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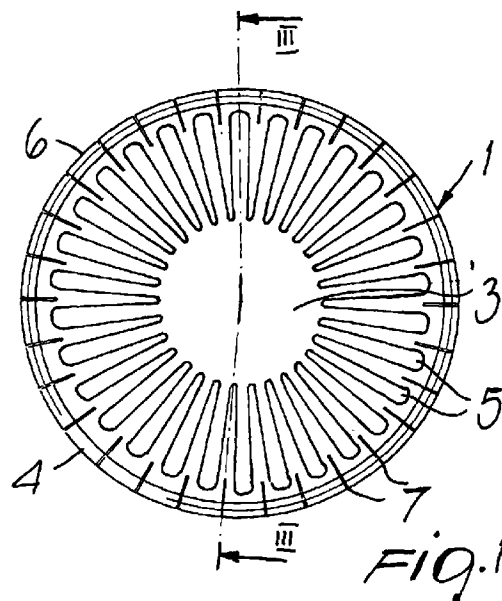
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(54) Heat exchanger with inner fin

(57) A wall for exchanging heat between a relatively warm fluid, which flows through a tubular passage (3) delimited within a heat-conducting wall (4), and a relatively cold fluid, which externally surrounds and encircles the exchange wall (4), characterized in that the exchange wall (4) is internally provided with a plurality of fins which protrude radially inside the tubular passage and delimit, between them, a plurality of slots (5) for the flow of a fluid.



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Description

[0001] The present invention relates to a high-efficiency heat exchanger particularly for heating liquids and/or for producing water vapor.

[0002] As it is known, transfer of heat between two fluids separated by a wall of a material which is made of a good heat conducting material is mainly governed by the difference in temperature between the two fluids and by their flow rate. However, flow rate of one or both fluids is a parameter which does not affect heat transmission in a linear manner, e.g. because at very low or modest flow rates a relatively static layer or film of liquid is formed almost inevitably on the container walls and moving fluid can flow thereon. The static layer constitutes a thermally insulating layer which, other conditions being equal, considerably lowers the heat exchange coefficient.

[0003] Furthermore, conventional combustion devices for heat generation generally comprise two separate bodies, i.e., a liquid- or gas-fired burner provided with suitable safety devices and a heating body arranged to vaporize a liquid.

[0004] For constructive simplification purposes and according to long-standing practice, long ago burner manufacturers have introduced standards for the production of burners depending upon the amount of heat delivered. Heating equipment manufacturers determine the minimum dimensions for the combustion chambers according to such standards.

[0005] Recent developments allow to manufacture very compact and highly efficient heating units having combustion chambers of smaller dimensions; advantage can be taken of this feature to develop new and more efficient heat exchangers.

[0006] The main object of the present invention is to provide a heat exchanging wall which ensures a high heat transmission coefficient between two fluids at different temperatures, thereby heating a colder fluid or cooling a warmer fluid.

[0007] Another object of the present invention is to provide a new highly efficient heat exchanger particularly for heating water both for domestic and industrial use.

[0008] According to a first aspect of the present invention, there is provided a wall for exchanging heat between a relatively hot fluid, which flows through a tubular passage delimited within a heat-conducting wall, and a relatively cold fluid, which externally surrounds and encircles said exchange wall, characterized in that said heat exchanging wall has a plurality of inner fins which extend radially inside said tubular passage and is externally threaded to increase the heat exchanging surface and to be coupled snugly to at least part of the internal wall of a combustion chamber.

[0009] According to another aspect of the present invention, there is provided a liquid heating device which has a tank for containing a liquid to be heated, at

least one combustion chamber which extends hermetically at least partly through by the tank and communicates with a stack, a burner arranged overhead each combustion chamber, and is characterized in that said combustion chamber internally accommodates a heat exchanging wall of the above specified type.

[0010] Further aspects and advantages of the present invention will become better apparent from the following detailed description of some currently preferred embodiments thereof, given by way of nonlimiting examples with reference to the accompanying drawings, wherein:

Figure 1 is a diagrammatic top view of a modular portion of an internally finned and externally threaded tubular heat exchanging wall;

Figure 2 is a side view of the module of Figure 1;

Figure 3 is a cross-sectional view, taken along the line III-III of Figure 1;

Figure 4 is a front elevation view, with parts shown in cross-section, of a heat exchanger having an open-front combustion chamber which is provided with a plurality of mutually angularly offset heat exchanging wall modules of Figures 1 to 3;

Figure 5 shows a combustion chamber for a gas-fired burner provided with a heat exchanging wall according to the present invention;

Figure 6 is a bottom view of Figure 5;

Figure 7 is a longitudinal sectional view of another embodiment of a water heater with a burner arranged at the top thereof;

Figure 8 is a top view of the water heater of Figure 7; and

Figure 9 is a diagrammatic longitudinal sectional view of an industrial-type water heater according to the present invention.

[0011] In the accompanying drawings, identical or similar parts or components have been designated by the same reference numerals.

[0012] With reference first to Figures 1 to 3, it will be seen that a modular portion or tubular module 1 of heat exchanging wall is provided with a plurality of inner fins 2 which extend radially toward the center of a cylindrical passage 3. Preferably, the fins 2 are equal to one another, integral with a peripheral annular portion 4 and mutually angularly spaced from one another, a radial recess or slot 5 being delimited between each pair of adjacent fins for passage of a relatively hot fluid (i.e. hot combustion gases of a burner). The presence of the fins 2 assists in considerably increasing the contact surface between hot fluid and heat exchanging wall 1.

[0013] The module 1 is preferably externally threaded at 6 to increase its contact surface and to provide snug coupling with a portion of a receiving wall which is the inner wall of a combustion chamber.

[0014] If desired, a series of slits 7 designed to reduce the effects of repeated thermal expansions can be provided at the peripheral portion 4.

[0015] Module 1 is made of a material which is a good heat conductor, preferably a pressure die-cast aluminum alloy. This makes it possible to obtain particularly long fins 2 having a considerable surface exposed to hot fluid to transmit heat to the annular portion 4 both by conduction and by radiation.

[0016] With reference to Figure 4, a single-body heating device is shown which comprises a substantially cylindrical tank 10, an axial combustion chamber 11 which extends throughout the entire length of the tank 10, and a heat exchanging surface 1 which is removably arranged inside the combustion chamber 11.

[0017] The tank 10 has, as usual, a lower inlet 12 for the water to be heated, which can be controlled by a suitable valve 13 and is connected to water distribution mains, and an upper outlet 14 for heated water which is provided with a control valve 15 and is connected to a user.

[0018] Combustion chamber 11 is constituted by a metallic tubular body which extends throughout the entire length of the tank 10 and protrudes at the top from it with an outer portion 16 which is connected to a stack 17. At its lower portion, the combustion chamber 11 is provided with a flange 18 for engaging and supporting a head of burner nozzles 19 of a preaerated burner 20 which is connected to both a fuel gas supply duct 21 and a forced air feeding duct 22 connected to an impeller 23 driven by an electric motor 24.

[0019] The upper portion of the combustion chamber 11 is internally threaded and five modules 1 having a large heat exchanging surface according to Figures 1 to 3 are screwed therein, said modules being mutually offset by such an angle that the fins of one module are aligned with the slots of the next module so as to produce turbulence in the combustion gases coming from the head 19. Each of the inserts 1 can be 50 mm high and 160 mm in diameter. With a burner 20 having a nominal heat output of 27,800 kCal/h, with a water temperature of 60°C at the inlet 12 and of 80°C at the outlet 14, an efficiency of 96% has been achieved in practice, with CO and NO_x content below the limits set by the law provisions in force.

[0020] Preferably, the central cavity of the modules 1 that is free from fins 2 is closed by a plug of thermally insulating material, generally designated by the reference numeral 25.

[0021] Figures 5 and 6 illustrate a combustion chamber whose distal end 31 is blind and whose proximal end is provided with a flange 32 for connection cantileverwise to the wall of a tank (not shown), so as to extend within said tank. The combustion chamber 30 has a threaded internal portion 33 which extends from the flanged end inwardly. At least part of the threaded portion 33 is engaged with a preset number of cylindrical modules 1 which are stacked and staggered around a central axial duct 34 which protrudes from the combustion chamber 30 and enters an external sealed container 35, where it extends through a header 36 and at

least partly accommodates a burner nozzle 37 and communicates with a comburent air inlet 38.

[0022] At its portion located inside the combustion chamber 30, duct 34 houses a Venturi-tube nosepiece 39 which is provided with a frustum-shaped flow control element 40 for improving flame stabilization at its downstream region.

[0023] The container 35 is connected to a fuel gas supply through an inlet opening 41 through a valve 42 with built-in stabilizer of any suitable type, fuel gas is fed to the nozzle 37, whose position can be adjusted with respect to the nosepiece 39.

[0024] The container 35 also locates a blower 43 provided with an electric motor 44, which can suck air directly from outside or preferably from a duct (not shown in the drawings) which is arranged around the header so as to preheat the comburent air to be supplied to the duct 38 and the initial portion of the duct 39 acting as a silenced gas-air mixer extremely simple in structure.

[0025] The container 35 also locates other conventional components, such as a flame control relay 45, a differential pressure switch 46, a porthole 47, an ignition electrode 48 and a flame detection electrode 49 (Figure 6).

[0026] Advantageously, the coupling flange 32 is blocked against a fixing ring 50 which is arranged in any suitable manner around a suitable opening in a side wall of a water heater 51, e.g. as shown in Figure 9. In Figure 9 two heating bodies 30 are provided which can operate together or one can act as a stand-by heating body for emergency, should the other one require maintenance, thereby ensuring uninterrupted operation.

[0027] With the above described structure, each heating body 30 can be easily and quickly disassembled from the water heater 51 for maintenance (cleaning, part replacement, etcetera) purposes without the need of replacing the entire heater 51. Furthermore, owing to the technical solution put forward by the present invention, the heater 51 can be protected internally by Teflon coating or low-temperature porcelainization, both of which are much easier and cheaper operations to perform than hot vitrification required up to now to reduce electrochemical attack due to the presence of mineral salts, acids, albumin substances etcetera in the water to be heated. The body of the heater 51 can even be made of reinforced polyester resin or other suitable reinforced synthetic corrosion-proofing material, thus drastically reducing manufacturing costs and the required investments and making it possible to manufacture the body of the heater in developing countries, where importation of very bulky heater bodies would be penalized by high shipping costs, whereas according to the invention only type-tested heating units 30 should be imported.

[0028] Figures 7 and 8 illustrate an embodiment in which a water heater 60 is provided with an axial heating unit 30 provided with a blower 43 and an electric motor 44 with an external air intake 61 and a rotatable

coupling holder disk for connection of the comburent air intake duct and the fuel gas intake duct and, separately, with a coupling disk 64 for a flue 65.

[0029] The above described invention is susceptible of numerous modifications and variations within the protective scope defined by the tenor of the claims.

[0030] The materials and the dimensions can be various according to requirements.

[0031] The priority of patent application VI98A000109 dated June 1, 1998 is assumed included herein by reference.

[0032] 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. A wall for exchanging heat between a relatively hot fluid, which flows through a tubular passage (3) delimited within a heat-conducting wall (4), and a relatively cold fluid, which externally surrounds and encircles said exchange wall (4), characterized in that said heat exchanging wall (4) has a plurality of inner fins (2) which extend radially inside said tubular passage and delimit therebetween a plurality of slots (5) for a fluid flow.
2. A heat exchanging wall according to claim 1, characterized in that it is provided with means (6) for removable engagement at its outer face.
3. A heat exchanging wall according to claim 2, characterized in that it is externally threaded (6) to increase the heat exchanging surface and to engage snugly with at least part of the internal wall of a combustion chamber.
4. A heat exchanging wall according to any one of the preceding claims, characterized in that it is provided with a plurality of longitudinal external slits (7).
5. A wall according to any one of the preceding claims, characterized in that it is constituted by an aluminum alloy obtained by pressure die-casting.
6. A liquid heating device having a tank (10, 51, 60) for containing a liquid to be heated, at least one combustion chamber (11, 30) which hermetically extends through at least part of the tank (10, 51, 60) and is connected to a stack (17, 36, 65), a burner (20, 37) arranged at one end of each combustion chamber (11, 30), and characterized in that said combustion chamber (11, 30) internally locates at least one heat exchanging wall (1) according to any one of claims 1 to 5.
7. A device according to claim 6, characterized in that said combustion chamber (11) extends throughout the entire length of said tank (10) and protrudes from it with an external portion (16) which is connected to a stack (17).
8. A device according to claim 7, characterized in that said combustion chamber (11) has a flange (18) for coupling and supporting a preaerated burner (20) which is connected both to a fuel gas feeding duct (21) and to a duct (22) for supplying forced air which is fed by a blower (23).
9. A device according to any one of claims 6 to 8, characterized in that an upper portion of the combustion chambers (11, 30) is internally threaded and a plurality of modules (1) of a surface with high heat exchange are screwed therein.
10. A device according to claim 9, characterized in that said modules (1) are mutually staggered by such an angle that the fins (2) of one module (1) are aligned with the slots (5) of the next module, thereby producing turbulence in the combustion gases.
11. A device according to any one of claims 6 to 10, characterized in that each one of said modules or inserts (1) is approximately 50 mm high and approximately 160 mm in diameter.
12. A device according to any one of claims 6 to 11, characterized in that it comprises a plug element (25) for a central cavity which is free from fins (2) and is formed in the modules (1).
13. A device according to any one of the preceding claims 6 and 9 to 12, characterized in that said combustion chamber (30) has a blind distal end (31) and a proximal end which is provided with a flange (32) for cantilevered coupling to the wall of the tank (51).
14. A device according to claim 13, characterized in that said combustion chamber (30) has a central axial duct (34) which protrudes from it in order to extend within an outer sealed container (35), where it crosses a header (36) and at least partially accommodates a burner nozzle (37) which is connected to a comburent air intake (38).
15. A device according to claim 14, characterized in that at its portion located inside said combustion chamber (30), said duct (34) accommodates a Venturi-tube nosepiece (39) which is provided with a downstream frustum-shaped flow control element

(40).

16. A device according to claim 14 or 15, characterized in that said sealed container (35) locates a blower (43) provided with an electric motor (44) for air suction from a duct which is in a heat exchange relationship with said header, thereby preheating the comburent air to be supplied to said combustion chamber.
17. A device according to any one of claims 13 to 16, characterized in that said coupling flange (32) can be locked against a fixing ring (50) which is provided around a suitable opening in a lateral wall of a heater (51).
18. A device according to any one of claims 6 to 17, characterized in that said heater (60) is provided with a heating unit (30) which has an external air intake (61) and a coupling support disk which can rotate for connection of a comburent air inlet duct (63) and a fuel gas duct and a coupling disk (64) for a flue (65).

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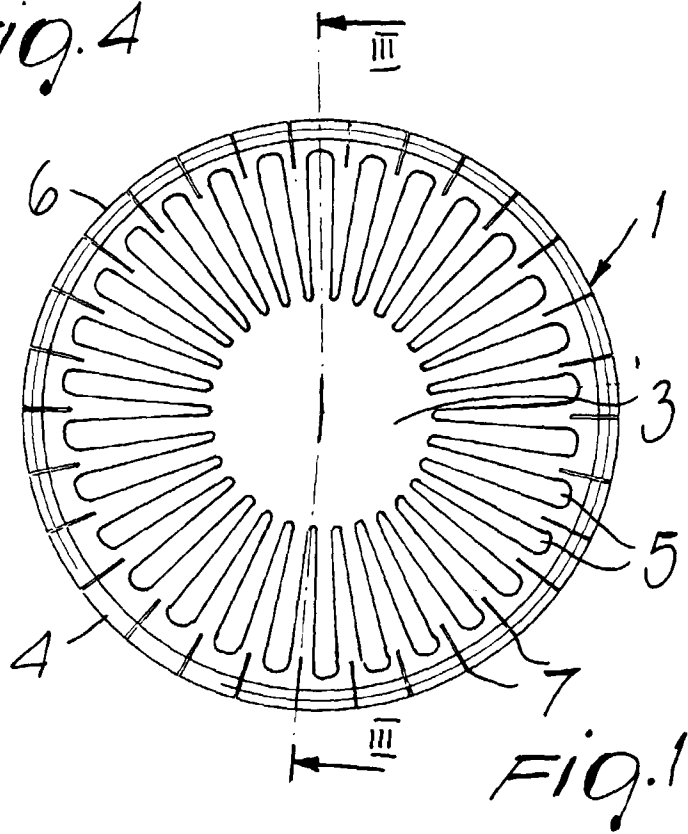
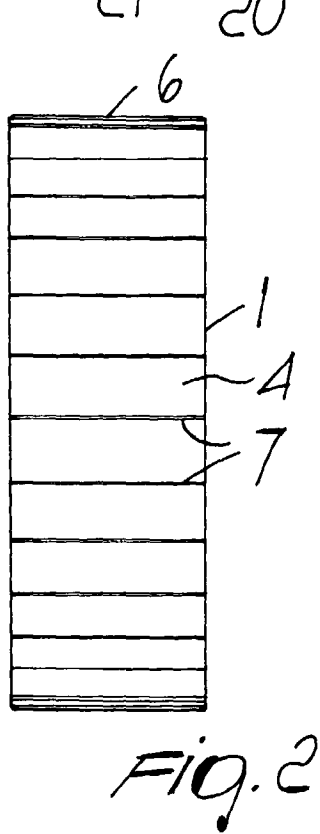
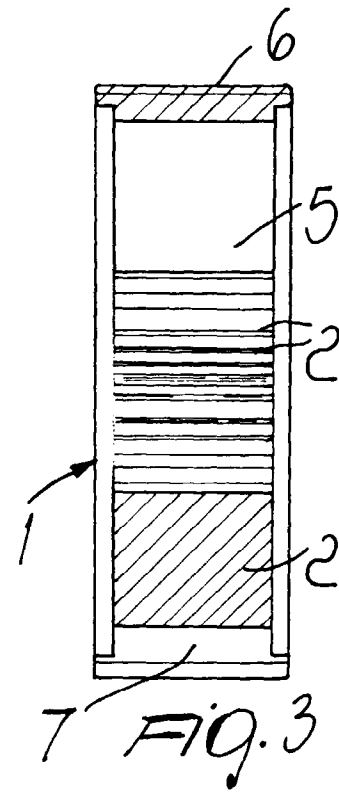
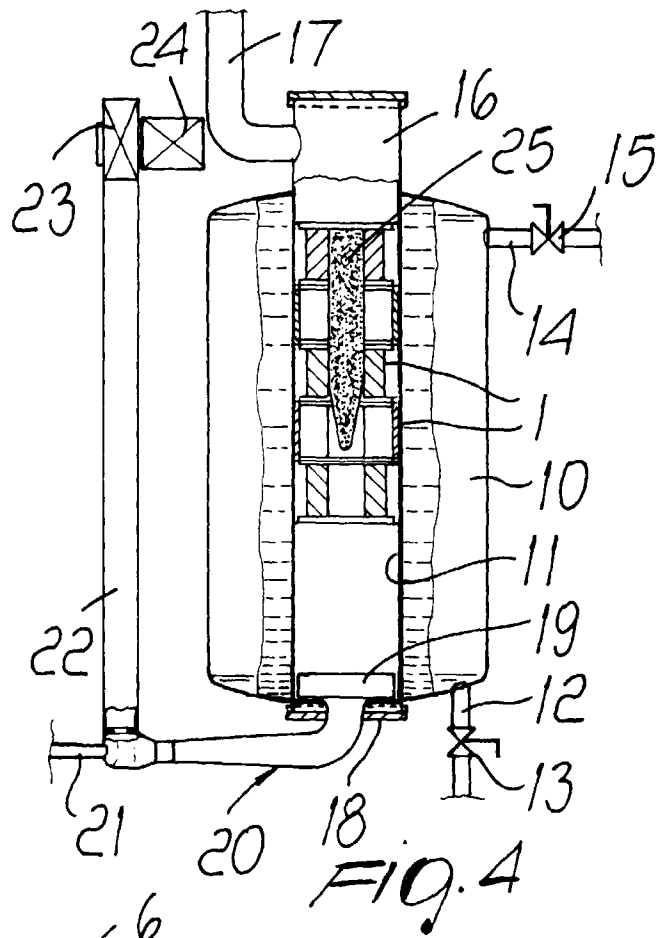
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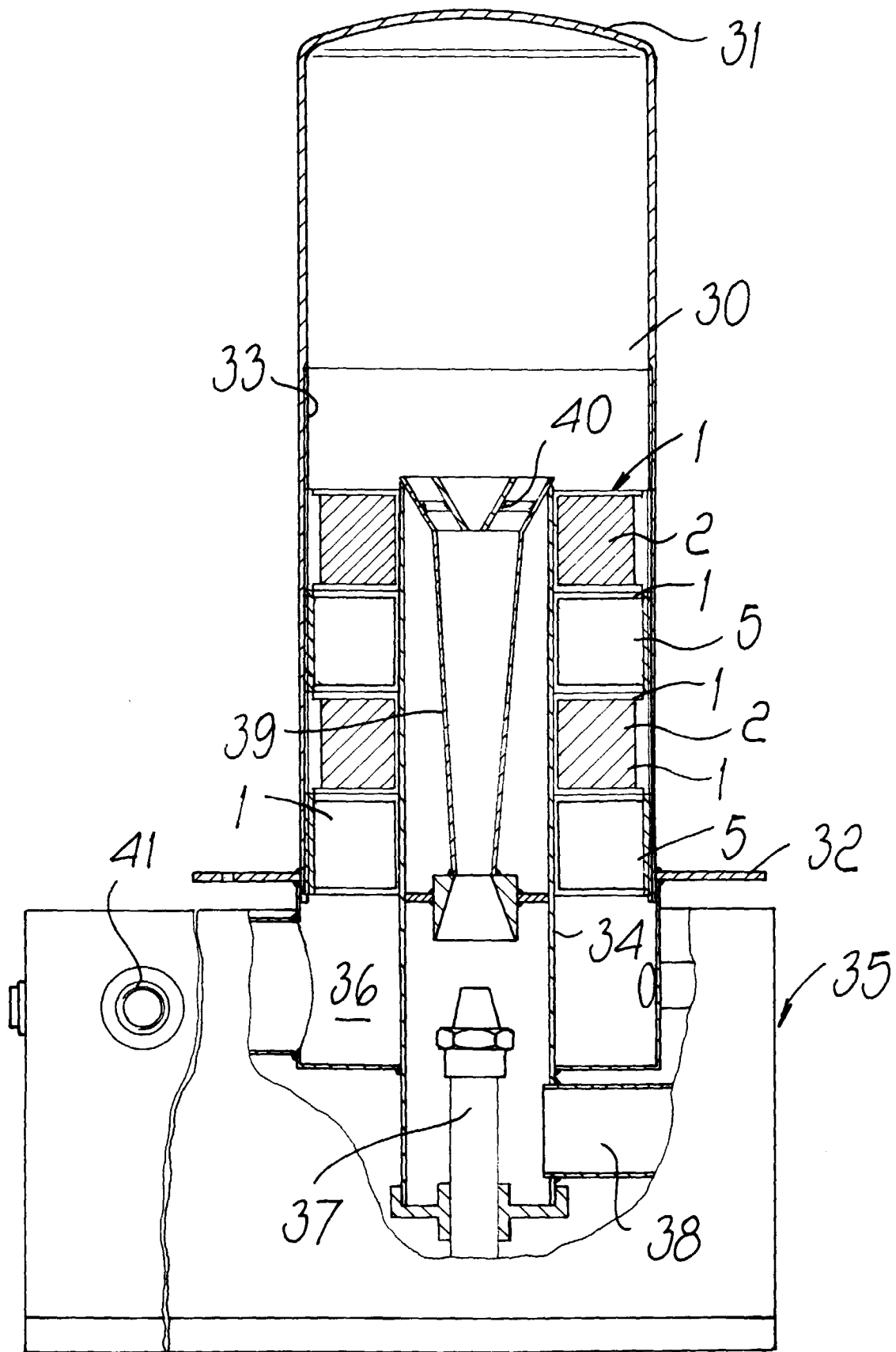


FIG. 5

