(19) DANMARK

(10) **DK/EP 2276576 T3**

Patent- og
Varemærkestyrelsen

(12) Oversættelse af
europæisk patentskrift

(51) Int.Cl.: ***B 04 B 1/20 (2006.01)*** ***B 04 B 9/04 (2006.01)*** ***F 16 C 33/66 (2006.01)*** ***F 16 H 1/46 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2018-09-24**

(80) Dato for Den Europæiske Patentmyndigheds
bekendtgørelse om meddelelse af patentet: **2018-06-20**

(86) Europæisk ansøgning nr.: **09723605.3**

(86) Europæisk indleveringsdag: **2009-03-17**

(87) Den europæiske ansøgnings publiceringsdag: **2011-01-26**

(86) International ansøgning nr.: **EP2009053135**

(87) Internationalt publikationsnr.: **WO2009115516**

(30) Prioritet: **2008-03-20 DE 102008015134**

(84) Designerede stater: **AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR**

(73) Patenthaver: **GEA Mechanical Equipment GmbH, Werner-Habig-Strasse 1, 59302 Oelde, Tyskland**

(72) Opfinder: **OSTKAMP, Wilhelm, Axthauser Weg 15, 59302 Oelde, Tyskland**
NEUBAUER, Richard, Kantstr. 24, 59329 Wadersloh, Tyskland

(74) Fuldmægtig i Danmark: **Patrade A/S, Ceresbyen 75, 8000 Århus C, Danmark**

(54) Benævnelse: **Geararrangement til en centrifuge**

(56) Fremdragne publikationer:
EP-A- 0 409 791
WO-A-2004/097255
WO-A-2005/011871
DE-U1-202005 001 539
US-A- 4 941 866
US-A- 5 772 573

The invention relates to a gear apparatus for a centrifuge, in particular for a solid bowl screw centrifuge, as claimed in claim 1.

For driving decanters, i.e. solid bowl screw centrifuges, use is made of gear apparatuses which are connected downstream of the drive motors and have elements which rotate at the rotational speed of the drum.

In decanter gear apparatuses which are continuously filled with oil, it is not readily possible to check the filling level or add more gear oil during ongoing operation. Leaks, for example toward the product space, can be detected only when the apparatus is stationary during maintenance work. In addition, in the decanter of the type in question, an elevated pressure can build up in the gear; it is desirable to avoid this.

Moreover, a generic gear apparatus is known from US 5 772 573 A according to the preamble of claim 1.

One problem in the prior art is that oil loss in the gear cannot be safely compensated. For example, if there is a larger air bubble in the gear, the holes in the drive shaft are empty and the oil would have to enter the shaft from the outside counter to the centrifugal force. In order to achieve a reflowing of the oil, the oil would have to be pressurized in a controlled manner in the container, which is not practical.

With regard to the technological background, reference is made to WO 2004/097255 A2, DE 19 18 130 A, DE 20 2005 001 539 U1, DE 103 34 370 A1, EP 0 409 791 B1, DE 1 009 865 A1 and DE 1 782 548 A.

Against the background of the problem described at the outset, the object of the invention is to at least largely eliminate this problem.

The invention achieves this object by way of the subject matter of claim 1.

The result is a solid bowl screw centrifuge with a drum to be driven and a screw which is to be driven, preferably at a differential rotational speed relative to the drum, the gear apparatus being connected between at least one or more drive motors and the screw and the drum and the gear apparatus being continuously filled with an oil-type free-flowing lubricant, wherein the gear apparatus is associated with a lubricant compensating system with a lubricant compensating container, which is connected via a line to at least one hollow channel of a drive shaft of the gear apparatus, the drive shaft being embodied as a hollow shaft and wherein the hollow shaft has two longitudinal channels extending preferably parallel in the axial direction, wherein the longitudinal channels extend eccentrically to the axis of rotation or wherein one of the longitudinal channels extends centrically relative to the axis of rotation and the other extends eccentrically or coaxially with the first longitudinal channel.

In order to compensate for any losses of oil and in order to promptly obtain during operation an indication of an existing leak, an oil compensating container is installed above the gear apparatus. The oil compensating container is connected to the oil volume in the gear via a rotary lead-in, the transfer point being located axially and centrally on the drive shaft of the gear. If oil is lost in the gear, oil can run out of the container into the gear. Damage is thus prevented in a simple manner.

In addition, the invention in a simple manner avoids differences in pressure or prevents pressure from building up in the gear during heating in a manner that might lead to "breathing" and possibly the infiltration of dirt/water.

In addition, oil losses become more reliably detectable. It is thus possible to visually detect a loss of oil before the gear is jeopardized.

In addition, possible contamination of the material to be centrifuged is impeded (in particular in the case of an internal gear).

In addition, it is possible to add more oil into the gear during ongoing operation if production has to be maintained.

Nevertheless, in an implementation of a drive concept with motors mounted on the end side and coaxially with the drive shaft – referred to as a direct drive – the concept of the central rotary lead-in is possible only with relatively great technical effort. However, motors with a hollow shaft can be used, the latter variant forming the advantageous subject matter of claim 3.

If the rotary lead-in is positioned in such a way that it surrounds the hollow drive shaft, the oil has to enter the hollow shaft via a hole in the lateral surface. It is conceivable to form this hole radially and thus to encounter a hole or line in the center of the shaft that then leads to the gear volume.

Nevertheless, when the gear housing is stationary, the rotating drive shaft attempts to pump oil out of the gear into the compensating container, since the oil is outwardly accelerated in the radial hole of the shaft. If the suction is sufficiently high, oil flows out and air is drawn into the gear under the dynamic seals. It is possible to avoid this effect if an equivalent radial hole is arranged at the inner end of the drive shaft.

Advantageously, in order to further solve the above problem, the gear apparatus with the drive shaft which is designed as a hollow shaft has the two axially extending oil holes – the longitudinal channels of claim 1 - which according to a variation are drilled eccentrically and obtain transverse holes positioned next to one another. Alternatively, one of the oil holes is formed centrically and the other eccentrically or for example coaxially with the first oil hole.

In this case, the transverse holes are drilled onto the longitudinal holes preferably so as to be laterally offset and oblique relative to one another (in accordance with the peeling disk principle).

In this case, it is particularly advantageous if the transverse holes are formed independently of the direction of rotation in such a way that one channel pumps and one draws in. When the housing rotates, a correspondingly designed rotary lead-through provides a defined system: oil is conveyed into the gear in a targeted manner and air is conveyed out. This arrangement has a plurality of advantages.

To begin with, it is operative independently of the direction of rotation.

In addition, it allows air to be brought safely out of the gear.

In addition, the solution can be implemented in a simple manner in designs having a secondary motor arranged on the end side for driving the screw. It is in particular suitable for lubricating the gear apparatus with oil instead of fat.

If the two channels in the rotary lead-through are uncoupled from each other by an intermediate seal and connected via two hoses, a passage and cooling are also conceivable.

Further advantageous configurations may be inferred from the sub-claims.

The invention will be described hereinafter based on exemplary embodiments and with reference to the drawings, in which:

fig. 1 is a sectional view of a partial region of a schematically illustrated first gear apparatus, which is not claimed, with which an oil compensating container is associated;
fig. 2 shows a partial region of a second gear apparatus, which is not claimed;
fig. 3a is a section through a partial region of a third gear apparatus;
fig. 3b – e are sections through various axial regions of a drive shaft;
fig. 4a – e are a section through a partial region of the third gear apparatus with a cooling device;
fig. 5a – e are a section through a partial region of the fourth gear apparatus; and
fig. 6, 7 are schematic illustrations of solid bowl screw centrifuges.

Fig. 1 is a sectional view through a gear apparatus 1 of a solid bowl screw centrifuge, the gear apparatus 1 not being claimed. With regard to the construction of a solid bowl screw centrifuge, reference is made to fig. 6.

The solid bowl screw centrifuge has a screw 22 and a drum 23, the gear apparatus being connected between at least one or two drive motors 24, 25.

When installed, the gear apparatus 1 is preferably oriented in such a way that rotating parts of the gear apparatus 1 each have horizontally oriented axes of rotation. The main axis of rotation of a central drive shaft 9, 18 (see figure 1 or 3 and also 5 and 6) is denoted by D. The elements to be lubricated of the gear apparatus include in particular a plurality of bearings 2.

The gear apparatus is designed as a gear apparatus which is continuously filled with oil. It can be constructed per se in various manners and have in particular one or more gears each having at least one or more gear stages which can be designed for example as planetary gear stages or the like.

For feeding torque, use is made of one or in this case two pulleys 3 which are coupled to the output shafts 28 of the drive motors (not shown here, but see fig. 6) via drive belts 26, 27 shown in fig. 6.

The output shafts 4 (not shown here in detail) can each be coupled in a rotationally fixed manner to the drum 23 and a screw body of the screw 22.

According to fig. 3 to 7, one drive motor 25, which serves to drive the screw 22, is on the other hand arranged directly in the axial extension of the drive shaft 18, thus creating a type of direct drive for the drive shaft on which, for example, a driving or braking moment for the screw is introduced into the gear apparatus 1.

The gear apparatus 1 serves to generate a differential rotational speed between the screw and the drum. The drum bearings at the two axial ends of the drum 23 are provided with the reference numeral 29.

For lubricating elements to be lubricated of the gear apparatus 1, in particular for lubricating the bearings 2, use is made of a free-flowing lubricant, in particular an oil, which can be guided into the gear apparatus 1 using a type of lubricant compensating system or preferably lubricant compensating circuit 5.

The lubricant compensating circuit 5 has a line 6 (see fig. 1 and 6), arranged at the end of which remote from the gear apparatus is a lubricant compensating container 7 which is filled up to a certain level with the lubricant and is arranged at a sufficient level above the gear apparatus 1. Preferably, the level of oil in the lubricant compensating container 7 is at all times higher than the highest point to be supplied with oil in the gear.

The other end of the line 6 opens here via an axial rotary lead-through 8 in the axial extension of a hollow shaft 9, which also serves as a drive shaft for the drive motor 25 (which is to this extent similar to fig. 6), into the hollow shaft 9 of the gear apparatus which can be designed in one or more pieces and axially penetrates preferably one or more, in particular all of the gears and/or gear stages of the gear apparatus.

The lubricant can be guided in such a simple manner axially into the region of all of the elements to be lubricated, in particular the bearings 2, of the gear apparatus.

Via channels 10 branching off preferably radially from the hollow shaft 9, the lubricant can flow to the elements of the gear apparatus that are to be lubricated and from which it enters – for example via axial and/or radially extending connecting spaces or channels – one or more annular space(s) 11 extending parallel to the axis of rotation.

In order to implement a circuit, the radial oil level P in the space 11 is limited by a conveying means, in particular a peeling disk-like element 12 or a scoop tube, which does not rotate or is stationary during operation, so that it can be used in the manner of a centripetal pump to pump lubricant away out of the rotating system, to begin with radially inward and then into a discharge line 13 extending radially outward.

The discharge line 13 opens, between the lubricant compensating container 7 and the gear apparatus 1, into the line 6.

This arrangement with a peeling disk or centripetal pump-like element 12 and the preferred feed line in a hollow shaft 9 as a feed line of the lubricant compensating circuit 5 allows a defined oil level to be set in a simple manner in the gear apparatus while at the same time supplying the inner rolling bearings 2.

The lubrication of the elements to be lubricated of the gear apparatus is in this way ensured in a simple manner.

Fig. 2 shows a detail of a gear apparatus 1 of a solid bowl screw centrifuge, the gear apparatus 1 not being claimed.

In this case, lubricant is discharged from a radially outer region of the gear apparatus into a radially inner region of the gear apparatus, again via a conveying means such as a peeling disk-like element or in this case a type of scoop tube 12', the discharge line 13' from the scoop tube opening in this case back into a radially internal space 21 of the gear apparatus 1. This is advantageous, as a lower oil pressure generally prevails in the center than further outward, as the gear can be connected here to an oil compensating container (see fig. 1) and only low centrifugal forces prevail. The inflow into the annular space 11 (for setting the lubricant surface area P) can be influenced by means of suitable dimensioning of a restrictor 33.

Fig. 3a shows a partial region of a further gear apparatus which is otherwise not illustrated in the present document and can be constructed per se – apart from the area of the manner in which the lubricant is fed into the gear apparatus – in a manner similar to the type of fig. 1, i.e. in particular a feed line from a lubricant compensating container 7 is provided as part of a lubricant compensating circuit 5 of the decanter gear apparatus 1 which is continuously filled with oil.

In contrast to fig. 1, in which the torque is fed via pulleys, provision is made in accordance with fig. 3 (and 4) for the drive shaft 18, which is embodied as a hollow shaft, in any case in certain portions, to be coupled, for feeding the driving moment for the screw, to a drive motor for the screw in the axial extension of the main axis of rotation of the gear apparatus 1, the drive motor being designed as a direct drive (fig. 6).

In this case, provision is in accordance with fig. 3 and 4 and also 5 preferably made to implement the oil feed line and if appropriate an air discharge line (wherein oil can be contained in the air) not into the drive shaft (hollow shaft) 18 from the axial direction but rather through transverse holes 16, 17 which extend at an angle – in particular in one or more planes parallel to the radial to the axis of rotation D – and open into the hollow shaft 18 "from the side".

According to figure 3, the hollow shaft 18 has, unlike in figure 1, not just a single hollow channel as an oil supply line but rather two longitudinal channels 14, 15 which extend preferably parallel in the axial direction, are arranged eccentrically, i.e. outside the axis of rotation D, and one of which serves as a lubricant feed line and the other as a lubricant discharge line 7. It would also be conceivable to arrange one of the longitudinal channels centrically and one eccentrically.

From the longitudinal channels 14, 15, the transverse holes 16a, b; 17a, b each lead outward from the longitudinal channels or lines 14, 15. In this case, the transverse holes 16a, b; 17a, b are each oriented preferably parallel (or alternatively at an angle) to the radial direction and arranged offset from one another axially in the direction of the axis of rotation D. The two associated transverse holes 16a, b and 17a, b respectively are oriented parallel to each other. However, they can also enclose an angle to each other and/or to the radial direction relative to the axis of rotation D which in this case extends centrically between the two longitudinal channels 14, 15. The transverse holes 16, 17 are oriented parallel or at an angle to the radial such that a respective pumping or suction effect is generated at the transverse holes while the hollow shaft 18 rotates during operation.

In particular, two respective adjacent branch channels or transverse holes 16a, b and 17a, b respectively are oriented in such a way that in each case oil is pumped into one of the longitudinal channels – for example the channel 14 – through one of the transverse holes – for example the hole 16a – and air (if appropriate with a low oil content) is discharged from the other longitudinal channel – for example the channel 15 – through the other transverse hole – for example the hole 16b.

In each case two of the transverse holes 16a, b; 17a, b, of which there are in total four in this case, open outward in each case into a common annular space 19 of a rotary lead-through element 32 surrounding the shaft or an annular space 20 in the gear, a type of rotary lead-through between the non-rotating and the rotating system being implemented on the rotary space 19 which opens into the line 6 which is connected to the oil compensating container 7 (not shown here).

The annular space 20 is connected to the elements to be lubricated such as the bearings 2.

It is particularly advantageous if the transverse holes 16a, b; 17a, b are formed in a peeling disk-like manner and independently of the direction of rotation in such a way that in each case one channel 14 pumps and the other channel 15 draws in.

Fig. 3b is a section perpendicular to the plane of the sheet along the line A, fig. 3c is a similar section on the line B, fig. 3d is a section on the line C and fig. 3e is a section on the line D.

The annular space 19 is connected to the line 6 to the oil compensating container 7. This provides a defined lubricant circuit 5 for a decanter gear apparatus 1 in a simple manner.

According to fig. 4, the transverse holes 16a, 16b open into annular spaces 19a, 19b of a rotary lead-through element 32 surrounding the shaft 18, the annular spaces being axially separated from each other, and from there into separate feed and discharge lines 6, 13 which are guided into the compensating container 7, so that a complete lubricant circuit is implemented here by the compensating container 7.

In the region of the discharge line 13, the lubricant compensating circuit 5 according to fig. 4 is additionally provided with an optional cooling device 30 having a coolant passage 35 and/or an optional filter 34 for cooling or filtering the lubricant (oil), although this/these do(es) not necessarily have to be provided in the design. Otherwise, the arrangement corresponds to that of fig. 3.

According to fig. 5 too, the transverse holes 16a, 16b open into annular spaces 19a, 19b of the rotary lead-through element 32 surrounding the shaft 18, the annular spaces being axially separated from each other, and from there into separate feed and discharge lines 6, 13 which are guided in this case separately from each other into the compensating container 7, so that a complete lubricant circuit is implemented here through the compensating container 7.

Fig. 7 shows a solid bowl screw centrifuge, the gear apparatus of which likewise has a lubricant compensating container 7 which guides oil into a hollow shaft 31 penetrating the drive motor 25 via a line 6 and a rotary lead-through (not shown here). The hollow shaft 31 is arranged directly in the axial extension of the hollow shaft 9 and connected thereto in a rotationally fixed and oil-tight manner.

Reference numerals

gear apparatus	1
bearing	2
pulleys	3
output shafts	4
lubricant compensating circuit	5
feed line	6
lubricant compensating container	7
rotary lead-through	8
hollow shaft	9
channels	10
annular space	11
conveying means	12
discharge line	13
longitudinal channels	14, 15
transverse holes	16a, b; 17a, b
shaft	18

annular space	19
space	20
space	21
screw	22
drum	23
drive motors	24, 25
drive belts	26, 27
output shafts	28
drum bearing	29
cooling device	30
hollow line	31
rotary lead-through	32
restrictor	33
filter	34
coolant passage	35
lubricant surface area	P
radial	R
axis of rotation	D

Patentkrav

1. Geararrangement (1) til en snekkecentrifuge, især en fuldkappe-snekkecentrifuge med en drevet tromle (23) og en drevet snekke (22), fortrinsvis drevet med et forskelligt omdrejningstal i forhold til tromlen (23), hvilket geararrangement (1) er tilsluttet mellem mindst en eller flere drivmotorer (24, 25) og snekken (22) og tromlen (23), og hvor geararrangementet (1) kontinuerligt fyldes med et flydedygtigt smøremiddel af olietypen, hvori geararrangementet er tilknyttet et smøremiddeludligningssystem med en smøremiddeludligningsbeholder (7), som er tilsluttet via en ledning (6) til mindst en hul kanal i en drivaksel i geararrangementet, hvilken drivaksel er udført som en hul aksel (9, 18), **kendetegnet ved, at** den hule aksel (9, 18) har to langsgående kanaler (14, 15), der forløber fortrinsvis parallelt i aksialretningen, hvori de langsgående kanaler (14, 15) forløber ekscentrisk i forhold til rotationsaksen, eller hvori en af de langsgående kanaler forløber koaksialt med rotationsaksen og den anden forløber ekscentrisk eller koaksielt med den første langsgående kanal.

2. Geararrangement ifølge krav 1, **kendetegnet ved, at** smøremiddeludligningssystemet er et smøremiddeludligningskredsløb (5).

3. Geararrangement ifølge krav 1 eller 2, **kendetegnet ved, at** en af drivmotorerne (25) er arrangeret direkte i aksiel forlængelse af drivakslen (9, 18).

4. Geararrangement ifølge krav 2 eller 3, **kendetegnet ved, at** ledningen (6) fra olieopsamlingsbeholderen (7) til den hule aksels (9, 18) hule kanal sker gennem en anden hul aksel (31) eller et hult akselafsnit i drivmotoren.

5. Geararrangement ifølge krav 4, **kendetegnet ved, at** olietilledningen fra olieopsamlingsbeholderen (7) ind i den hule aksel (9, 18) sker gennem en roterende gennemføring og mindst et hul (16) ind i den mindst ene hule kanal (14), der forløber aksielt i geararrangementets drivaksel (9, 18).

6. Geararrangement ifølge et af foregående krav 4 eller 5, **kendetegnet ved, at** olie tilledes fra olieopsamlingsbeholderen den som hul aksel (18) udformede ledning i geararrangementet gennem en roterbar gennemføring (8) arrangeret i aksiel forlængelse af geararrangementets hule aksel.

7. Geararrangement ifølge et af foregående krav 4 til 6, **kendetegnet ved, at** smøremidlet flyder gennem kanaler (10), der afgrenes fra den hule aksel (9) til de elementer, der skal smøres i geararrangementet, fra hvilke det kommer ind i mindst et ringformet rum (11) med en oliestand P.

8. Geararrangement ifølge det foregående krav 7, **kendetegnet ved, at** oliestanden P er begrænset radielt og i det ringformede rum (11).

9. Geararrangement ifølge det foregående krav 8, **kendetegnet ved, at** den radielle oliestand P i rummet (11) begrænses af et transportmiddel (12).

10. Geararrangement ifølge krav 9, **kendetegnet ved, at** transportmidlet er udformet som et skrabeskivelignende element (12) på sådan måde, at det under drift afgiver smøremiddel fra det roterende system til en udledning (13) på samme måde som en centripetalpumpe.

11. Geararrangement ifølge krav 10, **kendetegnet ved, at** det skrabeskivelignende element er tilvejebragt som en skovlrør (12'), som tillader smøremiddel at udledes fra et radielt yderområde af geararrangementet til et radielt indre område af geararrangementet.

12. Geararrangement ifølge et af de foregående krav, **kendetegnet ved, at** drivakslen (18) for tilførsel af drivmomentet til snekken (22) er tilkoblet en drivmotor (25) for snekken (22), hvor drivmotoren er direkte drivende i aksiel forlængelse af geararrangementets (1) hovedrotationsakse, hvor smøremidlet tilføres gennem tværgående huller (14, 15), som forløber i en vinkel, især i et eller flere planer vinkelret på rotationsaksen D, og udmunder i den hule aksel (18).

13. Geararrangement ifølge krav 12, **kendetegnet ved, at** de tværgående huller (16a, b; 17a, b) hver er arrangeret til at være indbyrdes aksielt forskudt i retning af rotationsaksen D.

14. Geararrangement ifølge et af de foregående krav 12 og 13, **kendetegnet ved, at** de tværgående huller (16a, b; 17a, b) hver er arrangeret i en vinkel på radialretningen.

15. Geararrangement ifølge et af de foregående krav 12 til 14, **kendetegnet ved, at** de tværgående huller (16a, b; 17a, b) hver er arrangeret parallelt med radialretningen.

16. Geararrangement ifølge et af de foregående krav 12 til 15, **kendetegnet ved, at** de tværgående huller (16, 17) er orienteret på sådan måde, at der under drift frembringes en pumpende eller sugende effekt ved de tværgående huller (16, 17) under rotation af den hule aksel (18).

17. Geararrangement ifølge et af de foregående krav 12 til 16, **kendetegnet ved, at** to tilstødende huller af de tværgående huller (16a, b henholdsvis 17a, b) er orienteret på sådan måde, at olie pumpes ind i en af de langsgående kanaler i hvert tilfælde gennem et af de tværgående huller, og at luft og eventuelt olie udledes af den anden langsgående kanal gennem det andet tværgående hul.

18. Geararrangement ifølge krav 17, **kendetegnet ved, at** de tværgående huller (16a, b; 17a, b) er udformet på skrabeskivelignende måde og uafhængig af rotationsretningen på sådan måde, at en af de langsgående kanaler (14, 15) pumper og den anden suger.

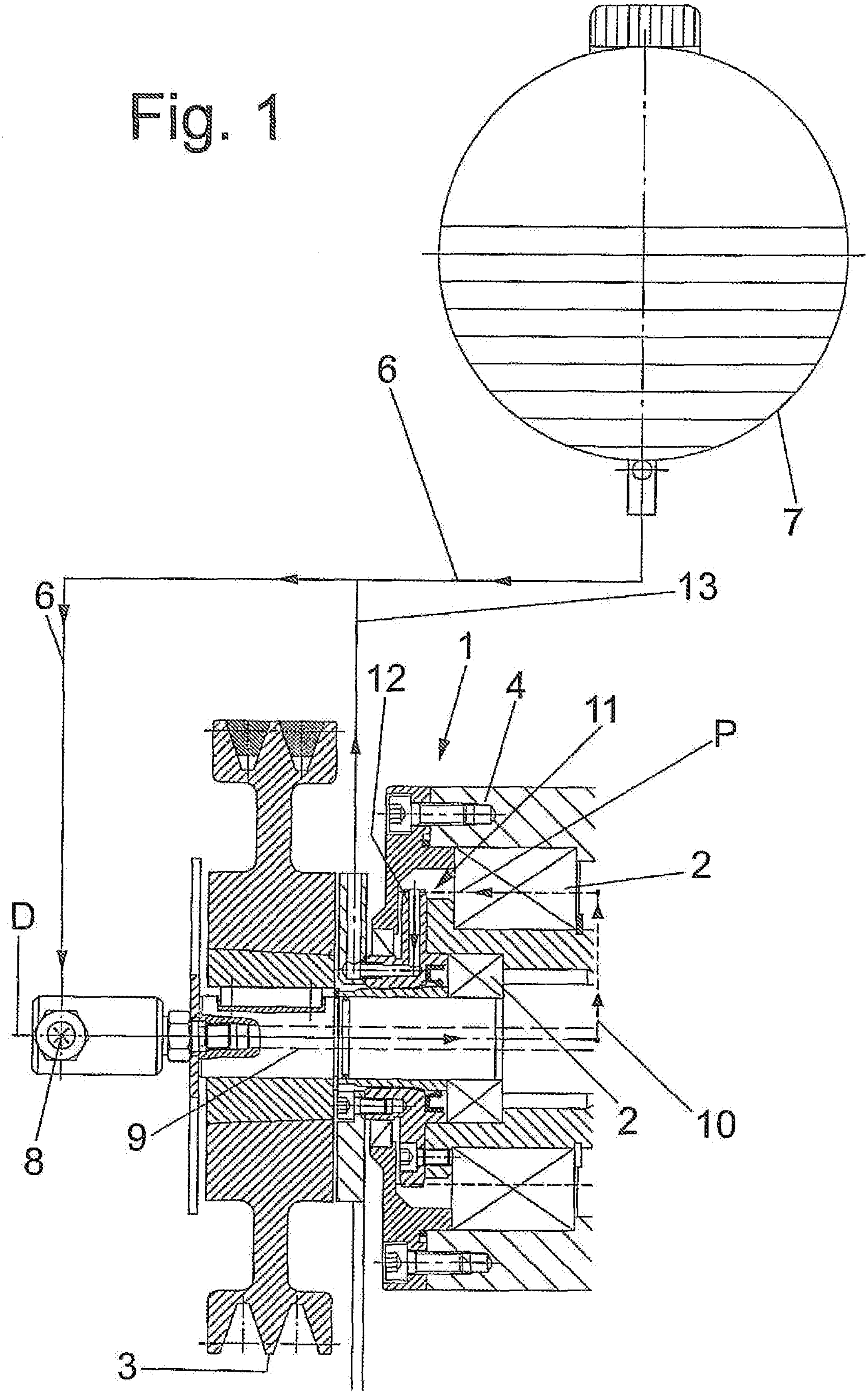
19. Geararrangement ifølge et af de foregående krav 12 til 18, **kendetegnet ved, at** de tværgående huller (16a, b) udmunder i mindst et fælles ringformet rum (19) eller to ringformede rum (19a, 19b) i et roterbart gennemgående element (32), der omgiver den hule aksel (18), hvor de ringformede rum er indbyrdes adskilt aksielt.

20. Geararrangement ifølge krav 19, **kendetegnet ved, at** tilførsels- og udledningsledningerne (6, 13) er ført ind i udligningsbeholderen (7), idet tilførsels- og udledningsledningerne er adskilt fra det roterbare, gennemgående elements (32) to ringformede rum (19a, 19b).

21. Geararrangement ifølge et af de foregående krav, **kendetegnet ved, at** smøremiddeludligningskredsløbet (5) har en køleindretning (30).

22. Geararrangement ifølge et af de foregående krav, **kendetegnet ved, at** smøremiddeludligningskredsløbet (5) har et filter (34).

Fig. 1



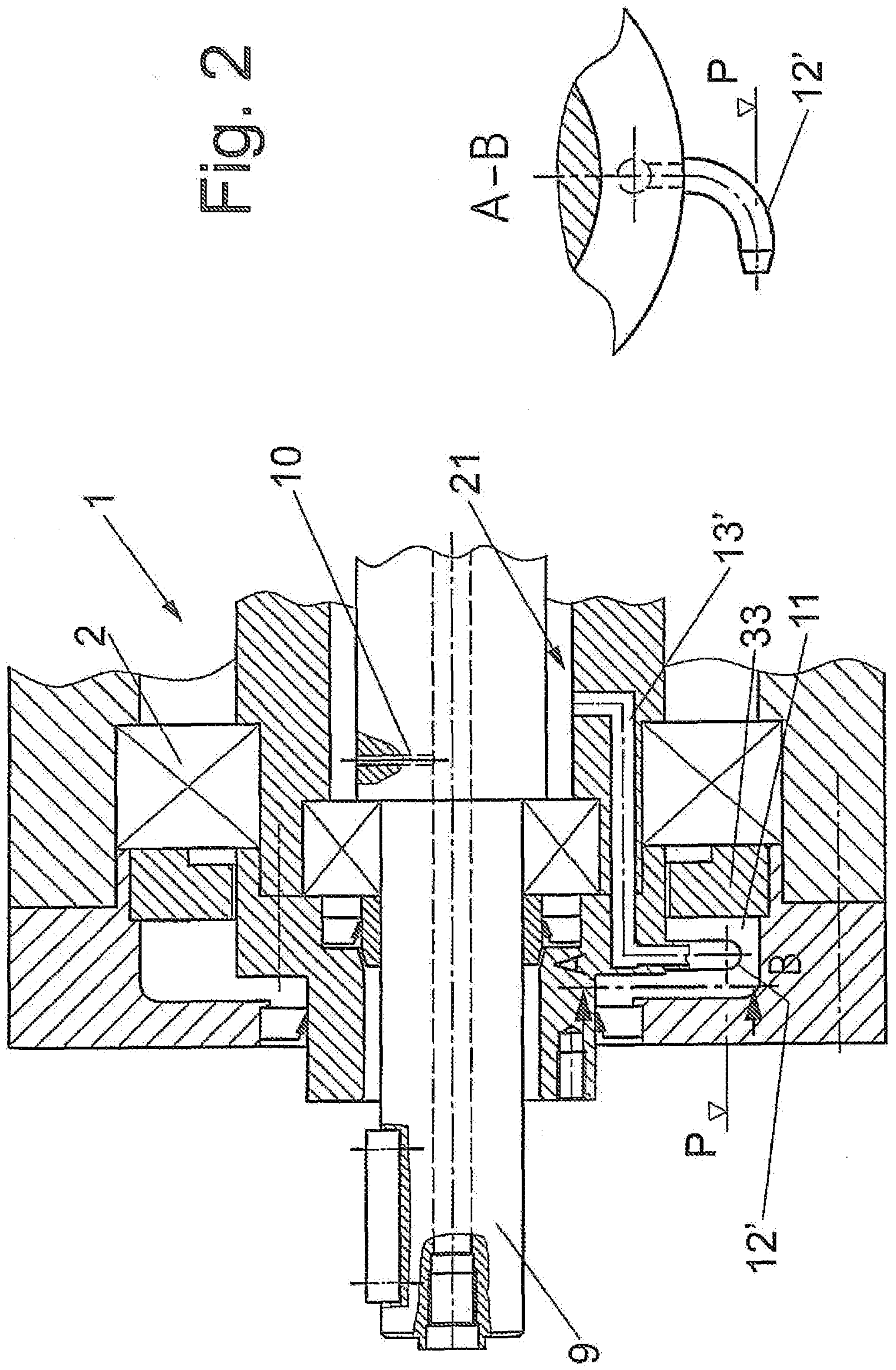


Fig. 2

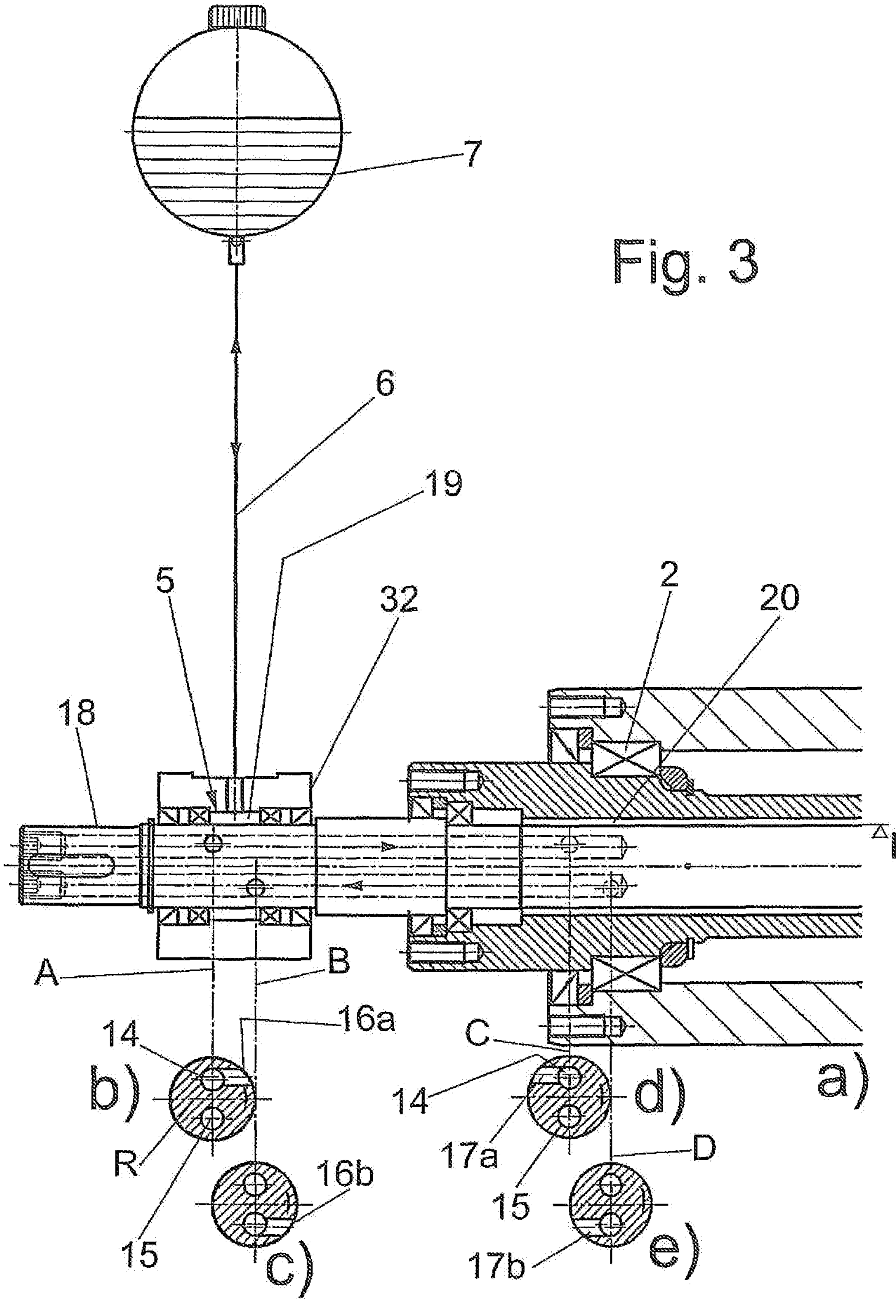


Fig. 3

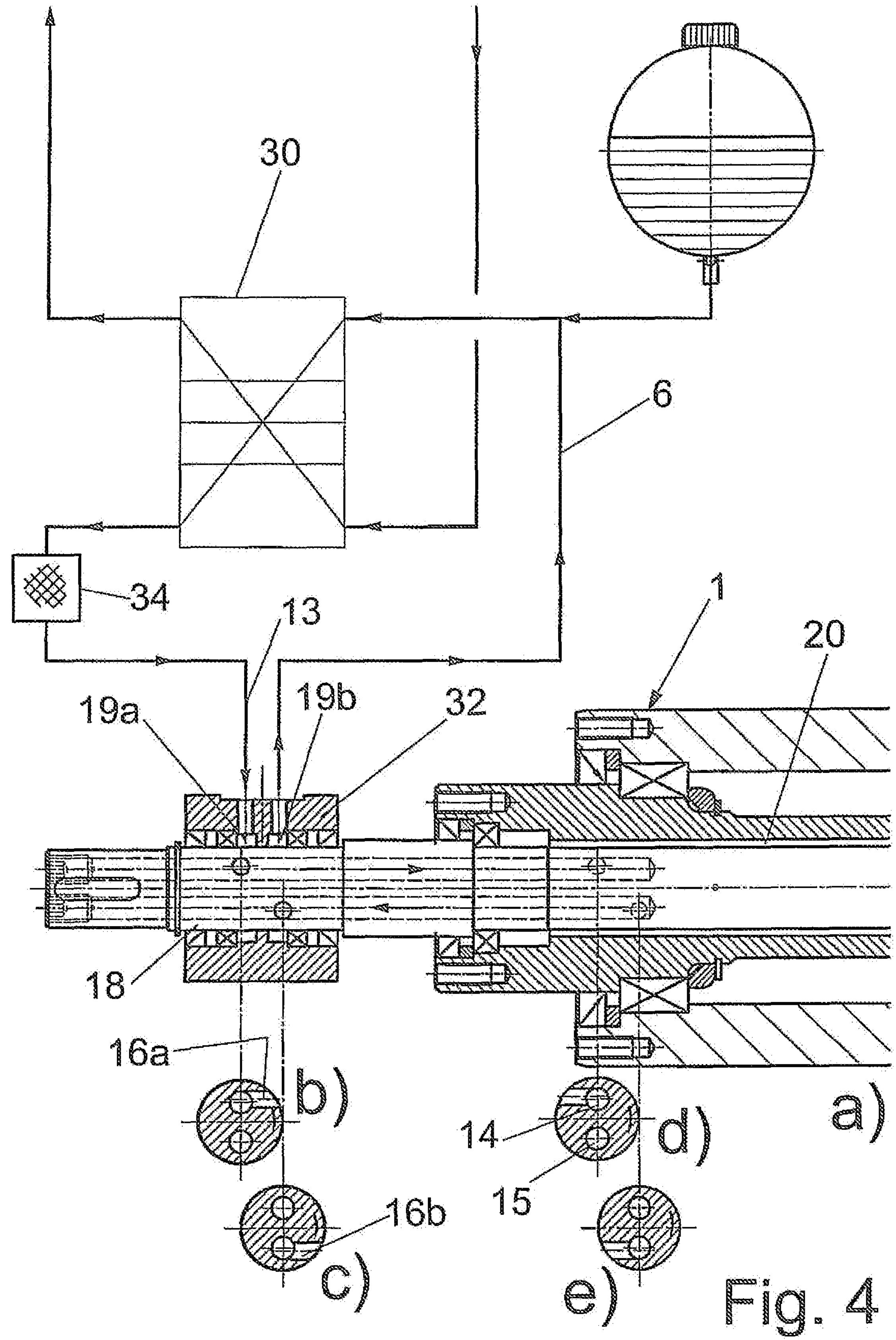


Fig. 4

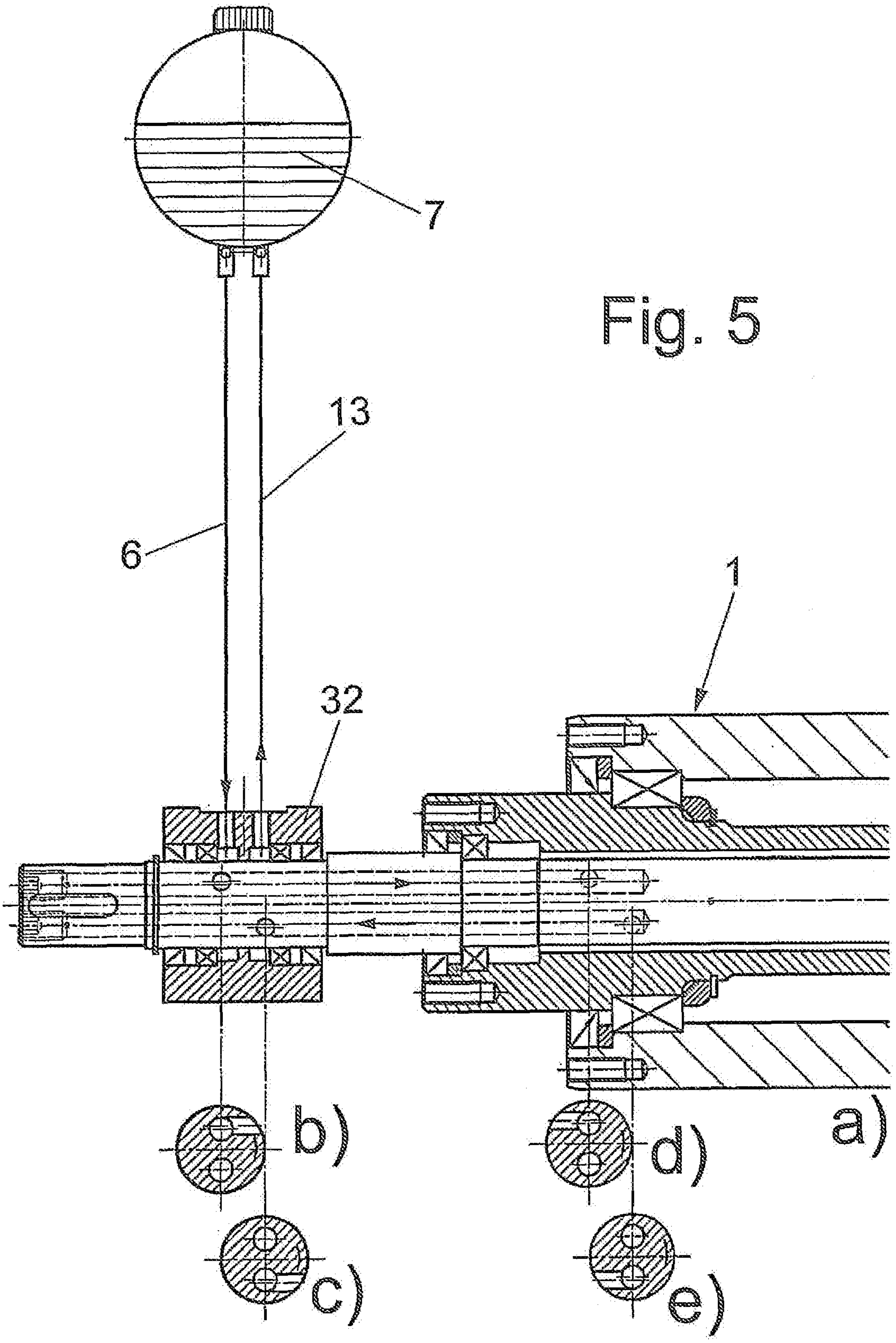
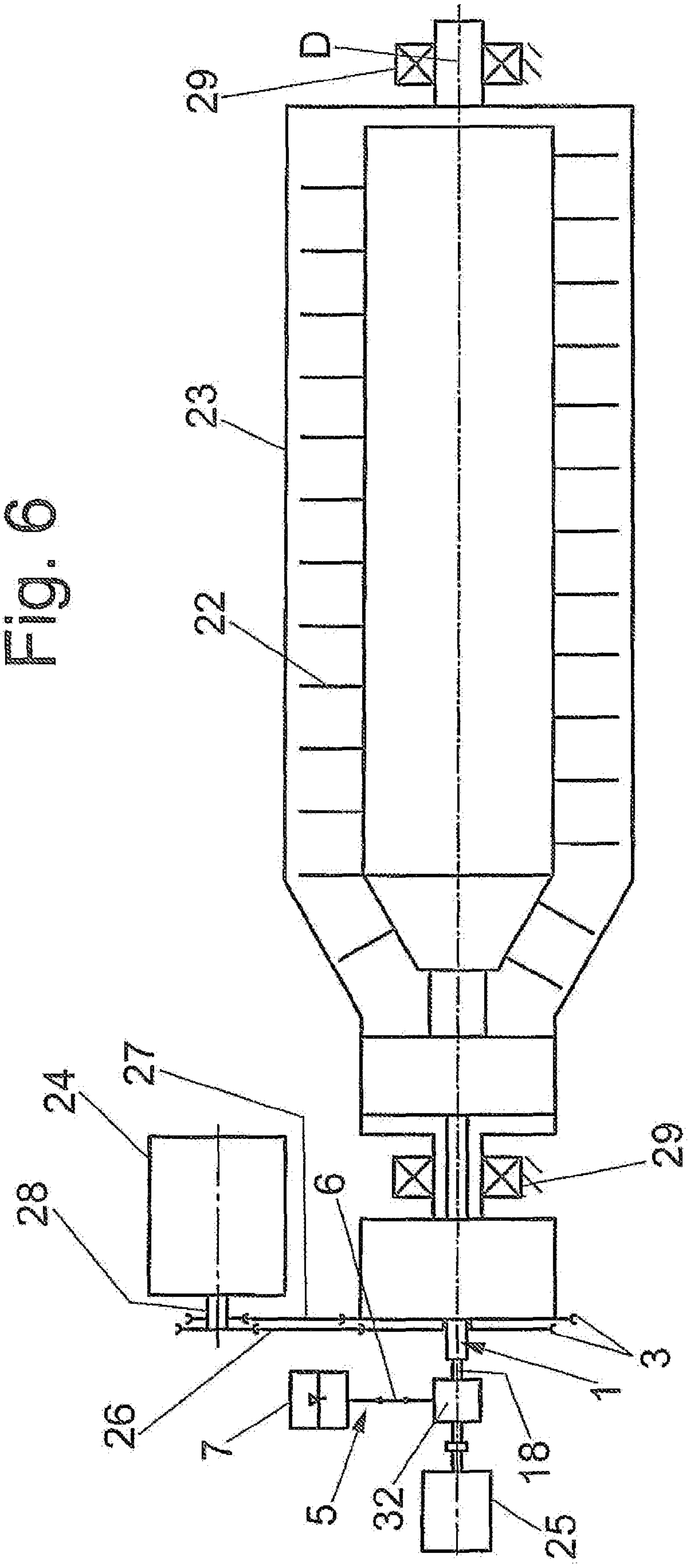


Fig. 5

Fig. 6



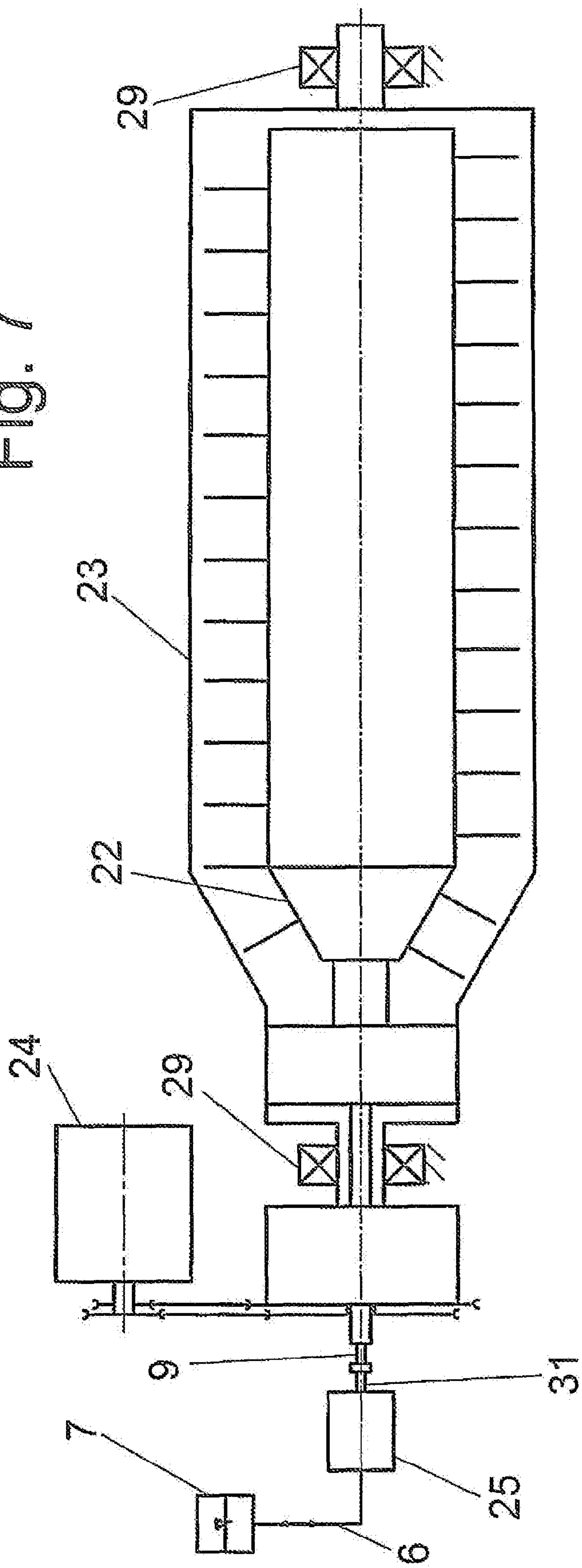


Fig. 7