Dec. 16, 1952 M. W. BEARDSLEY ET AL 2,621,492

APPARATUS AND METHOD FOR PRECOOLING MATERIAL BY VACUUM-INDUCED EVAPORATION

Filed July 18, 1949 2 SHEETS—SHEET 1

Fig. 1.

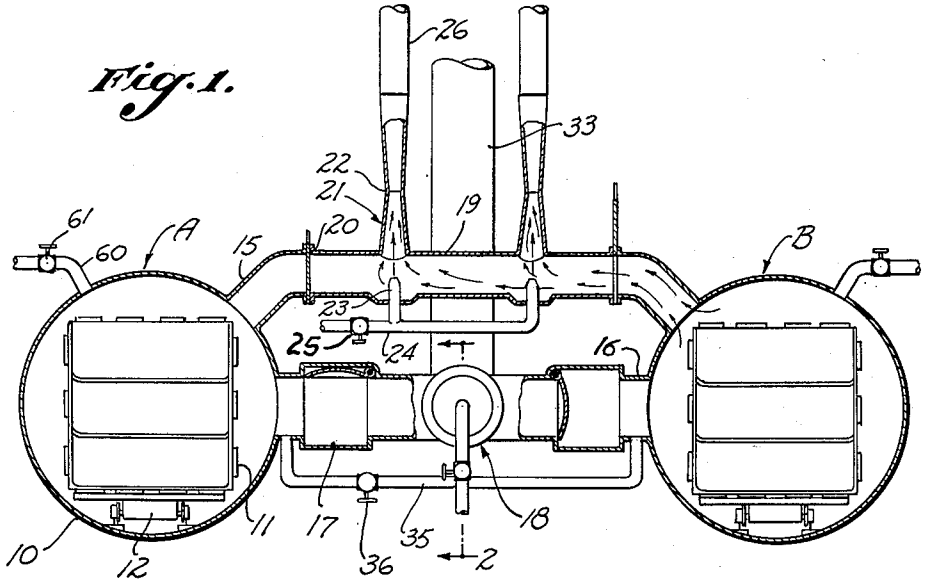


Fig. 2.

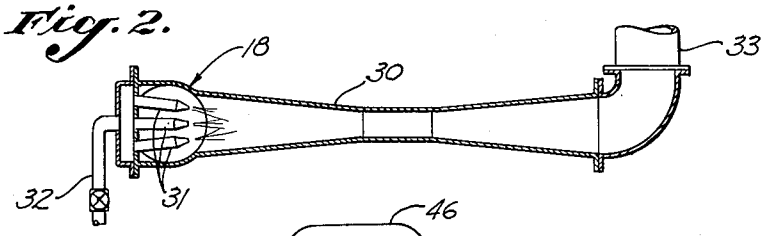
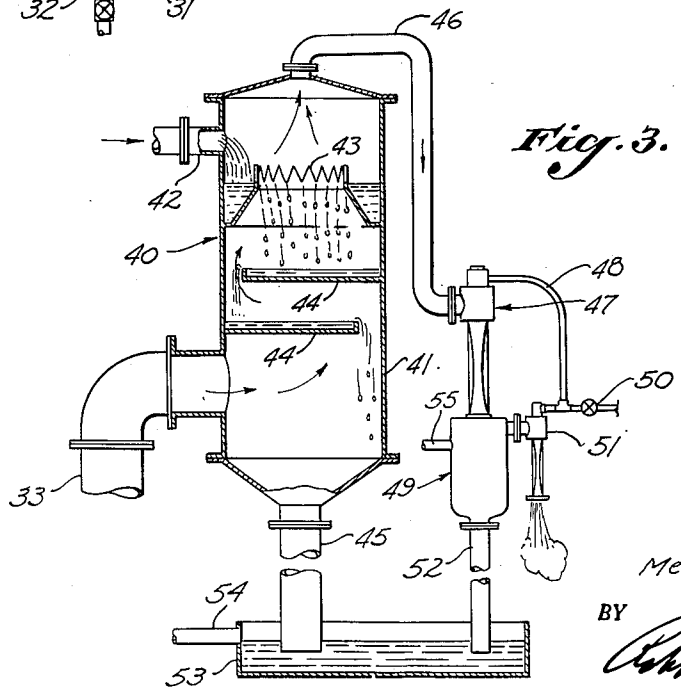


Fig. 3.



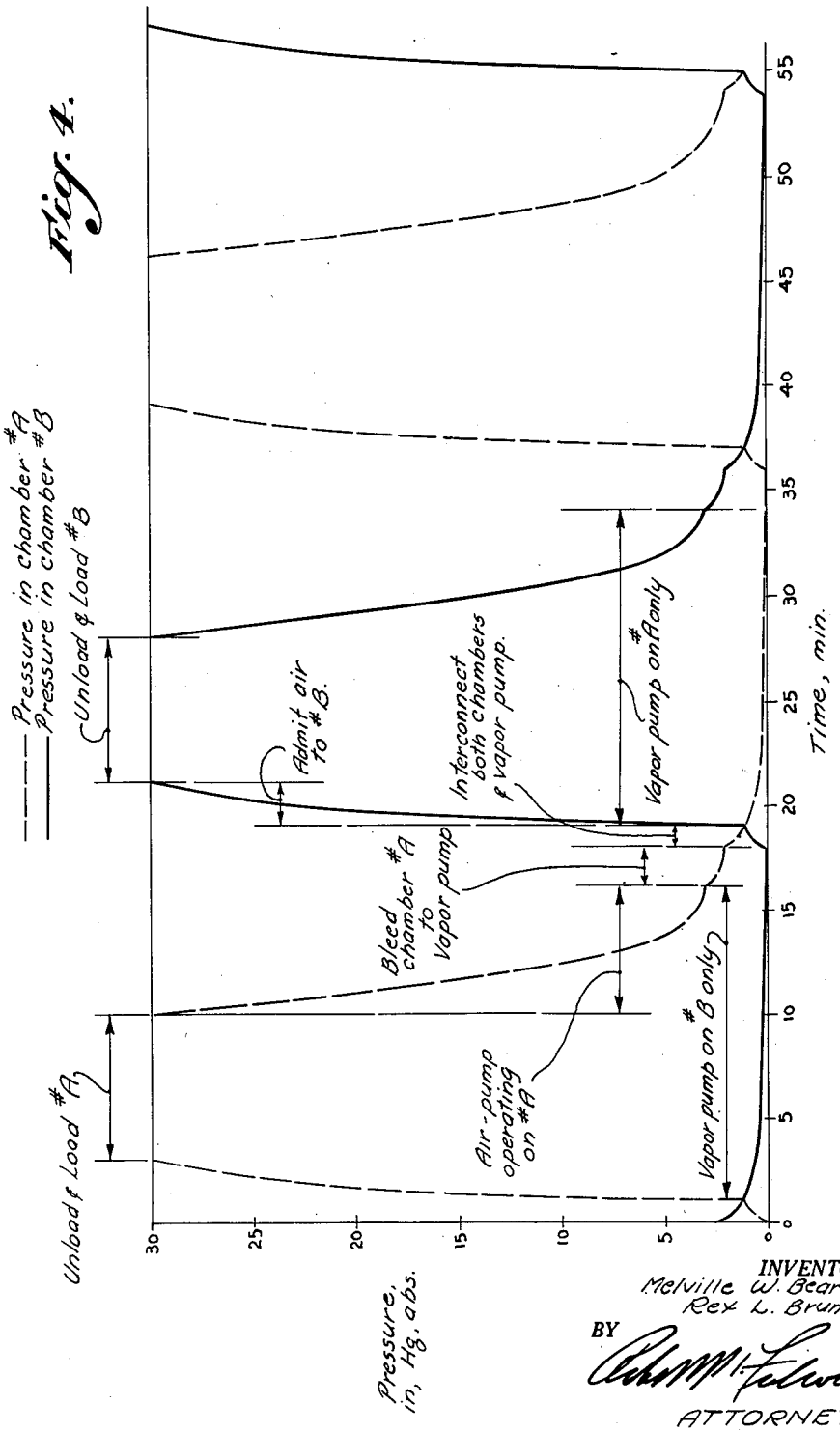
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Fig. 4.



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APPARATUS AND METHOD FOR PRECOOLING MATERIAL BY VACUUM-INDUCED EVAPORATION

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Application July 18, 1949, Serial No. 105,302

16 Claims. (Cl. 62—168)

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This invention relates generally to the precooling of vegetable produce prior to shipment thereof, and more particularly, to a refrigeration system for this purpose which cools the produce by reducing the vapor pressure surrounding the same, whereby to cause rapid evaporation of the surface moisture. These general principles are disclosed in Patent No. 2,344,151, issued March 14, 1944, to Morris Kasser.

The method of cooling disclosed in the above mentioned patent may be termed generally "vacuum cooling," and depends for its operation on the principle that evaporating water, or for that matter any liquid, absorbs heat of vaporization from the surrounding media.

One of the principal advantageous uses of the vacuum cooling principle is in the precooling of vegetable produce such, for example, as lettuce, celery, and other leafy vegetables, prior to their shipment in refrigerator cars. Prior to the use of vacuum cooling, it was the practice to interlayer the packed produce with layers of crushed ice as the material was packed, so that the entire body of the shipment would be kept at a temperature at or near 32° F. Such practice has numerous disadvantages, among which are the fact that the lumps of crushed ice tend to bruise tender vegetables such as lettuce; the water from the melting crushed ice causes a certain degree of deterioration of the produce and is generally a nuisance in the shipment; and the crushed ice, in spite of great care in distributing the same, does not maintain as uniform a temperature throughout the body of the packed shipment as is desired. Still further, the operation of packing the crushed ice into crates or other containers with the produce is a costly and time-consuming phase of the shipping operation.

With a view of avoiding the foregoing difficulties, it has been found advantageous to pack the produce without ice, and place the packed crates in a large, hermetically sealable chamber, and thereafter evacuate the chamber, whereupon the moisture on the leaves of the produce evaporates and rapidly reduces the temperature of the vegetable material. It will be seen that the cooling effected in this manner takes place substantially uniformly throughout the body of the vegetable, rather than merely cooling the surface thereof as is the case with ice or other external refrigeration means. The crated produce thus precooled may then be packed into refrigerator freight cars and shipped, the only refrigeration thereafter required being that provided by the ice bunkers in the refrigerator car itself.

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The present invention concerns itself with the efficient, continuous operation of a multiple-chamber vacuum cooling system operating on the general principles above described.

A major object of the invention is to provide a cooling system in which the power required to evacuate the cooling chambers is reduced to a practical minimum and in which the optimum use is made of the potential energy of the evacuated chambers.

Another object of the invention is to provide a system of the class described in which a number of evacuating pumps are employed, certain of the pumps being designed specifically for efficient operation on air, and other pumps being designed to operate most efficiently in the pumping of water vapor.

Still another object of the invention is to provide a refrigerating system in which the time periods for loading and unloading the cooling chambers may be so telescoped as to make possible substantially continuous operation of the power plant whereby the same need not be shut down for lengthy periods between successive cooling phases of the operation.

The foregoing and other objects and advantages of the invention will appear from the following detailed description thereof, as incorporated in a plant for precooling lettuce prior to shipment. It will be realized of course, that the system is not confined in its use to the cooling of lettuce but can be used with equivalent effect and with little or no modification on other materials. The description is illustrated in the attached drawings, wherein:

Figure 1 is a semi-schematic elevational view, taken through a dual chamber cooling system embodying the present invention;

Figure 2 is an elevational section taken on the line 2—2 in Figure 1;

Figure 3 is an elevational medial section taken through a barometric condenser system employed in connection with the plant in Figure 1; and

Figure 4 is a time-pressure graph illustrating the cyclic operation of the plant illustrated in Figure 1.

The dual chamber cooling system illustrated in Figure 1 is bilaterally symmetrical, that is, the elements associated with one of the cooling chambers are, for the large part, duplicated in connection with the other chamber. Accordingly, it is necessary herein to describe in detail only

one set of elements, it being understood that unless otherwise noted, such elements are duplicated in connection with the other chamber. The chambers have been designated generally by the reference character 10 and differentiated between themselves by the reference characters A and B, as shown in Figure 1.

Each of the chambers comprises a generally cylindrical hermetic enclosure provided with an air-tight door (not shown) whereby packed crates of produce 11 may be wheeled into and out of the chamber on conventional wheeled conveyors 12. Each of the chambers is provided with two exhaust conduits 15 and 16, the conduit 15 being for connection to a first pump adapted to the purpose of initially exhausting substantially all of the air from the chambers 10, and the conduit 16 being for connection to a second pump adapted to the purpose of further reducing the vapor pressure in the chambers 10 after substantially all of the air has been exhausted therefrom.

The exhaust conduits 15 are interconnected by a manifold 19 in which are mounted two or more steam ejector pumps 21 each of which comprises a restrictive throat or venturi portion 22 into which a nozzle 23 directs a jet of steam provided through a manifold connection 24 under the control of a valve 25. The air ejector pumps 22 exhaust upwardly through suitable exhaust pipes 26, discharging the steam and air carried thereby preferably through the roof of the building in which the cooling system is housed. The air ejector pumps 22 are especially designed to handle air at a pressure ratio up to approximately 10 to 1, that is, the pumps will continue to operate, exhausting against atmospheric pressure until the pressure within the chambers 10 reaches approximately three inches of mercury. After the chamber has been evacuated to this pressure, the air pumps 22 cease to operate efficiently, and in fact will cease to operate altogether, discharging the steam from the nozzle 23 back into the chamber 10. Accordingly, suitable valves 20 are provided in the exhaust connection 15 whereby to close the conduit of a particular chamber 10 when the pressure therein approaches that at which the air pump 22 will no longer operate efficiently. Suitable pressure-operated controls may be connected to the valve 20 for this purpose, and such controls being of well known design and operation need not be described in detail herein.

At certain stages of the cooling operations, as will hereinafter appear, it is desired to bleed one chamber 10 into the other, and for this purpose an interconnecting pipe 35 is provided, having a control valve 36 therein.

As the air pressure in the chamber 10 is reduced by the operation of the pumps, the rate of evaporation of the moisture on the surface of the produce increases and becomes very rapid when the pressure is reduced to the point where water boils at the then ambient temperature. At this stage in the operations the contents of the chamber 10 are predominantly water vapor. In order to reduce the temperature of the produce in the crates 11 to that approaching freezing, it is necessary to reduce the vapor pressure in the chamber 10 considerably below the three-inch limit which can be effected by the air pumps 22. To this end, a second pump (herein termed a "vapor pump") is provided and interconnected to the two chambers 10 by the conduits 16, the vapor pump being indicated by the reference character 18 in Figure 1. Valves 17 are provided in the conduits 16 so as to close the latter at certain points in the cooling cycle as will be hereinafter described.

The vapor pump 18 is similar in general design to the air pumps 22, although the shape of the throat 30 of the vapor pump 18 and the number and dispositions of the nozzles 31 thereof are specifically designed to operate on a gaseous mixture comprising principally water vapor, rather than the substantially pure air for which the air pumps 22 are designed. The design of gas ejector pumps for specific gases is well known in the art and the details of such design forming no part of the present invention, are not set forth herein.

The maximum pressure ratio of the vapor pump 18 being substantially the same as the air pumps 22, i. e., 10 to 1, it is necessary if the vapor pump 18 is to operate efficiently that it exhaust against a pressure substantially reduced from atmospheric. To this end, the exhaust of the vapor pump 18 is directed through a vertical conduit 33 into a barometric condenser 40, details of which are illustrated in Figure 3.

The condenser 40 will be seen to comprise a generally cylindrical body 41, closed at its upper and lower ends, and having a water inlet connection 42 adjacent the upper end thereof. The water from the inlet connection 42 discharges into an annular basin formed by a circular weir-like member 43, having a notched upper edge whereby the water discharges inwardly from the annular basin surrounding the weir 43 in a number of small streams around the axis of the condenser body 41. As the water descends through the condenser 40, it falls on tray-like baffles 44 having upturned edges over which, in turn, the water falls in a sheet downwardly onto the next baffle. The cooling water and condensate is discharged through a standpipe 45 at the bottom of the condenser body 41.

The steam and vapor from the pump 18, directed through the conduit 33, enters the condenser adjacent the lower end thereof as shown in Figure 3. Thus, as vapor passes upwardly through the condenser 40, it is passed in intimate heat-transfer relation with the water therein, causing condensation of a substantial proportion of the water vapor. Such vapor as is not condensed in the condenser 40 passes out of the top thereof through a conduit 46 to the intake of a second stage vapor-air pump 47, which in turn discharges into a second stage barometric condenser 49, which in turn is exhausted by a third stage pump 51, which exhausts to atmosphere. The principal function of the final stage pump 51 is to remove from the system such residual air as has not been removed by the pumps 22, and such air as may leak into the system during the cooling cycle.

Each of the barometric condensers 41 and 49 is provided with a standpipe 45 and 52 respectively, the lower ends of which are immersed in a tank 53 having a discharge 54. The purpose of the tank 53 is to provide a trap at the lower ends of the standpipes. It will be realized of course that as the pressure in the condensers 40 and 49 is reduced, the water rises in the standpipes 45 and 52. These pipes are somewhat greater than 34 feet in height so that the theoretical lower limit of pressure attainable in the condensers is equal to the vapor pressure of water at the ambient temperature.

The second stage condenser 49 is provided with a water intake 55, equivalent to that of the first

stage condenser 40, and the internal construction of the condenser 49 is substantially the same as that of the primary stage condenser 40, except on a smaller scale. The pressure in the condenser 40 being greatly depressed, the operation of the vapor pump 18 down to pressures less than one inch of mercury in the chamber 10 is possible.

The steam for the operation of the second and third stage pumps is provided through a connection 50 having a branch connection 48 leading to the second stage pump 47. All steam for operation of the system is provided by a single conventional steam plant (not shown).

Each of the chambers 10 is provided with a vapor intake connection 60 and a control valve 61 whereby small amounts of water vapor may be admitted to the chamber under certain conditions near the end of the cooling cycle. The vapor admitted in this manner serves to level off the cooling process whereby to prevent inadvertent freezing of the outside of vegetables, such for example, as heads of lettuce, before the internal temperature of the lettuce has been reduced to the desired point. Usually the vapor intake connection 60 is not employed except for limited operations when only one of the chambers 10 is in operation.

In the normal cyclic operation of the dual chamber cooling system, illustrated in Figure 1, the produce is alternately loaded into the two chambers, each of which is then successively evacuated of air and thereafter of vapor. One efficacious operation cycle is illustrated in Figure 4, wherein it will be seen that, at certain points in the operation, the two chambers are interconnected as through the interconnecting conduit 35 under the control of the valve 36. As indicated in the legend of Figure 4, the pressure in chamber A is indicated by a dashed line, whereas the pressure in chamber B is indicated in full line. It will be noted that, at the point in the cycle where the two chambers are interconnected, the descending pressure curve of the particular chamber then being cooled (evacuated) is relatively flat, thus indicating that a considerable amount of time would be taken to reach the desired pressure if pressure reduction continued at the then rate. It will be noted, however, that interconnection with the other chamber causes a material steepening of curve at this point, and thus makes use of the potential energy of the vacuum in the chamber in which the cooling has been completed to effect pressure reduction in the other cooling chamber. When the pressure in the two chambers is equalized as is indicated in Figure 4 by the crossing of the two curves, the valve 36 and one of the valves 17 are closed so as to permit further reduction of vapor pressure in the then "cooling" chamber.

Another important advantage of the present system is achieved by the fact that two separate pumping systems are provided, one specifically designed for evacuating the air and the other for evacuating vapor. It will be realized that if only the vapor pump 18 were provided, the system could operate but that the rate at which air could be evacuated from either of the chambers 10 would be limited to the capacity of the final stage pump 51. Thus, a system which comprised only the vapor pump 18 and the condenser system illustrated in Figure 3 would require a considerable period of time to exhaust the air from the chamber prior to the portion of the

cycle which reduces the water vapor pressure. This substantial amount of time could be avoided, of course, by employing a large capacity air pump in place of the relatively small capacity pump 51 used in the present system, but a system employing a large air pump continuously throughout the cycle would require an inordinately large amount of steam during the portion of the cycle in which substantially pure vapor is being exhausted from the chamber. Thus, the present system in which two different sizes and designs of pump are employed successively in evacuating the chambers is much more efficient than a single-pump system.

It will be realized, of course, that the number of chambers employed may be multiplied beyond the two illustrated herein to further increase the efficiency of the pumping system. The increase of efficiency is due in part to the fact that the demands on the steam plant is relatively constant, the load being shifted successively from one chamber to the other, thus to obviate intermediate shutdown periods when no steam is required. Such intermittent demand systems are inefficient because of the necessity of periodically reducing the boiler fire or, alternatively, providing for storage of substantial quantities of steam under relatively high pressures.

While the system and method illustrated and described herein is fully capable of achieving the objects and providing the advantages hereinbefore stated, it will be realized that considerable modification is possible without departing from the spirit of the invention. For this reason, we do not mean to be limited to the form shown and described, but rather to the scope of the appended claims.

We claim:

1. In a vacuum refrigeration system of the class described: a plurality of enclosed chambers each having an opening whereby produce may be loaded into said chamber and a hermetically sealable closure for said opening; a steam ejector air pump having a plurality of intake conduits, one connected to each of said chambers and an exhaust to atmosphere; a second steam ejector pump having a Venturi throat designed and adapted to pump water vapor and exhaust the same into a condenser, said ejector pump having a plurality of intake conduits, one connected to each of said chambers; a condenser having a condensation chamber connected to receive the discharge from said ejector pump, cooling water intake means for said condensation chamber, cooling water and condensate discharge means, and means to reduce the total pressure in said condensation chamber; and valves in said intake conduits to selectively close the same whereby to sequentially connect said air pump and said ejector pump to said chambers to first evacuate a substantial proportion of air from a given chamber and thereafter reduce the pressure of vapor in said given chamber evaporated from produce therein.

2. In a vacuum refrigeration system of the class described: an enclosed chamber of hermetic construction adapted to withstand external pressure, said chamber having an opening through which produce may be loaded into said chamber and a hermetically sealable closure for said opening; a steam ejector pump having a Venturi throat with a steam nozzle aligned therewith, designed and arranged to pump air and exhaust the same into atmosphere, said pump having an intake conduit connected to said chamber whereby

to exhaust air from the same; a second steam ejector pump having a Venturi throat with a steam nozzle aligned therewith, designed and arranged to pump water vapor and exhaust the same into a condenser, said second pump having an intake conduit connected to said chamber; a condenser having a condensation chamber connected to receive the discharge from said second pump, cooling water intake means and cooling water and condensate discharge means for said condensation chamber; a second stage steam ejector vapor-air pump having its intake connected to said condensation chamber whereby to reduce the total pressure therein; and valves in said first intake conduits whereby to effect sequential operation of said first and second pump to first evacuate a substantial proportion of air from said chamber and thereafter reduce the pressure of vapor evaporated from produce in said chamber.

3. In a vacuum refrigeration system of the class described: a plurality of enclosed chambers each having an opening through which produce may be loaded into said chamber, and a hermetically sealable closure for said opening; an air pump having a plurality of intake conduits, one connected to each of said chambers; an ejector pump having a venturi and steam nozzle therein designed and arranged to pump water vapor and exhaust the same into a condenser, said ejector pump having a plurality of intake conduits, one connected to each of said chambers; a condenser having a condensation chamber connected to receive the discharge from said second pump, cooling water intake means and cooling water and condensate discharge means for said condensation chamber; a second stage steam ejector vapor-air pump having its intake connected to said condensation chamber whereby to reduce the total pressure therein; valves in said first intake conduits whereby to effect sequential operation of said first and second pump to first evacuate a substantial proportion of air from said chamber and thereafter reduce the pressure of vapor evaporated from said produce in said chamber; and a conduit having a control valve therein connected between said chambers whereby selectively to bleed one of said chambers into the other to equalize the pressures therein.

4. In a vacuum refrigeration system of the class described: a plurality of enclosed chambers, each hermetically constructed and adapted to withstand external pressure, and each having an opening through which produce may be loaded into said chamber and a hermetically sealable closure for said opening; first and second manifolds each interconnecting said chambers; a bleed conduit interconnecting said chambers; a first steam ejector pump having a venturi throat, designed and arranged to pump air and exhaust the same into atmosphere, said first pump having its intake connected to said first manifold; a second steam ejector pump having a Venturi throat, designed and arranged to pump water vapor and exhaust the same into a condenser, said second pump having its intake connected to said second manifold; a condenser having a condensation chamber connected to receive the discharge from said second pump, cooling water intake means for said condensation chamber, and cooling water and condensate discharge means; a second stage steam ejector pump having its intake connected to receive vapor from said condensation chamber and designed and adapted to exhaust into a second condensation chamber; a second condensation chamber connected to receive the exhaust from said second stage pump and having cooling water intake means, and cooling water and condensate discharge means; a third stage pump having its intake connected to receive vapor from said second condensation chamber, said third stage pump being designed and arranged to discharge into atmosphere; control means including a plurality of valves in said first conduit, one positioned between said first pump and each of said chambers, a plurality of valves in said second manifold, positioned between said second pump and each of said chambers, and a valve in said bleed conduit whereby to effect sequential operation of said pumps to first evacuate a substantial proportion of air from a given chamber, thereafter reduce the pressure of vapor in said given chamber, and thereafter equalize the pressures in said chambers.

5. The method of precooling vegetable produce which comprises the steps of: placing a portion of said produce in a first hermetically sealed enclosure; placing a second portion of said produce in a second hermetically sealed enclosure; evacuating a substantial proportion of the air in said first enclosure; thereafter reducing the vapor pressure of vapor in said first enclosure; evacuating a substantial proportion of the air from said second enclosure concurrently with said reduction of vapor pressure in said first enclosure; thereafter interconnecting said enclosures whereby to further reduce the pressure in said second enclosure while permitting an increase of pressure in said first enclosure; disconnecting said enclosures from each other when the pressures therein are equalized; thereafter continuing to reduce the vapor pressure in said second enclosure; and admitting air into said first enclosure concurrently with said last-mentioned reduction of pressure in said second enclosure.

6. A vacuum refrigeration system comprising: a pair of hermetic chambers having air-tight doors to receive material for cooling in said chambers; a first, a second, and a third conduit, each interconnected between said chambers; an air pump connected intermediate the ends of said first conduit and arranged to exhaust air therefrom and discharge into atmosphere; a pair of valves in said first conduit, one between each of said chambers and said air pump; vapor exhausting means including a steam ejector pump connected in said second conduit and arranged to exhaust vapor therefrom, and a condenser connected to receive the discharge from said ejector pump; a pair of valves in said second conduit, one between each of said chambers and said ejector pump; and a valve in said third conduit operable independently of said first and second conduit valves to bleed one of said chambers into the other.

7. A vacuum refrigeration system comprising: a pair of hermetic chambers having air-tight doors to receive material for cooling in said chambers; a conduit system having a plurality of passageways interconnected between said chambers; an air pump connected to said conduit system to exhaust air therefrom and discharge the same to atmosphere; first valve means in said conduit system to communicate said air pump selectively with one or the other of said chambers; vapor exhausting means including a second pump connected to said conduit system to exhaust vapor therefrom; second valve means in said conduit system operable independently of said first valve means to communicate said second pump selec-

tively with one or the other of said chambers; a common power source connected to both said pumps to operate the same; and third valve means in said conduit system operable independently of said first and second valve means selectively to intercommunicate or separate said chambers.

8. A vacuum refrigeration system comprising: a pair of hermetic chambers having air-tight doors to receive material for cooling in said chambers; a conduit system having a plurality of passageways interconnected between said chambers; an air pump connected to said conduit system to exhaust air therefrom and discharge the same to atmosphere; a first pair of valves in said conduit system, one between each of said chambers and said air pump; vapor exhausting means including a steam ejector pump connected in said conduit system and arranged to exhaust vapor therefrom and a condenser connected to receive the discharge from said ejector pump; a second pair of valves in said conduit system, one between each of said chambers and said ejector pump; and a third valve in said conduit system operable independently of said first and second valve pairs to bleed one of said chambers into the other.

9. A vacuum refrigeration system comprising: a pair of hermetic chambers having air-tight doors to receive material for cooling in said chambers; a first, a second, and a third conduit interconnected between said chambers; an air pump connected intermediate the ends of said first conduit and arranged to exhaust air therefrom and discharge into atmosphere; a pair of valves in said first conduit, one between each of said chambers and said air pump; vapor exhausting means including a second pump connected in said second conduit and arranged to exhaust vapor therefrom; a pair of valves in said second conduit, one between each of said chambers and said second pump; a common power source connected to both of said pumps to operate the same; and a valve in said third conduit operable independently of said first and second conduit valves to bleed one of said chambers into the other.

10. A vacuum refrigeration system comprising: a pair of hermetic chambers having air-tight doors to receive material for cooling in said chambers; a first, a second, and a third conduit interconnected between said chambers; an air pump connected intermediate the ends of said first conduit and arranged to exhaust air therefrom and discharge into atmosphere; valve means in said first conduit to selectively block off one or the other of said chambers from said air pump; vapor exhausting means including a steam ejector pump connected in said second conduit and arranged to exhaust vapor therefrom, and a condenser connected to receive the discharge from said ejector pump; valve means in said second conduit arranged to selectively block off one or the other of said chambers from said steam ejector pump; and a valve in said third conduit operable independently of said first and second conduit valve means to bleed one of said chambers into the other.

11. A vacuum refrigeration system comprising: a pair of hermetic chambers having air-tight doors to receive material for cooling in said chambers; a first, a second, and a third conduit interconnected between said chambers; an air pump connected intermediate the ends of said first conduit and arranged to exhaust air therefrom and discharge into atmosphere; valve means in said first conduit to selectively block

off one or the other of said chambers from said air pump; vapor exhausting means including a second pump connected in said second conduit and arranged to exhaust vapor therefrom, a common power source connected to both of said pumps to operate the same; valve means in said second conduit arranged to selectively block off one or the other of said chambers from said second pump; and a valve in said third conduit operable independently of said first and second conduit valves to bleed one of said chambers into the other.

12. A vacuum refrigeration system comprising: a pair of hermetic chambers having air-tight doors to receive material for cooling in said chambers; a first, a second, and a third conduit each interconnected between said chambers; a steam powered air pump connected intermediate the ends of said first conduit and arranged to exhaust air therefrom and discharge into atmosphere; valve means in said first conduit arranged to selectively block off one or the other of said chambers from said air pump; steam powered vapor exhausting means connected in said second conduit and arranged to exhaust vapor therefrom; valve means in said second conduit arranged to selectively block off one or the other of said chambers from said vapor exhausting means; and a valve in said third conduit operable independently of said first and second conduit valve means to bleed one of said chambers into the other.

13. In a vacuum refrigeration system of the class described: an enclosed chamber of hermetic construction adapted to withstand external pressure, said chamber having an opening through which produce may be loaded into said chamber and a hermetically sealable closure for said opening; a steam ejector pump having a Venturi throat with a steam nozzle aligned therewith, designed and arranged to pump air and exhaust the same into atmosphere, said pump having an intake conduit connected to said chamber whereby to exhaust air from the same; vapor removing means including a second steam ejector pump connected by an intake conduit to said chamber; a condenser to receive the discharge of said second pump, and means to reduce the total pressure in said condenser; and valves in said pump intake conduits to effect sequential operation of said first and second pumps to first evacuate a substantial proportion of air from said chamber and thereafter reduce the pressure of vapor evaporated from produce in said chamber.

14. In a vacuum refrigeration system of the class described: an enclosed chamber of hermetic construction adapted to withstand external pressure, said chamber having an opening through which produce may be loaded into said chamber and a hermetically sealable closure for said opening; a steam powered air pump arranged to exhaust into atmosphere, said pump having an intake conduit connected to said chamber whereby to exhaust air from the same into atmosphere; vapor removing means including a second steam powered vapor pump connected by an intake conduit to said chamber, a condenser to receive the discharge of said second pump, and means to reduce the total pressure in said condenser; and valves in said pump intake conduits to effect sequential operation of said first and second pumps to first evacuate a substantial proportion of air from said chamber and thereafter reduce the pressure of vapor evaporated from produce in said chamber.

15. The method of continuously cooling moist produce which comprises the steps of: loading successive batches of produce alternately into one or the other of two hermetically sealed enclosures, and after each loading closing and subjecting the loaded enclosure to repetitive cycles, each consisting of the sequential steps of evacuating a substantial proportion of air therefrom, reducing the vapor pressure therein to a predetermined value, connecting said enclosure to the other enclosure, disconnecting said enclosure from said other enclosure, admitting air to said enclosure, and opening and unloading the same; said cycles being performed in such alternate time phase relationship that one of said enclosures is at said air evacuation stage and the other is at said reduced vapor pressure when said enclosures are connected together, whereby to bleed the former enclosure into the latter.

16. The method of continuously cooling moist produce which comprises the steps of: loading successive batches of produce alternately into one or the other of two hermetically sealed enclosures, and after each loading closing and subjecting the loaded enclosure to repetitive cycles, each consisting of the sequential steps of evacuating a substantial proportion of air and vapor

therefrom, to reduce the vapor pressure therein to a predetermined value, connecting said enclosure to the other enclosure, disconnecting said enclosure from said other enclosure, admitting air to said enclosure, and opening and unloading the same; said cycles being performed in such alternate time phase relationship that one of said enclosures is at said reduced vapor pressure and the other enclosure is loaded closed and at a pressure substantially greater than said value when said enclosures are connected together, whereby to bleed the latter enclosure into the former.

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