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METHOD OF REFRIGERATION

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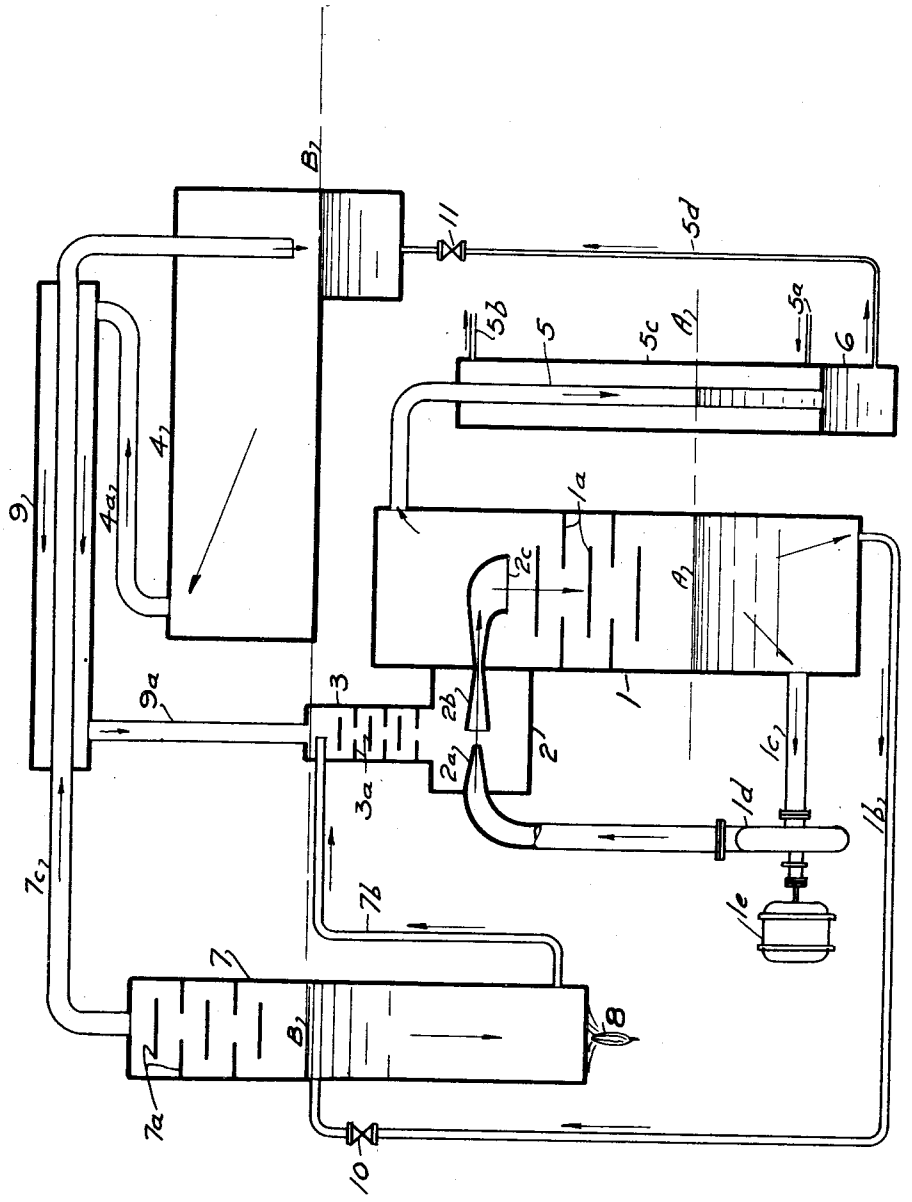


FIG. 1

INVENTOR

Bo Folke Randel

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BO FOLKE RANDEL, OF SAN DIEGO, CALIFORNIA

METHOD OF REFRIGERATION

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My invention relates to refrigerating method and the objects thereof are: First, to provide circulation of the mediums through the apparatus by utilizing the kinetic energy in a moving body of liquid; Second, to cause compression of a refrigerating medium by utilizing the kinetic energy in a moving body of liquid; Third, to cause the absorption of a secondary medium in one side of the apparatus into the liquid used by the removal of heat and cause the evaporation of said secondary medium out of the said liquid in another side of the apparatus by the application of heat or by lowering of the pressure; Fourth, to devise a method of refrigeration where the pressures are comparatively small, permitting economical construction of the apparatus and a low power consumption.

With these and other objects in view as will appear hereinafter, my invention consists of a certain novel method to produce refrigeration and certain arrangements of parts in an apparatus to accomplish this method of refrigeration as will hereinafter be described in detail and particularly set forth in the appended claims, reference being had to the accompanying drawing and to the character of reference thereon which form a part of this application in which:

Fig. 1 is a diagrammatical view, showing arrangement of parts of my apparatus used to carry out my method of refrigeration, and wherein 1 is the pressure chamber, 2 suction chamber, 3 absorber, 4 evaporator, 5 condenser, 6 receiver for liquid refrigerant, 7 generator, 8 heating element, and 9 heat exchanger.

The different parts of the apparatus necessary for carrying out my method of refrigeration are conventional and well known in the arts and may be constructed in many different forms. The condenser 5 may therefore be constructed as shown, allowing for cooling by water, this cooling water entering at 5*a*, filling jacket 5*c* and discharging at 5*b*. Condenser may also be constructed to allow for air cooling.

Absorber 3 may be constructed for air or water cooling as desired.

Generator 7 may be heated by flame 8 or by steam or hot water coil as conventional for such generators.

Liquid jet nozzle 2*a* and ejector nozzle 2*b*, the purpose of which is to cause a lowering of pressure in chamber 2 by exhausting vapors and liquids therefrom, may be constructed as shown, or any suitable arrangement utilizing the kinetic energy in a moving body of liquid to cause circulation may be used. Many of the present conventional vacuum pumps, employing a liquid as actuating agent, either by jet or jets or through centrifugal action in a pump casing, can be used in my system of refrigeration.

Evaporator 4 may be constructed in any conventional form or may be an ordinary pipe coil.

Baffle plates 1*a* in chamber 1, 3*a* in chamber 3, and 7*a* in chamber 7, the purpose of which is to assist in thoroughly mixing the different mediums and thus hasten the action, may also be constructed in several ways or may be entirely eliminated. Any construction which will assist in mixing the different mediums during the passage through the apparatus will be suitable in my method of refrigeration.

It is seen that in the arrangement of parts as shown in Fig. 1, the action of pump 1*d*, driven by motor 1*e* will cause a general circulation through the apparatus as follows: Pressure in chamber 2 will be lowered and in chamber 1 will be raised. Liquid in chamber 1 will pass through pipe 1*b* and discharge into generator 7; thence overflow and pass through pipe 7*b* into absorber 3 and through chamber 2 back to chamber 1. Any liquid in receiver 6 will be forced up through pipe 5*d* into evaporator 4, and assuming that the specific gravity of this liquid is the same as the specific gravity of the liquid in chamber 1, a level B will be maintained in chambers 4 and 7. This condition is, however, not necessary.

Pressures in chambers 7 and 4, these chambers being in communication, will be the same, and similarly the pressures in chambers 1 and 5 will be the same. The pressure difference between chambers 4, 7 and chambers 1, 5 will be the height of liquid column from level A to level B. If a larger pressure dif-

ference is desired, control valves 10 and 11, inserted in pipes 5*d* and 1*b* are operated.

Due to ejector action in chamber 2, any vapors in chamber 4 will be drawn through 4*a*, heat exchanger 9 and pipe 9*a* into chamber 3, and any vapors generated in generator 7 will pass through pipe 7*c*, heat exchanger 9, evaporator 4, and again through heat exchanger 9 into absorber 3.

I employ three mediums in the apparatus wherein my method of refrigeration is carried out.

The primary, or refrigerating medium is a gas, which may be readily liquefied under pressure.

The secondary, or supplementary medium is a gas, inert to the primary medium, but soluble in the tertiary medium, from which solution it may be driven out by the application of heat.

The tertiary, or motive power medium, is a liquid, in which the secondary medium may be absorbed, but which is inert towards the primary medium.

While many different mediums may be employed in my method, and I include any and all such mediums having the characteristics as enumerated above, I choose for purpose of more fully explaining the operation of my method the following mediums:

As primary medium, I select hexane vapor, as secondary medium ammonia vapor, and as tertiary medium, water. Hexane is insoluble in water and inert towards ammonia. Ammonia may be absorbed in water and again driven out of the solution by the application of heat.

It is assumed that the temperatures are maintained as follows: In condenser and absorber 90 degrees F. and in evaporator 10 degrees F. Under these conditions, pressure in condenser necessary to liquefy hexane vapor will be 4 pounds absolute, and evaporating pressure must be maintained at 0.4 lbs. abs. or less. These figures are approximate.

It is assumed further that the total pressure maintained throughout the apparatus is atmospheric or in round numbers 15 pounds abs. As previously stated, there will be a slight pressure difference due to the ejector action, sufficient to overcome liquid column from A to B, but this difference will be eliminated in the calculations. This pressure difference may be made larger by manipulating valves 10 and 11, inserted in pipes 5*d* and 1*b*, when it is desirable to operate under such conditions.

Due to the principle covering gases in mixture, the ammonia vapor will take up the balance of pressure throughout the apparatus to maintain this total of 15 lbs. abs. pressure. Pressure on ammonia in chamber 1 will therefore be 11 lbs. abs. with hexane under 4 lbs.

While hexane gas will tend to diffuse through the ammonia vapor, due to the general motion of vapors as indicated by arrows, it may be assumed that vapors in chamber 7, produced by application of heat to the generator, said vapors discharging into evaporator 4, are pure ammonia vapors under the total of 15 pounds abs. pressure.

With pressure on ammonia vapor in chamber 1 at 11 pounds abs. and a maintained temperature of 90 degrees F., the solution of water and ammonia in this chamber will be 24% concentration. Through the ejector action in chamber 2, this 24% solution is driven through pipe 1*b* into generator 7. It is assumed that sufficient heat is applied at this point to lower the solution to 18%. At 15 lbs. pressure, the temperature to do this will be approximately 125 degrees, or too low to vaporize any of the water, the gas generated in chamber 7 being practically dry gas. When valves 10 and 11 are added to the system, the pressure in generator may be maintained sufficiently low to cause evaporation of ammonia under normal temperature without addition of heat by a flame or heating coil, etc.

As ammonia vapors are absorbed in chambers 3 and 1, hexane vapor drawn in from evaporator 4, together with the ammonia, will accumulate in chamber 1, and this accumulation will cause liquefaction of same in condenser 5, the liquid collecting in receiver 6. The absorption of the ammonia in absorber 3 will take place when the weak liquor from generator trickles through same on the passage back to chamber 1.

The liquefied hexane will be driven up through pipe 5*d* into evaporator 4, which is filled with ammonia vapor under the total or 15 lbs. pressure. Into this evaporator, the hexane will evaporate as into a vacuum, and the resulting mixture of vapors will pass through absorber 3 back into chamber 1, there again to separate by condensation of the hexane and absorption of the ammonia.

The following will illustrate my method of refrigeration when a larger pressure difference is maintained between chamber 1 and chambers 4 and 7. In this slightly modified method, no heat is applied to generator, also valves 10 and 11 are inserted to control the pressure difference.

It is assumed as before that total pressure in chamber 1 and condenser is maintained at 15 lbs. abs. It is further assumed that through ejector action in chamber 2 and by throttling of valves 10 and 11, the total pressure in chambers 2, 3, 4, and 7 is maintained at 5 lbs. absolute.

Under 5 lbs. absolute, the 24% solution in generator 7 will boil at 60 degrees temperature, reducing the concentration to 18%. The ordinary room temperature will therefore be sufficient to evaporate ammonia from the solution.

This ammonia at 5 lbs. pressure will enter chamber 4 and the hexane liquid will boil as previously stated, producing refrigeration.

In evaporating in evaporator 4, each pound of hexane will remove approximately 160 heat units, thus producing refrigeration.

Having thus described my invention, what I claim as new and desire to secure by Letters Patents is:

1. A method of refrigeration, wherein a refrigerating medium inert towards a supplementary medium is separated from said supplementary medium by, on one hand, condensing and liquefying of the said refrigerating medium and, on the other hand, the absorption of said supplementary medium into a liquid medium which comprises, imparting motion to said liquid medium and utilizing the kinetic energy of said liquid in motion to cause a general circulation of said refrigerating medium said supplementary medium and said liquid through the different parts of the apparatus, then separating the absorbed supplementary medium out of the said liquid by mechanical action, then mixing the said liquefied refrigerating medium with the said separated supplementary medium in pressure proportions to cause evaporation of said liquefied refrigerating medium causing the removal of heat, then bringing the mixture of refrigerating medium and supplementary medium back to first mentioned point of separation, thus completing the cycle.

2. A method of refrigeration, wherein a refrigerating medium inert towards a supplementary medium is separated from said supplementary medium by, on one hand, condensing and liquefying of the said refrigerating medium and, on the other hand, the absorption of said supplementary medium into a liquid medium which comprises, imparting motion to said liquid medium and utilizing the kinetic energy of said liquid in motion to cause a general circulation of said refrigerating medium said supplementary medium and said liquid through the different parts of the apparatus, then separating the absorbed supplementary medium out of the said liquid by lowering of the pressure, then mixing the said liquefied refrigerating medium with the said separated supplementary medium in pressure proportions to cause evaporation of said liquefied refrigerating medium causing the removal of heat, then bringing the mixture of refrigerating medium and supplementary medium back to first mentioned point of separation, thus completing the cycle.

3. A method of refrigeration which comprises producing a general circulation of a combination of mediums by the kinetic energy of a moving body of liquid, bringing a liquid refrigerating medium into the presence of a supplementary gaseous medium in pressure proportions as to cause evaporation of the said liquid refrigerating medium, absorbing the supplementary medium and separating the supplementary medium from an absorption medium by reducing the pressure on the solution.

4. A method of refrigeration, which comprises producing a general circulation of a combination of mediums by the kinetic energy of a moving body of liquid, bringing a liquid refrigerating medium into the presence of a supplementary gaseous medium in pressure proportions as to cause evaporation of the said liquid refrigerating medium, separating the refrigerating medium from the supplementary medium by condensing said refrigerating medium to liquid form and absorbing said supplementary medium in the first mentioned liquid then separating said supplementary medium from said liquid by mechanical action, bringing said supplementary medium back to its initial gaseous state, thus completing the cycle.

5. A method of refrigeration employing a refrigerating medium, a supplementary gaseous medium substantially inert towards the said refrigerating medium, and a liquid medium substantially inert towards the said refrigerating medium but capable of absorbing the said supplementary gaseous medium, which comprises bringing the said refrigerating medium in liquid state into the presence of the said supplementary gaseous medium in pressure proportions as to cause evaporation of the said refrigerating medium in liquid state separating said supplementary medium from said refrigerating medium by absorbing said supplementary medium in said liquid medium and then separating said absorbed supplementary medium from said liquid by reducing the pressure on the solution.

6. A method of refrigeration employing a refrigerating medium, a supplementary gaseous medium substantially inert towards the said refrigerating medium and a liquid medium substantially inert towards the said refrigerating medium but capable of absorbing the said supplementary gaseous medium, which comprises bringing the said refrigerating medium in liquid state into the presence of the said supplementary gaseous medium in pressure proportions as to cause evaporation of the said refrigerating medium in liquid state, then separating the said refrigerating medium from the said supplementary medium by condensing the said refrigerating medium to liquid state and absorbing the said supplementary gaseous medium into the said liquid medium, separating said absorbed medium from said liquid by reducing the pressure.

7. A method of refrigeration employing a refrigerating medium, a supplementary gaseous medium substantially inert towards the said refrigerating medium and a liquid me-

dium substantially inert towards the said refrigerating medium but capable of absorbing the said supplementary gaseous medium, which comprises bringing the said refrigerating medium in liquid state into the presence of the said supplementary gaseous medium in pressure proportions as to cause evaporation of the said refrigerating medium in liquid state, then separating the said refrigerating medium from the said supplementary medium by condensing the said refrigerating medium to liquid state and absorbing the said supplementary gaseous medium into the said liquid medium, then separating the said absorbed supplementary gaseous medium from the said liquid medium by reducing the pressure bringing the said supplementary gaseous medium and the said refrigerating medium in liquid state back to point of beginning in presence of each other and wherein a general circulation of the mediums is caused by a mechanical force.

8. A method of refrigeration employing a refrigerating medium, a supplementary gaseous medium substantially inert towards the said refrigerating medium, and a liquid medium substantially inert towards the said refrigerating medium, but capable of absorbing the said supplementary gaseous medium, which comprises bringing the said refrigerating medium in liquid state into the presence of the said supplementary gaseous medium in pressure proportions as to cause evaporation of said refrigerating medium in liquid state, and wherein said supplementary medium after having been separated from the refrigerating medium by being absorbed in the liquid medium is later separated from said liquid medium by mechanical action.

9. A method of refrigeration employing a refrigerating medium, a supplementary gaseous medium substantially inert towards the said refrigerating medium and a liquid medium substantially inert towards the said refrigerating medium but capable of absorbing the said supplementary gaseous medium, which comprises bringing the said refrigerating medium in liquid state into the presence of the said supplementary gaseous medium in pressure proportions as to cause evaporation of the said refrigerating medium in liquid state, then separating the said refrigerating medium from the said supplementary medium by condensing the said refrigerating medium to liquid state and absorbing the said supplementary gaseous medium into the said liquid medium, then separating said supplementary medium from said liquid by reduction of the pressure upon the solution and wherein a general circulation of the mediums is caused by ejector action.

10. A method of refrigeration employing a refrigerating medium, a supplementary gaseous medium substantially inert towards the said refrigerating medium and a liquid medium substantially inert towards the said refrigerating medium but capable of absorbing the said supplementary gaseous medium, which comprises bringing the said refrigerating medium in liquid state into the presence of the said supplementary gaseous medium in pressure proportions as to cause evaporation of the said refrigerating medium in liquid state, then separating the said refrigerating medium from the said supplementary medium by condensing the said refrigerating medium to liquid state and absorbing the said supplementary gaseous medium into the said liquid medium, then separating the said absorbed supplementary gaseous medium from the said liquid medium by reducing the pressure on the solution bringing the said supplementary gaseous medium and the said refrigerating medium in liquid state back to the point of beginning in presence of each other and wherein a general circulation of the mediums is caused by ejector action.

11. A method of refrigeration which comprises evaporating a condensable cooling agent in the presence of a non-condensable gas; absorbing the non-condensable gas in absorption liquid and separating the cooling agent; condensing the cooling agent; reducing the pressure on the absorption liquid to separate therefrom the non-condensable gas; and again evaporating the cooling agent in the presence of the non-condensable gas, circulation of the mediums being caused by a mechanical force.

12. A method of refrigeration which comprises introducing a liquid cooling agent into the presence of a non-condensable gas, thus evaporating the cooling agent and forming a mixture of gases, introducing a liquid into the presence of the mixture into which the cooling agent is less soluble than the non-condensable gas thus separating the cooling agent; condensing the cooling agent; separating the non-condensable gas from the liquid by reduction of the pressure; and again introducing the liquid cooling agent into the presence of the non-condensable gas, circulation of the mediums being caused by a mechanical force.

13. A method of refrigeration which comprises introducing a liquid cooling agent into the presence of a non-condensable gas, thus evaporating the cooling agent and forming a mixture of gases, introducing a liquid into the presence of the mixture in which the cooling agent is less soluble than the non-condensable gas, thus separating the cooling agent; condensing the cooling agent; separating the non-condensable gas from the liquid by reduction of the pressure; cooling the non-condensable gas; and again introducing the liquid cooling agent into the presence of the non-condensable gas, circulation of the mediums being caused by a mechanical force.

14. That improvement in the art of refrigerating which consists in expelling a non-condensable gas from an absorption liquid by reduction of the pressure, conducting the expelled gas into the presence of a liquid cooling agent so that the cooling agent evaporates, conducting the mixture of non-condensable gas and gaseous cooling agent thus formed into the presence of the absorption liquid, absorbing the non-condensable gas and liquefying the cooling agent, circulation of the mediums being caused by a mechanical force.

15. That improvement in the art of refrigeration which consists in bringing a mixture of gaseous fluids into contact with a medium having a greater affinity to one of the fluids of the mixture than another, so that one fluid is absorbed and another is liberated, liquefying the liberated fluid, by the reduction of the pressure expelling the absorbed fluid from said medium in vapor form and introducing the last mentioned fluid in gaseous form into the presence of the liquefied fluid, circulation of the mediums being caused by a mechanical force.

16. That improvement in the art of refrigerating through the agency of an absorption system which consists in evaporating a cooling agent in the presence of a non-condensable gas, serving to equalize pressure, generating force by mechanical means within the system, circulating the cooling agent in the system due to said force, transporting the non-condensable gas in the system from the absorber to the evaporator by first absorbing same in an absorption agent, then by the reduction of the pressure on the resultant solution separating same from said absorption agent and introducing the non-condensable gas into the evaporator in gaseous form.

17. A method of refrigeration, wherein a refrigerating medium inert towards a supplementary medium is separated from said supplementary medium by, on one hand, condensing and liquefying of the said refrigerating medium and, on the other hand, the absorption of said supplementary medium into a liquid medium which comprises, imparting motion to said liquid medium through the means of an external mechanical force and utilizing the kinetic energy of said liquid in motion to cause a general circulation of said refrigerating medium said supplementary medium and said liquid through the different parts of the apparatus, then separating the absorbed supplementary medium out of the said liquid by the application of heat, then mixing the said liquefied refrigerating medium with the said separated supplementary medium in pressure proportions to cause evaporation of said liquefied refrigerating medium causing the removal of heat, then bringing the mixture of refrigerating medium and supplementary medium back to first mentioned point of separation, thus completing the cycle.

18. A method of refrigeration which consists in producing a general circulation of a combination of mediums by the kinetic energy of a moving body of liquid, generating the motion of said body of liquid by an external force, and bringing a liquid refrigerating medium into the pressure of a supplementary gaseous medium in pressure proportions as to cause evaporation of the said liquid refrigerating medium.

19. A method of refrigeration, which consists in producing a general circulation of a combination of mediums by the kinetic energy of a moving body of liquid, generating the motion of said body of liquid by an external force, and bringing a liquid refrigerating medium into the presence of a supplementary gaseous medium in pressure proportions as to cause evaporation of the said liquid refrigerating medium, then separating the refrigerating medium from the supplementary medium by condensing said refrigerating medium to liquid form and absorbing said supplementary medium in the first mentioned liquid.

20. A method of refrigeration employing a refrigerating medium, a supplementary gaseous medium substantially inert towards the said refrigerating medium, and a liquid medium substantially inert towards the said refrigerating medium, but capable of absorbing the said supplementary gaseous medium, which consists in bringing the said refrigerating medium in liquid state into the presence of the said supplementary gaseous medium in pressure proportions as to cause evaporation of said refrigerating medium in liquid state, and producing a general circulation of the mediums by ejector action, said ejector action being produced by a mechanical force.

21. A method of refrigeration employing a refrigerating medium, a supplementary gaseous medium substantially inert towards the said refrigerating medium and a liquid medium substantially inert towards the said refrigerating medium but capable of absorbing the said supplementary gaseous medium, which consists in bringing the said refrigerating medium in liquid state into the presence of the said supplementary gaseous medium in pressure proportions as to cause evaporation of the said refrigerating medium in liquid state, then separating the said refrigerating medium from the said supplementary medium by condensing the said refrigerating medium to liquid state and absorbing the said supplementary gaseous medium into the said liquid medium, a general circulation of the mediums being produced by ejector action, said ejector action being produced by means of a mechanical action.

22. A method of refrigeration employing a refrigerating medium, a supplementary gaseous medium substantially inert towards the said refrigerating medium and a liquid medium substantially inert towards the said refrigerating medium but capable of absorbing the said supplementary gaseous medium, which consists in bringing the said refrigerating medium in liquid state into the presence of the said supplementary gaseous medium in pressure proportions as to cause evaporation of the said refrigerating medium in liquid state, then separating the said refrigerating medium from the said supplementary medium by condensing the said refrigerating medium to liquid state and absorbing the said supplementary gaseous medium into the said liquid medium, then separating the said absorbed supplementary gaseous medium from the said liquid medium bringing the said supplementary gaseous medium and the said refrigerating medium in liquid state back to the point of beginning in presence of each other, a general circulation of the mediums being produced by ejector action, said ejector action being produced mechanically.

In testimony whereof, I have hereunto set my hand at San Diego, California, this 2nd day of November, 1929.

BO FOLKE RANDEL.