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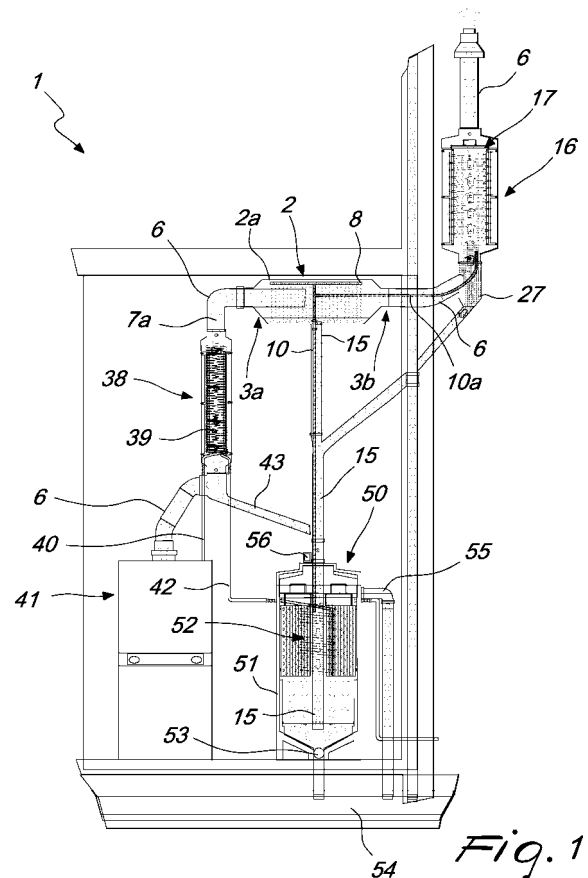
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(54) **Energy recovery apparatus**

(57) An energy recovery apparatus (1) particularly for heating or industrial systems that entail the combustion of products, consisting of at least one tubular element (2), which is arranged at a portion of a stack or flue (6) and is provided with a delivery (10) for feeding water for scrubbing the exhaust gases. The tubular element (2) has an outlet (15) for collecting the treated water that can be conveyed to a recuperator/heat exchanger (50). The apparatus (1) allows reduction of the emission of particulates and pollutants into the environment and makes it possible to achieve a reduction in the temperature of the exhaust gases as well as heat energy recovery.

*Fig. 1*

Description

[0001] The present invention relates to an energy recovery apparatus.

[0002] Currently it is known that boilers are used to heat water for residential and industrial uses.

[0003] These boilers are supplied by means of fuels which, by burning, release exhaust gases which are expelled by means of stacks or flues.

[0004] The combustion that occurs inside boilers inherently produces particulates and pollutants whose amount can vary as a function of the fuel used.

[0005] Moreover, the use of these boilers requires considerable energy resources and has high costs for operation in addition to the drawback consisting in the release of a quantity of hot exhaust gases at high temperature into the environment, which gases still have heat energy that is dispersed into the environment, altering the surrounding bioclimate.

[0006] The aim of the present invention is to solve the above-mentioned technical problems, eliminating the drawbacks of the cited background art, by providing a device which allows the reduction of emissions of particulates and pollutants and the reduction of the temperature of the exhaust gases released from flues and simultaneous recovery of part of the heat energy of the exhaust gases.

[0007] Within this aim, an object of the invention is to provide a device that allows reduction of the output temperature of the exhaust gases from the stacks or flues.

[0008] Another object of the invention is to make it possible to improve the energy balance of industrial/civil heating systems by lowering their operating costs.

[0009] Another object is to obtain a device that is effective, structurally simple, has low manufacturing costs and can be provided with conventional known systems.

[0010] This aim and these objects, as well as others which will become better apparent hereinafter, are achieved by an energy recovery apparatus, **characterized in that** it comprises at least one tubular element and/or a container, which are arranged at a portion of a stack or flue and are provided with a duct for feeding water for scrubbing the exhaust gases, said at least one tubular element and/or container having an outlet for collecting the treated water that can be conveyed to a recuperator/heat exchanger.

[0011] Further characteristics and advantages of the invention will become better apparent from the following detailed description of a particular but not exclusive embodiment thereof, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a partially sectional view of a first layout for the apparatus;

Figure 2 is a partially sectional view of a second layout for the apparatus;

Figure 3 is a schematic side perspective view of the first tubular element;

Figure 4 is a partially sectional side perspective view of the second tubular element;

Figure 5 is a partially sectional side view of the container.

[0012] In the exemplary embodiments that follow, individual characteristics, given in relation to specific examples, may actually be interchanged with other different characteristics that exist in other exemplary embodiments.

[0013] Moreover, it is noted that anything found to be already known during the patenting process is understood not to be claimed and to be the subject of a disclaimer.

[0014] With reference to the figures, the reference numeral 1 designates an energy recovery apparatus, consisting of a first hollow tubular element 2, which is elongated and preferably has a substantially cylindrical cross-section with a preferably flat top 2a, which has, proximately to a first end 3a and a second end 3b, a preferably frustum-shaped tapering portion 4a, 4b for connection to a first opening and a second opening 5a, 5b that have a preferably circular cross-section, respectively for inflow and outflow.

[0015] The first and second openings 5a, 5b are connected at a portion of a flue or stack, designated by the reference numeral 6, so that the flow of exhaust gases 7a that enters through the first opening 5a passes through all of the first tubular element 2 and exits through the second opening 5b, providing processed exhaust gases.

[0016] Inside the first tubular element 2 there is at least one first coil 8, which consists of at least one single tube arranged on a horizontal plane proximately to the top 2a.

[0017] The first coil 8 has a third closed end 9a, which is arranged proximately to the first opening 5a, and a fourth end 9b, which is arranged proximately to the second opening 5b and is connected to a delivery tube 10 for the water 11 used to scrub the exhaust gases that pass within the first tubular element 2.

[0018] The water 11 that is present inside the first coil 8 exits from a series of first holes 12 formed along its entire surface directed at least toward the bottom 13 of the tubular element 2.

[0019] The third and fourth ends 9a, 9b can be inverted in their arrangement, while the delivery tube 10 has a first portion 10a which protrudes axially with respect to the first tubular element 2 through the second opening 5b.

[0020] Further, the first tubular element 2 has, at the bottom 13 and preferably in a region that is adjacent to the second opening 5b, a second hole 14 with which a first drain 15 is associated which is adjacent to the delivery tube 10 so as to be able to convey the water, heated by scrubbing the exhaust gases, to a recuperator/heat exchanger 50 of the type described in EP 1975538 and consisting therefore of a box-like tank 51 which receives water from the drain 15 that almost reaches its lower end.

[0021] The tank 51 is provided internally with a set of tubes 52 and, in a lower region, with a valve 53 for se-

lective discharge of water, for example into the sewage system 54.

[0022] Moreover, in an upper region there is a duct 55 for overflow and for selective discharge of water for example into the sewage system 54.

[0023] Advantageously, the water conveyed in the delivery tube 10 is forced by means of a pump 56 which draws from the upper part of the recuperator/heat exchanger 50 and therefore has a higher temperature than the water that comes from the aqueduct or from a well.

[0024] A second tubular element 16 is provided sequentially downstream of the first tubular element 2, is arranged vertically and is interposed again between the flue or stack 6, optionally in an external part of the building.

[0025] Advantageously, the part of the flue 6 that is adjacent to a third lower drain opening 5c is arranged along an axis which is inclined with respect to the longitudinal axis of the second tubular element 16.

[0026] The second tubular element 16 is provided internally with at least one second coil 17, which consists of at least one single tube and can be extracted, the third and/or fourth ends 18a, 18b being removable.

[0027] The second coil 17 extends within the second tubular element 16 until it approximately skims its inner lateral surface 19, forming a series of circular turns which are supported by a locking means 20 of the double comb-like type, which is composed of two pairs of linear flanges 21a, 21b which are opposite each other and have a series of seats for positioning and supporting portions of the tube that form the second coil 17.

[0028] The locking means 20 is fixed to the second tubular element 16 by means of screws 22, which pass through appropriately provided holes formed in said second tubular element, which once unscrewed allow simultaneous extraction of the locking means 20 and of the second coil 17 by means of a handle 23 that can be gripped by a user since it is arranged transversely at the upper end of the locking means 20.

[0029] The second coil 17 is closed at a third or upper end 24 and has second holes 25 that are formed both on the surface directed toward the third or upper end 24 and on the surface directed toward the inner lateral surface 19 of the second tubular element 16.

[0030] The fourth lower end 26 of the second coil 17 is connected to the first portion 10a of the delivery tube 10 for the water used to scrub the exhaust gases that enter through the third opening 5c.

[0031] The second tubular element 16 also has a second outlet 27 for the water that filters the exhaust gases in countercurrent and is arranged below and adjacent to the end of the flue 6 that is connected, along an inclined axis, to the third opening 5c, so as to be arranged in axial alignment with the second tubular element 16.

[0032] The apparatus 1 can further consist, as shown in Figures 2 and 5, of a container 28 which is arranged downstream of the second tubular element 16 and also is interposed between the stack or flue 6, optionally in an

external part of the building.

[0033] The container 28 preferably has a box-like shape that is open in an upper region so as to form a closed bottom 29 and an open top 30, with the interposition of a body 31 that is shaped substantially like two different frustums that are arranged opposite each other at their larger end faces.

[0034] Water 11 can thus be stored inside the container 28 at a desired level 32.

[0035] The container 28 has, laterally to the body 31, at least one first duct 33 for conveying the exhaust gases which enter through a fourth opening 5d which is contiguous, with the interposition preferably of a fan 34, to the flue or stack 6.

[0036] The first duct 33 has a shape that causes its end 35 located within the container 28 to arrange itself below the level 32 of the water contained therein.

[0037] The container 28 further has, laterally to the body 31 but in a region that lies above the level 32, a second duct 36 for feeding water, which can be of the recirculation type for cooling that arrives for example from means adapted for heat recovery, such as sewage system heat recovery.

[0038] The container 28 further has, laterally to the body 31 but in a region that approximately corresponds to the level 32, a third outlet 37 for the water for maintaining the level 32; this is therefore an overflow for return for example to means suitable for heat recovery, such as sewerage system heat recovery, or to the recuperator/heat exchanger 50.

[0039] Figure 1 also illustrates a further third tubular element 38, which is interposed between two ends of a stack or flue 6 and provided internally with at least one third removable coil 39, which is provided with a first connector 40 which conducts water to a boiler 41 and with a second delivery connector 42 for receiving water from the recuperator/exchanger 50.

[0040] The water that flows in the third coil 39 is heated by drawing heat from the exhaust gases that skim such coil and raises the temperature of the water that is about to be conveyed into the boiler 41, further improving efficiency.

[0041] Any condensation that might form outside the third coil 39 is conveyed, through a fourth outlet connection 43 that is interconnected to the first drain 15 that leads into the recuperator/heat exchanger 50.

[0042] The operation of the apparatus is as follows.

[0043] When a burner starts to operate, for example the burner of the boiler 41, the exhaust gases that originate from the combustion are guided into the stack or flue, and along their path they pass through the various components of the devices and are thus scrubbed before exiting into the atmosphere.

[0044] When the burner is turned on, a pump is in fact actuated which draws water 11 from the recuperator/heat exchanger 50 and conveys it along the delivery tube 10 until it reaches the first coil 8 and the second coil 17.

[0045] The water 11 flows through the first and second

coils along their entire length, exiting through the first and second holes 12, 25: a shower of drops is thus formed which, in falling, passes through the flow of exhaust gases that passes through the respective tubular element.

[0046] A similar function is observed in the container 28 and heat recovery is achieved also with the device 38.

[0047] The amount of water used to spray the exhaust gases and the pressure of such exhaust gases are balanced so as to avoid causing any problems of pressure or negative pressure to the combustion.

[0048] Further, the pump continues to operate and therefore draw water as long as the burner is operating: shutdown of the burner is in fact followed by the halting of the pump within a few seconds.

[0049] More precisely, the water in this manner is able to lower the temperature of the exhaust gases, which is harmful for the environment and which without the device is approximately 70/90°C if it exits from condensation boilers and approximately 120/400°C if it exits from boilers which are of the non-condensing type or from ovens or dryers.

[0050] Moreover, the water is able to capture a substantial fraction of the suspended particulates, which are thus guided and conveyed with the treated water into the outlet to the recuperator/heat exchanger for heat recovery.

[0051] In practice it has been found that the invention has achieved the aim and objects cited above, an apparatus having been obtained which, by scrubbing the exhaust gases, makes it possible to eliminate from them a substantial fraction of the particulates and pollutants and at the same time allows a strong reduction of the output temperature of such exhaust gases, increasing the temperature of the scrubbing water, which can be conveyed to a recuperator/heat exchanger for heat recovery.

[0052] The materials used, as well as the dimensions that constitute the individual components of the invention, may of course be selected by the skilled person so as to be the most pertinent according to specific requirements.

[0053] The various means for performing certain different functions need not certainly coexist only in the illustrated embodiment but can be present per se in many embodiments, including other possible embodiments that are not illustrated and which are within the scope of the appended claims.

[0054] The characteristics indicated as advantageous, convenient or the like may also be omitted or be replaced with equivalents.

[0055] The disclosures in Italian Patent Application No. TV2009A000025 from which this application claims priority are incorporated herein by reference.

[0056] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

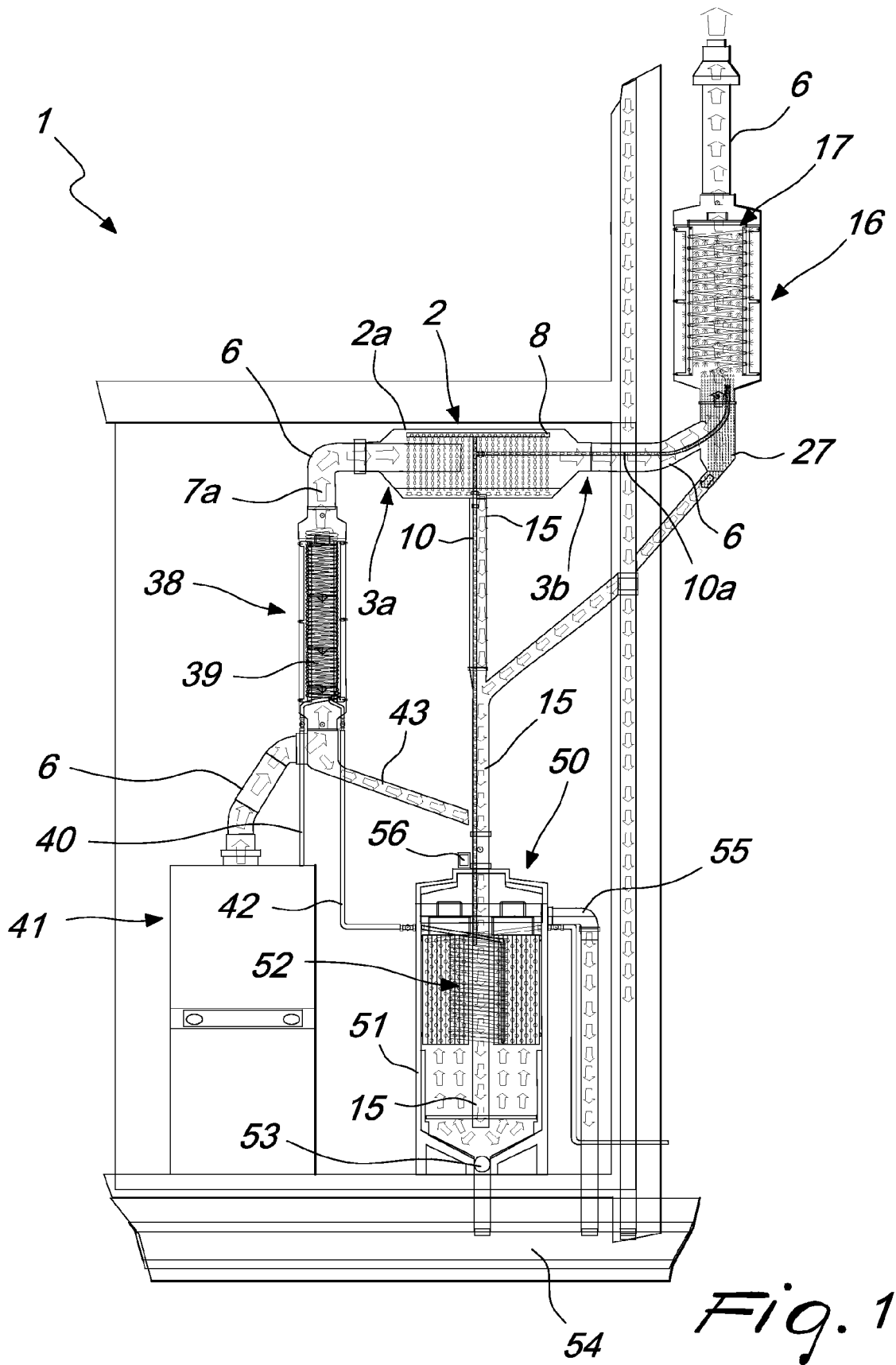
1. An energy recovery apparatus (1), **characterized in that** it comprises at least one tubular element (2, 16, 28), which is arranged at a portion of a stack or flue (6) and is provided with a delivery (10) for feeding water for scrubbing the exhaust gases, said at least one tubular element (2, 16, 28) having an outlet (15, 27, 37) for collecting the treated water that can be conveyed to a recuperator/heat exchanger (50).
2. The apparatus according to claim 1, **characterized in that** it comprises a first hollow tubular element (2), which is elongated and preferably has a substantially cylindrical cross-section with a preferably flat top (2a), which has, proximately to a first end and a second end (3a, 3b), a preferably frustum-shaped tapering portion (4a, 4b) for connection to a first opening and a second opening (5a, 5b) that have a preferably circular cross-section, respectively for inflow and outflow, said first and second openings (5a, 5b) being connected at a portion of a flue or stack (6) so that the flow of exhaust gases (7a) that enters through said first opening (5a) passes through all of said first tubular element (2) and exits through said second opening (5b), providing processed exhaust gases.
3. The apparatus according to claims 1 and 2, **characterized in that** at least one first coil (8) is provided within said first tubular element (2) and consists of at least one single tube that is arranged on a horizontal plane proximately to the top (2a), said first coil (8) having a third closed end (9a), which is arranged proximately to said first opening (5a), and a fourth end (9b), which is arranged proximately to said second opening (5b) and is connected to said delivery constituted by a delivery tube (10) for the water (11) used to scrub the exhaust gases that pass through said first tubular element (2), said water (11) that is present inside said first coil (8) exiting from a series of first holes (12) that are formed along its entire surface directed at least toward the bottom (13) of said tubular element (2), said delivery tube (10) having a first portion (10a) that protrudes axially with respect to said first tubular element (2) through said second opening (5b).
4. The apparatus according to claims 1 and 3, **characterized in that** said first tubular element (2) has, at said bottom (13) and preferably in a region that is adjacent to said second opening (5b), a second hole (14) with which a first drain (15) is associated which is adjacent to said delivery tube (10), so as to be able to convey the water, heated by scrubbing the exhaust gases, to a recuperator/heat exchanger (50), which consists of a box-like tank (51) and receives water from said first outlet (15) that reaches almost

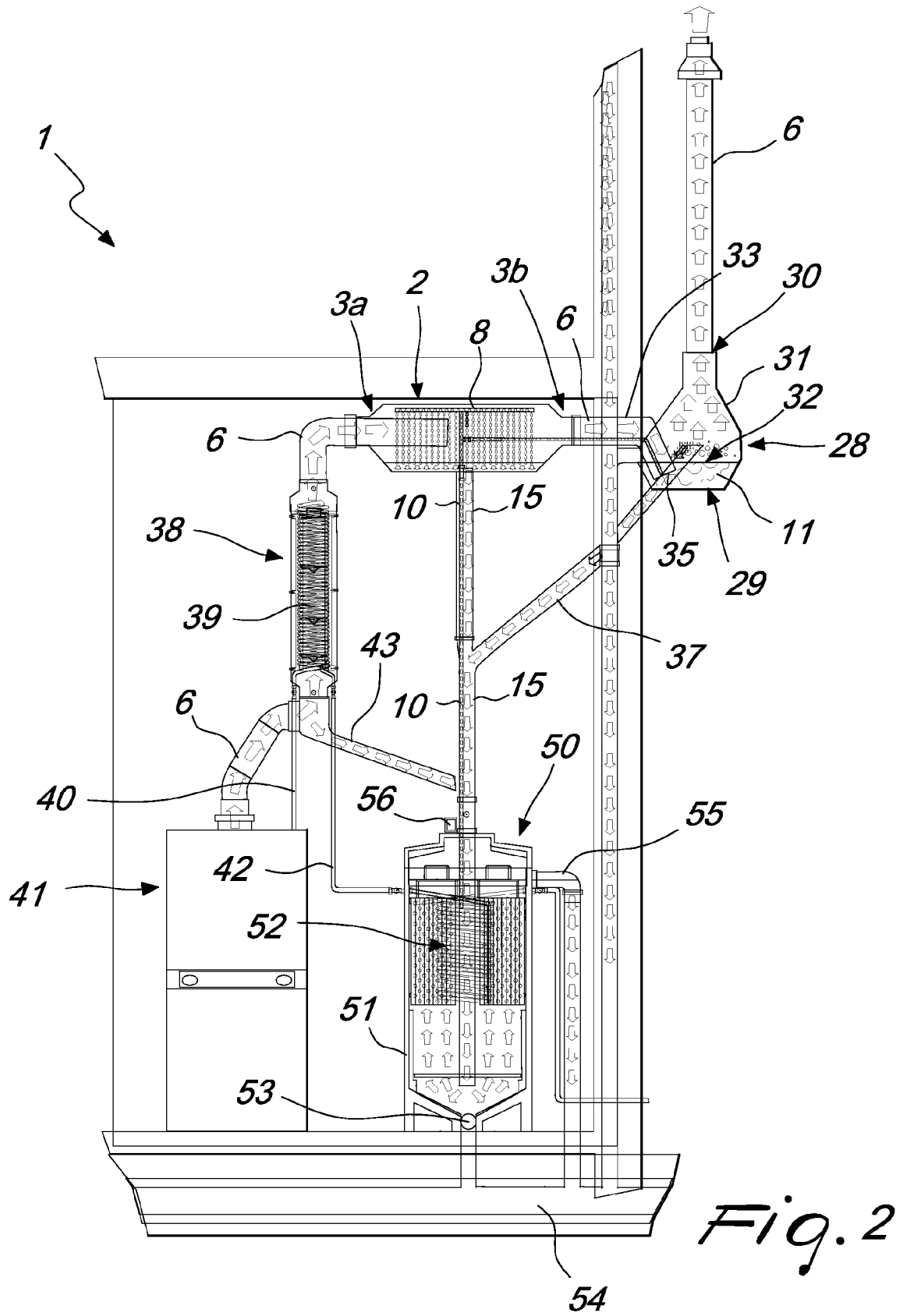
its lower end, said tank (51) being provided internally with a set of tubes (52) and in a lower region with a valve (53) for selective discharge of water, preferably into the sewage system (54), above said tank (51) there being a duct (55) for overflow and for selective discharge of water preferably into the sewage system (54).

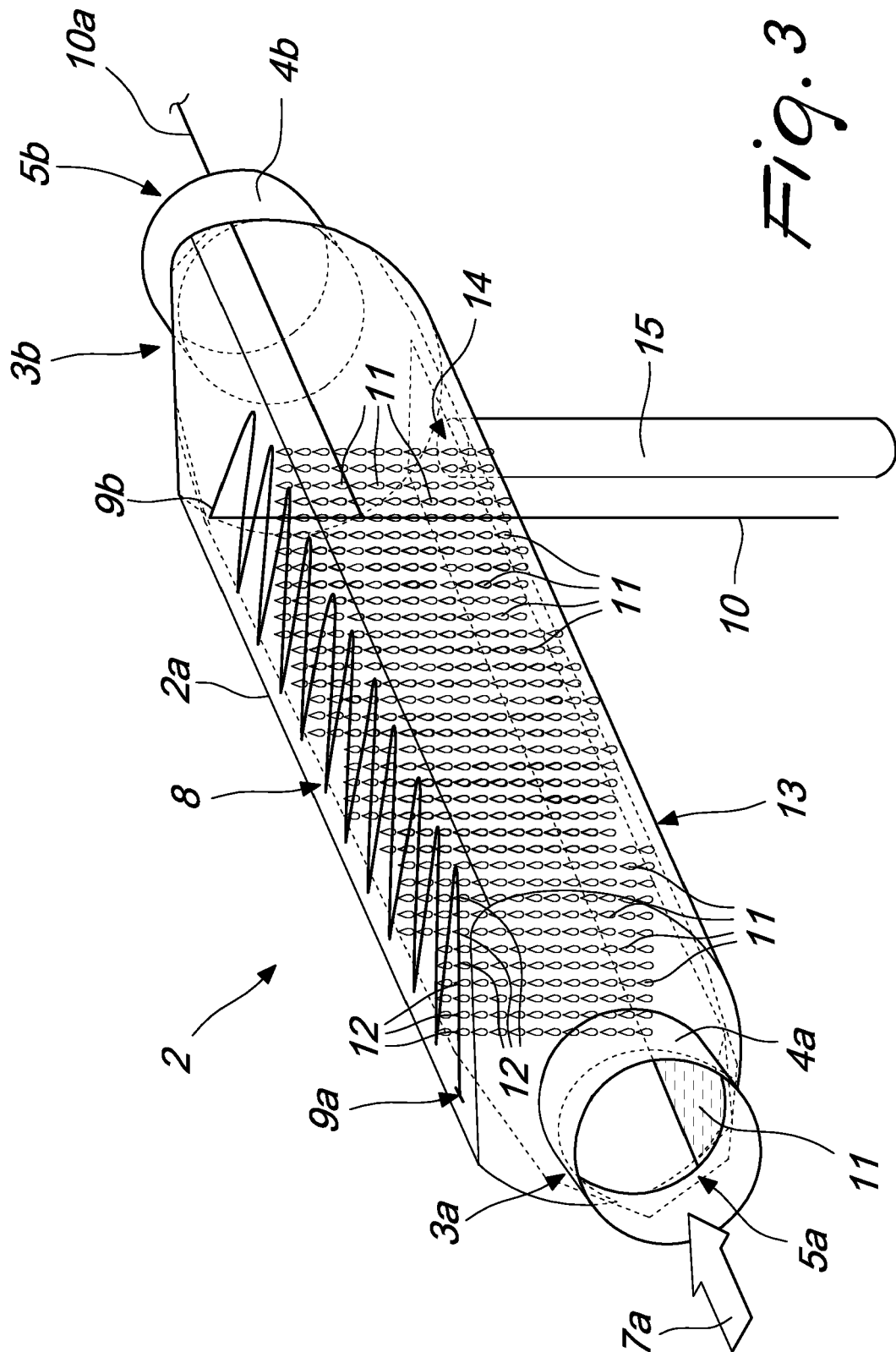
5. The apparatus according to claims 1 and 4, **characterized in that** a second tubular element (16) is provided connected sequentially downstream of said first tubular element (2), is arranged vertically and is interposed again between the flue or stack (6), optionally in an external part of the building, advantageously the part of said flue (6) that is adjacent to a third lower drain opening (5c) of the second tubular element (10) being arranged along an axis that is inclined with respect to the longitudinal axis of said second tubular element (16), which is provided internally with at least one second coil (17) that consists of at least one single tube and can be extracted from said second tubular element (16), the third and/or fourth ends (18a, 18b) whereof are removable.
6. The apparatus according to claim 5, **characterized in that** said second coil (17) extends within said second tubular element (16) until it approximately skims its inner lateral surface (19), forming a series of circular turns, which are supported by a locking means (20) of the double comb-like type, which is composed of two pairs of linear flanges (21a, 21b), which are opposite each other and have a series of seats for positioning and supporting portions of the tube that form the second coil (16), said locking means (20) being fixed to said second tubular element (16) by means of screws (22), which pass through appropriately provided holes formed in said second tubular element and which once unscrewed allow simultaneous extraction of said locking means (20) and of said second coil (17) by means of a handle (23) that can be gripped by a user since it is arranged transversely at the upper end of said locking means (20).
7. The apparatus according to claim 6, **characterized in that** said second coil (17) is closed at a third upper end (24) and has second holes (25) that are formed both on the surface directed toward the third end (24) and on the surface directed toward the inner lateral surface (19) of the second tubular element (16), a fourth lower end (26) of said second coil (17) being connected to said first portion (10a) of said delivery tube (10) for the water used to scrub the exhaust gases that enter through said third opening (5c), said second tubular element (16) having a second outlet (27) for the water that filters the exhaust gases in countercurrent, said second outlet (27) being arranged below and adjacent to the end of said flue

(6) that is connected, along an inclined axis, to said third opening (5c), so as to be arranged in axial alignment with said second tubular element (16).

8. The apparatus according to claim 4, **characterized in that** it comprises a container (28) which is arranged downstream of said first tubular element (2) and also is interposed between the stack or flue (6), optionally in an external part of the building, said container (28) preferably having a box-like shape that is open in an upper region so as to form a closed bottom (29) and an open top (30), with the interposition of a body (31) that is shaped substantially like two different frustums which are arranged opposite to each other at their larger end faces, water (11) being storable within said container (28) at a desired level (32), said container (28) having, laterally to said body (31), at least one first duct (33) for conveying the exhaust gases (7a), which enter through a fourth contiguous opening (5d), with the interposition preferably of a fan (34), to the flue or stack (6).
9. The apparatus according to claim 8, **characterized in that** said first duct (33) has a shape which causes its end (35) located within said container (28) to arrange itself below the level (32) of the water contained therein, said container (28) having, laterally to said body (31) but in a region that lies above said level (32), a second duct (36) for feeding water, of the recirculation type for cooling that arrives from means suitable for heat recovery, said container (28) having, laterally to said body (31) but in a region that approximately corresponds to the level (32), a third outlet (37) for the water for maintaining said level (32); this is therefore an overflow for return to means suitable for heat recovery or to said recuperator/heat exchanger (50).
10. The apparatus according to one or more of the preceding claims, **characterized in that** it comprises a third tubular element (38), which is interposed between two ends of a flue or stack (6), provided internally with at least one third extractable coil (39), which is provided with a first connector (40) conducting water to a boiler (41), and with a second delivery connector (42), for receiving water from the recuperator/exchanger (50), any condensation that might form outside said third coil (39) being conveyed, through a fourth outlet connection (43) that is interconnected with said first drain (15) to said recuperator/heat exchanger (50).







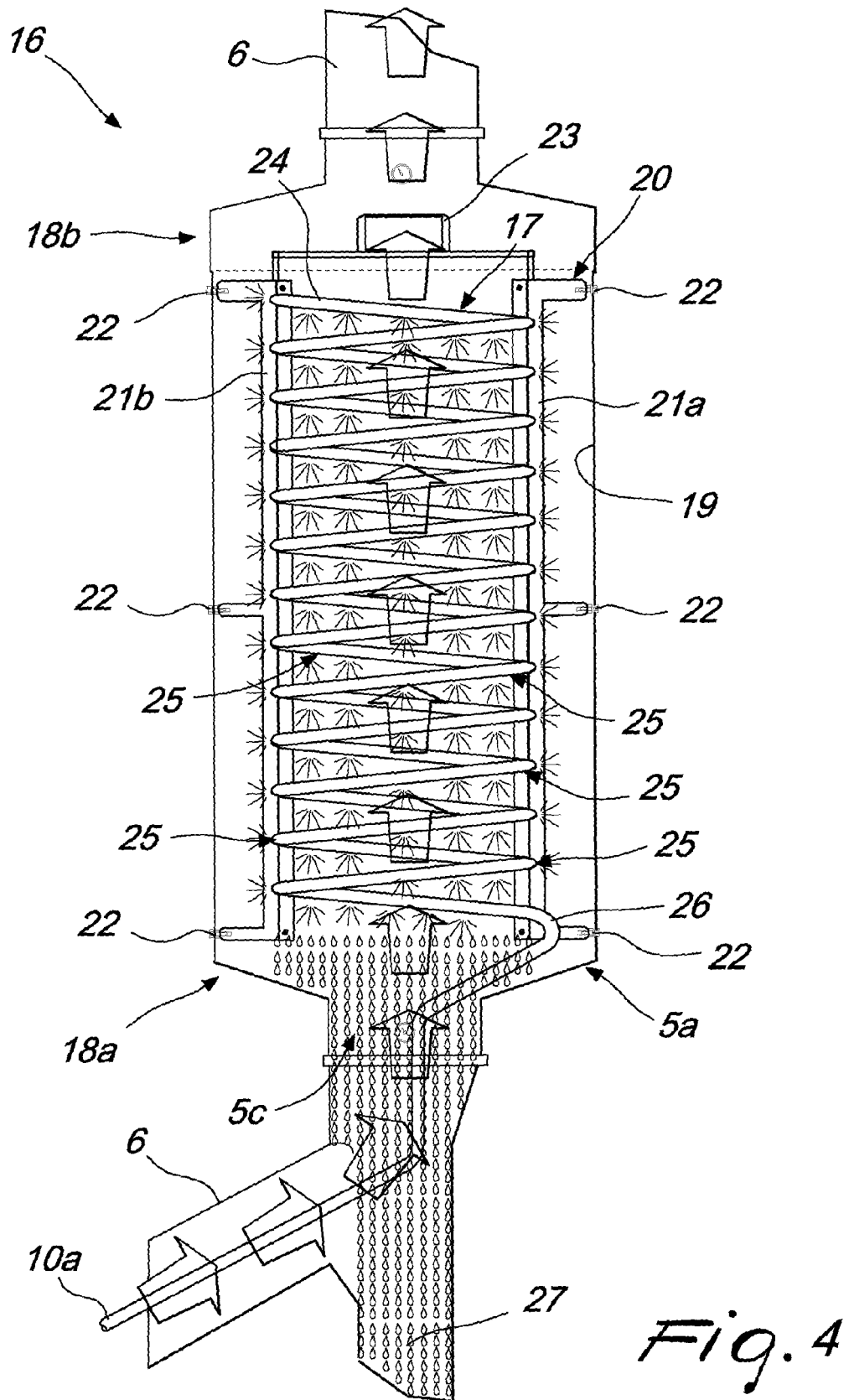


Fig. 4

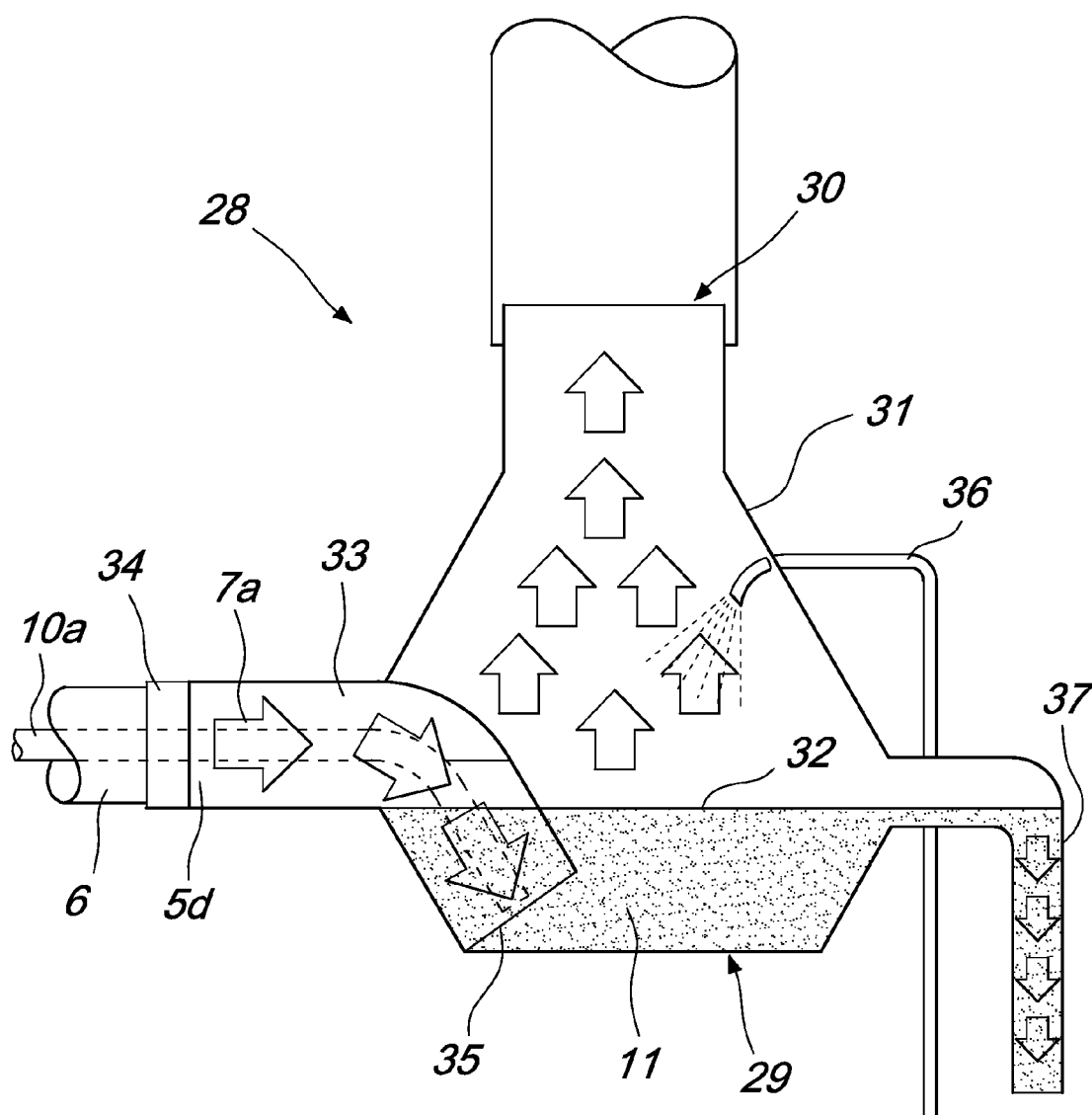


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 10 15 3858

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 25 March 2010	Examiner Gavriliu, Costin
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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