Oct. 6, 1936. C. MORTENSEN 2,056,581

HEAT EXCHANGE APPARATUS

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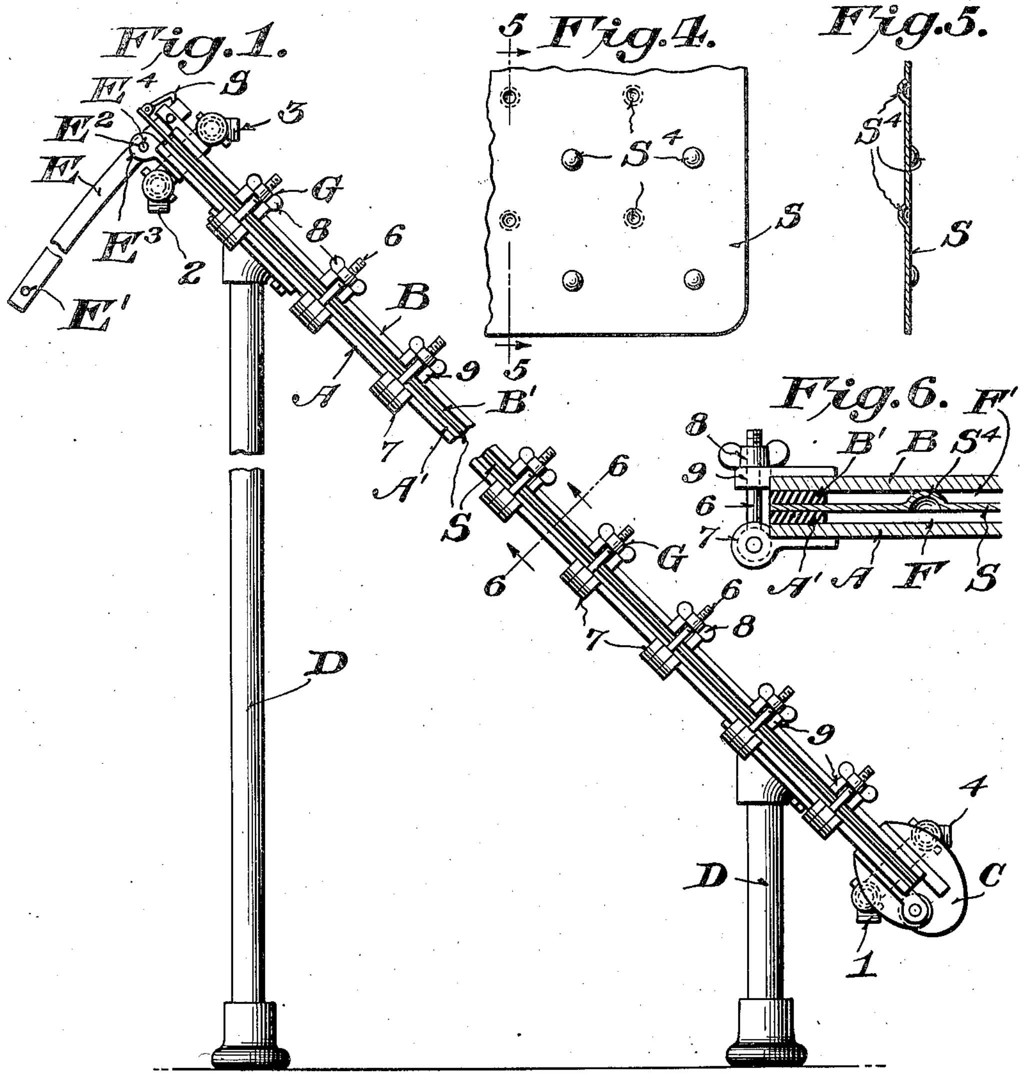
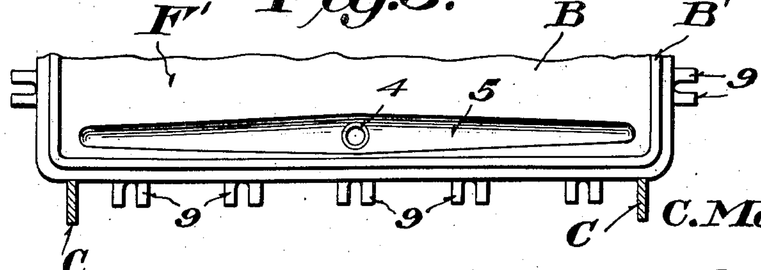


Fig. 3.



Inventor

C. Mortensen,

By D. P. Wolhaupter

Attorney

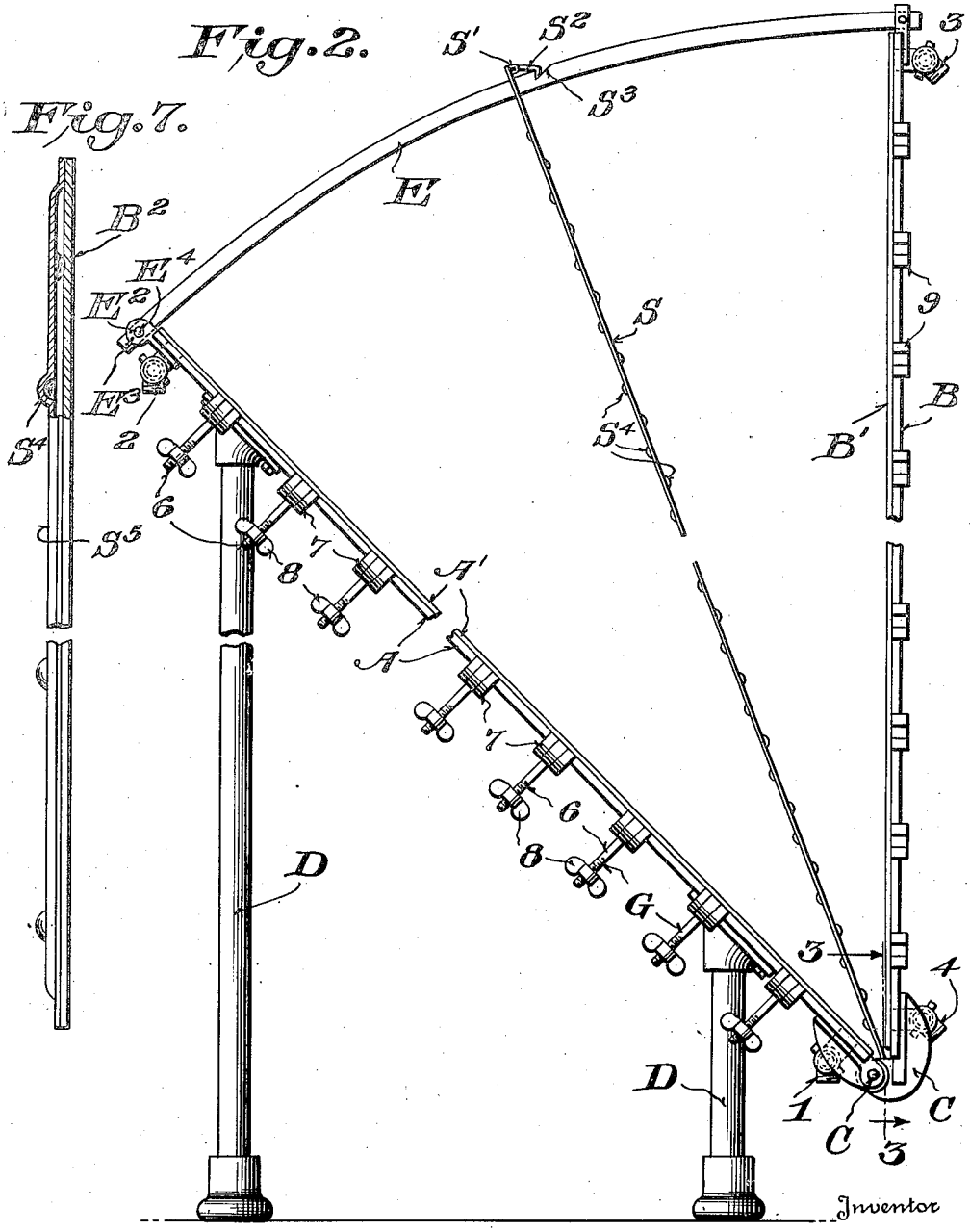
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Fig. 2.

Fig. 7.



Inventor

C. Mortensen,

By D. P. Wolcan Jr.

Attorney

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HEAT EXCHANGE APPARATUS

Cornelius Mortensen, Louisville, Ky.

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9 Claims. (Cl. 257—245)

This invention relates to heat exchange apparatus.

A primary object is to provide a device that will quickly transfer heat from one body of fluid to another, and more particularly to effect the heat transfer in flowing liquids by causing the same to move in a thin diffused film which is spread or deployed over a comparatively wide area between the points of intake and outlet, thereby greatly facilitating heat absorption by the relatively cooler medium. In that connection the invention contemplates a construction which provides a film producing flow-chamber inclined at an angle oblique to a perpendicular plane. This feature is desirable to avoid excessive splashing which would otherwise occur and produce bubbles or air spaces if the chamber were vertical, while at the same time permitting the heated liquid to flow in a film below a film of cooler liquid so as to more readily absorb heat convection currents and increase the efficiency of the apparatus. Moreover, this arrangement insures adequate drainage of the chambers which would not be possible if the film forming chamber or chambers were horizontally disposed.

Another object of the invention is to provide a chamber forming member of maximum heat conductivity, for example, sterling silver, which has a coefficient of heat conductivity that is more than twenty points higher than copper, and, at the same time, has greater sanitary advantages that many other materials do not possess in the handling of some liquids, such for example as milk.

A further object is to provide a construction that is readily accessible for cleaning and yet when in operation provides tight film forming chambers that are leakproof and which compel straight film flow.

A still further object of the invention is to provide an apparatus that meets the high standards necessary to comply with health regulations in handling liquid foods. In that connection the invention provides a construction wherein there is no substantial depth to the passing liquids as in pipes or other enclosures, containers, or conduits defined by a closed passage which presents either undesirable depth or pockets, or corners, which have a tendency to impede flow and harbor or temporarily trap some of the liquid at a particular zone or area.

With the above and other objects in view which will more readily appear as the nature of the invention is better understood, the same consists in the novel construction, combination and arrangements of parts hereinafter more fully described, illustrated and claimed.

A preferred and practical embodiment of the invention is shown in the accompanying drawings, in which:—

Figure 1 is a side elevation of the improved apparatus.

Figure 2 is a side elevation of the apparatus shown in its open position.

Figure 3 is a detail sectional view taken on the line 3—3 of Fig. 2.

Figure 4 is an enlarged detail view of a portion of the separating diaphragm or plate.

Figure 5 is a vertical sectional view taken on the line 5—5 of Fig. 4.

Figure 6 is a detail cross-sectional view taken on the line 6—6 of Fig. 1.

Figure 7 is a detail view illustrating a modification of one of the sections of the apparatus wherein the diaphragm or separating plate is rigidly fixed to one of the sections.

Similar reference characters designate corresponding parts throughout the several figures of the drawings.

According to the embodiment of the invention shown in the drawings the same essentially includes in its organization a casing formed of a pair of sections A and B, the former constituting in effect a base and the latter performing more or less the functions of a cover. The casing sections A and B are preferably connected at one edge by suitable hinge means C whereby they may be opened or swung apart and both sections are supported on a stand designated generally as D. As will be observed from the drawings the base section A is preferably rigidly secured to the supports forming the stand and when the sections are closed they are normally supported in a plane inclined obliquely to the perpendicular. The edges of the casing sections opposite the hinge are preferably provided with means for holding them in open position to temporarily hold them in spaced relation for cleaning. By way of example means to that end is shown in the drawings as comprising an arcuate arm E preferably carried by the relatively movable section B, and having an opening E^1 therein intended to register with an opening E^2 in a bifurcated lug E^3 carried by the relatively fixed or base section A thereby to receive a pin E^4 for maintaining the arm in its extended position.

The sections A and B are intended to receive therebetween a diaphragm or separating plate S. As will be observed from Figs. 1 and 2 this plate may be provided at its upper end with an ex-

tended portion S' carrying a hook or latch S^2 intended to engage with a keeper notch S^3 in the arm E so that when the sections are opened up as shown in Fig. 2 the separating plate or diaphragm may be held in spaced relation to both of the sections A and B.

The sections A and B are preferably provided at their inner faces with gasket means A' and B' thereby to clamp the edges of the separating plate or diaphragm S tightly therebetween so as to provide the relatively shallow film forming flow-chambers F and F' (Fig. 6), which are coextensive with the casing sections and provide a relatively wide area over which the liquids must flow in passing through the apparatus.

A distinctive feature of the apparatus resides in making the diaphragm or separating plate S of a material having a high coefficient of heat conductivity. In that connection it has been found that sterling silver is particularly adapted for the purpose because it has a higher capacity for heat transfer than copper. Therefore, by combining film forming flow-chambers with an imperforate separating plate or diaphragm having a high coefficient of conductivity it will be apparent that heat will be readily exchanged from a warm flowing medium to a relatively cooler flowing medium with great rapidity.

Each of the casing sections A and B are formed with inlet and outlet connections. In the preferred form of the invention the base section A is provided with the heated fluid inlet connection 1 at the lower side thereof and the outlet connection 2 at the upper side. On the other hand the upper section B is provided with the cold fluid inlet 3 at the upper side thereof while the lower portion is provided with an outlet 4. Thus, heated liquid flows in at the bottom of section A and when cooled flows out of the top connection 2, while the cold fluid is normally intended to enter the cold fluid inlet 3 and descent toward the lower warm fluid outlet 4. The flow of hot and cool liquids is therefore in opposite directions so as to obtain the maximum efficiency of heat transfer under all conditions of use.

In connection with the inlet and outlet means for each of the casing sections reference may be made to Fig. 3 of the drawings which shows how it is proposed to distribute or deploy fluids entering and accelerate their exit from the film forming flow-chambers. That is to say, both of the casing sections A and B are formed at their inner faces, adjacent the inlet and outlet connections, with countersunk flared chambers 5 so that as the liquid enters each chamber it will be quickly spread or distributed and likewise collected and carried off with great rapidity thereby preventing the formation of hot spots or cold spots in the casing of the apparatus. The portions 5 function more or less as manifolds for distributing and removing the liquid of different temperatures.

Suitable means is provided for preventing distortion of the diaphragm or separating plate S under the pressure of flowing liquids. A device of the character set forth herein usually has the liquid pumped through the same by a pressure pump, and while ordinarily the pressures are balanced on each side of the diaphragm or plate S, nevertheless, it is desirable to provide means to prevent the bulging or billowing of the plate so as to avoid any movement therein which would have a tendency to set up crystallization which might lead to fracture or rupture. One way of preventing this distortion is to provide the plate S with a plurality of oppositely offset button-like members S^4 (Figs. 4 and 5), the same being arranged in staggered relation and in parallel rows. The crown or zenith of each projection S^4 is intended to engage with the inner face of a casing section. These projections, while serving to reinforce the plate against unequal pressures do not in any way offer substantial impedance to the flow of liquid film through the film forming flow-chambers. On the other hand, they serve as a measure to assist in diffusing the flow, without perceptible agitation, thereby to materially assist in heat exchange.

The casing sections A and B are held together in any suitable manner to clamp the diaphragm or separating plate S therebetween. As shown in Figs. 1 and 2 the edges of the sections may be provided with suitable clamps G. Each clamp preferably comprises a bolt 6 pivoted between the ears 7 on one of the sections, for example, the base section A, the said bolt 6 being threaded and carrying a winged nut 8 adapted to engage with the bifurcated portions 9 on the upper or cover section B of the casing. When the wing nuts 8 are in the position shown in Fig. 1 it will be apparent that the sections A and B will securely clamp the casing sections A and B together thereby to force the gasket means A' and B' securely against the edges of the diaphragm or separating plate S.

Figure 7 of the drawings illustrates a modification of the invention wherein the separating plate S^5 is carried by one of the casing sections B^2. In the form of the invention shown in Figs. 1–6 inclusive the separating plate is intended to be free from the casing sections so that the apparatus may be opened up for cleaning purposes. However, in the event that it is desired to use the apparatus in connection with the cooling or heating medium such as ammonia and brine or hot water, it is of course desirable to seal one of the film forming chambers with respect to the other, at all times, so that there will be no danger of leakage of the cooling fluid. Therefore, it will be apparent that it is entirely within the scope of the present invention to anchor the diaphragm or separating plate S^5 to one of the sections. Otherwise all of the features and advantages of the invention heretofore described remain the same.

While the present construction and arrangement is particularly adapted for heating and cooling milk, nevertheless, it will be understood that the same may be adapted for handling other liquids.

When the apparatus is used in connection with milk machinery, hot milk from the pasteurizer is fed into the inlet connection 1 and forced through the film forming chamber F toward the upper outlet 2. Cold, raw milk may then be fed into the upper inlet 3 and descends through the film forming chamber F' to the lower outlet 4. In that way milk coming from the pasteurizer at approximately 140° will be materially and quickly reduced in temperature in passing from inlet 1 to outlet 2, while at the same time the cold milk, at approximately 32°, which is fed into the inlet 3 of the section B may be led off at the outlet connection 4 at a substantially higher temperature. Thus, the present apparatus provides for using the heat of the pasteurized milk for preheating the cold milk going to the final heater prior to its introduction into the pasteurizer. Ordinarily pasteurized milk must be bottled at a temperature

of approximately 32° and the use of the present apparatus will enable hot milk coming from the pasteurizer to be quickly reduced in temperature so that it may be finally cooled to bottling temperature with great facility. On the other hand, cold raw milk may have its temperature elevated so as to materially economize and expedite the heating of the milk prior to its introduction into the final heater.

Without further description it is thought that the features and advantages of the invention will be readily apparent to those skilled in the art, and it will of course be understood that changes in the form, proportion and minor details of construction may be resorted to, without departing from the spirit of the invention and scope of the appended claims.

I claim:—

1. A heat exchange apparatus including a pair of hingedly connected casing sections having a diaphragm arranged therebetween to provide film forming flow-chambers at opposite sides thereof.

2. A heat exchange apparatus including hingedly connected sections, a diaphragm arranged between said sections to provide film forming flow-chambers at opposite sides thereof, and means for spacing the diaphragm with reference to adjacent faces of the section to prevent distortion thereof under pressure.

3. A heat exchange apparatus including a pair of casing sections hingedly connected at one edge, a diaphragm arranged between said sections and adapted to be free therefrom when the sections are spread apart on the hinges, and means on the diaphragm and extending to opposite sides thereof to engage with the inner sides of the sections when closed to form a casing thereby to brace the diaphragm against distortion under pressure.

4. A heat exchange apparatus including a stand, a pair of casing sections supported by said stand normally at the angle oblique to the perpendicular and one of said sections being rigidly carried by the stand, hinge means for swingingly connecting the other of said sections to the section which is rigidly mounted on the stand, a separating plate arranged between the hinged sections to provide film forming flow-chambers at opposite sides thereof when the sections are closed, and means for preventing distortion of the plate under pressure of liquids passing through the film flow-chambers.

5. A heat exchange apparatus including a stand, a pair of casing sections supported on said stand normally at an angle oblique to a perpendicular plane, one of said sections being rigidly carried by the stand, hinge means at the common edges of said sections for swingingly connecting one of said sections to the section rigidly carried by the stand, a plate-like diaphragm loosely mounted between said sections whereby it may be moved to a spaced position from said sections when one section is moved relative to the other, means for preventing distortion of said plate-like diaphragm under liquid pressure, and means at the edges of said sections opposite their point of hinged connection for holding the sections and the plate-like diaphragm spaced apart.

6. A heat exchange apparatus including a stand, a casing comprising a pair of sections mounted on said stand and normally occupying an angle oblique to a perpendicular plane, one of said sections constituting a base rigidly carried by the stand and the other of said sections being hingedly connected at one edge to the other to provide a swinging cover, a plate-like diaphragm arranged between the sections and providing film forming flow-chambers at opposite sides thereof when the cover and base sections of the casing are closed, inlet and outlet connections carried by each section of the casing, means for normally clamping said sections together, and means at the edges of said sections opposite their point of hinged connection to hold the sections and the intermediate diaphragm separated to permit sustained access to the interior of the apparatus.

7. A heat exchange apparatus including a stand, a pair of casing sections supported on said stand normally at an angle oblique to a perpendicular plane, means for hinging the sections together at their lower ends, gaskets at the inner edges of said sections, a thin plate-like diaphragm of high heat transfer capacity clamped between the gaskets and coextensive with the sections to provide film forming flow-chambers at opposite sides of the diaphragm, means for preventing distortion of the diaphragm under pressure, and inlet and outlet means for each section.

8. A heat exchange apparatus including a stand, a pair of casing sections supported on said stand normally at an angle oblique to a perpendicular plane, means for hinging the sections together at their lower ends, gaskets at the inner edges of said sections, a thin plate like diaphragm of high heat transfer capacity clamped between the gaskets and coextensive with the sections to provide film forming flow-chambers at opposite sides of the diaphragm, means for preventing distortion of the diaphragm under pressure, inlet and outlet means for each section, and means at the inner faces of the sections adjacent the inlet and outlet means to compel distribution of the liquid through the chambers and to facilitate liquid exit therefrom.

9. A heat exchange apparatus including a casing comprising separable sections pivotally connected at their lower sides, a diaphragm mounted between said sections to provide separate film flow-chambers at opposite sides thereof, and a stand for supporting said sections and diaphragm at an angle oblique to the perpendicular to facilitate flow of liquid over and in contact with the interior surfaces of the apparatus without splashing.

CORNELIUS MORTENSEN.