



(12) **EUROPEAN PATENT APPLICATION**  
published in accordance with Art. 153(4) EPC

(43) Date of publication:  
**20.04.2016 Bulletin 2016/16**

(51) Int Cl.:  
**F27D 3/12** <sup>(2006.01)</sup> **F27D 3/00** <sup>(2006.01)</sup>  
**B65G 47/82** <sup>(2006.01)</sup> **C21D 9/00** <sup>(2006.01)</sup>

(21) Application number: **14810703.0**

(86) International application number:  
**PCT/ES2014/070399**

(22) Date of filing: **14.05.2014**

(87) International publication number:  
**WO 2014/198977 (18.12.2014 Gazette 2014/51)**

(84) Designated Contracting States:  
**AL 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 RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**

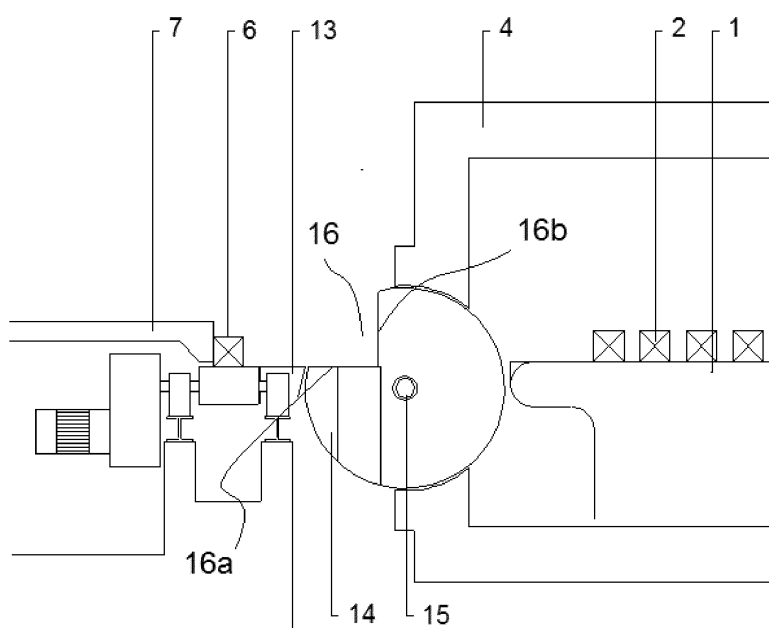
(71) Applicant: **Fives Stein Bilbao, S.A.**  
**48011 Bilbao (Bizkaia) (ES)**  
(72) Inventor: **VALLEJO BAYONA, Felipe**  
**E-48450 Etxebarri (ES)**  
(74) Representative: **Rebate Conde, Maria Fernanda**  
**Eurosigno**  
**C/ Txakursolo, 23**  
**48992 Getxo (ES)**

(30) Priority: **12.06.2013 ES 201330873**

(54) **DEVICE AND METHOD FOR LOADING AND UNLOADING A REHEATING FURNACE**

(57) The invention relates to a device and method for loading and unloading a reheating furnace (4) comprising a plurality of beams (1) for supporting products (2), a roller conveyor (9) for transferring the billet (6) to be loaded to a position facing the furnace, and a loading push rod arranged on the exterior of said furnace and provided with a plurality of fingers (7). Said device is characterised in that the entrance to the furnace (4) is provided with a rotating door (14) which is leak-tight and which rotates in relation to a cooled shaft (15), said rotating door (14) having a cylindrical cross-section with a cut-out angular sector (16) designed to receive the billet (6) to be loaded into the furnace.

acterised in that the entrance to the furnace (4) is provided with a rotating door (14) which is leak-tight and which rotates in relation to a cooled shaft (15), said rotating door (14) having a cylindrical cross-section with a cut-out angular sector (16) designed to receive the billet (6) to be loaded into the furnace.



**FIG.4**

## Description

[0001] The invention relates to a device for loading and unloading billets and other products, such as tubes or bars, in steel reheating furnaces by means of a rotating door.

## Prior art

[0002] The loading and unloading of billets in steel reheating furnaces causes air inlets in the furnace and, sometimes, this process is made by means of cooled equipment installed inside the furnace causing important thermal losses that are extremely damaging to the heating quality, as well as the furnace efficiency.

[0003] Air inlets caused by door openings can also disrupt the operation of the burners, in particular increasing the amount of pollutants in the furnace, such as nitrogen oxides, NOx.

[0004] Furthermore, the air inlets caused by the opening of the unloading door can also increase the amount of scale produced in the furnace.

[0005] The prior art closest to the proposal described herein is the document FR2657152, which describes a device containing a cylinder mounted in the furnace around an horizontal axis in which are disposed two diametrically opposite housings receiving each of them a billet or long product, and a block of variable width located in the cylinder sliding between housings. This block includes the extendable elements that can be brought near or away from each other in order to push towards outside the cylinder, each product received in the first housing after a rotation of 180 degrees of the cylinder. This device allows the uniform reheating of long steel products and thereby obtain improved characteristics for them.

[0006] Nevertheless, this document does not resolve the described technical problems, because it does not isolate the furnace inside from the outside, or prevents air inlets in loading or unloading processes.

## Description of the invention

[0007] It is an object of the invention a device that solves the problem generated by the cold air inlets in the furnace, achieving that the process of loading and unloading billets in a steel reheating furnace neither causes significant currents of air, nor needs to use cooled equipment inside the furnace.

[0008] It is a second object of the invention the method that solves the described problem.

[0009] In particular, the device of the invention includes a rotating door, with a cylindrical profile and adjusted to separate completely the inside of the furnace from the outside. The door comprises a trimmed angular sector, wherein the billet is placed for its introduction and extraction, such that, the transfer of the billet between the exterior and interior of the furnace is allowed by the simple rotation of the door.

[0010] The device is completed by a transfer element, which is the only element necessary to move the billet from the feeding roller conveyor to the rotating door, as well as from the rotating door to the beams placed inside the furnace. That is, the transfer element is the responsible for loading and unloading movements between outside and inside the furnace.

[0011] In a second aspect of the invention, the method object of the invention comprises the transfer of the billet from the outside of the furnace to the inside by means of two simple mechanical movements: a first rotation of 90 degrees of the rotating door and the linear movement of the transfer element, such that in this movement the outside and the inside are completely isolated.

[0012] Thanks to the device and method described, a separation between the outside and the inside of the furnace is optimized precisely because of the presence of the rotating door, which reduces the pressure variations inside and the cool air inlets; saving energy, reducing pollutant emissions (NOx) and reducing the heating or surface defects which may happen in the product.

[0013] Furthermore, thanks to the device proposed herein, it is possible the loading and unloading of heavy billets avoiding sudden movements of the billets that may affect to the loading system.

[0014] Throughout the description and claims, the word "comprise" and its variants are not intended to exclude other technical features, additives, components or steps. For a person skilled in the art, other objects, advantages and features of the invention, will become apparent from the description and practice of the invention. The following examples and drawings are provided to illustrate and are not intended to restrict the present invention. Furthermore, the present invention takes into account all combinations of particular realization herein indicated.

## Brief description of the figures

[0015] Afterwards are described very briefly several drawings that provide a better understanding of the invention and closely related with an example embodiment of this invention presented as a non-restrictive example thereof.

FIG.1 shows a longitudinal section of the furnace illustrating the front loading process according to the prior art.

FIG.2 shows a longitudinal section of the furnace illustrating the lateral loading process according to the prior art.

FIG.3 shows a longitudinal section of the furnace illustrating the lateral loading process according to the prior art.

FIG.4 shows a longitudinal section of the billets re-

heating furnace including the device of the invention.

FIG.5 shows the first sequence of the billet loading in the furnace of the figure 4.

FIG.6 shows the billet loading operation in furnace of the figure 4.

FIG.7 shows an input sequence of the billet in the furnace of the figure 4.

FIG.8 shows the furnace of the figure 4 in the unloading position of the billet.

FIG.9 shows a second view as indicated in figure 8.

FIG.10 shows a realization of the invention including a transfer machine.

### Preferential example embodiment of the invention

[0016] According to the current state of the prior art, the loading and the unloading of billets (or bars or tubes on each case) in a steel reheating furnace is carried out frontally or laterally.

[0017] The figure 1 shows the principle of the frontal loading according to the prior art, while figures 2 and 3 show the principle of the lateral loading. However, these example embodiments have several problems that are solved by the present invention.

[0018] The figure 1 shows a longitudinal section of the furnace (4) comprising a plurality of walls that form an internal enclosure in which are housed a plurality of beams (1) that support the bed of products (2) to be transferred from the furnace inside (4) to the outside to ensure the reheating up to the target temperature.

[0019] The billet (6) to be loaded is brought in front of the furnace (4) by means of a roller conveyor (9) whose rollers rotate on bearings (10) driven by a gear motor (11). The billet (6) is transferred from the roller conveyor (9) to the beams (1) of the furnace by means of the fingers (7) of a pusher, which displaces the product from the roller conveyor (9) to the sliders (8) and, on them, to the beams (1) to bring the product to the marked position (3).

[0020] To ensure the transfer of the billet (6), the front door (5) of the furnace (4) must be open across the entire width of the furnace, which causes an important pressure change of the internal atmosphere of the furnace and allows a passage of the outside air, which pollutes the internal atmosphere of the furnace, decreasing the internal temperature and, therefore, its overall performance.

[0021] Moreover, this opening keeps the furnace area cooler, which reduces the effective length of the heating in the furnace.

[0022] Finally, the cool air penetration takes place into the area where the waste gas evacuation ducts are and therefore they will be cooled, which reduces the efficiency of the energy recovery, decreasing the overall perform-

ance of the furnace.

[0023] The figure 2 shows the principle of lateral loading of the billets in a reheating furnace. The loading door (12) is in one side of the furnace and it is smaller in size than a frontal loading door (5), as it corresponds to the billet section while the front door corresponds to the length of the billet.

[0024] In this case, the roller conveyor (9) are placed inside the furnace (4) and are mounted on bearings (10) placed outside as well as the motor. The roller conveyor (9) ensure the transfer of the billet from the outside to furnace inside, so that the billet is pushed from the roller conveyor (9) on the beams (11) by the pusher fingers (7) bringing the billet (6) to the loading position, as shown in figure 2.

[0025] It is evident for a person skilled in the art that the instructions given for loading are equally valid for billets unloading. Thereby, in figure 2, the movement of the billet in unloading will be the opposite of the loading movement shown in figure 2. Accordingly, the billet that rests on the beams (1) will be taken by the fingers (7) of the pusher machine to be brought by a rectangular movement to the cooled roller conveyor (9) for unloading.

[0026] The sketch shown in figure 1 for frontal unloading is identical to the described one, that is, the pusher machine that comprises the fingers (7) executes a rectangular movement to collect the product from the beams (1) of the furnace through the opening of the front door (5) and to place it on the roller conveyor (9) which will carry out the evacuation of the billet (6) to the rolling mill for the next stage of the steelmaking process.

[0027] The devices shown for the unloading of the billets have the same kind of problems than the ones for the loading, that is, the presence of refrigerated mechanical elements that reduce the energy efficiency of the furnace, or the existence of unloading doors that mean important inlets of air decreasing the furnace efficiency and causing additional oxidation in products, which increases material loss and can cause defects in the finished products during the subsequent rolling process.

[0028] In loading, the issues of the solutions of the prior art are more critical because the temperature level inside the furnace is much greater than in the loading side and the immediate impact on the product and its quality is higher, as can cause local cooling in the products that can generate problems during its subsequent rolling.

[0029] These problems are solved by the invention according to the example embodiments shown in figures 4 to 7. Therefore, due to the invention the air inlets from the exterior are significantly reduced in order not to disturb the atmosphere inside the furnace, thus increasing energy efficiency by reducing the amount of pollutants emitted, i.e., increasing the quality of the heating of the product. Due to the invention, cold areas in loading and unloading zones are suppressed and, thus, its effective length for an efficient heating of the furnace for a given total length is optimized.

[0030] The figure 4 shows the longitudinal section of

the reheating furnace for billets that includes the device of the invention. That figure 4 shows the furnace chamber (4), the beams (1) for supporting the product (2), a roller conveyor (9) to transport the billet (6) to be loaded in front of the furnace and outside the furnace, a loading pusher machine provided with a plurality of fingers (7).

**[0031]** This furnace is provided with a rotating door (14) that rotates around an axis (15), which is refrigerated. The rotating door (14) is of cylindrical section, with an angular sector (16) trimmed at certain angle and arranged to introduce the billet (6) in the furnace. That is, the angular sector (16) is aligned horizontally with the roller conveyor (9) on one side (16a), while the other side (16b) opposite to the first, is arranged to work like a stopper during the introduction of the billets (6).

**[0032]** In accordance with an example embodiment of the invention the angular sector (16) is about 90°.

**[0033]** The figure 5 shows the first sequence of loading the billet (6), wherein the fingers (7) of the pusher machine move the billet (6) from the roller conveyor (9) on the slides (13) of the rotating door (14) to stop with the angular sector (16) trimmed in the rotating door (14) like described above.

**[0034]** The figure 6 shows the operation of loading a billet (6). In this case, the rotating door (14) has rotated around its axis (15), for example, by the action of one or more hydraulic cylinders not shown in the figure. Subsequently, the billet (6) is placed inside the furnace chamber (4), on a slide vertically aligned with the upper plane of the beams (1).

**[0035]** The figure 7 shows the fingers (7) of the pusher machine which through openings in the rotating door (14), have displaced the billet (6) from the slides of the rotating door (14) to the beams (1), till to reach the maximum position defined by the fingers (7) stroke, depending on the dimensions of the billet (6) and the desired load in the furnace (4). After the retraction of the fingers (7), the rotating door (14) returns to the position shown in figure 4.

**[0036]** In figures 4 to 7 it can be seen that the loading rotating door (14) is cylindrical and manufactured, for example, with refractory concrete or a combination of metal structures lined with refractory concrete or an insulating equivalent.

**[0037]** The cylindrical shape of the rotating door (14) is such that it fits perfectly to the walls of the furnace (4), in order to ensure a good tightness between air and fumes to isolate perfectly the atmosphere inside the furnace (4) from the outside atmosphere. This tightness can be improved, if necessary, by adding seals or scrapers, for example, made of fibrous refractory whose flexibility allows to compensate any possible gap between the furnace walls and the rotating door (14) in the open or closed position, or during the movement of the door.

**[0038]** It is also noted in figures 4 and 7 that, during periods where the door is locked in position of loading or unloading, the tightness of the door is ensured due to the external shape of the rotating door (14) matching with

the furnace walls (4), which can be completed with seals.

**[0039]** The figures 8 and 9 show the rotating door (14) in the unloading position of the billet into the furnace (4). As in figures from 4 to 7, it can be seen how the connection between the external shape of the rotating door (14) and the furnace wall (4) ensures the tightness.

**[0040]** To further reduce the leakage of gases, the openings through which the fingers (7) of the pusher machine go through the rotating door (14) will be adjusted to the maximum, so that between the fingers (7) and the openings there is not a clearance, i.e., the clearance is the minimum necessary to allow the passage of the fingers (7).

**[0041]** The transfer of the billet (6) from the outside to inside of the furnace (4) it is ensured by two simple mechanical movements: 90° rotation of the rotating door (14) and the linear movement of the fingers (7) of the pusher machine. The technology of the pusher machine is well known for a person skilled in the art to obtain the linear movement of the fingers hydraulically using one or more cylinders, or mechanically, by a motor.

**[0042]** The rotating door (14) can be mounted on two bearings arranged at the ends or intermediate support bearings for longer doors.

**[0043]** It should be mentioned that there is no mechanical equipment permanently inside the furnace, so it is not subjected to failures created by the operating conditions at high temperatures. Indeed, in closed position, the rotating door (14) only exposes to the hot atmosphere of the furnace a surface lined of refractory concrete, which is less sensitive than mechanical equipment like, for example, the cooled rollers described in the prior art.

**[0044]** It is clear from the description that the device allows the unloading of a billet in a reheating furnace, significantly reducing the heat losses caused by air inlets or by the presence of the cooled elements inside. The energy balance of the furnace improves and the quantity of pollutants is reduced.

**[0045]** The figure 8 shows the unloading sequence of the invention. The last product (3) in a first position (6) is transferred by the beams (1) of the furnace (4) to the rotating door (14) in a second position (6'). After the rotation of the rotating door (14), as shown in Figure 9, the product ready to be unloading is in a third position (6'').

**[0046]** The arms of the transfer machine are known for a person skilled in the art, for example with a lineal movement of the fingers (17) driven by a gear motor meshed with a rack via a pinion, where that rack is integrally attached to a finger (17), and wherein the lifting movement is controlled by one or more hydraulic cylinders.

**[0047]** The figure 10 shows a variant of the invention including a transfer machine with fingers (17). Thus, the figure shows how the last billet (6) on the beams (1) of the furnace (4) is lifted by the fingers (17) of the transfer machine that moves with a substantially rectangular cycle to the rotating door (14).

**[0048]** After the rotation of the rotating door (14), the situation is shown in figure 9, where the same fingers

(17) of the transfer machine move the product from the rotating door (14) to the rollers conveyor (9).

**[0049]** Lastly, the figures 8 and 10 show the rotating door (14) positioned to receive the product to be unloading and in figure 9, the rotating door (14) is positioned to unloading the product, with a hermetic sealing of the furnace (4), preventing air inlets which can create scale on the surface of the product, besides all disadvantages mentioned above. This absence of air does not further disrupts burner's combustion, which improves the quality of that combustion and the generation of contaminants.

**[0050]** Finally, it is understood that this heating and unloading process can be applied to all kinds of steel products such as bars of round section, square or half-finished products such as "beam blanks" and tubes. Likewise it can be applied in heat treatment furnaces with continuous or batch operation.

## Claims

1. Device for loading and unloading in a reheating furnace (4) which comprises a plurality of beams (1) for supporting the products (2), a roller conveyor (9) to move the billet (6) to be loaded in front of the furnace and outside the furnace, a loading pusher machine provided with a plurality of fingers (7); **characterized by** that the entrance of the furnace (4) is provided with a rotating door (14) which is tight and rotates around a cooled shaft (15); being the rotating door (14) of cylindrical section and wherein the external shape matches with the external shape of the walls of the furnace (4), and further comprising an angular sector (16) trimmed and configured to introduce the billet (6) to be loaded and horizontally aligned with the roller conveyor (9); and wherein the rotating door (14) comprises openings through which the fingers (7) of the pusher machine are introduced without clearance.

2. Device as per claim 1 wherein the angular sector (16) is horizontally aligned with the roller conveyor (9) in one side (16a), while the other side (16b) opposite the first, is configured as a stopper in the introduction of the billets (6).

3. Device as per claims 1-2 wherein the angular sector (16) is about 90°.

4. Device as per claims 1-3 wherein the rotating door (14) comprises a slide vertically aligned with the upper face of the beams (1) of the furnace (4).

5. Device as per claims 1-4 wherein the rotating door (14) comprises sealing tight gaskets in the joint with the furnace (4).

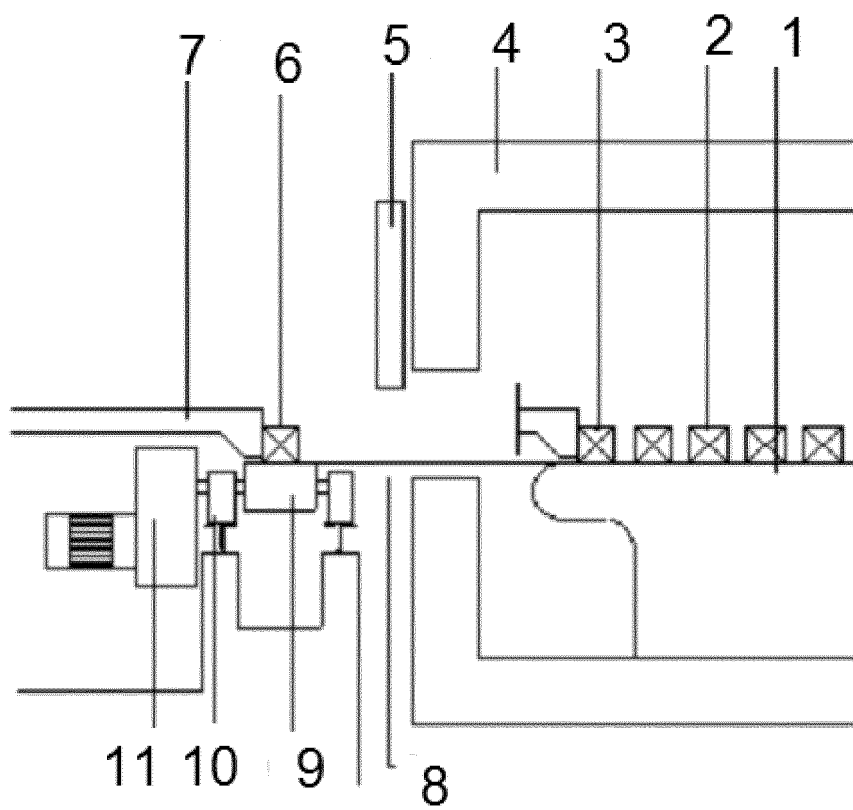
6. Method for the loading and unloading in a reheating

furnace (4) provided with the device as per claims 1-5 comprising the following steps:

- i) move horizontally the billet (6) from the roller conveyor (9), on the slides (13) of the rotating door (14) until stops with the angular sector (16) trimmed in the rotating door (14);
- ii) rotate the rotating door (14) until the angular sector (16) faces inside the furnace (4) aligned with the beams (1);
- iii) move the billet (6) until reaching the maximum position inside the furnace (4) by the fingers (7) of the pusher machine and through some openings in the rotating door (14), thereafter pulling back the fingers (7);
- iv) rotate the rotating door (14) to the position of the step (i);

and where for unloading, the last of the products (3), placed in a first position (6) is transferred by the beams (1) of the furnace (4) to the rotating door (14) in a second position (6'); and where after the rotation of the rotating door (14) the product to be unloading is placed in a third position (6'').

7. Method as per claim 6 where the rotation is 90°.



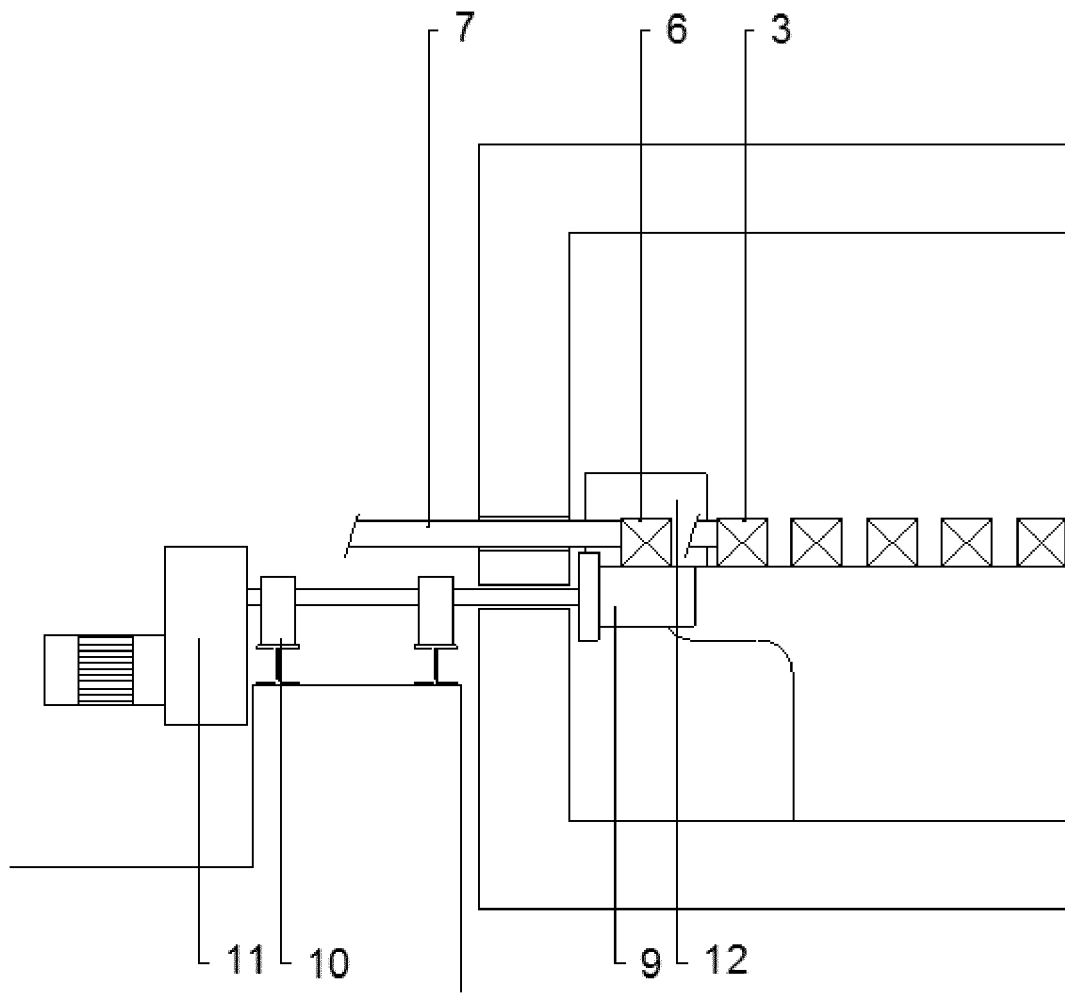


FIG.2

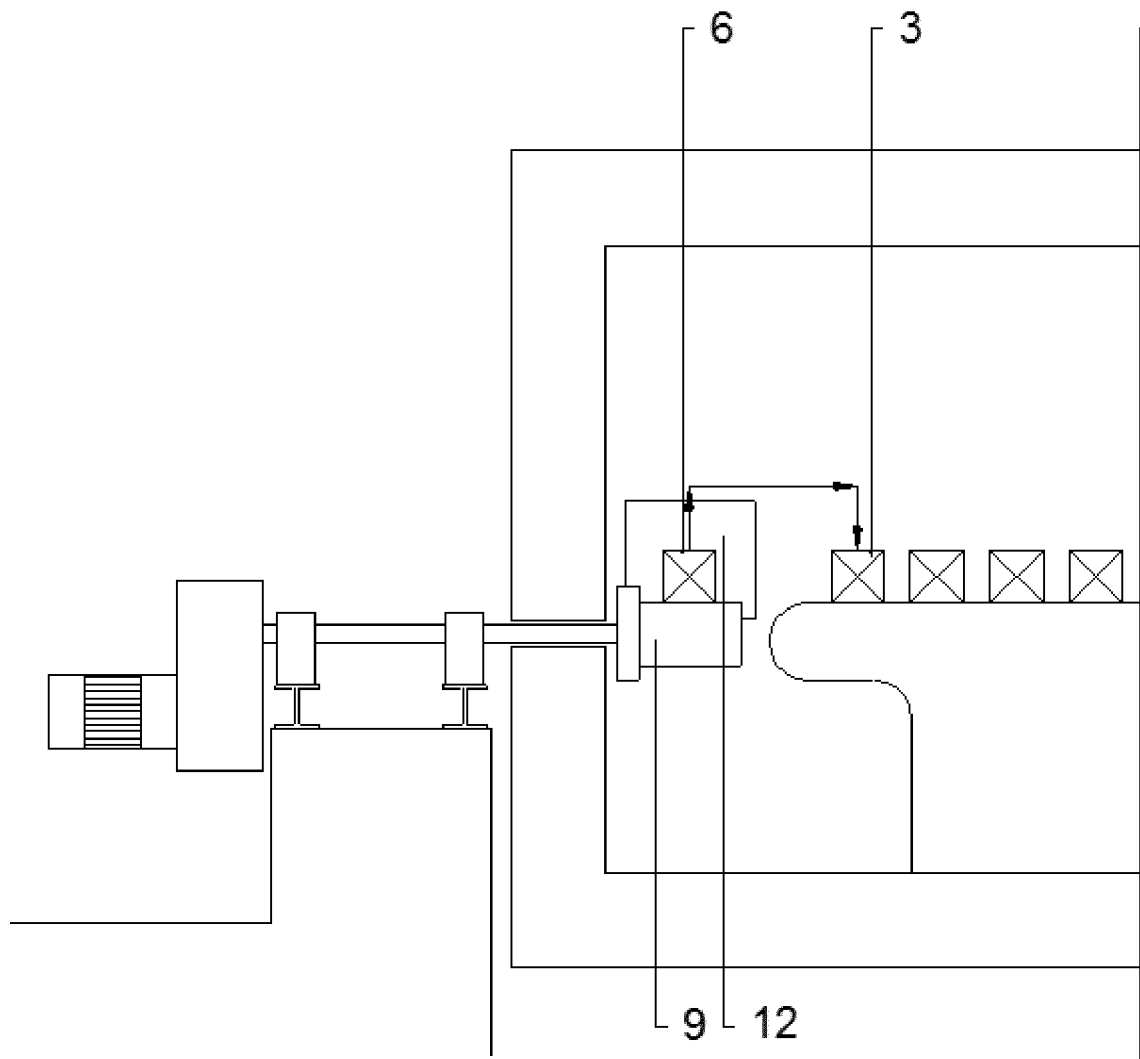


FIG.3

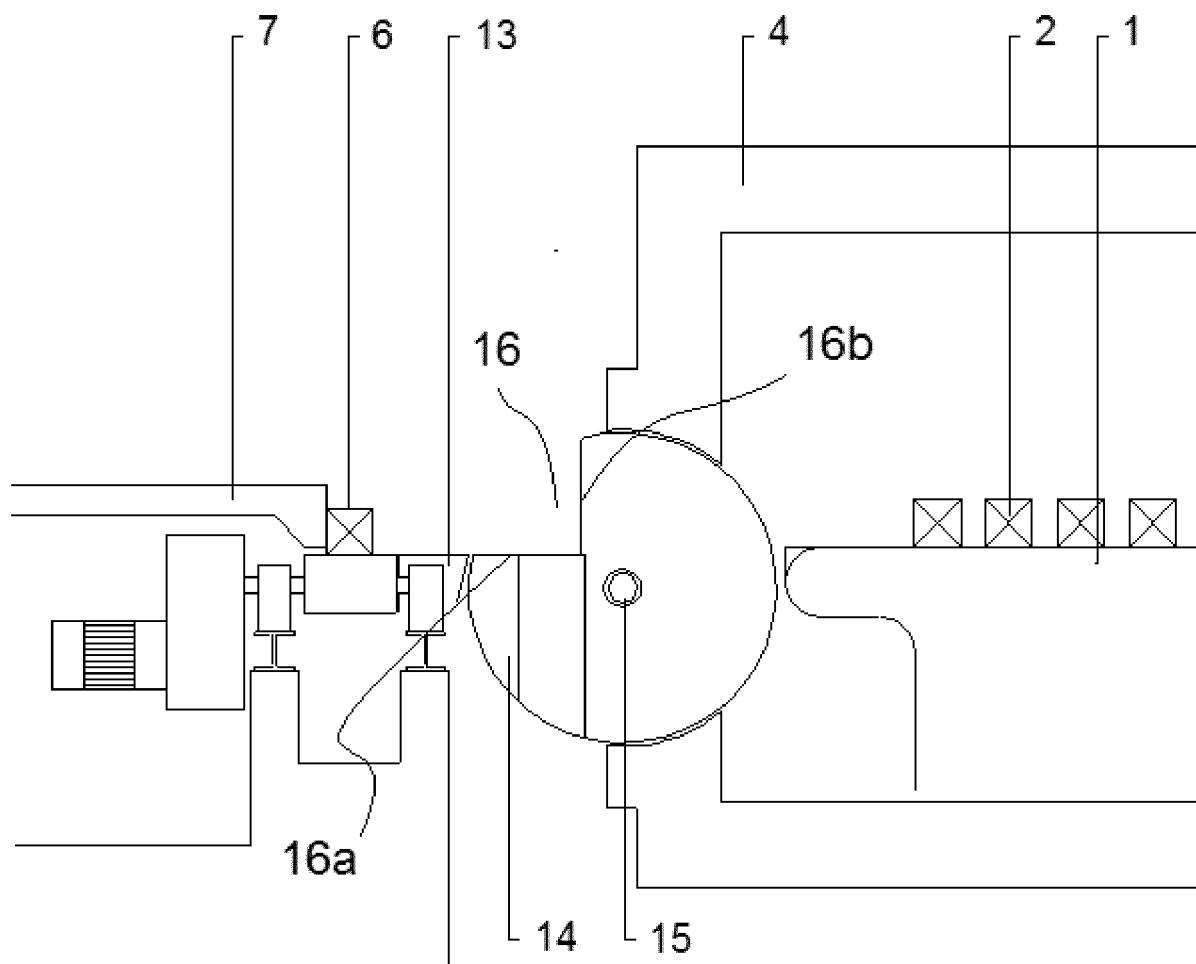


FIG.4

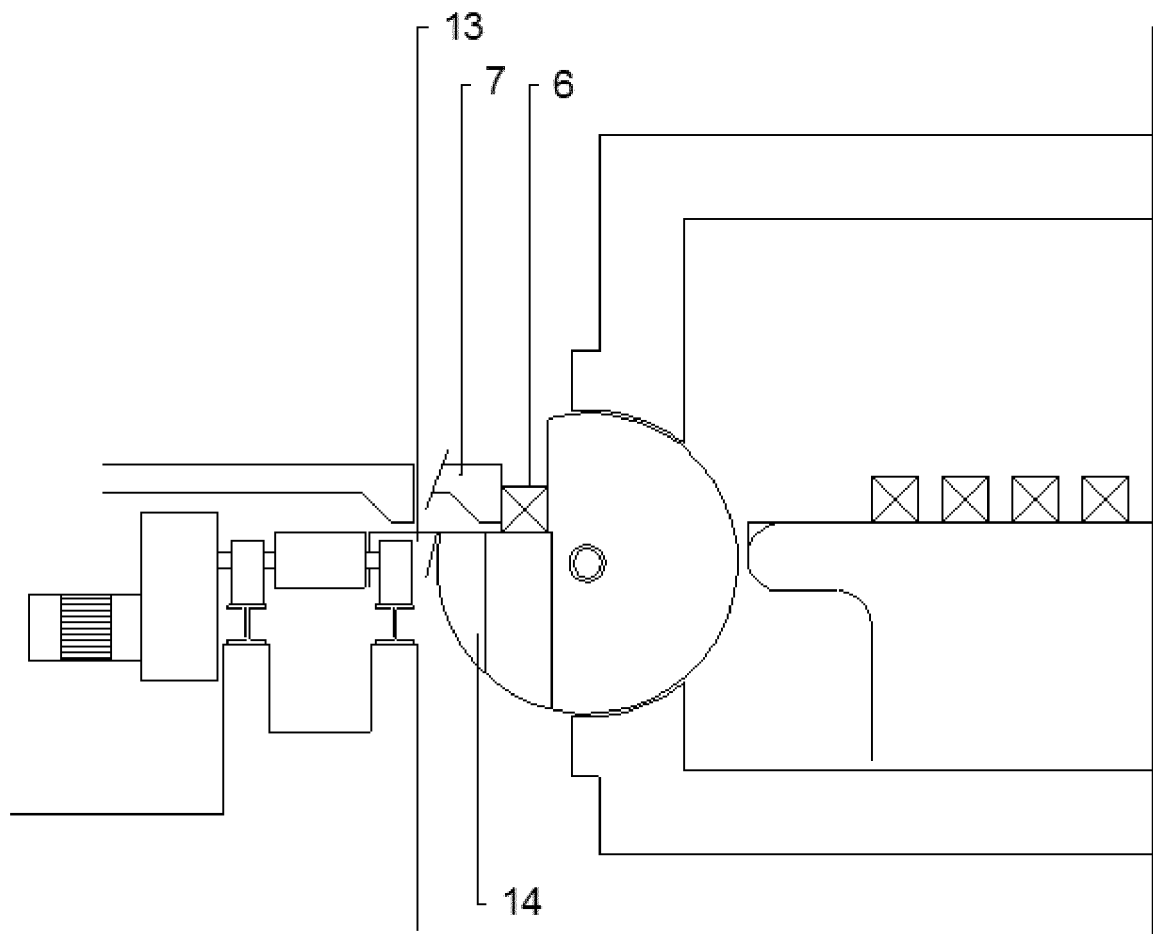


FIG.5

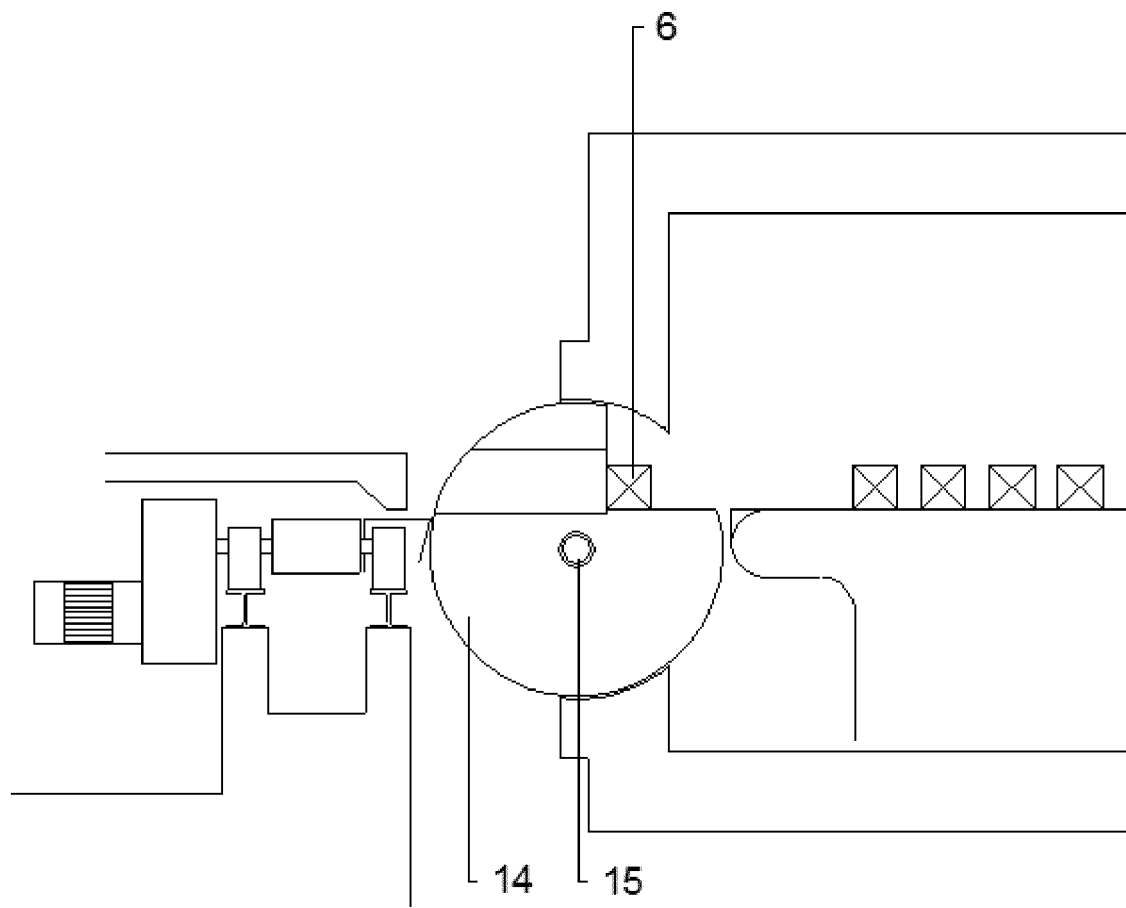


FIG.6

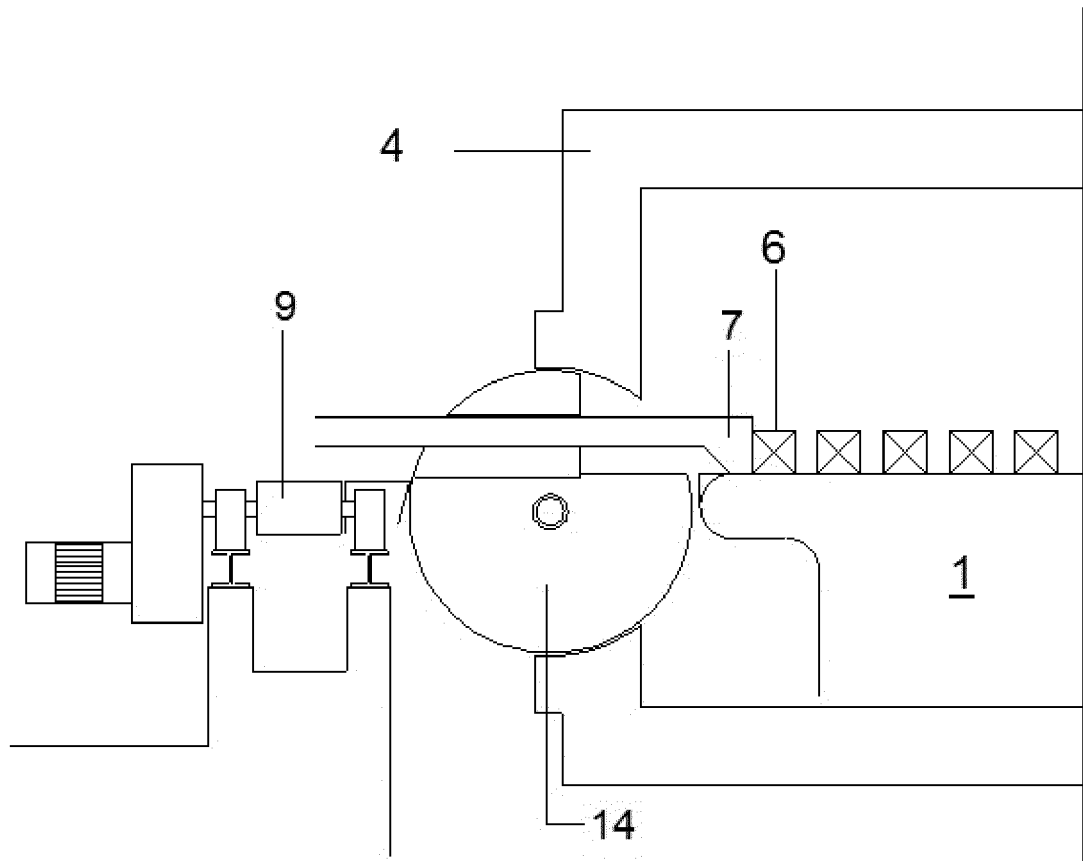


FIG.7

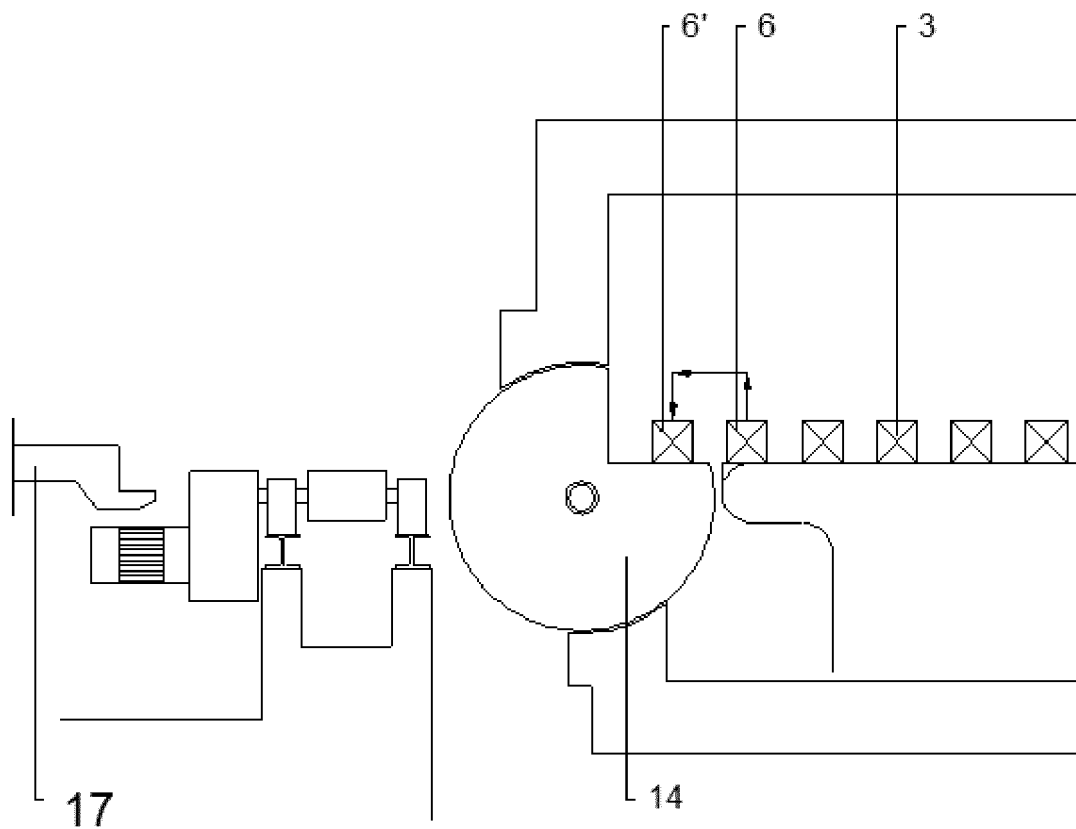


FIG.8

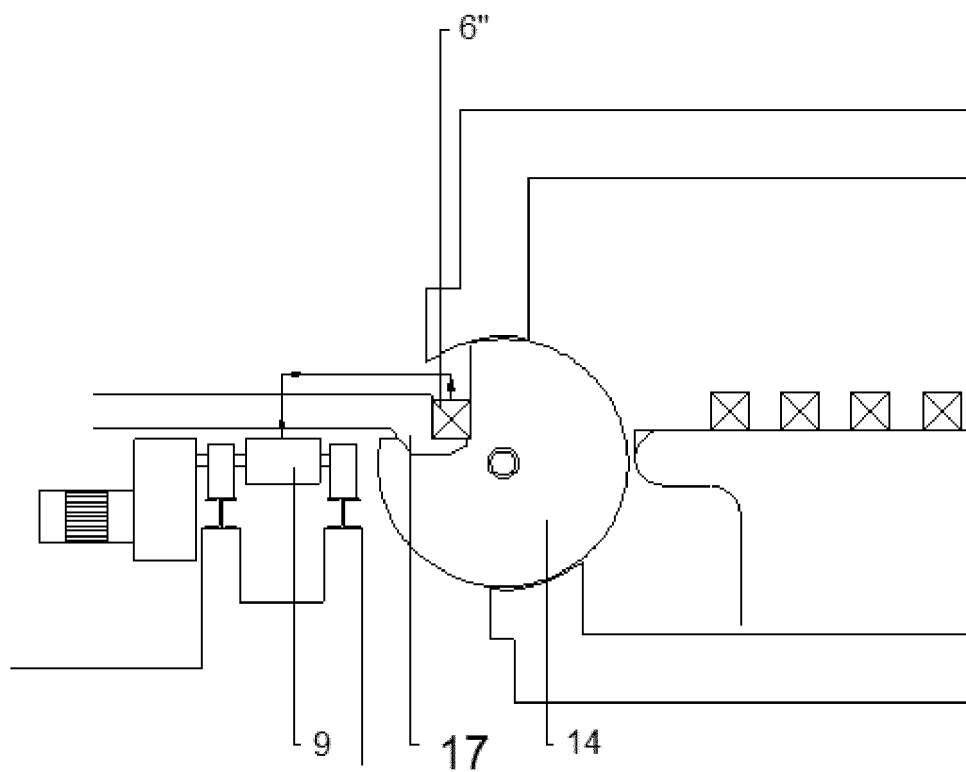


FIG.9

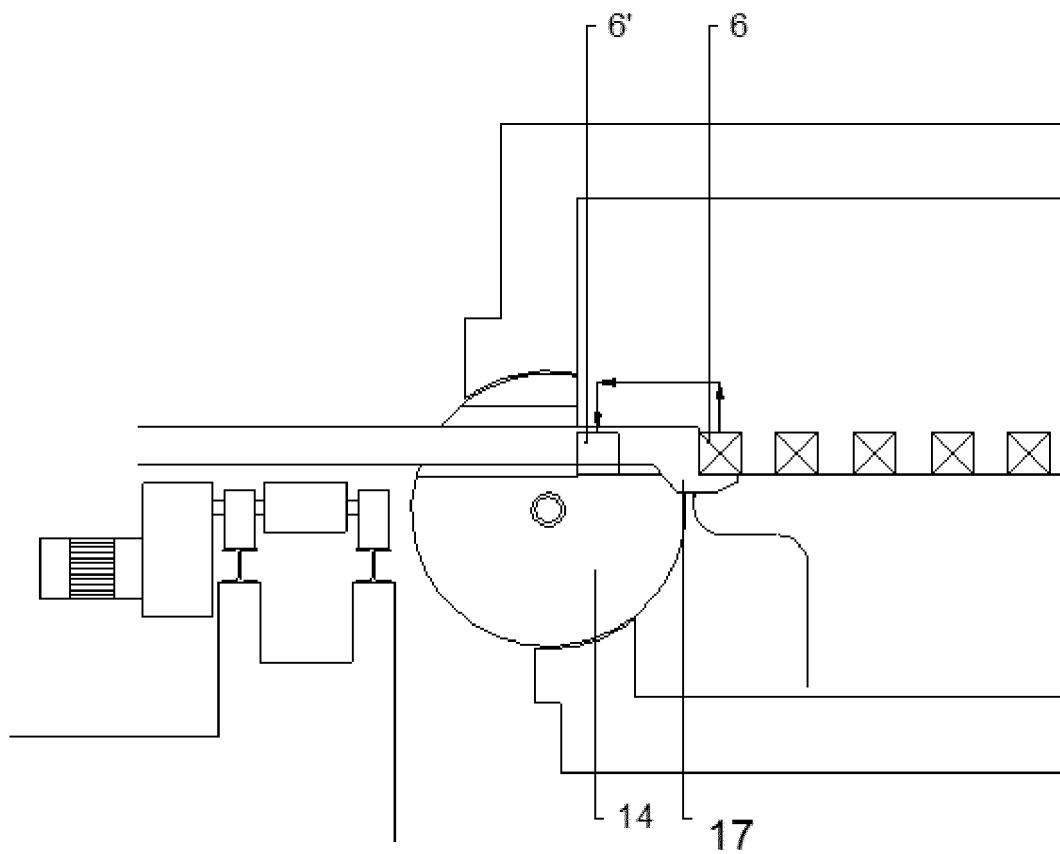


FIG.10

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/ES2014/070399

## A. CLASSIFICATION OF SUBJECT MATTER

**See extra sheet**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F27D, B65G, C21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, INVENES

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                           | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | US 4397600 A (JACUBOWIEZ ISIDORE) 09/08/1983, column 1, lines 7 - 11; lines 43 - 47; column 2, line 38 - column 3, line 4; figures.                                                                          | 1-7                   |
| A         | US 3222043 A (TROGLIONE VINCENT R ET AL.) 07/12/1965, column 1, lines 9 - 11; lines 24 - 63; column 2, lines 29 - 49; column 2, line 70 - column 3, line 3; column 3, lines 20 - 25; lines 40 - 47; figures. | 1,6                   |
| A         | EP 0131214 A2 (ITALIMPIANTI) 16/01/1985, column 2, line 64 - column 3, line 18; figures 1 - 5.                                                                                                               | 1-7                   |
| A         | US 3154298 A (MAURICE AMADIEU) 27/10/1964, column 5, lines 8 - 13; figure 3.                                                                                                                                 | 1,6                   |

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

|                                                                                                                                                                         |                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| * Special categories of cited documents:                                                                                                                                | "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention                                         |
| "A" document defining the general state of the art which is not considered to be of particular relevance.                                                               |                                                                                                                                                                                                                                             |
| "E" earlier document but published on or after the international filing date                                                                                            |                                                                                                                                                                                                                                             |
| "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) | "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone                                                                |
| "O" document referring to an oral disclosure use, exhibition, or other means.                                                                                           | "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other documents, such combination being obvious to a person skilled in the art |
| "P" document published prior to the international filing date but later than the priority date claimed                                                                  | "&" document member of the same patent family                                                                                                                                                                                               |

Date of the actual completion of the international search  
03/07/2014Date of mailing of the international search report  
(08/07/2014)

Name and mailing address of the ISA/

Authorized officer  
A. Rodríguez CogolludoOFICINA ESPAÑOLA DE PATENTES Y MARCAS  
Paseo de la Castellana, 75 - 28071 Madrid (España)  
Facsimile No.: 91 349 53 04

Telephone No. 91 3498534

Form PCT/ISA/210 (second sheet) (July 2009)

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/ES2014/070399

Information on patent family members

| Patent document cited<br>in the search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-----------------------------------------------|---------------------|----------------------------|---------------------|
| US4397600 A                                   | 09.08.1983          | NONE                       |                     |
| US3222043 A                                   | 07.12.1965          | GB1061345 A                | 08.03.1967          |
| EP0131214 A2                                  | 16.01.1985          | BR8403378 A                | 18.06.1985          |
|                                               |                     | CA1219748 A1               | 31.03.1987          |
|                                               |                     | US4585411 A                | 29.04.1986          |
|                                               |                     | US4585411 B1               | 12.03.1991          |
|                                               |                     | AT45806T T                 | 15.09.1989          |
|                                               |                     | IT1199468 B                | 30.12.1988          |
|                                               |                     | IT1171194 B                | 10.06.1987          |
| US3154298 A                                   | 27.10.1964          | GB992530 A                 | 19.05.1965          |
|                                               |                     | US3179390 A                | 20.04.1965          |
|                                               |                     | FR81426E E                 | 20.09.1963          |
|                                               |                     | GB969067 A                 | 09.09.1964          |
|                                               |                     | FR1300858 A                | 10.08.1962          |
|                                               |                     | BE629260 A                 | 30.11.0002          |
|                                               |                     | BE614780 A                 | 30.11.0002          |

Form PCT/ISA/210 (patent family annex) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/ES2014/070399

5

**CLASSIFICATION OF SUBJECT MATTER**

*F27D3/12* (2006.01)

*F27D3/00* (2006.01)

*B65G47/82* (2006.01)

*C21D9/00* (2006.01)

10

15

20

25

30

35

40

45

50

55

Form PCT/ISA/210 (extra sheet) (July 2009)

**REFERENCES CITED IN THE DESCRIPTION**

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

**Patent documents cited in the description**

- FR 2657152 [0005]