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⑰ **Water tube boiler.**

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㉒ Proprietor: **Prime Boilers Inc.**
2 Shepherd Avenue East Suite 1705
Toronto Ontario (CA)

㉓ Inventor: **Cooke, George**
2 Shepherd Avenue East
Suite 1705 Toronto (CA)

㉔ Representative: **Eggert, Hans-Gunther, Dr.**
Räderscheidtstrasse 1
D-5000 Köln 41 (DE)

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Description

This application relates to improvements in the construction and operation of a water tube boiler comprising a housing containing upper and lower left and right water manifolds. Tubes connect the left manifolds and other tubes the right manifolds. The tubes are bent toward one another to form a plurality of superposed chambers through which combustion gases must successively flow, from front to back in one chamber and from back to front within the next.

In U.S. Patent 4,355,602 there is described a simple boiler of the abovementioned type which is relatively simple and inexpensive to manufacture and operate. That boiler comprises a housing having a top provided with a gas outlet, bottom, left and right sides and a front and back, the housing containing an upper manifold and a lower manifold substantially parallel to the top, bottom and side walls, two sets of tubes, each set comprising a plurality of tubes, one set joining the upper manifold to the lower manifold on the left and the other set joining the upper manifold to the lower manifold on the right, the tubes of each set rising from the lower manifold upwardly along their respective side wall, crossing the housing to the opposite side wall, rising adjacent the opposite side wall re-crossing the housing to their respective side wall, rising therealong and eventually joining the upper manifold, the horizontal runs of the tubes of one set being vertically offset relative to the horizontal runs of the tubes of the other set so as to form a plurality of superposed chambers, individual tubes of the sets being differently bent so as to form access openings from each chamber to the chambers above and below, the openings from chamber to chamber being front to back and the next chamber from back to front, means for introducing liquid into one of the manifolds and for withdrawing the liquid from the other manifold, and means for introducing a hot gas into the lower-most of the superposed chambers, the hot gas rising successively through the chambers which it successively and alternatively traverses from front to back and then from back to front until it exits from the uppermost chamber through the gas outlet in the top, liquid flowing through the manifolds and tubes being heated by the hot gas, at least one baffle within at least one of the chambers extending from top to bottom and from one of the sides toward but terminating short of the other, whereby hot gas traversing that chamber from front to back is additionally forced to flow laterally to get around said baffle.

It is an object of the present invention to improve the efficiency of operation of such a boiler by simple structural modifications and by simple procedural demands.

These and other objects and advantages are realized in accordance with the present invention by means of a boiler having the features of the first part of Claim 1, in which at least one upper and at least one lower manifold project from the

inside of the housing to the outside, a downcomer outside the housing connects the top of the lower manifold and the lowest part of the upper manifold, thereby permitting the boiler to operate within a shallow level of water in the upper manifold, speeding up circulation of water and its heating, and permitting substantially dry steam to be discharged from the upper manifold, and a baffle (or baffles) is angled within its chamber so that the hot gas hits it at an angle less than 90° so as to be deflected thereby in the direction of its advance, thereby avoiding hot spots, and further successive chambers of the boiler are reduced in volume from bottom to top to make up for the reduction in volume as the hot gas cools, thereby keeping the gas velocity high and maintaining turbulence which helps heat exchange.

The invention will be further described with reference to the accompanying drawings, wherein:

Figure 1 is a perspective view of a boiler in accordance with the invention;

Figure 2 is a front view of the boiler of Figure 1 without baffles and downcomer;

Figure 3 is a side view of the boiler showing the connection of tubes and downcomer with the manifolds;

Figure 4 is a plan view of the preferred arrangement of baffles in a chamber of the boiler; and

Figure 5 is a perspective view of one baffle of Figure 4.

Referring now more particularly to the drawings, in Figure 1 there is shown a housing 10 having a top wall 12, a bottom wall 14, a left side wall 16, a right side wall 18, a front wall 20 and a rear wall 22. A lower manifold 24 and an upper manifold 26 project through the front and rear walls 20 and 22. Means are provided to introduce cold water into the lower manifold at 28 and to remove steam from the upper manifold at 30, outside the housing.

A downcomer 32 outside the housing connects the lowest part of the upper manifold 26 with the top of the lower manifold 24 so that water in the upper manifold can rapidly run down for reheating, speeding up the circulation. This also permits the upper manifold to operate with a shallow level of water which also speeds up production of steam and which permits substantially dry steam to be discharged from the upper manifold 26.

A plurality of tubes 36, illustratively twenty-three, extend from the left upper manifold 26 to the left lower manifold 24 and a similar number of tubes 38 extend from the right upper manifold 26 to the right lower manifold 24. Except for the first 36a and last 36c few tubes in each set, for a reason to be described later, the balance of the tubes 38b are all similarly bent as are the tubes 38.

Each tube has a vertical component and tubes 38a and 38b have two horizontal components, i.e. one run to the left side of the boiler, or actually to the tubes 36, and then a return run. The bends in tubes 38 are not identical to those of tubes 36 but rather complementary so that together they form

a series of vertically superposed chambers 40a, 40b, 40c, 40d and 40e, decreasing in volume from bottom to top to make up for reduction in volume as the hot gas cools, thereby keeping the gas velocity high and maintaining turbulence which helps heat exchange.

Advantageously, the boiler has five, seven or nine chambers. Combustion gases in chamber 40a rise through such space and enter chamber 40b traversing it horizontally from back to front. The tube bends similarly cause the gases to traverse successive chambers until they reach the topmost chamber 40e where they exit through an opening in the top 12.

For improved heat exchange, in addition to the tortuous gas flow so far defined, a more complex flow is possible. Thus rectangular baffles 46 having the shape shown in Figure 5 may be provided, extending from adjacent one side wall toward but short of the other. They are just high enough to span a chamber being held in position by their fit between the troughs formed by adjacent tubes. They are inserted by simple sliding and may be removed, or slid more or less into their chambers, either manually or automatically (not shown), as desired.

If more than one baffle 46 is present in a given chamber they must alternately extend from opposite sides. Thus, while the combustion gas is moving from rear to front in chamber 40b the gas stream must move from side to side to get around the baffles.

As shown in Figures 4 and 5 the baffles have front and rear elements which are high and low enough to lodge in the nips between adjacent tubes. In between there is a lower section which is just high enough to clear the minimum vertical space of the chamber. This section is arranged at an angle less than 90°C, e.g. about 45° so the gas will be deflected off it in a direction which will help advance the gas, thereby avoiding hot spots.

In Figures 1 and 3 it can be seen that the connections between the tubes and upper manifold are not in a straight line but rather are staggered. However, all the tubes join the upper manifold at or below the upper manifold's horizontal center line and each tube in going from lower to upper manifold has lengths which rise or are horizontal but has no lengths which go downwardly, thereby avoiding entrapment of gas.

The baffles can serve a further purpose, viz. maintaining efficient utilization of fuel notwithstanding fluctuating fuel feed rates as a consequence of fluctuation in steam demand. Specifically, one monitors the oxygen content of the hot gas exiting the boiler which otherwise will change as feed and demand vary. However, the position of the baffle or baffles is adjusted to maintain this oxygen content substantially constant, e.g. as demand goes down the oxygen content will go up, so the baffle positions will be adjusted to give more baffling and thereby restore the oxygen level to the predetermined value.

Claims

1. Boiler comprising a housing (10) having a top (12) provided with a gas outlet, bottom (14), left (16) and right (18) sides and a front (20) and back (22), the housing containing an upper manifold (26) and a lower manifold (24) substantially parallel to the top, bottom and side walls, two sets of tubes (36, 38), each set comprising a plurality of tubes, one set joining the upper manifold to the lower manifold on the left and the other set joining the upper manifold to the lower manifold on the right, the tubes of each set rising from the lower manifold upwardly along their respective side wall, crossing the housing to the opposite side wall, rising adjacent the opposite side wall, re-crossing the housing to their respective side wall, rising therealong and eventually joining the upper manifold, the horizontal runs of the tubes of one set being vertically offset relative to the horizontal runs of the tubes of the other set so as to form a plurality of superposed chambers (40 a, b, c, d, e), individual tubes of the sets being differently bent so as to form access openings from each chamber to the chambers above and below, the openings from chamber to chamber being offset so as to require a gas flowing through said chambers to traverse one chamber from front to back and the next chamber from back to front, means for introducing liquid into one of the manifolds and for withdrawing the liquid from the other manifold, and means for introducing a hot gas into the lowermost (40a) of the superposed chambers, the hot gas rising successively through the chambers which it successively and alternately traverses from front to back and then from back to front until it exits from the uppermost chamber (40e) through the gas outlet in the top, liquid flowing through the manifolds and tubes being heated by the hot gas, at least one baffle (46) within at least one of the chambers extending from top to bottom and from one of the sides toward but terminating short of the other, whereby hot gas traversing that chamber from front to back is additionally forced to flow laterally to get around said baffle, characterized by the following features
 - a) at least one upper (26) and at least one lower (24) manifold project from the inside of the housing (10) to the outside, and a downcomer (32) outside the housing connecting the top of the lower manifold and the lowest part of the upper manifold, thereby permitting the boiler to operate with a shallow level of water in the upper manifold, speeding up circulation of water and its heating, and permitting substantially dry steam to be discharged from the upper manifold,
 - b) the baffle (46) is angled within its chamber so that the hot gas hits it at an angle less than 90° so as to be deflected thereby in the direction of its advance, thereby avoiding hot spots,
 - c) successive chambers from bottom (14) to top (12) are reduced in volume to make up for the reduction in volume as the hot gas cools, thereby keeping the gas velocity high and maintaining turbulence which helps heat exchange.

2. Boiler according to Claim 1, characterized in that all the tubes (36, 38) join the upper manifold (26) at or below the upper manifold's horizontal center line.

3. Boiler according to Claim 1 or 2, characterized in that each tube (36, 38) in going from lower (24) to upper (26) manifold has lengths which rise or are horizontal but has no lengths which go downwardly, thereby avoiding entrapment of gas.

4. Boiler according to one of the Claims 1 to 3, characterized in that the boiler has five, seven or nine chambers (40).

5. Boiler according to one of the Claims 1 to 4, characterized by a plurality of baffles (46) in a plurality of chambers (40).

Patentansprüche

1. Wasserrohrkessel mit einem Gehäuse (10), das eine mit einem Gasauslaß versehene Decke (12), einen Boden (14), eine linke (16) und eine rechte (18) Seitenwand sowie eine Vorder- (20) und eine Rückwand (22) aufweist und in dem zur Decke, zum Boden und zu den Seitenwänden im wesentlichen parallel eine obere Sammelleitung (26) und eine untere Sammelleitung (24) angeordnet sind und das zwei Rohre (36, 38) aufweist, von denen jeder eine Vielzahl von Rohren enthält und von denen der eine Satz die obere Sammelleitung mit der unteren Sammelleitung auf der linken Seite und der andere Satz die obere Sammelleitung mit der unteren Sammelleitung auf der rechten Seite verbindet, wobei die Rohre eines jeden Satzes von der oberen Sammelleitung entlang ihrer korrespondierenden Seitenwand aufwärts steigen, dann das Gehäuse bis zur gegenüberliegenden Seitenwand durchqueren, nahe dieser gegenüberliegenden Seitenwand weiter aufwärts steigen, des Gehäuse wieder zu ihrer korrespondierenden Seitenwand hin durchqueren, entlang dieser aufsteigen und schließlich in der oberen Sammelleitung münden, und wobei die horizontalen Teilstücke der Rohre das einen Satzes gegenüber den horizontalen Teilstücken der Rohre des anderen Satzes vertikal versetzt sind, um eine Mehrzahl von einander überlagerten Kammern (40 a, b, c, d, e) zu bilden, und wobei einzelne Rohre der Sätze unterschiedlich gebogen sind, um von jeder Kammer zu den darüber und darunter befindlichen Kammern Zutrittsöffnungen zu bilden, die von Kammer zu Kammer gegeneinander versetzt sind, um durch die Kammern aufsteigendes Gas zu veranlassen, die eine Kammer von vorn nach hinten und die nächste Kammer von hinten nach vorn zu durchqueren, und mit einer Einrichtung zum Zuführen von Flüssigkeit in eine der Sammelleitungen und zum Abführen der Flüssigkeit aus der anderen Sammelleitung, sowie mit einer Einrichtung zum Zuführen eines heißen Gases in die unterste (40a), der überlagerten Kammern, das heiße Gas aufsteigend durch die Kammern, welche es aufeinanderfolgend abwechselnd von vorn nach hinten und dann von hinten nach vorn

durchquert, bis es aus der obersten Kammer (40e) durch den Gasauslaß in der Decke austritt, wobei es die durch die Sammelleitungen und Rohre strömende Flüssigkeit erhitzt, ferner mit wenigstens einem im wenigstens einer der Kammern angeordneten Umlenblech (46), das sich von der Decke bis zum Boden und von einer der Seiten nach der anderen Seite zu, aber kurz vor dieser endend, erstreckt, wodurch diese Kammer von vorn nach hinten durchquerendes heißes Gas zusätzlich gezwungen ist, um dieses Umlenblech herumzuströmen, gekennzeichnet durch die folgenden Merkmale

a) wenigstens eine obere (26) und wenigstens eine untere (24) Sammelleitung erstrecken sich von der Innenseite zur Außenseite des Gehäuses (10) und ein außerhalb des Gehäuses angeordnetes Fallrohr (32) verbindet das Oberteil der unteren Sammelleitung und den untersten Teil der oberen Sammelleitung, dadurch den Betrieb des Kessels mit einem niedrigen Wasserspiegel in der oberen Sammelleitung und damit eine Beschleunigung der Zirkulation des Wassers und seiner Erhitzung sowie des Auslasses von im wesentlichen trockenem Dampf aus der oberen Sammelleitung ermöglichend,

b) das Umlenblech (46) ist innerhalb seiner Kammer abgewinkelt, so da das heiße Gas unter einem Winkel von weniger als 90° auf das Blech auftrifft und in Richtung seiner Vorwärtsbewegung abgelenkt wird und dadurch überhitzte Stellen verhindert werden,

c) vom Boden (14) zur Decke (12) aufeinanderfolgende Kammern sind im Volumen reduziert, um die Volumenverringerung des Gases beim Abkühlen auszugleichen, dadurch die Gasgeschwindigkeit hoch- und die Turbulenz aufrechterhaltend, was den Hitzaustausch fördert.

2. Wasserrohrkessel nach Anspruch 1, dadurch gekennzeichnet, daß alle Rohre (36, 38) an der oberen Sammelleitung (26) in Höhe oder unterhalb ihrer horizontalen Mittellinie angeschlossen sind.

3. Wasserrohrkessel nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß jedes Rohr (36, 38) auf dem Weg von der unteren (24) zur oberen (26) Sammelleitung aufsteigende oder horizontale Teilstücke, zur Vermeidung des Einschlusses von Gas aber keine abwärts gerichteten Teilstücke aufweist.

4. Wasserrohrkessel nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß er fünf, sieben oder neun Kammern (46) aufweist.

5. Wasserrohrkessel nach einem der Ansprüche 1 bis 4, gekennzeichnet, durch eine Mehrzahl von Ablenkflächen (46) in einer Mehrzahl von Kammern (40).

Revendications

1. Chaudière comportant un caisson (10) présentant un sommet (12) munie d'une sortie de gaz (14), d'un fond de côtés droit (18) et gauche (16), d'un avant (20) et d'un arrière (22), le caisson contenant un collecteur supérieur (26) et un col-

lecteur inférieure (24) sensiblement parallèles aux parois latérales, du fond et du sommet, deux jeux de tubes (36, 38), chaque jeu comprenant une pluralité de tubes, un jeu reliant le collecteur supérieure au collecteur inférieure sur la gauche et l'autre jeu reliant le collecteur supérieur au collecteur inférieur sur la droite, les tubes de chaque jeu montant à partir du collecteur inférieure à la verticale le long de leur paroi latérale respective, traversant le caisson vers la paroi latérale opposée, montant au voisinage de la paroi latérale opposée, traversant à nouveau le caisson vers leur paroi latérale respective, montant le long de celle-ci et rejoignant finalement le collecteur supérieur, les parcours horizontaux des tubes de l'un des jeux étant décalés verticalement par rapport aux parcours horizontaux des tubes de l'autre jeu de façon à former une pluralité de chambres superposées (40, a, b, c, d, e), des tubes individuels des jeux étant coudés différemment de façon à former les ouvertures d'accès de chaque chambre vers les chambres du dessus et du dessous, les ouvertures de chambre à chambre étant décalées de façon à obliger un gaz d'écoulant à travers lesdites chambres à traverser une chambre d'avant en arrière et la chambre suivant d'arrière en avant, des moyens pour introduire du liquide dans un des collecteurs et pour retirer le liquide de l'autre collecteur, et des moyens pour introduire un gaz chaud dans la plus basse (40a) des chambres superposées, le gaz chaud montant successivement à travers les chambres qu'il traverse successivement et alternativement d'avant en arrière et ensuite d'arrière en avant jusqu'à ce qu'il sorte de la chambre la plus élevée (40e) à travers la sortie de gaz du sommet, du liquide s'écoulant à travers les collecteurs et des tubes étant chauffés par le gaz chaud, au moins une des chicanes (46) à l'intérieur de la dernière chambre s'étendant du sommet vers le bas et de l'un des côtés presque jusqu'à l'autre mais sans l'atteindre, si bien que du gaz chaud traversant cette chambre d'avant en arrière est de

plus obligé de s'écouler latéralement pour contourner ladite chicane, caractérisée par les caractéristiques suivantes:

5 a) un collecteur supérieur (26) au moins et un collecteur inférieure (24) au moins font saillie à partir de l'intérieur du caisson (10) vers l'extérieure, et un tube de retour (32) hors du caisson reliant le sommet du collecteur inférieur à la partie la plus basse du collecteur supérieur, si bien que la chaudière peut fonctionner avec un niveau d'eau de faible profondeur dans le collecteur supérieur, accélérant la circulation d'eau et son échauffement, et permettant l'écoulement d'une vapeur sensiblement sèche à partir du collecteur supérieur,

10 b) la chicane (46) forme un angle à l'intérieur de sa chambre de façon que le gaz chaud la frappe sous un angle inférieure à 90° de façon à être dévié par celle-ci dans la direction de son mouvement d'avance, évitant ainsi les points chauds,

20 c) des chambres successives du fond (14) au sommet (12) sont réduites en volume pour compenser la réduction en volume lorsque le gaz chaud se refroidit, conservant ainsi la vitesse élevée du gaz et maintenant la turbulence qui favorise l'échange de chaleur.

2. Chaudière selon la revendication 1, caractérisée en ce que tous les tubes (36, 38) rejoignent le collecteur supérieur (26) au niveau de la ligne centrale horizontale du collecteur supérieur ou en dessous.

3. Chaudière selon la revendication 1 ou 2, caractérisée en ce que chaque tube (36, 38) en allant du collecteur (24) vers le collecteur supérieur (26) présente des longueurs montantes ou horizontales mais ne présente pas de longueurs descendantes, évitant ainsi les piégeages de gaz.

4. Chaudière selon l'une des revendications 1 à 3, caractérisée en ce qu'elle comporte cinq, sept ou neuf chambres (40).

5. Chaudière selon l'une des revendications 1 à 4, caractérisée par une pluralité de chicanes (46) situées dans une pluralité de chambres (40).

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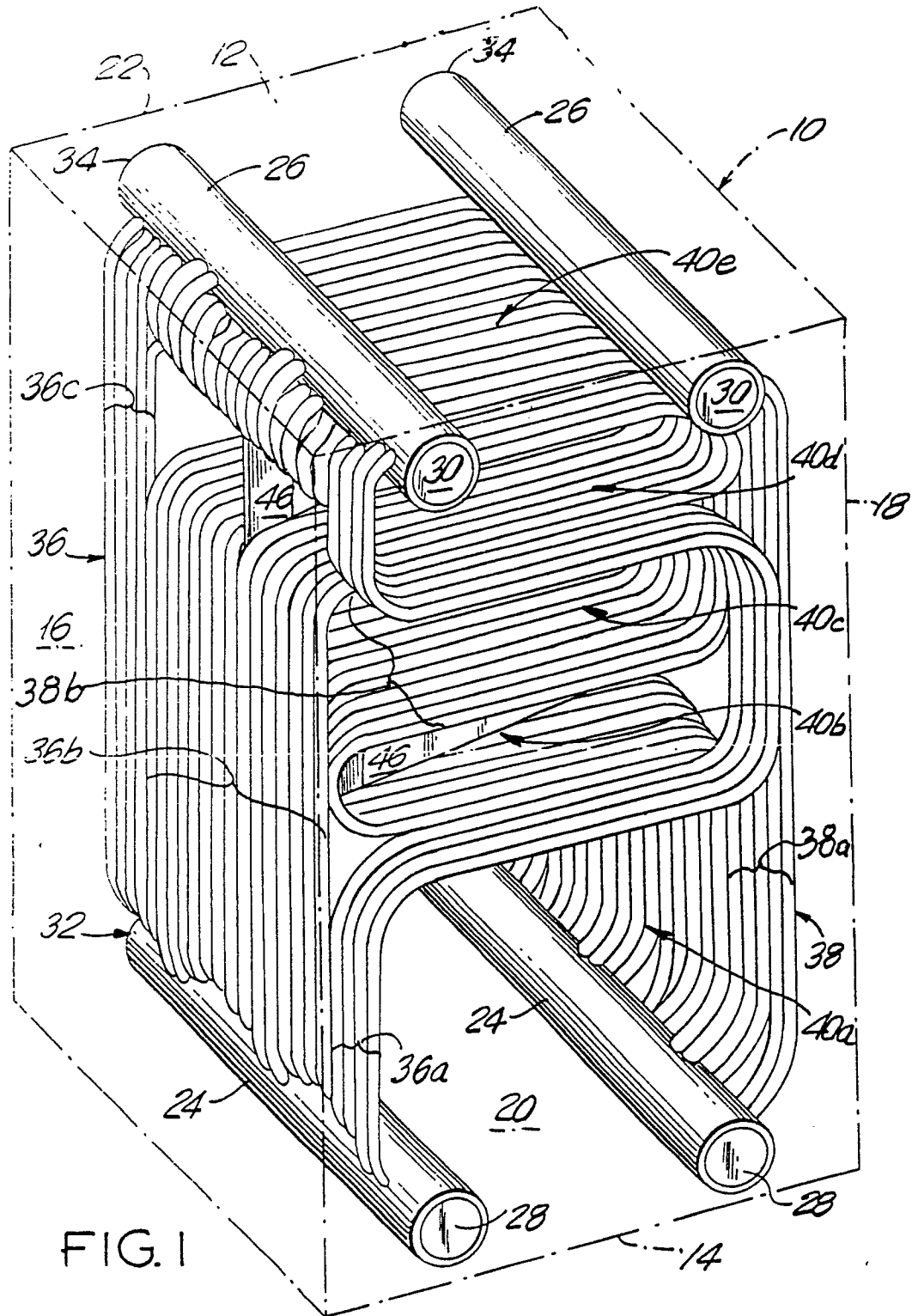


FIG. 1

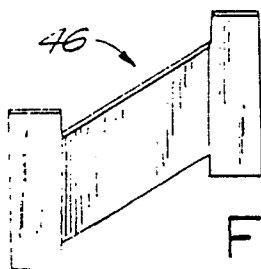


FIG. 5

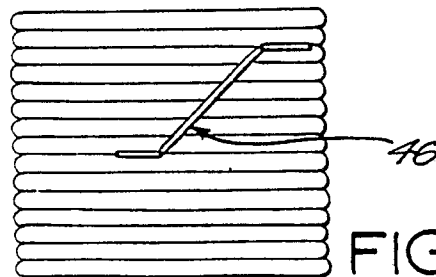


FIG. 4

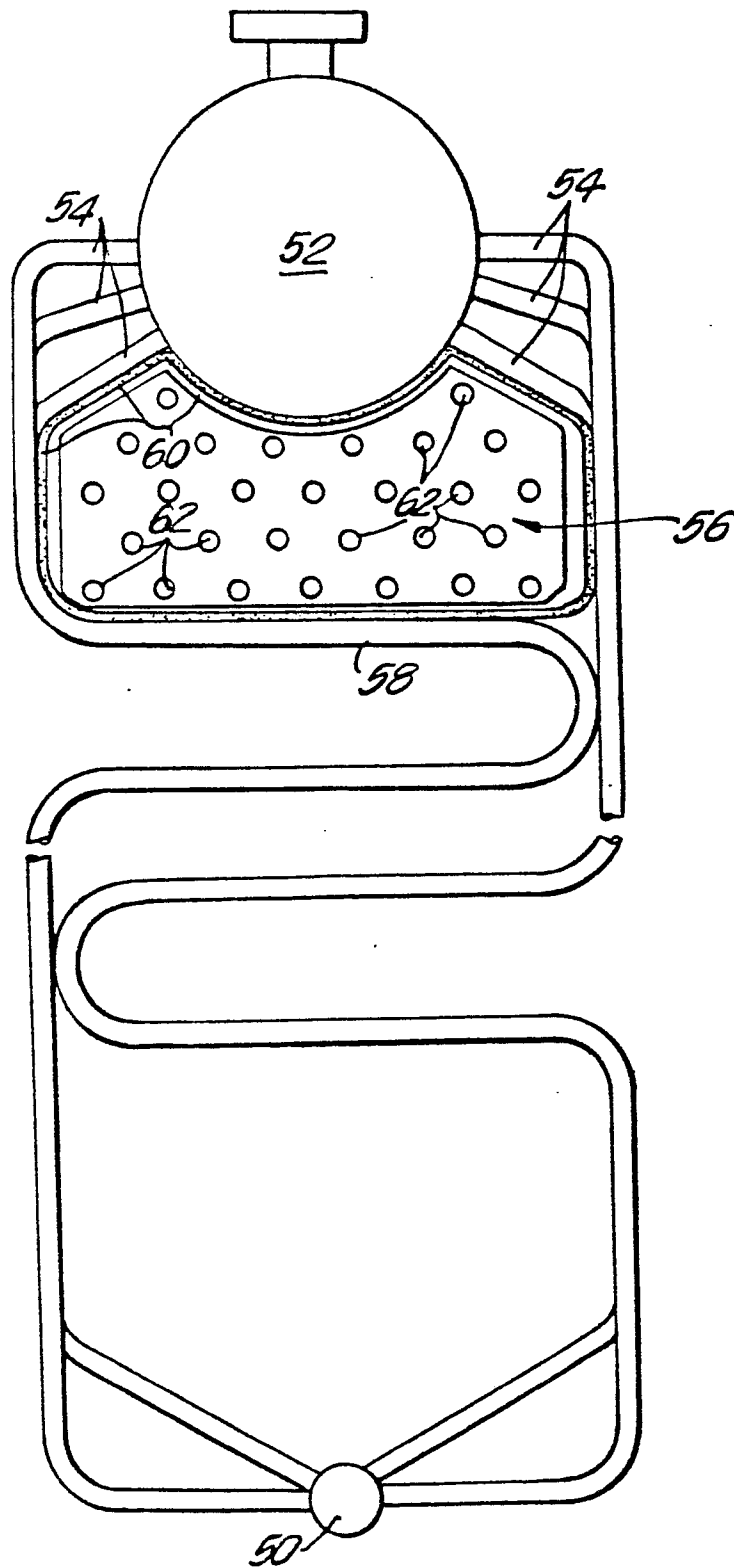


FIG. 2

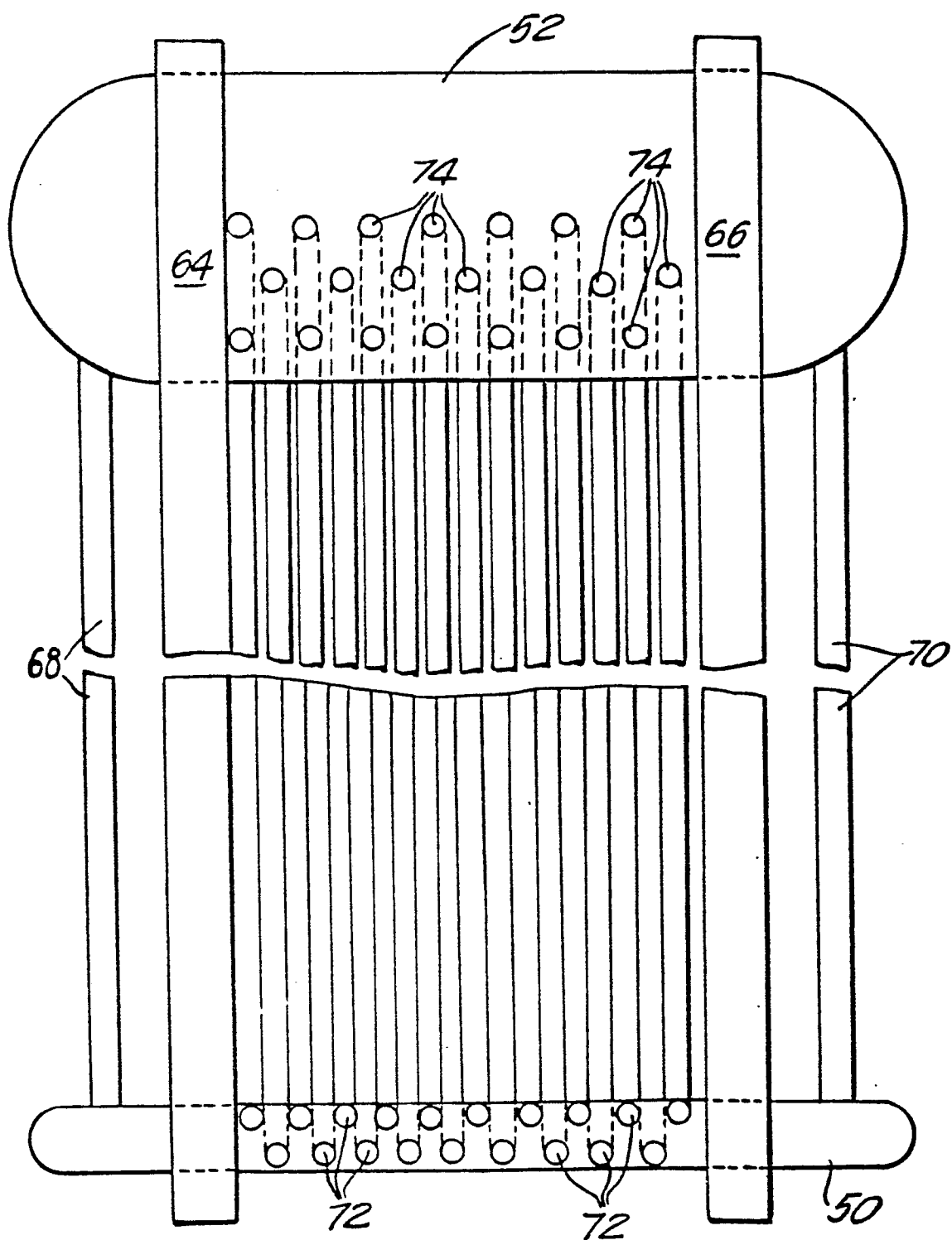


FIG. 3