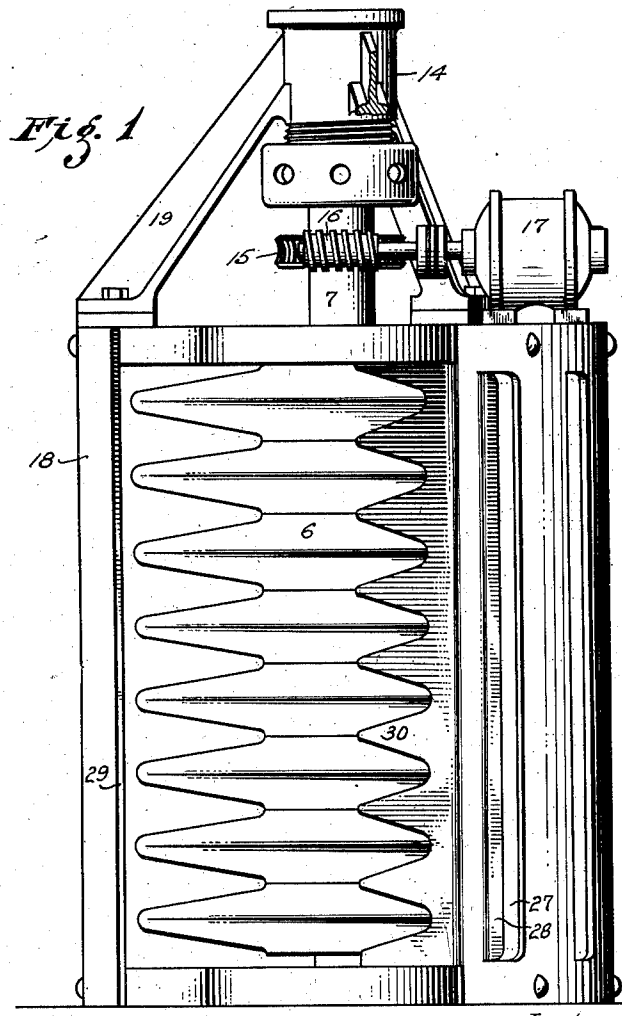
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HEAT EXCHANGER

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Fig. 1



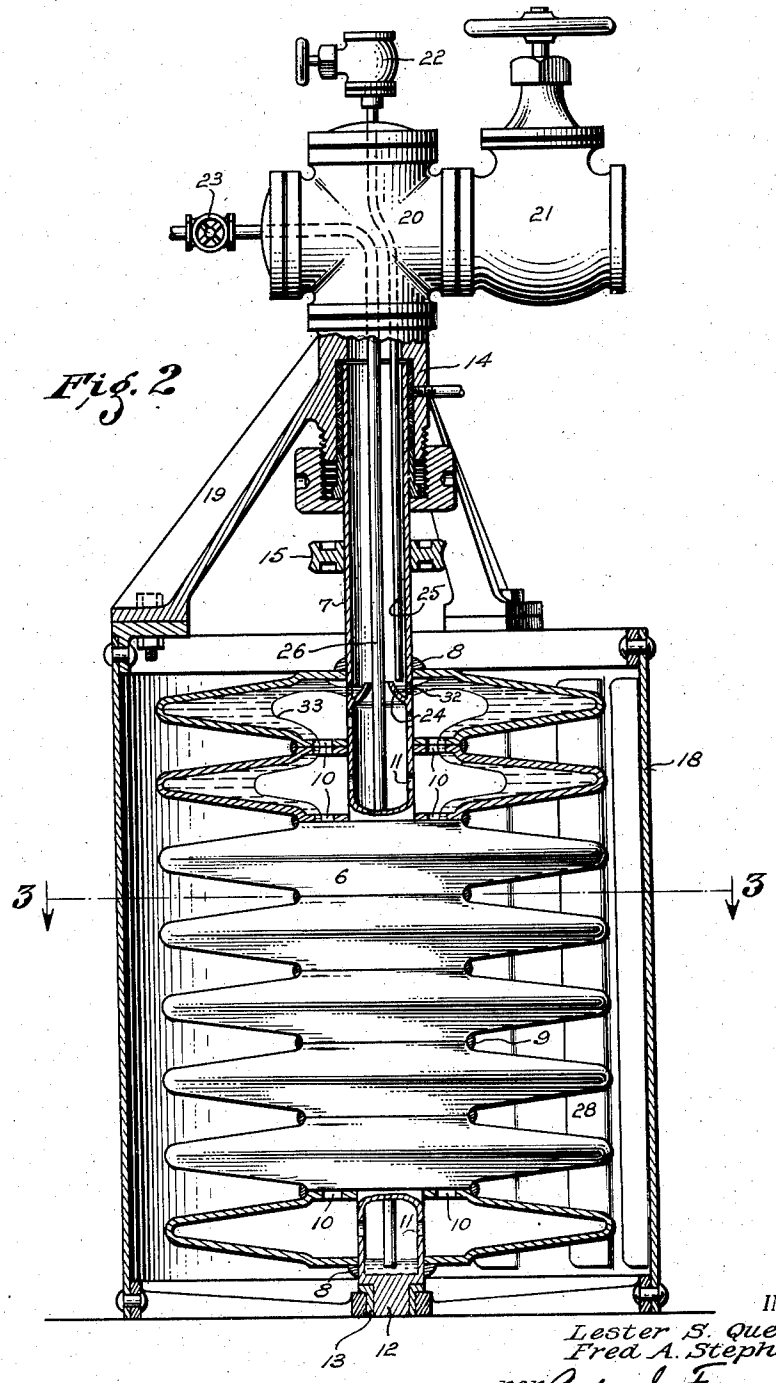
INVENTORS;
Lester S. Quensel and
Fred A. Stephens,
per Arthur J. Farnsworth.
THEIR ATTORNEY

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Fig. 2



INVENTORS;
Lester S. Quensel and
Fred A. Stephens,
per Arthur J. Farnsworth.
THEIR ATTORNEY

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Fig. 3

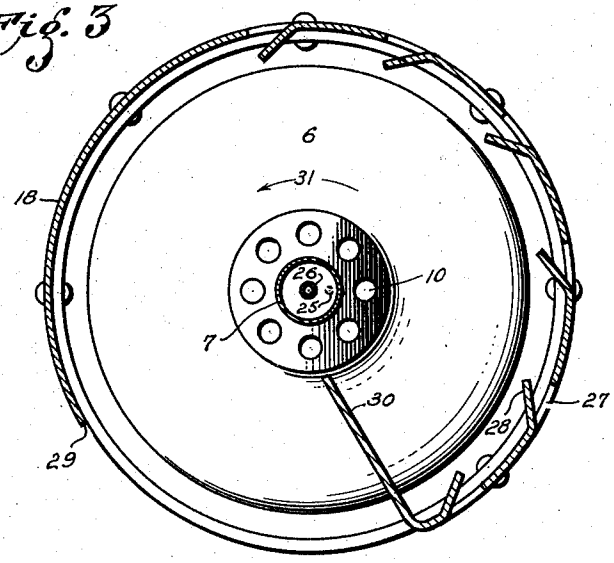
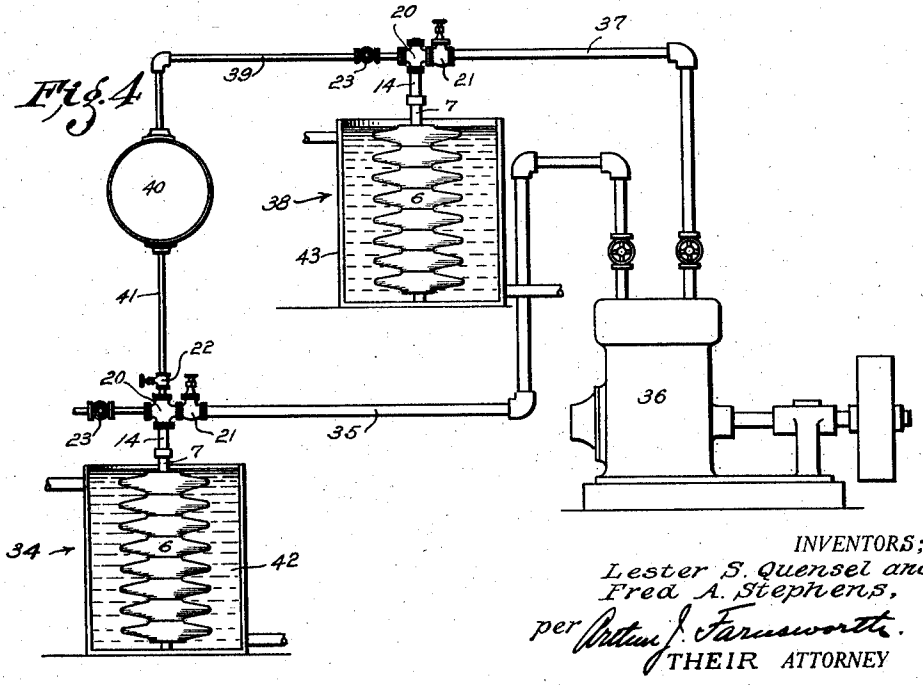


Fig. 4



INVENTORS;
Lester S. Quensel and
Fred A. Stephens,
per Arthur J. Farnsworth.
THEIR ATTORNEY

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1,746,497

UNITED STATES PATENT OFFICE

LESTER S. QUENSEL, OF SANTA BARBARA, AND FRED A. STEPHENS, OF LOS ANGELES, CALIFORNIA

HEAT EXCHANGER

Application filed December 11, 1928. Serial No. 325,201.

Our invention relates to heat-exchangers, and particularly to apparatus of this character that is adapted for either vaporizing liquids or condensing vapors. Among its principal objects are, first, to provide a very compact type of heat-exchanger that nevertheless embodies a relatively great amount of available wall area for the transfer of heat; second, to furnish facilities for causing a thin film of liquid to flow over the interior surface of said walls, when the device is being used as an evaporator; third, to supply in an evaporator, a relatively great evaporating surface of liquid for the liberation of vapor; fourth, to afford means for securing a rapid and continuous circulation of liquid over the outer surfaces of the heat-exchanging walls; fifth, to make it possible to greatly increase the efficiency of mechanical refrigeration systems by incorporating therein heat-exchanging devices that embody the above features; and sixth, to accomplish the above by means of a simple and relatively inexpensive construction.

Our objects are attained in the manner illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of a typical form of our improved heat-exchanger;

Figure 2 is a similar elevation in central section;

Figure 3 is a cross section of the above devices taken on the line 3—3 of Fig. 2; and,

Figure 4 is a diagram illustrating a mechanical refrigeration system in which our improved heat-exchanger is incorporated for the purposes of condensing and re-vaporizing a suitable refrigerant, such as ammonia.

Similar reference numerals refer to similar parts throughout the several views.

It is well known that the results that are obtainable in heat-exchangers of the closed type, depend upon the area of the heat-exchanging surfaces, and upon the rapidity with which the respective fluids may be made to flow over those surfaces. Thus it is not only desirable to have the heat-exchanging surfaces as great as possible consistent with the practical limitations imposed upon the apparatus, but also to circulate the respective fluids over such surfaces very rapidly, and, if possible, in thin films. We employ in our improved exchanger a series of superposed spheroidal drums 6, that are mounted upon a hollow vertical shaft 7. The upper and lower drum of the series are permanently attached to the shaft by means of sealed joints, such as the welded joints 8. The intermediate drums are connected by sealed joints as indicated by the weldings 9. All of these drums communicate with each other through orifices 10, and with the interior of the hollow shaft through orifices 11. The lower end of the hollow shaft is provided with a solid journal 12 that is rotatable in a bearing 13; the latter being adapted for supporting the weight of the shaft, its attached drums, and the contents of the latter. The upper end of the shaft passes through, and is rotatable within, a stuffing box 14. Below the stuffing box the shaft carries a worm gear 15, and the latter is in mesh with a worm 16 on the shaft of a motor 17. Thus the shaft with its attached drums may be continuously rotated by means of the motor.

Surrounding the above rotating elements is an incomplete cylindrical casing 18, into the bottom of which is fitted bearing 13, and on the top of which is a spider 19 for supporting the stuffing box and superposed parts. The motor is also suitably mounted upon the top of the casing.

Above the stuffing box is a cross-fitting 20 that supports a gas valve 21, and by means of the latter the flow of gas to or from the interior of the hollow shaft is controlled. A liquid inlet valve 22, by means of which liquid is introduced when the device is being used as an evaporator, and a liquid outlet valve 23, by means of which liquid refrigerant can be withdrawn from the device, are associated with cross-fitting 20 as shown.

Within shaft 7, and opposite the upper part of the upper drum 6, is an annular trough 24, and an inlet pipe 25 leads down from valve 22, through the cross fitting 20 and the hollow shaft, so as to discharge into this trough. A liquid outlet pipe 26 extends from valve 23 down through the hollow shaft to nearly the bottom thereof, for withdraw-

ing such liquid as may accumulate at that point.

Casing 18 is provided with a plurality of vertical slits or louvers 27, having inwardly extending flaps 28. It has already been stated that the casing is incomplete. One end of its cylindrical wall is shown at 29. The other end of the wall is in-turned and deeply notched to form fingers 30 that closely fit the configuration of the drums and extend inwardly between them without touching.

The whole apparatus just described may be lowered into a tank of liquid for the purpose of serving as a heat-exchanger. When rotated in the direction of arrow 31, the friction of the drums will impart a rotary motion to the liquid within casing 18, and cause the latter to flow outwardly between extremity 29 and finger plate 30. A corresponding volume of flow will take place inwardly through louvers 27, and the flaps 28 serve to direct the rotating liquid toward the center to prevent intereference with the incoming flow through the louvers. It will thus be evident that when one of these rotary heat-exchangers is submerged in a body of liquid, and rotated therein, it will cause a rapid circulation of the liquid over the outer surfaces of drums 6.

When our device is being utilized as an evaporator in a refrigerating system, the liquid refrigerant is introduced through valve 22 and pipe 25 to annular trough 24. The centrifugal motion of the machine will throw this liquid outwardly through orifices 32, against the upper inner wall of the top drum 6. Centrifugal force will cause this liquid to spread out in a thin film of increasing diameter, and further accretions, in view of the combined action of centrifugal force and gravity, will cause the liquid within the drum to assume some such contour as is shown at 33. Still further accretions of the liquid under the influence of gravity, will cause it to flow downwardly through intercommunicating orifices 10 to the drum below, and this process will be repeated within the succeeding lower drums. It will be obvious that the liquid, before it reaches the lowest drum, will have passed over a large heat-transfer surface and have absorbed a correspondingly great amount of heat from the outside of the drums. By suitably proportioning and operating the apparatus, practically all of the incoming refrigerant will be vaporized either before it reaches the lower drum, or within the latter. Vapor given off from the liquid at any point is free to pass through orifices 11 to the hollow shaft, and to be withdrawn therefrom through gas valve 21. Such liquid as may not be vaporized will flow to the bottom of hollow shaft 7, and can be withdrawn therefrom through pipe 26 and outlet valve 23.

When our heat-exchanger is being used as a condenser, the above described process is substantially reversed. Gas is drawn or forced to the device through gas valve 21 and, in this case, passes through orifices 11 to the drums where it is condensed and tends to accumulate in the bottom of hollow shaft 7. The condensate is withdrawn through pipe 26 and outlet valve 23. When the device is used as a condenser there is no need of valve 22 or pipe 25, and these simply are inoperative in such service.

The diagram of Fig. 4 illustrates a complete mechanical refrigeration system that employs our improved heat-exchangers for the purposes of condensing and re-evaporating the refrigerant. Assuming that one of our devices is being used as an evaporator at 34, the vapor therefrom passes out and through pipe 35 as a cold gas to the intake of a compressor 36. After being compressed, the gas passes through pipe 37 to gas valve 21 of the condensing exchanger 38. Liquid refrigerant from this condenser passes out through pipe 39 to storage tank 40, and thence through pipe 41 and valve 22 to the evaporating exchanger 34, where the cycle starts afresh. Evaporator 34 is immersed in a brine tank 42, and condenser 38 is immersed in a cooling tank 43.

We desire particularly to point out certain of the great practical advantages that result from the use of our rotary heat-exchangers. Among the more important of these is the great elasticity they afford in the operation of a refrigerating system. For instance, the speed of rotation of the exchanger units may be varied, and they may be variously assembled and placed in the system, where required to meet varying conditions of operation. For example, an additional heat-exchanger unit, which can readily be handled by a crane, may be placed at any time in brine tank 42, to work in parallel with one or more similar exchangers already so located. It is only necessary to install header connections to enable such changes to be made at will. Furthermore the action of the rotary exchangers themselves constitutes a ready and very efficient means for securing adequate circulation within the brine tanks or cooling tanks in which they are submerged. It is not necessary to use circulating pumps for such purposes when our rotary exchangers are employed.

It will of course be obvious that the rapidity of circulation of the submerging fluid can be greatly increased if desired, by adding suitably shaped ribs or vanes on the outer walls of drums 6. Still further we desire to point out that our rotary exchangers can be used interchangeably as either condensers or evaporators, without change or adjustment of parts. Finally, we wish to point out that the displacement of the submerging liquid by the drums, largely or wholly offsets the weight of the rotating parts, and thereby the thrust duty of bearing 13 is greatly lessened.

The method disclosed for assembling the drums upon the hollow shaft has the great advantage of eliminating heavy stresses therein as a result of temperature changes. The end drums of the series are affixed to the shaft, while the intermediate drums are free to move longitudinally thereon. The whole series of drums therefore is adapted to act like an accordion to obviate heavy stresses due to thermal expansion or contraction.

Having thus fully described our invention in a manner that will be readily understood by those who are familiar with the art involved, we claim:—

1. A heat-exchanger comprising; a vertically rotatable hollow shaft having a closed lower end supported by a bearing, and its upper end passing through a stuffing-box; a series of intercommunicating and superposed drums, mounted upon said shaft, the lower and upper drums of the series being in communication with the interior of the shaft; pressure-tight means adapted for introducing and withdrawing vapors from the hollow shaft while rotating; and similar means for introducing liquid into the upper drum and for withdrawing liquid from the lower end of the hollow shaft; said drums being adapted for immersion and rotation in a liquid bath.

2. A heat-exchanger comprising; a series of intercommunicating and superposed spheroidal drums adapted for being immersed and rotated in a liquid bath; pressure-tight means adapted for introducing and withdrawing vapors from the drums while rotating; similar means for introducing liquid at the top of said series, and for withdrawing liquid at the bottom thereof; and a casing surrounding said series; said drums being adapted when rotated to draw liquid into the casing over the external surfaces of the drums, and thereafter to discharge this liquid from the casing.

3. A heat-exchanger comprising; a series of intercommunicating and superposed spheroidal drums adapted for being immersed and rotated in a liquid bath; pressure-tight means adapted for introducing and withdrawing vapors from the drums while rotating; similar means for introducing liquid at the top of said series, and for withdrawing liquid at the bottom thereof; and an incomplete cylindrical casing surrounding said series, having vertical louvres therethrough with inwardly turned flaps; one extremity of the side wall of the casing being dentated to a contour corresponding to a diametral section of the drum series, and being turned inwardly to closely approach the exterior walls of said series without touching them; and said drums being adapted when rotated to draw liquid into the casing through said louvres over the external surfaces of the drums, and thereafter to discharge this liquid between the extremities of the side walls of the casing.

4. In apparatus of the character described; a series of intercommunicating drums mounted upon a rotatable hollow shaft; the end drums of the series being in communication with the interior of the shaft and affixed to the shaft by a pressure-tight joint; and the intermediate drums being free to move longitudinally upon the shaft and having pressure-tight joints between them and the adjacent drums.

5. In apparatus of the character described; a rotatable hollow shaft having a closed end, and its other end passing through a stuffing-box and communicating with the interior of a pressure chamber; a heat-exchanging drum mounted upon said shaft and communicating with its interior; means adapted for introducing and withdrawing vapor from said chamber; means leading from the exterior through said chamber into said shaft for introducing liquid at one portion of the latter; and separate means leading from the exterior through said chamber into said shaft for withdrawing liquid from another portion of the shaft.

LESTER S. QUENSEL.
FRED A. STEPHENS.