A. D. HARRISON.

HEAT EXCHANGING APPARATUS.

APPLICATION FILED JULY 9, 1918.

1,325,637.

Patented Dec. 23, 1919.

3 SHEETS—SHEET 1.

Fig. 1.

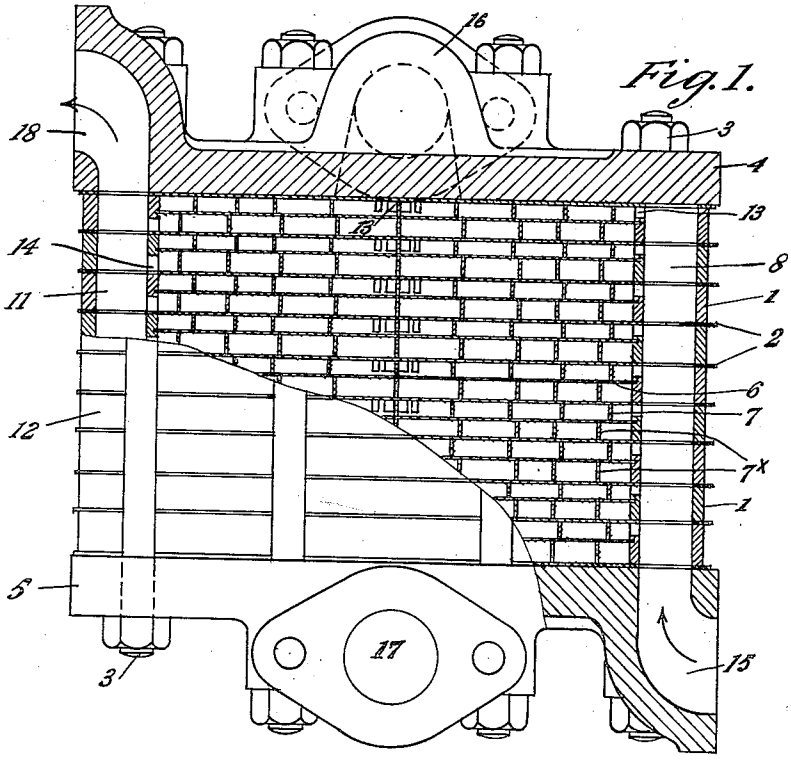
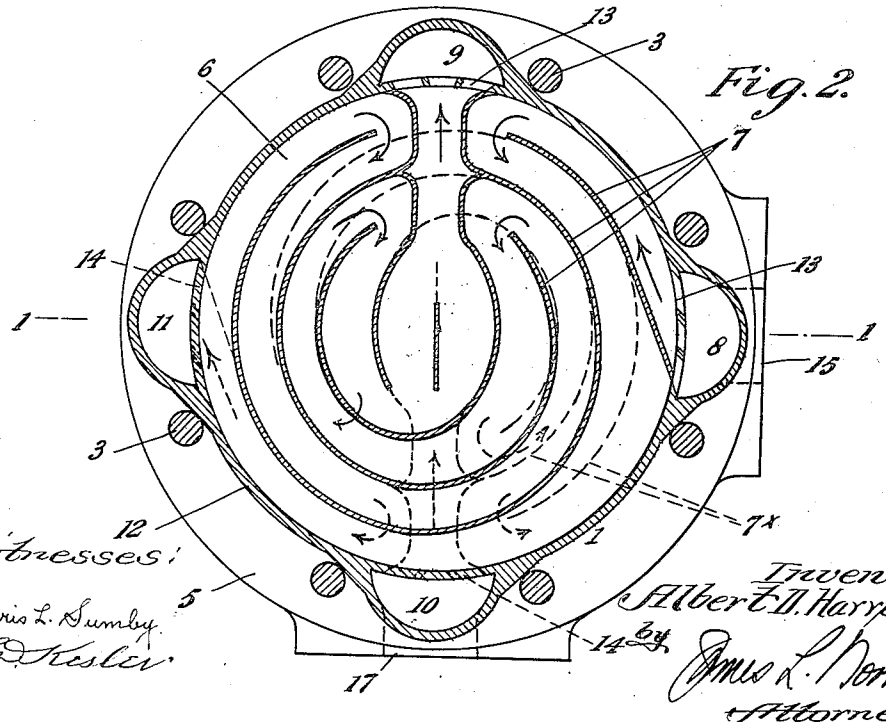


Fig. 2.



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3 SHEETS—SHEET 2.

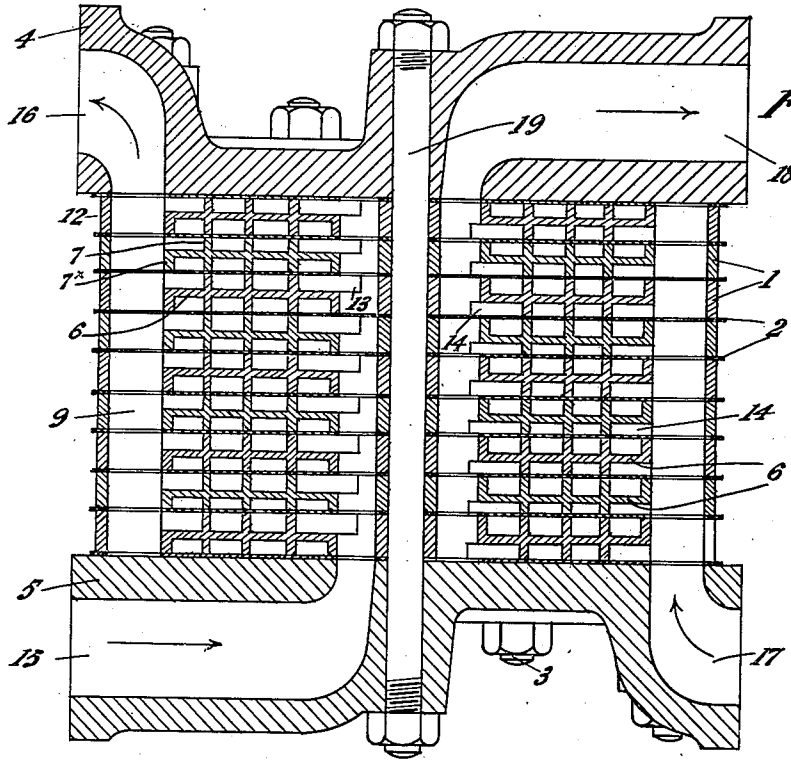


Fig. 3.

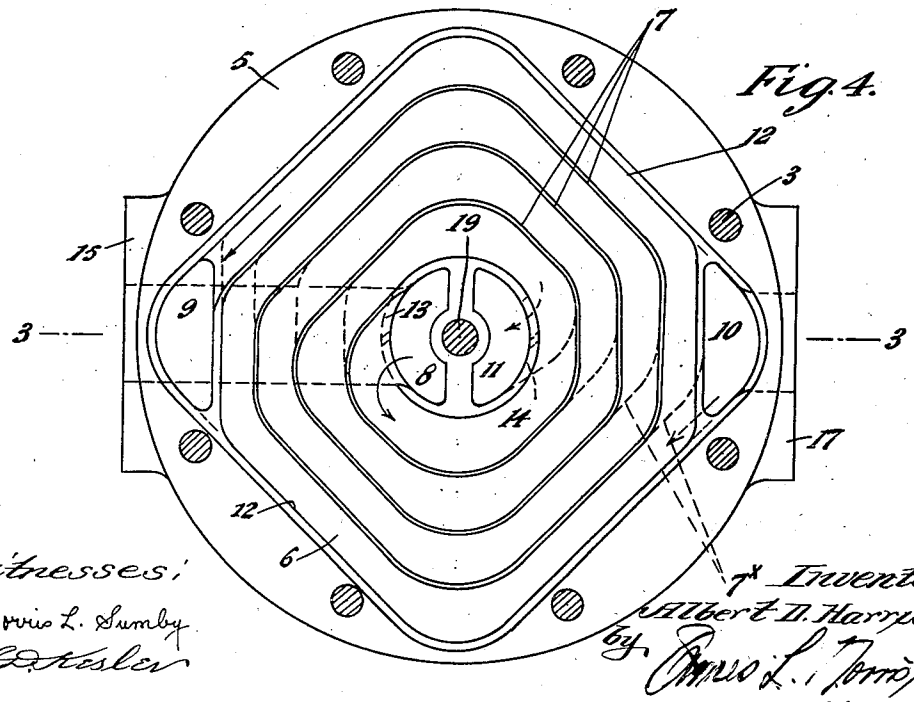


Fig. 4.

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3 SHEETS—SHEET 3.

Fig. 8.

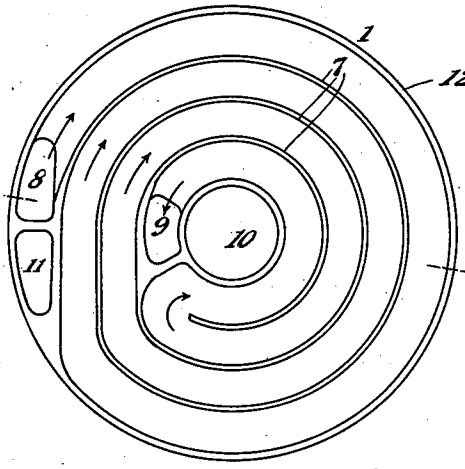


Fig. 9.

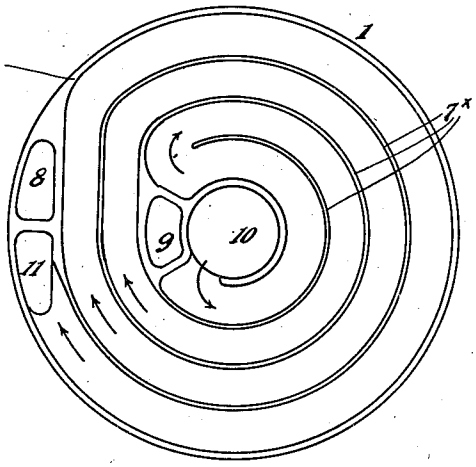


Fig. 10.

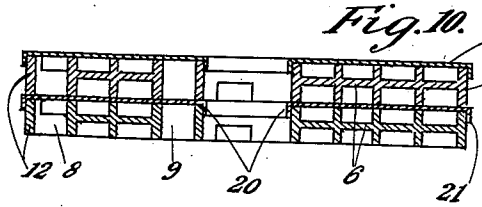


Fig. 5.

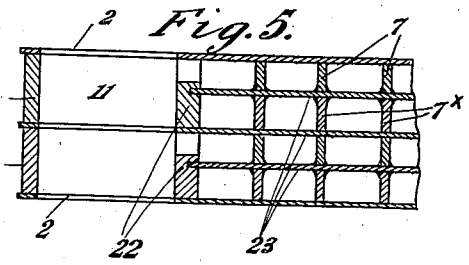


Fig. 7.

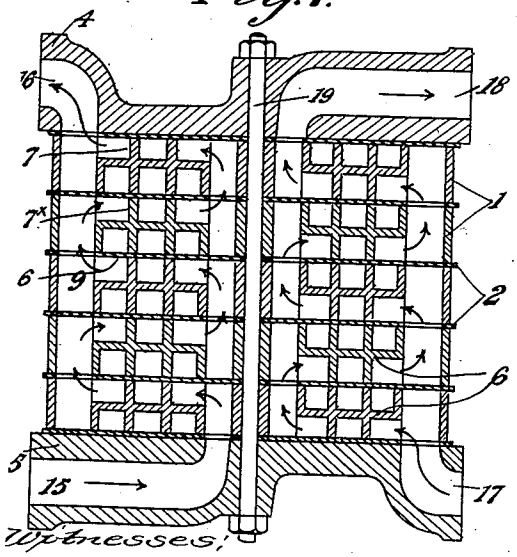
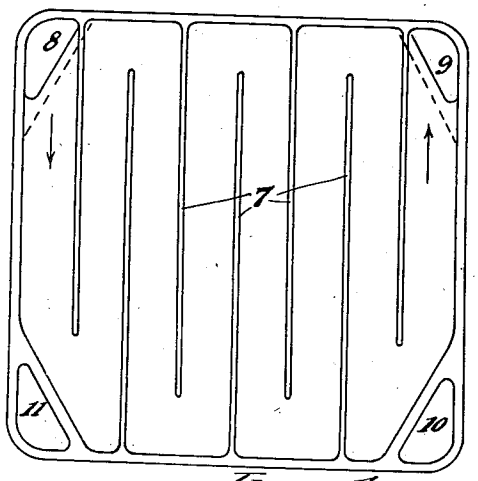


Fig. 6.



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UNITED STATES PATENT OFFICE.

ALBERT DEX HARRISON, OF MARPLE, ENGLAND.

HEAT-EXCHANGING APPARATUS.

1,325,637. Specification of Letters Patent. Patented Dec. 23, 1919.

Application filed July 9, 1918. Serial No. 244,081.

To all whom it may concern:

Be it known that I, ALBERT DEX HARRISON, a subject of the King of Great Britain, residing in Marple, England, have invented certain new and useful Improvements in Heat-Exchanging Apparatus, of which the following is a specification.

My invention relates to apparatus for the transmission or exchange of heat between two fluids, of the type wherein two sets of plate elements are arranged alternately, face to face, to constitute a nest or pile and are clamped between end plates or covers by bolts, the plates included in the said elements being held apart by flanges and distance pieces or ribs, which may be either separate from or integral with the plates and are so arranged that a succession of chambers or compartments is formed between the plates, and wherein the two fluids passing through four inlet and outlet connections on the end covers flow respectively through adjacent compartments, and means are provided to prevent the fluids coming into contact with each other.

The invention consists in improved construction and arrangement of parts in such apparatus, the object being to provide a simple form of apparatus particularly applicable to the case in which the fluids are in liquid form.

In one known form of heat interchanging apparatus similar to the above kind of apparatus but in which, while one of the fluids makes its entry and exit from one set of compartments by means of inlet and outlet passages provided respectively in the two end plates or covers, the other fluid is introduced into its set of compartments through openings in the sides of the nest of plate elements, each plate element near two of its edges, for instance near both its upper and lower edge, is formed with an aperture, the plates being assembled so that the apertures at the lower edges are coaxial and form a pocket which is an extension of the said inlet passage, the upper apertures of the plates being likewise disposed to constitute a second pocket which is an extension of the said outlet passage. In such a construction the fluid entering the inlet pocket is enabled to reach the outlet pocket by flowing through one compartment only and without traversing all the other compartments.

In constructing my improved apparatus I provide therein four pockets, two for the conduct of one of the fluids and two for the conduct of the other fluid, and to this end the plates of alternate plate elements, that is to say the plates of one set of elements, are formed each with four apertures or holes, two of which constitute respectively an inlet and an outlet for one of the fluids in its passage through a compartment adjacent to one face of the plate and two form an inlet and an outlet for the other fluid to and from the compartment on the other face of the plate. The plates of the intermediate plate elements, or second set of elements, are provided with two or more holes, the number varying according to the length of path that a fluid is required to traverse in passing through the apparatus. The fluids on issuing from the respective inlet pockets enter passages which are formed by the ribs on the faces of the plates. The flanges between the plates of the plate elements extend around the holes in the plates and are cut away to permit the passages formed by the ribs to communicate with the hole from or to which it is desired a fluid should flow. The ribs are so arranged that each passage is of a spiral, circuitous or zigzag nature and, traversing the whole surface of a plate, is of comparatively long length. Fluid entering a plate passage from an inlet pocket is thus caused to flow over the whole surface of the plate before reaching the outlet hole.

The pockets in the improved apparatus may each be either continuous from end to end between the end covers, or divided along its length into sections according as the fluid traversing it is required to pass one or more times over the surfaces of the plates.

The improved construction, though designed more especially for dealing with liquids may, however, with advantage be used for the cooling or heating of air where, on account of the relatively poor heat transmission factor, the passages are required to be much longer than in the case of steam having a high transmission factor.

To enable the invention to be fully understood it will now be described with reference to the accompanying drawings as applied to an oil cooler, in which Figure 1 is an elevation partly in section on line 1—1 of Fig. 2, of an oil cooler constructed in accordance with this invention; Fig. 2 is a plan of Fig. 1 with the top plate or cover removed; Fig. 3 is a sectional elevation on

line 3—3 of Fig. 4 of a modified form of oil cooler; Fig. 4 is a plan of Fig. 3 with the top plate or cover removed; Fig. 5 is a section on an enlarged scale of two assembled plates as shown in Figs. 1 and 2; Fig. 6 is a plan of a further modified form of plate; Fig. 7 is a sectional elevation of a modification of the construction shown in Fig. 3; Fig. 8 is a plan of one side of a modified form of plate element; Fig. 9 being a plan of the reverse side thereof; and Fig. 10 is a sectional elevation of two plate elements of the modified form shown in Figs. 8 and 9 assembled alternately with elements consisting each of a flat rolled plate furnished with flanges.

In the several figures corresponding parts are denoted by corresponding reference numerals.

The oil cooler illustrated in Figs. 1 and 2 is built up of a plurality of elements 1 and 2 clamped together by bolts 3 between end covers 4 and 5. The elements 1 consist of a plate 6 furnished on its two sides with ribs 7 and 7× respectively, and with four apertures which when the elements are assembled form four pockets 8, 9, 10 and 11, the positions of which vary according to the type of plate employed. A flange 12 surrounds the plate 6 and the several apertures therein, the depth of such flanges being equal to the depth of the ribs 7, 7× on the two sides of the plate respectively.

The element 2 consists of a plain rolled plate furnished with apertures corresponding to those in the element 1.

In Fig. 2 the full lines indicate the ribs 7 forming by and between them a series of spiral or approximately spiral passages which connect the oil inlet pocket 8 with the oil outlet pocket 9 and the dotted lines the ribs 7× forming by and between them similar passages which connect the water inlet pocket 10 with the water outlet pocket 11. The passages are arranged so that the flow of the respective liquids is reversed while passing through said passages.

Communication between the several pockets and their respective passages is obtained by the provision of apertures 13 and 14 respectively in the flange 12.

When the elements 1 and 2 are placed alternately one above the other as shown in Fig. 1 a continuous passage is produced on the upper face of plate 1 connecting oil inlet pocket 8 with oil outlet pocket 9, while a similar passage is produced on the lower face of the same plate connecting the water inlet pocket 10 with the water outlet pocket 11. The oil cooler is built up by arranging any desired number of plates 1 and 2 alternately in the above manner; the clamping bolts 3 pass on the outside of the plates and through holes provided on the end covers and serve to clamp the plates tightly together preventing leakage through the joints made by the flanges 12.

The oil is introduced at connection 15 and enters the oil inlet pocket 8 from which it is allowed to enter the oil passages through apertures 13 and after circulating over the plate along a circuitous path leading to the center, it flows radially to the oil outlet pocket 9 which connects with the oil outlet connection 16. Similarly, water enters at connection 17 and into water pocket 10 from which through apertures 14 it flows radially to the center of the plate and afterward by spirally disposed passages it enters the water outlet pocket 11 and is discharged at the water outlet connection 18.

The construction shown in Figs. 3 and 4 varies from that already described in that the flow of the liquids is not reversed in the passages and the oil inlet and the water outlet pockets 8 and 11, respectively, are located in the center of the plate instead of at the periphery. The joints to prevent leakage from these pockets are made by a centrally disposed bolt 19.

Fig. 5 illustrates one method of building up one of the elements 1 shown in Figs. 1 and 2. According to this arrangement a cast or rolled metal band 22 of the required shape is furnished on its internal face with a groove adapted to receive a plate 23. The pockets 8, 9, 10 and 11 are formed by strips 24 secured in the desired positions to the band 22 in any known manner. The ribs 7, 7× are formed of strips bent to the required shape and secured to the plate 23 in any desired manner such as by brazing or soldering.

Fig. 6 illustrates a modified form of plate element 1 in which straight passages are formed for the oil and water which follow a zigzag path, the water passages on the reverse side of the plate being similarly arranged, such passages commencing and finishing at the pockets not occupied by the oil. While the construction is somewhat simplified the resistance to the flow of the liquid is somewhat increased beyond that in the case of plates of the forms as described above.

In the plate element 1 shown in Figs. 3 and 4 the required flanges 12 and ribs 7, 7× are cast in one with the plate 6.

It will be evident that the channels for the passage of the fluids between adjacent plate elements may be variously formed, and although these passages are shown in the several figures of the drawings as being formed by ribs on both sides of the plates of one set only of plate elements, the other plate elements being plain or unribbed, it must be understood that this is only one way of forming the fluid passages between

adjacent plate elements and that the invention is not to be considered as being restricted thereto.

If desired, instead of the plates all being arranged in parallel as in the constructions above described, so that the fluids pass only across one plate in their passage between the inlet and outlet connections, they may be formed and arranged so that one or other or both of the fluids will before reaching an outlet pocket pass over two or more plates, that is, will pass over the plates in series. Such an arrangement is shown in Fig. 7, in which each of the plate elements 1 has four holes and plate elements 2 two apertures or holes only.

In this construction it will be seen that the liquids are compelled to pass first over one plate and then over the one above and so on right through the complete series, before being delivered respectively to the connections 16 and 18 in the top cover. The direction of flow of the fluids can be reversed if a contra-flow arrangement of the fluids is desired.

Many modifications can be made to the flow of the fluids by suitably placing plain plate elements 2 having two, three or four holes. Thus by placing a plate element 2 having two holes midway between the covers, the remainder of the plates having four holes, the fluids are caused to pass over one half of the plates and then over the other half, the positions of the outlet connections being accordingly altered.

Again, by using plate elements 2 provided with three holes, one fluid may be caused to flow over the plates in series and the second fluid in parallel.

Such constructions and arrangements of plates render it possible to deal with any number of fluids.

The plate elements may be produced by pressing, die-casting or stamping without departing from the principle of this invention.

In plate elements 1, formed as shown in Figs. 8 and 9, the holes or pockets are so disposed that the plates themselves may be circular and have a central round hole. Fig. 8 shows the arrangement of the pockets and passages through which the oil is caused to flow, and Fig. 9, the reverse side of the same plate, illustrates the water passages.

Fig. 10 shows the plate element 1 in Figs. 8 and 9 assembled alternately with a plane plate element 2 having external and internal flanges. The element 1 is turned on the outside and bored, while plate element 2 has flanges adapted to fit over the outer and inner edges of element 1. These flanges can be formed by pressing, stamping or spinning, the object being to provide an improved means of making the inner and outer joints between the two elements.

Having thus described the nature of the said invention and the best means I know of carrying the same into practical effect, I claim: —

1. Apparatus for the transmission or exchange of heat between two fluids comprising two sets of plate elements, fluid passages formed by ribs between adjacent plate elements, said ribs being so disposed that each of said passages traverses the whole surface on one side of a plate, four sets of coaxial apertures in the plate elements forming fluid pockets, passages connecting half of said pockets with alternate fluid passages, and passages connecting remainder of pockets with remainder of fluid passages, substantially as and for the purpose herein set forth.

2. Apparatus for the transmission or exchange of heat between two fluids, comprising two sets of plate elements, fluid passages formed by ribs between adjacent plate elements, said ribs being disposed to cause reversals of direction of flow of the fluids in traversing the fluid passages, four sets of coaxial apertures in the plate elements forming fluid pockets, passages connecting half of said pockets with alternate fluid passages, and passages connecting remainder of pockets with remainder of fluid passages, substantially as and for the purpose herein set forth.

3. Apparatus for the transmission or exchange of heat between two fluids comprising two sets of plate elements, fluid passages formed by ribs between adjacent plate elements, said ribs being so disposed that each of said passages traverses the whole surface on one side of a plate and causes reversals of the fluids traversing the fluid passages, four sets of coaxial apertures in the plate elements forming fluid pockets, passages connecting half of said pockets with alternate fluid passages, and passages connecting remainder of pockets with remainder of fluid passages, substantially as and for the purpose herein set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ALBERT DEX HARRISON.

Witnesses:

OLIVER IMRAY,

C. S. HOPKINS.