Sept. 6, 1938. O. W. MOJONNIER ET AL 2,129,473

HEAT EXCHANGE ELEMENT

Original Filed May 7, 1934 3 Sheets-Sheet 1

Fig. 1.

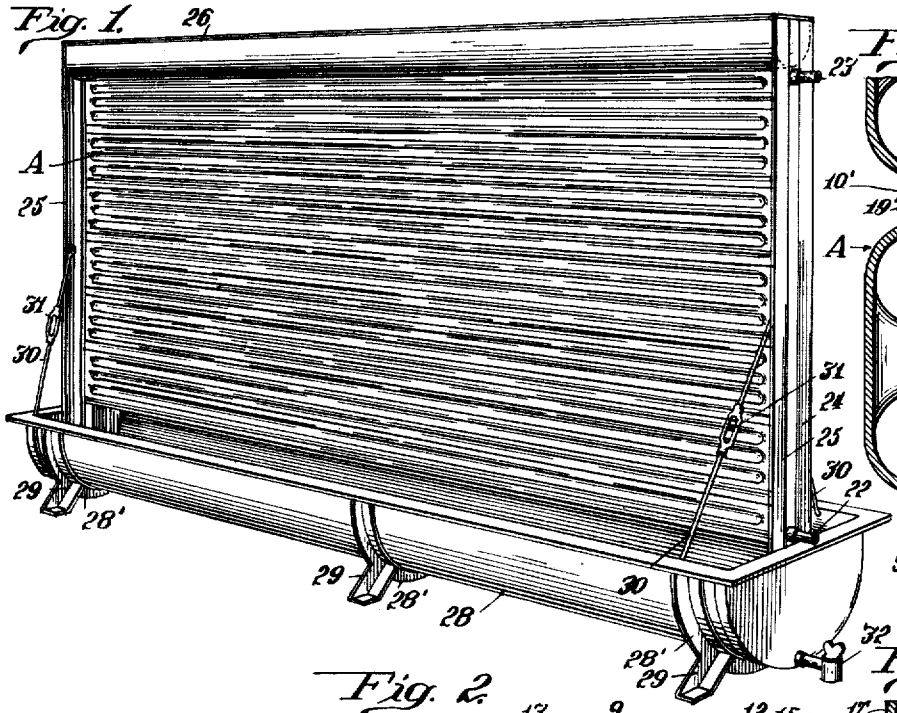


Fig. 3.

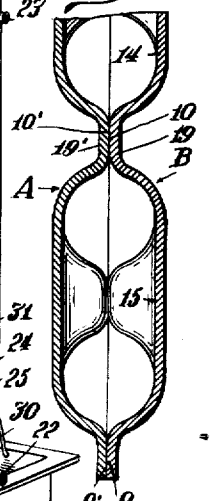


Fig. 2.

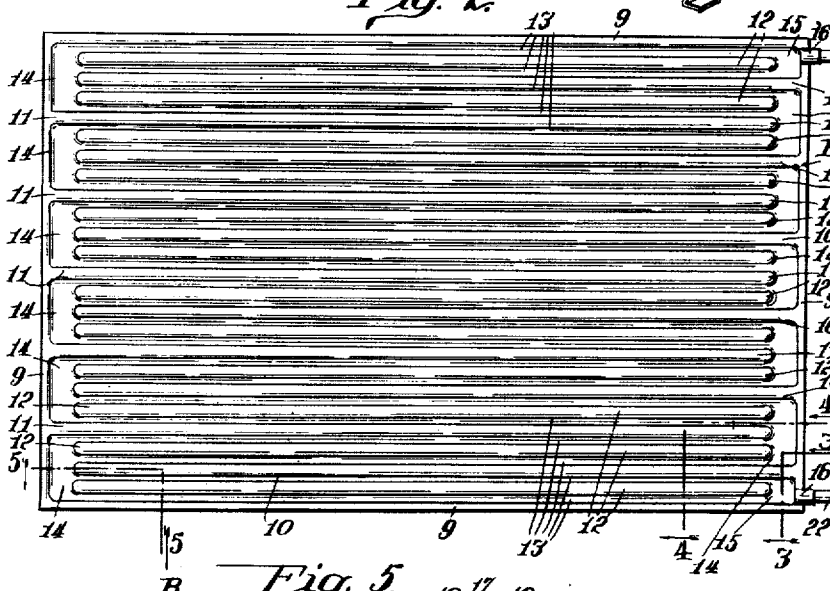


Fig. 4.

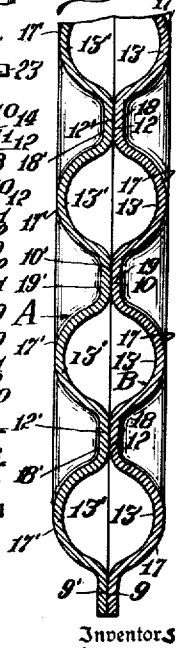
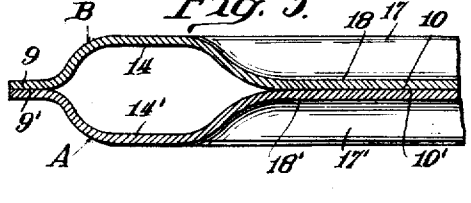


Fig. 5.



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Fig. 6.

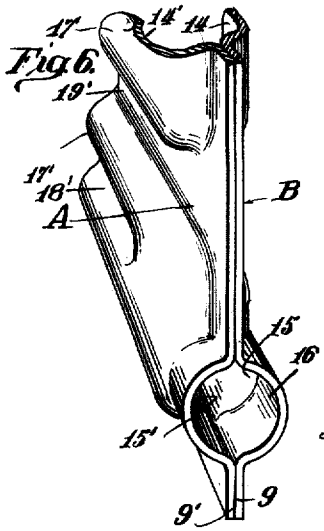


Fig. 8.

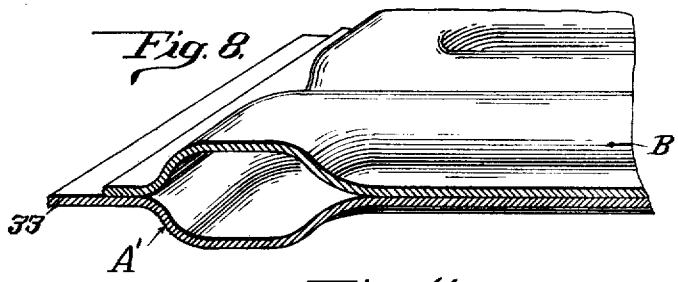


Fig. 11.

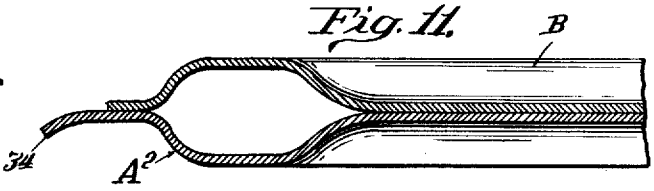


Fig. 7.

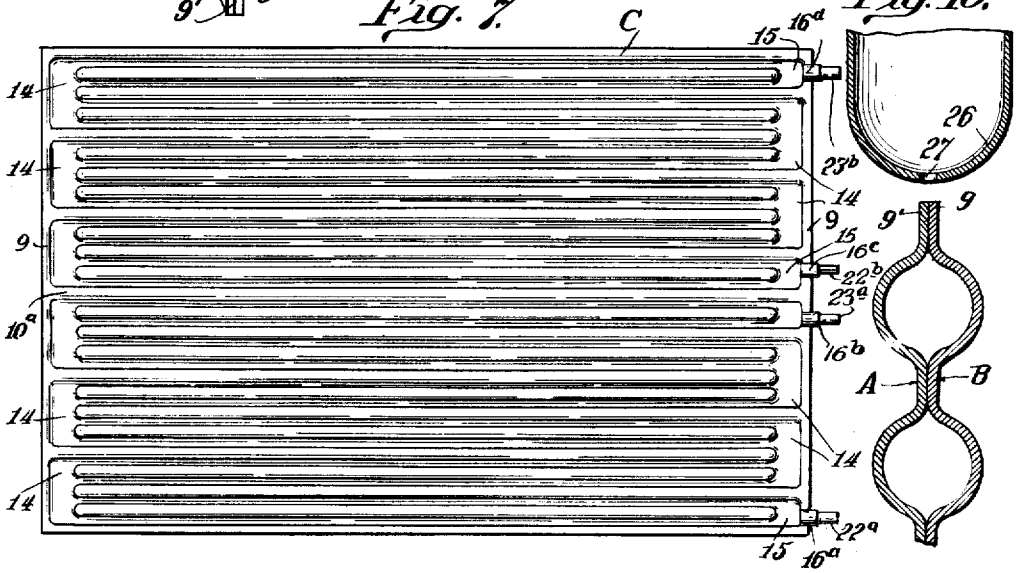
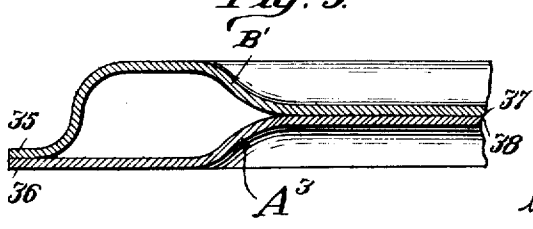


Fig. 10.

Fig. 9.



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Fig. 12.

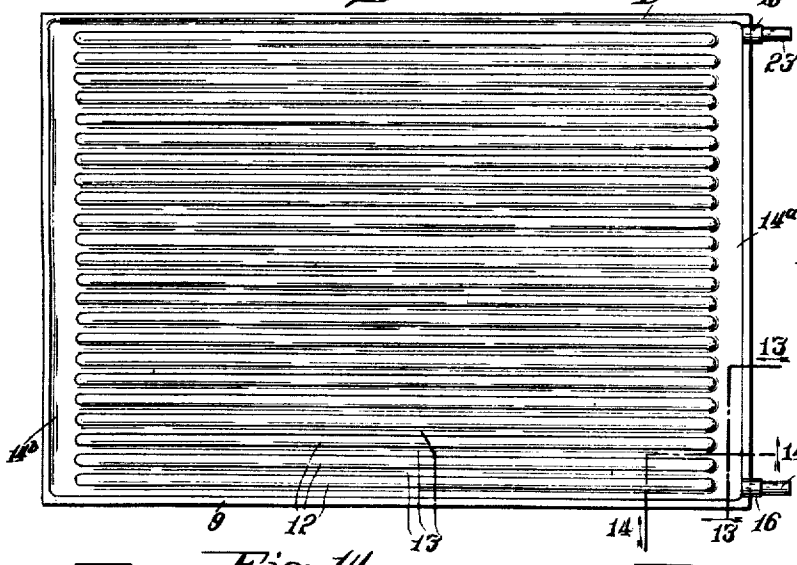


Fig. 13.

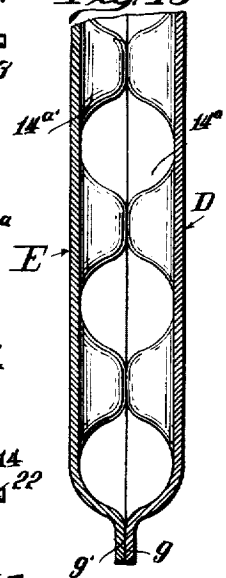


Fig. 14.

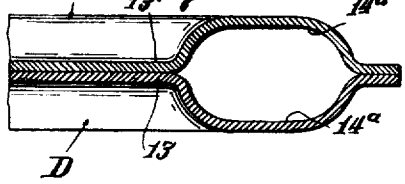


Fig. 15.

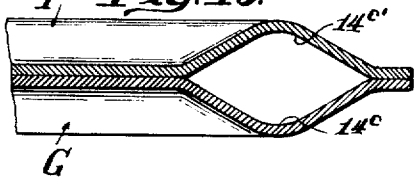


Fig. 16.

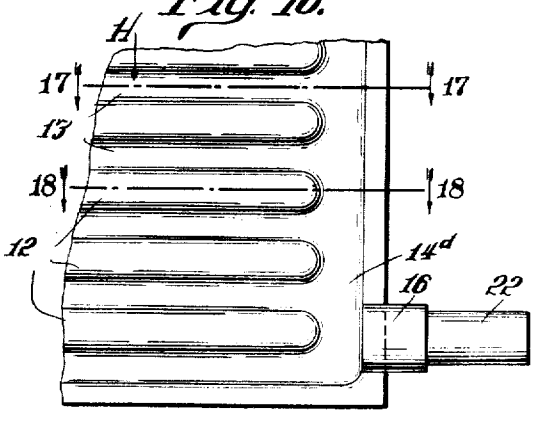


Fig. 17.

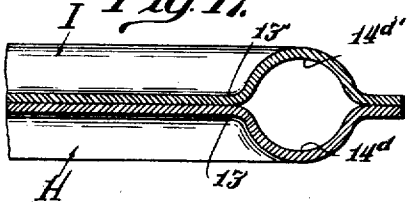
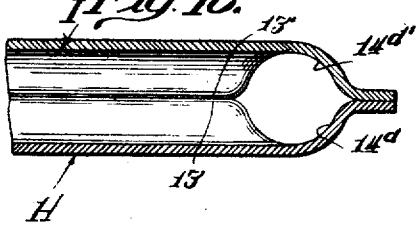


Fig. 18.



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UNITED STATES PATENT OFFICE

2,129,473

HEAT EXCHANGE ELEMENT

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Continuation of application Serial No. 724,242, May 7, 1934. This application September 16, 1935, Serial No. 40,820

6 Claims. (Cl. 257—183)

The present invention relates to heat exchange elements generally and more particularly to heat exchange elements for treating milk and other fluid products. In such elements the heat is supplied to or taken from the fluid being treated through the agency of another fluid acting in a dominating or controlling capacity. The one fluid passes down over or engages the outer surfaces of the element, and the dominating fluid, whether it be for cooling or heating, passes through the interior of the element. In such elements the controlling and controlled fluids are separated by thin walls of metal and the heat passes from one fluid to the other through the metal.

The principal objects of the present invention are (1) to provide an element of the kind mentioned wherein all the requisite outer surfaces and the requisite inner spaces and passages are provided with a minimum of parts, (2) to provide the same in the simplest form and of the simplest construction, and (3) to arrange the construction so that the element may be readily shaped out of sheet metal which is composed or treated so as to be incontaminable to milk.

With a view to meeting these objects, we make the entire heat exchange unit out of two reversely arranged counterpart metal stampings and preferably connect the same together where they contact each other. Each stamping has coplanar and offset portions. Thus, depressions or channels are formed on the one side and bulges or ridges on the other side. These channels and ridges combine in the unit to form interior passages and exterior wavy surfaces for the milk to travel over. Strict unity of plane for the contacting portions need not be. Sometimes it might be preferable to have one plane for one portion and another plane for another portion. The coplanar and bulging portions may be arranged variously. Preferably there is for each unit a main central or inner set, and an auxiliary or outer set. The passages may be staggered to provide a zigzag path for the controlling fluid, or they may provide multiple paths in parallel. If the element is to cool, then brine or the like may be used; if to heat, then hot water or steam. Again, one part of the element may heat and another part cool.

The various objects above enumerated and other objects, features and advantages of the invention will be understood more fully upon reference to the following description and the accompanying drawings, while the scope of the invention will be more particularly set forth in the appended claims.

In said drawings, Fig. 1 is a perspective view of a heat exchanger embodying a heat exchange element constructed and arranged in accordance with the present invention; Fig. 2 is a side elevation of one of the stampings employed in forming the complete unit or element of Fig. 1; Fig. 3 is a vertical section through a portion of the same complete unit, taken on a plane indicated by the line 3—3 of Fig. 2; Fig. 4 is a similar view taken on a plane indicated by the line 4—4 of Fig. 2; Fig. 5 is a horizontal sectional view of a portion of the same complete unit taken on a plane indicated by the line 5—5 of Fig. 2; Fig. 6 is a perspective view on an enlarged scale of a portion of the same element, showing the corner where the dominating fluid inlet is located; Feb. 7 is an elevation similar to Fig. 2, illustrating a stamping having a plural arrangement of interior circulatory channels; Fig. 8 is a fragmentary perspective view showing how one stamping may be modified by extending its edge; Fig. 9 is a view similar to Fig. 5, illustrating a further modification in which contacting surfaces of the two stampings meet in parallel planes; Fig. 10 is a vertical sectional view of a portion of the novel unit in association with a supply trough, also in section, showing the way in which the fluid to be treated is supplied to the unit; Fig. 11 is a sectional view of a portion of a unit having a modified stamping provided with a curved end; Fig. 12 is an elevation similar to Fig. 2 of a modified stamping in which there is provision for but one end channel at each end of the unit; Fig. 13 is a vertical section of a portion of an element made of stampings like that of Fig. 12, the plane of section being indicated by the line 13—13 of Fig. 12; Fig. 14 is a horizontal sectional view of a portion of the same element, the plane of section being indicated by the line 14—14 of Fig. 12; Fig. 15 is a view similar to Fig. 14 but illustrating a differently shaped end channel; Fig. 16 is an elevation of a portion of a still further modified stamping wherein the end passages or channels have a substantially circular section; Fig. 17 is a sectional view of an element made up of stampings of the modified form of Fig. 16, the plane of section being indicated by the line 17—17 of Fig. 16; and Fig. 18 is a similar view taken on a plane indicated by the line 18—18 of Fig. 16. Throughout these views like characters refer to like parts.

The heat exchange element of our invention is made up of two reversely counterpart sheet metal stampings. In carrying out the invention these

stampings may be considerably varied in form. We have illustrated one pair of counterpart stampings A and B, and these serve as the basis of our main description. Other forms are illustrated by the stampings A^1, A^2, A^3, B^1 and C and counterparts D, E; F, G and H, I.

Referring at first to the stampings A and B, it will be noted that since they are the same except that they are reversely arranged, it will suffice to consider in detail the stamping B which is shown in elevation in Fig. 2 with the inner surfaces in view. As stated, the stamping is preferably made out of a single sheet of metal of uniform thickness.

The particular sheet may be composed of one metal throughout or it may be composed of different metals but when milk is to be treated the surfaces over which the milk flows must be such as not to contaminate the milk. There must be no tainting, defiling or corrupting of the milk or the milk product being treated. Suitable metals for the purpose are (1) stainless steel, appearing on the market under various trade names, as Inconel, Allegheny metal, etc., but all containing chromium, nickel and iron, (2) copper tinned or chromium plated, and (3) iron tinned or chromium plated. Where the more common metal is plated, the plating may be done before or after stamping as judgment may dictate, and then it need be placed only on that side of the sheet which is to be engaged by the milk or milk product.

The sheet metal blank is stamped so as to offset the bulging portions and leave the coplanar portions in the original plane of the sheet. Referring to element B, it will be seen that these coplanar portions provide many contacting surfaces. Thus, there is the peripheral or marginal surface 9 which lies in the same plane as the face of the original sheet out of which the stamping is made. Besides this peripheral marginal surface 9, there are a plurality of transverse surfaces 10, 11 which extend from opposite ends of the element throughout the greater portion of its length. Thus, as clearly shown in Fig. 2, the surfaces 10 join with the marginal surface 9 at the right hand end but do not extend completely to the marginal surface 9 at the left hand end; and in like manner the surfaces 11 join with the marginal surface 9 at the left hand end but do not extend the full length of the unit into engagement with the marginal surface 9 at the right hand end. Intervening between the several sets of surfaces 10, 11 are surfaces 12 which terminate at both ends a little short of the full length of the unit. As clearly shown, the transverse surfaces 10, 11, 12 are substantially parallel to each other and they extend in this parallel relation throughout substantially the entire height of the unit. Furthermore, in this embodiment all the surfaces 9, 10, 11, 12 lie in the plane of the face of the original sheet out of which the stamping was pressed.

It will be obvious from the sectional views that the portions of the metal between the adjacent parallel surfaces 10, 11, 12 are offset to form the bulging portions which provide for the formation of the controlling fluid passages on the one side and the wavy or corrugated fluid-engaging surfaces on the other side. This offsetting in the stamping forms transverse channels or depressions 13 which are determined in extent by the adjacent relatively elevated faces 10, 11, 12. In addition to the surfaces 9, 10, 11, 12 and the intervening channels 13, there are at the ends of these channels other channels 14, 15. The latter cooperate in the assembled structure to provide passages between the ends of the transverse passages formed in part by the channels 13. As shown, the end channels 14 embrace or span in each instance four channels 13 and the shorter channels 15 embrace but two transverse channels 13. An inspection of Fig. 2 will also show that at the right the lower-most end channel 15 embraces or spans the first two channels 13 while the lowermost end channel 14 at the left embraces the first four channels 13. Likewise, continuing at the right, the first or lowermost channel 14 embraces the third, fourth, fifth and sixth transverse channels 13.

Thus, in the assembled element, comprising the stampings A and B, there are end passages at one end in staggered relation to end passages at the other end, and, by reason of this staggered relation, a fluid, entering at the low point 16, would pass through the element back and forth in a zig-zag path, which may be traced by reference to the depressions or channels of Fig. 2, as into the lowermost end channel 15, thence through the first two transverse channels 13 to the left-hand lowermost end channel 14, thence through the latter and the third and fourth channels 13 to the first channel 14 at the right, and so on, back and forth, through the element to an end channel that has an outlet. This might be at the top of the element or it might be at some lower point, as desired. In the embodiment illustrated in Fig. 2, the uppermost channel 15 is the one provided with the outlet and is the last one to be traversed by the controlling fluid. From this channel the fluid passes from the unit at the point 16'.

Referring to the wavy surfaces produced by the bulging portions of the stamping B, it will be obvious that where the channels 13 have been formed there will be an outer bulging surface 17. Between these tubular outer surfaces 17 there will be valleys 18 and 19, the valleys 18 extending only through part of the width of the element and the valleys 19 extending out to the marginal surface 9 at one end or the other as the case may be, depending upon the extent of the surfaces 10, 11 to which they correspond.

The result of stamping up a sheet of metal in this way is to provide a unit sheet which has a substantially corrugated central portion and bulging end portions and a peripheral relatively thin marginal portion, which marginal portion occupies a single plane except at those points where the margin is pressed out into semi-tubular or other form to provide for the inlet and outlet connections, whether they be nipples, castings or otherwise.

As explained, the plates A and B when stamped out are exact reverse counterparts. This means that wherever there is a depression or channel in one plate there is an equal and opposite depression or channel in the other plate. Because of this similarity it is needless to repeat a description which will apply to the plate A. It may be stated, however, that in the drawings corresponding numerals have been employed for the corresponding parts in the plate A, except that in the case of the plate A the numerals are primed. Thus, in the assembled structure the channels 13 in stamping B lie opposite, and cooperate with the channels 13' in stamping A, to provide the transverse tubular passages. The outsides of the plates at these points provide the bulging faces 17 and 17' of the corrugations. In a similar way, surface 9 contacts with surface 9', surface 10 contacts with surface 10', and so on for the other

surfaces 11, 11', and 12, 12'. Since the corrugations provided by the external surfaces 17, 18, 19 on the one side and the external surfaces 17', 18', 19' on the other side, are counterparts, the total vertical distances measured along these corrugated surfaces are equal. This means that the two streams of liquid flowing down over the element, where such use is made of the structure, receive the same heat exchange treatment. In other words, that going down over the surfaces 17, 18, 19 takes up or gives off the same amount of heat as that going down over the surface 17', 18', 19'.

When the two stamped-up plates A and B are brought together in assembled relation, then they are welded or otherwise secured together preferably at all points where they contact each other. This welding may well be electric welding and will usually be electric seam welding. Thus, the marginal surfaces 9, 9' are welded together throughout, except at the tubular points 16, 16'. The transverse surfaces 10, 10' and 11, 11' and 12, 12', respectively, are welded together. Indeed, wherever there are two contacting surfaces they should be welded together unless it is desired that the dominating fluid should pass through between them. From what has been said it will be seen that when the two plates A and B are thus welded together, there is a complete relatively thin edged unit having corrugated outer faces provided by the elevations 17 and valleys 18 and 19 on the one side and the elevations 17' and valleys 18' and 19' on the other.

The interior of what we may call the A—B unit, comprises, as before noted, a staggered arrangement of end passages, which gives a to and fro zigzag flow to the control fluid as it passes from the inlet point 16 to the outlet point 16'. The lower one of these points is provided with a metal casting or nipple 22. This connecting part is preferably welded into the opening and constitutes an inlet for the arrangement shown in Fig. 2. In like manner a like casting or nipple 23 is welded into the opening at the point 16' at the top of the element and constitutes the outlet for the dominating fluid.

It will be noted that the outer set of coplanar portions, 9—9', and the associated outer bulges, 14—14', 15—15', cover a relatively small area of the entire element B and that they are so positioned as to constitute a boundary extending peripherally around the inner set of coplanar portions, 10—11—12, and the associated bulging portions 13. It will also be noted that the inner set of coplanar and bulging portions, covers a relatively large area of the element A—B, the same extending almost entirely throughout the length and breadth of the face of the element.

Instead of connecting up the unit in this way, it is obvious that the interior passages might be separated, by partition portions, into a plurality of sections, and each section might then be treated as we have treated the single A—B unit. Such an arrangement is shown in Fig. 7, where a stamping C is substantially identical with the stamping B except that it is divided into two sections by a coplanar portion having the face 10^a. As clearly shown, the latter extends the full width of the stamping and unites the marginal surfaces 9 at the opposite ends of the unit. In this instance two controlling fluids may be used in the finished unit. When so used, one enters at 16^a through the connection 22^a and leaves at 16^b through a pipe connection 23^a; and the other enters at 16^c through pipe 22^b and departs at 16^d through pipe 23^b. These fluids may differ; the one for the upper section may heat and the one for the lower section cool, as is common in the art of milk treating.

From this illustrative modification, it will be clear that many different arrangements of the chambers and passages within the unit may be made without departing from the invention. As a further illustration along this line, it will be noted that the stamping D, shown in Fig. 12, is one that is the same in arrangement and construction as that shown in Fig. 2 except that the several end channels of Fig. 2 give place to single end channels, the channel 14^a being located at the right hand end, and the channel 14^b at the left hand end, as clearly shown. These long end channels are in sense provided by breaking down the partitions caused by the coplanar portions having the surfaces 10 at the right end in Fig. 2 and the coplanar portions having the surfaces 11 at the left end in the same figure. In other words, in this embodiment all the coplanar portions which break up the interior of the stamping into transverse channels are the coplanar portions having the surfaces 12 which terminate at both ends some distance short of the marginal surfaces 9. With this arrangement it will be obvious that when the stamping D and its counterpart stamping E are brought together in the manner shown in Fig. 13, then the end passageway, made up by the uniting of the counterpart channels 14^a and $14^{a'}$, will extend the full height of the unit. This will be true also of the passage formed at the opposite end of the unit by the channel 14^b and its counterpart.

With this arrangement, it is clear that the fluid which enters the unit through the connection 22 will fill the unit, or tend to fill it, up to a certain level without having a zigzag path of travel as in the case of the unit of Fig. 2. The arrangement of Fig. 12 with these unitary end passages is useful in certain types of heat exchangers where the controlling fluid is a substance like ammonia which at one temperature is in liquid form but readily evaporates and upon taking up a small amount of heat becomes a gas at a slightly different temperature. Where such a controlling fluid is used it is quite essential that as soon as the gas is formed it may pass quickly from the unit. To assist in this action it is therefore desirable to have unobstructed passages leading to the outlet through as short a distance as possible. The end passages of the unit made up of the channels 14^a, 14^b and their counterparts, brings about this desired result most effectively. In this instance, as in the case of the A—B unit, the controlling fluid enters at the point 16 and leaves at the point 16'. As in the case of the previously illustrated embodiments of the invention, the counterpart surfaces are the same as the ones fully illustrated and described and are referred to by the same characters primed, thus the depression 14^a of stamping D cooperates with the depression $14^{a'}$ of the stamping E, as illustrated more particularly in Fig. 14.

In Fig. 15, we have still a further modification in which the counterpart stampings F and G provide a somewhat different shaped end passage. As clearly shown this is made up of the counterpart channels 14^c and $14^{c'}$. The passage provided by these channels is diamond shaped rather than the more nearly oval shape illustrated in Fig. 14.

A still further modification of end passage is

provided by the stampings H, I, shown in Figs. 16, 17 and 18. In this case the channel 14d in the stamping H has a depth equalling approximately half its width. From this proportioning of dimensions it follows that when the counterpart channels 14d and 14d' come together they provide an end passage which is substantially circular in cross section. Thus, it will be seen that the end passages of Fig. 16 are similar to the end passages of Fig. 12 but somewhat narrower so that the more effective circular formation may result without causing the walls forming the passage to extend out beyond the limits of the transverse corrugations of the unit. This circular cross-section is preferable in most cases to the prolonged or oval sections of the earlier figures and this is especially so where the sheet out of which the stampings are made is relatively thin with respect to the pressure which may be exerted by the controlling fluid passing through the element.

Obviously in these cases, the inlet connection, be it 22, 22a, or 22b, would be connected with some suitable source of dominating fluid, such as steam or brine or the like. Likewise, the outlet connections 23, 23a, or 23b, as the case may be, would be correspondingly connected in each case as a return to the steam or brine or other source, so as to carry back to the supply all the dominating fluid.

Obviously, too, the units made according to this invention may be variously assembled in a finished heat exchanger. A very simple heat exchanger, employing the A—B unit, is shown in Fig. 1. As there shown, the unit is supported between uprights 24, 25 which take the form of angle irons with parallel flanges which lie upon opposite sides of the unit in supporting contact with it. The upper ends of each set of the angle irons 24, 25 are connected together by the end of a supply trough 26 for the milk. The upper ends of the posts 24, 25 are suitably shaped to fit the ends of the trough 26 to which they may be secured in any desired way, as by welding. The trough 26 is a simple distributer trough, provided with openings 27 in its under side which allow the milk to pass out into engagement with opposite sides of the unit and to trickle down in two films or sheets over the same.

The lower ends of the supporting posts 24, 25 are secured to the ends of a collecting trough 28 located at the bottom of the unit and provided for collecting the treated milk or other liquid which travels down over the surfaces of the unit plates A, B. The trough 28 may be of any preferred construction and in the present instance is shown provided with supporting frames 28' and legs 29. Tie-rods 30, having turn-buckles 31, connect the edges of the trough with the coplanar flanges of the posts 24, 25 at the one end and with the like flanges of the posts 24, 25 at the other end, to give rigidity to the structure. The treated milk or other liquid may be withdrawn from the trough 28 in any desired way as through the valve controlled outlet 32. These various details concerning the mounting of the novel unit, form in themselves no part of the present invention and are included here merely for the purpose of showing a complete heat exchanger employing the novel unit of the invention.

It will be obvious that the other stampings which we have illustrated and described might be combined into units and that then these units might be mounted in the same way as the A—B unit, as shown in Fig. 1. In other instances, the resulting unit might be mounted quite differently. All these arrangements and mountings are matters which come within the judgment of the builder and may be varied as desired.

When the counterpart stampings, A, B, or otherwise, are made and assembled as described, they lie within the same boundary limits, although it will be clear that the invention would not be departed from by having extensions, one or more, here and there, as illustrated in Fig. 8. There we have in assembled relation the stamping B and a modified stamping A'. The latter is the substantial counterpart of the former but has an extension 33. Such an extension may be required in some instances for mounting or securing in place when installing. Its presence still leaves the stamping A' a substantially reverse counterpart of the stamping B. The same is true of the structure illustrated in Fig. 11 wherein the modified stamping A^2 has an extension 34 which is curved away from the plane of meeting, as clearly shown. These two cases illustrate the possibilities in the way of modifications which may be indulged in without changing the substantially counterpart character of the mating stampings and, therefore, without departing from the spirit of the invention.

Besides these modifications, it is clear that, as before indicated, the strict unity of plane for the contacting surfaces might be departed from and some contacting surfaces might meet in one plane and others in another plane, or planes. Such a modification is shown in Fig. 9, wherein the upper stamping B' is similar, say, to the stamping B, but differs in having a differently positioned marginal edge 35 that meets the marginal edge 36 of the mating stamping A^3 in a plane parallel to and considerably offset from the plane on which the portions 37, 38 meet.

There are also many other ways in which the unit or element may be modified without departing from the spirit and scope of the invention. To a certain extent what is shown and described is merely typical and indicative of the many possible forms which the invention may take.

Likewise, instead of welding the various contacting faces of the mating stampings, the same might be secured together by sweating with a suitable solder, or in any other desired way.

It is also intended that the term "milk" as used herein and in the claims, be considered generically as covering fluid milk, cream, sour milk, sour cream, buttermilk, ice cream mix and other like products, all of these requiring a metal for the milk contacting surfaces which will not contaminate, taint or otherwise injure the milk or milk product and thus render it unsalable.

This case is a continuation of our application, Serial No. 724,242, filed May 7, 1934.

And here it may be pointed out that although the invention is well suited to the heating and cooling of milk and milk products it need not be so limited. The provision of the coplanar portions, 12, which are completely surrounded by bulging portions, has the effect of splitting up the stream of water or other medium passing through the element. The provision of this divider in the channel results in structural advantages which make the element useful in many relations other than in the treating of milk. This is especially true where the element is made of a relatively hard metal, as many of the stainless steels heretofore mentioned. The invention, therefore, should not be restricted beyond the requirements of the language of the claims.

We claim:

1. A heat exchange element for treating liquids adapted to be positioned upright to receive the liquid at its upper edge and deliver the same at its lower edge, said element comprising two substantially reversely counterpart sheet metal stampings reversely juxtaposed, said stampings having contacting coplanar portions and oppositely bulging portions, said coplanar and bulging portions cooperating to form interior passages for the controlling fluid and wavy exterior surfaces for engaging the liquid in its downward flow, said coplanar portions being arranged in two sets, an outer set and an inner set, the outer set extending about said inner set and the inner set extending transversely of the direction of travel of the liquid over the element, the individuals of said inner set being positioned in spaced substantially parallel relation to each other, said bulging portions being arranged likewise in two sets, one set extending transversely of said stampings in alternate relation with said transversely extending coplanar portions and forming transverse passages, and the other set being located at the ends of said first set of passages and forming end passages connecting with said transverse passages, certain of the coplanar portions of the inner set being completely surrounded by bulging positions, said stampings being united along contacting coplanar portions and having suitable inlet and outlet openings communicating with said passages, the outer wavy liquid-engaging surfaces of said stampings being smooth and well rounded at all points.

2. A heat exchange element for treating liquids adapted to be positioned upright to receive the liquid at its upper edge and deliver the same at its lower edge, said element comprising two substantially reversely counterpart sheet metal stampings reversely juxtaposed, said stampings having contacting coplanar portions and oppositely bulging portions, said coplanar and bulging portions combining to form passages for the controlling fluid within and wavy contacting surfaces for the liquid without, said coplanar portions being arranged in two sets, an outer set and an inner set, the outer set peripherally bounding said stampings to provide the same with a relatively thin peripheral edge, and the inner set extending transversely of the direction of travel of the liquid, and the individual coplanar portions of the inner set being spaced apart in said direction of travel, said bulging portions being arranged likewise in two sets, one set extending transversely of said stampings in alternate relation with said transversely extending coplanar portions and forming therewith transverse passages, and the other set being located at the ends of said first set of passages and forming end passages connecting with said transverse passages, said stampings being united along contacting coplanar portions and being provided with suitable inlet and outlet openings at different points in the periphery of the assembled element, the wavy liquid-contacting surfaces on the outside of said stampings being substantially corrugated surfaces, smooth and well rounded at all points where the coplanar and bulging portions merge into each other.

3. A heat exchange element for treating liquids adapted to be positioned upright to receive the liquid at its upper edge and deliver the same at its lower edge, said element comprising two substantially reversely counterpart sheet metal stampings reversely juxtaposed and having contacting coplanar portions and oppositely bulging portions, said stampings being united along contacting coplanar portions to form the element and said bulging portions combining with said coplanar portions in the assembled element to form interior passages for the controlling fluid and exterior surfaces for the flowing liquid, said coplanar portions including two sets, the coplanar portions of the first set extending transversely of the direction of liquid travel, said first set having individual portions which terminate at both ends to within short distances of the ends of the element, and other individual portions each of which terminates at one end within a short distance of the end of the element and at the opposite end merges into a coplanar portion of the second set, the individual coplanar portions of said first set occupying positions in substantial parallelism to each other, the intervening bulging portions cooperating therewith in the assembled element to form passages likewise extending transversely of the direction of liquid travel, and the second set of coplanar portions being relatively short and positioned at the ends of said first set in staggered relation, those at the one end to those at the other end, to provide in conjunction with said first set communication between said transverse passages back and forth through the element, said element having suitable openings to said passages at inlet and outlet points, the wavy liquid-contacting surfaces on the outside of said stampings being substantially corrugated surfaces, smooth and well rounded at all points where the coplanar and bulging portions merge into each other.

4. A heat exchange element for treating milk and the like, adapted to be positioned upright to receive the milk at its upper edge and deliver the same at is lower edge, said element comprising two substantially reversely counterpart sheet metal stampings reversely juxtaposed and having contacting coplanar portions and bulging portions therebetween, said stampings being united along contacting coplanar portions to form the element and said bulging portions combining with said coplanar portions in the assembled element to form interior passages for the controlling fluid and exterior surfaces for the flowing milk, said coplanar portions including two sets, the coplanar portions of the first set extending transversely of the element and of the direction of travel of the milk thereover, certain of said portions terminating at both ends within short distances of the ends of the element and others of said portions each of which terminates at one end within a short distance of the end of the element and at the opposite end merges with a coplanar portion of the second set, the individuals of the first set being in parallel relation to each other, the intervening bulging portions cooperating therewith in the assembled element to form interior passages which extend transversely of the direction of milk flow, and the second set of coplanar portions being relatively short and positioned at the ends of said first set in staggered relation, those at the one end to those at the other end, to cooperate with the adjacent bulging portions to provide communication between said transverse passages back and forth through the element, th stampings of said element being bulged out at their peripheries to provide suitable inlet and outlet openings in the periphery of the assembled element for the passage of the controlling fluid into and out of

the element, the wavy milk-contacting surfaces on the outside of said stampings being substantially corrugated surfaces, smooth and well rounded at all points where the coplanar and bulging portions merge into each other, and also incontaminable to milk.

5. A heat exchange element for treating liquids, adapted to occupy an upright liquid-treating position, said element having outer liquid-contacting surfaces over which the liquid flows in a downward direction, the same being delivered at the lower edge of the element, said element also having inner passages for the controlling fluid to pass through, said element comprising two substantially reversely counterpart sheet metal stampings reversely juxtaposed and having contacting coplanar portions and bulging portions therebetween, said stampings being united along said contacting coplanar portions to form the element and said bulging portions combining with the coplanar portions in the assembled element to form the interior passages, said coplanar portions including two sets, a main set extending transversely of the element, and thus transversely of the direction of travel of the downwardly flowing liquid, and having its individual coplanar portions in spaced relation to each other with the intervening bulging portions cooperating in the assembled element to form interior passages which are transverse to the direction of liquid travel, and an auxiliary set of said coplanar portions cooperating with adjacent bulging portions to provide passages at the ends of the main set to provide communication between said transverse passages, certain of said end passages spanning at least four of said transverse passages, said element having suitable openings to said passages at inlet and outlet points, the outer liquid-engaging surfaces of said stampings being smooth and well rounded at all points.

6. A heat exchange element for treating milk and the like, adapted to occupy an upright milk-treating position, said element having outer milk-contacting surfaces over which the milk flows in a downward direction, the same being delivered at the lower edge of the element, said element also having inner passages for the controlling fluid to pass through, said element comprising two substantially reversely counterpart sheet metal stampings reversely juxtaposed, said stampings having contacting coplanar portions and oppositely bulging portions, said coplanar portions being arranged in two sets, an outer set and an inner set, the outer set extending around and inclosing the inner set and the individuals of the inner set being spaced apart in the direction of travel of the downwardly flowing milk and extending transversely of said direction, said bulging portions being arranged likewise in two sets, one set of said bulging portions extending transversely in alternate relation with said transversely extending coplanar portions and forming therewith passages which extend transversely of the direction of milk flow, and the other set of said bulging portions being located at the ends of said first sets of said passages and forming with adjacent coplanar portions end passages connecting with said transverse passages, certain of said end passages spanning at least four of said transverse passages, said stampings having suitable inlet and outlet openings communicating with said passages, the outer milk-engaging surfaces of said stampings being smooth and well rounded at all points, said surfaces being also incontaminable to milk.

OLIVER W. MOJONNIER.
HARRY G. MOJONNIER.

CERTIFICATE OF CORRECTION.

Patent No. 2,129,473. September 6, 1938.

OLIVER W. MOJONNIER, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, first column, lines 2, 35 and 70, claims 1, 2 and 3 respectively, after the word "liquids" insert a comma; line 29, claim 1, for "positions" read portions; and second column, line 12, claim 3, strike out "to"; line 60, claim 4, before "first" insert entire; line 71, same claim, for "th" read the; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 6th day of December, A. D. 1938.

Henry Van Arsdale

(Seal) Acting Commissioner of Patents.

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