

(19)



(11)

EP 3 469 263 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

01.04.2020 Bulletin 2020/14

(51) Int Cl.:

F23J 15/04 ^(2006.01)

(86) International application number:

PCT/IB2017/053299

(21) Application number: **17737047.5**

(22) Date of filing: **05.06.2017**

(87) International publication number:

WO 2017/212387 (14.12.2017 Gazette 2017/50)

(54) **CONDITIONING PLAN FOR EXHAUST FUMES**

AUFBEREITUNGSPLAN FÜR ABGASE

PLAN DE CONDITIONNEMENT POUR FUMÉES D'ÉCHAPPEMENT

(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**

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(30) Priority: **10.06.2016 IT UA20164296**

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(43) Date of publication of application:

17.04.2019 Bulletin 2019/16

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Description

[0001] The invention relates to a conditioning plant for exhaust fumes, in particular an installation for the washing and heat energy recovery from fumes.

[0002] Boilers, especially in industrial complexes, are fed generally with fuels that by burning generate fumes then expelled through chimneys or chimney stacks. Combustion produces thin powders and polluting agents that are released into the environment along with high temperature fumes. So not only the environment is polluted, but a huge amount of caloric energy is wasted that disperses into the atmosphere with the fumes.

[0003] WO 2014020456, DE 3600797 C1, EP 2221539 and US 4909161 disclose conditioning plants for exhaust fumes.

[0004] The main object of the invention is a plant improving this state of the art. Especially a plant that allows both reducing emissions of fine powders and pollutants, and recovering some of the thermal energy of the fumes.

[0005] The plant serves for washing the fumes from suspended particles and for recovering thermal energy from the fumes, and comprises in use:

a first stage and a second stage for washing fumes, a first tank, a second tank and a third tank, arranged to communicate water from one to another in cascaded fashion, wherein the first stage comprises:

- an inlet for the fumes and an outlet for the fumes toward the second stage,
- water jets forming water curtains,
- a tortuous, obligated path for the fumes that forces them to cross the water curtains,
- a conduit for water heated by the fumes towards the first tank, and

the second stage comprises:

- an inlet for the fumes from the first stage and an output for the fumes,
- a tortuous path for the fumes,
- water jets to spray water into the tortuous path,
- a conduit for water heated by the fumes towards the second tank,

wherein the first and second tanks each comprise a heat exchanger, the heat exchangers belonging to a same flowing-water circuit which enters first into the second tank and then in the first one; and the second tank comprises an outlet for fumes toward the second stage and the third tank comprises:

- a tortuous path for a water coming from the second tank, the tortuous path comprising means for sifting the water flow and

- an outlet for the water flow.

[0006] The use of two stages allows subtracting more heat from the fumes because one can inject in the first stage a smaller water flow and therefore the water there heats itself more. The residual heat of the fumes coming out of the first stage is then recovered in the second stage.

[0007] Note that to clean from the powders the fumes in a single stage, plenty of water would be needed, which however would cross the first stage very fast thereby subtracting little heat from the fumes.

[0008] Another advantage of the plant is that it can also subtract bad smells from the fumes, improving the quality of the emissions into atmosphere.

[0009] Below are some preferred plant variants.

1. to form the tortuous path, the second stage comprises vertical walls or baffles in order to form vertical channels for the fumes, and water jets to flow water down the vertical channels along a direction of vertical descent of the fumes. In this way the fumes are pushed through the second stage, avoid engulfing the system due to load losses; and/or

2. a or each of said vertical channels inferiorly connects to another vertical channel devoid of water jets, wherein the fume can run up also pushed by the jets of the previous vertical channel; and/or

3. in the second stage the tortuous path comprises a sequence of vertical channel with water jets as in point 1, connected preferably to vertical channels as in point 2, these latter being connected at the top to the first ones with an elbow-shaped segment; and/or

4. to simplify the system and reduce caloric losses, a or each of the vertical channels as in point 1 has an outlet for water directed towards the second tank; in particular

5. a or each of the vertical channels has the bottom which comprises an opening which opens directly into the second tank; and/or

6. a or each of the vertical channels as in point 2 is isolated from the second tank; and/or

7. to simplify the system and reduce caloric losses, the assembly of vertical channels as in point 1 and 2 is placed directly above the second tank, wherein the vertical channels as in point 1 has an opening on the bottom thereof to let water get out towards the second tank; and/or

8. to regulate the fumes flow and/or the gurgling in the second tank (which determines the release of powders from the fumes to the water), the vertical channels as in point 1 are integral with each other and are movable relatively to the second tank and/or to an external frame of the second stage (e.g. with vertical travel of ± 5 cm). The goal is to regulate the flow of fumes which penetrate into the water of the second tank; and/or

9. each of the vertical channels as in point 1 has the outlet for water on a same horizontal plane and the

assembly of the vertical channels as in point 1 and 2 is located inside an upper mouth or opening of the second tank, so that the water outputs of each vertical channel as in point 1 can be lifted from - or soak into - the surface of the water contained in the second tank. This precaution minimizes the losses and simplifies the coupling between the second stage and the second tank; and/or

10. the second stage comprises an outer casing containing the vertical channels, and the casing is vertically movable inside a top mouth of the second tank (which is preferably an open-top basin), between the casing and the edges of the upper mouth being provided waterproof sealing means, such as, for example, gaskets; and/or

11. in the third tank, said means comprise grids interposed along the tortuous path, to precipitate or retain the powders suspended in the water; and/or

12. in the third tank, the outlet for the water flow is connected to the water jets of the first and second stages, to recirculate the water in the plant and decrease the complexity thereof; and/or

13. in the third tank the tortuous path for the water comprises internal baffles or walls which delimit vertical channels mutually connected to form a coil in which the water performs subsequent decanting between adjacent channels: In particular, two adjacent vertical channels are inferiorly connected with an elbow-shaped segment while superiorly the water passes from one channel to the next by skimming (i.e. there is effusion of water from one channel to the next because an excess of water forms at a predetermined level, preferably set by the upper edge of a vertical wall that delimits a channel). To ensure a proper effusion, the vertical walls that delimit the vertical channels have a top portion than alternatively comes at a higher or lower level; and/or.

14. in the third tank the portion of the elbow-shaped segment that is lower comprises or is constituted by a grid, to sift the water; and/or

15. in the third tank the portion of the elbow-shaped segment that is lower comprises a vertical wall that protrudes vertically from the elbow-shaped segment to obstruct and/or slow the passage of water across the two channels connected by that elbow-shaped segment; and/or

16. in the third tank the portion of the elbow-shaped segment that is lower comprises or is constituted by a grid, to sift the water.

[0010] Further features and advantages of the invention will be more evident from the description of a particular embodiment, illustrated in the attached drawings, wherein

Fig. 1 illustrates a plant diagram according to the invention;

Fig. 2 illustrates in partial transparency a second

plant according to the invention;

Fig. 3 illustrates an enlargement of the plant of fig. 2;

Fig. 4 illustrates a cross-section according to plane IV-IV;

Fig. 5 illustrates a cross-section according to the plane V-V;

Fig. 6 shows a cross-section of the plant of fig. 2 according to a vertical plane.

[0011] In the figures:

- F indicates a path or flow of fumes;
- By H₂O a path or flow of water is indicated;
- By H the water level in the tanks is indicated;
- to avoid crowding the figures some numbers are omitted, especially in presence of modular or repeated parts.

[0012] The plant and its components are described as in use, and to this case terms as *upper*, *lower*, *top* or *bottom* must be interpreted.

[0013] In fig. 1 the symbols F and H₂O and the arrows imply the presence of appropriate fluid transport ducts.

[0014] The system MC of fig. 1 serves to recover heat energy from hot fumes discharged by a combustion chamber, such as a boiler (not shown), which pours the fumes into a chimney 12 to dispose of them.

[0015] The system MC comprises a first tank 20, a second tank 22 and a third tank 24, arranged to communicate water one to the other in a cascaded fashion, i.e. water can pass from the first tank 20 to the second tank 22, and then from the second tank 22 to the third tank 24.

[0016] The system MC further comprises a first fumes interception and washing stage 30 and a second fumes interception and washing stage 60. The chimney 12 is artificially blocked by a plug 14 to divert the fumes F from the chimney 12 to the entrance of the first stage 30. The stage 30 and the stage 60 are cascaded, so the fumes F coming out of the first stage 30 feed the input of the second stage 60, and after passing through it they keep going until expulsion into the atmosphere e.g. by returning to the chimney 12.

[0017] Each stage 30, 60 comprises water jets that, by clashing with the fumes F, subtract heat and dust from them. The water heated and spoiled in the first (second) stage 30 is conducted inside the first (second) tank 20 (22).

[0018] The first and second tanks 20, 22 each comprise a heat exchanger 26, 28, e.g. a serpentine. Heat exchangers 26, 28 are part of a same circuit of flowing water that first enters into the second tank 22 and then into the first tank 20. The water running through the heat exchangers 26, 28 encounters hotter and hotter water contained in the tanks 20, 22, and subtracts away heat from it according to the principle of countercurrent caloric transfer.

[0019] The third tank 24 is fed by the water leaving the second tank 22, and contains means for sifting the pow-

ders scattered in the water. The water so cleaned preferably is sent to the water jets present in the stages 30, 60.

[0020] The second tank 22 almost certainly also contains fumes, dragged by the water leaving the second stage 60, and to evacuate these fumes the system MC provides ducts adapted to recirculate fumes preferably within the second stage 60 to re-wash them (another option among the possible ones is e.g. to send the fumes inside the chimney 12).

[0021] Having described the general architecture of the system MC, with reference mainly to Figures 2-6 we now describe the preferred internal structure for its various components.

[0022] The first stage 30 generally comprises (Fig. 4):

- an inlet (duct) 32 for the fumes F taken from the chimney 12 and an outlet (conduit) 34 for the fumes F toward the second stage 60,
- water jets 36 forming water curtains 38 crossed by the fumes F during their advancing within the first stage 30;
- a tortuous path for fumes F preferably formed by septa or trays 40. The tortuous path forces the fumes F to collide with the water curtains 38 as they go through the stage 30, and
- a duct 42, for water heated by the fumes F, which carries water from the first stage 30 to the first tank 20.

[0023] The second stage 60 (Figures 5 and 6) generally comprises:

- an inlet (duct) 34 for fumes F coming from the first stage 30 and an outlet 64 for the fumes F, optionally equipped with an aspirator 92;
- a tortuous path for the fumes F, formed by preferably vertical and/or oblique septa or trays 66, comprising vertical sections 68,
- water jets 70 to flow water down into the vertical sections 68 along the vertical descent direction of the fumes F,
- outlet ducts or openings 72, for water heated by the fumes F, which drain water directly into the second tank 22.

[0024] The septa or trays 66 form inside the stage 60 a particular tortuous path 10 for the fumes F. The vertical sections 68 are of two types: sprayed vertical sections 68d and non-sprayed vertical sections 68u.

[0025] Within the sprayed vertical sections 68d there are sprayers 70, which sprinkle water onto the fumes F. The water sprayed by gravity washes the fumes F and pushes them toward the bottom of the sections 68d. At the bottom of sections 68d there are the outlet ducts or openings 72, which drain the water inside the tank 22, and the inlet of a further section 68u.

[0026] In the non-sprayed vertical sections 68u there

are no water sprayers, and the fumes F can climb them without resistance pushed also by the fall of water in a previous sections 68u.

[0027] The tortuous path (Figure 5) is a sequence of N sections 68d and 68u ($N > 1$), connected at the top by an elbow-shaped fitting or wall 75.

[0028] Thus the fumes F within the stage 60 enter the duct 34, zigzag vertically up and down through the sections 68d, 68s, and exit from the outlet duct 64 to end up into the atmosphere (e.g. by returning to the chimney 12).

[0029] Note the technical effect of the sections 68d: not only the fumes F are washed from dust, but they are subtracted their heat, then recovered in the tank 22's water, and are kept moving with the jets 70 avoiding engulfing or load losses.

[0030] Also note that the combined action of the sprayers 70 and the inertia of the fumes F causes the fumes F to enter into the tank 22, and upon encountering the surface H of the water create bubbles and gurgling, useful to mix the water and detach powders from the fumes F.

[0031] The amount of water coming out of the sprayers 70 also permits to control the feed speed of fumes F within the stage 60.

[0032] The second stage 60 is preferably mounted directly above an upper mouth of the tank 22, so that water dripping from the stage 60, that is water coming out by gravity from the ducts or openings 72, falls thereinto vertically, without additional tubes and without caloric losses. In this configuration the second tank 22 is, for example an open-top basin.

[0033] Note that the configuration of the channels 68d, 68u has a technical effect and advantages independent of the remaining components of the system MC, and therefore it can also be exploited as isolated.

[0034] The paths 68u, 68d are obtained and placed within a casing 76 which is movable (see arrow and axis Y) vertically with respect to the tank 22. For example, the casing 76 is movable with respect to an outer frame 74 mounted above and integral with the tank 22.

[0035] The casing 76 is movable along the axis Y in an adjustable manner, e.g. through the adjustment of screws 80 to be screwed in threaded flanges 78 integral with the casing 76 (other adjusting systems are however possible). The position of the housing 76 can be controlled this way: when the incoming fumes F decrease or have low speed, the casing 76 is raised; when incoming fumes F increase or have high (greater) speed, the casing 76 is lowered.

[0036] The casing 76 is slidably coupled to the water-proof walls of the tank 22 (for this purpose there may be gaskets or seals). That is, the casing 76 and what it contains is movable relative to the tank 22 without the fumes F being able to come out of the latter. Instead, the fumes F get out of the tank 22 via a pipe 82 (Fig. 2) and are returned to the stage 60, at the beginning of the first section 68d.

[0037] What matters is that the bottom edge of the cas-

ing 76 and/or the outlets of the ducts (or openings) 72 can move relative to the water level H inside the tank 22, in particular being able to remain lifted from the level H by a few centimeters (e.g. 5 cm) or end up submerged below the level H by some centimeters (e.g. 5 cm).

[0038] When the water level H inside the tank 22 is higher than the bottom edge of the housing 76 and/or than the level of the outlet ducts (or openings) 72, the water stops up the bottom edge of the casing 76 and/or the outlets of the ducts (or openings) 72 proportionally to the sinking of the casing 76.

[0039] When the water level H inside the tank 22 is lower than or grazes the bottom edge of the casing 76 and/or than the level of the ducts (or openings) 72, the water does not block any more (or very little) the fumes F.

[0040] Thus, by adjusting the distance of the casing 76 from the tank 22 it is possible to regulate

- the generation and intensity of bubbles or gurgling in correspondence of the level H, and/or
- the load on the fumes F coming from the first stage 30, and eventually the resistance to the flow of the fumes F.

[0041] Note that the relative mobility between the second stage 60 (or the casing 76) and the tank 22 has a technical effect and advantages independent of the remaining components of the system MC, and therefore it is also possible to take advantage of it when it is isolated, even if the stage 60 (or the casing 76) and the tank 22 were used alone as a stand-alone apparatus.

[0042] The third tank 24 serves to clean the waters of the tanks 20, 22 by decantation from the powders extracted from the fumes F.

[0043] The third tank 24 is also suitable for separating oil and/or light powders on its top portion, while heavy powders plummet to the bottom.

[0044] The third tank 24 (see detail in Figure 3) generally comprises:

- a tortuous path 132 for a water flow from the second tank 22, the tortuous path comprising grids 136 for sifting the water flow and
- an outlet 62 for the water flow, which a pump 99 directs e.g. towards the water jets of the first and second stage.

[0045] The grids 136 serve to filter the powders suspended in the water, and are located in the tortuous path, which comprises internal verticals walls or septa 138 delimiting vertical channels 140 inside an outer casing 142.

[0046] The channels 140 are interconnected to form a coil in which a stream of water establishes which pushes the water to execute sequential pourings across adjacent channels 140. In particular, the channels 140 are distinguished between falling water channels 140d and rising water channels 140s. In the channels 140d by gravity the water drops down toward the bottom of the tank 24 and

in the channels 140s the water rises to the top of the tank 24.

[0047] Two adjacent vertical channels 140d, 140s connect at the bottom with a bottom elbow-shaped section comprising or consisting of a grid 136, arranged e.g. horizontally. At that point the descending water turns 180 ° towards a channel 140s and has almost no vertical speed, so the powders that it carries have time to fall and, by passing through the grid 136, can be collected at the bottom of the tank 24.

[0048] Preferably the grid 136 is horizontal, and preferably comprises a vertical wall 144 projecting vertically from the grid 136. The effect of the wall 144 is to further slow down the water and scrape it from the powders in suspension, especially the heaviest ones.

[0049] The top of a channel 140s communicates directly with the input of a subsequent channel 140d, and two adjacent channels 140d, 140s are separated by a wall 148 higher than the one between two adjacent channels 140s, 140d. In this way, the water passes from a channel 140s to the next channel 140d by overflowing, that is, there is water effusion from a channel 140s to the next 140d because an excess of water is formed compared to the preset level H. To this aim, for example, the upper edges of the dividing walls between the channels 140s, 140d are at a same horizontal level.

[0050] Preferably the lower wall of each vertical channel 140s comprises or consists of a grid 150, for sifting the water.

[0051] Preferably under a or each of the grids 136 there is placed a second grid 137, with the effect of favoring the precipitation of the heavy powders thanks to the local slowdown of water.

[0052] It should be noted that the internal structure of the tank 24 has the advantage of being suitable for separating oils and light powders from the heavy powders. The oils and the light powders float or remain confined at the top of the tank 24 (at the inlet of the channels 140d, 140s). From here they are, for example, evacuated with water through an exhaust duct. The heavy powders precipitate and, passing through the grid 136, come to the bottom, from where they are eliminated with an Archimedean screw.

[0053] According to a preferred variation, the positional control of the stage 60 is automatic, i.e. regulated by a programmed microprocessor. The boiler's combustion is usually less intense when ignited, reaches a peak, and then runs at an intermediate value. Thus the flow and speeds of the fumes F is minimal at first, has an intermediate peak, and falls again at steady state (or may have swings of flow). Then the microprocessor at the start of the combustion keeps the stage 60 lifted above the level H to not load the circuit of fumes F, while when the combustion has a peak the microprocessor lowers the stage 60 at or below the level H. When the combustion is steady the microprocessor keeps the stage 60 at an intermediate level.

[0054] According to a preferred variant, also the water

flow from the sprayers 70 is controlled by the microprocessor to be proportional to the flow of fumes F, to adjust the energy recovery to the actual flow of fumes.

[0055] As variants in the second stage 60:

- the advancing direction of the fumes F can be reversed with respect to the direction of spraying and/or falling of the water. Thus the fumes F would advance inside the channels 68d from the bottom to the top being frontally hit by the water; and/or
- even in the channels 68u there can be arranged water sprayers, so that the fumes can also be sprayed here. The spraying direction may be concordant or contrary to the direction of advancing of the fumes F; and/or
- in each channel 68d, 68u the spraying direction of the sprayed water can be controlled, e.g. by a control unit, in particular according to this rule: if the fumes F have little speed or flow, water is sprayed along the direction of advancing of the fumes F to facilitate their advance; if instead the fumes F have sustained (or higher) speed, water is sprayed along a direction opposite to the direction of advancing of the fumes F, to exploit a more effective impact between water and fumes F.

Claims

1. Plant (MC) for washing fumes from suspended particles and for recovering thermal energy from fumes (F), comprising:

a first stage (30) and a second stage (60) for washing fumes,
a first tank (20), a second tank (22) and a third tank (24), arranged to communicate water (H₂O) from one to another in cascaded fashion, wherein
the first stage comprises:

an inlet (32) for the fumes and an outlet (34) for the fumes toward the second stage,
water jets (36) forming water curtains (38),
a tortuous, obligated path (40) for the fumes that forces them to cross the water curtains,
a conduit for water heated by the fumes towards the first tank (42), and
the second stage comprises:

an inlet (34) for the fumes from the first stage and an output (64) for the fumes,
a tortuous path (68d, 68u) for the fumes,
water jets (70) to spray water into the tortuous path,
a conduit (72) for water heated by the fumes towards the second tank,

wherein the first and second tanks each comprise a heat exchanger, the heat exchangers (26, 28) belonging to a same flowing-water circuit which enters first into the second tank and then in the first one;
and the second tank comprises an outlet for fumes toward the second stage and
the third tank comprises:

a tortuous path (140s, 140d) for a water coming from the second tank, the tortuous path comprising means (136) for sifting the water flow and
an outlet (62) for the water flow.

2. Plant according to claim 1, wherein the second stage's tortuous path comprises vertical walls or partitions forming vertical channels for the fumes, and water jets for flowing water down the vertical channels along a direction of vertical descent of the fumes.
3. Plant according to claim 1 or 2, wherein a or each of said vertical channels inferiorly connects to another vertical channel (68u) devoid of water jets, wherein the fume can run up also pushed by the jets of the previous vertical channel.
4. Plant according to claim 2 or 3, wherein a or each of the vertical channels has the bottom which comprises an opening (72) which opens directly into the second tank.
5. Plant according to any one of the preceding claims, wherein the vertical channels are integral with each other and are movable relatively to the second tank and/or to an external frame of the second stage, in order to regulate the flow of fumes which penetrate in the water of the second tank.
6. Plant according to any one of the preceding claims, wherein the assembly of the vertical channels is placed inside an upper mouth or opening of the second tank, so that the water outputs of each vertical channel can be lifted from - or soak into the - surface of the water (H) contained in the second tank.
7. Plant according to any one of the preceding claims 2 to 6, wherein the assembly of vertical channels is placed directly above the second tank (22), wherein the vertical channels has an opening on the bottom thereof to let water get out towards the second tank (22).

8. Plant according to any one of the preceding claims, wherein the second stage comprises an outer casing (76) containing the vertical channels, and the casing is vertically movable inside a top mouth of the second tank. 5
9. Plant according to any one of the preceding claims, wherein in the third tank said means comprise grids (136) interposed along the tortuous path, to precipitate or capture the dust suspended in the water. 10
10. Plant according to any one of the preceding claims, wherein in the third tank the tortuous path for the water comprises internal baffles or walls (138, 148) which delimit vertical channels (140s, 140d) mutually connected to form a coil in which the water performs subsequent decanting between adjacent channels, two adjacent vertical channels being inferiorly connected by an elbow-shaped segment and separated superiorly by an edge so that the water passes from one channel to the next by skimming. 15 20
11. Plant according to any one of the preceding claims, wherein in the third tank the portion that is lower than the elbow-shaped segment comprises a vertical wall (144) that protrudes vertically from the elbow-shaped segment to slow the passage of water between the two channels connected by that elbow-shaped segment. 25 30

Patentansprüche

1. Anlage (MC) zum Waschen von Abgasen aus suspendierten Partikeln und zur Rückgewinnung von Wärmeenergie aus Abgasen (F), umfassend: 35
- eine erste Stufe (30) und eine zweite Stufe (60) zum Waschen von Abgasen, 40
- einen ersten Behälter (20), einen zweiten Behälter (22) und einen dritten Behälter (24), die dazu eingerichtet sind, Wasser (H₂O) in Kaskade von einem zum anderen zu leiten, wobei die erste Stufe folgendes umfasst: 45
- einen Einlass (32) für die Abgase und einen Auslass (34) für die Abgase in Richtung der zweiten Stufe, 50
- Wasserstrahlen (36), die Wasservorhänge (38) bilden,
- Eine gewundene Zwangstrecke (40) für die Abgase, die sie dazu zwingt, die Wasservorhänge zu durchqueren, 55
- eine Leitung für abgasbeheiztes Wasser in Richtung des ersten Behälters (42) und wobei die zweite Stufe folgendes umfasst:

einen Einlass (34) für die Abgase aus der ersten Stufe und einen Auslass (64) für die Abgase,

eine gewundene Strecke (68d, 68u) für die Abgase,

Wasserstrahlen (70), um Wasser in die gewundene Strecke zu werfen,

eine Leitung (72) für abgasbeheiztes Wasser in Richtung des zweiten Behälters,

wobei der erste und der zweite Behälter jeweils einen Wärmetauscher umfassen, wobei die Wärmetauscher (26, 28) zum selben Kreislauf von fließendem Wasser gehören, das zuerst in den zweiten Behälter und dann in den ersten eindringt;

und der zweite Behälter einen Abgasauslass in Richtung der zweiten Stufe umfasst und wobei der dritte Behälter folgendes umfasst:

eine gewundene Strecke (140s, 140d) für einen Wasserstrom aus dem zweiten Behälter, wobei die gewundene Strecke Mittel (136) zum Sieben des Wasserstroms umfasst, und einen Auslass (62) für den Wasserstrom.

2. Anlage nach Anspruch 1, wobei die gewundene Strecke der zweiten Stufe folgendes umfasst vertikale Wände oder Trennwände, die vertikale Kanäle für die Abgase bilden, und Wasserstrahlen, um Wasser in vertikalen Kanälen entlang einer vertikalen Abwärtsrichtung der Abgase nach unten fließen zu lassen.
3. Anlage nach Anspruch 1 oder 2, wobei einer oder jeder der genannten vertikalen Kanäle unter einem anderen vertikalen Kanal (68u) ohne Wasserstrahlen angeschlossen ist, wobei der Abgas auch durch die Strahlen des vorhergehenden vertikalen Kanals nach oben steigen kann.
4. Anlage nach Anspruch 2 oder 3, wobei einer oder jeder der vertikalen Kanäle einen Boden aufweist, der eine Öffnung (72) umfasst, die direkt in den zweiten Behälter mündet.
5. Anlage nach einem der vorhergehenden Ansprüche, wobei die vertikalen Kanäle miteinander fest verbunden und in Bezug auf den zweiten Behälter und/oder einen Außenrahmen der zweiten Stufe beweglich sind, um den in das Wasser des zweiten Behälters eintretenden Abgasstrom zu regulieren.

6. Anlage nach einem der vorhergehenden Ansprüche, wobei die Anordnung der vertikalen Kanäle innerhalb einer Mündung oder oberen Öffnung des zweiten Behälters liegt, so dass die Wasserauslässe jedes vertikalen Kanals aus der Oberfläche (H) des sich im zweiten Behälter enthaltenen Wassers, aufsteigen oder in diese eintauchen können. 5
7. Anlage nach einem der vorhergehenden Ansprüche 2 bis 6, wobei die Anordnung der vertikalen Kanäle direkt über dem zweiten Behälter (22) liegt, wobei die vertikalen Kanäle eine Öffnung am Boden aufweisen, um Wasser in Richtung des zweiten Behälters abfließen zu lassen. 10
8. Anlage nach einem der vorhergehenden Ansprüche, wobei die zweite Stufe ein äußeres Gehäuse (76) umfasst, das die vertikalen Kanäle enthält, und wobei das Gehäuse innerhalb einer oberen Mündung des zweiten Behälters vertikal beweglich ist. 15 20
9. Anlage nach einem der vorhergehenden Ansprüche, wobei im dritten Behälter die genannten Mittel Gitter (136) umfassen, die entlang der gewundene Strecke zwischengeordnet sind, um die im Wasser suspendierten Pulver abscheiden oder zurückhalten zu lassen. 25
10. Anlage nach einem der vorhergehenden Ansprüche, wobei im dritten Behälter die gewundene Strecke für das Wasser Innenwände oder innere Trennwände (138, 148) umfasst, die vertikale Kanäle (140s, 140d) begrenzen, die miteinander angeschlossen sind, um eine Schlange zu bilden, in der das Wasser nacheinander zwischen benachbarten Kanälen fließt, wobei zwei benachbarte vertikale Kanäle unten mit einem Ellbogenstück angeschlossen und oben durch eine Kante so getrennt sind, dass das Wasser durch Überlauf von einem Kanal zum nächsten fließt. 30 35 40
11. Anlage nach einem der vorhergehenden Ansprüche, wobei in dem dritten Behälter der Abschnitt, der niedriger als das Ellbogenstück liegt, eine vertikale Wand (144) umfasst, die vertikal aus dem Ellbogenstück herausragt, um den Wasserdurchgang zwischen den beiden durch dieses Ellbogenstück angeschlossenen Kanälen zu verlangsamen. 45

Revendications

1. Installation (MC) pour le lavage des fumées des particules en suspension et la récupération de l'énergie thermique des fumées (F), comprenant :

un premier étage (30) et un deuxième étage (60) de lavage des fumées,

un premier réservoir (20), un deuxième réservoir (22) et un troisième réservoir (24), agencés pour communiquer de l'eau (H2O) de l'un à l'autre en cascade, où

le premier étage comprend :

une entrée (32) pour les fumées et une sortie (34) pour les fumées vers le deuxième étage,
des jets d'eau (36) qui forment des rideaux d'eau (38),
un chemin tortueux forcé (40) pour les fumées qui les oblige à traverser les rideaux d'eau,
un conduit pour l'eau chauffée par les fumées vers le premier réservoir (42), et
le deuxième étage comprend :

une entrée (34) pour les fumées du premier étage et une sortie (64) pour les fumées,
un chemin tortueux (68d, 68u) pour les fumées,
des jets d'eau (70) pour jeter de l'eau dans le chemin tortueux,
un conduit (72) pour l'eau chauffée par les fumées vers le deuxième réservoir où les premier et deuxième réservoirs comprennent chacun un échangeur de chaleur, les échangeurs de chaleur (26, 28) appartenant au même circuit d'eau courante qui entre d'abord dans le deuxième réservoir puis dans le premier ;
et le deuxième réservoir comprend une sortie pour les fumées vers le deuxième étage e
le troisième réservoir comprend :

un chemin tortueux (140s, 140d) pour un flux d'eau provenant du deuxième réservoir, le chemin tortueux comprenant des moyens (136) pour tamiser le flux d'eau et une sortie (62) pour le flux d'eau.

2. Installation selon la revendication 1, où le chemin tortueux du deuxième étage comprend parois ou cloisons verticales formant des canaux verticaux pour les fumées, et des jets d'eau pour faire descendre l'eau dans les canaux verticaux selon une direction verticale de descente des fumées. 50

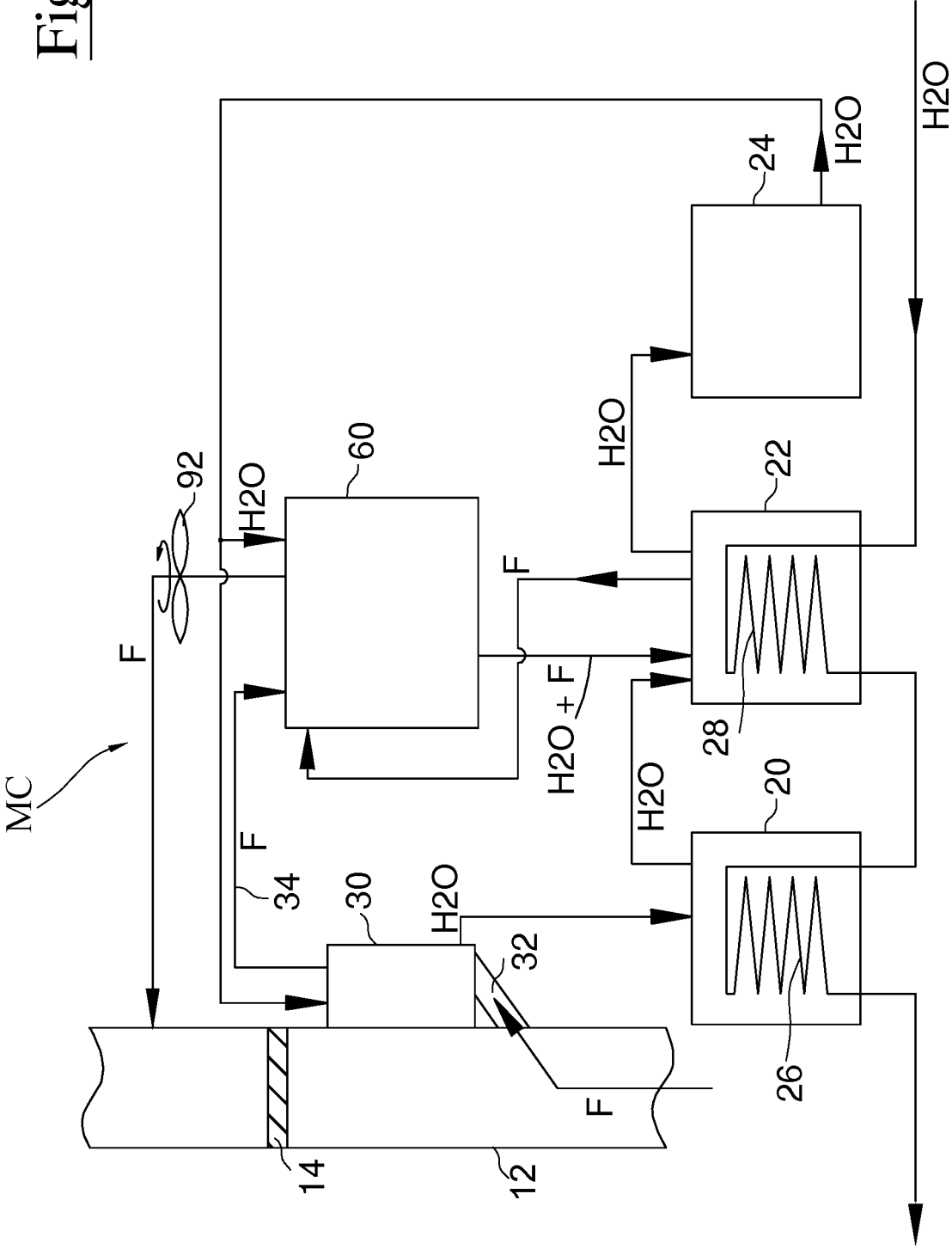
3. Installation selon la revendication 1 ou 2, où un ou chacun desdits canaux verticaux se raccorde en bas à un autre canal vertical (68u) sans jets d'eau, où la fumée peut monter poussée aussi par les jets du 55

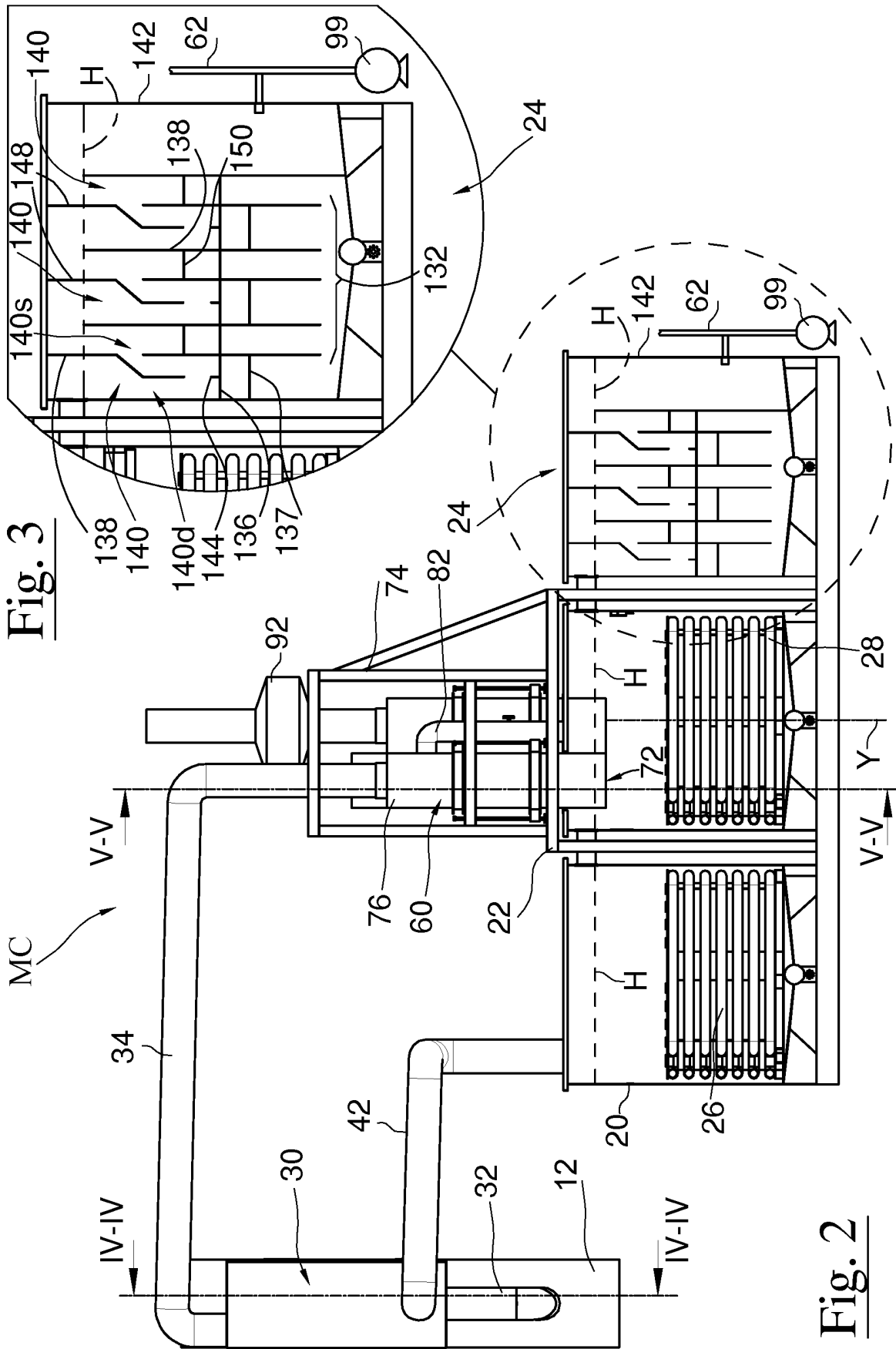
canal vertical précédent.

4. Installation selon la revendication 2 ou 3, où un ou chacun des canaux verticaux a le fond qui comprend une ouverture (72) qui débouche directement dans le deuxième réservoir. 5
5. Installation selon l'une quelconque des revendications précédentes, où les canaux verticaux sont solidaires les uns des autres et sont mobiles par rapport au deuxième réservoir et/ou à un cadre extérieur du deuxième étage, afin de réguler le débit de fumées qui pénètrent dans l'eau du deuxième réservoir. 10
6. Installation selon l'une quelconque des revendications précédentes, où l'ensemble des canaux verticaux est placé à l'intérieur d'une embouchure ou d'une ouverture supérieure du deuxième réservoir, de sorte que les sorties d'eau de chaque canal vertical puissent s'élever de la - ou s'immerger dans la - surface de l'eau (H) contenue dans le deuxième réservoir. 20
7. Installation selon l'une quelconque des revendications précédentes de 2 à 6, où l'ensemble des canaux verticaux est placé directement au-dessus du deuxième réservoir (22), où les canaux verticaux ont une ouverture sur le fond pour laisser l'eau s'écouler vers le deuxième réservoir. 25
8. Installation selon l'une quelconque des revendications précédentes, où le deuxième étage comprend une enveloppe extérieure (76) contenant les canaux verticaux, et l'enveloppe est mobile verticalement à l'intérieur d'une bouche supérieure du deuxième réservoir. 30
9. Installation selon l'une quelconque des revendications précédentes, où dans le troisième réservoir lesdits moyens comprennent des grilles (136) interposées le long du chemin tortueux, pour précipiter ou retenir les poudres en suspension dans l'eau. 35
10. Installation selon l'une quelconque des revendications précédentes, où dans le troisième réservoir le chemin tortueux pour l'eau comprend des parois ou des cloisons intérieures (138, 148) qui délimitent des canaux verticaux (140s, 140d) raccordés les uns aux autres pour former une serpentine où l'eau effectue des transferts ultérieurs entre les canaux adjacents, deux canaux verticaux adjacents étant raccordés en bas avec une section de coude, et séparés en haut par un bord pour que l'eau passe d'un canal à l'autre par effleurement. 40
11. Installation selon l'une quelconque des revendications précédentes, où dans le troisième réservoir la partie qui est plus basse que la section de coude 45

comprend une paroi verticale (144) qui fait saillie verticalement de la section de coude pour ralentir le passage de l'eau entre les deux canaux raccordés de cette section de coude.

Fig. 1





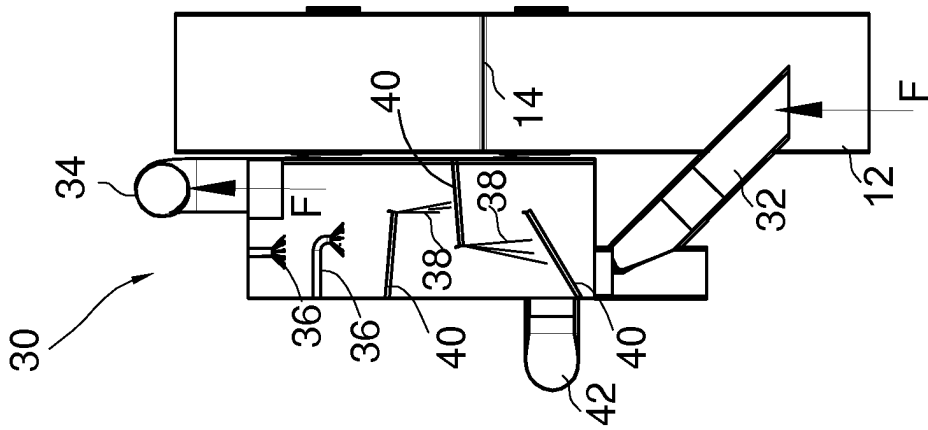


Fig. 4

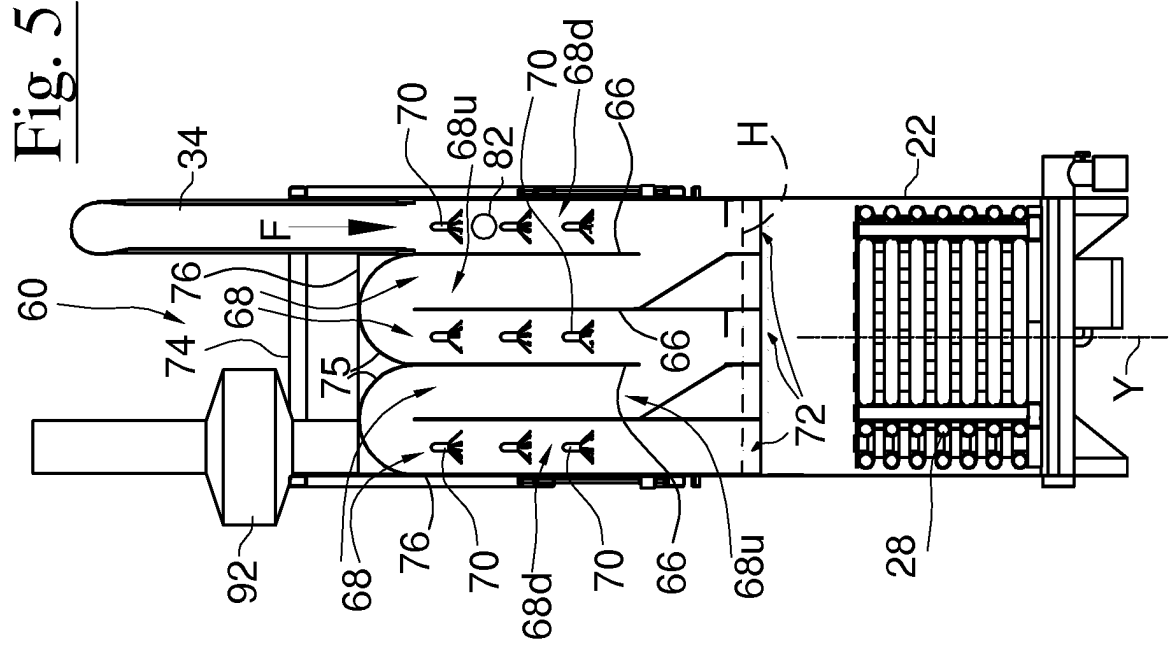


Fig. 5

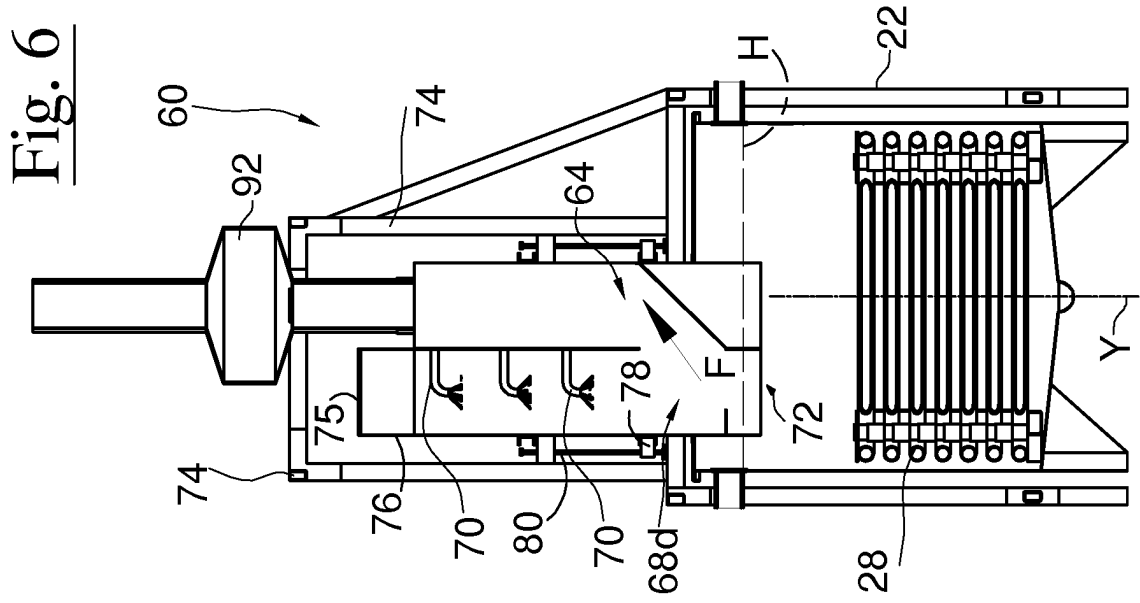


Fig. 6

REFERENCES CITED IN THE DESCRIPTION

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