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(54) Monitoring system of a ceramics kiln

(57) Method for monitoring and regulating a ceramics kiln (1) comprises the following phases:

picking up at preset intervals of time a sample of ceramic products (4) emerging from the kiln (1);
measuring the plan dimensions and the flatness of each of said products (4);
checking that said dimensions and said flatness are comprised within preset values;
modifying the regulation of the kiln (1) if said dimensions and/or said flatness do not fall within said preset values.

Apparatus for monitoring and regulating a ceramics kiln (1) comprises picking up means (5) of ceramic products (4) at the outlet of said kiln (1), cooling means (7) of said ceramic products (4), optical scan means of said ceramic products (4) and monitoring and regulating means (12, 13) of the ceramics kiln (1), operationally connected to said optical scan means (8).

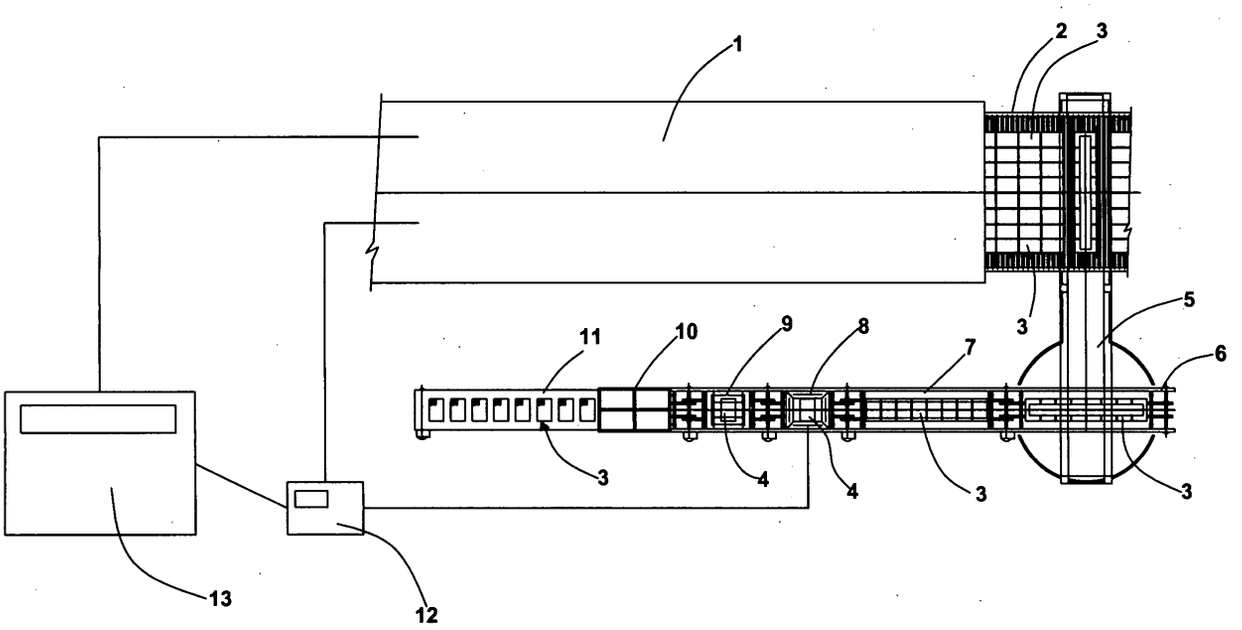

Fig. 1

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Description

[0001] The present invention relates to a monitoring system of a ceramics kiln, i.e. a system for checking that the products emerging from a ceramics firing kiln meet preset quality standards and for intervening to regulate the ceramics kiln, in order to eliminate possible firing defects.

[0002] Firing ceramic products, in particular ceramic tiles, is a very delicate phase of the productive process because any defects in the products that arise because of firing defects lead to product rejects or to products that are not top quality.

[0003] In the prior art, monitoring of the output of a ceramics kiln is performed by specialised personnel who periodically check the quality of the ceramic products emerging from the kiln, for example, in the case of ceramic tiles, their calibre and flatness, and who adjust the regulating system of the different zones of the kiln to remedy any firing defects.

[0004] It is apparent that in particular during night-shifts or holiday shifts, when available personnel are reduced, surveillance of the kilns cannot take place with great frequency, which as a consequence may mean that there is a delay in detecting and correcting any firing defects with the result that significant proportions of output are not top quality.

[0005] No automated prior-art system exists for monitoring the output of a ceramics kiln and intervening on the kiln if firing defects are detected.

[0006] The object of the present invention is to provide a system for automatically monitoring the output of a ceramics kiln and for regulating the kiln if irregularities are detected.

[0007] According to a first aspect of the present invention a method is provided for monitoring and regulating a ceramics kiln that comprises the following phases:

picking up by means of picking up means, at preset intervals of time, a sample of products emerging from the ceramics kiln;
sending said sample to measuring means for measuring the plan-view dimensions and the flatness of each of said products;
checking that said dimensions and said flatness are comprised within preset values;
modifying the regulation of the ceramics kiln if said dimensions and/or said flatness do not fall within said preset values.

[0008] The system according to the invention enables human personnel to be dispensed with for monitoring output, and regulating the firing parameters of a ceramics kiln; it also enables said monitoring to be conducted much more frequently than human personnel would be able to do, thereby making it possible to remedy possible firing defects in very short spaces of time, thereby minimising product rejects due to said firing defects.

[0009] According to a preferred embodiment of the present invention, checking dimensions and flatness occurs by means of optical scan of the products picked up at the outlet of the ceramics kiln.

[0010] This enables rapid, precise and automatic detection of the dimensions and flatness of the products.

[0011] According to a further preferred embodiment of the present invention, the dimensional data detected by said optical scan are compared with reference values and the results of this comparison are used to modify operating parameters of the ceramics kiln, when said dimensional data differ from said reference values by an amount that is greater than a preset amount.

[0012] This enables the regulation of the ceramics kiln to be modified rapidly and promptly in order to eliminate operating defects in the shortest possible time that are reflected in the quality of the products emerging from the kiln.

[0013] According to a further preferred embodiment of the present invention, said dimensional data are sent to a data-processing unit that is suitable for interacting with the monitoring and regulating system of the ceramics kiln; alternatively, said dimensional data are sent directly to the monitoring system regulating the kiln.

[0014] This enables rapid, precise automatic adjustment of the operating parameters of the kiln without the need for intervention by human personnel.

[0015] In a further preferred embodiment of the present invention, each row of said products, after optical scan and printing, is stacked in a single pile.

[0016] This enables the moment at which each product was picked up from the kiln outlet to be determined with the greatest rapidity and certainty inasmuch as all the products of the same row are picked up simultaneously and therefore a product's belonging to the same pile identifies with certainty the moment at which said product was picked up at the outlet of the kiln.

[0017] The invention will now be disclosed below purely by way of non-limiting example with reference to the enclosed drawings, in which:

Figure 1 is a schematic view from above of a system according to the invention;
Figure 2 is a schematic transverse section of a ceramics roller kiln that may be used with the system according to the invention.

[0018] With reference to Figure 1, 1 indicates a kiln for firing ceramic products, in particular flat ceramic products, for example a roller kiln for firing ceramic tiles, at the outlet of which a conveying line 2 is arranged for the ceramic products 4 emerging from the kiln 1 in rows 3 that are parallel to one another.

[0019] A picking up and transfer device 5, arranged transversely to the conveying line 2, picks up at preset intervals of time a row 3 of ceramic products 4 from the conveying line 2, and transfers it by rotating it by 90° onto a further conveying line 6 along which there are

arranged in succession a cooling device 7, a two-three dimensional scan device 8, a printing device 9 and a stacking device 10.

[0020] The ceramic products 4 moving along the further conveying line 6 first pass through the cooling device 7, which lowers the temperature of the products to a preset value, for example to the value of ambient temperature, in such a way that the optical scan measurements are conducted in a substantially constant manner for the different rows of products subsequently picked up from the conveying line 2.

[0021] After passing through the cooling device 7, the ceramic products 4 reach an optical scan device 8, by means of which the lengths of the sides of the product and the variations in the thickness of the product, i.e. its flatness are measured. The optical scan device 8 may be of the type suitable for conducting optical scan of the products 4 whilst the latter are moving along the further conveying line 6, or of the type that requires a temporary stop of each product 4 in order to be able to conduct the optical scan thereof.

[0022] The data detected by the optical scan device are sent to a data-processing system 12 in which the data are compared with reference data to establish whether the dimensions of the sides of the ceramic product and its flatness fall within a range of values considered to be acceptable for being able to classify the products as top quality products or not.

[0023] If this comparison shows that the measurements of the sides and/or the flatness of one or more of the ceramic products 4 of the row 3 do not fall within said preset values the data-processing system 12 intervenes on the monitoring and regulating system 13 of the kiln 1 or intervenes directly on the regulating devices installed in the kiln by varying the kiln operating parameters to eliminate the firing defects that have led to dimensional and/or flatness defects in the ceramic products 4. Varying the operating parameters of the kiln occurs according to preset methods that depend on the type of defect detected by the optical scan and the position of the defective product 4 or products 4 in the row 3 picked up at the outlet of the ceramics kiln 1.

[0024] If, after the elapsing of a preset time after the variation of the operating parameters of the kiln, the detected defect is not eliminated, the data-processing system 12 actuates an alarm signal to request the intervention of the kiln 1 maintenance personnel, stopping if necessary the kiln and the system that supplies it.

[0025] The alarm signal may be transmitted by modem, or telephone, to a remote control station.

[0026] Alternatively, the optical scan device 8 can be operationally connected directly with the monitoring and regulating means 13 of the kiln 1. In this case the processing of the data on the optical scan will be carried out directly by said monitoring and regulating means 13.

[0027] After passing into the optical scan device 8, the ceramic products 4 pass through a printing device 9 by means of which data identifying the product, the time of picking up of the product from the conveying line 2, data on the dimensional parameters of the product and any indications of detected faults are printed on each product 4.

[0028] After passing through the printing device 9, the ceramic products 4 reach a stacking device 10 that places in a single pile 11 the products of each row 3 picked up from the conveying line 2. The piles 11 of products 4 are then taken to a storage zone, that is not shown, where they can be examined by the personnel in charge of maintenance and supervision of the system.

[0029] Owing to the system according to the invention, all the operations of dimensional monitoring of the ceramic products 4 and the operations of regulation of the ceramics kiln 2 are automated without the need for intervention by specialised personnel. Intervention by specialised personnel is requested only if modifications to the regulation of the kiln 1 are unable to eliminate the detected defects.

[0030] Automation of the process of monitoring of the ceramic products 4 and of regulation of the kiln on the basis of said monitoring enables the time frequency to be optimised with which the monitoring is conducted in such a way as to minimise product rejects that may arise because of temporary kiln 2 malfunctions. This is particularly advantageous during night time and holiday periods of operation of the kiln 2, during which the monitoring performable by specialised personnel would be significantly less frequent, with a significant increase in the percentage of product rejects in the event of kiln 2 malfunction.

[0031] Figure 2 illustrates a section of a ceramics kiln 1 that is particularly suitable for being used with the system according to the invention.

[0032] The ceramics kiln 1 is equipped with a plurality of burners 15, arranged on each wall of the combustion chamber 14, in two rows, which may be staggered, one of which is distributed above the plane defined by the rollers 19 that convey the ceramic products 4 through the kiln 1 whereas the other is distributed below said plane.

[0033] The burners 15 are of the type that produces a plurality of flames directed radially in relation to the head of the burner, i.e. directed substantially on a plane parallel to the walls of the kiln. Alternatively, the burners 15 may be of the rotating type that produces a crown of flames directed radially in relation to the head of the burner, i.e. directed substantially on a plane parallel to the walls of the kiln. This type of burner enables a more uniform temperature to be obtained in the section of the kiln, in such a way as to prevent the possibility of zones being created with noticeably different temperatures, which would negatively influence firing of the products 4.

[0034] With each burner 15 a respective wall thermocouple 16 is associated that detects the temperature existing along the wall of the kiln, near the respective burner 15.

[0035] Each thermocouple 16 is operationally con-

nected to a respective regulating device 17 that controls regulating means 18 that regulates the supply to the respective burner 15.

[0036] The regulating devices 17 intervene on the supply to the respective burners 15 according to the temperature values detected by the thermocouples 16 and by further known thermocouples that are not shown that are installed in such a way as to measure the temperature in the central zone of the kiln. The regulating devices 17 intervene by varying the supply to the burners 15 in such a way as to maintain a substantially uniform temperature inside the combustion chamber 14 of the kiln 2 on its entire section.

[0037] The system according to the invention can be operationally connected to the regulating devices 17, to provide regulation of the temperature in the different zones of the kiln, in order to compensate for any firing defects in the products 4.

[0038] In the practical embodiment, the materials, dimensions and constructional details may be different from those indicated but be technically equivalent to them without thereby falling outside the legal scope of the present invention .

Claims

1. Method for monitoring and regulating a ceramics kiln (1) that comprises the following steps:

   picking up at preset intervals of time a sample of ceramic products (4) emerging from the kiln (1);
   measuring the plan dimensions and the flatness of each of said products (4);
   checking that said dimensions and said flatness are comprised within preset values;
   modifying the regulation of the kiln (1) if said dimensions and/or said flatness do not fall within said preset values.

2. Method according to claim 1, wherein said picking up comprises picking up a row of ceramic products (4) from conveyor means (2) located at the outlet of said kiln (1), said row of products (4) being arranged transversely on said conveyor means (2).

3. Method according to claim 1, or 2, wherein said measuring is carried out by optical scan means (8).

4. Method according to any claim 1 to 3, wherein between said picking up and said measuring said row (3) of ceramic products (4) is rotated by 90°.

5. Method according to any preceding claim, wherein between said picking up and said measuring said ceramic products (4) are cooled to a preset temperature by cooling means (7).

6. Method according to any preceding claim further comprising comparing data obtained from said measuring with preset values and modifying operating parameters of the ceramics kiln (1) by means of monitoring and regulating means (13) of the kiln (1) on the basis of the results of said comparing.

7. Method according to claim 6, wherein said comparing is carried out by data processing means (12) that interacts with said monitoring and regulating means (13).

8. Method according to claim 6, wherein said comparing is carried out by said monitoring and regulating means (13).

9. Method according to any preceding claim, further comprising, after said measuring, printing on said ceramic supports (4) identifying data of the supports and of the results of said measuring.

10. Method according to claim 9, wherein, after said printing, the ceramic supports (4) of each row (3) are arranged in a respective pile (11).

11. Apparatus for monitoring and regulating a ceramics kiln (1) **characterised in that** it comprises picking up means (5) of ceramic products (4) at the outlet of said kiln (1), cooling means (7) of said ceramic products (4), optical scan means of said ceramic products (4), monitoring and regulating means (13) of the ceramics kiln (1), operationally connected to said optical scan means (8).

12. Apparatus according to claim 11, wherein said monitoring and regulating means (13) is operationally connected to said optical scan means (8) by means of data processing means (12).

13. Apparatus according to claim 11, or 12, wherein said picking up means (5) picks up each time a row (3) of ceramic products (4) from a conveyor (2) arranged at the outlet of said kiln (1).

14. Apparatus according to claim 13, further comprising rotating means, to rotate by 90° said row (3) of ceramic products (4).

15. Apparatus according to claims 11 to 14, further comprising a further conveyor (6) for conveying the ceramic products (4) picked up by said picking up means (5).

16. Apparatus according to claim 15, wherein said cooling means (7) and said optical scan means (8) are arranged along said further conveyor (6).

17. Apparatus according to claims 11 to 16, further com-

prising printing means (9) suitable for printing said ceramic products (4).

18. Apparatus according to claims 11 to 17, further comprising stacking means (10) suitable for stacking said ceramic products (4).

19. Apparatus according to claim 18, wherein said stacking means (10) stacks in a single pile (11) a respective single row (3) of ceramic products (4).

20. Apparatus according to claims 17 to 19, wherein said printing means (9) and said stacking means (10) are arranged in succession along said further conveying line (6) after said optical scan means (8).

21. Apparatus according to claims 11 to 20, wherein said ceramics kiln (1) comprises a combustion chamber (14) within which said ceramic products (4) are conveyed by drive rollers (20), onto opposite walls of said combustion chamber (14), rows of burners being arranged (15), each of said burners (15) being of the type that produces a plurality of flames distributed substantially on a plane parallel to said walls.

22. Apparatus according to claim 21, wherein said burners (15) are of the rotating type and said plurality of flames is a crown of flames distributed on said plane.

23. Apparatus according to claim 21, or 22, **characterised in that** on each wall of said combustion chamber (14) there are arranged a first and second row of said burners (15), said first row being arranged above said rollers (19) and said second row being arranged below said rollers (19).

24. Apparatus according to claim 23, wherein said first and said second row are staggered between one another.

25. Apparatus according to claims 21 to 24, wherein each burner (15) is associated with a respective wall thermocouple(16).

26. Apparatus according to claim 25, wherein each wall thermocouple (16) is operationally associated with a respective regulating device (17) that is suitable for interacting with regulating means (18) suitable for regulating the supply to the respective burner (15).

27. Apparatus according to claim 26, wherein said regulating device (17) is operationally associated with said monitoring and regulating means (13).

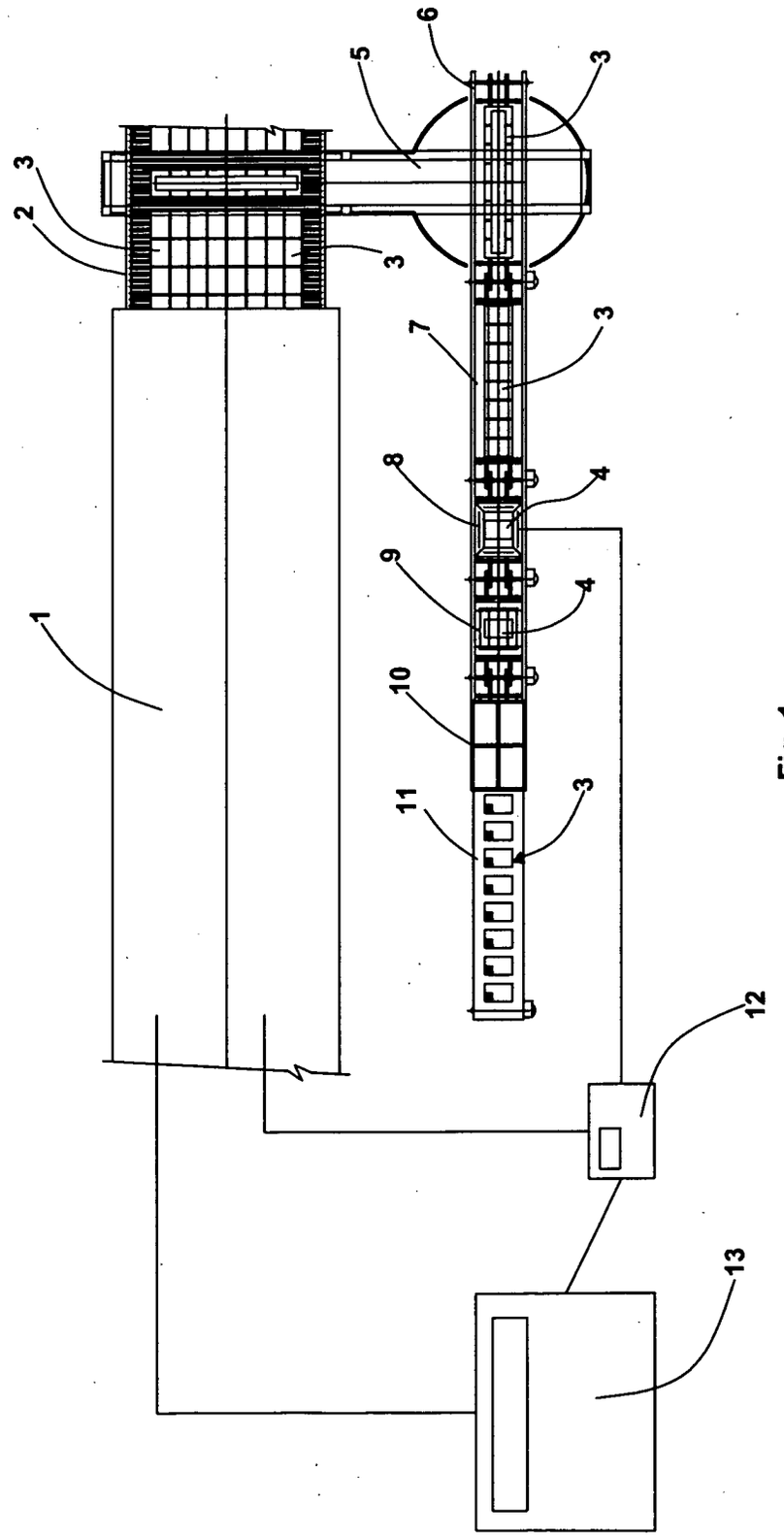

Fig. 1

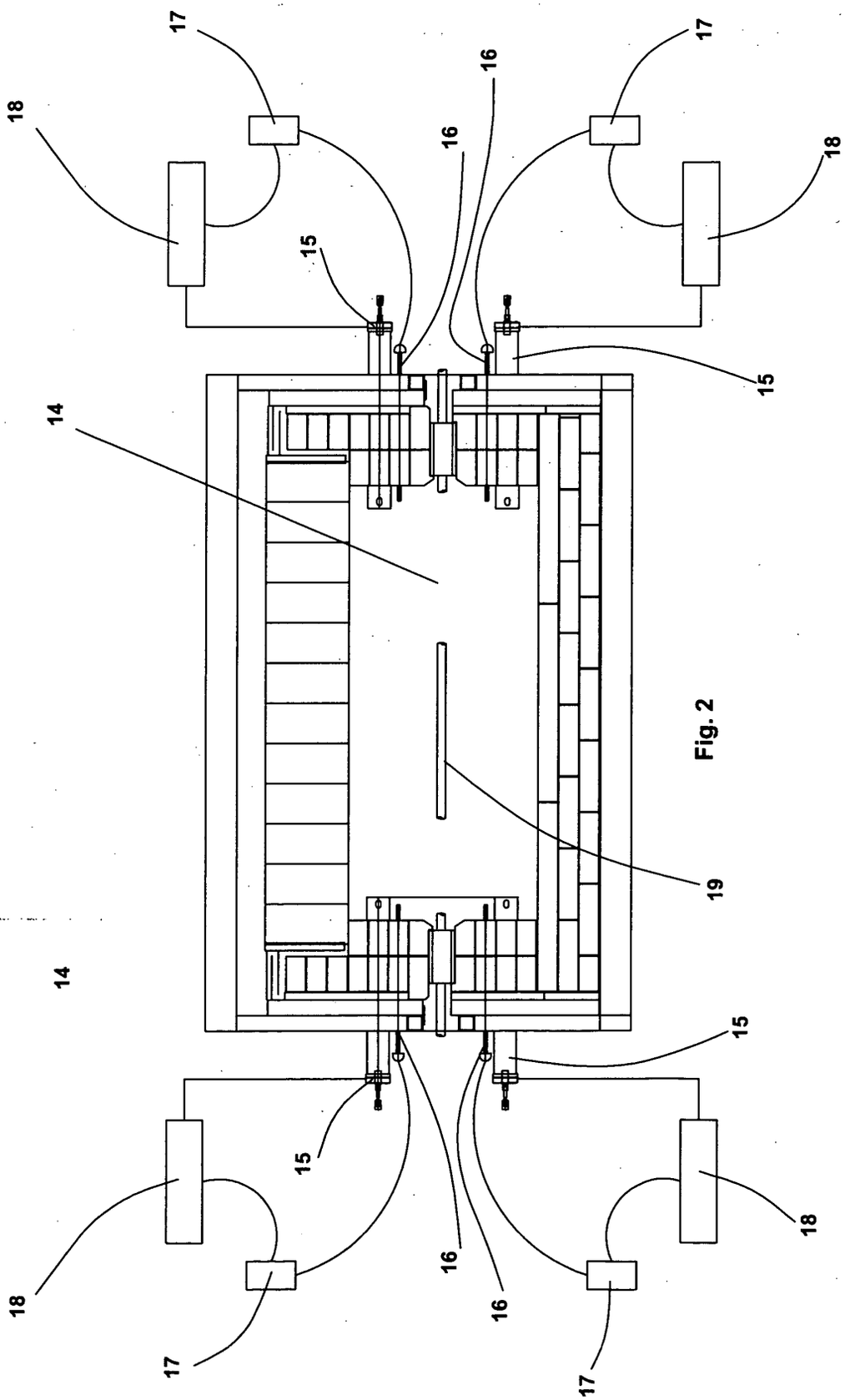

Fig. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 01 7200

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	15 October 2004	Coulomb, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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