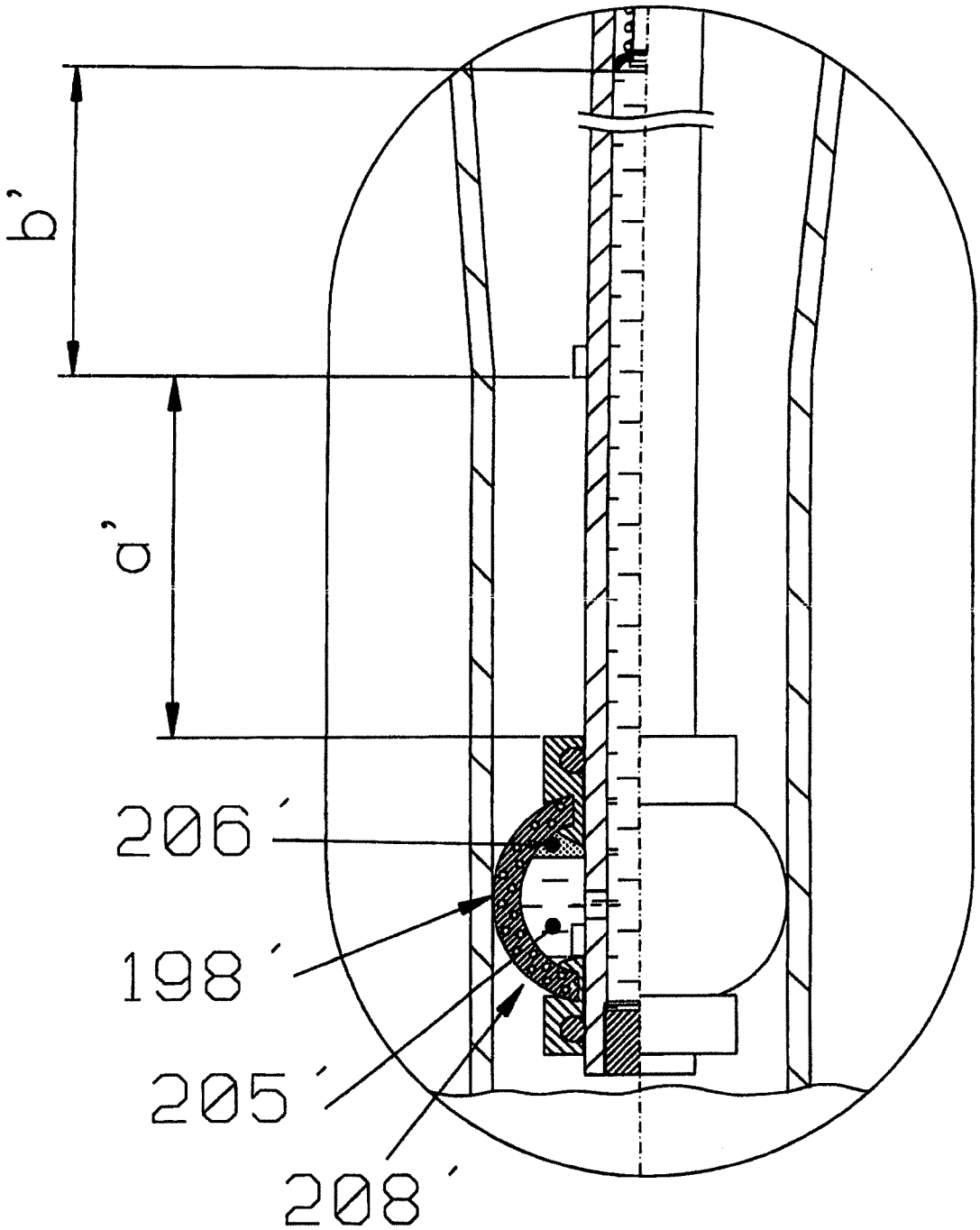


Fig.206C

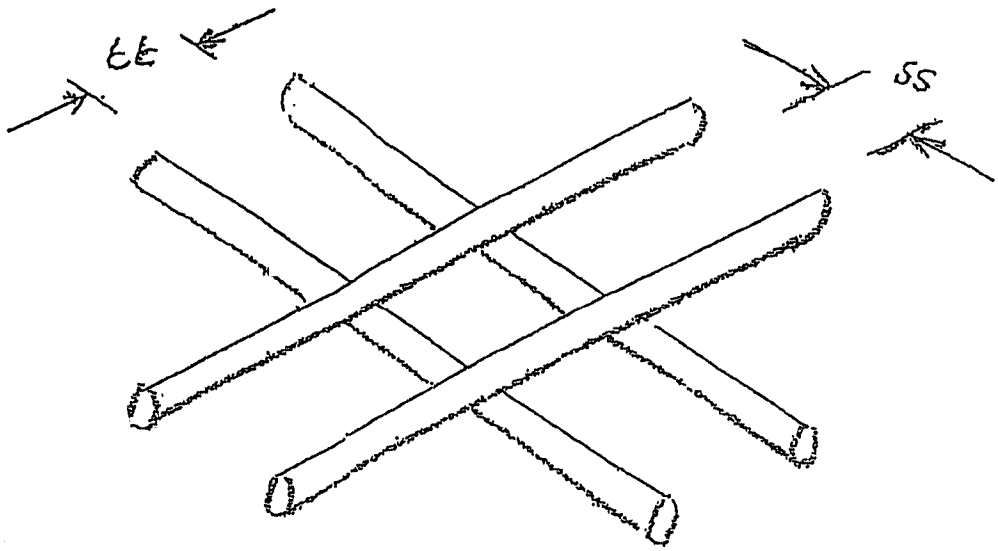


Fig.206D

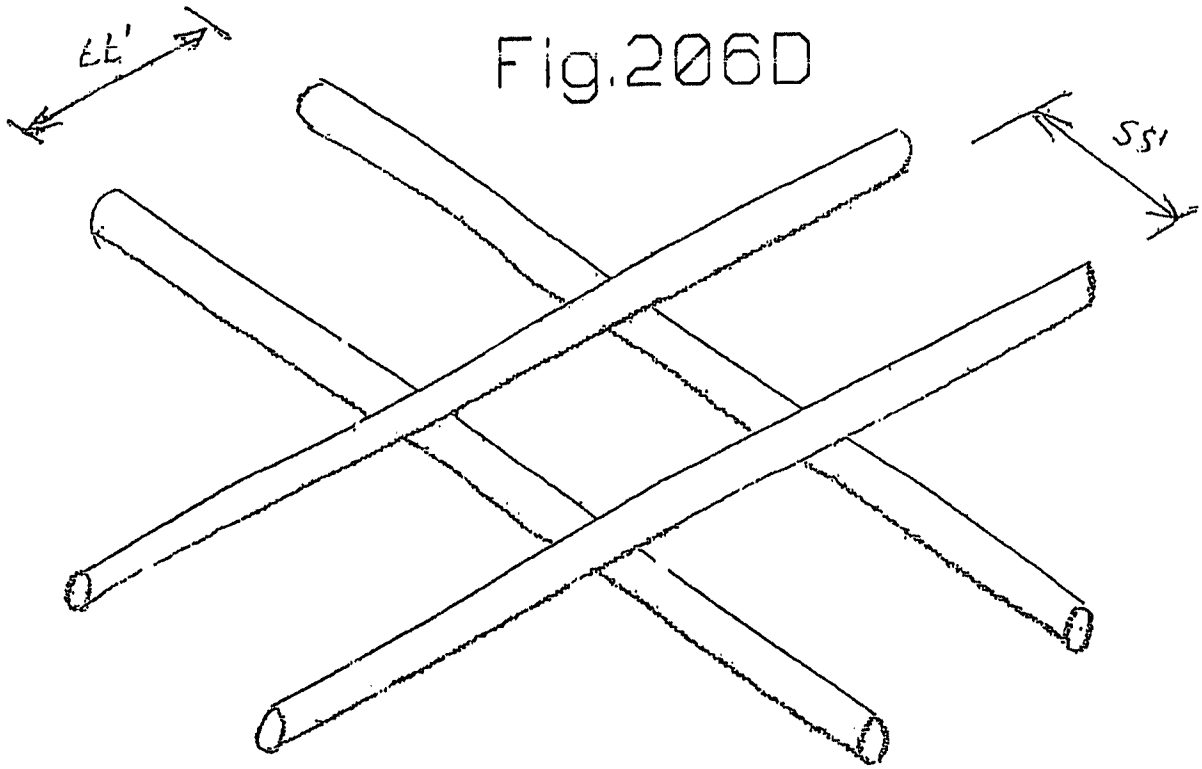


Fig.206E

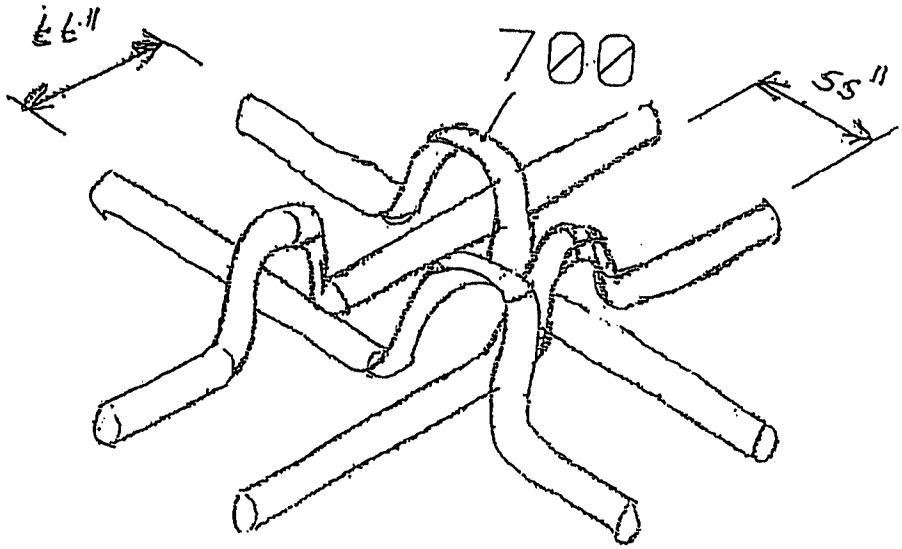


Fig.206F

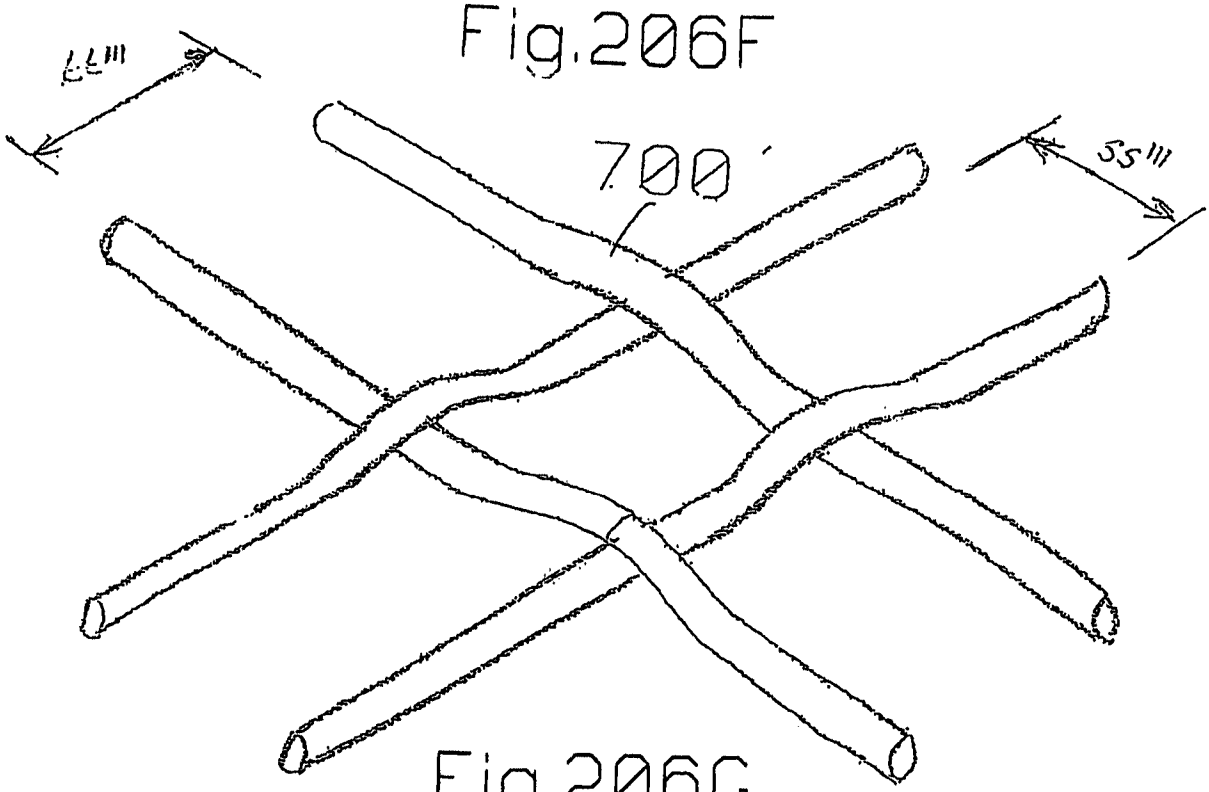


Fig.206G

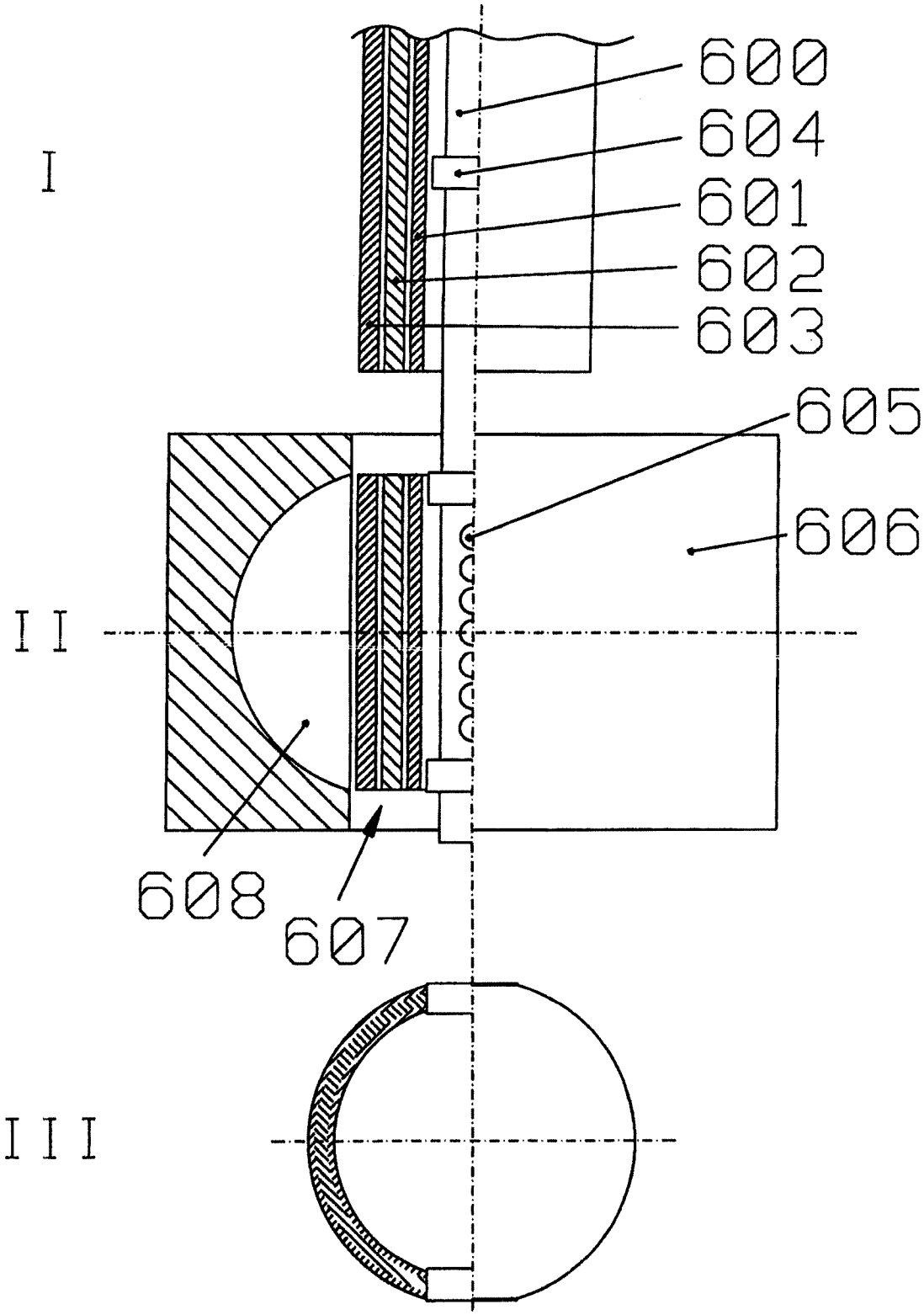


Fig.206H

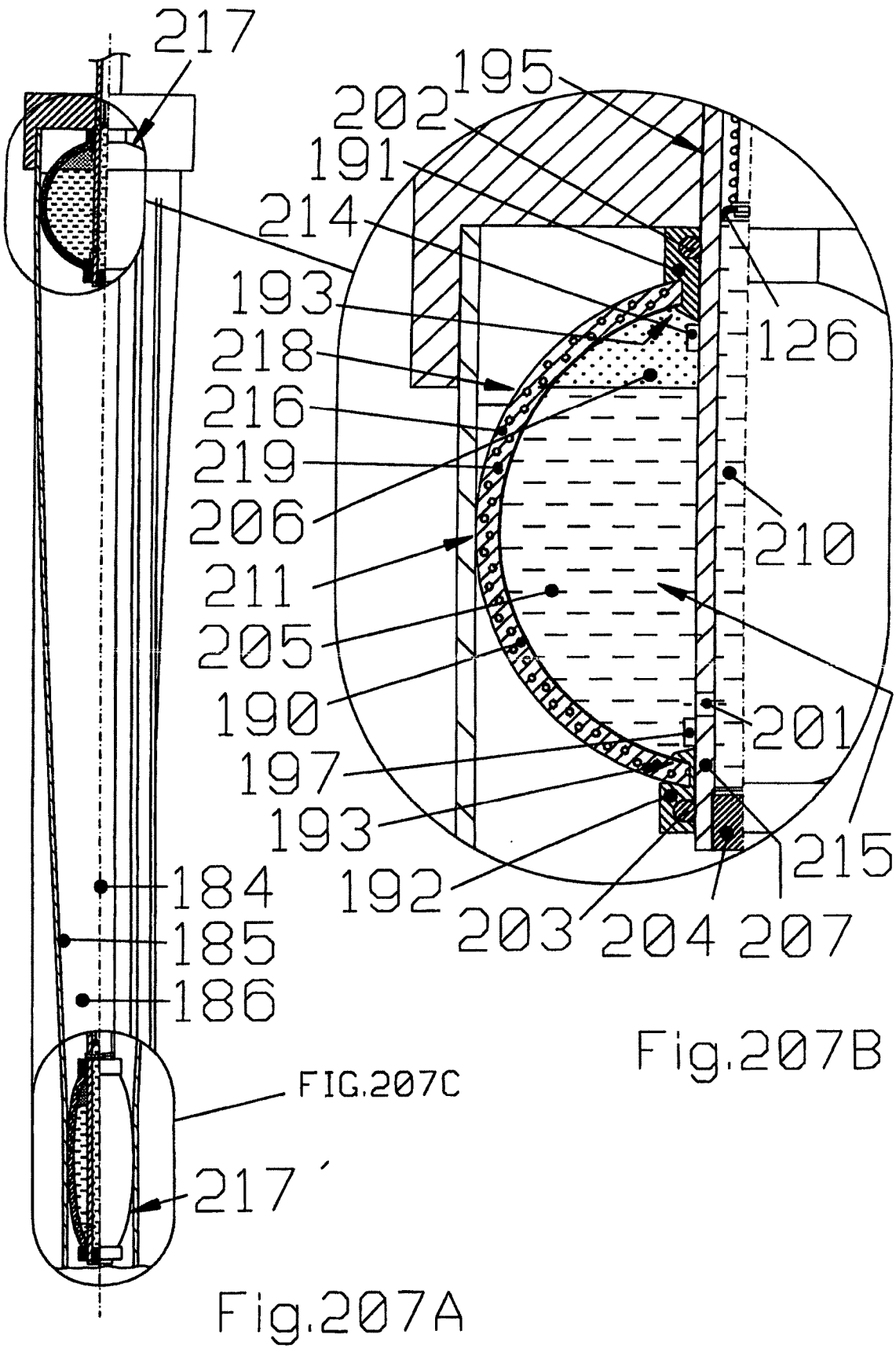


Fig.207B

Fig.207A

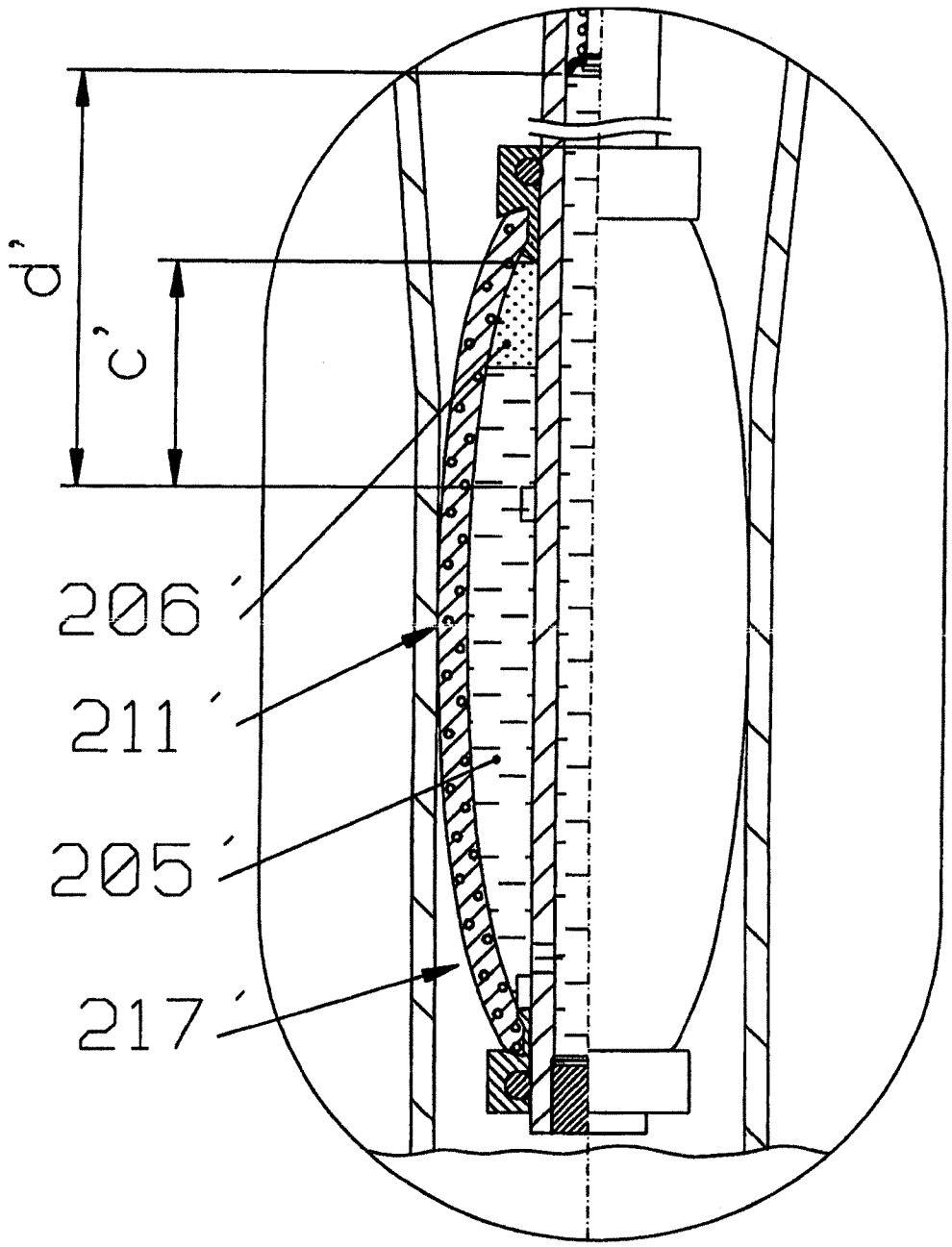


Fig.207C

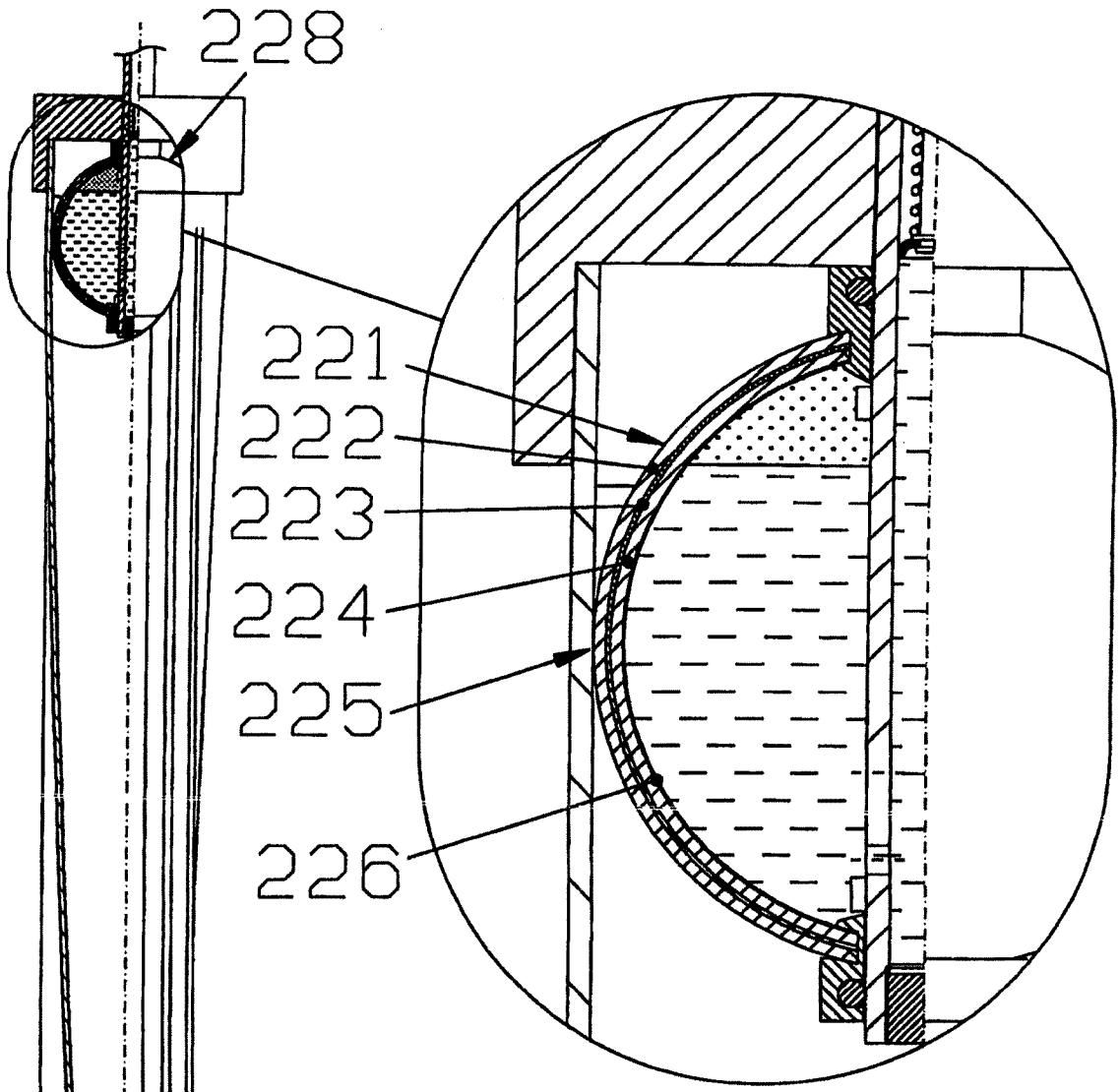


Fig.208B

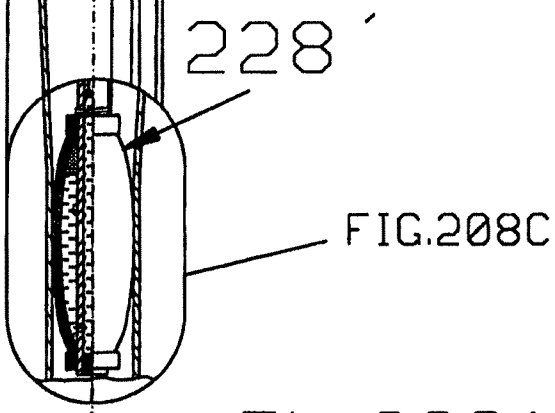


FIG.208C

Fig.208A

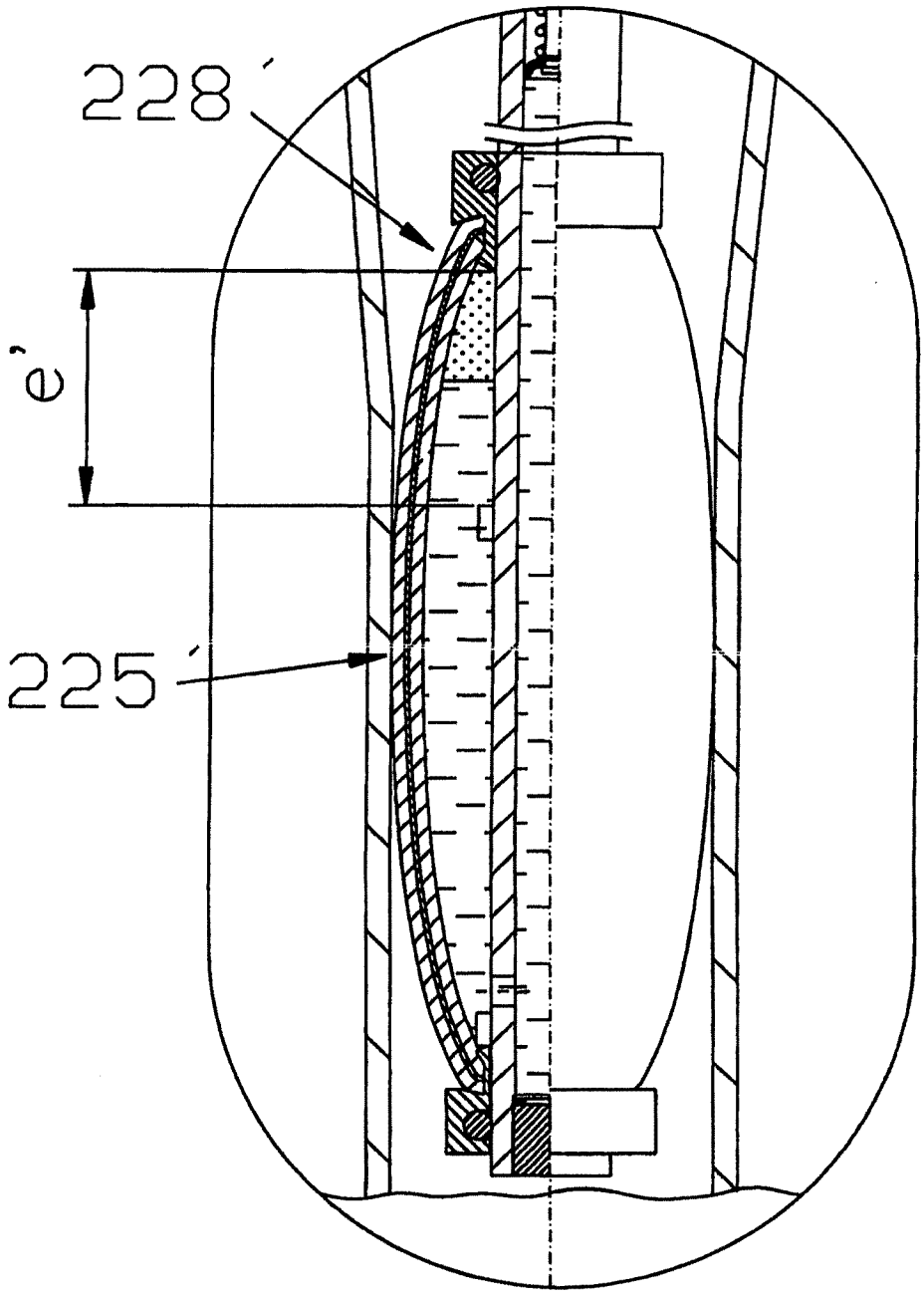


Fig.208C

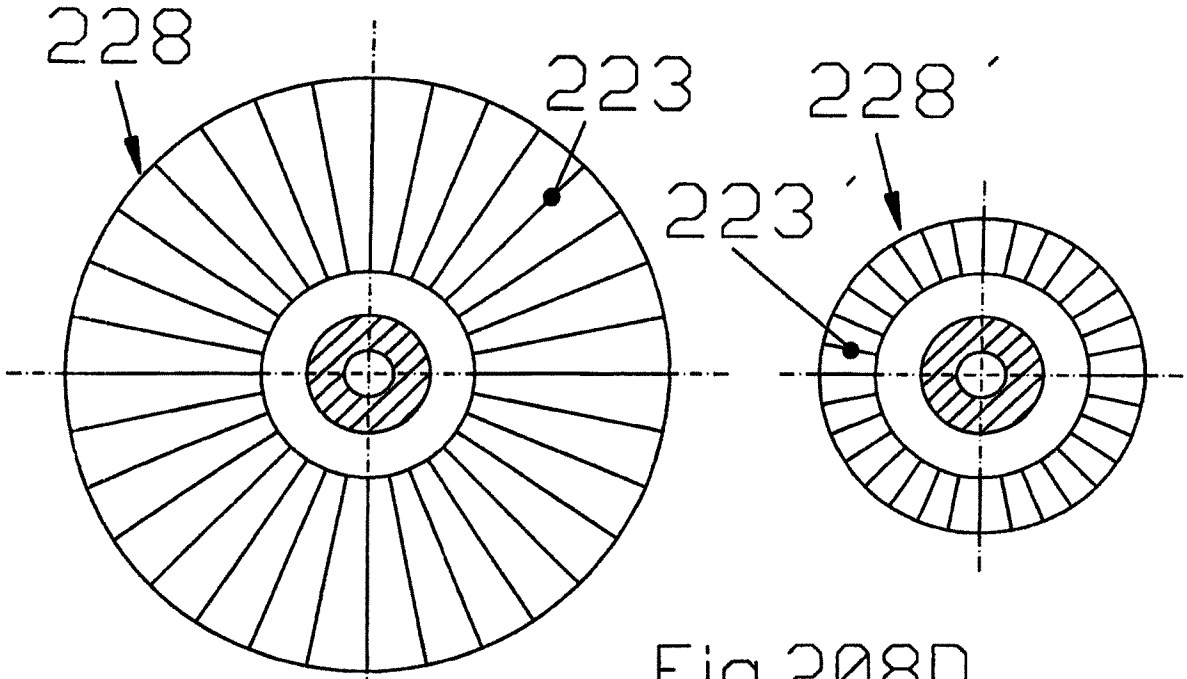


Fig.208D

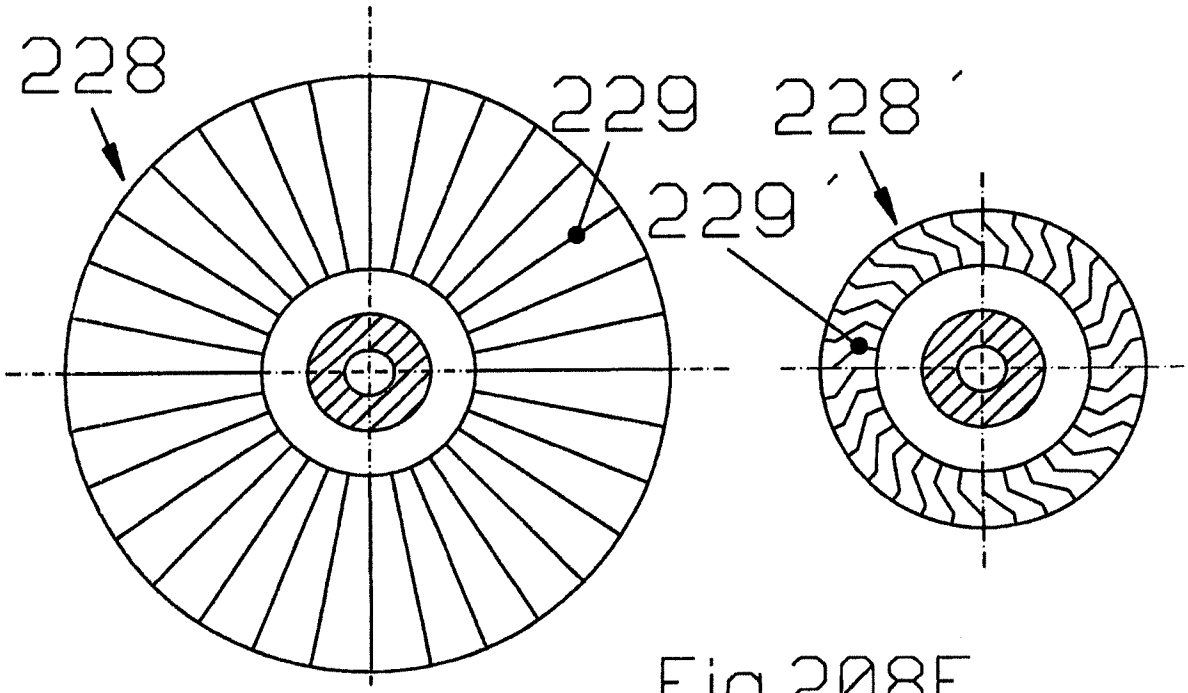


Fig.208E

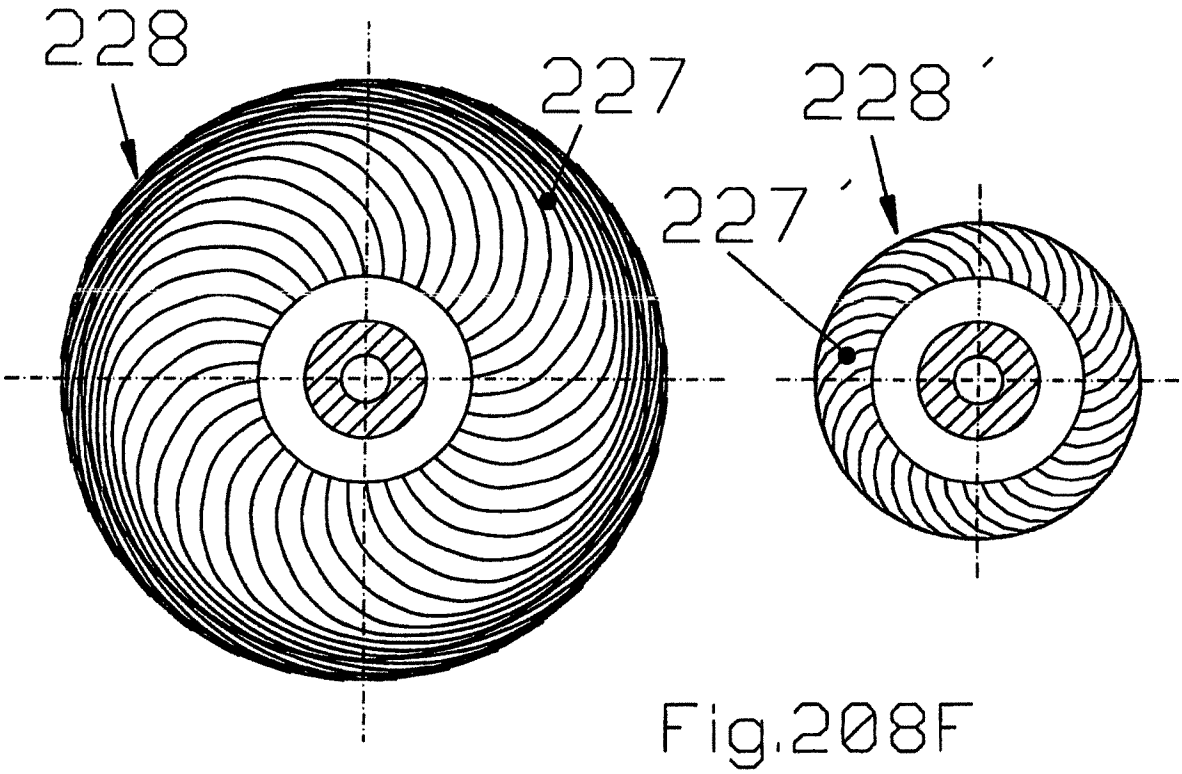


Fig.208F

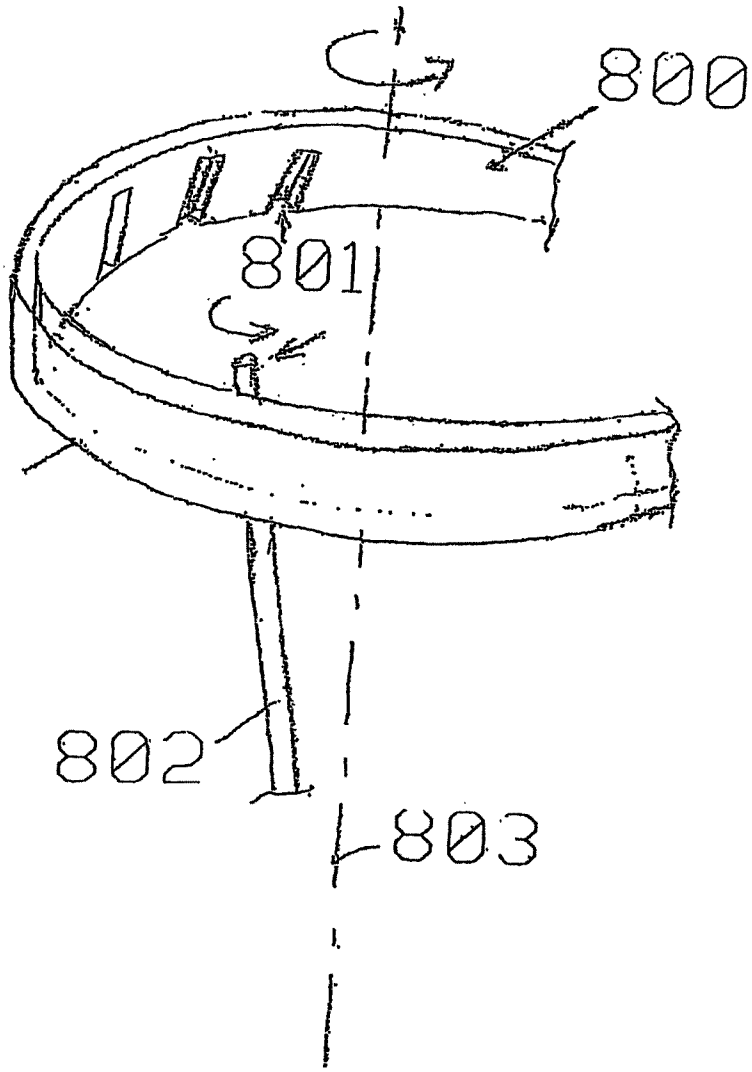


Fig.208G

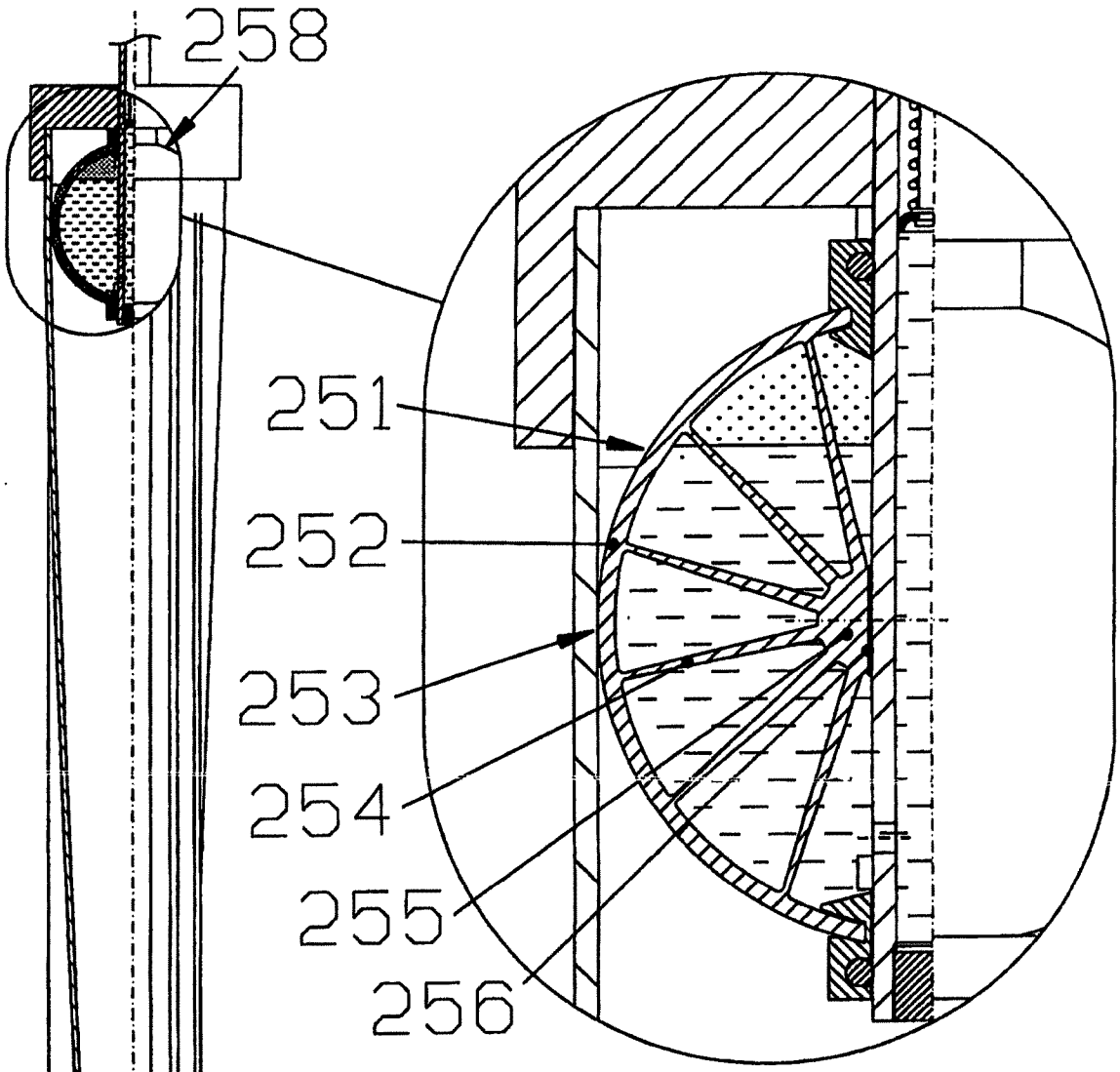


Fig.209B

FIG.209C

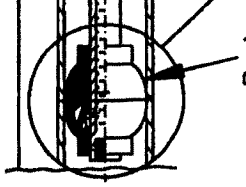


Fig.209A

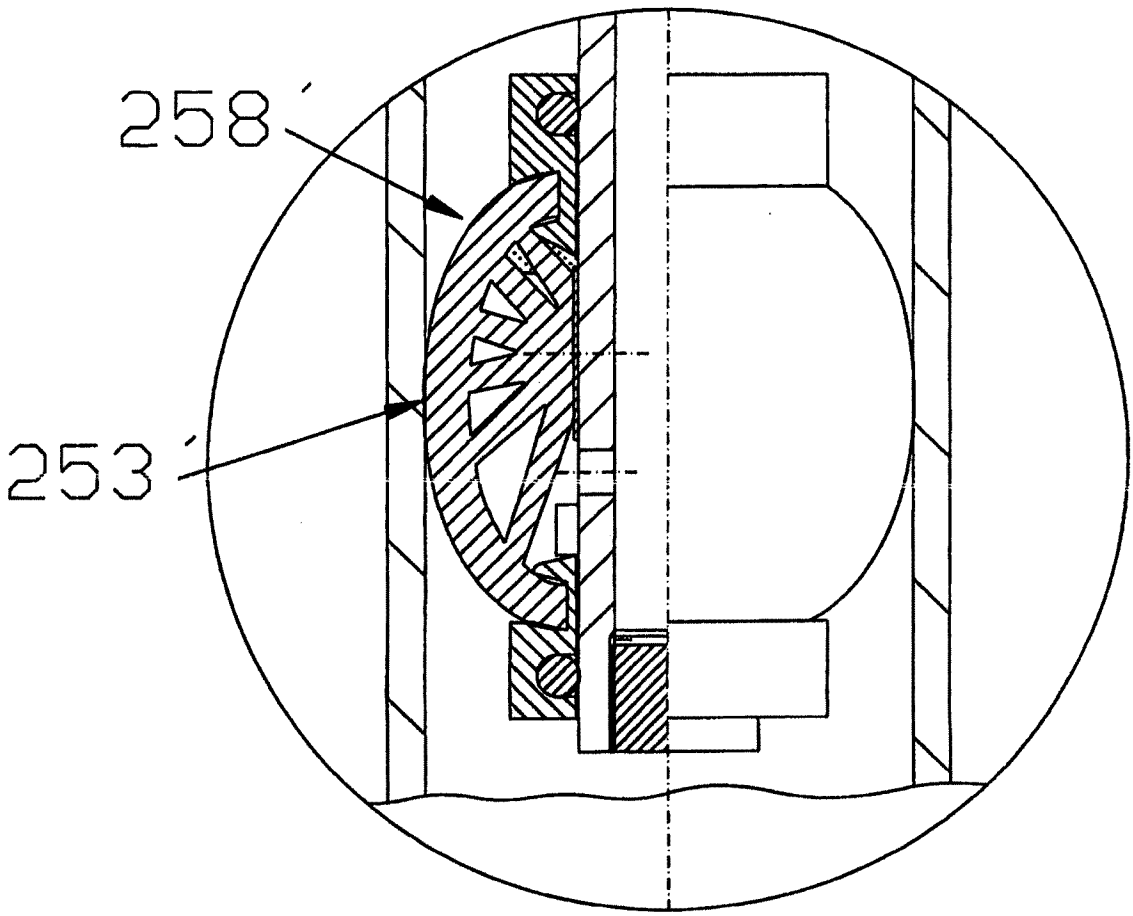


Fig.209C

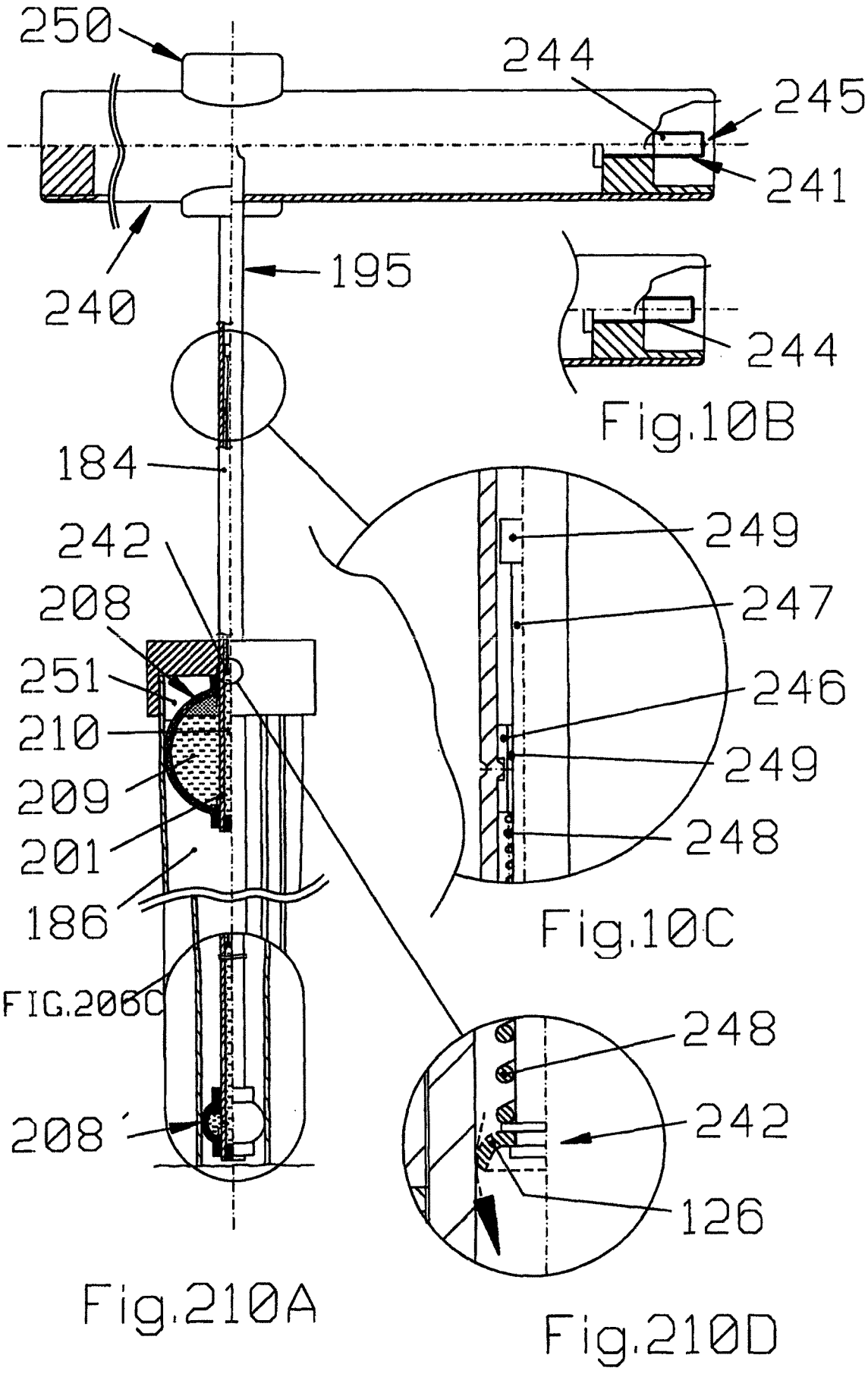


Fig.10B

Fig.10C

Fig.210A

Fig.210D

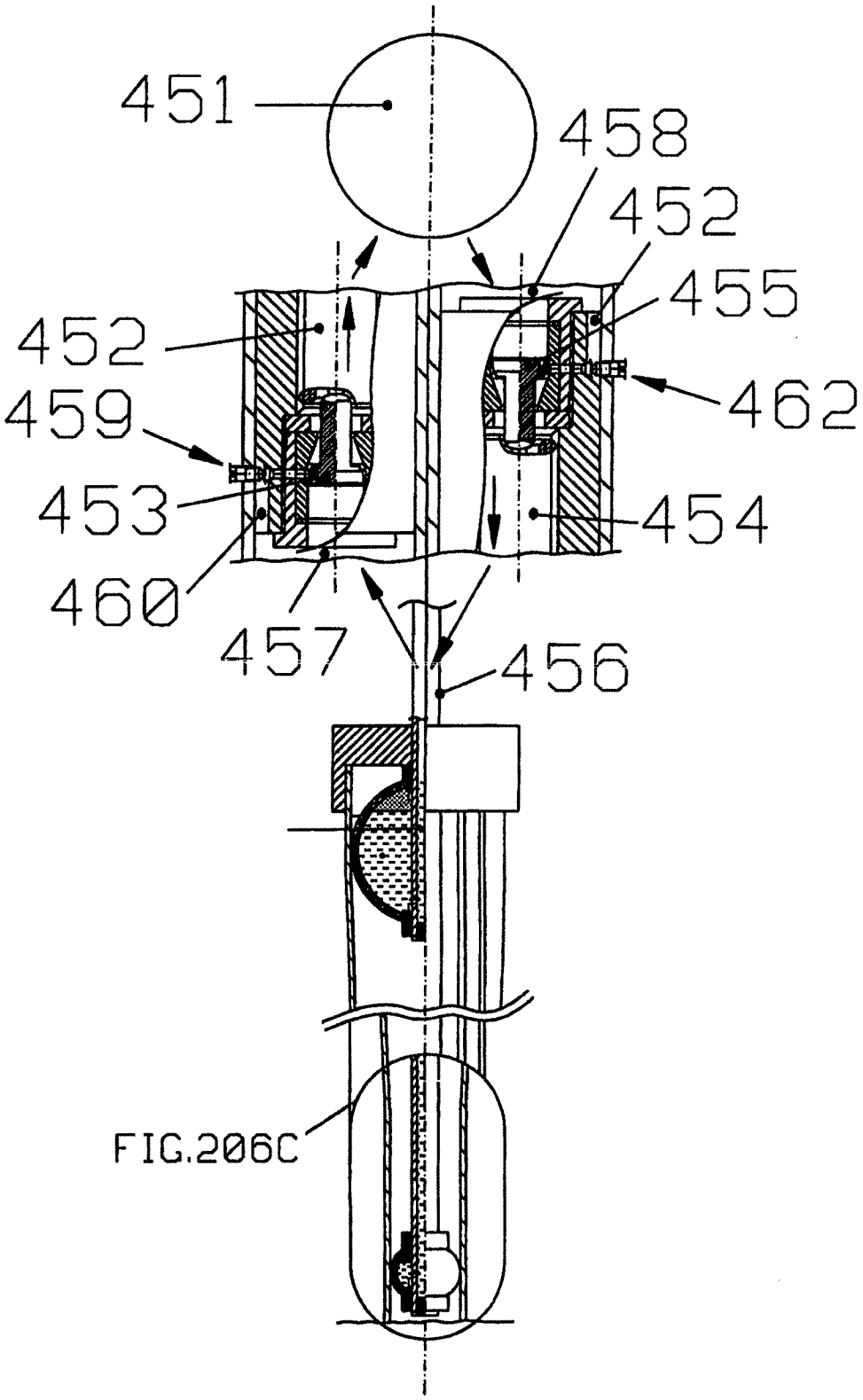


FIG.206C

Fig.210E

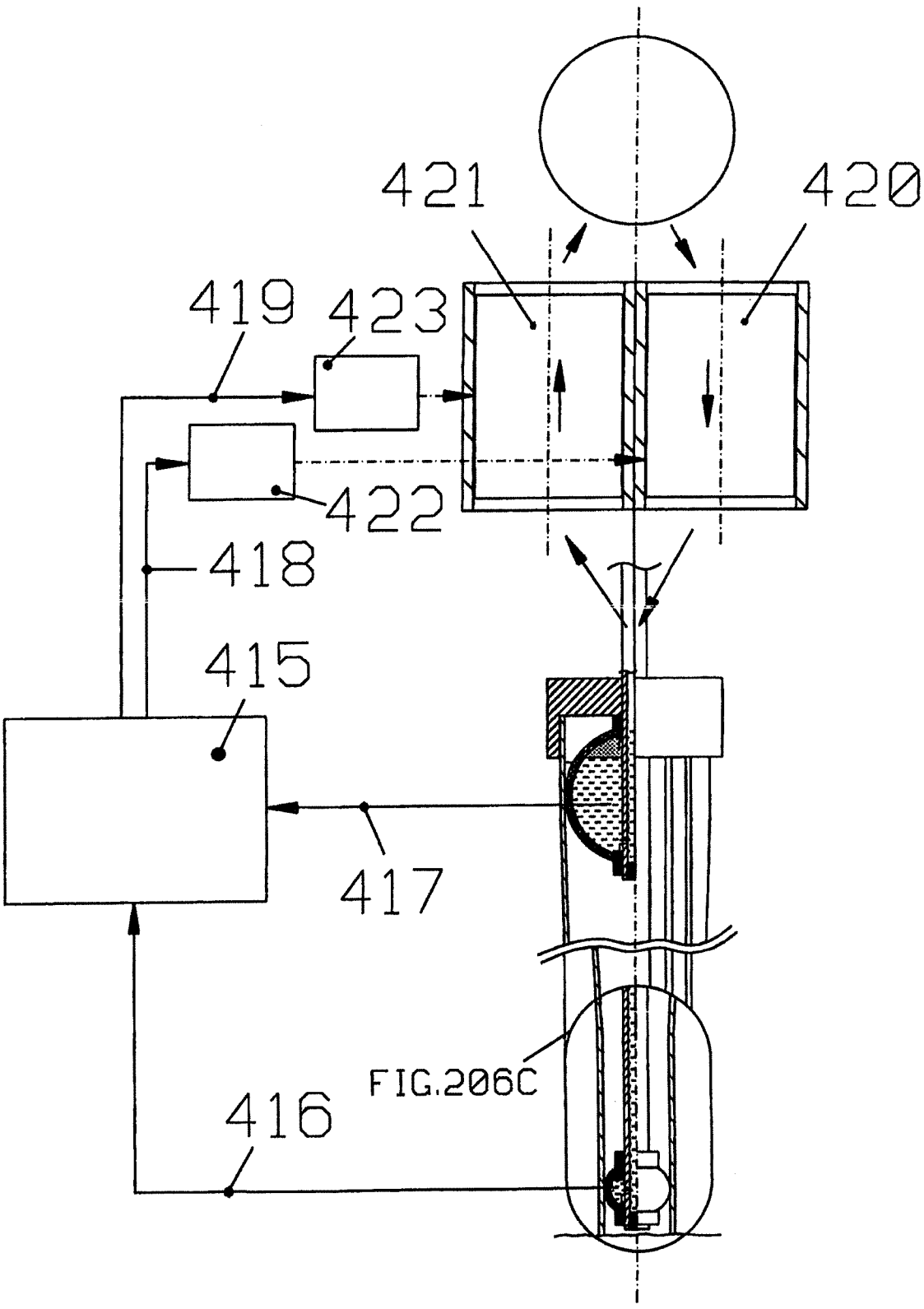


Fig.210F

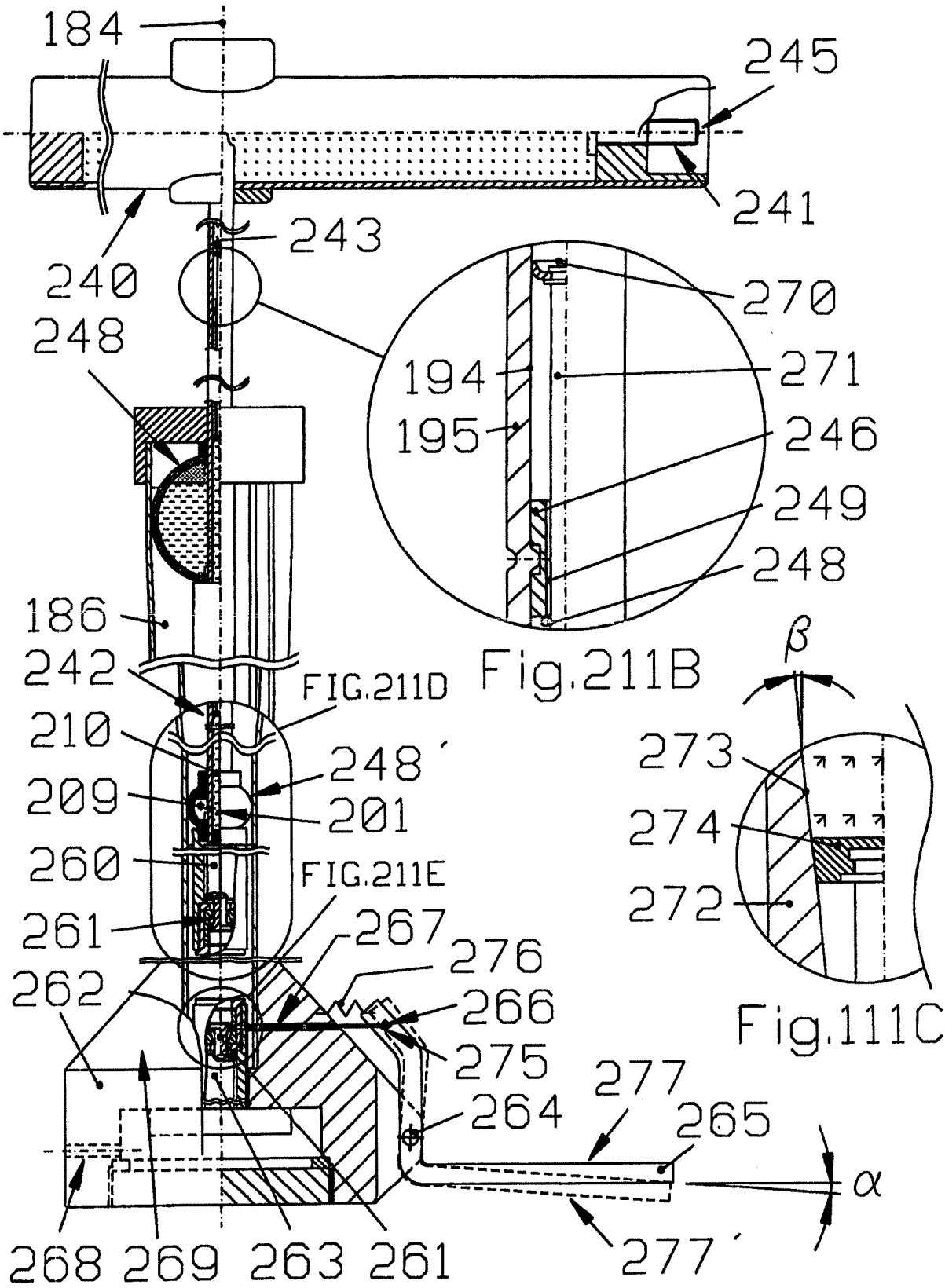


Fig.211B

Fig.111C

Fig.211A

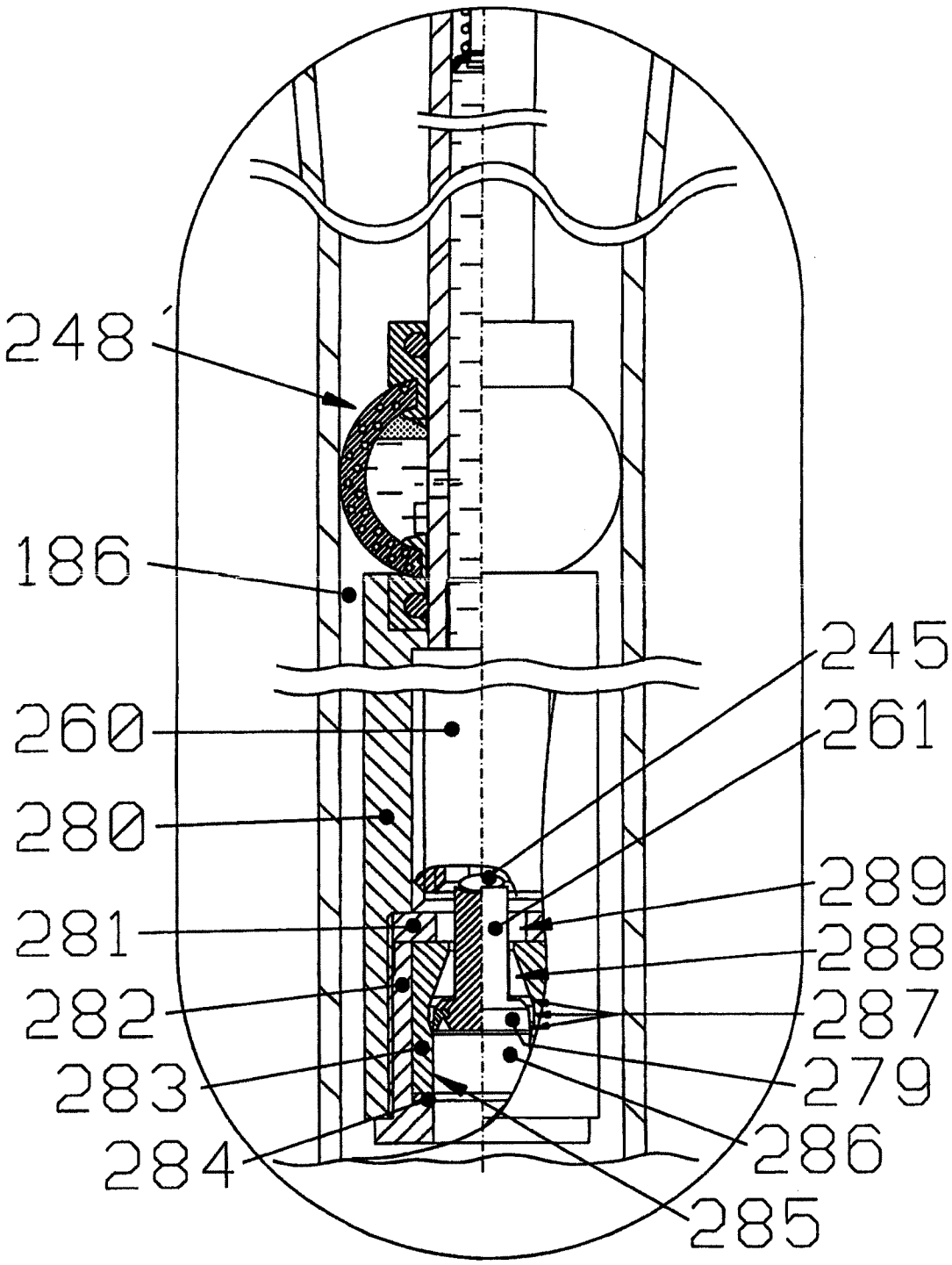


Fig.211D

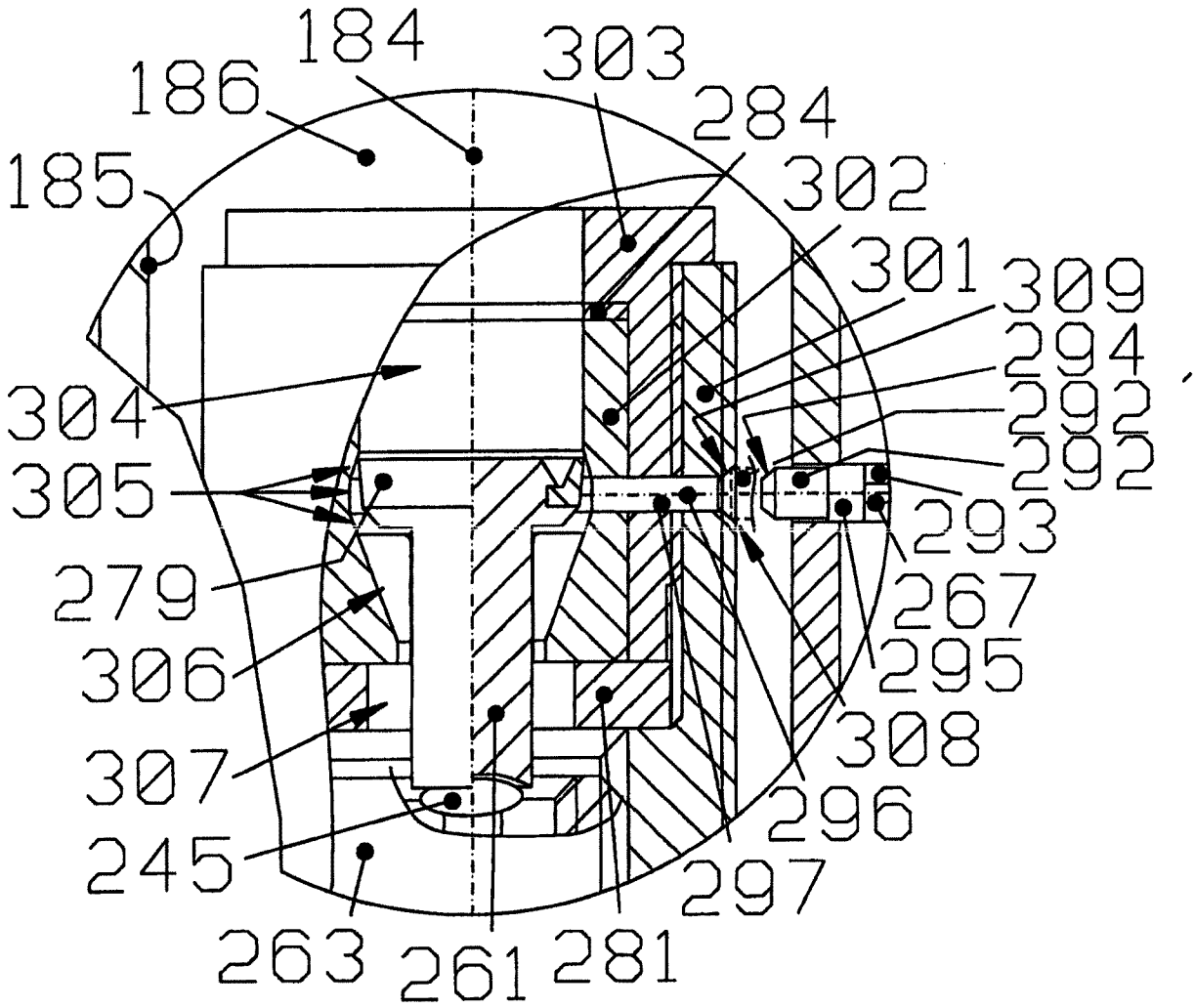

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Fig.211E

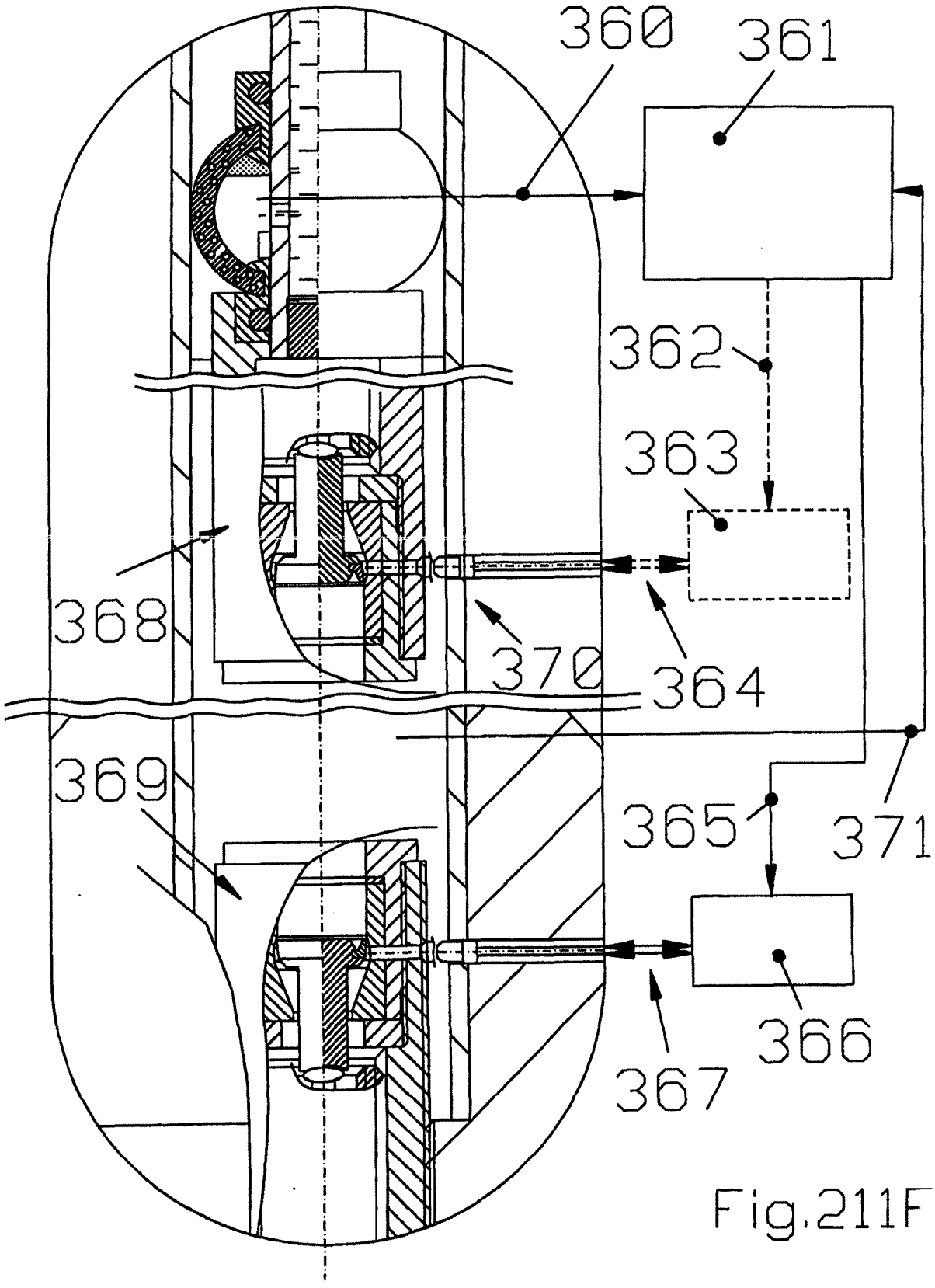


Fig.211F

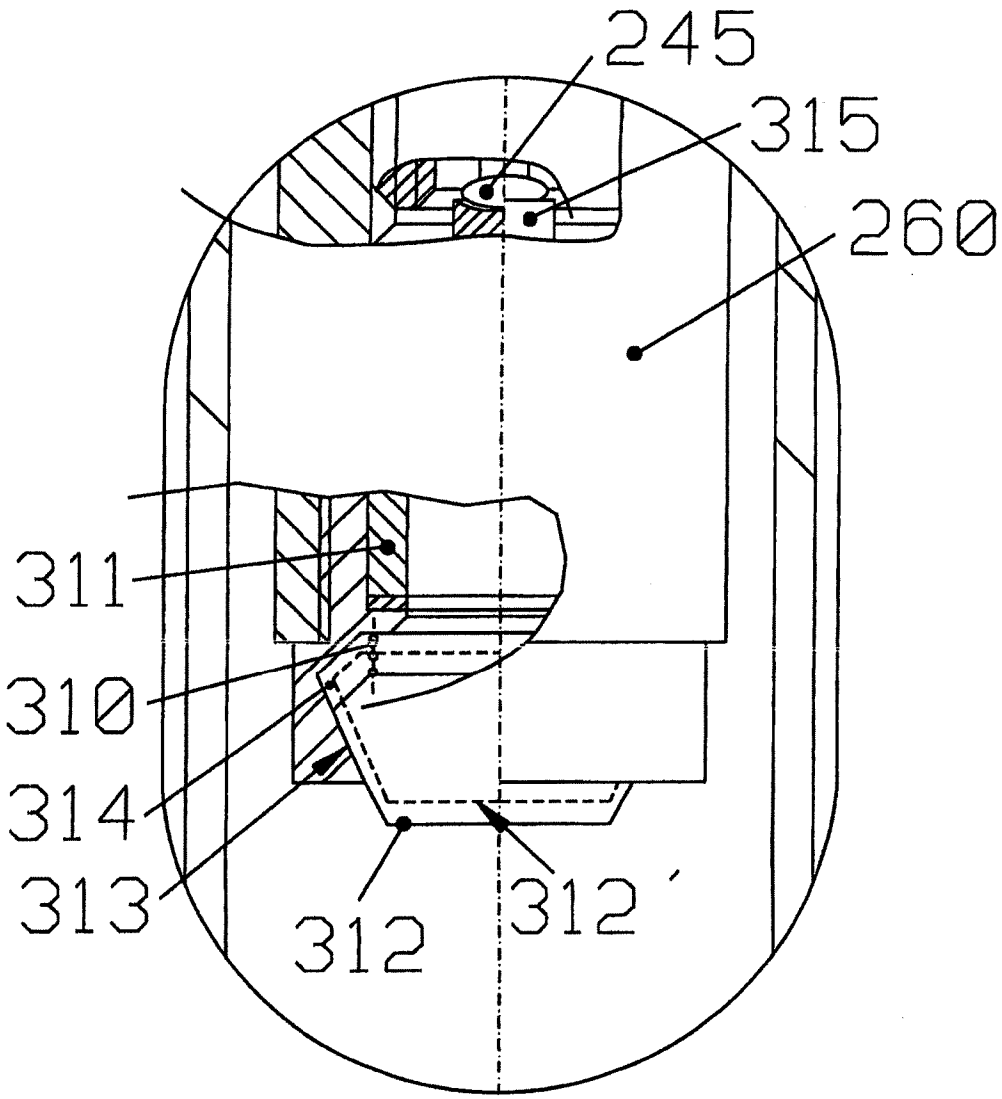


Fig.211G

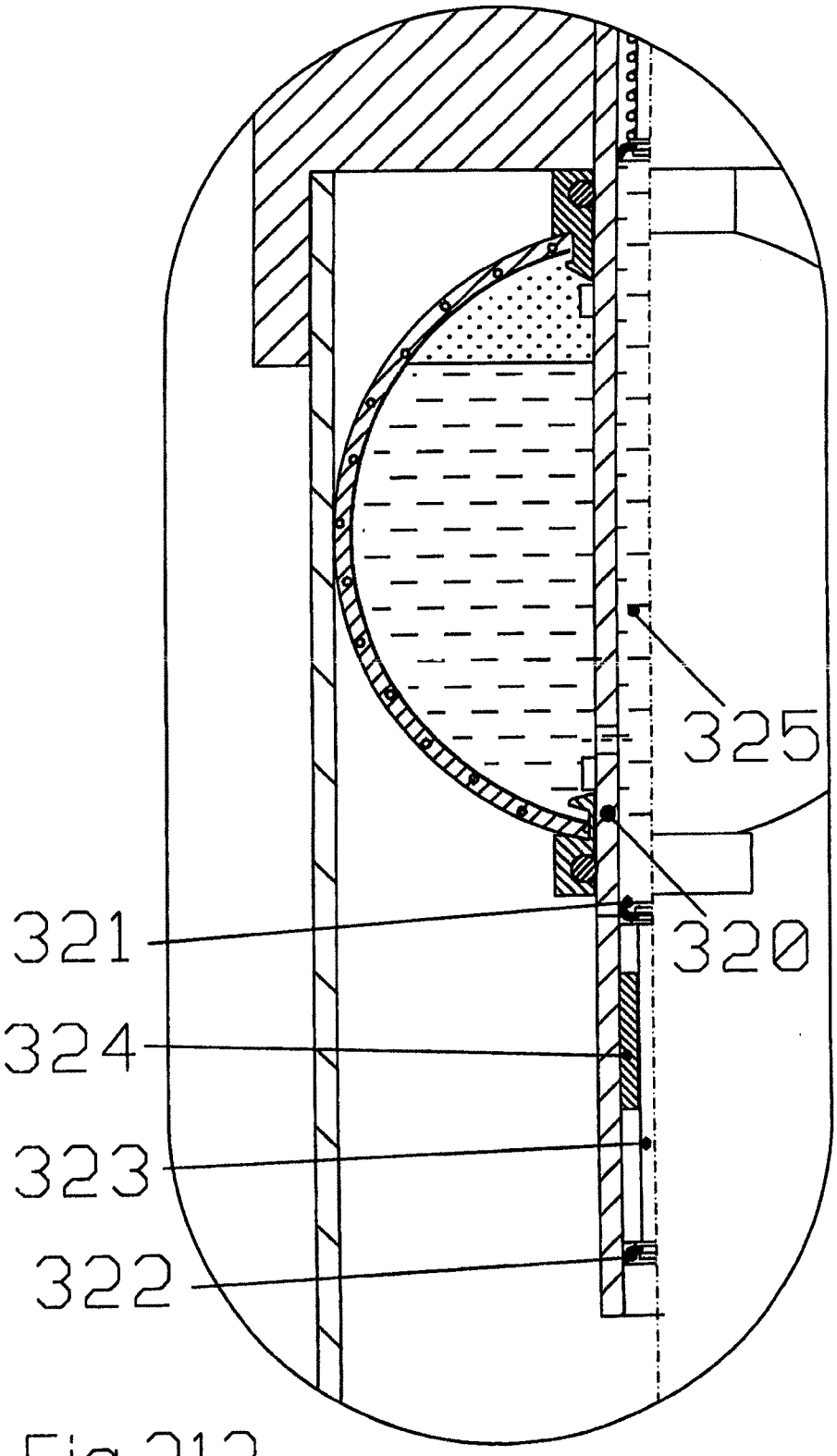


Fig.212

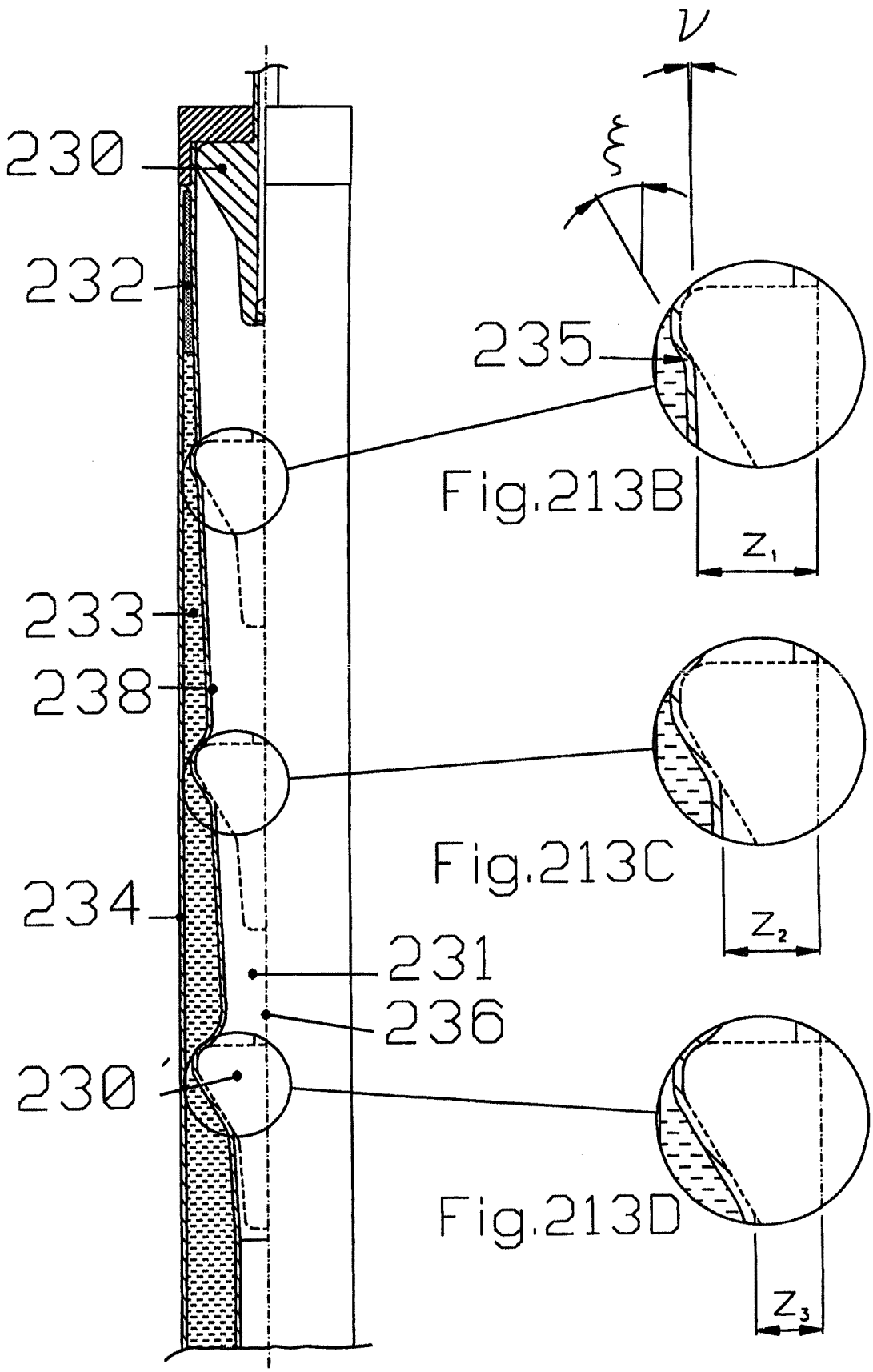


Fig.213B

Fig.213C

Fig.213D

Fig.213A

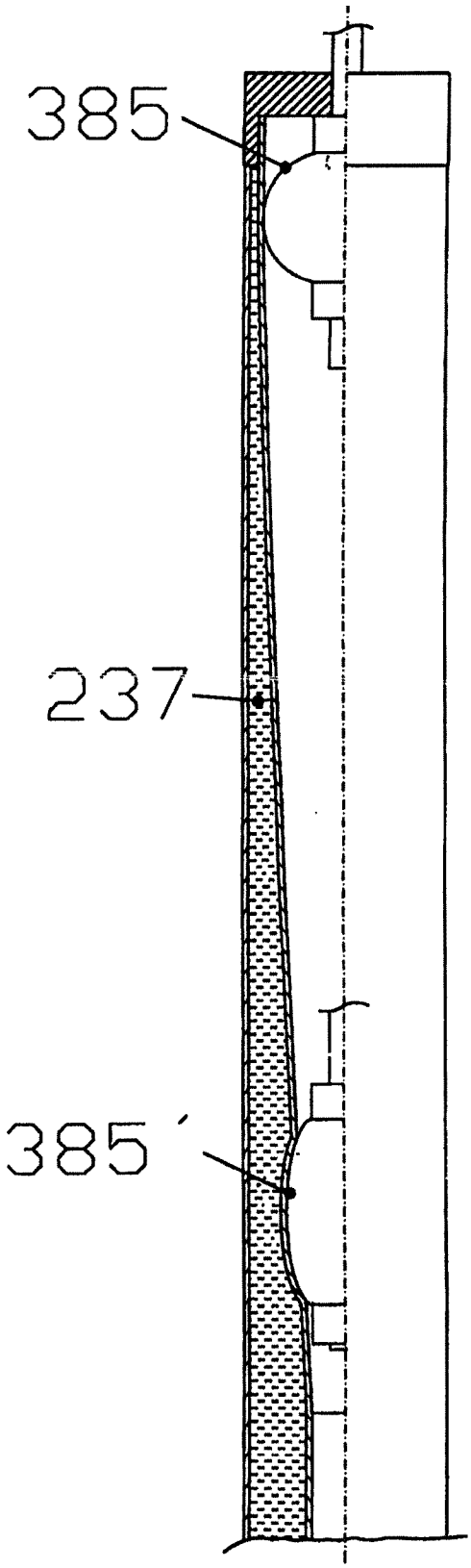
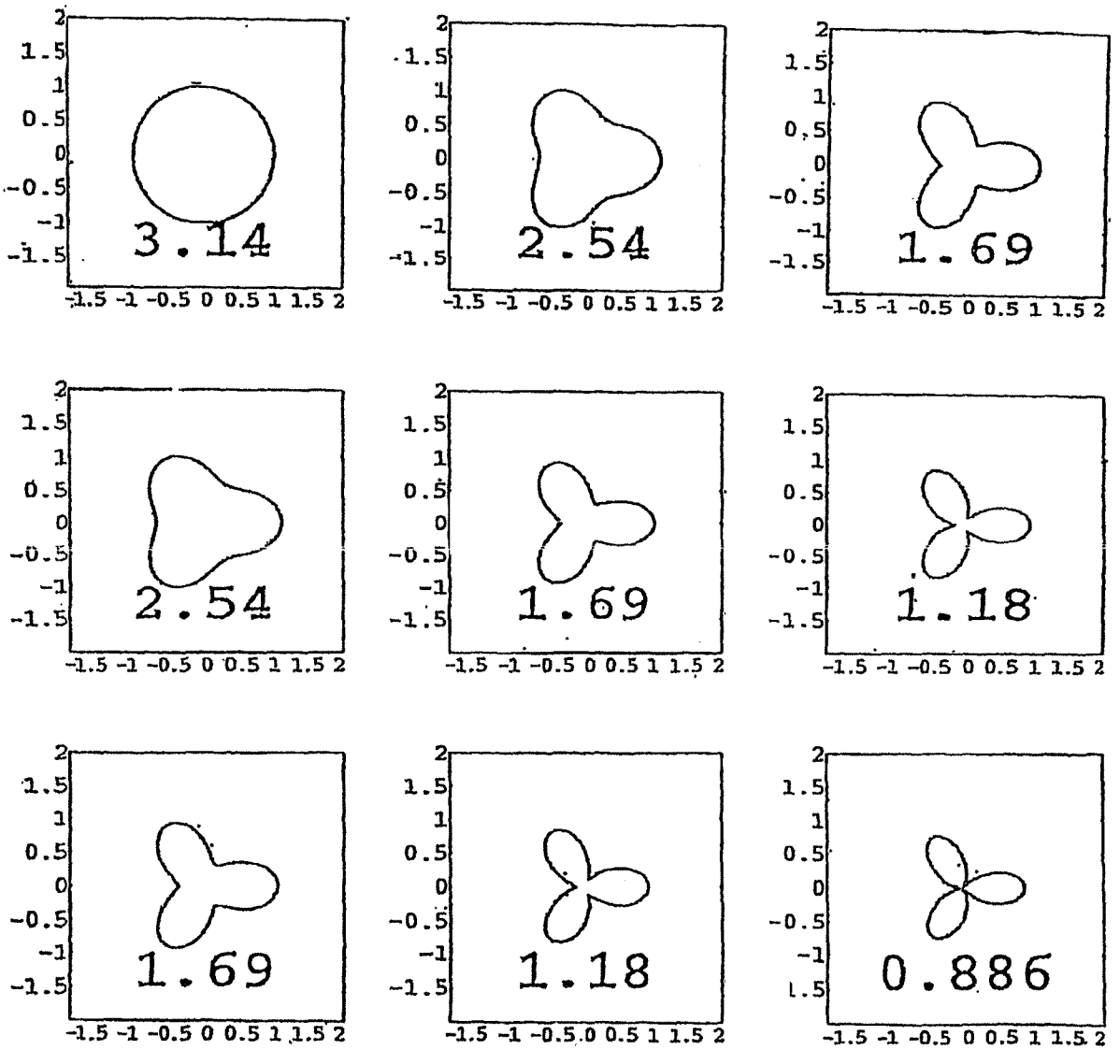


Fig.214



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

$c_1=0$

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

$c_3=p+q$

Fig.215A

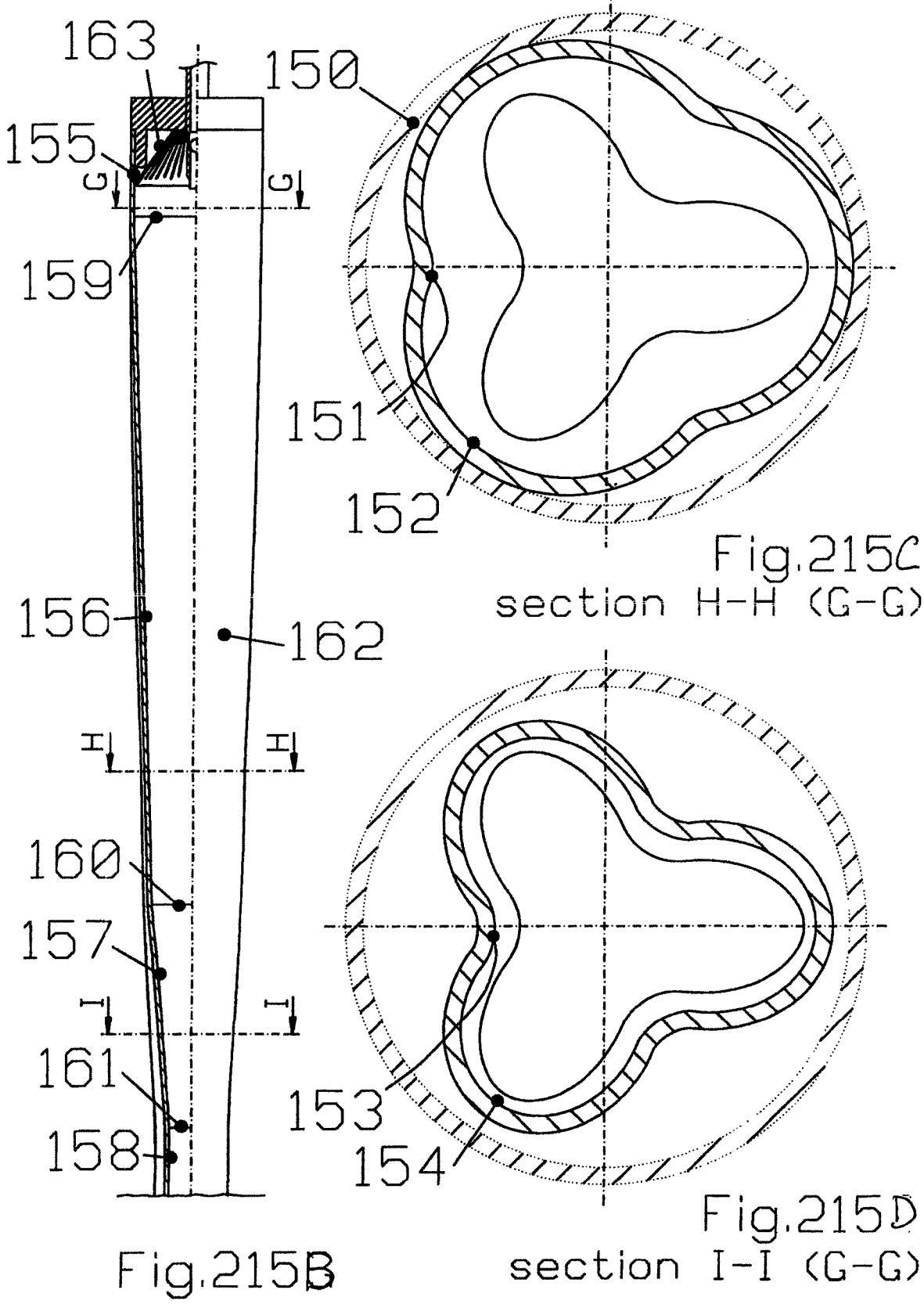
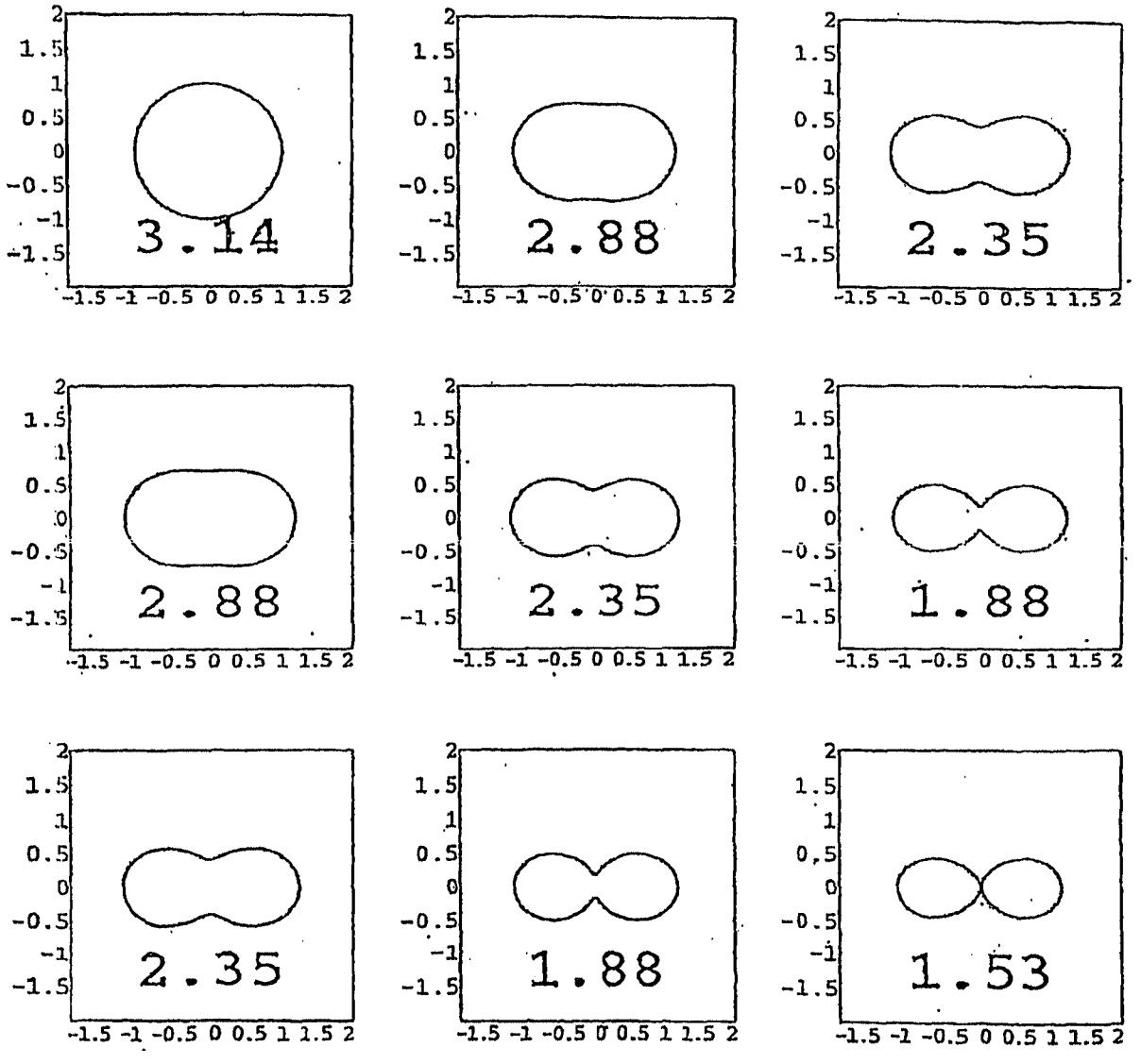


Fig.215B

Fig.215C
section H-H (G-G)

Fig.215D
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.215E

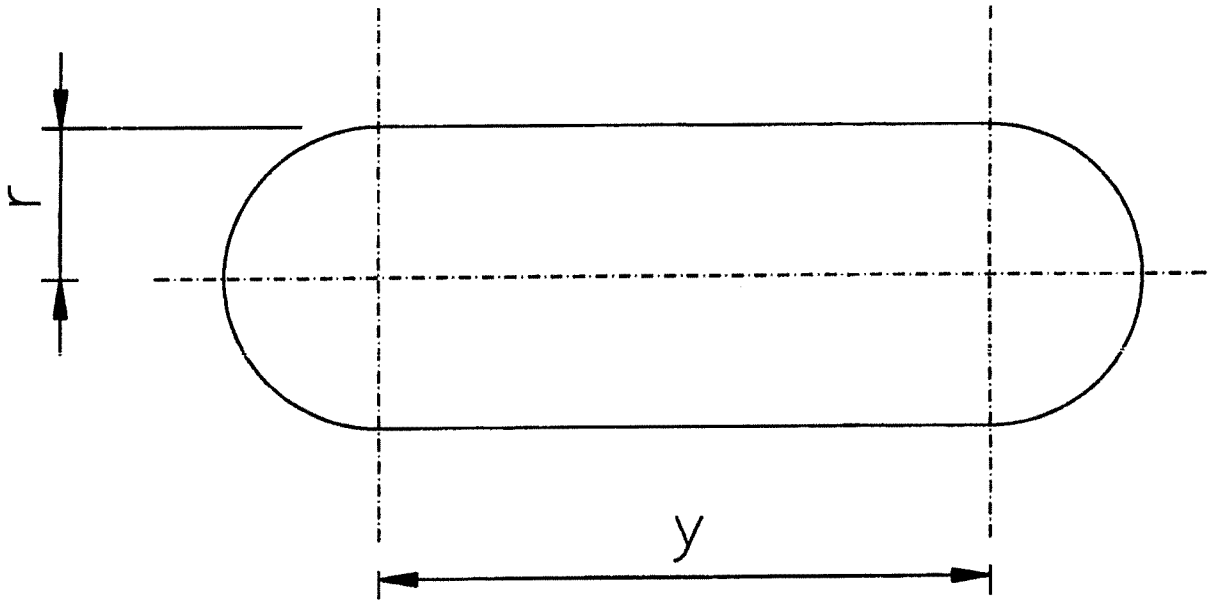


Fig.215F

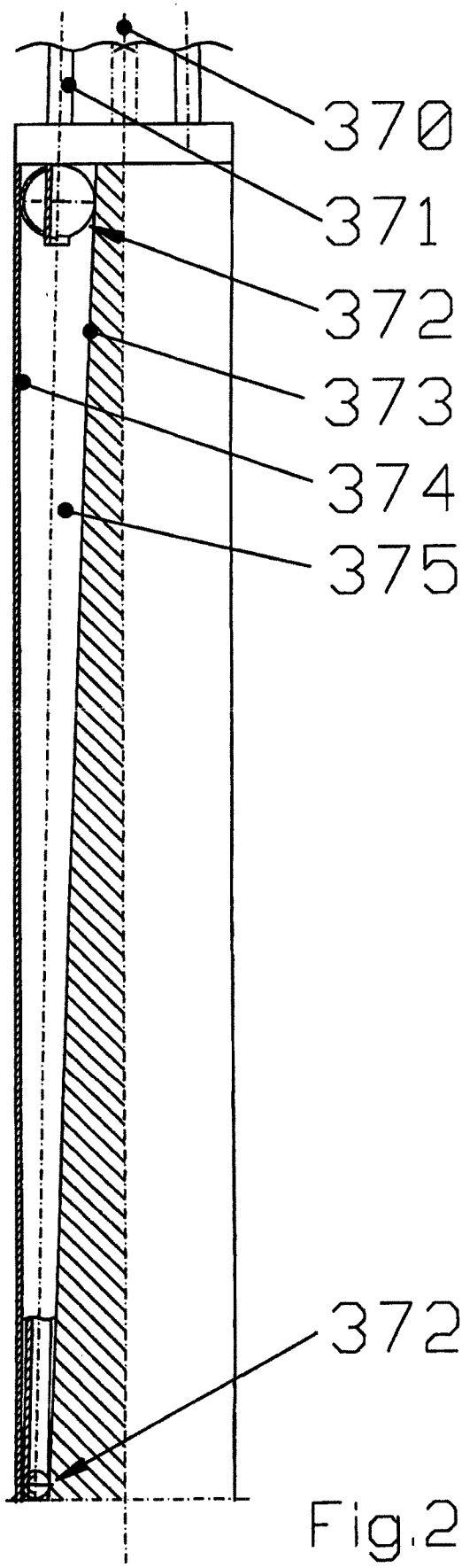


Fig.216

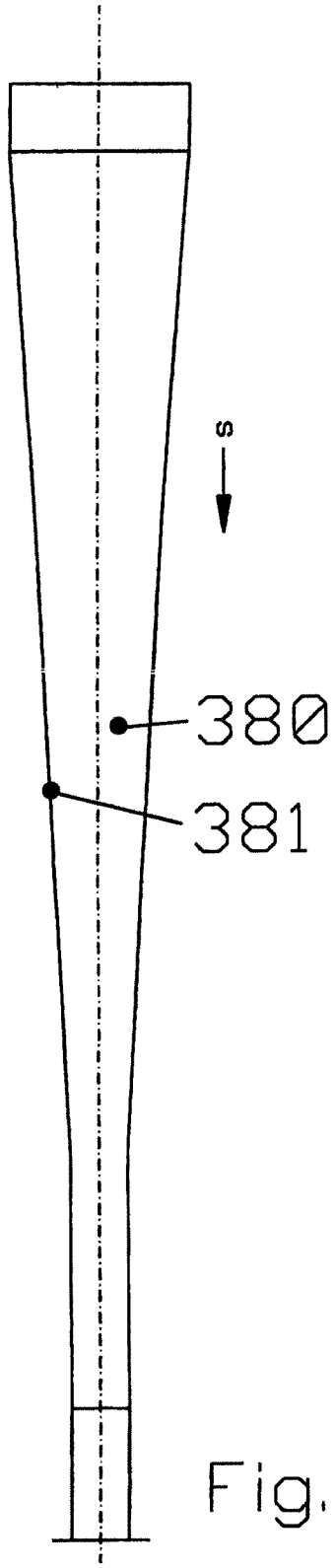


Fig.217A

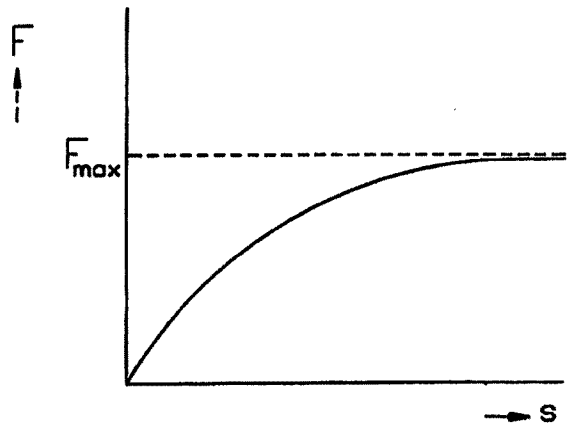


Fig.217B

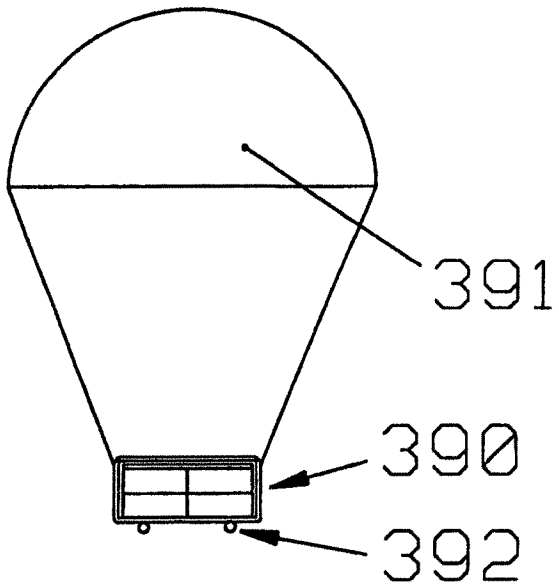


Fig.218A

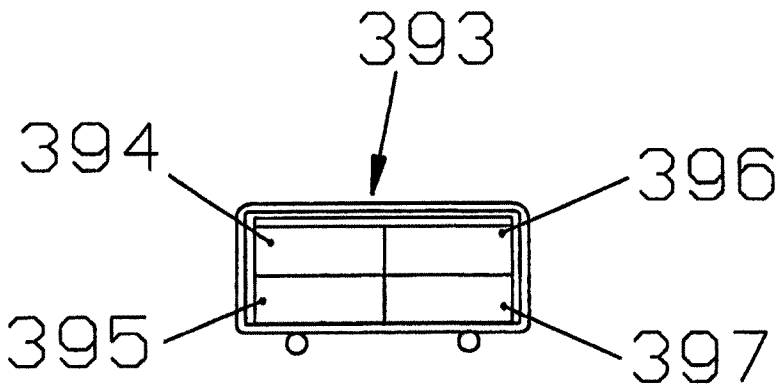


Fig.218B

ANY REFERENCE TO FIGURES 219 TO 300
SHOULD BE CONSIDERED
AS NON-EXISTENT

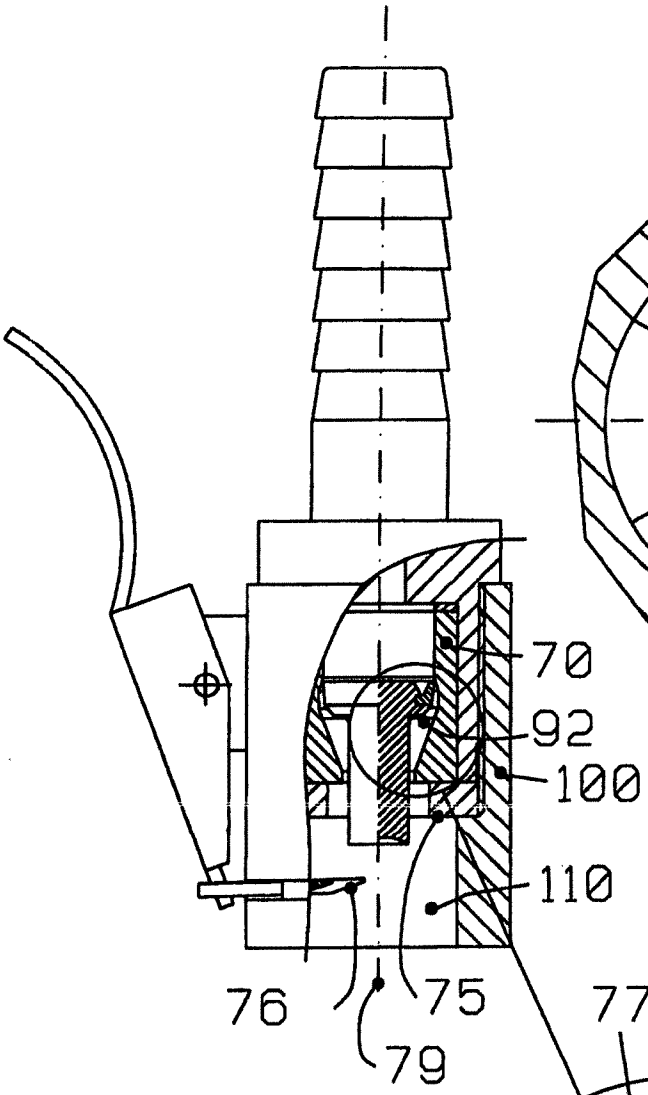


Fig.301

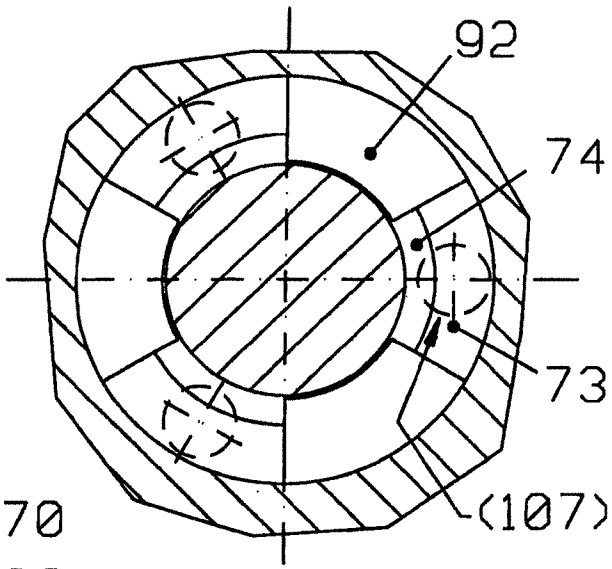


Fig.301B

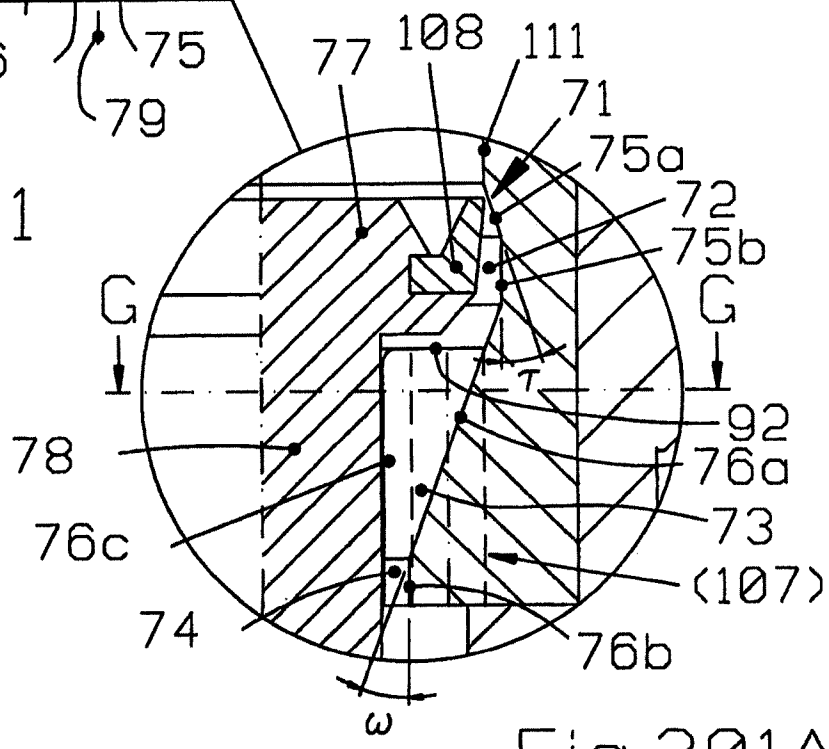


Fig.301A

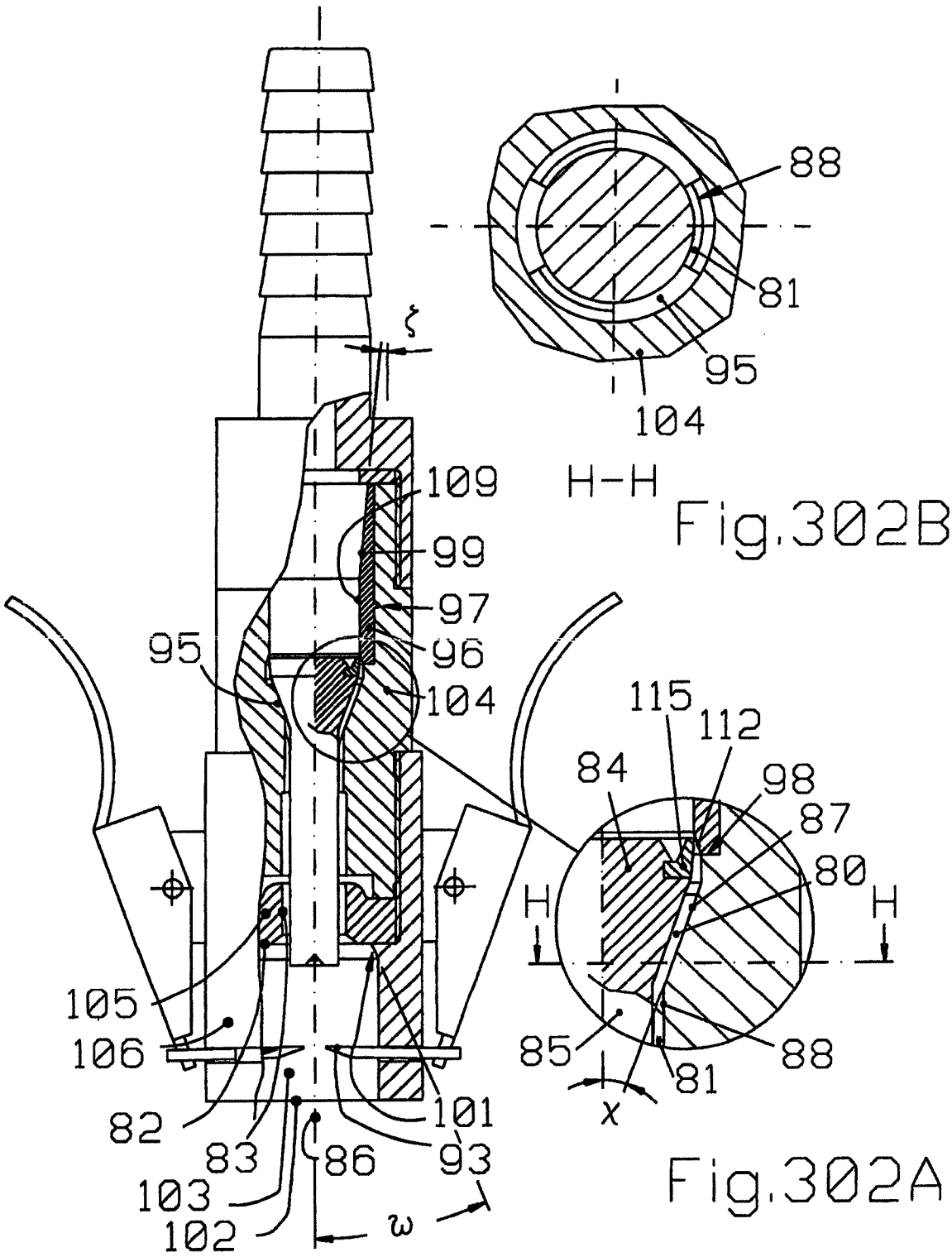


Fig.302B

Fig.302A

Fig.302

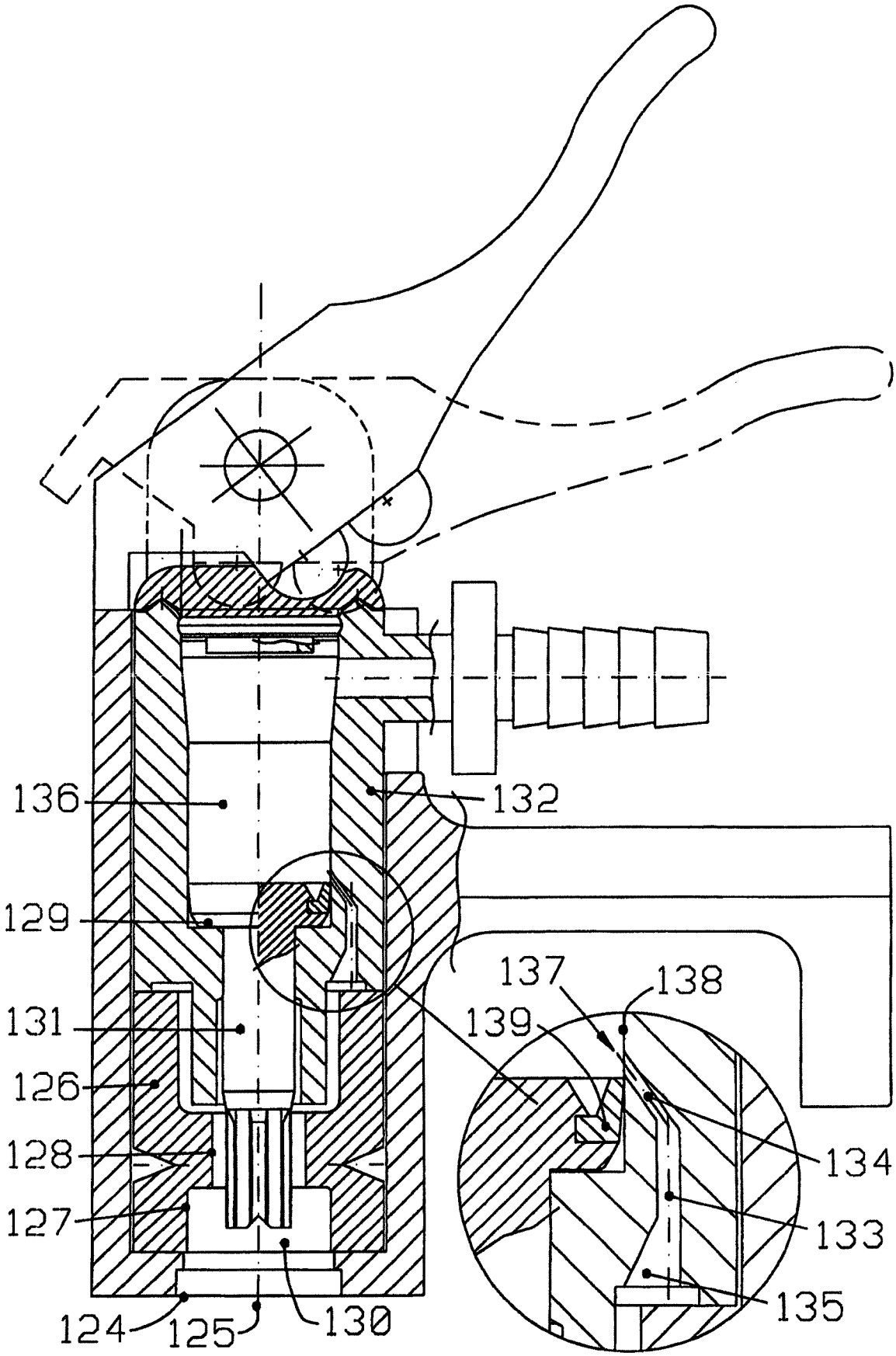


Fig.303

Fig.303A

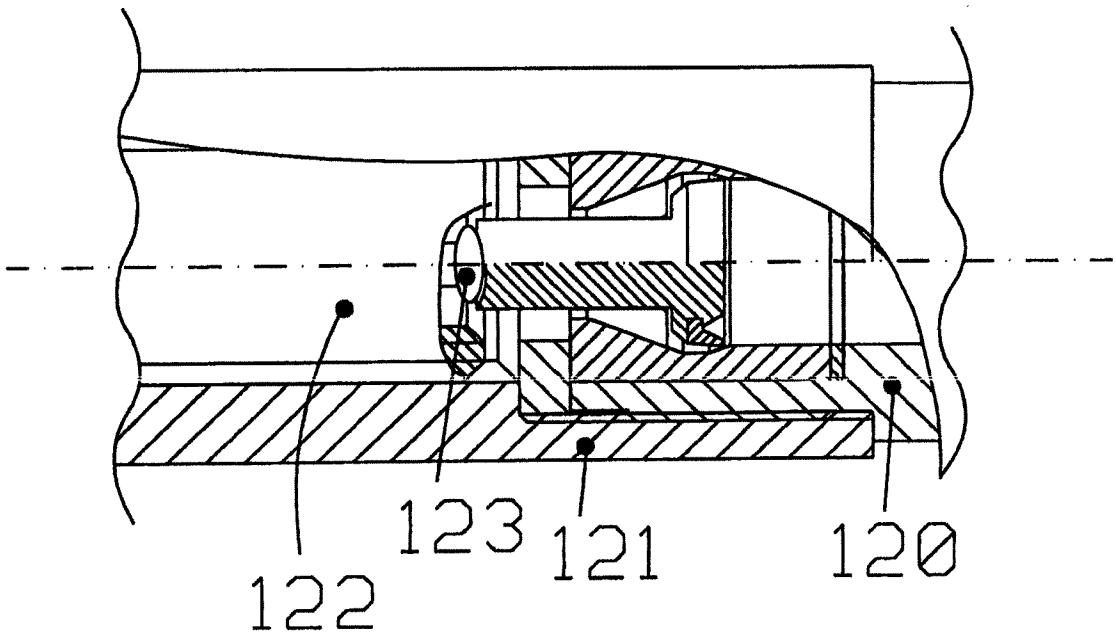


Fig.304

ANY REFERENCE TO FIGURES 306 TO 400
SHOULD BE CONSIDERED
AS NON-EXISTENT

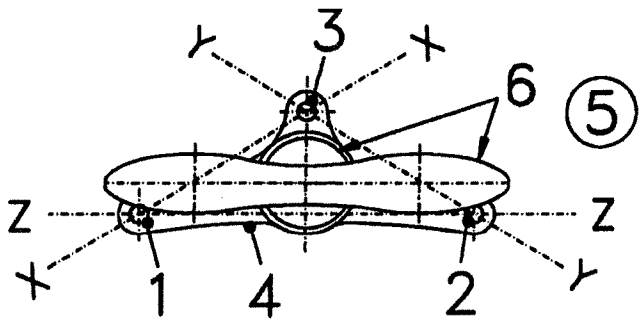


Fig.401A

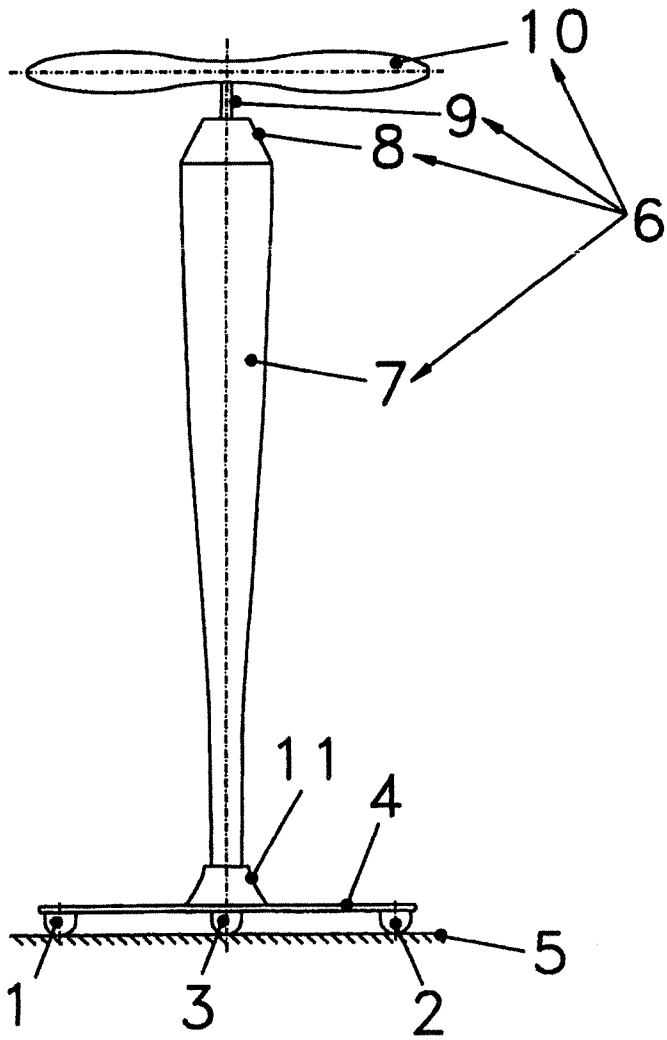


Fig.401B

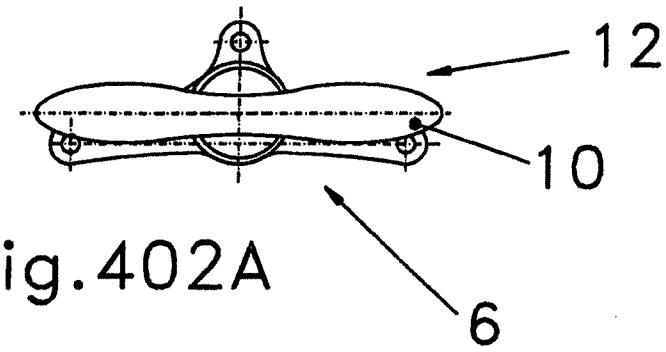


Fig.402A

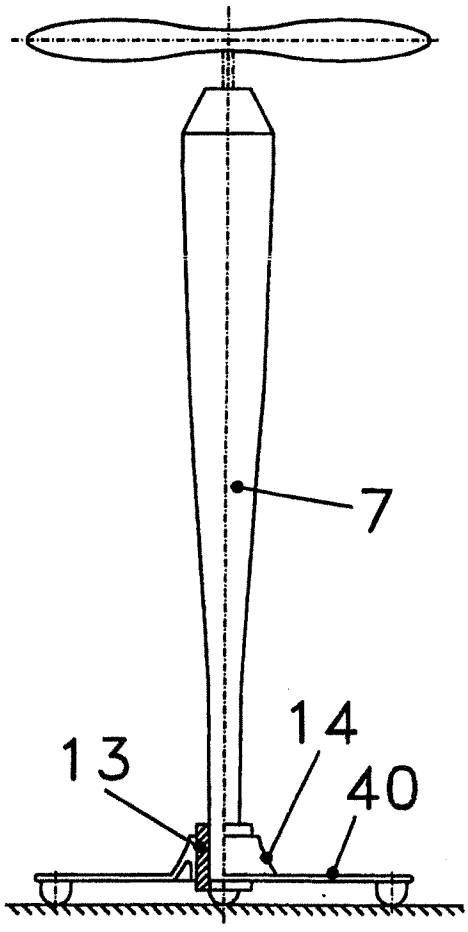


Fig.402B

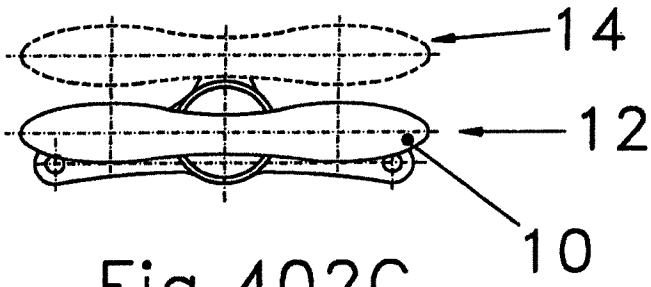


Fig.402C

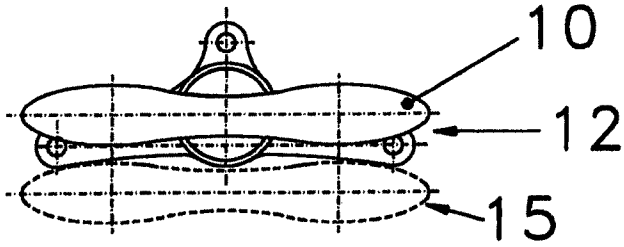


Fig.402D

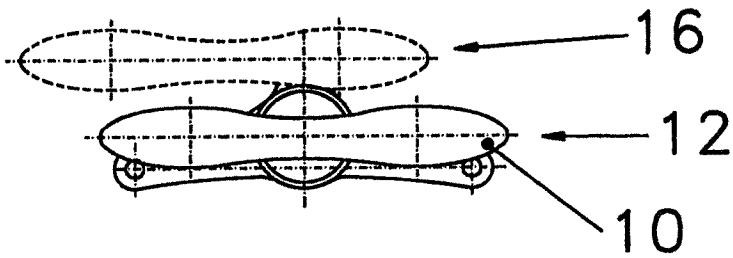


Fig.402E

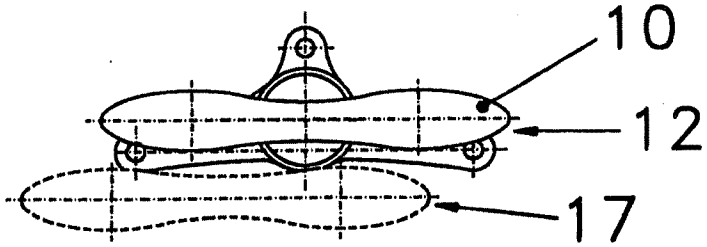


Fig.402F

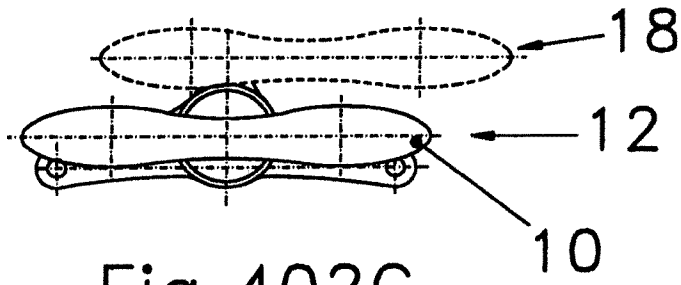


Fig.402G

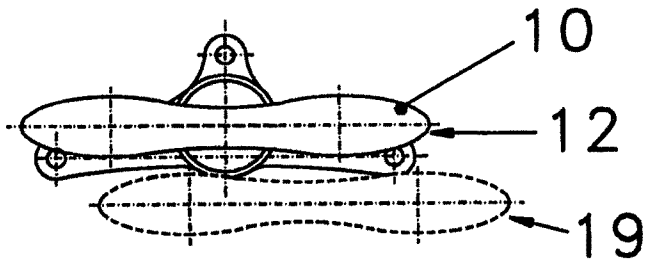


Fig.402H

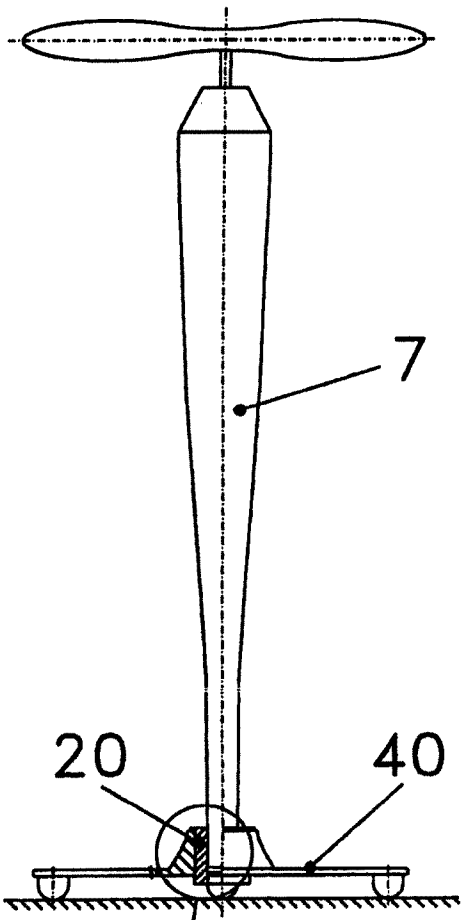


Fig.403A

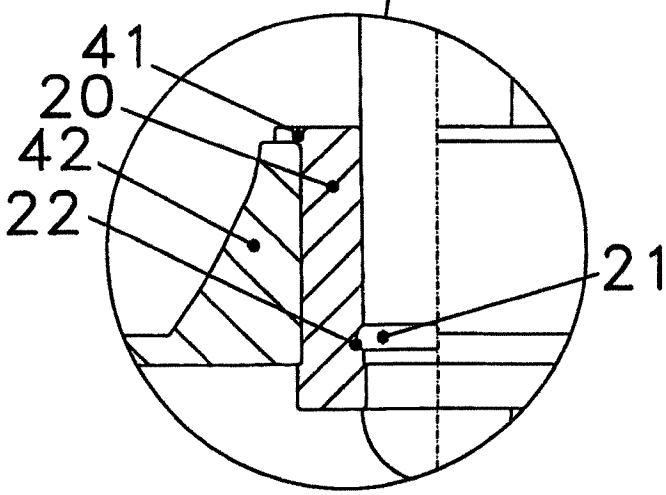


Fig.403B

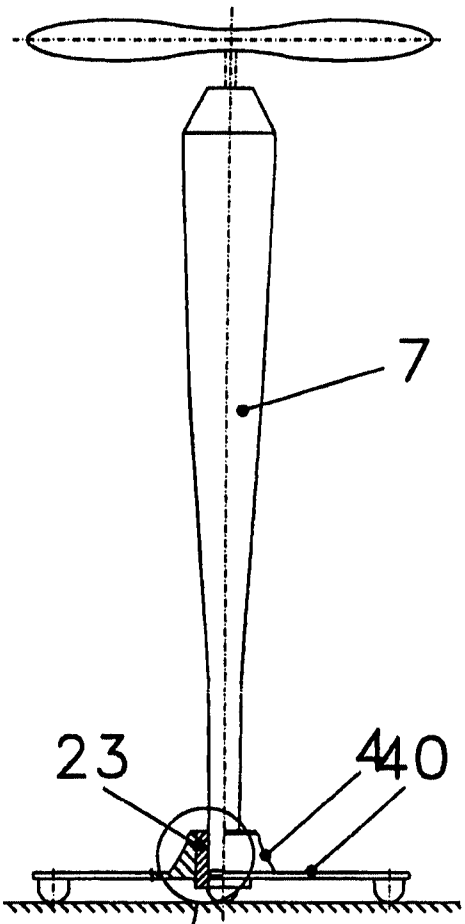


Fig.403C

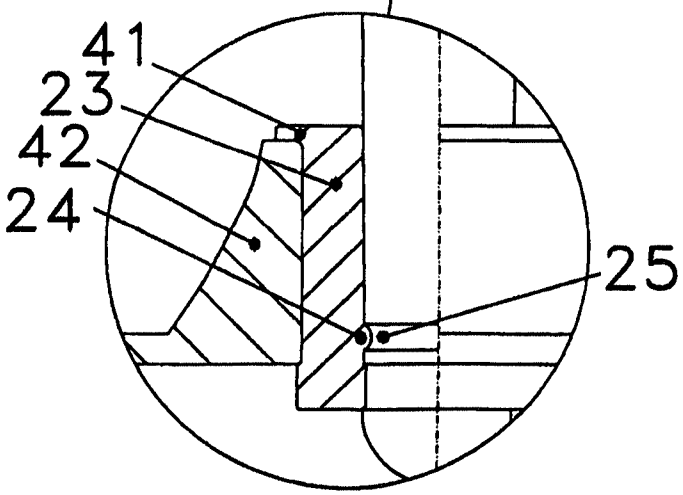


Fig.403D

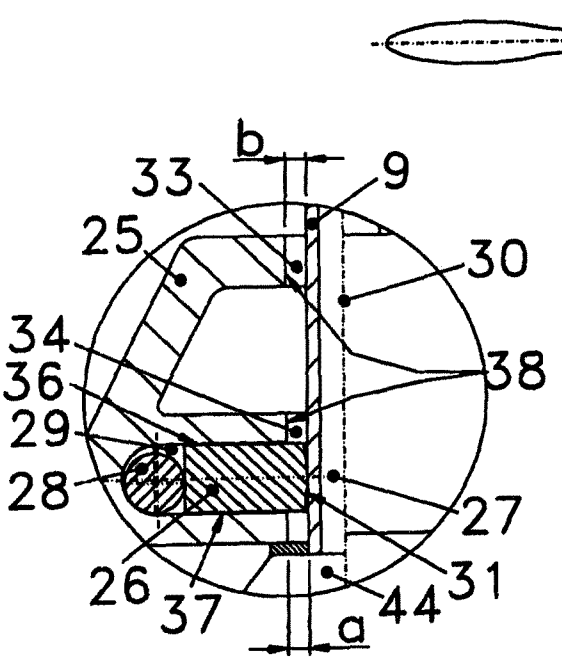


Fig.404B

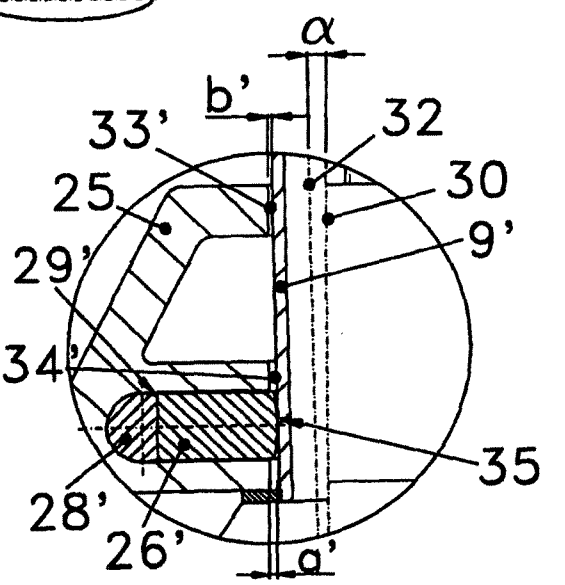


Fig.404C

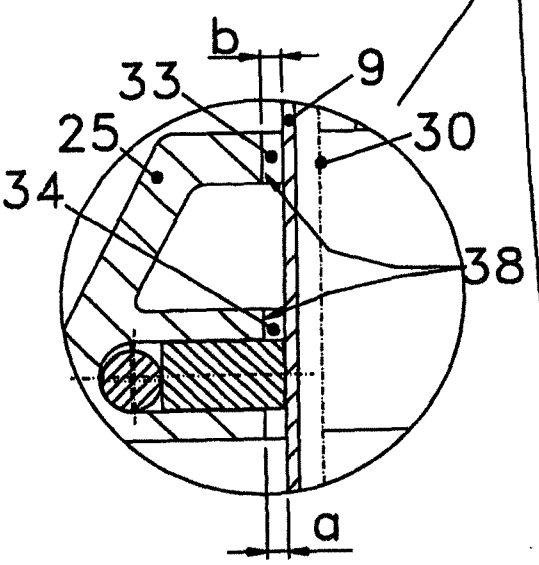
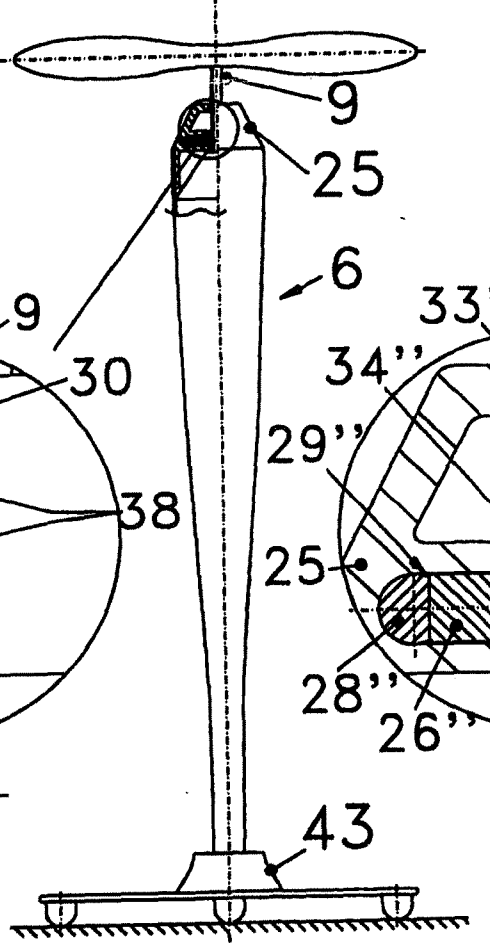


Fig.404D



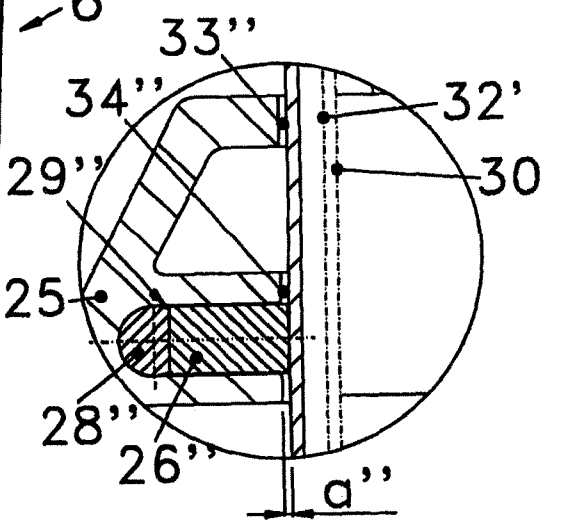


Fig.404E

Fig.404A

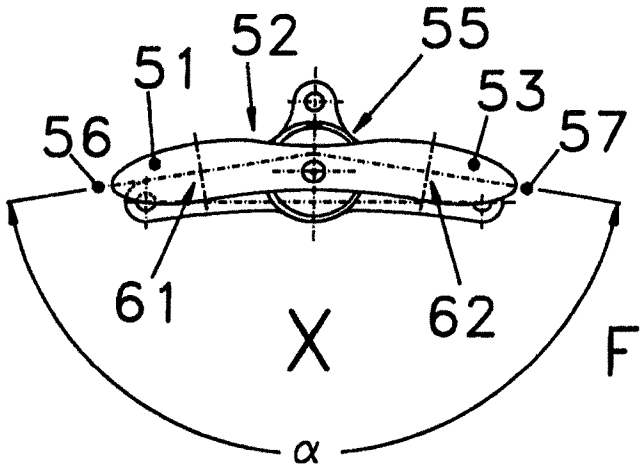


Fig.405A

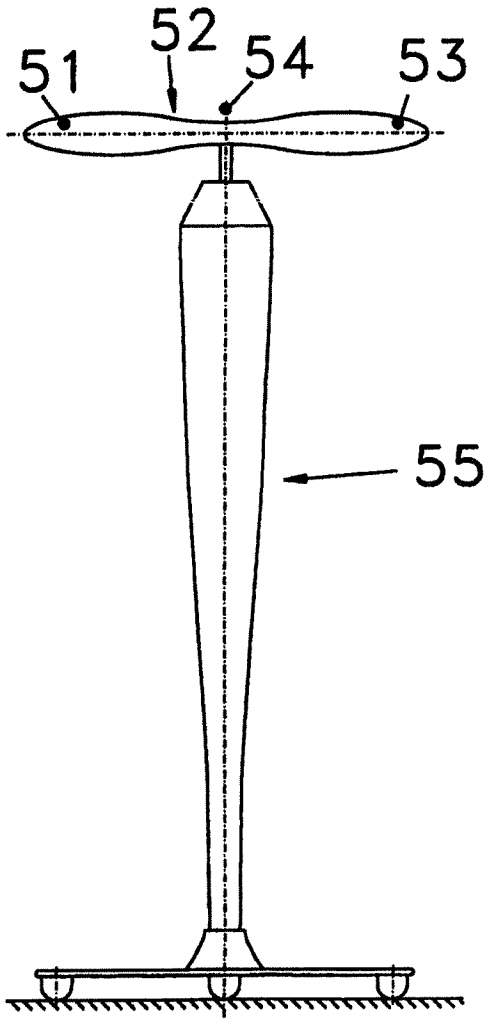


Fig.405B

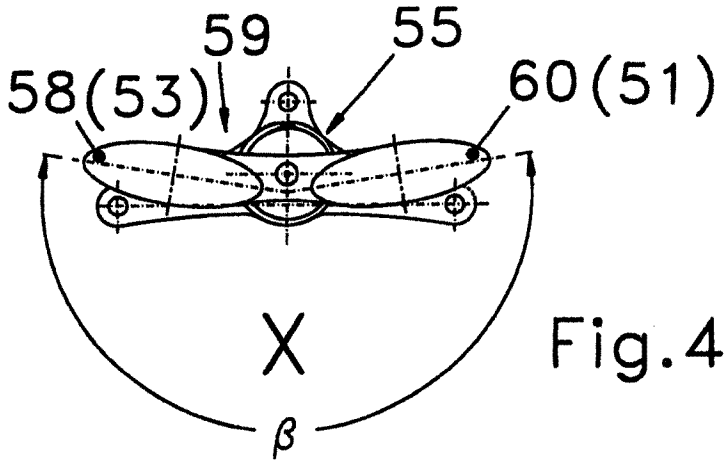


Fig.406A

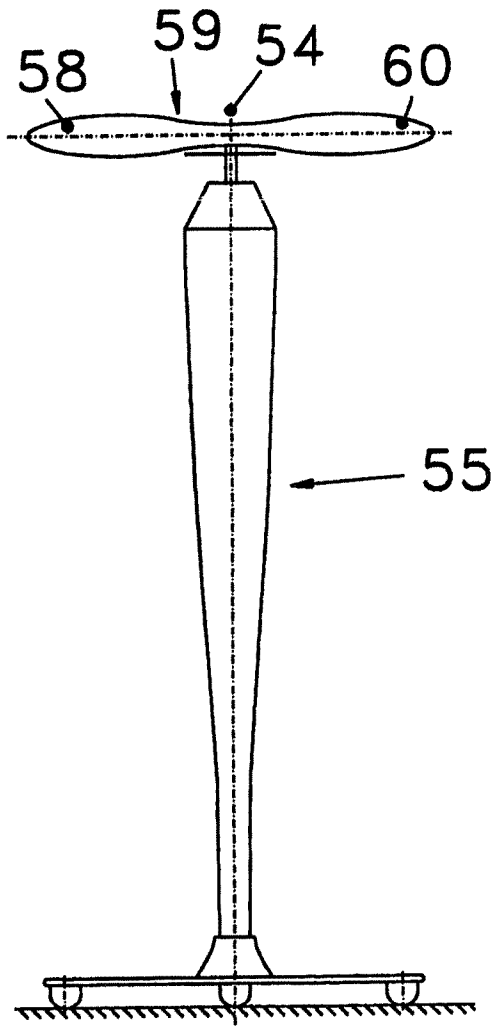


Fig.406B