(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 287 142 A2**

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **88200501.0**

(22) Date of filing: **18.03.88**

(51) Int. Cl.[4]: **F24H 1/38 , F28F 13/08 , F28F 1/12**

(30) Priority: **18.03.87 NL 8700641**

(43) Date of publication of application: **19.10.88 Bulletin 88/42**

(84) Designated Contracting States: **AT BE CH DE FR GB LI LU NL**

(71) Applicant: **RADSON B.V.**
Industrieterrein 6
NL-5981 NK Panningen(NL)

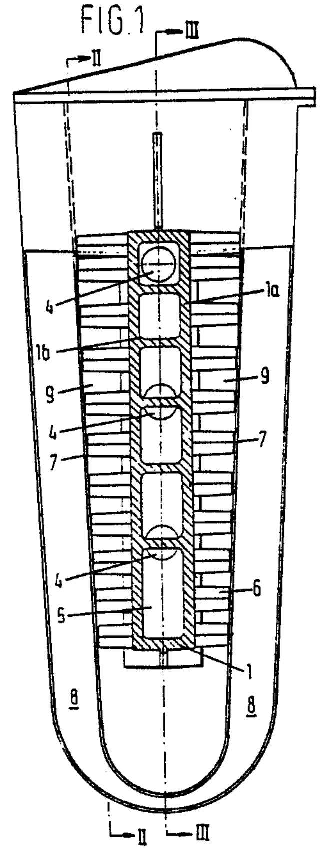
(72) Inventor: **Deckers Jan Hubertus Anna**
Waterloostraat 6
NL-5935 BG Steijl(NL)

(74) Representative: **Smulders, Theodorus A.H.J. et al**
Vereenigde Octrooibureaux Nieuwe Parklaan 107
NL-2587 BP 's-Gravenhage(NL)

(54) **A boiler element.**

(57) A counter-current heat exchange element, in particular for a central heating boiler, comprising a substantially flat box-shaped body (1) containing a water passage (5), the flat side walls (1a, 1b) of said body (1) being provided with protrusions (6) extending into flue passages (9) on both sides of said body (1) and being arranged according to a pattern of laterally offset rows with the lateral spacing of said protrusions (6) gradually decreasing from the high temperature area towards the low temperature area in each flue passage (9), the water passage (5) extending along a serpentine trajectory between a cool water inlet (2) in the low flue gas temperature area and a heated water outlet (3) in the high flue gas temperature area, the water passage (5) narrowing from the inlet (2) towards the outlet (3) in such a manner that the water flow velocity at the outlet (3) is higher than at the inlet (2).

FIG.1



EP 0 287 142 A2

A boiler element.

This invention relates to a light-metal, one-piece heat exchange element, in particular for a central heating boiler, comprising a substantially flat, box-shaped body through which a water passage extends along a curved path between an inlet and an outlet, said water passage having a varying sectional area, the flat side walls of the body being provided with protrusions extending into flue gas passages on either side of said body, said flue gas passages having a decreasing sectional area in the direction of flow of the gas.

In a water heater of this kind, which is disclosed in NL-A-7604830, corresponding with FR-A-2 310 537, flue gases flow from a burner arranged underneath the boiler element along the body upwards between the protrusions, which are designed as vertical longitudinal ribs. The water to be heated is introduced at the bottom of the boiler element and flows concurrently with the flue gases upwards into a curved water passage whose sectional area is larger at the water outlet than at the inlet. For the purpose of keeping the flow velocities of gas and water constant, in the known boiler element, the contraction of the flue gases due to cooling and the expansion of the water due to heating are compensated for by varying the respective sectional areas of passage. In view of the slight expansion of water over the temper ature range which in the practice of a central heating boiler is between about 20° and about 85°C, this means a hardly perceptible increase in sectional area necessary for keeping the velocity of the flow of water constant. The temperature of the flue gases, which in conventional atmospheric burners decreases from e.g. 800° to 150°C, requires a larger reduction of the sectional area for a constant gas velocity.

It is an object of the present invention to provide a heat exchange element of the above kind, designed for a central heating boiler, in which an optimum capacity is obtained using a minimum of light metal.

To that effect, according to the present invention, while the heat exchange element is designed as a counter current exchange element the water passage has a serpentine or zigzag form, with a sectional area decreasing uniformly over the total length of the water passage from the inlet in the low gas temperature area to the outlet in the high gas temperature area so strongly (e.g. in the ratio of 2:1) that the flow velocity at the outlet is higher than at the inlet.

The present invention is based on the insight that in the high-gas temperature area, the temperature differential with the heated water is amply sufficient to ensure effective and fast heat transfer. The hot gas will give up the major part of its heat to the heat exchange element in the first half of the gas trajectory. As the gas in the second half of the gas trajectory is brought in a heat-exchanging relationship with relatively slowly flowing and moreover relatively cold water, it is possible to strongly cool the gas, and even to bring it to condensation level.

For obtaining optimum heat transfer over the entire length of the flue gas passages, into which protrusions of decreasing height project to increase the heated surface area, according to the present invention, the protrusions can be designed as studs arranged according to a pattern of laterally offset rows, with the interspace of the studs decreasing gradually from the high towards the low gas temperature area, e.g. in total in the ratio of 2.5:1.

In the high gas temperature area, heat transfer per unit of time is high, because the temperature differential relative to the water flowing in the adjoining part of the water passage is large and in the low gas temperature area, true, the heated surface area is smaller than in the high gas temperature area but, due to the closer spacing of the studs, an inventive contact with the low temperature flue gas is ensured and the adverse effect of the lower temperature differential on the heat transfer between the flue gas and water is compensated for at least in parts.

It is observed that EP-A-0021512 discloses, per se, a heat exchanger wherein pins are provided in the flue gas passages in a pattern of laterally offset rows, with the interspace of the studs decreasing gradually from the high to the low temperature area, but not in combination with counter-currently supplied water with the velocity of the discharged hot water being higher than that of the entering cold water.

The present invention also concerns a water heating boiler comprising a heat exchange element according to the present invention and a burner, the boiler element according to the present invention being fittingly enclosed on either side by a substantially U-shaped duct for supplying a combustible gas and air mixture to the top of a perforate burner plate disposed in a burner chamber provided above the boiler element, the bottom of said chamber being in open communication with the flue gas passages enclosed by the body of the boiler element and the inner wall of the gas/air duct.

Such a central heating boiler, if fitted with a boiler element of outside dimensions in the order of 25 × 15 × 20 (H × W × T), a water passage decreasing stepwise in cross section from about 10 cm^2 at the inlet to about 5 cm^2 at the outlet, and on either side studs having on an average a cross-sectional area of 1 cm^2 and, in the high gas temperature area, a length of 23 mm and an interspace of 7 mm and in the low temper ature area a length of 15 mm and an interspace of 5 mm, can provide per kg of aluminium a power output of about 3 KW, which is very high for such a small and light-weight boiler. Preferably, use is made of a heat-resistant burner, i.e. one having a perforate plate made e.g. from ceramic material, to the rear of which the gas and air mixture is supplied under pressure, and which, at the front, functions as a burner bed. This allows to obtain a flue gas temperature exceeding 1,200°C.

One embodiment of the boiler element according to the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a vertical part-sectional elevation of a boiler fitted with the boiler element according to the present invention;

Fig. 2 is a side-elevational view of the boiler according to the arrow II-II of Fig. 1;

Fig. 3 is a longitudinal sectional view taken on the line III-III of Fig. 1; and

Fig. 4 is an end elevational view of the boiler according to the arrows IV-IV of Fig. 3.

As shown in the drawings, the boiler element, cast in one piece from light metal, such a aluminium alloy, has a flat, box-shaped body 1 with a water inlet nipple 2 and a water discharge nipple 3 in one of the end walls. Formed in the opposite end wall are closable studs 4, which serve for removing the casting core.

Between water inlet 2 and outlet 3, a water passage 5 extends in serpentine fashion, whose sectional area decreases stepwise down to a ratio of 2:1, see Figs. 1 and 3.

Extending from the side walls 1a, 1b on either side of body 1, are finger-shaped protrusions 6, which in the embodiment shown, have the form of four-sided studs, which taper slightly for ease of release from the mould. Studs 6 are arranged in a pattern of laterally offset horizontal rows (see Fig. 2), which are placed more closely together at the bottom than at the top. As shown in Fig. 1, studs 6 are also shorter at the bottom of the body 1 than at the top.

Against the tops of the lugs 6 lies the inner wall 7 of a substantially U-shaped gas/air duct 8. With the side walls 1a, 1b of body 1 wall 7 encloses flue gas passages 9.

Above body 1, there is provided a chamber 10, containing a perforate burner plate B. Fig. 4 shows a gas supply device 11 and a blower 12 for the forced supply of a combustible gas and air mixture through the U-shaped duct 8 to the top of burner chamber 10.

In operation, flue gases are generated in burner chamber 10 which have a very high temperature of about 1,200°C, and which are forcibly moved downwardly through the flue gas passages 9 and are discharged through the bottom of the boiler element, cooled at 70-80°C or lower. During their passage in the labyrinthine trajectory between studs 6, they give up heat, directly to body 1 and indirectly through studs 6 with which they are brought into close contact due to vortexes produced thereby. Through body 1 the heat absorbed is transferred to the water flowing in passage 5. The heat transfer or thermal conduction per unit of surface area is determined by the temperature differential and the time.

As a result of the construction of the boiler element, the cold water in the lower, low-temperature area of the boiler element, flows much more slowly than in the upper, high gas temperature area. It is true that in the lower, low gas temperature area, the heated surface area has been reduced on the gas side by narrowing the flue gas passages 9, but because the studs are more closely spaced, the flue gas, whose volume has been reduced due to drop in temperature, intensely swirled in the narrow passages between studs 6 and hence forced into close contact with the stud sides and with the portions of the body walls 1a, 1b intermediate studs 6, so that the flue gases have an opportunity of optimally giving off their heat.

The design of the water passage 5 is highly important for the efficiency of the boiler element. Baffles 13-17 form a serpentine or zigzag trajectory 5 in the hollow inner space of body 1, which trajectory becomes narrower at each bend and, in the embodiment shown, is halved in five steps so that, with a constant flow rate, the output velocity at 3 is about double the input velocity at 2. As, in addition, the water is heated during its passage through body 1 and thereby expands, the velocity at outlet 3 will be more than double the velocity at inlet 2.

An essential feature of the present invention is that in the portion of the heat exchanger where relatively cool flue gases have to give off their (residual) heat to cold inflowing water, the water passes at a relatively low velocity and the flue gases are forced to make frequent and intensively contacts, with the heated surface, while in the high gas temperature area, a large contact surface area is offered to the inflowing gases of very high temperature. The large temperature differential (in the order of 1,100°C) enables a fast heat transfer to the water, so that this can be discharged relatively quickly.

Claims

1. A light-metal, one-piece heat exchange element, in particular for a central heating boiler, comprising a substantially flat, box-shaped body (1) through which a water passage (5) extends in a curved path between an inlet (2) and an outlet (3), said water passage having a varying sectional area, with the flat side walls (1a, 1b) of body (1) being provided with protrusions (6) extending into flue gas passages (9), disposed on either side of body (1), said flue gas passages having a decreasing sectional area in the direction of flow of the gas, characterized in that, while the heat exchange element is constructed as a counter-current exchange element, the water passage (5) has a serpentine or zigzag form with a sectional area decreasing from the inlet (2) in the low gas temperature area to the outlet (3) in the high gas temperature area so strongly that the flow velocity at outlet (3) is higher than at inlet (2).

2. A heat exchange element as claimed in claim 1, characterized in that the sectional area at the inlet (2) is about twice as large as at the outlet (3).

3. A heat exchange element as claimed in claim 1 or 2, characterized in that, for forming the serpentine or zigzag water trajectory, the boiler element (1) comprises baffles (13-17) whose interspace and length are such that the sectional area is reduced upon each reversal of the flow direction.

4. A heat exchange element having protrusions (6) of a height decreasing in gas flow direction throughout the entire length of the flue gas passages (9), said protrusions projecting into said passages to increase the heated surface area thereof, characterized in that the protrusions are formed as studs (6), arranged in a pattern of laterally offset rows, with the interspace of the studs (6) decreasing gradually from the high to the low gas temperature area.

5. A heat exchange element as claimed in claim 4, characterized in that the interspace of studs (6) in the high gas temperature area is 2.5 times as large as in the low gas temperature area.

6. A water heating boiler having a heat exchange element as claimed in any of the preceding claims, characterized in that the boiler element is fittingly enclosed on either side by a substantially U-shaped duct (8) for supplying a combustible gas and air mixture to the top of a perforate burner plate (B) disposed in a burner chamber (10) provided above the boiler element, the bottom of said chamber (10) being in open communication with the flue gas passages (9) enclosed by the body of the boiler element and the inner wall (7) of the gas and air duct (8).

7. A boiler as claimed in claim 6, characterized in that the burner plate (B) is made of ceramic material.

FIG.1

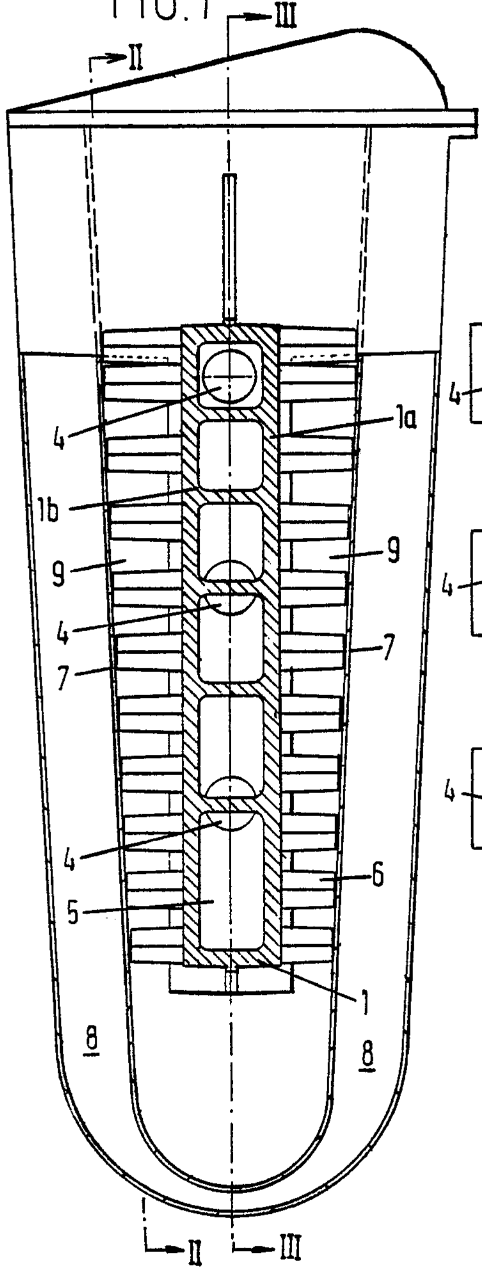


FIG.2

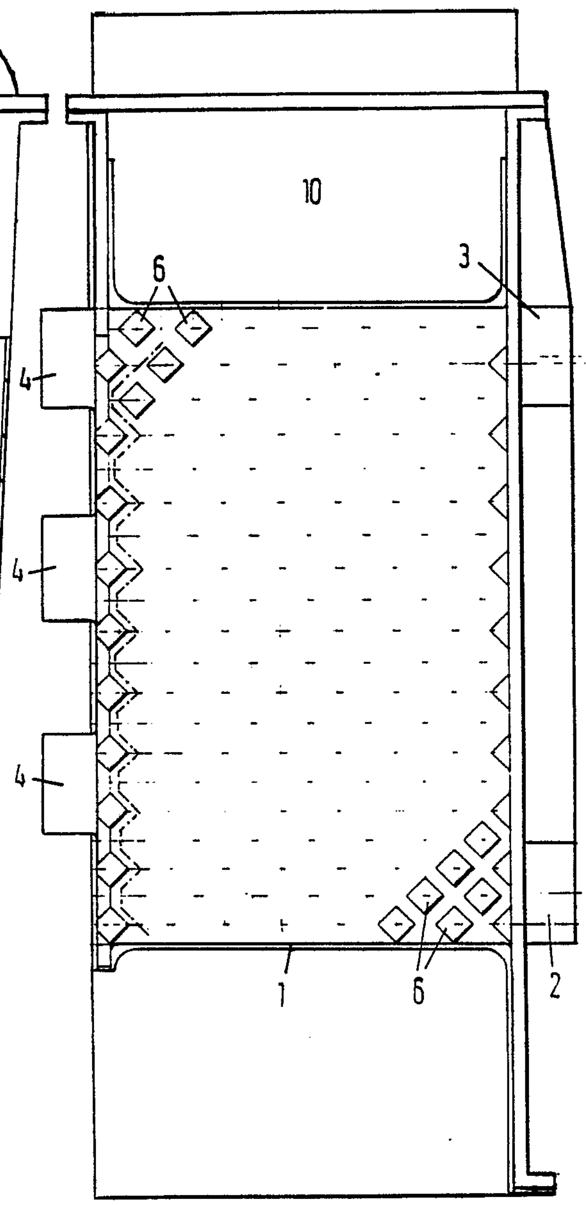


FIG. 4

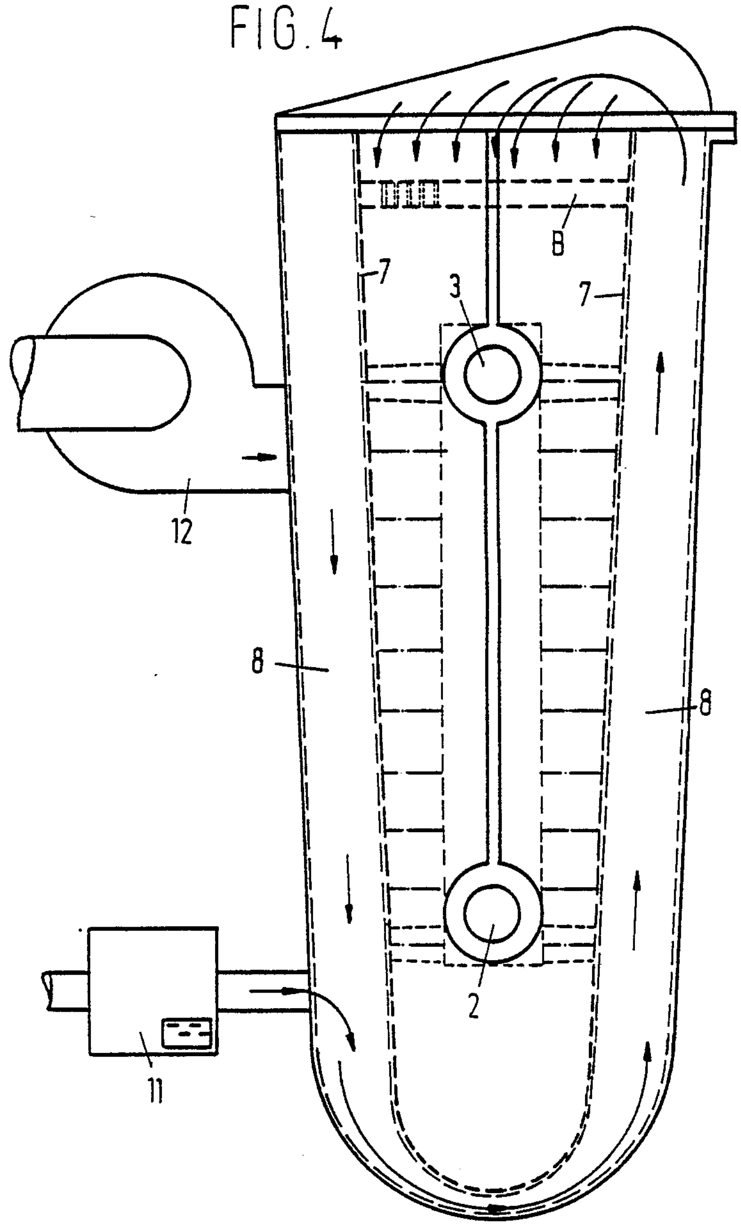


FIG. 3