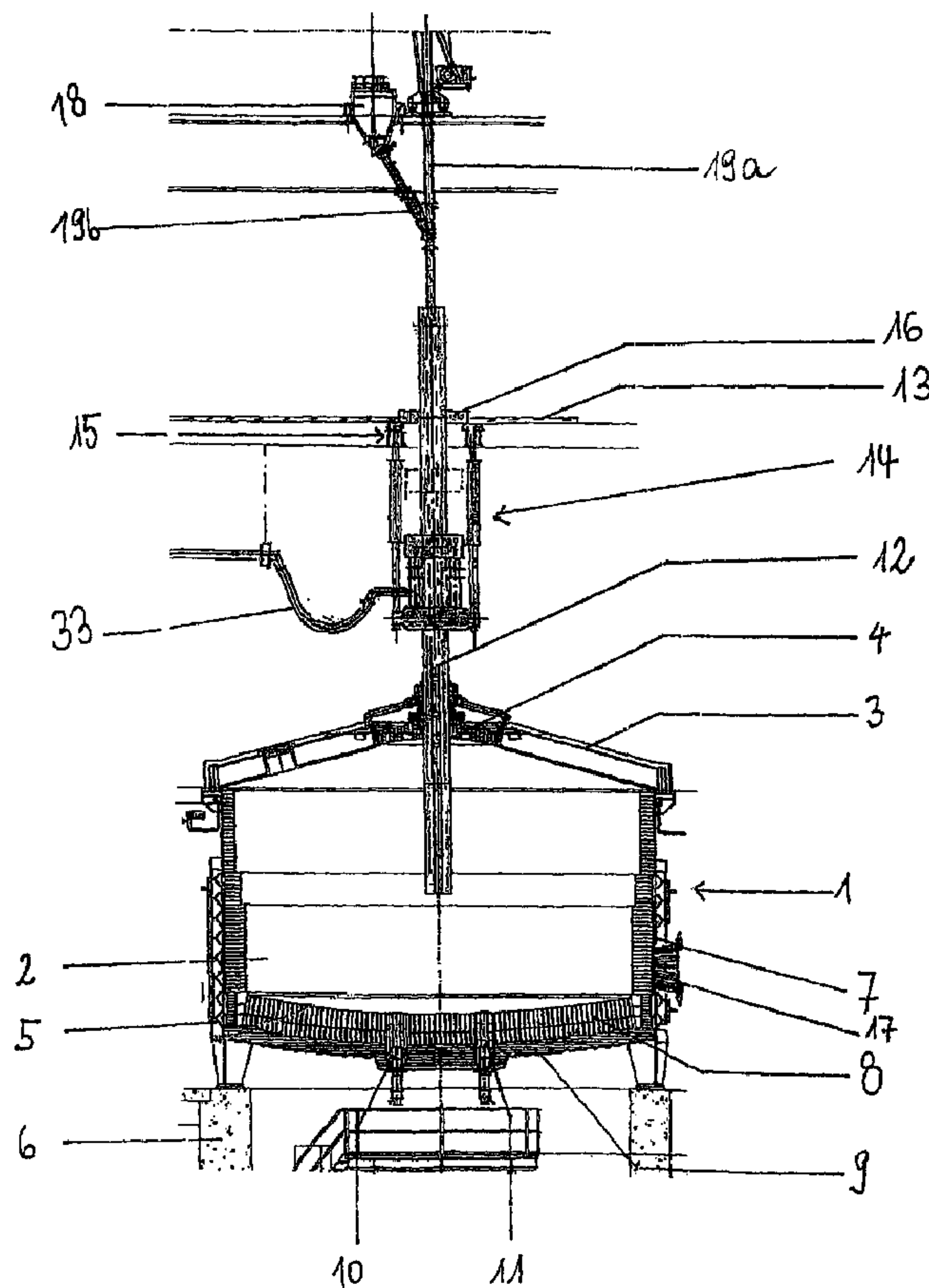




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(54) Title: DIRECT CURRENT ARC FURNACE



(57) Abrégé/Abstract:

The invention relates to a direct current arc furnace (1) comprising an electrode (12) which is maintained inside the furnace and which can be replaced in order to compensate the combustion of the electrode. Said direct current arc furnace also comprises a

(57) **Abrégé(suite)/Abstract(continued):**

counter electrode (10, 11) which is arranged in the furnace, for example, a base electrode. In order to prevent loss of power during replacement and/or attachment of the electrode in said type of furnace and in order to improve the sealing power of the electrode in the furnace cover, the whole electrode branch (14) is arranged with an electrode holder and a replacement device is arranged on a furnace platform (13) or a frame above the furnace (1).

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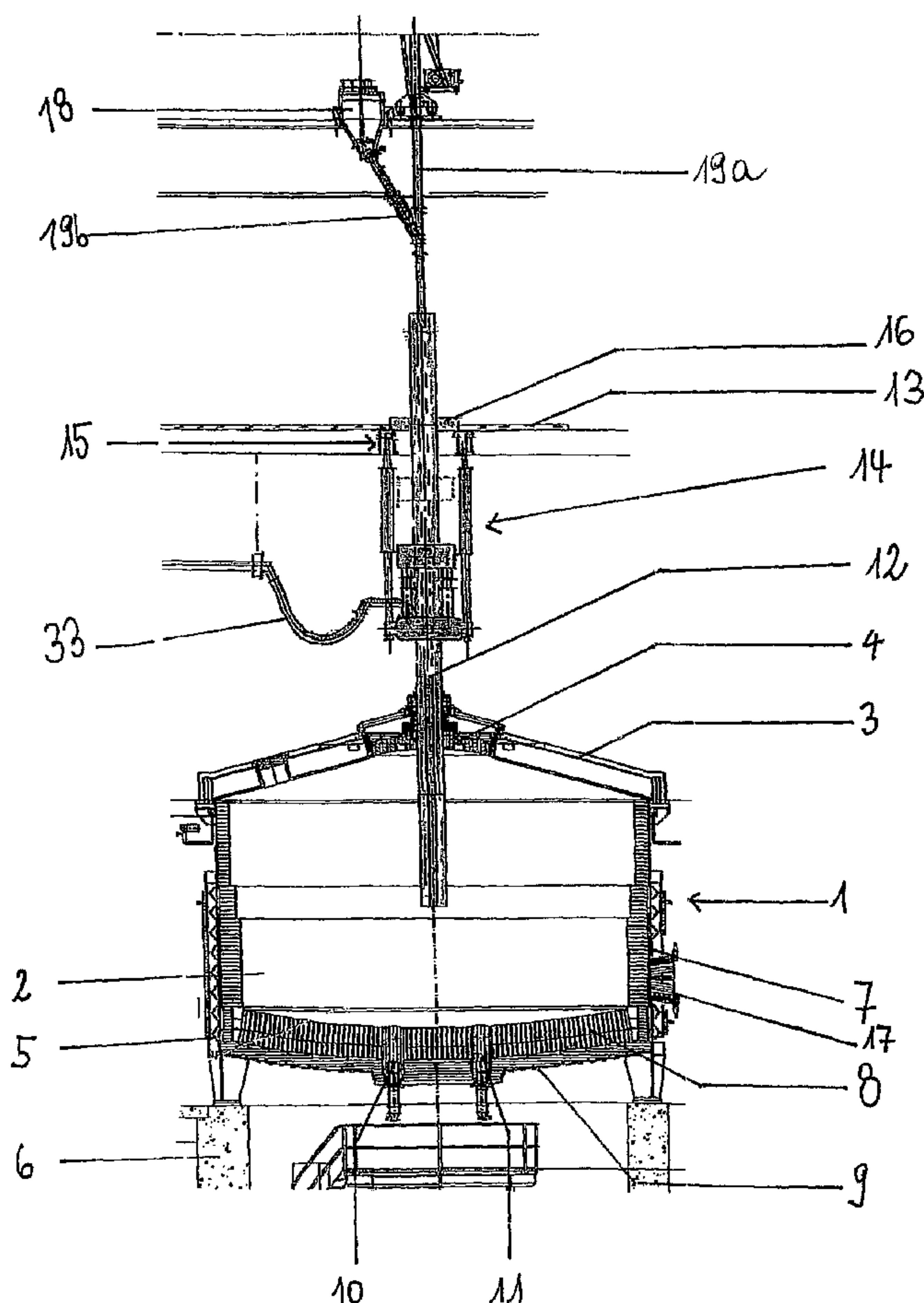
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[Fortsetzung auf der nächsten Seite]

(54) Title: DIRECT CURRENT ARC FURNACE

(54) Bezeichnung: GLEICHSTROM-LICHTBOGENOFEN



(57) **Abstract:** The invention relates to a direct current arc furnace (1) comprising an electrode (12) which is maintained inside the furnace and which can be replaced in order to compensate the combustion of the electrode. Said direct current arc furnace also comprises a counter electrode (10, 11) which is arranged in the furnace, for example, a base electrode. In order to prevent loss of power during replacement and/or attachment of the electrode in said type of furnace and in order to improve the sealing power of the electrode in the furnace cover, the whole electrode branch (14) is arranged with an electrode holder and a replacement device is arranged on a furnace platform (13) or a frame above the furnace (1).

(57) **Zusammenfassung:** Die Erfindung betrifft einen Gleichstrom-Lichtbogenofen (1) mit einer Elektrode (12), die im Ofeninneren gehalten und zur Kompensation des Elektrodenabbrandes nachführbar ist, sowie mit einer Gegenelektrode (10, 11) im Ofen, beispielsweise einer Bodenelektrode. Um bei einem solchen Ofen Leistungsverluste beim Nachsetz- bzw. Annipelvorgang der Elektrode zu vermeiden und die Abdichtung der Elektrode im Ofendeckel zu verbessern, wird vorgeschlagen, dass der gesamte Elektrodenstrang (14) mit einer Elektrodenfassung und einer Nachsetzeinrichtung an einer Ofenbühne (13) oder einem Rahmen oberhalb des Ofens (1) angeordnet ist.

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TRANSLATION (HM-684):

**Translation of WO 2004/110,104A1 (PCT/EP2004/005,122)
with Amended Pages Incorporated Therein**

DIRECT-CURRENT ARC FURNACE

The invention concerns a direct-current arc furnace with at least one electrode, which is held inside the furnace and can be advanced to compensate electrode consumption, and with a counter electrode in the furnace, for example, a bottom electrode, wherein the entire electrode train with an electrode holder and an advancing device is mounted as a suspension system on a furnace platform or a frame above the furnace.

Direct-current arc furnaces for melting steel scrap generally have at least one centrally arranged electrode and at least one bottom electrode to produce a flow of current through the steel bath. As is well known, the electrode, which projects into the furnace vessel from above, is held and guided by a support arm construction, which is arranged to the side of the furnace and extends with an L shape above the roof of the furnace. The electrode is guided vertically into the furnace by the support arm and is advanced inside the furnace to compensate consumption of the tip of the electrode. Since the furnace roof is swung away to charge the furnace, for example, with scrap,

the electrode can also be moved out of the furnace by this support arm construction. A support arm construction of this type is described, for example, in DE 36 40 298 A1 and DE 195 26 161 C2.

In reduction furnaces, it is well known that the electrode train can be arranged above the furnace roof with an electrode mount, as is described, for example, in DE 43 42 511 A1, according to which the electrode projecting into the furnace is held by a clamping ring of an advancing device, which is supported on a frame by a lifting cylinder. An electrode mount is mounted on the frame, and an electrode holding ring, which likewise embraces the electrode, is arranged on the electrode mount. The frame is supported on a control and maintenance platform by a regulating cylinder. The electrode can also be moved back by the advancing device.

In the previously known support arm construction of direct-current arc furnaces, a large support arm travel distance is necessary to embrace the newly attached electrode length. Due to the vibrations produced by the direct-current operation, the support arm that holds and guides the electrode is also caused to vibrate. This vibrational motion of the support arm leads to uncontrolled movement of the electrode at the seal in the furnace roof. This results in wear and thus leakage.

Furthermore, the power supply to the furnace must be interrupted during advancing and attachment of the electrode. In addition, the furnace crane needs large lifting power to hold the electrode during advancing and attachment.

Proceeding on the basis of this prior art, the objective of the invention is to avoid power loss during the advancing and attachment operation in a furnace operated with direct current and to improve the sealing of the electrode in the furnace roof, especially when the furnace is operated with a highly concentrated CO atmosphere.

Advantageous features and refinements of the invention are further described hereafter.

The basic idea of the invention is to use an alternating-current electrode train that is typical for a reduction furnace or a typical electrode body design in a direct-current arc furnace. The electrode train consists essentially of an electrode holder and an advancing device, which is mounted on a furnace platform or frame located above the furnace.

This electrode train makes it possible to advance the electrode and to move it back without having to interrupt the furnace power supply and without the use of heavy equipment, such as the furnace house crane. The same is true for the

connection of a new electrode length. In addition, advancing and attachment are possible while power is still being supplied to the furnace. This means a large yield of molten metal, because fewer scheduled furnace shutdowns and thus fewer process interruptions are necessary.

Vibrations of the electrode and undesired horizontal movements that occur in combination with a support arm mount are avoided by the electrode train that is used. This results in better sealing of the electrode in the furnace roof, which is an advantage with respect to safe furnace operation, especially with a highly concentrated CO atmosphere.

Preferably, the electrode of the electrode train can also be designed as a hollow electrode, through which charge material, for example, fine charge material, can be conveyed into the furnace.

Accordingly, in one aspect, the present invention resides in a direct-current arc furnace with at least one electrode, which is held inside the furnace and can be advanced to compensate electrode consumption, and with a counter electrode in the furnace, wherein an entire electrode train with an electrode holder and an advancing device is mounted as a suspension system on a furnace platform or a frame above the furnace, wherein the suspension system comprises an electrode guide frame, which is mounted on the furnace platform, electrode regulating cylinders having pistons, which extend along an axis of the electrode, are

mounted on a cylinder side by suspension on the guide frame, and are connected on a furnace side with an electrode holding ring by said pistons, such that the holding ring operates with two pressure stages, and lifting cylinders, which are supported on the holding ring and by which a first electrode advancing ring can be moved along the electrode axis within the electrode regulating cylinders, such that to advance the electrode, the first electrode advancing ring is released and moved upward by means of the lifting cylinders, the first electrode advancing ring is then reclamped around the electrode to hold said electrode, and then the electrode is advanced into the furnace by a stroke movement in the opposite direction.

BRIEF DESCRIPTION OF THE DRAWINGS.

The invention is explained below with reference to the specific embodiment illustrated in the drawings.

-- Figure 1 shows a side view of a direct-current arc furnace of the invention in combination with an electrode train typically used for a reduction furnace.

-- Figure 2 shows detail of the suspension system of the electrode train of Figure 1.

-- Figure 3 shows the sectional view A-A of Figure 2.

-- Figure 4 shows the sectional view B-B of Figure 3.

Figure 1 shows an arc furnace 1 that is operated with direct current. It comprises essentially a furnace vessel 2 and a furnace roof 3 with a central roof section 4. The furnace vessel 2 is rigidly mounted by means of a frame construction 5 on columns 6. The furnace wall 7 is lined on the inside with refractory material 8. Two bottom electrodes 10, 11 are mounted in the furnace bottom. An electrode 12 extends into the inside of the furnace from above. It is not mounted on a support arm located next to the furnace, as is customary in conventional furnaces of this type, but rather on an electrode train 14, which is mounted on the furnace platform 13 and is designed as a suspension system in the embodiment illustrated here. The electrode train 14 is mounted on a guide frame 16, which is arranged above the furnace 1 along the furnace platform 13.

The direct-current arc furnace 1 with the electrode train 14 is preferably used for the production of slags that contain TiO_2 , for ferrochromium, ferromanganese, and other ferroalloys, and for nonferrous slag processes customarily carried out in a reduction furnace. For this purpose, charge material, for example, ilmenite in sand form, is charged into the furnace as the base product, specifically, through the electrode, which is designed as a hollow electrode. Ilmenite is mixed with reducing

agents and melted. The pig iron formed during the reduction, which, together with the bottom electrodes, forms an extended anode, is then tapped through a side tap hole 17. The charge material is stored in vessels 18 above the furnace platform 13 and charged into the inside of the furnace through vertical or lateral charging lines 19a, b and through the hollow electrode 12.

The individual components of the electrode train are shown in detail in Figure 2. The guide frame 16 surrounds a guide roller 20 on the electrode side to avoid tilting during the advancing of the electrode 12. The suspension system 15 consists, first, of hydraulically operated electrode regulating cylinders 21, 22, which take on the suspension of the entire electrode train 14. These cylinders are mounted on the cylinder side by suspension on the guide frame 16 by connecting elements 23, 24 and extend along the longitudinal axis of the electrode. The connecting elements 23, 24 are anchored in the guide frame 16. The ends 25, 26 of their pistons are rigidly connected with a holding ring 27 for the electrode 12. Two hydraulic lifting cylinders 28, 29 that can be operated at both ends are mounted on the side of this holding ring 27 that faces away from the furnace. A first or upper advancing ring 30 can be hydraulically moved along the longitudinal axis of the electrode

by these lifting cylinders 28, 29. The oil lines are numbered 31 and 32. Current is conducted to the electrode 12 through the holding ring 27. To this end, a power supply line 33 is guided to the holding ring 27 first through a rigid line and then a flexible line. Two power supply lines 33a, b can also be provided, as shown in the detail drawing of Figure 2.

The manner of operation of the lower holding ring 27 is apparent from the detail drawings of Figures 3 and 4. The lower holding ring 27, which simultaneously serves as a second advancing ring, surrounds a power supply jaw 34 and two clamping jaws 35, 36, which can be pressed with varying intensity on the circumferential surface of the electrode. To this end, the holding ring 27 is provided with a hydraulic contact pressure element 37. In a first pressure stage, the clamping jaws 35, 36 come to rest against the surface of the electrode, so that an effective flow of current from the power supply lines is possible. In this pressure stage, however, the electrode can be pushed through the holding ring 27. In a second pressure stage, the clamping jaws 35, 36 clamp tightly around the surface of the electrode by means of the expanding contact pressure element 37, so that the holding ring 27 can hold the electrode by itself.

The manner in which an advancing operation is carried out in the direct-current arc furnace of the invention will now be

explained. The electrode 12 is guided into the interior of the furnace and held by means of the suspension system 15. The electrode 12 extends into the furnace 1 through the guide frame 16 and through the central section 4 of the roof. Figure 2 shows that the opening in the furnace roof is sealed from the circumferential surface of the electrode with a seal 38. Initially, the electrode is held by the upper advancing ring 30. When the electrode 12 is then to be advanced, this advancing ring 30 is released and moved upward by the advancing stroke distance x in the direction of the guide frame 16 by extension of the double-acting lifting cylinders 28, 29. In this way, the distance between the holding ring 27 and the advancing ring 30 is increased. The advancing ring 30 in its displaced position is then clamped to the electrode 12 again. The holding ring 27 is placed in the first pressure stage by releasing the contact pressure element 37. While current can continue to flow, the electrode can be pushed farther into the furnace through the released holding ring 27 by moving the lifting cylinders 28, 29 back and reducing the distance between the advancing ring 30 and the holding ring 27. During this operation, the electrode 12 slides vertically along the guide rollers 20 of the guide frame 16 and the seal 38 of the opening in the furnace roof. When the advancing operation has been completed, the holding ring 27 is

again pressed against the electrode 12 with increased contact pressure.

All together, the replacement of a support arm construction by an electrode train supported above the furnace has been found to be very advantageous for a direct-current arc furnace. By making it possible to advance the electrode without shutting down the furnace, the total yield is increased. Compared to the previous system, this system operates more smoothly and thus more effectively and economically. The elimination of vibrations reduces wear in guide locations and sealing locations, especially in the furnace roof. Due to the better and longer-lasting seals, safety is improved in processes in which CO is produced.

List of Reference Numbers

- 1 direct-current arc furnace
- 2 furnace vessel
- 3 furnace roof
- 4 central section of roof
- 5 frame construction
- 6 columns
- 7 furnace wall
- 8 refractory material
- 9 furnace bottom
- 10 bottom electrode
- 11 bottom electrode
- 12 electrode
- 13 furnace platform
- 14 electrode train
- 15 suspension system
- 16 guide frame
- 17 tap hole
- 18 vessel
- 19 vertical charging line or lateral charging line
- 20 guide roller

- 21 electrode regulating cylinder
- 22 electrode regulating cylinder
- 23 connecting element
- 24 connecting element
- 25 piston end
- 26 piston end
- 27 electrode holding ring or lower advancing ring
- 28 lifting cylinder
- 29 lifting cylinder
- 30 first or upper advancing ring
- 31 oil line
- 32 oil line
- 33 power supply line (33a and b)
- 34 power supply jaw
- 35 clamping jaw
- 36 clamping jaw
- 37 contact pressure element
- 38 seal

WE CLAIM:

1. Direct-current arc furnace (1) with at least one electrode (12), which is held inside the furnace and can be advanced to compensate electrode consumption, and with a counter electrode (10, 11) in the furnace, wherein an entire electrode train (14) with an electrode holder and an advancing device is mounted as a suspension system (15) on a furnace platform (13) or a frame above the furnace (1), wherein the suspension system (15) comprises

- an electrode (12) guide frame (16), which is mounted on the furnace platform (13),

- electrode regulating cylinders (21, 22) having pistons, which extend along an axis of the electrode, are mounted on a cylinder side by suspension on the guide frame (16), and are connected on a furnace side with an electrode holding ring (27) by said pistons (25, 26), such that the holding ring (27) operates with two pressure stages, and

- lifting cylinders (28, 29), which are supported on the holding ring (27) and by which a first electrode advancing ring (30) can be moved along the electrode axis within the electrode regulating cylinders (21, 22), such that to advance the electrode (12), the first electrode advancing ring (30) is released and moved upward by means of the lifting cylinders (28, 29), the first electrode advancing ring (30) is then reclamped around the electrode (12) to hold said electrode, and then the electrode (12) is advanced into the furnace by a stroke movement in the opposite direction.

2. Direct-current arc furnace in accordance with Claim 1, characterized by the fact that the holding ring (27) is connected with a power supply line (33) and thus conducts current into the electrode, and that a hydraulic contact pressure element (37), which operates with two pressure stages, is integrated in the holding ring (27), such that in a first said pressure stage, the holding ring (27) is in contact with the electrode in such a way that current flows into the electrode, and the electrode (12) is advanced into the furnace through the holding ring (27), and such that in the second other said pressure stage, the electrode (12) is held by the holding ring (27) as a second advancing ring, while the first advancing ring (30) is opened.

3. Direct-current arc furnace in accordance with Claim 1 or Claim 2, characterized by the fact that the electrode (12) is a hollow electrode, through which charge material is charged to the furnace (1).

4. Direct-current arc furnace in accordance with any one of Claims 1 to 3, wherein the counter electrode comprises a bottom electrode.

5. Use of a direct-current arc furnace (1) in accordance with any one of Claims 1 to 4 for producing slag that contains TiO_2 for further processing for the pigment industry, wherein a titanium-containing ore, is charged to the furnace as a base product, mixed with reducing agents, and melted and reduced by the energy of the electrodes.

. . . .

6. Use of a direct-current arc furnace (1) in accordance with any one of Claims 1 to 4 for producing ferroalloys or for nonferrous slag processes.

7. Use of a direct-current arc furnace as claimed in Claim 5, wherein the titanium-containing ore comprises ilmenite in sand form.

8. Use of a direct-current arc furnace as claimed in Claim 6, wherein said ferroalloys are selected from the group consisting of ferrochromium and ferromanganese.

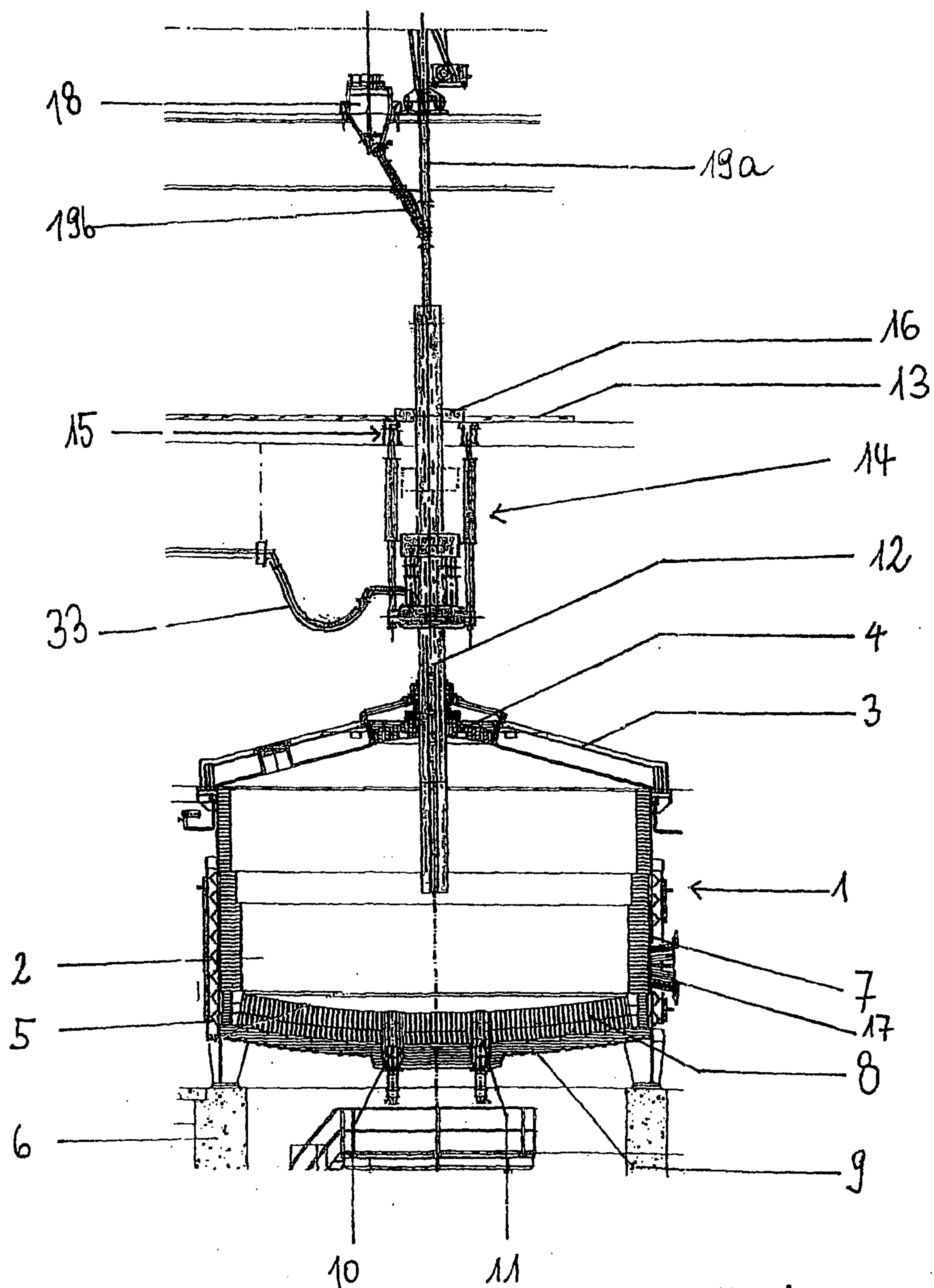


Fig. 1

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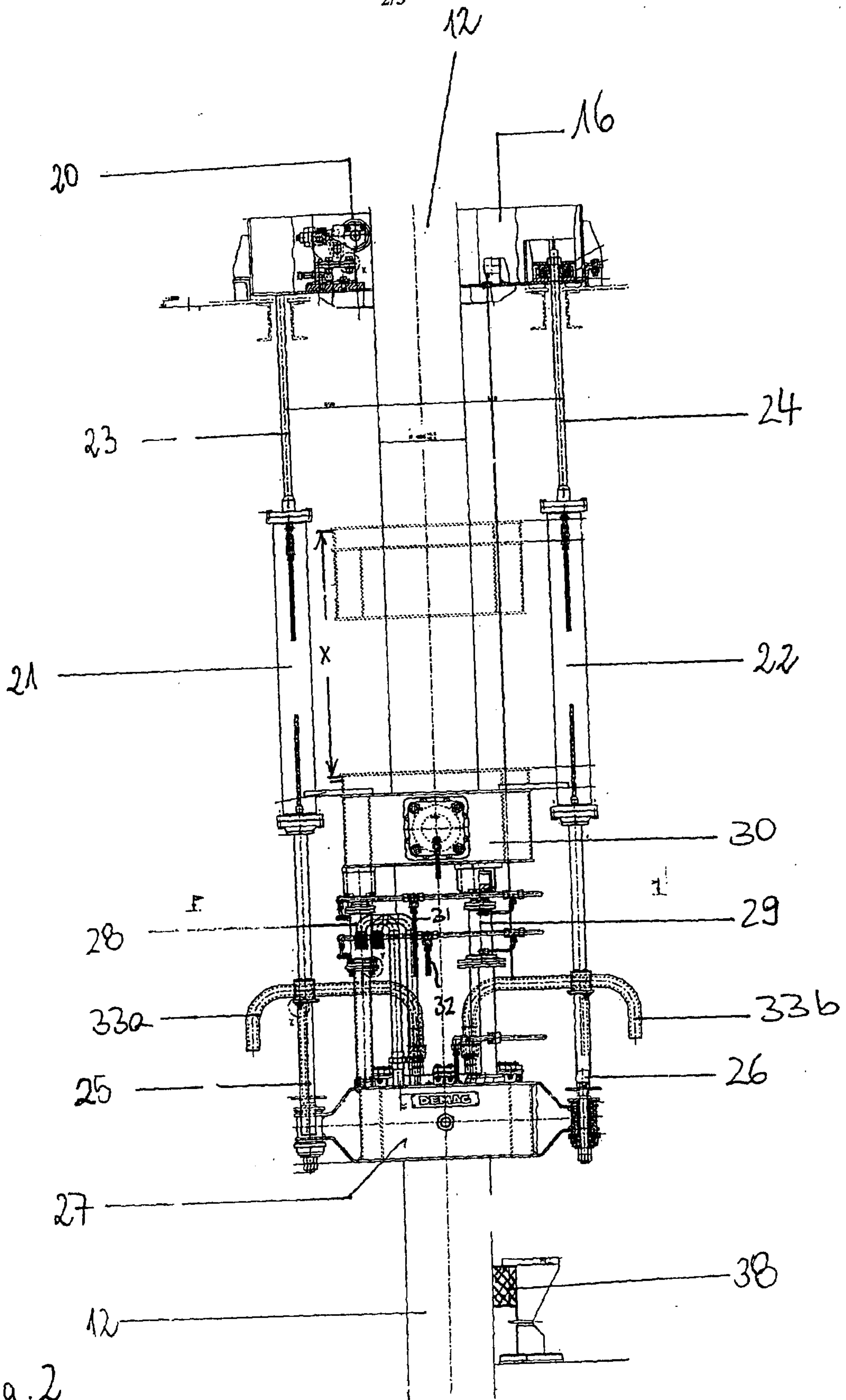


Fig. 2

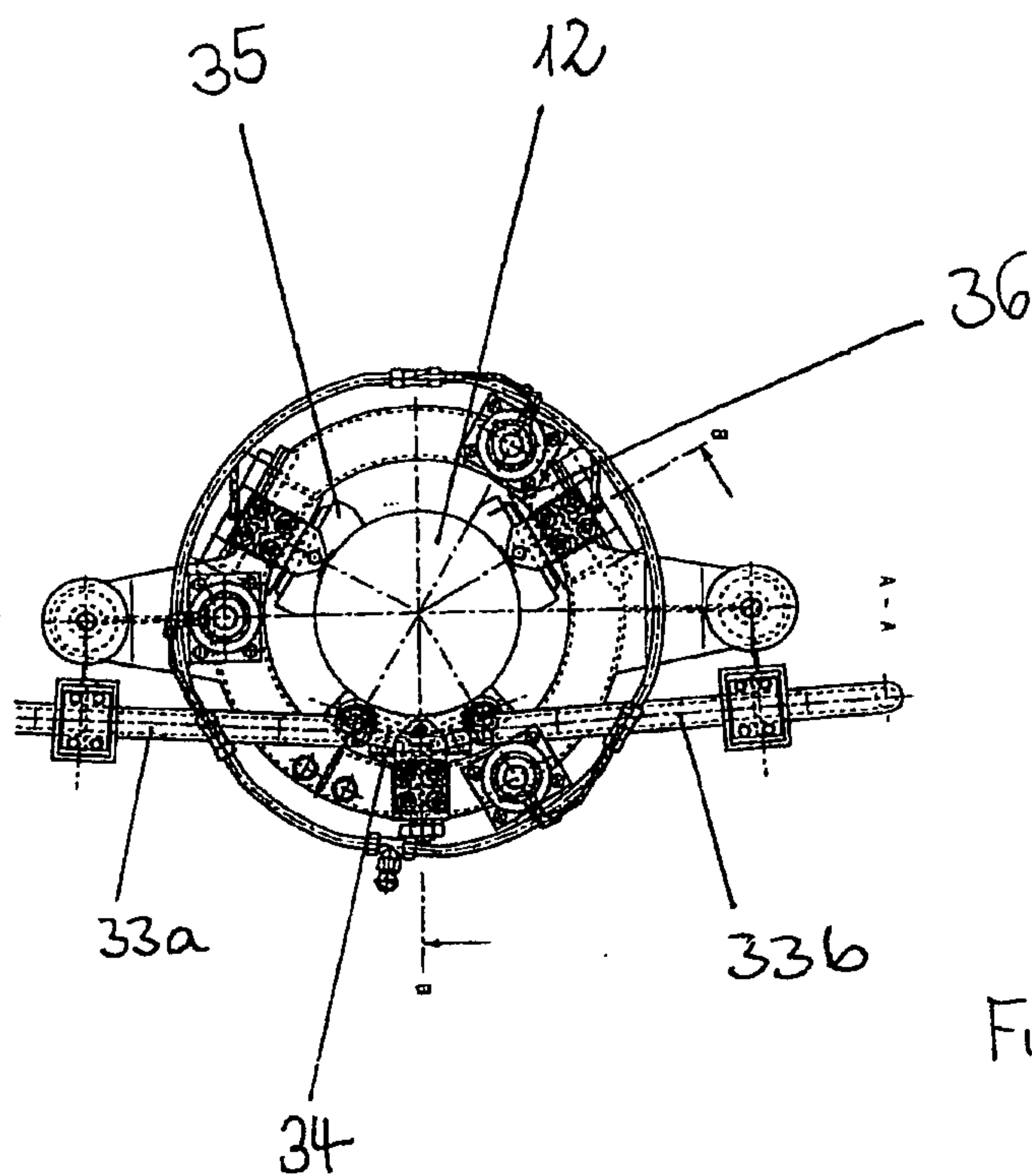


Fig. 3

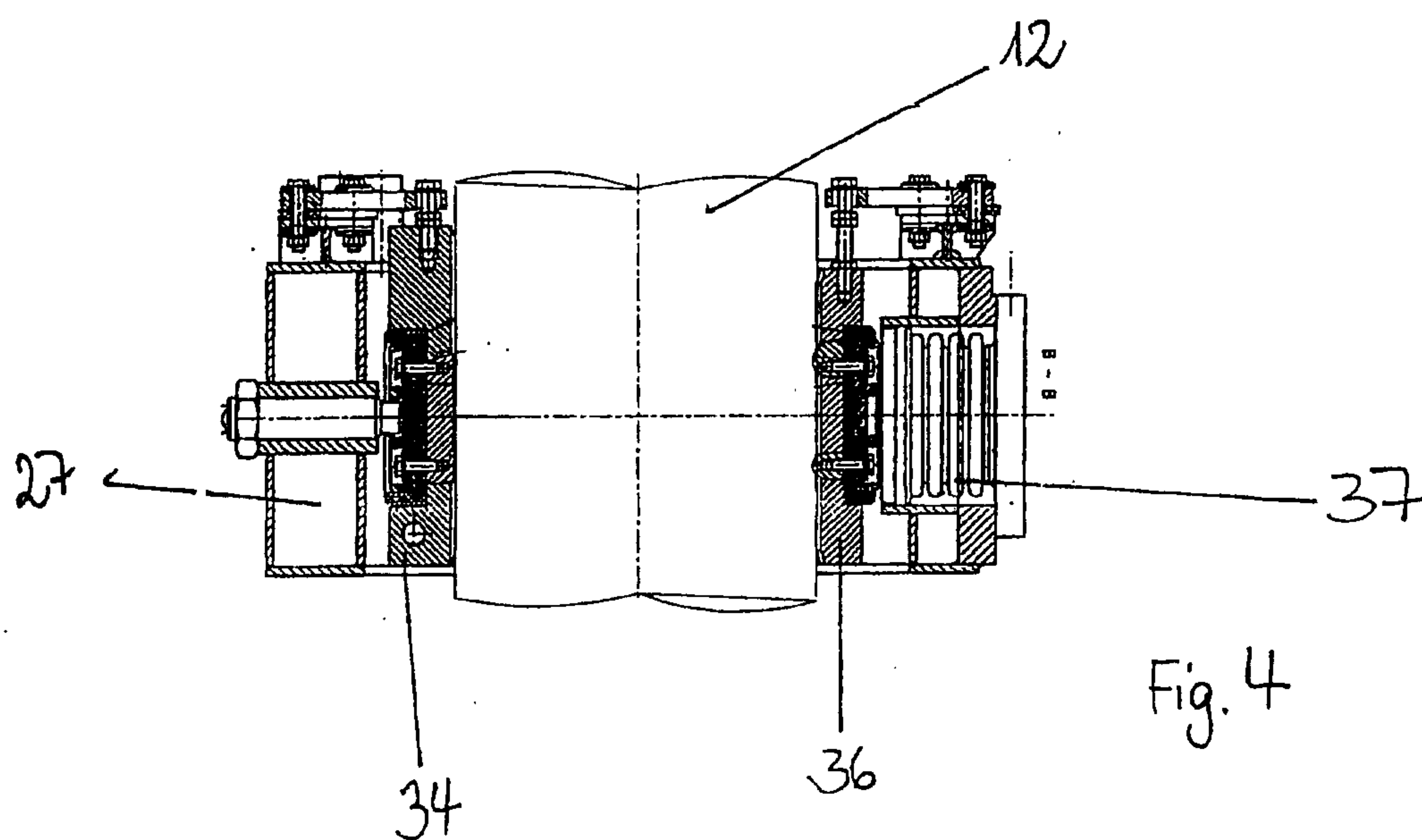


Fig. 4

