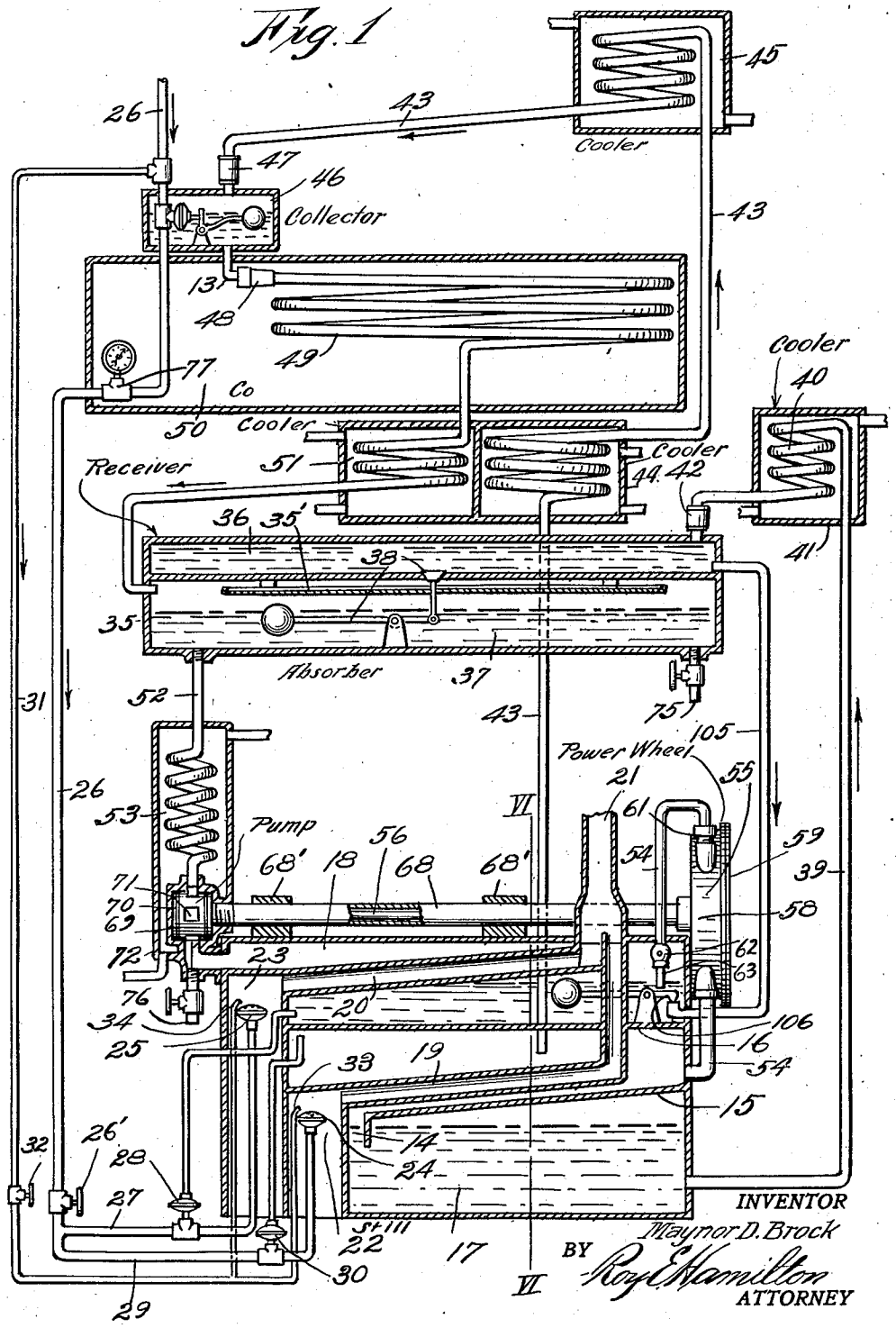
May 24, 1932. M. D. BROCK 1,860,133

AUTOMATIC CONTINUOUS REFRIGERATOR

Filed March 30, 1928 3 Sheets-Sheet 1

Fig. 1



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AUTOMATIC CONTINUOUS REFRIGERATOR

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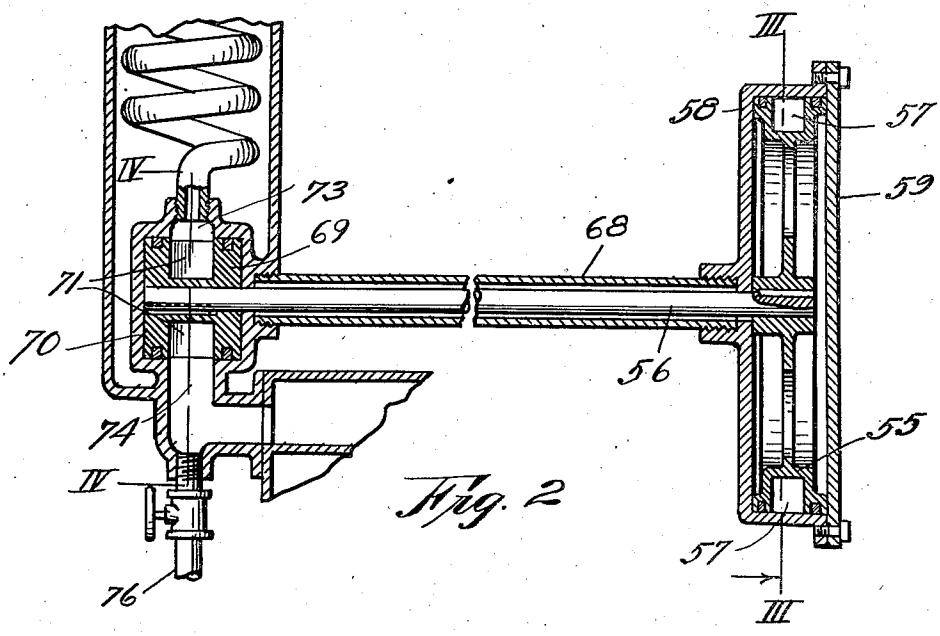

Fig. 2

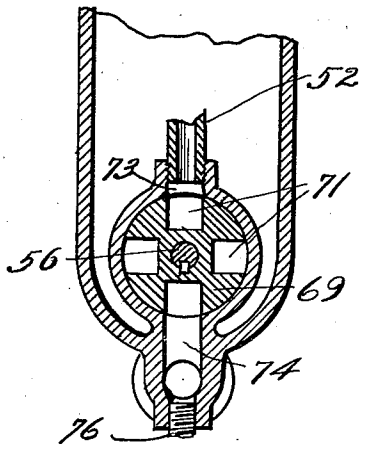

Fig. 4

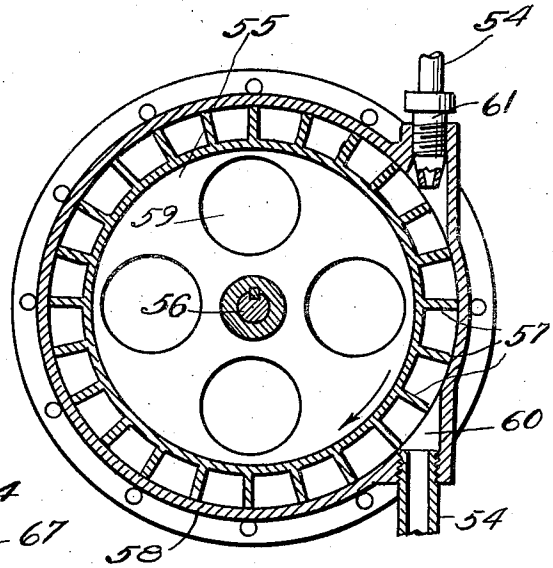

Fig. 3

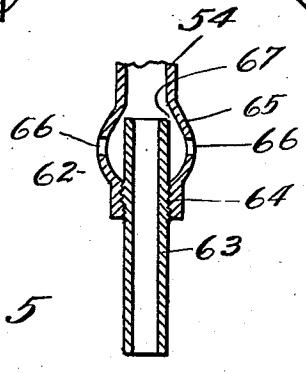

Fig. 5

INVENTOR
Maynor D. Brock
BY Roy C. Hamilton
ATTORNEY

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AUTOMATIC CONTINUOUS REFRIGERATOR

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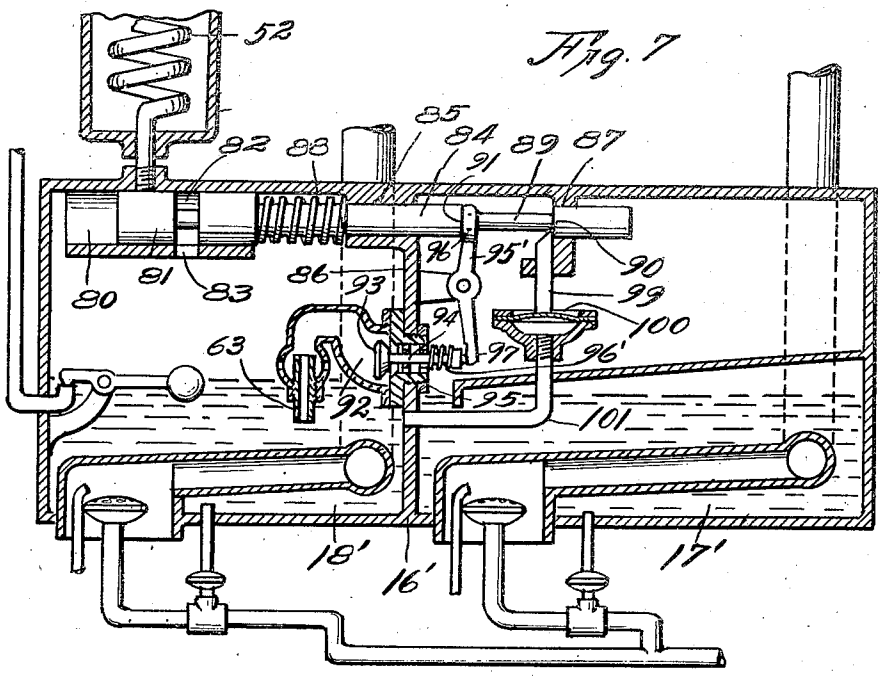

Fig. 7

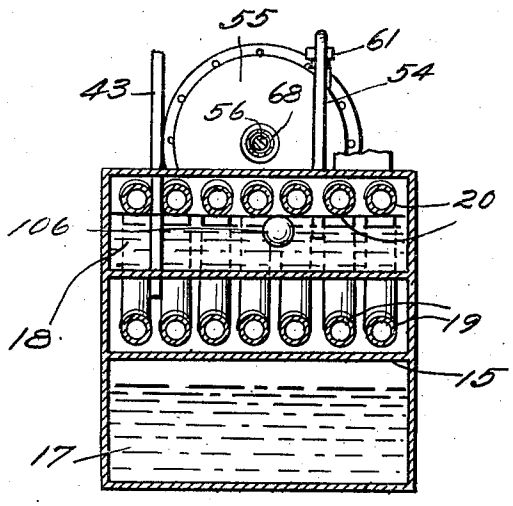

Fig. 6

INVENTOR
Maynor D. Brock
BY Roy E. Hamilton
ATTORNEY

Patented May 24, 1932 1,860,133

UNITED STATES PATENT OFFICE

MAYNOR D. BROCK, OF KANSAS CITY, MISSOURI

AUTOMATIC CONTINUOUS REFRIGERATOR

Application filed March 30, 1928. Serial No. 265,979.

The present invention relates to refrigerating systems of the absorption type, and has for its primary object the provision of a self-contained hermetically closed apparatus wherein circulation of fluid is obtained entirely under influence of factors within the apparatus.

Among the various objects of this invention are: a refrigerating system of the absorption type, in which the circulation of fluid within the closed circuit operates a mechanical device whereby the fluid is forced from the absorber in which the fluid is of relatively low pressure to the still where a relatively higher pressure is maintained; to provide a refrigerating system of the absorption type in which the circulation through the complete system is produced by the application of heat; to provide a refrigerating system of the absorption type, with a closed system having three separate compartments, each containing a fluid under pressure, and with different pressures in each compartment, while the machine is in operation; to provide a refrigerating system having a still with two compartments, with a power wheel located in a passageway connecting the two compartments, said wheel being rotated as the fluid flows from one compartment to the other, also a rotary device driven by said power wheel by means of which fluid from the absorber is transferred to the still; to provide a refrigerating system having heating means for the still which is automatically controlled by the system to maintain a predetermined temperature of refrigeration without danger of accident due to overheating; to provide a refrigerating system wherein a device is provided by means of which a mixture of gas and liquid is employed to operate a power device; to provide a refrigerating system having simplicity and economy of construction, ease, economy and safety of operation, and adaptability for use in domestic refrigerators.

In a refrigerating system of the absorption type, it is necessary to employ fluids having widely diverging boiling points, so that the more volatile fluid may be readily driven off by evaporation from the other by the application of heat, and also having an affinity for each other to insure the proper absorption. While this device has been designed for the use of ammonia as the refrigerant, and water as the absorbent, it is evident that any of the well known refrigerants and absorbents may be used without departing from the structure shown and claimed.

With these general objects in view, as well as minor objects, which will appear during the course of the detailed specification, the invention will now be described with reference to the accompanying drawings, wherein

Figure 1 is a diagrammatic view, partially in section, of a refrigerating system embodying this invention.

Fig. 2 is a fragentary view of the power wheel and rotary transfer device.

Fig. 3 is a section of the power wheel taken on line III—III of Fig. 2.

Fig. 4 is a section taken on line IV—IV of Fig. 2.

Fig. 5 is an enlarged view of the mixer taken on line V—V of Fig. 1.

Fig. 6 is a cross-section of the still taken on line VI—VI of Fig. 1, and

Fig. 7 is a sectional view showing a modified view of the still with reciprocating means for transferring the fluid from the absorber to the still.

Like reference characters refer to like parts throughout the several views, and the numeral 16 designates a still having two separate compartments 17 and 18, respectively. Compartment 18 is positioned above 17 in such a manner that heat from said lower compartment will assist in heating the contents of the upper compartment. This, however, is not essential, but is only for the purpose of economy in the use of the fuel. Extending through compartments 17 and 18, respectively, are heating tubes 19 and 20, which are connected to a common flue 21. Compartment 17 is partially divided horizontally by means of a division plate 15, which is so positioned as to form a narrow passage-way 14, whereby liquid deposited above said division plate may pass therebelow to expose only a small portion of the surface of said liquid to the gases which are above plate 15. Com-

municating with tubes 19 and 20, respectively, are heating chambers 22 and 23, in which are positioned burners 24 and 25, respectively. Said burners being in communication with pipe 26, whereby fluid fuel may be supplied to the same. Pipe line 27 leading from pipe 26 to burner 25 is provided with a pressure or temperature control valve 28, controlled by the pressure or temperature in compartment 18, which may be so adjusted as to regulate the flow of gas to said burner to produce a predetermined pressure in compartment 18. Likewise, pipe 29, communicating with burner 24 is provided with a pressure or temperautre control valve 30, controlled by the pressure or temperature in compartment 17, by means of which a predetermined pressure may be maintained in compartment 17. With this pressure control means, it is possible to maintain different pressures in the compartments. A direct flow line 31, having a control valve 32 connects with the pipe line 26 to supply fluid fuel to the pilot burners 33 and 34, respectively, thus making it possible to entirely shut off burners 24 and 25 during the operation of the apparatus, without interfering with the continuous operation of the system. Positioned above the still is a combined receiver and absorber 35 having the receiver 36 positioned above the absorber 37, with a liquid level control valve 38 positioned in said absorber and adapted to permit the flow of fluid from said receiver to said absorber when the fluid in the absorber falls below a predetermined level. I do not wish to limit 35 to a combined receiver and absorber, one above the other, as they may be separated and have a passage-way connecting the same. A tube 39 connects with the lower portion of compartment 17, and the upper portion of receiver 36, and is provided with a cooling coil 40 which is positioned within a water cooling jacket 41. To prevent a backward flow of fluid from the receiver 36 to the compartment 17, a check valve 42 is provided in pipe 39. Communicating with the upper portion of compartment 17, is a pipe 43 which passes through coolers 44 and 45, and thence into the liquid collector 46. A check valve 47 is provided in pipe 43 to prevent the flow of fluid from collector 46. Leading from the lower portion of collector 46 is a pipe 13, which communicates with an expansion valve 48 by means of which a relatively lower pressure is maintained in expansion coil 49, and by means of which fluid of higher pressure is discharged into said expansion coil to absorb heat in the cooling chamber 50. Fluid from the expansion coil 49 then passes through cooler 51 and into the absorber 35 where the refrigerant is again absorbed by the water and passes as a liquid through pipe 52 into cooler 53, where it is delivered back into the chamber 18 by means of a device which will hereinafter be fully described.

In this system of refrigeration, the pressure in the absorber is much less than the pressure maintained within chamber 18 of the still so that in order to transfer fluids from the absorber to the still, it is necessary to use a device operated by force produced within the system. For this purpose we have provided the following means:

By means of the burners 24 and 25, which are automatically controlled by the system, a greater pressure is maintained in compartment 18 than that maintained in compartment 17. A passage-way 54, between the compartments of the still is provided, which communicates with the upper portion of compartment 18, and the upper portion of compartment 17. Within passageway 54 is operably mounted a power wheel 55, having a series of radial blades 57 adjacent its outer periphery, and being keyed to a drive shaft 56. The wheel 55 is rotatably mounted in a housing 58 which is provided with a closure 59, by means of which said wheel is hermetically sealed therewithin, and in which any suitable lubricant may be placed to properly lubricate said wheel. As is clearly shown in Fig. 3, fluid from compartment 18 flowing through passage-way 54 will impinge radial blades 56, thereby forcing wheel 55 to rotate in the direction indicated by the arrow, and causing the rotation of shaft 57. As the wheel 55 rotates, the fluid deposited from above will be discharged through the outlet 60 and passage-way 56 into compartment 17. In order to maintain the proper predetermined pressure in compartments 17 and 18, to operate the wheel 55, a pressure regulating valve 61 is provided in the passage-way 54 which will not permit the passage of fluid from compartment 18 until the desired predetermined pressure is reached, in said compartment. Valve 61 may be any of the well known types. By this means, a differential of pressure in the two compartments is sufficient to produce a flow of fluid through passage-way 54, which will drive the power wheel 55.

For the purpose of causing a mixture of gas and liquid to pass through passage-way 54 to operate power wheel 55, a mixing device 62 is positioned on the end of said passage-way 54 in such a manner that the adjustable tube 63 which is screw threaded at 64 in the enlarged end 65 of the passage-way 54 extends below the liquid level in compartment 18, while the openings 66 in the enlarged portion 65 are above said liquid level so that gases from above the water level may pass therethrough. Tube 63 is positioned in 65 in such a manner that the opening 67 between the upper end of said tube and the wall of 65 is sufficient to allow only a portion of the fluid to pass therethrough, which is neces-

sary to operate the power wheel 55. Therefore, a portion of the liquid will be forced through tube 63 to mix with the gases entering at 67, to cause a proper combination. This device will also act as an injector, due to the fact that gases passing through the restricted opening 67 will tend to draw the liquid through tube 63.

Shaft 56, which is encased in a tubular housing 68, and in which a proper lubricant may be placed is securely keyed to a rotor 69 of a rotary pump 70. Rotor 69 is provided with a series of pockets 71 which are centrally located in its outer periphery. The housing 72, in which the rotor 69 is operably mounted, is provided with diametrically disposed passages 73 and 74, which communicate respectively with pipe 52 and compartment 18. Said openings being so positioned relative to the pockets 71 that as the rotor is moved, said pockets will successively communicate with said passages, and liquid at a low pressure will be delivered through pipe 52 into one of the pockets 71, then be rotated until the fill pocket registers with passage 74 when it will pass through said passage and be deposited into compartment 18, thereby transferring fluid from a low pressure area to a higher pressure compartment. Casing 72 also is extended to form a housing for the coiled portion of pipe 52 in which water is circulated for the purpose of cooling the fluid in said pipe. The power wheel and pump device is attached to the still by means of brackets 68', however, the relation of these parts may be varied to suit conditions.

For convenience in charging the system with the necessary fluid, valve controlled drain pipe 75 has been positioned in the bottom of the absorber, and also a valve controlled drain pipe 76 has been provided to communicate with passage 74.

It will be noted that the liquid level in the compartment is below the division plate 15. This arrangement is for the purpose of preventing the overheating of said liquid and also to prevent the absorption of refrigerant gases, as stated above.

It is desirable to maintain a predetermined temperature in the refrigerating box, and it is for this purpose that the thermostatically controlled valve 77 has been placed in the fuel line 26 to control the passage of fuel therethrough, and thereby maintain the proper temperatures and pressures within the system. Valve 77 is so controlled that when the temperature in the cooler drops below the predetermined set temperature, the supply of gas through pipe 26 will be decreased.

To prevent an excess of the liquid refrigerant in collector 46, a liquid level float 78 has been provided, which shuts off the flow of fuel in pipe 26, when the liquid in said collector rises above a fixed level. This is accomplished by the float operating the valve 79 to close it when said float is raised above the desired level.

When it is desired to close the system when not in operation, a valve 26' located in pipe 26 is closed, as is also the valve 32 in the pilot burner line.

The absorber 35 is provided with a spreader plate 35', which is positioned to receive liquid from the receiver for reasons hereinafter fully set forth.

To maintain a predetermined liquid level in compartment 18 by supplying liquid thereto, a pipe 105 is provided to connect receiver 36 with the lower portion of compartment 18. The flow through pipe 105 to the compartment is controlled by a liquid level control valve 106 which opens when the liquid in 18 drops below normal and again closes when the predetermined level is reached.

Fig. 7, which shows a modified form of the still and power means for transferring liquid from the absorber to the still will now be described. The main difference between this and that shown in the preferred form, is that instead of using rotary means for transferring said liquid, a reciprocating device is substituted. Also, the two compartments of the still 17' and 18' of the still 16' are placed in a horizontal position. The heating devices with their pilot lights and controls are identical in operation with those shown in the preferred form. Positioned within the upper portion of chamber 18' is a cylinder 80 in which is reciprocably mounted a piston 81, having an annular recess 82 which alternately registers with opening 83 in cylinder 80, which communicates with compartment 18' and with the pipe 52 which leads from the absorber. Piston 81 is of such dimension as will cause the proper closing of 52 when 83 is open, and vice versa. Piston 81 is provided with a concentric stem 84 which extends through the opening 85 in the partition 86 between the two compartments 17' and 18', thence through a supporting bracket 87 which is carried by the walls of compartment 17'. Positioned on the stem 84, intermediate the piston 81 and the partition wall 86, is a coil spring 88, which normally holds said recess 82 in register with pipe 52. As clearly shown, the outer end of piston 81 is entirely exposed to the pressure in compartment 18', while the inner end of said piston is not exposed in as great a degree, inasmuch as the stem 84 extends through partition wall 86 and into compartment 17'. Therefore, when the device is in operation, the normal tendency of said piston would be to move inwardly against the action of spring 88. That portion of the stem 84, which extends within compartment 17' is provided with an elongated annular channel 89 intermediate the bracket 87, and the partition wall 86, thus forming shoulders 90 and 91. A passage-way 92, between compartments 18' and 17' is adapted to be closed

by means of valve 93, having a valve stem. Said stem being slidably mounted in housing 95 and being provided with a compression spring 96′, which normally tends to hold said valve in the closed position. Pivotally mounted in compartment 17′, intermediate stem 84 and valve 94, is a rocker arm 95′. Opposite ends 96 and 97 of arm 95′ are adapted to operably engage shoulder 91 and valve stem 94, respectively, so that when recess 82 is in alignment with opening 83, rocker arm 95′ will engage valve stem 94 to open valve 93 against the action of spring 98, and when recess 82 is in register with pipe 52, valve 93 will be closed. To maintain valve 93 in the open position until the pressures in compartment 18′ and 17′ become properly adjusted, a pressure regulated stop 99 is provided. This stop is slidably mounted in bracket 87, and engages the shoulder 90 on stem 84 through the action of a pressure operated diaphragm 100 to which pressure is transferred through pipe 101 communicating with compartment 18′. As it is desirable to pass both gas and liquid from compartment 18′, through passage-way 92, and into compartment 17′, the device 62, shown in the preferred form, has been provided.

The operation of the system is as follows: The absorber and compartments of the still are charged with the proper amount of liquid which has been formed by mixing a refrigerant and absorber in proportion best adapted for use in this system. All heat and liquid level regulating devices are properly regulated and adjusted as the parts are assembled in manufacture. Valve 32 in fuel gas line 31, which connects with pipe 26 is opened and the pilot burners 33 and 34 lighted. Valve 26′ in line 26, which is supplied with fluid fuel from any desirable source, not shown, is opened and said fuel permitted to flow to burners 24 and 25, due to the fact that all valves in the fuel line are then open. Fuel issuing from the burners is then ignited by the pilot lights, and heat is applied to the liquid contained within the two compartments 17 and 18. When the predetermined pressures have been attained in compartments 17 and 18, fluid will pass through pipe 54 to operate the pressure regulating valve 61, which will open to permit the discharge of fluids against the radial blades 56 of power wheel 55, thereby rotating said wheel. The discharge of fluid from said wheel is permitted through passage 60 and pipe 54 into chamber 17. The mixer 62 is properly adjusted to cause a proper quantity of gas and liquid to be used in the operation of driving the power wheel 55. This mixing operation has been thoroughly described above.

As the vapors are driven off from the liquid in compartment 17 by the action of heat, said vapors will pass from the compartment through pipe 43, thence into the first cooler 44 where the steam will be condensed and permitted to flow back into compartment 17, while the refrigerant gases, which have a lower boiling point will pass on upwardly into the cooler 45, where it is condensed and permitted to flow by gravity past check valve 47 and into collector 46. When a sufficient pressure has been built up in compartment 17, and its connecting pipes, the liquid refrigerant in the collector 46 will be discharged through the expansion valve 48, into the expansion coils 49, which is located in the refrigerator box 50. Thus absorbing the heat in said box to cause refrigeration. The gas from the expansion coil then passes through the cooler 51 and into the absorber where it will again be absorbed by the absorbent and the liquid contained therein. Liquid from the absorber enters pipe 52 which is provided with a cooler 53, and is then transferred from this compartment of low pressure to the still where a higher pressure is maintained, by means of the rotary pump 70 which is driven by the power wheel 55, the operation of which has been fully described. For the purpose of maintaining a proper amount of weak solution in the absorber, a pipe connection 39 is in communication with the lower portion of compartment 17, which contains a quantity of said weak solution, extends to and is in communication with the receiver 36. Intermediate said compartment and receiver, the pipe is provided with a cooling coil 40, and also a check valve 42 which prevents back flow of said liquid and gases from said receiver. When the liquid level in the absorber drops below the predetermined level, control valve 38 will open and permit a flow of the weak solution from said receiver into said absorber, until the proper liquid level is again attained. Also, to facilitate the absorption of gases entering the absorber, the weak solution entering from the receiver is spread out over a deflector 35′ which is located above the liquid level. Should the liquid level in compartment 18 drop below the desired height, liquid from the receiver will then be transferred into said compartment as described above. Should the pressures in compartments 17 and 18 become too high, it is apparent that the control valves 28 and 30, which are regulated by the pressures in said compartments, respectively, will so control the gas flow to the burners, that less heat will be applied to said compartments, and the pressure will again return to normal.

With the construction as shown and described, it is apparent that any predetermined temperature may be uniformly maintained in the compartment 50. Due to the construction of the system, different pressures may be constantly maintained in the three zones or divisions, as described, and a strong flow

of fluid between the two compartments of the still will be obtained so that a suitable power device may be operated thereby, to force the low pressure liquid in the absorber into the higher pressure compartment of the still.

I do not limit this invention to the structure shown and described, as many modifications may be made within the scope of the appended claims without departing from the spirit thereof.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a refrigerating system of the character described, an absorber, a still having two separate compartments, means controlled by the system to maintain a differential of pressure in said compartments, a passage-way between said compartments, a mixing device attached to said passage-way whereby a mixture of gas and liquid is forced through said passage-way, a power wheel operably positioned in said passage-way, and a rotary pump driven by said power wheel to transfer liquid from said absorber to said still.

2. In a refrigerating system of the character described, an absorber, a still having two compartments, one positioned above the other, means controlled by the system to maintain a differential of pressure in said compartments, a passage-way between said compartments, a power wheel operably positioned in said passage-way, and a rotary pump driven by said power wheel to transfer liquid from said absorber to said still.

3. In an absorption refrigerating system of the character described, a distilling device having two separate compartments, an expansion chamber, an absorber, cooling means and heating means controlled by the system to maintain a differential of pressure in each of said compartments and expansion chamber respectively when the system is in operation.

4. In a refrigerating system of the character described, an absorber, a still having two separate compartments, a solution containing a refrigerant fluid and an absorbent fluid in each compartment, heating means controlled by the system to maintain a differential of pressure in said compartments, means for causing the flow of fluid from one compartment to the other when a predetermined pressure is reached in the higher pressure compartment, means for condensing and collecting refrigerant vapor driven from the compartment of lower pressure, means for discharging said condensed refrigerant into an expansion chamber of lower pressure, and to receive weak solution from said still, and mechanical means driven by the flow of fluid in said system whereby liquid from said absorber is forced into said still.

5. In a refrigerating system of the character described, an absorber, a still having two separate compartments, a receiver, a solution containing a refrigerant fluid and an absorbent fluid in each compartment, heating means controlled by the system to maintain a differential of pressure in said compartments, means for causing the flow of fluid from one compartment to the other when a predetermined pressure is reached in the higher pressure compartment, means for condensing and collecting refrigerant vapor driven from the compartment of lower pressure, means for discharging said condensed refrigerant into an expansion chamber of lower pressure, a connection between said receiver and lower pressure compartment, a valve controlled connection to said absorber from said receiver, said absorber to receive vapors from said expansion chamber, and to receive weak solution from said still, and mechanical means driven by the flow of fluid in said system whereby liquid from said absorber is forced into said still.

6. In a refrigerating system of the character described, as absorber, a still having two separate compartments, one positioned above the other, a receiver positioned above said absorber, a liquid level valve controlled connection from said upper compartment to said receiver, a liquid level control valve between said receiver and absorber, a solution containing a refrigerant fluid and an absorbent fluid in each compartment, heating means controlled by the system to maintain a differential of pressure in said compartments, whereby fluid will flow from the upper compartment to the lower compartment, means for causing the flow of fluid from the upper compartment when a predetermined pressure has been reached therein, means for condensing and collecting refrigerant vapor driven from the lower compartment, means for discharging said condensed refrigerant in an expansion chamber of lower pressure, a connection between said receiver and lower compartment whereby a weak solution is forced from said lower compartment to said receiver, connection from said expansion chamber to said absorber, and mechanical means driven by the flow of fluid in said system whereby liquid from said absorber is forced into the upper compartment of said still.

7. A process of refrigeration which comprises applying heat to a solution including a refrigerant fluid and an absorbent fluid in a container, whereby refrigerant vapor is driven off, raising said refrigerant vapor to a predetermined pressure within said container by the application of heat, then mixing liquid with said vapor and discharging the same through a power device into a region of lower pressure, collecting said discharged liquid in a separate compartment, condensing the refrigerant vapor, then expanding said condensed refrigerant by de-

livering it into a region of lower pressure, withdrawing a portion of the solution from said separate compartment into a separate receiver, cooling said withdrawn solution during its withdrawal, depositing a portion of said cooled solution in an absorber, reabsorbing the expanded refrigerant in said absorber and returning the strong solution in said absorber to the original container by means of said power device.

In testimony whereof, I hereunto affix my signature.

MAYNOR D. BROCK.