April 27, 1965 H. C. RHODES 3,180,108

LIQUID COOLING DEVICE

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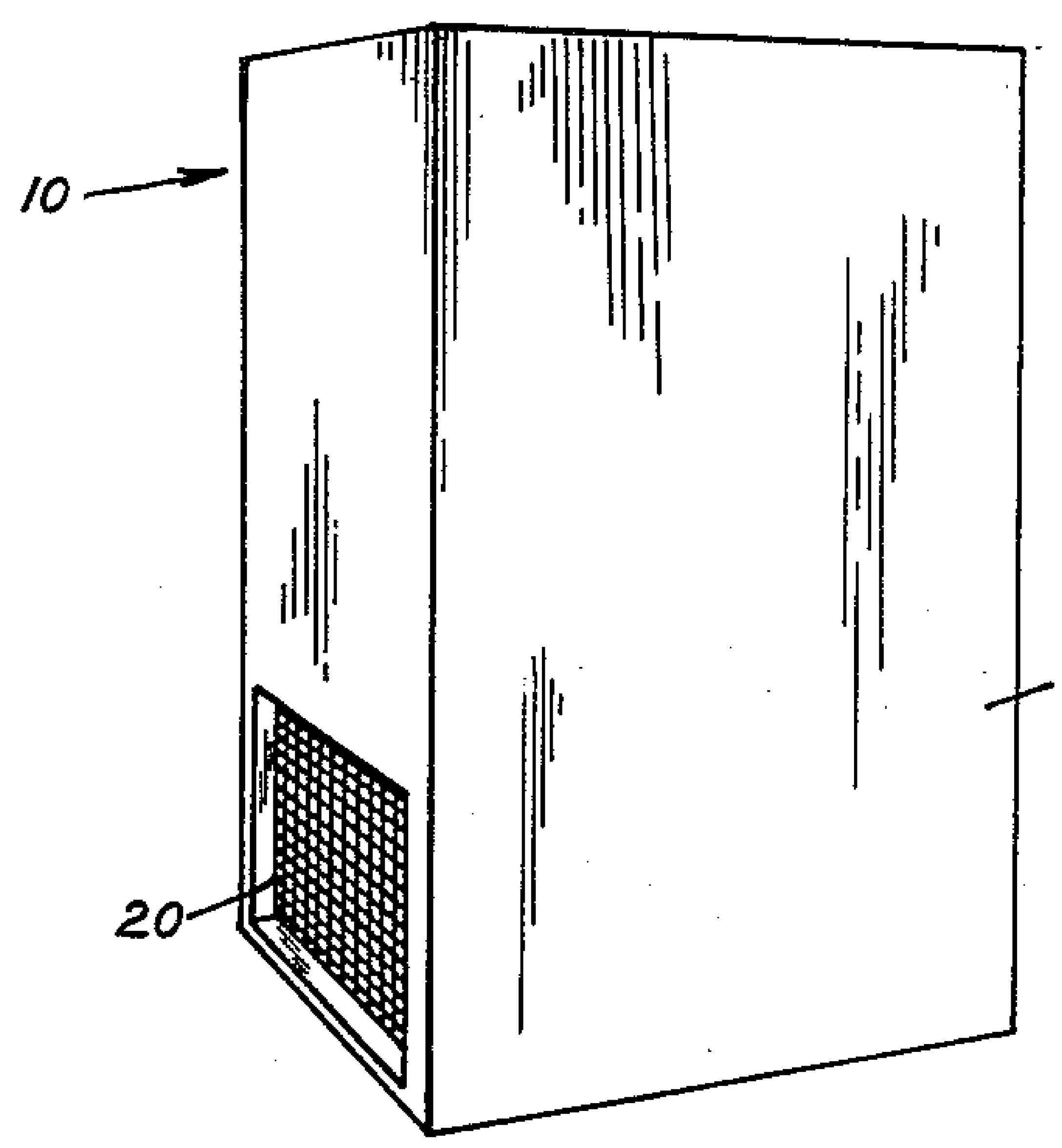

Fig. 1

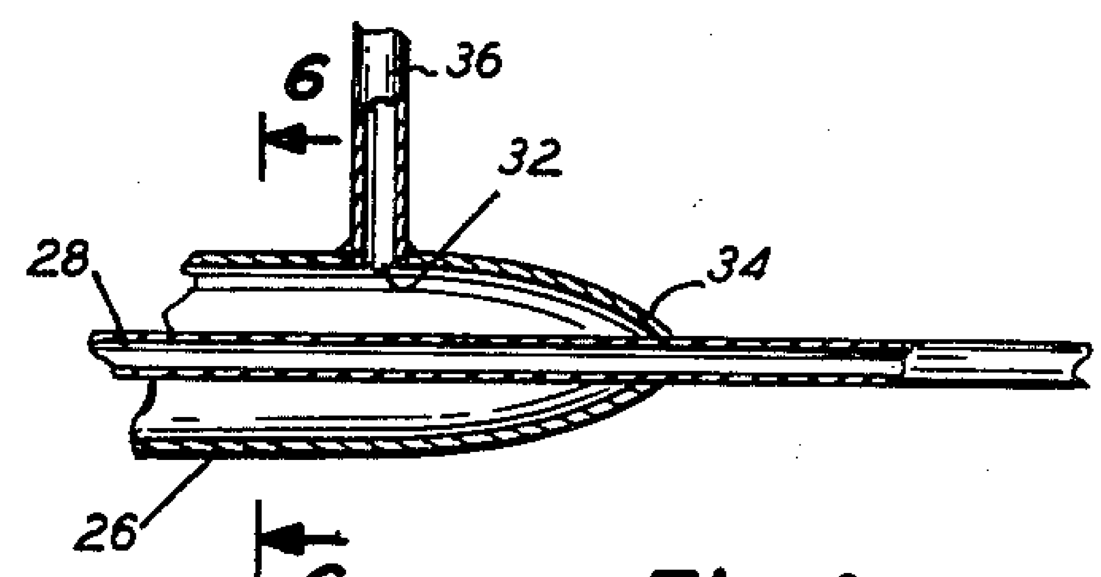

Fig. 4

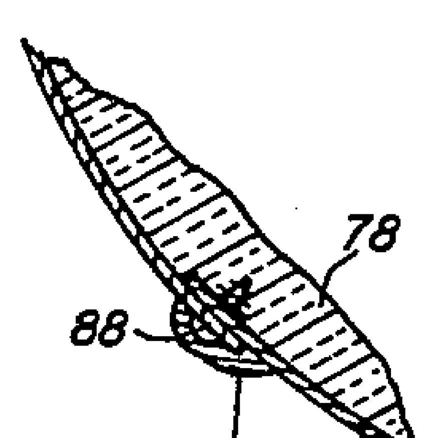

Fig. 5

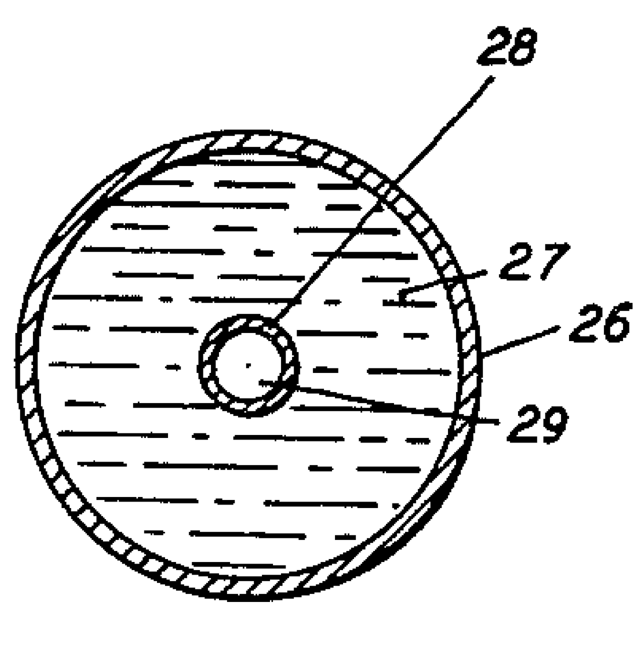

Fig. 6

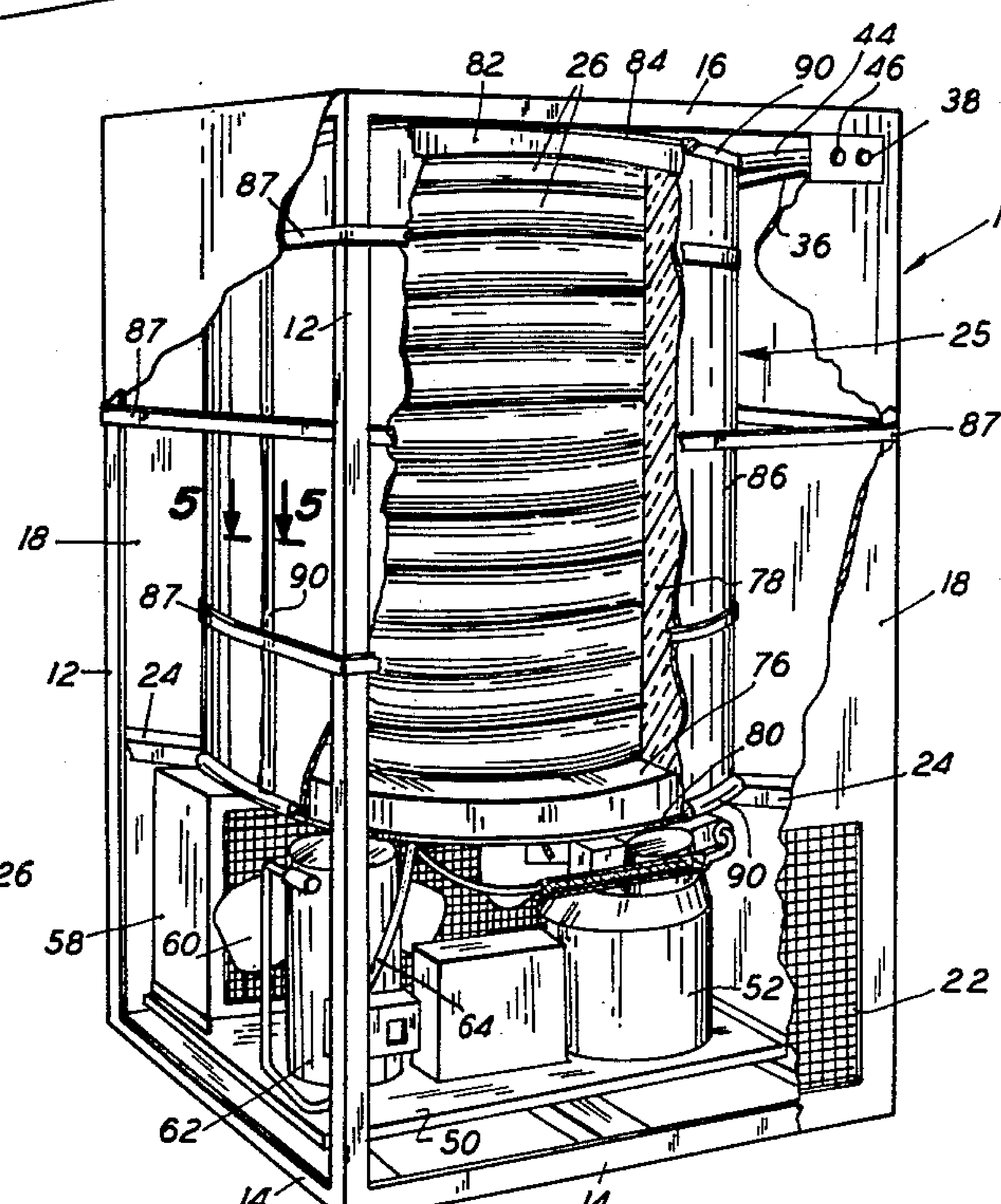

Fig. 2

HERBERT C. RHODES
INVENTOR
BY
BUCKHORN, BLORE, KLARQUIST & SPARKMAN
ATTORNEYS

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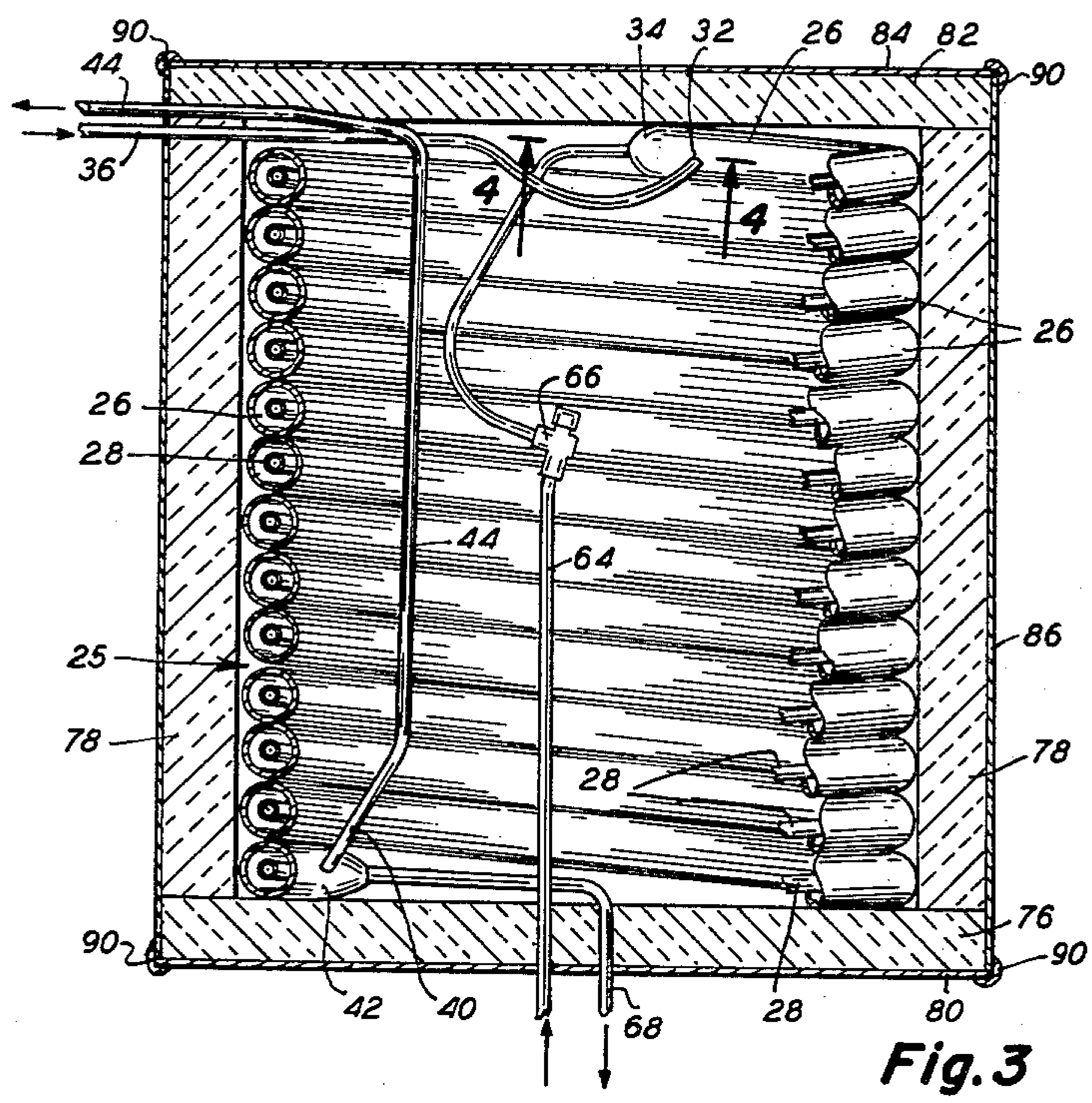

Fig. 3

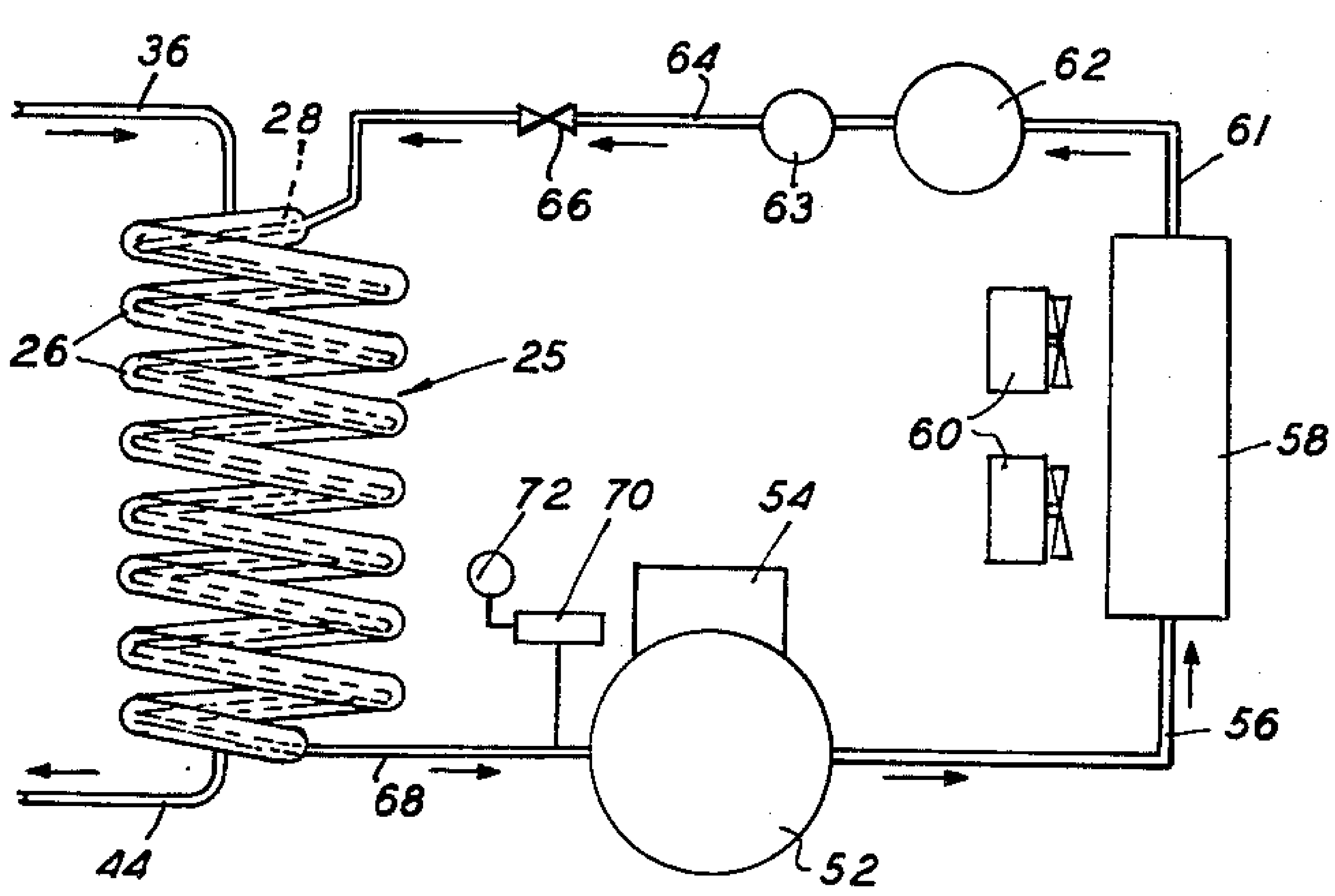

Fig. 7

HERBERT C. RHODES
INVENTOR

BY

BUCKHORN, BLORE, KLARQUIST & SPARKMAN
ATTORNEYS

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LIQUID COOLING DEVICE

Herbert C. Rhodes, 10106 SE. Stark, Portland, Oreg.

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1 Claim. (Cl. 62—222)

The present invention relates to cooling systems and more particularly to a water and other liquid cooling system for providing large quantities of liquid at constant temperature.

Most known water cooling systems employ as the cooling element or evaporator, a coil in a tank of water to be cooled through which an expanded refrigerant is circulated to reduce the water temperature to the desired level. However in many applications, as for example in baking, large quantities of cooled water at a constant low temperature must be withdrawn from the cooling system within the course of only a few minutes' time. In such instances warm water entering the tank to replace the cold water being withdrawn mixes with the already cooled water in the tank to raise the temperature of the water being withdrawn above the required level. Extremely large capacity, cumbersome and expensive cooling systems, including compressors driven by relatively high horsepower motors would ordinarily be required in such instances to cool the entering warm water fast enough to prevent it from raising the temperature of the cold water being withdrawn.

Accordingly, a primary object of the present invention is to provide a new and improved liquid cooling device which prevents the mixing of incoming warm liquid with cold liquid being withdrawn, so as to enable the withdrawal of cooled liquid from the system at a constant temperature.

Another object of the invention is to provide a new and improved liquid cooling device from which a large quantity of cooled liquid can be drawn off at constant temperature within a short expanse of time.

A further object of the invention is to provide a new and improved liquid cooling device which cools rapidly through maximum exposure of the liquid to be cooled to the refrigerant coils.

Other objects of the invention include the provision of a new and improved chiller which requires a minimum of floor space and which is efficient and economical to operate.

In fulfillment of the above and other objects a cooling device is provided having liquid storage coils of relatively large diameter and refrigerant coils that extend substantially coaxially within the storage coils for the full length of the latter. Warm liquid enters one end of the storage coils and is cooled progressively as it proceeds to the opposite end thereof where cooled liquid may be drawn therefrom. This arrangement of coils restricts the mixing of warm entering liquid with the already cooled liquid in the storage coil to a short length of the storage coil adjacent the inlet end thereof whereby substantially the entire volume of stored liquid may be withdrawn without introduction of warming, entering liquid.

The foregoing and other objects and advantages of the present invention will be more readily ascertained from inspection of the following specification taken in connection with the accompanying drawing wherein like numerals refer to like parts throughout, while the scope of the invention will be defined in the appended claims.

With reference to the drawings:

FIG. 1 is a perspective view of a cooling device in accordance with the present invention as viewed from the right front thereof;

FIG. 2 is a perspective view of the cooling device of FIG. 1 as viewed from the right rear with portions broken away for clarity;

FIG. 3 is a side elevational view of the evaporator portion of the cooling device of FIG. 1 with portions broken away for clarity;

FIG. 4 is a view of an end portion of the storage coil taken approximately along the line 4—4 of FIG. 3;

FIG. 5 is a fragmentary sectional view taken along the line 5—5 of FIG. 2;

FIG. 6 is a sectional view taken along the line 6—6 of FIG. 4;

FIG. 7 is a diagrammatic view illustrating the cooperative relationship of the various components of the cooling device and the flow path of the refrigerant.

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First with reference to FIGS. 1 and 2, the illustrated cooling device 10 includes an upright frame structure including vertically extending frame members 12, bottom frame members 14 and top frame members 16. The frame structure is enclosed by a sheet metal housing 18 having lower front and rear openings 20 and 22 respectively to permit air circulation and to provide access to the cooler components within the lower portion of the housing.

The frame structure further includes a pair of diagonally extending frame members defining an interior shelf portion 24 intermediate the top and bottom of such structure, which supports an evaporator means 25. With reference to FIGS. 2 and 3, the evaporator means comprises an outer liquid storage coil 26 consisting of a first helically coiled length of tubing, or conduit, of predetermined, relatively large diameter, and an inner refrigerant coil 28 consisting of a second helically coiled length of tubing of considerably smaller diameter than the first tubing extending substantially coaxially through the larger tubing from end to end thereof.

The storage coil 26 is enclosed at both ends and includes an inwardly directed water supply inlet 32 adjacent its upper end 34 to which is connected a length of supply conduit 36 leading from the inlet 32 to an exterior intake coupling 38 (FIG. 2) mounted at the upper rear of the housing 18 for connection to a water supply. Similarly, an inwardly directed cold water outlet 40 is provided in the sidewall of the storage coil 26 adjacent the lower end 42 thereof and is connected by a length of outflow conduit 44 extending upwardly through the coil 26 to an external outflow coupling 46 laterally adjacent the intake coupling 38.

As shown most clearly in FIG. 4, the refrigerant coil 28 extends coaxially through the end wall of the storage coil 26 at the upper end 34, and the two coils are preferably brazed at their intersection to provide a fluid-tight seal. The intersection of the respective coils at the lower end 42 of the storage coil is similar. However, it has been found that no steps need be taken to maintain the inner and outer coils in exact coaxial relationship to one another between the ends of the storage coil, as no appreciable gain in cooling efficiency results therefrom.

The approximate coaxial relationship of the outer storage coil 26 containing liquid 27 to be cooled and inner refrigerant coil 28 through which refrigerant vapor 29 is circulated is clearly shown in FIG. 6, whereby heat is transferred from the liquid 27 through the walls of the refrigerant conduit 28, to the circulating refrigerant and thence out of the coil 28 according to the usual principles of heat transfer. In this regard, the refrigerant circulates through the inner coil 28 at a slightly lower temperature than the cooled liquid, and the coils 26 and 28 are made of copper or other suitable material having a high thermal conductivity, or k, value.

The remaining principal components of the cooling system are mounted beneath the shelf portion 24 on a base member 50 supported on the bottom frame members 14. These components, individually, are all of conventional construction, and accordingly, are shown diagrammatically in FIG. 7. Such components include a compressor 52, including an integral motor 54, for compressing a suitable refrigerant, such as, for example, Freon. Of course, any other of the known refrigerants may be used, depending on the requirements of the system and individual preference. The compressed refrigerant flows through a conduit 56 to a condenser 58, which includes a pair of fans 60 rearwardly of the condenser coils for speeding the cooling and thus liquefaction of the refrigerant. From the condenser, the liquefied refrigerant is conducted through a conduit 61 to a receiver 62, where the liquefied refrigerant is stored at high pressure and used by the system as needed.

Liquid refrigerant flows under high pressure from the receiver 62 through a drier 63 and thence through an upwardly extending riser conduit 64 to an expansion valve 66, where the pressure of the refrigerant is reduced and metered as it enters the refrigerant coil 28 at the upper end 34 of the storage coil 26 and circulates downwardly therethrough. Referring again to FIG. 3, the riser conduit 64 passes upwardly centrally through the storage coil 26 to the expansion valve 66, which is conveniently located inwardly of the storage coil 26 adjacent its upper, inlet end 34. After the expanded refrigerant has circulated downwardly through the coil 28, it continues its downward flow, through a return conduit 68 to the compressor 52 to complete the cooling cycle.

A pressure control 70 is connected into the flow path of the refrigerant, and more specifically, in the return conduit 68, for maintaining the cooled liquid within the lower, outlet end 42 of the storage coil at a preselected constant temperature. The control 70 preferably includes a limit control for shutting off the compressor when the pressure exceeds a predetermined upper limit. As an added safety measure should the pressure control ever fail, a low limit pressure safety switch 72 with manual reset as part of the pressure control 70 is used. When the temperature of the liquid within the storage conduit approaches its freezing point, the switch 72 is actuated to cut off the compressor 52. Without such a safety device, failure of the pressure regulator could result in freezing of the liquid 27 and consequent rupture of the storage coil.

As will be evident from FIGS. 2 and 3, the entire storage coil is encased in insulation and then hermetically sealed to minimize heat transfer from the environment externally of the coils to the environment within the coils and thereby promote efficient operation of the system. The storage coil 26 and its entire load of stored liquid is supported on a circular disk 76 of insulating material having a high compressive strength, such as, for example urethane foam. The diameter of the insulation disk 76 is slightly greater than the overall diameter of the storage coil 26 for accommodating and helping to support vertically extending insulation 78 which encases the outer sides of the coil 26. Since the vertical insulation 78 does not support a load other than its own weight, it may be of spun glass or similar easily packed material of low structural strength. The insulation disk 76 rests on a circular sheet metal bottom cover plate 80, which in turn is supported on the shelf portion 24. A similar insulation disk 82 and top cover plate 84 is laid on top of the storage coil 26.

A vertically extending sheet metal casing 86 is wrapped around the storage coil 26 and is fastened together at its opposite ends along an overlapping seam 88 as shown in FIG. 5. The top and bottom edges of the casing 86 abut the top and bottom cover plates 84 and 80 respectively, and the joints between the casing and the cover plates are then sealed with a suitable caulking compound 90. Preferably the vertical seam 88 is also caulked. The riser and return conduits 64 and 68 extend downwardly from the refrigerant coil and pass through snugly fitting access holes in the bottom insulating disk and cover plate 80. Metal bands 87 encircle the casing 86 and opposite vertical frame members 12 to secure the coils centrally within the upper housing and prevent lateral displacement thereof.

The foregoing arrangement has been found to be especially effective in cooling large quantities of water rapidly and in enabling the withdrawal of substantially the full capacity of the storage coil at a constant temperature. The exceptionally high rates of discharge at constant temperature possible with this device are made possible by the fact that the storage coil effectively restricts intermixing of warm liquid entering the coil and cooled liquid within the coil to a relatively short length of tubing at the inlet end of the coil.

Having illustrated and described a preferred embodiment of the invention, it should be apparent to those skilled in the art that the invention permits of modification in arrangement and detail. I claim as my invention all such modifications as come within the true spirit and scope of the appended claims.

I claim:

A device for cooling large quantities of water and withdrawing substantially all of such water within a short expanse of time at a substantially constant low temperature, said device comprising:

an upright frame structure, including a housing enclosing said structure,

said frame structure including shelf means dividing the interior of said housing horizontally into a relatively large upper compartment and a smaller lower compartment,

load-supporting insulating means supported on said shelf means in said upper compartment,

a single continuous, helically wound coil of water storage conduit comprising a plurality of turns supported on said load-supporting insulating means and extending substantially from the top to the bottom and from side to side of said upper compartment,

a single continuous, helically wound coil of refrigerant conduit extending within said water storage coil from end to end thereof,

the refrigerant coil having a number of turns corresponding to the number of turns of the water storage coil and having an outside diameter substantially no more than one-half the inside diameter of said water storage coil to provide for ample water storage capacity within said latter coil, said water storage coil being closed at both terminal ends,

a warm water supply conduit connected in flowing communication to the upper end of said water storage coil from a source of supply under pressure outside said housing,

a cold water outflow conduit connected to the lower end of said water coil and extending upwardly through the central space defined by the vertically extending said water storage coil to a source of demand outside said housing,

a riser refrigerant conduit extending upwardly from said lower compartment through said load-supporting insulation means and said central space into flowing communication with the upper terminal end of said refrigerant coil,

a return refrigerant conduit in flowing communication with the lower terminal end of said refrigerant coils and extending downwardly therefrom, through said load-supporting insulation, into said lower compartment,

compressor means in said lower compartment in communication with said riser and return conduits for compressing a refrigerant,

drive means in said lower compartment for driving said compressor means,

condenser means in said lower compartment on the high-pressure side of said compressor means for condensing said refrigerant, control means in association with said compressor means for regulating the temperature of water in said storage coil,

expansion valve means in that portion of said riser conduit within said central space in said upper compartment,

coil insulating means next adjacent said water storage coil and in communication with said load-supporting insulating means for encasing said storage coil,

thin, relatively nonporous wall means in abutment with the outer surfaces of said load-supporting insulating means and said coil insulating means for encasing and holding said coil insulating means in place,

said nonporous wall means being substantially hermetically sealed to prevent air from entering into the interior of the cooling unit defined by said wall means.

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ROBERT A. O'LEARY, *Primary Examiner.*