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(71) Applicant: **Sacmi Forni S.p.A.**
40026 Imola (BO) (IT)

(72) Inventors:
- **VACCARI, Pier Francesco**
  40026 IMOLA (BO) (IT)
- **MAZZALI, Simone**
  40026 IMOLA (BO) (IT)
- **LANZANI, Federico**
  40026 IMOLA (BO) (IT)

(74) Representative: **Musconi, Roberta et al**
Studio Torta S.p.A.
Via Viotti, 9
10121 Torino (IT)

(54) DEVICE TO DETECT THE FLOW RATE OF GASES FLOWING OUT OF A CHIMNEY OF A KILN FOR THE FIRING OF CERAMIC PRODUCTS AND KILN FOR THE FIRING OF CERAMIC PRODUCTS PROVIDED WITH SAID DEVICE

(57) A device (12) to detect the flowrate of the gases flowing out of a chimney (11) of a kiln (3) for the firing of ceramic products having a suction device (9) which directs the gases present in the kiln (3) towards the chimney (11); and wherein said device (12) is housed inside the chimney (11) and comprises a casing (13) provided with an axis (L) and having a head portion (16); and at least one sensitive element (24) having an end portion (28) housed inside the end portion (16) and which is subjected to a temperature variation proportional to the speed of the out-flowing gas flow (F); and a cleaning device (29) to clean the sensitive element (24) wherein an element (30) movable along the first axis (L) is operated by actuator means (31) so as to slide on the end portion (28) and to remove the pollutants that have deposited there.

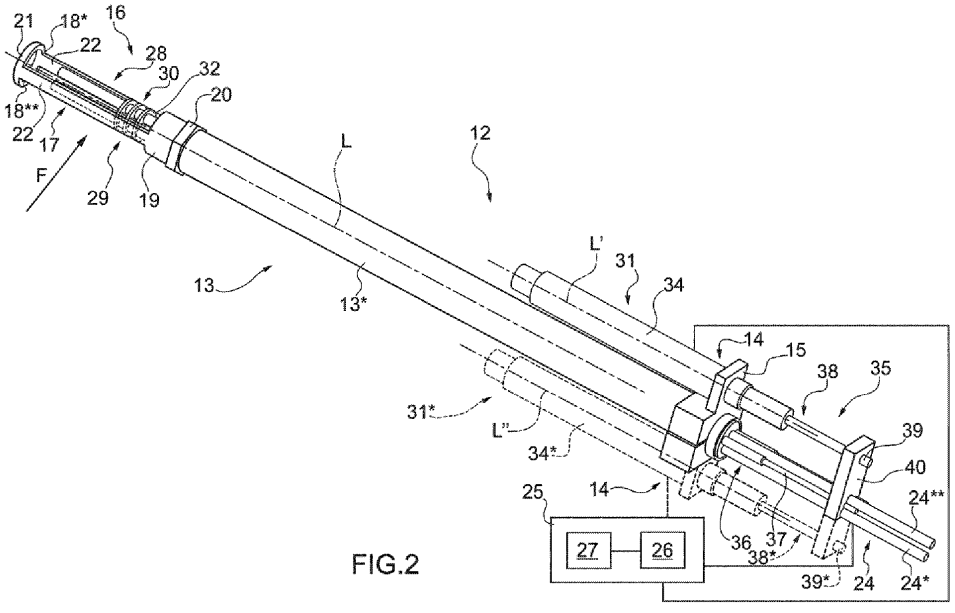

FIG.2

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Description

PRIORITY CLAIM

[0001] *This application claims priority from Italian Patent Application No.* 102017000052447 *filed on 15/05/2017.*

TECHNICAL FIELD

[0002] The present invention is relative to a device to detect the flowrate of the gases flowing out of a chimney of a kiln for the firing of ceramic products and a kiln for the firing of ceramic products provided with said device.

PRIOR ART

[0003] In the field of the manufacturing ceramic products, such as, for example ceramic tiles and slabs, it is known to use systems comprising equipment for pressing a ceramic powder, and a kiln, in particular a tunnel kiln, positioned downstream of the pressing equipment for the firing of ceramic articles.

[0004] The inside of the kiln is typically divided into a pre-heating zone, a true firing chamber for the ceramic products and a cooling chamber positioned downstream of the firing chamber to reduce the temperature of the ceramic products coming from the firing chamber.

[0005] The kiln also comprises an extraction station, to extract the gases coming from the firing chamber to be released into the outside provided with a suction device designed to generate by means of suction an outflow of gas from the kiln and a duct connected to the firing chamber to direct the gases towards an outlet chimney which directs them towards the outside.

[0006] Safety legislation requires the inside of the chimney to be provided with a probe able to detect the flowrate of the outflow of gases coming from the firing chamber, to ascertain, for example, that the chimney is not clogged and that the gases produced in the firing chamber are expelled correctly to the outside.

[0007] Usually, for these types of applications, Pitot tubes or hot-wire anemometers are used which are housed in proximity to an outlet mouth of the gas, are hit by the outflow of gas and, by measuring the speed of the gas flow, allow determination of the flowrate.

[0008] The gas flow coming out of the firing chamber is so rich in pollutants, such as powders and other impurities, that deposit on the probes as they are lapped by the gas flow, that the performances of the probes in terms of reliability of the measurements taken deteriorate very rapidly.

[0009] To solve this problem, the probes are inserted as required inside the chimneys so as to periodically take sample recordings of the flowrate of the outflow of gases coming from the firing chamber. This solution, however, has the drawback of not allowing continuous measurement of the flowrate of the gases flowing out of the kiln and not allowing effective recognition of any danger conditions, such as, for example, when the chimney is clogged and the gases produced in the firing chamber cannot be discharged to be outside.

DESCRIPTION OF THE INVENTION

[0010] The object of the present invention is to provide a device to detect the flowrate of gases flowing out of a chimney of a kiln for firing ceramic products, which is free from the drawbacks of the state of the art and at the same time is easy and inexpensive to produce.

[0011] A further object of the present invention is to provide a kiln for firing ceramic products provided with a device for detecting the flowrate of the gases flowing out of a chimney which is free from the drawbacks of the state of the art and at the same time is easy and inexpensive to produce.

[0012] According to the present invention a device for detecting the flowrate of the gases flowing out of a chimney of a kiln for firing ceramic products and a kiln for firing ceramic products provided with said device are provided, as claimed in the attached claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The invention is described below with reference to the accompanying drawings, which illustrate some non-limiting implementation examples thereof, in which:

- figure 1 is a schematic view of a system for the production of ceramic products produced in accordance with the present invention;
- figure 2 is a perspective view of a device 1 for detecting the flowrate of the fumes flowing out of a chimney of the system of figure 1 and produced in accordance with the present invention;
- figure 3 is a perspective view of a detail of figure 2; and
- figure 4 is a section view along the line IV-IV of the detail of figure 3.

PREFERRED EMBODIMENTS OF THE INVENTION

[0014] In figure 1, the number 1 indicates overall a system for the production of ceramic products, such as, for example ceramic tiles or slabs. The system 1 comprises a pressing unit 2 (known and not described in detail) designed to press a ceramic powder, and a kiln 3 (in particular a tunnel kiln) for firing the ceramic articles positioned downstream of the pressing unit 2.

[0015] The system 1 further comprises a conveying device designed to convey the ceramic products along the system 1, from the pressing unit 2 to the kiln 3. The conveying device 4 is preferably made as a roller conveyor, to move the ceramic products in a given feed direction A.

The inside of the kiln 3 is divided into a preheating zone

5, a firing chamber 6 provided with burners (of a known type and not described) and adapted to treat the ceramic products by means of heat (in particular inside the firing chamber 6 temperatures, in the order of 1000 - 1250°C, are reached) and a cooling chamber 7 positioned downstream of the firing chamber 6 to reduce the temperature of the ceramic products coming from the firing chamber 6. The kiln 3 comprises an extraction station 8 for extracting the gases present in the kiln to be released into the outside; the extraction station 8 is preferably arranged at an inlet of the preheating zone 5.

[0016] At the extraction station 8 for extracting the gases, a suction device 9 is provided, which is fluidically connected to the preheating zone 5 and designed to generate, by means of suction, a flow F of gas flowing out of the kiln 3. In particular, the suction device 9 preferably comprises a fan and a duct 10 connected to the preheating zone to direct the gases flowing out of the kiln 3 towards an outlet chimney 11 to release them to the outside.

[0017] The inside of the outlet chimney 11 houses a device 12 for detecting the flowrate of the gases flowing out of the kiln 3.

[0018] According to a preferred variation, the device 12 is housed in proximity to the outlet mouth of the gases, at the chimney 11 in which the out-flowing gases have the lowest temperature.

[0019] As illustrated in figures 2 to 4, the device 12 comprises an outer casing 13, with a substantially cylindrical development around a longitudinal axis L provided with a central portion 13* defined by a cylindrical side wall and a base 14 provided with a flange 15. The outer casing 13 is furthermore provided with a head 16 which, in use, is immersed in the outflow of gas. The head 16 is defined by a tubular element 17 also with a cylindrical development around the longitudinal axis L; in the tubular element 17 two through openings 18 are obtained indicated by 18* and 18**, equal to each other and symmetrical with respect to the longitudinal axis L and designed to make the inside of the head 16 accessible. In other words, the head 16 is defined by a lower annular portion 19 for connection to the central portion 13* by means of a flange 20 and an upper annular portion 21; wherein the lower annular portion 19 and the upper annular portion 21 are joined to each other by means of two arms 22 diametrically opposite with respect to the longitudinal axis L.

[0020] Preferably, the outer casing 13 and the base 14 are made of any material with a high mechanical strength, such as, for example stainless steel.

[0021] The device 12 has an inner cavity 23 coaxial with the longitudinal axis L which crosses the base 14 and the outer casing 13. The inner cavity 23 has a substantially circular shaped cross section.

[0022] The inner cavity 23 has dimensions such as to allow at least one sensitive element 24 to be housed inside it.

[0023] The device 12 further comprises an electronic unit 25 connected to the sensitive element 24. The electronic unit 25 comprises, in turn, a handling module 26 for handling the signals, designed to acquire, store and transmit the signals detected by the sensitive element 24 to a processing module 27 for processing the signals detected by the sensitive element 24. The processing module 27 processes the signals so as to determine the speed of the outflow of gas.

[0024] According to a preferred variation, the inner cavity 23 has dimensions such as to allow two sensitive elements 24*, 24** arranged side by side to be housed inside it. The two sensitive elements 24*, 24** are both housed in a fixed manner inside the inner cavity 23. The two sensitive elements 24*, 24** have a respective head end portion 28*, 28** that projects from the cavity 12 and is housed inside the head 16 so that they are both accessible through the openings 18* and 18**.

[0025] The sensitive element 24* acts as a reference sensitive element 24*, whereas the sensitive element 24** acts as a measuring sensitive element 24**. Each sensitive element 24 is made of a resistance temperature detector, namely a resistor whose resistance value is proportional to the temperature.

[0026] The reference sensitive element 24* is designed to detect the current temperature T_G of the outflow of gas in which the device 12 is immersed.

[0027] According to the current temperature T_G of the out-flowing gas flow detected by the reference sensitive element 24*, the measuring sensitive element 24** is instead powered by means of an electric heating current with known intensity until reaching a reference temperature value T_{ref} different from the current temperature T_G, preferably greater than the current temperature T_G.

[0028] According to a first variation, by maintaining constant the electric heating current supplied to the measuring sensitive element 24**, the measuring sensitive element 24** is subjected to a temperature variation proportional to the speed of the outflow of gas by means of a thermal exchange coefficient. Knowing the thermal exchange coefficient, the processing module 27 determines the speed of the outflow of gas as a function of the temperature gradient, i.e. as a function of the difference between the reference temperature T_{ref} and the effective temperature reached in the unit of time by the measuring sensitive element 24**.

[0029] According to a second variation, the reference temperature T_{ref} of the measuring sensitive element 24** is maintained constant; the electric heating current supplied to the measuring sensitive element 24** to maintain the reference temperature T_{ref} constant is proportional to the speed of the outflow of gas by means of a thermal exchange coefficient. Knowing the thermal exchange coefficient of the measuring sensitive element 24**, the processing module 27 determines the speed of the outflowing gas as a function of the heating current supplied to the measuring sensitive element 24** in the unit of time.

[0030] The mass flowrate of the outflow of gases is calculated by the processing module 27 via the product

of the speed of the outflow of gas, the section of the outflow chimney 11 in which the device 12 is installed and the density of the out-flowing gas flow.

[0031] According to a further embodiment, the inner cavity 23 has dimensions such as to allow a single sensitive element 24 to be housed within it. The sensitive element 24 is housed in a fixed manner inside the inner cavity 23 and has a head end portion 28 that projects from the inner cavity 23 and is housed inside the head 16 so as to be accessible through the openings 18* and 18**. The sensitive element 24 is made of a resistance temperature detector, namely a resistor whose value is proportional to the temperature and is designed to detect the current temperature T_G of the outflow of gas in which the device 12 is immersed.

[0032] According to the current temperature T_G of the out-flowing gas flow, the sensitive element 24 is powered by means of an electric heating current with known intensity until reaching a reference temperature value T_{ref} different from the current temperature T_G, preferably greater than the current temperature T_G.

[0033] According to a first variation, by maintaining the electric heating current constant, the sensitive element 24 undergoes a temperature variation proportional to the speed of the outflow of gas by means of a thermal exchange coefficient. Knowing the thermal exchange coefficient, the processing module 27 determines the speed of the outflow of gas as a function of the temperature gradient, i.e. as a function of the difference between the reference temperature T_{ref} and the actual temperature reached in the unit of time by the sensitive element 24.

[0034] According to a second variation, the reference temperature T_{ref} of the sensitive element 24 is maintained constant; the electric heating current supplied to the sensitive element, to maintain the reference temperature T_{ref} constant, is proportional to the speed of the outflow of gas by means of a thermal exchange coefficient. Knowing the thermal exchange coefficient, the processing module 27 determines the speed of the outflow of gas as a function of the heating current supplied to the sensitive element 24 in the unit of time.

[0035] Also in this case, the mass flowrate of the outflow of gases is calculated by the processing module 27 via the product of the speed of the outflow of gas, the section of the outlet chimney 11 in which the device 12 is installed and the density of the outflow of gas.

[0036] The device 12 is furthermore provided with a cleaning device 29 for cleaning the sensitive elements 24.

[0037] The cleaning device 29 for cleaning the sensitive elements 24 is made through a piston 30 housed inside the head 16 and mobile along the longitudinal axis L under the thrust of actuator means 31.

[0038] The piston 30 is made of a number of discs 32 coaxial with the longitudinal axis L, each of which is provided with a number of through openings 33 equal to the number of sensitive elements 24. The discs 32 have dimensions that approximate downwards the internal dimensions of the head 16. Each through opening 33 has dimensions substantially equal to or approximating the dimensions of the sensitive element 24. Advantageously, the discs 32 are equally spaced along the longitudinal axis L. As better illustrated in figures 3 and 4, the cleaning device 29 for cleaning the sensitive element 24 comprises, for example, three discs 32 coaxial with the longitudinal axis L. Each disc 32 is furthermore provided with two through openings 33 opposite to each other with respect to the longitudinal axis L engaged by the two sensitive elements 24.

[0039] Advantageously, the actuator means 31 comprise at least one actuator device 31 such as a hydraulically or pneumatically operated cylinder. According to a first variation, the actuator device 31 is provided with an outer body 34 with a cylindrical development around a longitudinal axis L', substantially parallel to the longitudinal axis L. One end of the outer body 34 is connected to the flange 15.

[0040] According to a further variation, the actuator means 31 comprise a further actuator device 31* provided with an outer body 34* with a cylindrical development around a longitudinal axis L", substantially parallel to the longitudinal axis L and the longitudinal axis L'. The actuator device 31 and the actuator device 31* are positioned respectively above and below the outer casing 13. In other words, the outer casing 13 is interposed between the actuator devices indicated by 31 and 31*. One end of the outer body 34* is connected to the flange 15.

[0041] According to a further embodiment, the actuator means 31 comprise an electric stepper motor.

[0042] According to further embodiments (not illustrated), the actuator means 31 alternatively comprise a worm, or a screw - nut screw system, or a screw linear axis, or a cog belt linear axis or a linear actuator.

[0043] The disc assembly 32 receives the motion from the actuator means 31 through a stem 35. In the case described above in which a single actuator device 31 is provided, the stem 35 has a U shape.

[0044] In particular, a branch 36 of the stem is made through a pair of rods 37 housed inside the cavity 23 and sliding along the longitudinal axis L. The inner cavity 23 has, in fact, dimensions that allow the two rods 37 to be housed inside it. Each rod 37 is fixed with one end thereof to each disc 32 at respective peripheral connection zones diametrically opposite one another and interposed between the through openings 33.

[0045] If a single actuator device 31 is provided, a branch 38 of the stem 35 is made through a rod 39, mobile along the longitudinal axis L' which receives the motion directly from the actuator device 31 and is connected to the rods 37 by the interposition of a plate 40.

[0046] If two actuator devices 31, 31* are provided, a further branch 38* of the stem 35 is provided made through a rod 39*, mobile along the longitudinal axis L" which receives the motion directly from the actuator device 31 and is connected to the rods 37 with the interposition of the plate 40.

[0047] The plate 40 is anchored to the rod 39, to the rods 37, and if necessary to the rod 39*. Two through holes are obtained in the plate 40, inside which the two sensitive elements 24 are inserted, on the surface on which the plate 40 slides in use.

[0048] If only one sensitive element 24 is provided, each disc 32 is provided with a single through opening 33, preferably coaxial with the longitudinal axis L, and engaged by the sensitive element 24. Similarly, a single through hole is obtained in the plate 40, preferably coaxial to the longitudinal axis L, and inside which the sensitive element 24 is inserted.

[0049] Under the thrust of the actuator means 31, the piston 30 moves between two stroke end positions along the longitudinal axis L. In particular, the piston 30 moves between a retracted position in which it is arranged during normal operation of the device 12 at the base of the head 5 (position illustrated in figures 2 and 3) and an advanced position which it reaches during the cleaning operations of the sensitive elements 24 at the ends of the terminal portions 28 (position not illustrated); and vice versa.

[0050] In use, the device 12 for detection of the flowrate of the outflow of gases is arranged inside the outlet chimney 11 so as to be hit crosswise by the out-flowing gas flow F. In particular, the device 12 for detection of the flowrate of the out-flowing gases is arranged inside the outlet chimney 11 so that the end portions 28 of the sensitive elements 24 are directly hit by the out-flowing gas flow F (i.e. without the screening of the arms 22).

[0051] The electronic unit 25 is connected to the actuator means 31 to drive them at a given frequency.

[0052] Once a certain number of minutes of operation have elapsed, the command is given to the actuator means 31 to perform a cleaning cycle of the sensitive elements 24. During each cleaning cycle of the sensitive elements 24, the actuator means 31 move the piston 30 from the retracted position to the advanced position, and vice versa. Advantageously, the movement from the retracted position to the advanced position, and vice versa, can be repeated a plurality of times for each cleaning cycle as required. In this way, the discs 32 slide on the end portions 28 of the sensitive elements 24 removing dust and impurities that have deposited on the sensitive elements 24, while the device 12 is lapped by the out-flowing gas flow F.

[0053] The device 12 for detecting the flowrate of the out-flowing gases described so far has some advantages.

[0054] In particular, the device 12 is simple and inexpensive to produce and, due to the presence of the cleaning device 29 for cleaning the sensitive elements 24, it provides continuous reliable measurement of the flowrate of the outflow of gases and allows effective recognition of any danger situations, for example when the outlet chimney 11 is clogged and the outflow of gases and the gases present in the kiln 3 cannot be discharged to the outside.

Claims

1. A device (12) to detect the flowrate of the gases flowing out of a chimney (11) of a kiln (3) for the firing of ceramic products; the kiln (3) comprises a suction device (9), which is arranged in the area of an extraction station (8) to extract the gases to be released outwards; wherein the suction device (9) directs the gases present in the kiln (3) towards the chimney (11); and wherein said device (12) is housed inside the chimney (11) so as to be hit by an outflow of gas (F); the device (12) is **characterized in that it comprises** an outer casing (13), which is provided with a first axis (L) and has a head portion (16); and at least one sensitive element (24), which is partially housed inside a cavity (23) obtained in the outer casing (13), has an end portion (28) projecting from said cavity (23) and engaging the head portion (16), and is made so as to be subjected to a temperature variation that is proportional to the speed of the outflow of gas (F); wherein at least one opening (18) is made in the head portion (16) so as to expose the end portion (28) to the outflow of gas (F); and **in that** it comprises a cleaning device (29) to clean the sensitive element (24) provided with a mobile element (30), which is mobile along the first axis (L) and housed in the head portion (16) and is operated by actuator means (31) so as to slide on the surface of the end portion (28) and to remove the pollutants that have deposited there.

2. The device according to claim 1, wherein the movable element (30) is obtained by means of a number of discs (32) coaxial to the first axis (L), each provided with an opening (33), which is engaged by the sensitive element (24); the through opening (33) has dimensions that are substantially equal to or approximate the dimensions of the sensitive element (24).

3. The device according to claim 1 or 2, wherein the actuator means (31) comprise at least one actuator device (31), such as for example a hydraulically or pneumatically operated cylinder.

4. The device according to claim 3, wherein the outer casing (13) comprises a base (14) provided with a flange (15), to which a first actuator device (31) is connected; the first actuator device (31) has a respective second axis (L'), which is parallel to the first axis (L).

5. The device according to claim 4 and comprising a second actuator device (31*), which is connected to the flange (15) and has a respective third axis (L"), which is parallel to the first axis (L); wherein the outer casing (13) is interposed between the first actuator device (31) and the second actuator device (31*).

6. The device according to claim 1 or 2, wherein the actuator means (31) comprises an electric stepper motor.

7. The device according to one of the preceding claims, wherein the movable element (30) receives the motion from the actuator means (31) through a stem (35), preferably having a U-shape.

8. The device according to claim 7, wherein a first branch (36) of the stem (35) is manufactured through a pair of first rods (37), which are partially housed and can slide inside the cavity (23) along the first axis (L); wherein each first rod (37) is fixed by an end thereof to the movable element (30) .

9. The device according to claim 8, wherein a second branch (38) of the stem (35) is manufactured through a second rod (39), which is movable along a second axis (L'), directly receives the motion from the actuator means (31) and is connected to the first rods (37) with the interposition of a plate (40).

10. The device according to claim 9, wherein a third branch (38*) of the stem (35) is manufactured through a third rod (39*), which is movable along a third axis (L"), directly receives the motion from the actuator means (31) and is connected to the first rods (37) with the interposition of the plate (40).

11. The device according to claim 9 or 10, wherein the plate (40) is provided with a through hole, into which the sensitive element (24) is inserted, on whose surface, in use, the plate (40) slides.

12. The device according to one of the preceding claims, wherein the sensitive element (24) is made of a resistance temperature detector, namely a resistor whose resistance value is proportional to the temperature and which is powered with a heating electric current.

13. The device according to one of the preceding claims and comprising two sensitive elements (24), which are partially housed inside the cavity (23), are next to one another, and each have an end portion (28), which projects from the cavity (23) and engages the head portion (16).

14. The device according to claim 13, wherein a first sensitive element (24*) is designed to detect the current temperature (T_G) of the out-flowing gas flow (F) and a second sensitive element (24**) is powered with a heating electric current.

15. The device according to one of the preceding claims, wherein the head portion (16) is defined by a tubular element (17) having a cylindrical shape developing around the first axis (L); in the tubular element (17) there are two through openings (18), which are equal to one another and symmetrical relative to the first axis (L) and are designed to expose the end portion (28) of the sensitive element (24) to the out-flowing gas flow.

16. A kiln (3) for the firing of ceramic products, which is provided with a device (12) to detect the flowrate of the gases flowing out of a chimney (11) according to any one of the claims from 1 to 15.

17. The kiln according to claim 16 and comprising a firing chamber (6), which is provided with burners and is designed to treat the ceramic products by means of heat, and a pre-heating area (5), which is arranged upstream of the firing chamber (6); wherein the extraction station (8) is placed in the area of an inlet of the pre-heating area (5) of the kiln (3) .

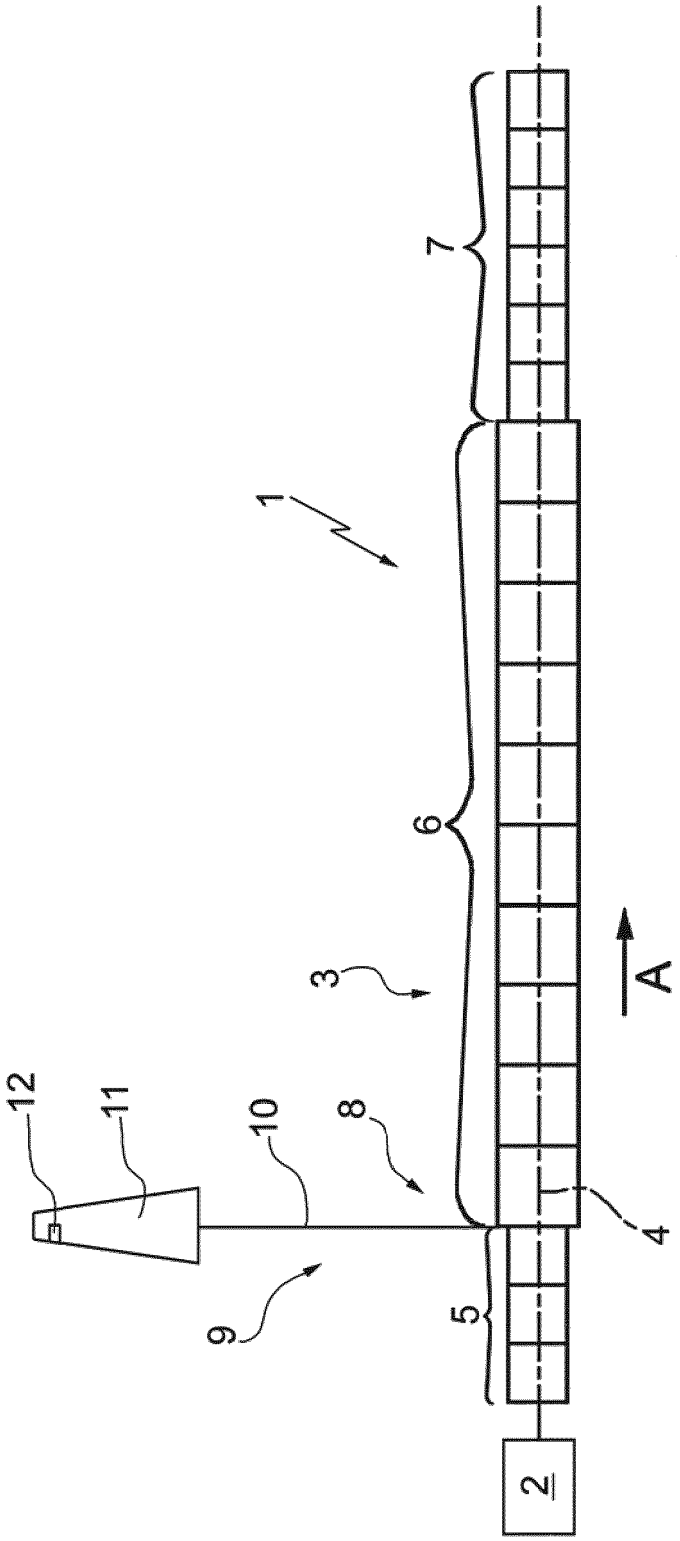

FIG.1

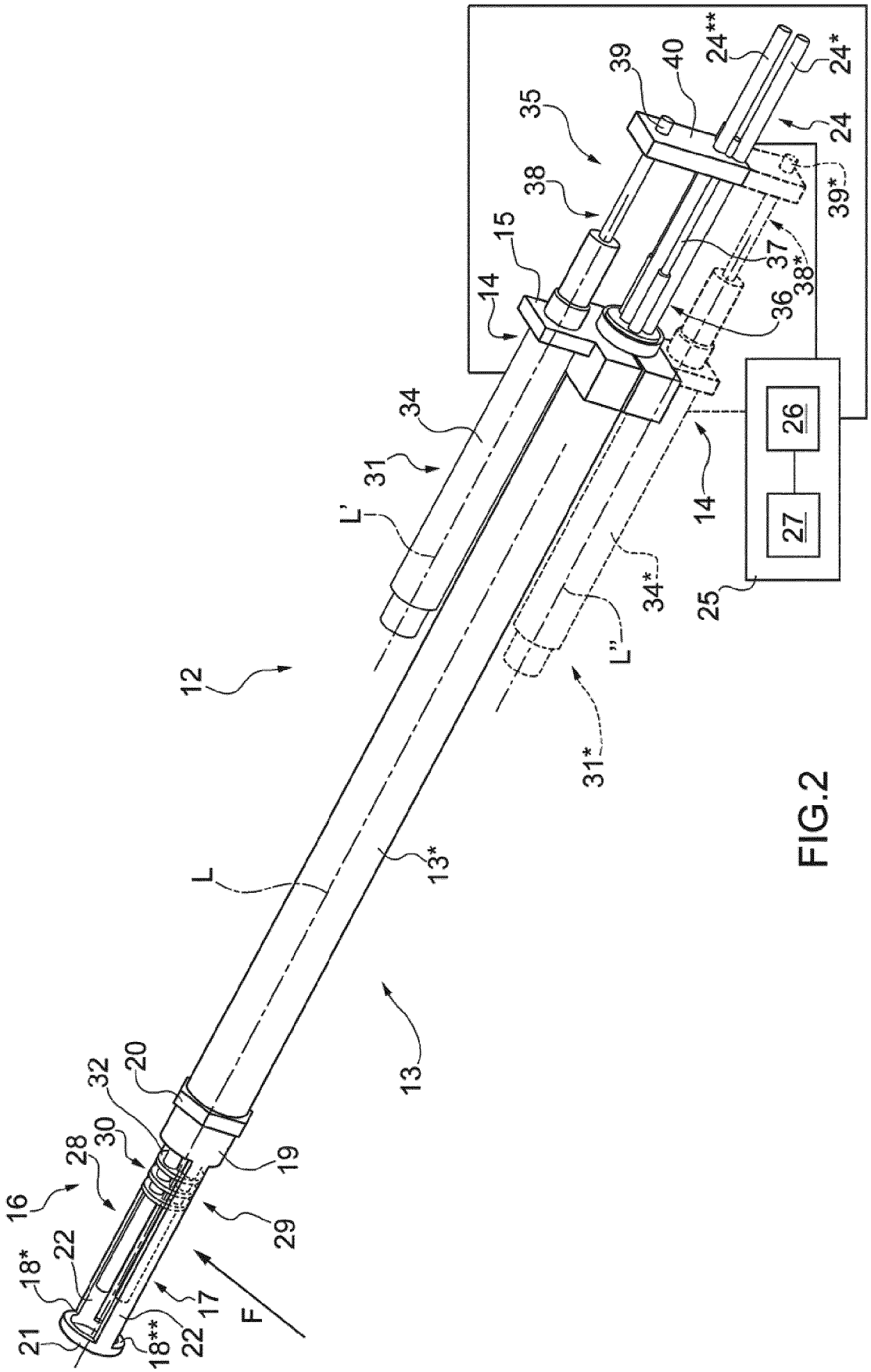
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FIG.2

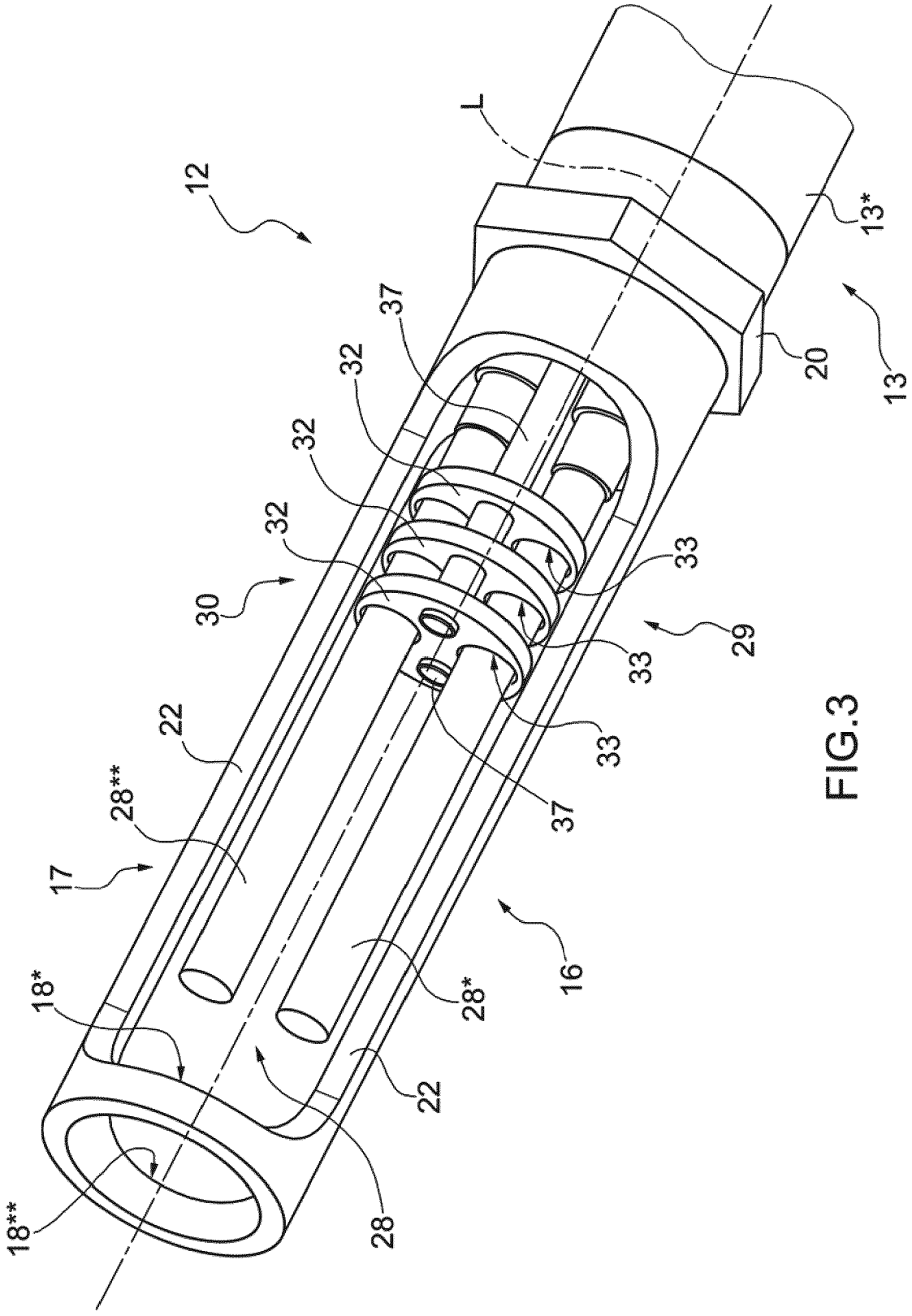

FIG.3

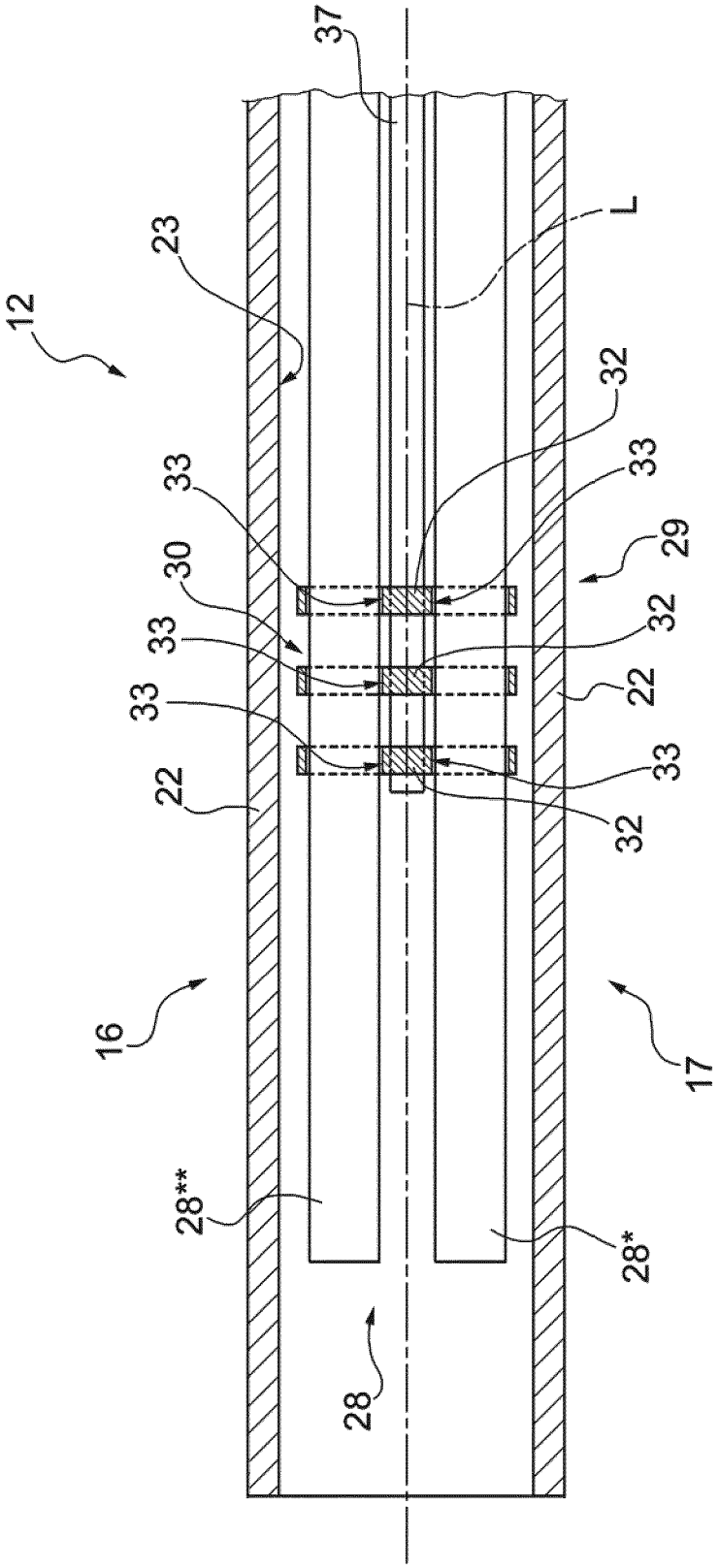

FIG.4

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EUROPEAN SEARCH REPORT

Application Number
EP 18 17 2494

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	WO 2012/145829 A1 (TENOVA GOODFELLOW INC [CA]; SCIPOLO VITTORIO [CA]; NEGRU OVIDIU [CA];) 1 November 2012 (2012-11-01) * the whole document *	1-17	
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A	DE 41 00 363 A1 (VER KRAFTWERKS AG PEITZ NIEDER [DE]) 9 July 1992 (1992-07-09) * the whole document *	1,17	TECHNICAL FIELDS SEARCHED (IPC) F27B F27D G01F G01P
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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
Munich	16 August 2018	Gavriliu, Alexandru

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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