United States Patent

Hock et al.

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[54] CONTROL SYSTEM FOR FREEZERS

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[52] **U.S. Cl.** **62/136**, 62/233, 62/352

[51] **Int. Cl.** **F25c 7/14**

[58] **Field of Search** 62/136, 135, 233, 352

[56] **References Cited**

UNITED STATES PATENTS

2,446,156 7/1948 Kolz 62/136

3,059,444 10/1962 Bickel et al. 62/135

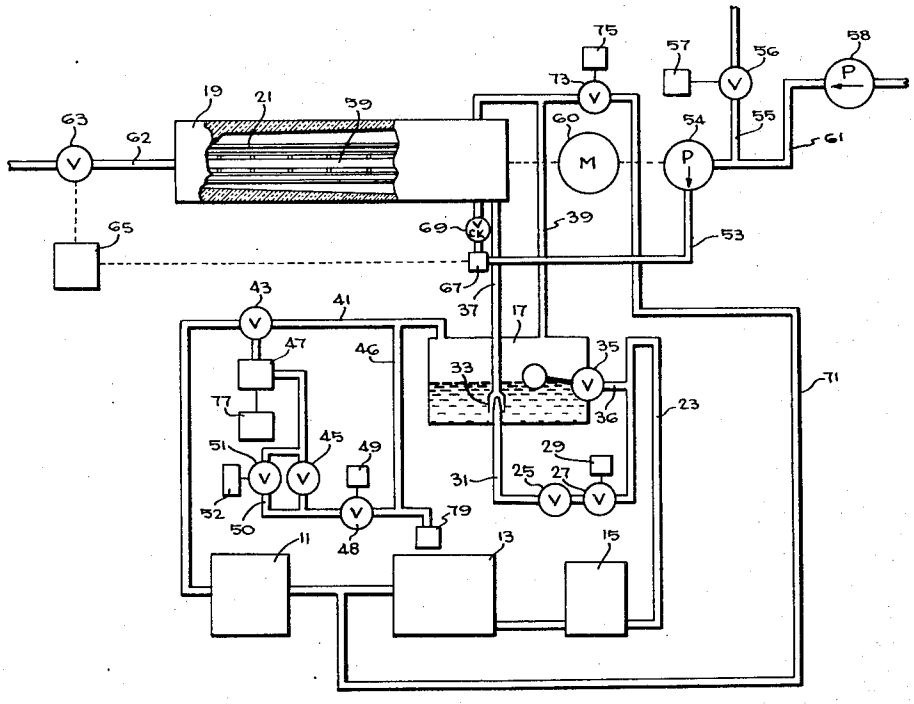
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[57] **ABSTRACT**

The present invention is directed to a freezing system of the hot gas type and a control system therefor. The freezing system is particularly directed to the type wherein a single motor is used to drive a dasher for a mix pump or pumps. The control system of the invention includes timing devices for controlling the start-up and shut-down of the freezing system in accordance with a predetermined sequence.

7 Claims, 2 Drawing Figures



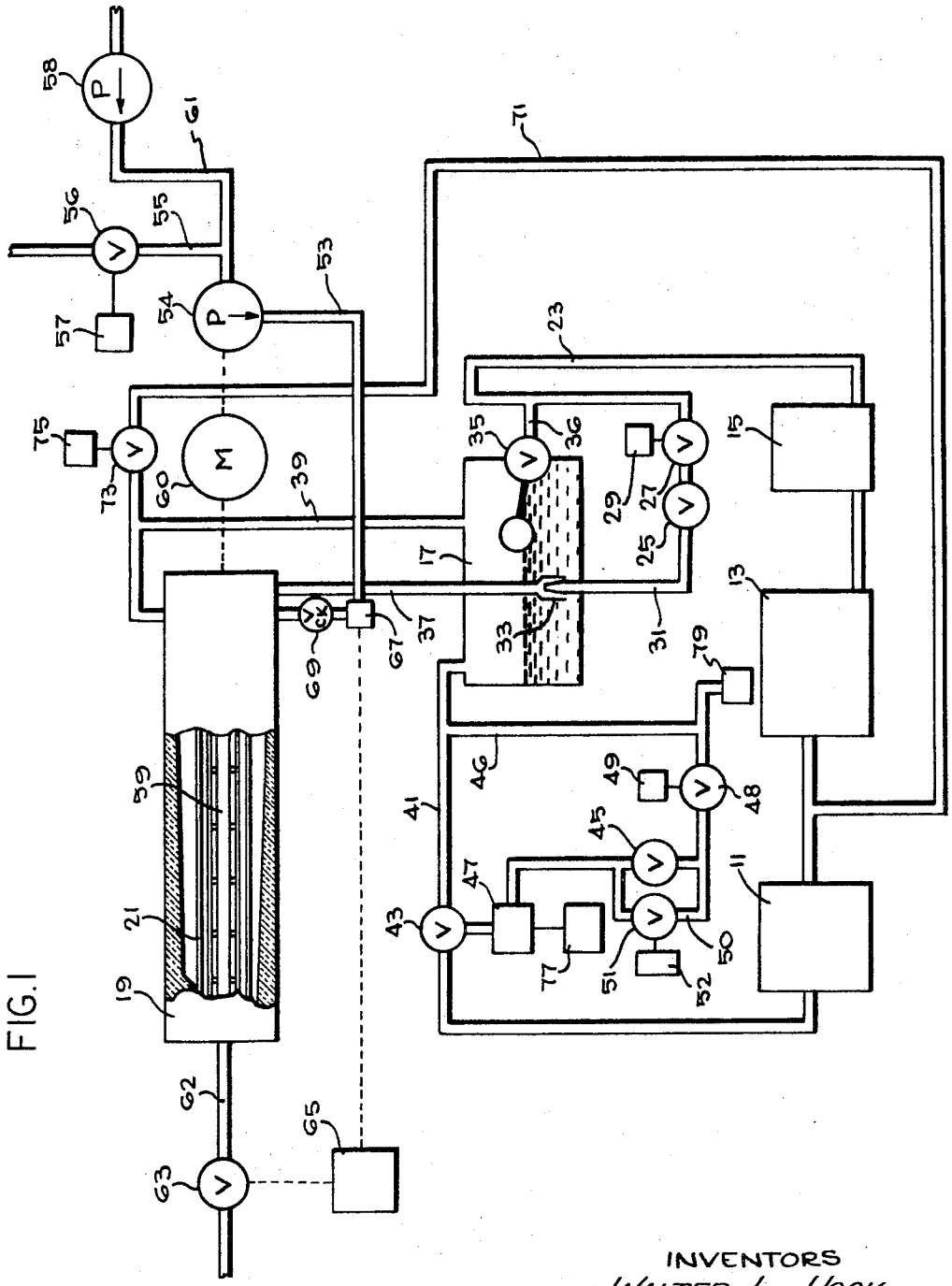
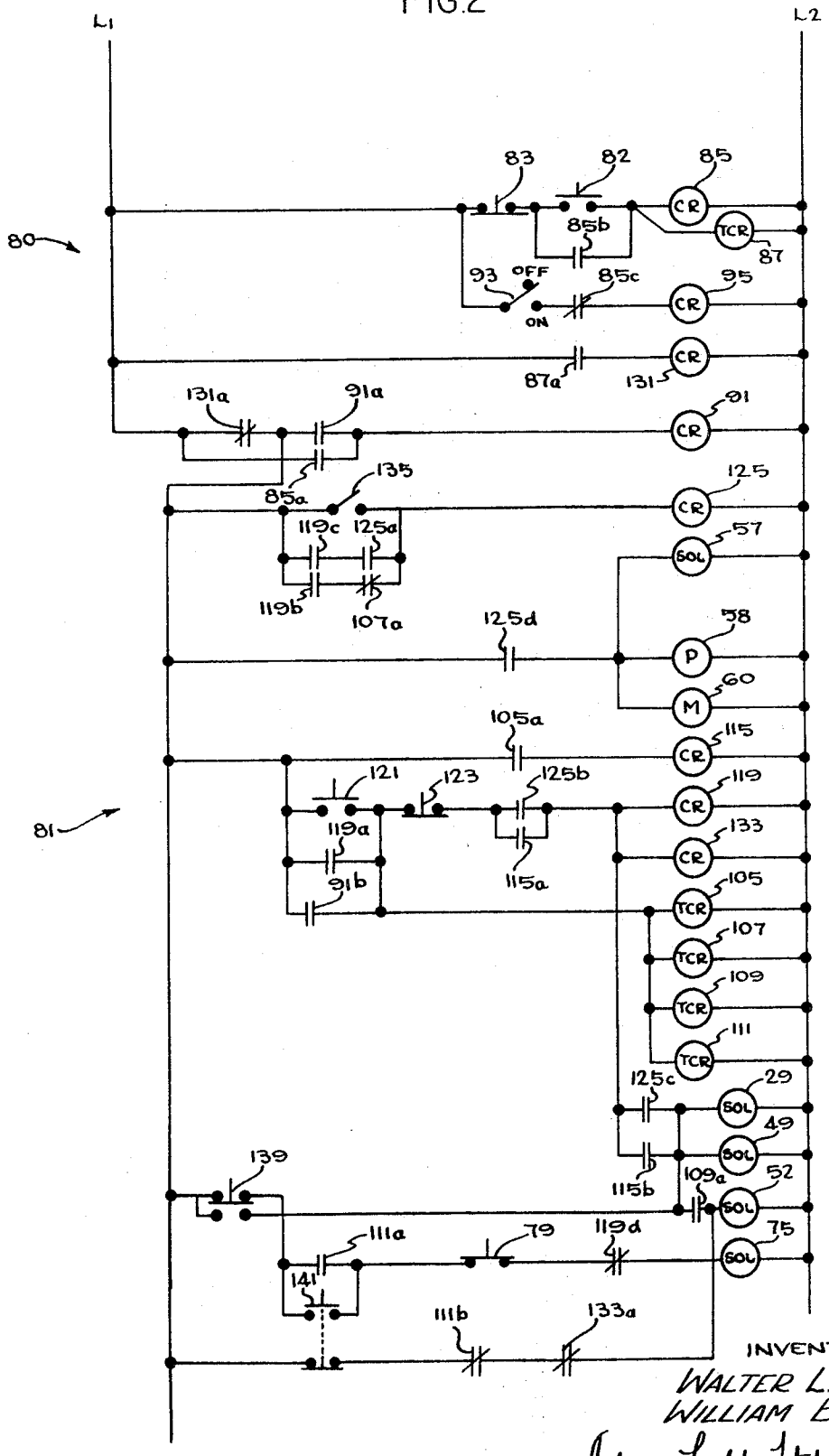


FIG. 1

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FIG.2



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CONTROL SYSTEM FOR FREEZERS

The present invention relates generally to a freezing device, such as an ice cream freezer, and more particularly relates to an improved control system for freezing devices wherein hot refrigerant gas from the refrigerant system is automatically injected into the freezing device upon shut-down so as to instantly warm the contents of the freezing chamber.

At the present time, many continuous ice cream freezers utilize the so-called "hot gas" refrigeration system in which hot refrigerant gas is automatically injected into the evaporator of the freezing system upon shut-down to instantly warm the contents of the freezing chamber so as to substantially eliminate troublesome "freeze-up" of the freezing chamber. In hot gas refrigeration systems, hot refrigerant gas is injected into the evaporator of the freezing system when the freezing system is shut down. The hot gas vaporizes the liquid refrigerant remaining in the evaporator. The vaporized refrigerant is then returned to the compressor and condenser of the refrigerant system and is returned to a liquid state. The use of hot gas permits remote starting and stopping of ice cream freezers by merely pushing a button.

A refrigeration system of the hot gas type is fully described in U.S. Pat. No. 3,059,444 to Fay D. Bickel et al. However, the control systems used to date for freezers using the hot gas principle have not been entirely satisfactory. For those types of freezers using a common motor drive for the dasher and mix pump, there is a tendency to produce soft and unusable ice cream when the freezing system is started after a shut-down.

Accordingly, it is a primary object of the present invention to provide a control system for continuous ice cream freezers of the hot gas type that will enable the freezing operation to be instantly started without the production of soft ice cream. It is another object of the present invention to provide an improved continuous ice cream freezer of the hot gas type that will substantially reduce the amount of re-run upon start-up. It is a further object of the present invention to provide a continuous ice cream freezer of the hot gas type that has an improved control system and permits starting and stopping of the freezer by merely pushing a button.

These and other objects of the invention will become more clear from the following detailed description and the accompanying drawings, in which:

FIG. 1 is a diagrammatic presentation of a freezing system embodying the present invention; and

FIG. 2 is a diagram of a basic control circuit for the freezing system of the invention.

Generally, the present invention is directed to a freezing system of the hot gas type and a control system therefor. The freezing system includes a condenser, a receiver, an expansion device, an evaporator, which includes a freezing tube for congealing a product supplied thereto, and an accumulator. All of the components of the freezing system are connected in series-flow relationship to form a refrigeration system. The freezing system also includes a dasher for agitating a product within the freezing tube and pumps for supplying a product to the freezing tube. The freezing system of the invention particularly is directed to the type wherein a single motor is used to drive the dasher and a mix pump or pumps. The control system of the invention includes timing devices for controlling the start-up and shut-down of the freezing system in accordance with a predetermined sequence.

More particularly, referring now to the drawings, as seen in FIG. 1, the principal components of the freezing system of the invention are illustrated. These components include a compressor **11**, a condenser **13**, a receiver **15**, an accumulator **17** and an evaporator **19**, all of the principal components being connected in series-flow relationship. The evaporator **19** includes a freezing tube **21**, into which an ice cream mix is introduced for freezing. Liquid refrigerant flows from the receiver **15** through duct **23** to an automatically controlled expansion valve **25**, which may be of any conventional type. Valve **27** is controlled by solenoid **29**, and is used to shut off the flow of liquid refrigerant through duct **23** as required.

The liquid refrigerant flows from the expansion valve **25** through duct **31**, which is connected at its other end to jet injector **33**. The jet injector **33** is located in accumulator **17** at a point below the liquid level that is maintained therein by float valve **35**. Float valve **35** controls the flow of refrigerant into the accumulator through a line **36** connected with duct **23**.

A duct **37** connected to the jet injector **33** carries the liquid refrigerant into the evaporator **19**, and a return line **39** carries vaporized refrigerant from the evaporator **19** back to the accumulator **17** from where it is withdrawn by compressor **11** through suction line **41**. The vaporized refrigerant is then compressed, condensed and again circulated through the system.

A back pressure regulator valve **43** is located in line **41** to maintain the desired pressure within the evaporator and thereby provide control of the freezing temperature. The regulator valve **43** variably restricts the amount of refrigerant gas flow in line **41** and thereby maintains the pressure in line **41** and the evaporator **19** at a desired value. The regular **43** may be of any suitable type; however, regulator **43** is preferably of a type that is controlled by a pilot valve **45** located in a line **46** which connects the control portion **47** of the regulator valve **43** with line **41** at a point upstream from the regulator valve **43**. When pilot valve **45** is fully open, the control portion **47** of regulator valve **43** senses the full pressure of line **41** and acts to fully open regulator valve **43** and permit full flow of refrigerant gas through line **41** from evaporator **19**, which results in maximum cooling of the refrigeration system. Pilot valve **45** is normally maintained in a partially open condition so as to restrict the pressure to the control portion **47** of regulator valve **43** and to thereby restrict and control flow of refrigerant gas through line **41** at less than maximum cooling. Regulator valve **43** may be fully closed by shutting off the flow of gas to the control portion **47** of valve **43**. The flow of gas to the control portion **47** may be shut off by valve **48**, which is controlled by solenoid **49**.

Bypass line **50** is provided which routes the flow of refrigerant gas around pilot valve **45** so as to remove the function of pilot valve **45** as a control on the regulator valve **43**. When bypass line **50** is open, the flow of gas to the portion **47** of regulator valve **43** is sufficient to cause regulator valve **43** to remain in a fully open position. Bypass line **50** is controlled by valve **51**, which is actuated by solenoid **52**.

Ice cream mix is supplied from a suitable source (not shown) and is pumped into the freezing tube **21** through a duct **53** by means of motor-driven mix pump **54**. Air is incorporated into the mix to provide the desired amount of overrun through air line **55**. The air is sucked into pump **54** from the atmosphere through an adjustable air valve (not shown). The flow of air through air line **55** is further controlled by valve **56**, which is actuated by solenoid **57**. Booster pump **58** may be used to feed ice cream mix through line **61** at a positive pressure to mix pump **54**. A motor-driven dasher **59** constantly agitates the ice cream mix in the freezing tube **21** to provide uniform freezing. Dasher **59** and mix pump **54** are driven by a common motor **60**.

Processed frozen ice cream is forced out of an outlet in the end of freezing tube **21** and into line **62**. Throttle valve **63** regulates the flow of ice cream through line **62**. Throttle valve **63** is air-controlled by controller **65**. Controller **65** is actuated by pressure sensor **67** located in duct **53** which feeds ice cream mix from pump **54** to the freezing tube **21**. The operation of throttle valve **63** will be more fully described hereinafter in connection with a discussion of the control system of the invention. Check valve **69** is in duct **53** to prevent ice cream from freezing tube **21** from backing up in duct **53** to pump **54** when the freezing system is shut down.

The system as thus far described operates as follows: Liquid refrigerant is supplied from the high pressure side of compressor **11** to condenser **13** and receiver **15**. The liquid refrigerant is expanded and cooled by expansion valve **25**. The expansion valve **25** maintains the liquid refrigerant at a suitable operating pressure for the jet injector **33**. Liquid refrigerant in passing through injector **33** withdraws additional refrigerant

from accumulator 17. Liquid refrigerant is then directed against the heat exchange surfaces of the freezing tube 21 to cool the contents of the tube. As the refrigerant evaporates from the freezing tube 21, the vapor thus formed is returned through the duct 39 to the accumulator 17 where gas and entrained liquid within the gas are separated. The gaseous refrigerant is withdrawn from the accumulator 17 through the suction line 41 to the compressor 11 for recirculation through the system. Regulator valve 43 maintains the desired pressure and temperature in the evaporator 19. The desired pressure and temperature are set by manually adjusting pilot valve 45 which feeds a gas pressure signal to the control portion 47 of regulator valve 43.

The freezing system is also provided with means whereby hot gas may be automatically injected into the evaporator 19 to warm the contents of the freezing tube 21 upon shutdown. In the hot gas portion of the free freezing system, warm, vaporized refrigerant from the high pressure side of compressor 11 is removed through a duct 71 that leads directly to the evaporator 19. The admission of the hot gas into the evaporator 19 is controlled by valve 73 which is actuated by solenoid 75. To warm the contents of the freezing tube quickly, the pressure setting of the regulator valve 43 is changed to allow a higher than normal operating pressure so as to build up the pressure of the hot gas in the evaporator 19 rapidly. The pressure setting of regulator valve 43 is changed by providing in duct 46 a valve 48 controlled by a solenoid 49 which shuts off the flow of gas through the pilot valve 45 and allows a secondary pilot 77 to control regulator valve 43. The secondary pilot 77 is set so that the regulator valve 43 remains closed until valve 73 is closed to stop the admission of hot gas, or until a predetermined higher pressure of approximately 60 psig is reached. A pressure limit switch 79 is provided to close the hot gas valve 73 when the pressure reaches a predetermined value of about 40 psig. The normal mode of operation of the hot gas valve in the control system of the present invention is such that the pressure limit switch 79 is not used to inactivate the hot gas valve 73, as will be explained more fully hereinafter.

Referring now to FIG. 2, the electric control system of the present invention will be described in detail. The circuit is supplied from a source of electrical energy (not shown) which terminates in electrical supply lines L1 and L2. The circuit includes an upper power circuit 80 and a lower control circuit 81. A push button start switch 82 and a push button stop switch 83 are connected across L1 and L2. The two switches are used to start and stop the freezer system from a remote location be means of the control circuit 81. The control circuit 81 can be duplicated for each of several freezer systems so that each freezer system can be remotely started and stopped by the switches 82 and 83. The two switches 82 and 83 are connected in series with a main holding coil 85 and a time delay holding coil 87. The main holding coil 85 controls a set of main contacts 85*a*. When multiple freezer systems are being controlled, main holding coil controls a set of contacts in the control circuit of each freezer system. For purposes of simplicity in description only a single control circuit for a single freezer system is shown in FIG. 2. When the start button 82 is pressed, the main holding coil 85 is energized, closing the contacts 85*a*. This permits current to flow to holding coil 91. Holding coil 91 controls contacts 91*a* and 91*b*. When holding coil 91 is energized by closing the contacts 85*a*, holding coil 91 closes contacts 91*a* which act to lock holding coil 91 in an energized condition. Main holding coil 85 also controls the contacts 85*b* which act to lock in the main holding coil 85 after the start switch is pressed. Current is supplied to lower control circuit 81 through normally closed contacts 131*a*, whose function is described hereinbelow.

Time delay holding coil 87 is of the type which is cocked when current is applied and which is triggered when current is removed. When current is removed from time delay holding coil 87, such as by pressing stop switch 83, the time delay sequence is triggered. Time delay holding coil 87 comes into use during the stop sequence, which is explained more fully below.

A bypass circuit around start switch 82 and stop switch 83 is provided. The bypass circuit includes an on-off switch 93, normally closed contacts 85*c* and timer 95. Normally closed contacts 85*c* are controlled by main holding coil 85. When the start switch is pressed, which activates holding coil 85, the normally closed contacts 85*c* are opened. The on-off switch 93 is then placed in the "On" position. Subsequently, when the freezer system is stopped and main holding coil 85 is deenergized, the normally closed contacts 85*c* become closed and timer 95 is started. This provides a check on the elapsed time that the freezer is maintained in a "stop" condition.

As previously indicated, energization of holding coil 91 closes contacts 91*a* and 91*b*. This permits current to flow through contacts 91*a* and 91*b* and energizes time delay holding coils 105, 107, 109 and 111. Time delay holding coils 105, 107 and 109 are of the type which are cocked when no power is applied and which are triggered by the application of power. Time delay holding coil 111 is of the type which is cocked by the application of power, and which is triggered upon the cessation of power.

Upon the application of power through contacts 85*a*, 91*a* and 91*b*, time delay holding coil 105 closes immediately and controls contacts 105*a*. Contacts 105*a* are normally open and are closed when time delay holding coil 105 is activated. The contacts 105*a* are maintained closed for the timing cycle of time delay holding coil 105. This time period is usually maintained at about 15 seconds, but may be adjusted within the range of from about 5 to about 30 seconds. Closing of contacts 105*a* activates holding coil 115. Holding coil 115 controls contacts 115*a* and 115*b*. When holding coil 115 is energized, contacts 115*a* and 115*b* are closed and power is supplied to holding coil 133 and to solenoids 29 and 49, which open valves 27 and 48 respectively.

The closing of contacts 115*a* and 115*b* also energizes holding coil 119. Holding coil 119 controls contacts 119*a*, 119*b*, 119*c* and 119*d*. Contacts 119*a* are used to lock in holding coil 119 when independent start switch 121 and stop switch 123 are used. Independent stop and start switches 121 and 123 are located at individual freezers and are used to effect manual operation of the system.

Contacts 119*b* are used to energize holding coil 125 when the timing sequence initiated by time delay holding coil 107 is terminated. Time delay holding coil 107, upon energization opens immediately and closes after a time delay of from about 3 to about 15 seconds, preferably about 5 seconds. Time delay holding coil 107 controls normally closed contacts 107*a*. During the time period of time relay holding coil 107, contacts 107*a* are open and holding coil 125 remains unenergized. After time delay holding coil 107 closes contacts 107*a* are closed and holding coil 125 is energized. Holding coil 125 activates contacts 125*a* which, in combination with contacts 119*c*, lock in holding coil 125 to the circuit after energization. Holding coil 125 also controls contacts 125*b*, which lock in holding coil 119 to the circuit, and contacts 125*c*, which lock in solenoids 29 and 49, which hold valves 27 and 48 in the open position. Holding coil 125 also closes contacts 125*d*, which completes the circuit to solenoid 57 (which opens valve 56), pump 58 and motor 60. Thus, solenoid 57, pump 58 and motor 60 are not activated until after the time delay period introduced by time delay holding coil 107 has terminated. Contacts 119*d* are used to open the circuit to solenoid 75 when holding coil 119 is energized. Solenoid 75 controls valve 73 which controls the flow of hot gas to the evaporator 19. Thus, hot gas is not admitted to evaporator 19 when holding coil 119 is energized.

Time delay holding coil 109 opens immediately and closes after a period of from about 5 to about 60 seconds, preferably about 15 seconds. Time delay holding coil 109 controls contacts 109*a*. During the time period initiated by holding timing coil 109, contacts 109*a* are closed and solenoid 52 is activated. Solenoid 52 opens valve 51 which permits a full pres-

sure signal to be sent through bypass line **50** to the control portion **47** of regulator valve **43**. This holds regulator valve **43** in a fully open position for the time period that time delay holding coil **109** is set. This permits a maximum flow of refrigerant through the freezing system to effect maximum freezing during the timing period of time delay holding coil **109**.

In summary of the control system to this point, after start switch **82** is pressed, main holding coil **85** is energized and power is supplied to time delay holding coils **105, 107, 109** and **111**. Timing coils **105, 107** and **109** act to supply full refrigeration to freezing tube **21** for a time period. At the end of another time period, pump **58** and motor **60** are started. Motor **60** starts dasher **59** and mix pump **54**. Solenoid **57** is activated and air is introduced through valve **56** and line **55**. At the end of a further timed period, full refrigeration is stopped and normal controlled refrigeration is supplied to freezing tube **21**. The use of a controlled sequence for starting dasher **59**, mix pump **54** and effecting full refrigeration for a controlled period acts to supply refrigeration sufficient to reduce the amount of soft ice cream that is produced during start-up of the freezing system.

Throttling valve **63** is located at the output of freezing tube **21**. Throttling valve **63** is controlled by a sensor which senses the pressure in mix line **53**. The pressure in mix line **53** is controlled by the consistency and hardness of the ice cream in freezing tube **21**. When the consistency and hardness of the ice cream in freezing tube **21** are too low, the pressure in mix line **53** drops and sensor **67** transmits a signal to controller **65** which sets throttling valve **63** so as to reduce the output of ice cream from freezing tube **21**. This further reduces the amount of soft ice cream that is produced upon start-up of the freezing system.

When it is desired to stop the freezing system, stop switch **83** is depressed. This interrupts current to main holding coil **85**. When main holding coil **85** is de-energized, contacts **85*a*** are opened and holding coil **91** is de-energized. Time delay holding coil **87** is also de-energized. This triggers the timing cycle of time delay holding coil **87** which closes for a few seconds and then opens. Time delay holding coil **87** controls contacts **87*a***, which close during the timing cycle. Closing of contacts **87*a*** energizes holding coil **131**. Holding coil **131** controls normally closed contacts **131*a*** and holds these contacts open during the timing cycle of time delay holding coil **87**. This interrupts power to the lower control circuit **81** by having contacts **131*a*** and **85*a*** open simultaneously. After the timing cycle of time delay holding coil **87** ends, contacts **131*a*** are closed and power is again supplied to the lower control circuit **81** to permit manual operation and to operate the hot gas control sequence described hereinbelow.

Interruption of power to the lower control circuit **81** drops out holding coils **125** and **115** and interrupts power to time delay holding coil **111**. This stops motor **60**, pump **58** and closes valves **56, 27, 48** and **51**.

Upon interruption of current to time delay holding coil **111**, the timing period is triggered and time delay holding coil **111** closes for a period of from about three-fourths to about 5 minutes, preferably about 2 minutes, and then opens. Time delay holding coil **111** controls normally open contacts **111a**. Contacts **111*a*** when closed during the timing cycle of time delay holding coil **111** supply current to solenoid **75** which opens valves **73** and permits hot gas to move into the freezing tube **21**. As indicated, the hot gas is permitted to flow into freezing tube **21** for a timed period which is controlled by time delay holding coil **111**. Pressure switch **79** is present to permit closing valve **73** if the pressure within the freezing tube should rise to above about 40 psig.

For manual operation of the dasher and mix pump, which is desirable during cleanup, switch **135** is closed so as to energize holding coil **125**. When the switch **135** is closed, holding coil **125** is energized; contacts **125*a***, **125*b***, **125*c*** and **125*d*** are then closed. Contact **125*d*** supplies power to and starts pump **58**, motor **60**, and energizes solenoid **57**. Contacts **125*b*** and **125*c*** have no effect since holding coil **91** is not energized and contact **91*b*** is open. The start system of the invention maybe manually initiated and stopped by depressing start switch **121** or stop switch **123**. When start switch **121** is depressed the timed relay sequences controlled by contact **91*b*** are started.

Two-way switch **139** is used to supply power to solenoids **29** and **49** in its down position and to DPST momentary switch **141** in its up position. Switch **141** controls power to hot gas solenoid **75** or to solenoid **52**. Power to hot gas solenoid **75** may be manually applied by depressing switch **141** when switch **139** is in the up position. Power is applied through normally closed contacts **119*d*** and pressure limit switch **79**. When switch **141** is in its normal uppermost position, power is applied to solenoid **52** which opens by pass valve **51**. This power is applied through normally closed contacts **111*b*** and **133*a***. This permits a full flow of refrigerant gas to the control portion **47** of regulator valve **43** when the refrigeration system is off. This maintains a maximum flow of refrigerant gas throughout the system during shut-down so as to keep the refrigerant in the accumulator as cold as possible during shut-down. This further reduces the amount of soft ice cream.

The freezing system of the present invention provides a control system for minimizing the amount of soft ice cream produced upon start-up of a "hot gas" freezing system which uses a common motor drive for the dasher and mix pump. The control system of the invention provides a unique time delay actuation of the freezing system so as to effect minimization of soft ice cream.

What is claimed is:

1. A freezer apparatus comprising an evaporator, including a freezing tube to which the product to be frozen is supplied, first conduit means for conducting liquid product to said freezing tube, second conduit means for conducting frozen product away from said freezing tube, pump means in said first conduit means for supplying product to said freezing tube, dasher means within said freezing tube for agitating said product during cooling thereof, single motor means for driving both said dasher means and said pump means, a first supply line to carry liquid refrigerant to said freezing tube, a second supply line to carry hot refrigerant gas to said freezing tube, a normally closed valve in sad second supply line, a refrigerant discharge line leading from said freezing tube to carry gaseous refrigerant therefrom, pressure regulator means in said refrigerant discharge line to control pressure at preselected values, first timing means to inactivate said pressure regulator means for a first predetermined period and provide a maximum flow of liquid refrigerant to said freezing tube during said first predetermined period and second timing means for delaying activation of said motor means for a second predetermined period occurring during at least a portion of the time period of said first predetermined period.

2. A freezing apparatus in accordance with claim **1** wherein said first timing means and said second timing means are activated upon start-up of the freezing apparatus.

3. A freezing apparatus in accordance with claim **1** which further includes third timing means for controlling the opening of said valve in said second supply for a predetermined period.

4. A freezing apparatus in accordance with claim **3** wherein said third timing means is activated upon shut-down of the freezing apparatus.

5. A freezing apparatus in accordance with claim **1** which further comprises throttle valve means in said second conduit means and pressure sensing means in said first conduit means, said pressure sensing means controlling said throttle valve means at preselected values to control the softness of said frozen product.

6. An electrical control circuit for freezing apparatus having an evaporator including a freezing tube, a pump to supply liquid product to the freezing tube, a dasher within the freezing tube to agitate the product while it is being frozen, a single motor for driving both the pump and the dasher, a pressure regulator for controlling the pressure of refrigerant supplied to

the evaporator, an adjustable valve for controlling a pressure signal to the pressure regulator, a bypass line around the adjustable valve, a first solenoid controlled valve in the bypass line, a second solenoid controlled valve for controlling the supply of refrigerant to the evaporator, and a third solenoid controlled valve for controlling the supply of hot gas to the evaporator, said control circuit comprising an electrical power source, a stop switch, a start switch, a main holding coil connected in series with said start and stop switches across said power source, first and second solenoids for said first and second solenoid controlled valves to open said valves when the respective solenoid is energized, a first time control relay and a second time control relay, said main holding coil being energized when said start switch is pressed, said first and second time control relays being energized by said main holding coil, first and second solenoid being controlled by said first time control relay, said motor starter circuit having a set of contacts operated by said second time control relay, said first and second time control relays being set in a way so that said first and second solenoids are opened a predetermined period before said motor starter circuit is energized.

7. An electrical control circuit in accordance with claim 6 which further comprises a third solenoid for controlling said third valve and a third time control relay, said third time control relay being energized when said stop button is pressed and said third time solenoid being controlled by said third time control relay so as to admit hot gas to the evaporator for a predetermined period of time.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,667,244 Dated June 6, 1972

Inventor(s) Walter L. Hock & William E. Myers

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, actual line 65, (indicated line 66) - after "is" insert --located--.

Column 3, line 17, delete "free"

Column 4, actual line 47, (indicated line 48) - after "3" insert --seconds--.

Column 4, actual line 51 (indicated line 50) - change relay to delay

Column 5, actual line 57 (indicated line 58) - change "three-fourths" to --1/4 minute--.

Column 6, actual line 44 (indicated line 45) - after "control" insert --refrigerant-- (Claim 1)

Signed and sealed this 2nd day of January 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334