Jan. 24, 1939. J. C. HERSEY 2,145,084

HEAT EXCHANGE APPARATUS

Filed Feb. 9, 1937 2 Sheets-Sheet 1

Fig. 1.

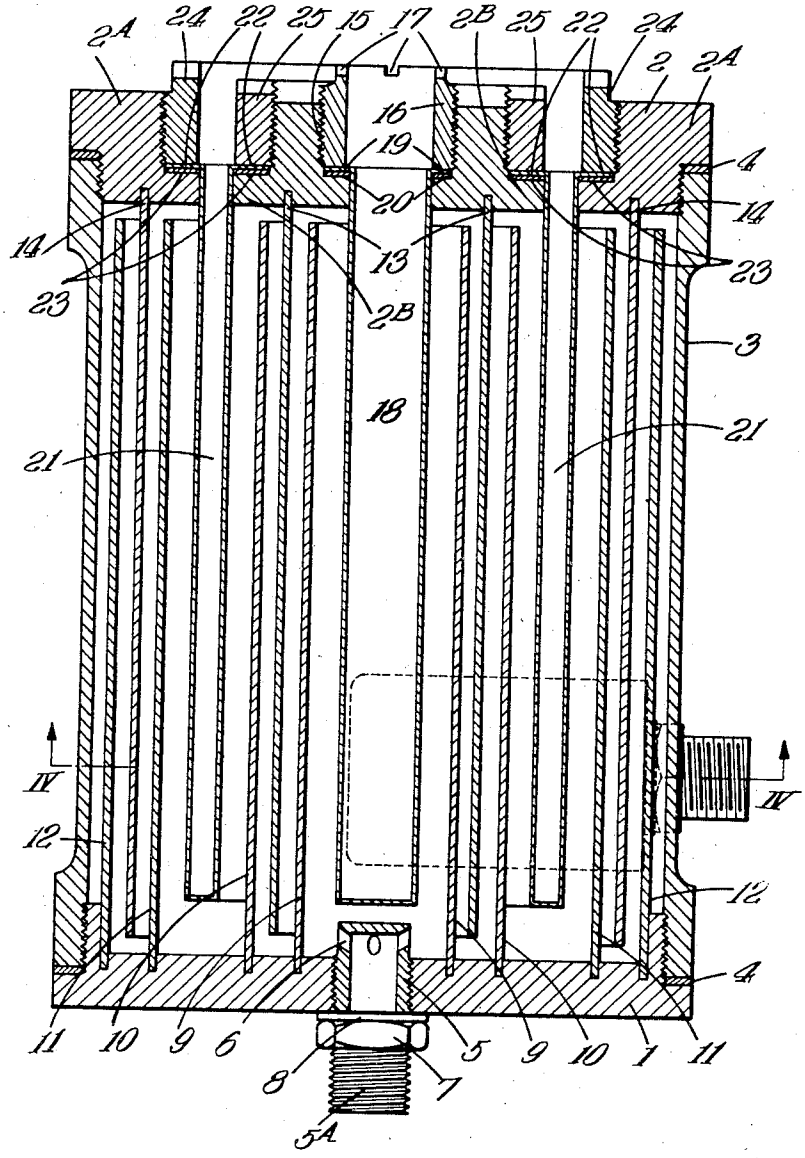
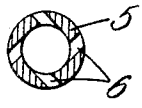


Fig. 2.



INVENTOR:
JOHN CRONIN HERSEY
BY Haseltine, Lake & Co.
ATTORNEYS

Jan. 24, 1939. J. C. HERSEY 2,145,084

HEAT EXCHANGE APPARATUS

Filed Feb. 9, 1937 2 Sheets-Sheet 2

Fig. 3.

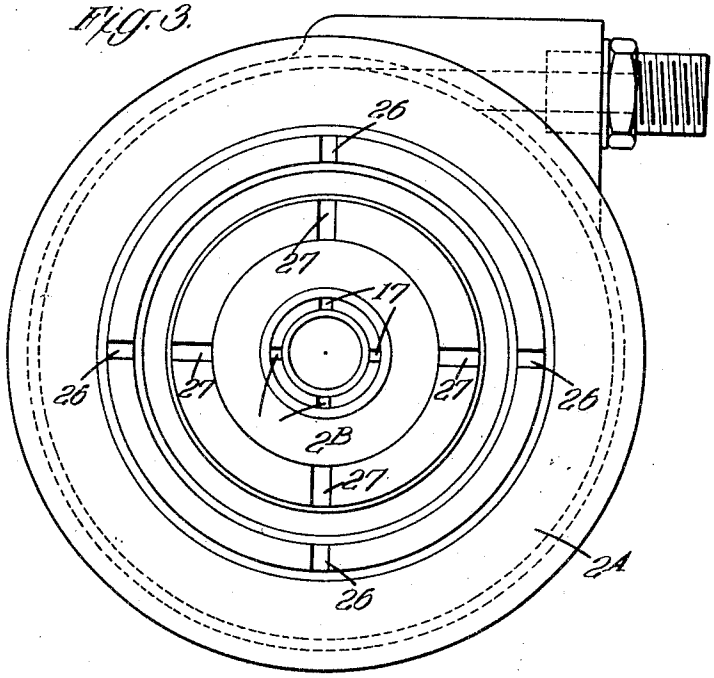
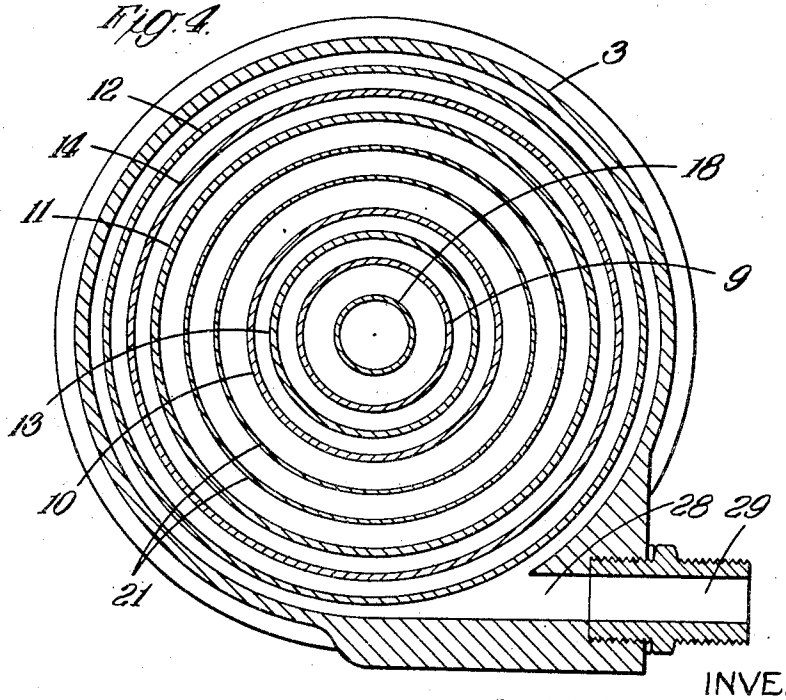


Fig. 4.



INVENTOR:
JOHN CRONIN HERSEY
BY Haseltine, Lake & Co.
ATTORNEYS

Patented Jan. 24, 1939 2,145,084

UNITED STATES PATENT OFFICE

2,145,084

HEAT EXCHANGE APPARATUS

John Cronin Hersey, Welwyn Garden City, England

Application February 9, 1937, Serial No. 124,798
In Great Britain February 12, 1936

5 Claims. (Cl. 257—232)

This invention relates to heat-exchange apparatus of the type comprising a plurality of chambers nested one within the other and arranged to be inter-communicating at points alternately at opposite ends of the chambers, heating means being located within the chambers so as to lie in the path of fluid flowing through one chamber to the next and there being means for feeding and withdrawing fluid so that it may pass through some or all of the chambers successively. In this type of heat exchanger the nested chambers are formed by cylindrical partitions arranged so as to be substantially coaxial, whereby fluid introduced into the apparatus may follow a sinuous path travelling through one chamber constituted by the cylindrical space located between adjacent cylindrical partitions to the next chamber.

With heat exchange apparatus of this type it is found that difficulty is experienced in repairing the heating elements which are usually the parts of the apparatus liable to deterioration, such difficulties arising through inaccessibility of the heating means. It is a primary object of the invention to overcome this difficulty.

In accordance with the invention there is provided a heat-exchange apparatus of the type referred to, wherein the heating means is removably located in one or more casings, the (or each) such casing totally enclosing the associated heating means except for one end of the casing which forms the mouth of the same, and wherein the end wall of the apparatus on which a casing is supported is formed in a plurality of parts which are united by being connected removably around the margins of the mouth of the casing (or mouths of the casings) as the case may be, whereby such end wall is effectively continuous and the heating element or elements may be readily withdrawn from the casing or casings, or the latter removed at will by disassembling the end wall.

In order that the said invention may be clearly understood and readily carried into effect, the same will now be described more fully with reference to the accompanying drawings, in which:—

Figure 1 is a longitudinal section through a heat exchange apparatus in accordance with the invention;

Figure 2 is a sectional view of a detail of the apparatus shown in Figure 1;

Figure 3 is a plan view of the apparatus shown in Figure 1, and

Figure 4 is a sectional view on the line IV—IV of Figure 1 as seen in the direction indicated by the arrows.

The illustrated apparatus is intended more particularly for the heating of water. There is a base or end plate 1, and a multi-part top plate 2. Both the plates are of circular shape, and are joined by a cylindrical connecting member 3. The member 3 is internally screw-threaded at both ends to co-operate with external screw-threading formed upon the plates 1 and 2. In order to afford a liquid-tight joint between the member 3 and the plates 1 and 2, washers 4 are interposed. The plate 1 has a central aperture into which there is screwed a feed nozzle 5. A sectional view through the nozzle 5 is shown in Figure 2, and it will be seen that feed openings 6 are formed in the nozzle. As shown in Figure 1, the openings 6 are inclined upwardly from the hollow centre of the feed nozzle to the exterior thereof, and from Figure 2 it can be seen that the openings are set tangentially to the nozzle. The feed nozzle 5 is locked in position on the plate 1 by means of a lock nut 7 and interposed washer 8. The threaded lower portion 5A of the nozzle then serves as one part of a connecting union for a feed pipe.

Around the feed nozzle 5, there is carried by the plate 1 a cylindrical partition 9. The partition 9 is of such length that there is a small clearance between its upper end and the interior adjacent wall of the upper end plate 2. A concentric partition 10 is also carried by the plate 1, there being further partitions of a like kind, 11 and 12. All the concentric partitions carried by the end plate 1 terminate short of the end plate 2. The end plate 2 also carries two cylindrical and concentrically positioned partitions 13 and 14. The end plate 2 is formed with a central aperture which is opened to a larger diameter at the exterior side of the plate. The portion of the aperture of larger diameter is internally screw-threaded as at 15, to receive an externally screw-threaded sleeve 16. The sleeve 16 has grooves 17 cut across its top face for the reception of a turn-key. A cylindrical shell or casing 18 formed with a flanged mouth 19, is held in the central aperture of the plate 2, there being a suitable packing piece 20 located between the shoulder of the plate and the flanged mouth 19 of the casing 18. The lower end of the cylindrical casing 18 is closed, but at its upper end it is left free for the insertion of a heating element.

The multi-part upper end plate 2 is made in two distinct parts 2A and 2B. The part 2B is formed as an inverted T-section annulus, whilst the part 2A is made as a substantially S-section annulus, the two parts being connected one to the other by means of a cylindrical hollow shell 21.

The shell 21 fits between the partitions 10 and 11 carried by the lower end plate 1, and has a flanged mouth 22 seated upon packing washers 23. A nut member 24 of annular form is arranged to engage screw-threading upon the part 2A and to hold one side of the flanged mouth of the shell upon its seating in the member 2A. A further annular nut member 25 engages screw-threading upon the part 2B of the top end plate, and presses the other side of the flanged mouth of the shell 21 upon its seating. The upper surfaces of both the nut members 24 and 25 are formed with grooves 26 and 27 to allow a turn-key to be brought into operation on the nuts for the purpose of tightening or withdrawing them.

As may be seen from Figure 4 of the drawings, the external connecting wall 3 is formed at one point with a portion of increased thickness, such portion having an axial bore 28. The bore 28 is shouldered back near its outer end and is internally screw-threaded to receive part of a connecting union 29. The bore 28 opens into the chamber formed between the outer wall 3 and the partition 12.

When the apparatus is in use for the purpose of heating water, electric or other heating means are disposed within the cylindrical casing 18 and the shell 21. The shell 21 may, for example, receive an electrical heating element made in two semi-cylindrical parts, whilst the casing 18 may receive a rod type heating element. The water inlet pipe is connected at 5A and water issues through the apertures 6, the arrangement and formation of the apertures as described, being such that the water swirls around in the space between the partition 9 and the cylindrical casing 18. The water rises in such space whilst being in contact with the heating surface of the casing 18. At the top of the partition 9 the water escapes downwardly through the space between the partition 9 and the partition 13, and then rises through the space between the partition 13 and the partition 10 to begin a downflow movement in the space between said partition 10 and the interior wall of the shell 21. The wall of the shell 21 is heated so that the water rises in temperature in flowing past this surface. The water flows beneath the shell 21 at its lower end, and then rises between the outside wall of the shell and the partition 11. The water finally escapes by rising over the top of the partition 11, travelling down the space between said partition 11 and the next partition 14, rising upwardly between the partition 14 and the partition 12 and lastly, travelling downwardly between the partition 12 and the exterior wall 3 to the outlet channel 28. It will thus be understood that the partitions 9—14 and the shell 21 form chambers nested one within the other and intercommunicating alternately at their top and bottom ends. The water in flowing from one chamber to the next thus has to follow a sinuous path and to flow past the heating means. It is important that the water should follow the sinuous path indicated even when not directly in contact with the shell 21 or the casing 18. This is true for the reason that with the design of the apparatus described, a high temperature will normally be reached at the centre of the apparatus. It is, as far as possible, desirable that there should be a fairly even fall in temperature from the centre of the apparatus toward the outside cylindrical walls thereof in order that no considerable amount of heat shall be lost in radiation and, as far as possible, all heat absorbed by the water flowing through the apparatus. The partitions 9, 13 and 10 become, to a certain extent, heated due to conduction through the end walls of the apparatus and, therefore, the sinuous path that has to be followed by the water in flowing between such partitions results in a gain in thermal efficiency, due to the taking up of that heat which escapes by conduction from the centre of the apparatus towards the peripheral walls thereof. The partitions 11, 14 and 12, perform a similar function and again tend to increase thermal efficiency.

In order to effect a maximum heat transfer, the external and internal surfaces of the casing 18 and the shell 21, are preferably mat and black-anodized when such casing and shell are made from aluminium or its alloys. Furthermore all the surfaces of the partitions are preferably mat and anodized, although not necessarily black-anodized, if such partitions are also of aluminium or its alloys.

It will be clear that the apparatus described above may be used for the heating of all fluids whether gaseous or liquid, and that if desired the apparatus may be used for the cooling of fluids, merely by the substitution of cooling media in place of the heating elements in the casing 18 and the cylindrical shell 21. For this reason the expression "heat-exchanging means" has been used in the appended claims to include both heating and cooling means. The apparatus described above also lends itself to an arrangement for vaporizing or atomizing liquids, or for the carburation of liquid fuels. Thus air might be introduced at the inlet side of the apparatus, such air passing the casing 18 which in this instance has a heating element arranged within it. The heated air passing through the intermediate passages before contact with the shell 21 may be arranged to encounter a flow of petrol or like vaporizable fuel, the mixture thus formed being further heated by contact with the shell 21 which in this instance would also contain a heating element or elements. The outlet from the apparatus then supplies the mixture to an internal combustion engine.

The invention will also be found of value in the pre-heating of fuel for Diesel engines.

The apparatus described above may be modified in its constructional form in order to comply with the requirements of its use, and furthermore the exterior wall may be lagged to increase the efficiency. The thickness of the partitions may be increased or decreased towards the exterior of the apparatus, and also the spacing between the partitions may be decreased or increased towards the exterior.

The concentric and cylindrical arrangement of the partitions and outer wall may be varied without departing from the spirit of the invention. Furthermore, the multipart end plate may be formed in more than two parts and a correspondingly increased number of cylindrical shells employed. Inlet and outlet openings may be disposed at various points in the apparatus, and may be more numerous than indicated in the drawings. In particular it may be desirable to utilize the central aperture having the feed nozzle 5, as the outlet and the bore 28 as the inlet, a swirling inflow being still obtained by virtue of the tangential setting of the bore 28. Any number of heating elements or sources of heat may be employed in casings or shells such as 21 or 18, and the central casing 18 dispensed with if desirable.

It is noteworthy that with the apparatus described above, the heating elements are not di-

rectly immersed in the liquid to be treated. The elements may in fact be removed from their protective casings without disturbing the passage of liquid through the apparatus. Further, the protective casings may be removed by disassembling the multi-part end wall of the apparatus.

The term "chamber" as used herein and in the claims that follow is to be read as meaning the space that is bounded by a partition and an adjacent partition, or a partition and the adjacent exterior walls of the apparatus.

What I claim and desire to secure by Letters Patent of the United States is:—

1. A heat-exchange apparatus comprising a plurality of inter-communicating nested chambers, a pair of end walls common to the chambers, at least one of said end walls being multi-part, at least one casing formed as a container for heat-exchanging means, said casing being totally closed except for the mouth thereof, releasable connections between the margins of the mouth of said casing and the parts constituting said multipart end wall whereby the latter is effectively continuous, and an inlet and an outlet for the introduction and withdrawal of fluid to be passed through said chambers.

2. A heat-exchange apparatus comprising a pair of end walls of which at least one is multi-part, a plurality of nested partitions, adjacent partitions being alternately secured, one to one end wall and the other to the other end wall, all said partitions terminating short of the end wall opposite that to which they are secured, at least one casing formed for the heat-exchanging means, said casing being totally enclosed, except for the mouth thereof, releasable connections between the margins of the mouth of said casing and the parts constituting said multipart end wall, whereby the latter is effectively continuous, and an inlet and an outlet for the introduction and withdrawal of fluid to be passed through the spaces between said partitions.

3. A heat-exchange apparatus comprising a plurality of concentrically disposed cylindrical partitions, a pair of circular ends walls, of which at least one is multi-part, each of said partitions having one end secured to one of said end walls, the free end of such partitions terminating short of the corresponding end wall, an enclosing cylindrical wall secured at each end around the peripheries of the said end members, at least one casing formed as a container for the heat-exchanging means and located concentrically with said partitions, said casing being totally closed except for the mouth thereof, releasable connections between the margins of the mouth of said casing and the parts constituting said multi-part end wall, whereby the latter is effectively continuous, and an inlet and an outlet for the introduction and withdrawal of fluid to be passed through the spaces between the partitions.

4. A heat-exchange apparatus comprising a plurality of concentrically located cylindrical partitions, a pair of circular end walls, of which at least one is multi-part, each of said partitions having one end secured to one of said end walls, so that adjacent partitions have their opposite ends secured to an end wall, the free ends of such partitions terminating short of the corresponding end wall, an enclosing cylindrical wall secured at each end around the peripheries of said end members, a cylindrical casing located at the centre of said concentric partitions, at least one annular casing located to be concentric with said partitions, both said casings being for the reception of heat-exchanging means and being totally enclosed, except for the mouths thereof, releasable connections between the margins of the mouths of said casings and the parts constituting said multi-part end wall, whereby the latter is effectively continuous, and an inlet and an outlet for the introduction and withdrawal of fluid to be passed through the spaces between the partitions.

5. A heat-exchange apparatus comprising a plurality of inter-communicating nested chambers, a pair of end walls common to the chambers, at least one of said end walls being multi-part, at least one casing formed as a container for heat-exchanging means, said casing being totally closed, except for the mouth thereof, flanges upon the margins of the mouth of said casing, seatings formed upon the parts of said multi-part end wall, and locking rings formed to hold said margins and thus to position the parts of said multi-part end wall, whereby the latter is effectively continuous, and an inlet and an outlet for the introduction and withdrawal of fluid to be passed through said chambers.

JOHN CRONIN HERSEY.