Oct. 27, 1953 M. H. HOFMEISTER 2,657,020

HEAT EXCHANGER

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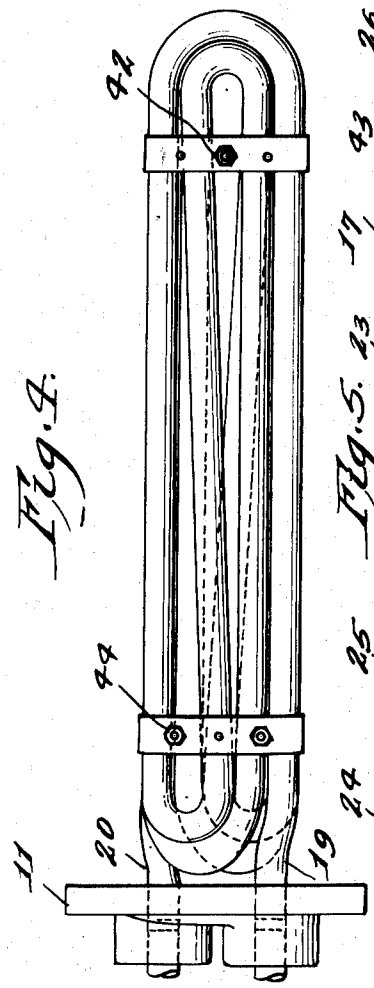



Fig. 4.

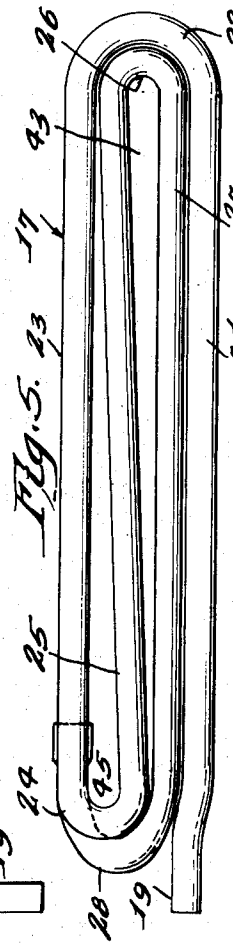



Fig. 5.




Fig. 7.

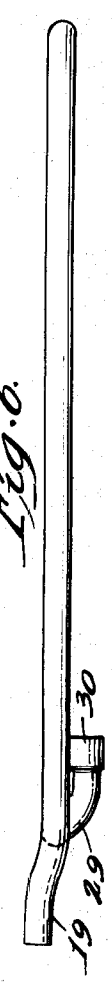



Fig. 6.

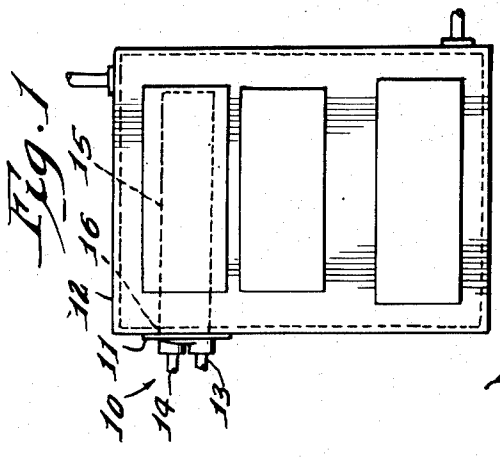



Fig. 1.

Inventor:
Maurice H. Hofmeister
By. John W. Darley
Attorney.

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Fig. 3.

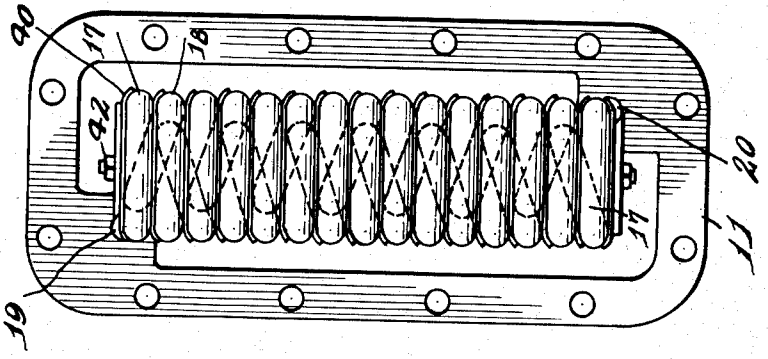
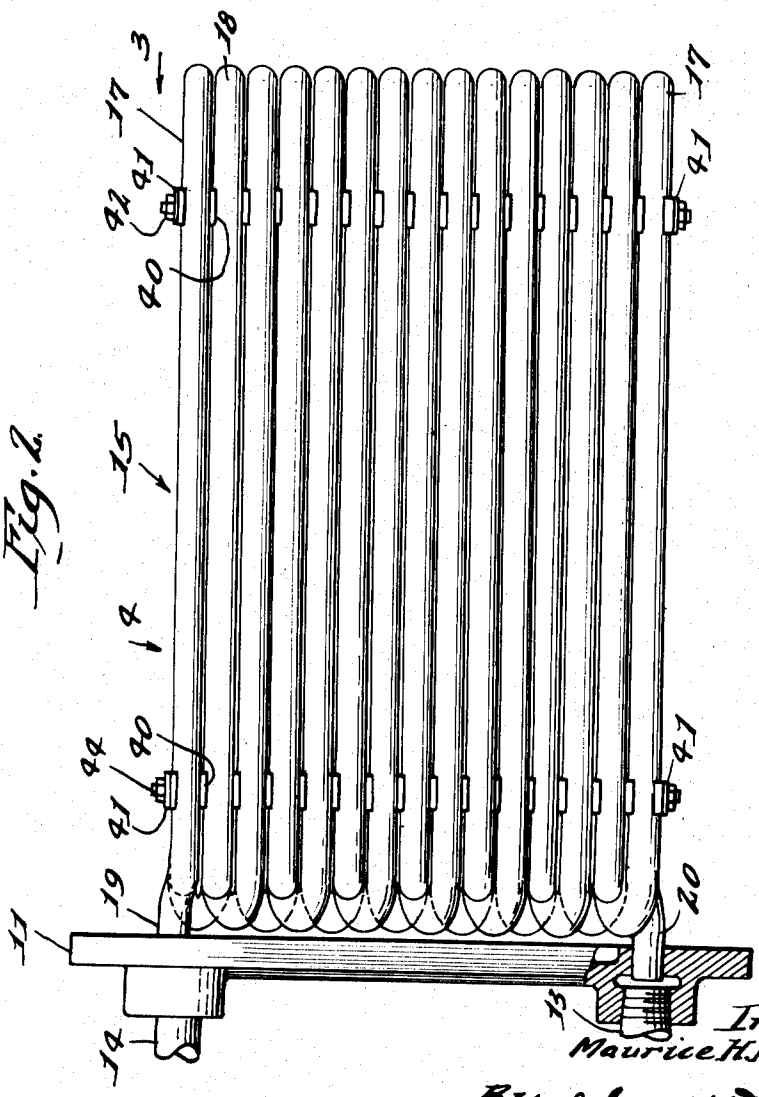



Fig. 2.




Inventor:
Maurice H. Hofmeister.
By. John W. Darley
Attorney

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# UNITED STATES PATENT OFFICE

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## HEAT EXCHANGER

Maurice H. Hofmeister, Evanston, Ill., assignor to Bell & Gossett Company, Morton Grove, Ill., a corporation of Illinois

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2 Claims. (Cl. 257—255)

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My invention relates to heat exchangers and more particularly to a unit which is characterized by certain operating advantages in relation to the more common forms of this device.

Characteristic units are those employed in the production of hot water for domestic or factory purposes wherein the exchanger is inserted through an opening in the wall of a boiler, or it may be submerged in a separate chamber through which the heating fluid is circulated. In such units, the heating surface is provided by tubing which is bent into a helical coil, or may comprise a bank of straight tubes, the ends of the tube or tubes being connected to a header or headers, as the case may be. However the heat exchanger tubing may be arranged, the outside dimensions of the mass of tubing, measured transversely of the tubing, are limited by the size of the opening through which the exchanger is inserted for immersion.

It is therefore one object of my invention to devise a heat exchanger in which the tubes are constructed and arranged to provide the maximum heating surface in relation to the size of opening available in the boiler or other chamber.

A further object is to provide an exchanger as above indicated which is characterized by the maximum heating surface, considering the dimensions of the space occupied by the exchanger when submerged, i. e., the space included between intersecting planes which are tangent to the sides, ends, top and bottom of the mass of tubing.

A further object is to provide an exchanger as above which comprises a stack of coiled tube components which are reversely positioned with respect to each other from the top to the bottom of the heater.

These and further objects of the invention will be set forth in the following specification, reference being had to the accompanying drawings, and the novel means by which said objects are effectuated will be definitely pointed out in the claims.

In the drawings:

Fig. 1 is a schematic elevation showing the application of the heat exchanger to a hot water boiler.

Fig. 2 is an enlarged side elevation of the exchanger as it appears in Fig. 1.

Figs. 3 and 4 are views looking in the directions of the arrows 3 and 4, respectively, in Fig. 2.

Figs. 5 and 6 are, respectively, plan and side views of the uppermost coil as shown in Fig. 2.

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Fig. 7 is a plan view of the coil immediately below the uppermost coil.

By way of example, the heat exchanger, designated generally by the numeral 10 in Fig. 1, will be described as a unit for the production of hot water. However, my invention has general application in the field of heat exchange, including refrigeration, and is not to be limited by the particular application disclosed.

The exchanger 10 includes a header 11 which is suitably attached to the outside of a hot water boiler 12 and has connected thereto inlet and outlet pipes 13 and 14, respectively. A stack or bank of tubes, indicated generally by the numeral 15, extends through an opening 16 in the boiler wall into a water space of the boiler and its lower and upper portions communicate, respectively, with the pipes 13 and 14 as presently described.

The tube stack 15 is composed of a plurality of coils 17 and 18 (see Figs. 2, 5 and 7), each of which is identically bent so far as the principal heat exchange portions thereof are concerned, the alternate coils 17, including the uppermost coil, lying in the same position with respect to each other and the intervening coils 18 turned over 180° in relation to the alternate coils as hereinafter set forth. The uppermost and lowermost coils 17 in the tube stack differ only from the remaining coils in that extensions 19 and 20 are provided for attachment to the header 11 and communication with the pipes 13 and 14, all respectively.

Each coil 17 is flat and possesses an elongated shape, all elements thereof lying in the same horizontal plane with the exception of the extensions 19 and 20 for the uppermost and lowermost coils 17, respectively. Considering the uppermost coil as shown in Figs. 5 and 6, it includes a straight leg 21 which connects at one end with the extension 19 and at the opposite end is reversely bent at 22 from which extends a straight leg 23 that is parallel to and spaced from the leg 21. The leg 23 terminates short of the end of the extension 19 and is reversely bent at 24 towards the leg 21. From the bend 24, a straight leg 25, positioned between the legs 21 and 23, angles towards the bend 22 and is reversely bent at 26 within the bend 22, the bends 22 and 26 being struck from the same center of curvature. A straight leg 27 extends from the bend 26 parallel to the leg 21 and included between the legs 21 and 25, and adjacent the bend 24, the leg 27 is reversely bent downwardly at

28 to lie immediately below the left end of the leg 23, as viewed in Figs. 5 and 6 and as indicated by the numeral 29. The portion 29 is cut off at a convenient location and expanded at 30 to receive the left end of the straight leg 31 of the coil 18 which lies immediately below the coil 17.

Referring to Fig. 7, it will be noted that the coil 18 is bent in the same manner as the coil 17, except that, as assembled in the tube stack, the coil 18 is turned over through an angle of 180° so that it presents the appearance as indicated in Fig. 7. Therefore, in addition to the straight leg 31, the coil 18 successively includes a reverse bend 32, a straight leg 33 parallel to and spaced from the leg 31, a reverse bend 34, a straight leg 35 which angles toward the bend 32, a reverse bend 36 within and struck from the same center of curvature as the bend 32, a straight leg 37 close to and parallel to the leg 31 and included between the legs 31 and 35, and a reverse bend 38 which extends downwardly beneath the adjacent end of the leg 33 to terminate in an expanded extremity 39 for receiving the end of the leg 21 on the underlying coil 17, this coil obviously not including an extension 19.

When the coils 17 and 18 are assembled in the stack shown in Figs. 2 and 3, they are spaced from each other adjacent their respective ends by shims 40. The coils are held in the assembled relation by clamping strips 41 which extend transversely of the upper and lower sides of the corresponding coils adjacent their ends and bridged between the strips 41 at the right end of the stack is a clamping bolt 42 which extends through the openings 43 within the bends 26 and 36, and at the left end a pair of clamping bolts 44 extend through the openings 45 and 46 in the coils 17 and 18 which lie inwardly of the bends 24 and 34, all respectively, and between the legs 21 and 27 in the coil 17 and between the legs 31 and 37 in the coil 18, the legs 21, 27, 31 and 37 being appropriately spaced for this purpose.

In simple terms, the major portion of each coil may be regarded as composed of a number of simple shapes. For example, the coil 17 is formed from a length of continuous tubing, one portion is bent into the shape of a U, including the legs 21 and 23 and the bend 22, while the other portion is bent as a flattened S, including the legs 25 and 27 and the bends 24 and 26, which lies between the legs 21 and 23.

All of the components of each coil are spaced from each other so that the full surface of the tubing is available for heat exchange. The disposition described herein will provide as much as twenty-five per cent more surface in relation to other tubing arrangements now in common use which occupy a comparable space in the fluid to which the exchanger is exposed. A further advantage is that the tube bank is completely drainable by gravity.

I claim:

1. A heat exchanger including a plurality of connected, flat coils placed side by side in spaced and aligned relation to each other, each coil being continuous and elongated in shape and comprising spaced, parallel first and second straight legs, a first reverse bend connecting an end of the first leg to the adjacent end of the second leg, a third straight leg disposed between the first and second legs and connected by a second reverse bend to the other end of the second leg, the third leg angling towards the junction of the second leg with the first bend, and a fourth straight leg disposed between the first and second legs and connected at one end to the third leg by a third reverse bend positioned inwardly of the first bend, the opposite end of the fourth leg being reversely bent and terminating beside said other end of the second leg and said opposite end of the fourth leg being connected to the first leg on the adjacent coil, all of the legs in each coil lying substantially in the same plane, the angling of the third leg in each coil defining on opposite sides thereof triangular openings with the second and fourth legs and the alternate and intervening coils being relatively positioned so that the third legs therein respectively angle in different directions whereby the third and fourth legs in each coil substantially register with said openings, respectively, in the immediately adjacent coils to increase turbulent flow in the fluid passing over the coils.



2. A heat exchanger including a plurality of connected flat coils spaced from each other and arranged in aligned stack formation, each coil being continuous and comprising spaced, parallel first and second legs, a first reverse bend connecting an end of the first leg to the adjacent end of the second leg, a third leg disposed between the first and second legs and connected by a second reverse bend to the other end of the second leg, the third leg angling towards the junction of the second leg with the first bend, and a fourth leg disposed between the first and second legs and connected at one end to the third leg by a third reverse bend positioned inwardly of the first bend, the opposite end of the fourth leg being reversely bent and terminating beneath said other end of the second leg and said opposite end of the fourth leg being connected to the first leg on the adjacent coil, all of the legs in each coil lying substantially in the same plane, the angling of the third leg in each coil defining on opposite sides thereof triangular openings with the second and fourth legs and the alternate and intervening coils being relatively positioned so that the third legs therein respectively angle in different directions whereby the third and fourth legs in each coil substantially register with said openings, respectively, in the immediately adjacent coils to increase turbulent flow in the fluid passing over the coils.

MAURICE H. HOFMEISTER.


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