Vogt®

03TA

TUBE-ICE® MACHINE

(Includes models HE60 & P112F)

Service Manual

$50^{00}

NOTICE

This manual is the property of the owner of this particular Tube-Ice® machine.

Model #_____ Serial #_____.

It is to be left on the premises with this machine at all times. After start-up, it should be stored in a safe place where it can be readily available when needed for future reference in maintaining troubleshooting or servicing.

Failure to comply with this notice will result in unnecessary inconvenience and possible additional expenses.

This manual is intended as an informational tool for the installation, operation, maintenance, troubleshooting, and servicing of this equipment. If an existing situation calls for additional information not found herein, we suggest that you contact your distributor first. If further assistance or information is needed, please feel free to contact the factory at 502-635-3000 or FAX at 502-635-3024.

IMPORTANT: The Warranty Registration/Start-Up Report found in the front of this manual is to be completed and returned to the factory promptly after the official start-up.

Please return to: TUBE ICE®, LLC
1000 W. Ormsby Ave.
Louisville, KY 40210

Tube Ice L.L.C.
1000 W. Ormsby
Louisville, KY 40210
(502) 635-3235
FAX #502-635-3024

Vogt Order Number: _____

THIS FORM MUST BE SENT TO VOGT TO ACTIVATE WARRANTY

Warranty Registration / Start-Up Form
(Medium & Large Machines)

Model Number: _____ **Serial Number:** _____

This form must be filled out completely and signed by the customer in order to assure acceptance by Vogt.

Date of Start-Up: _____ Form Completed By: _____

AC Condenser Model Number: _____ AC Condenser Serial Number: _____

Water Treatment System? ☐ Yes ☐ No Manufacturer: _____ Model: _____

Bin Manufacturer: _____ Model: _____ Bin Capacity: _____ lbs.

Distributor

Company Name: _____ Phone: _____

Address: _____ City: _____ State: _____ Zip: _____

Service Company

Company Name: _____ Phone: _____

Address: _____ City: _____ State: _____ Zip: _____

Customer (location of equipment)

Company Name: _____ Phone: _____

Address: _____ City: _____ State: _____ Zip: _____

PRE-OPERATION CHECK

- ☐ Machine room suitable 50°F minimum, 110°F maximum
- ☐ Power Supply _____ V _____ PH _____ HZ (machine not running)
- ☐ Crankcase heater on for 2 hours minimum, prior to start
- ☐ All valves opened or closed as tagged
- ☐ Water supply and drains connected properly
- ☐ Sufficient make-up water supply (minimum 30 PSIG)
- ☐ Leak checked entire system (including AC condenser if applicable)
- ☐ AC condenser cold weather temperature setting(s)
  Solenoid _____ Fan_____
- ☐ AC condenser installed above machine ☐ Yes ☐ No
  Approx. _____ft.
- ☐ AC condenser line length (in equivalent feet) _____
- ☐ AC condenser properly piped — all lines insulated
- ☐ Bin control(s) installed properly
- ☐ Instruction manual and warranty certificate left on-site
  Name of person left with: _____

OPERATION CHECK

- ☐ Power Supply _____ V _____ PH _____ HZ (machine running)
- ☐ Compressor oil level, i.e. 1/4 – 1/2 – 3/4: _____
- ☐ Compressor, pump , cutter & other motor direction of rotation correct
- ☐ Compressor amps (Start of freeze cycle) L1_____ L2_____ L3_____
- ☐ Cutter motor amps RLA_____ Actual _____
- ☐ Water pump amps RLA_____ Actual _____
- ☐ Condenser motor amps (if applicable) _____
- ☐ Incoming potable water temperature: _____°F
- ☐ All water distributors in place (visually inspected)
- ☐ Make-up water float valve adjusted properly
- ☐ Clear ice ☐ Yes ☐ No
- ☐ Bin control(s) operate(s) properly to stop and start machine with ice on them
- ☐ Hour meter in control panel connected and operating
- ☐ Suction Pressure: End of freeze _____ End of harvest _____
- ☐ Discharge Pressure: End of freeze _____ End of harvest _____

Test Cycle	Make-up Water Temp	Freeze Time Min/Sec	Harvest Time Min/Sec	First Ice Out Min/Sec	All Ice Out Min/Sec	Avg. Hole Size	Ice Lb. Per Harvest	Ice Lb. Per Day
#1								
#2								
#3								
#4								

Note: Ice lb. per day can be found by: $\frac{\text{ice lb. per harvest}}{\text{(freeze time + harvest time)}} \times \mathbf{1440}$

Remarks: _____

Technician Signature: _____ **End User Signature:** _____

I certify that I have performed all of the above procedures.

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Model 03TA

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1. Introduction

TUBE ICE â, LLC

A Brief History Of Our Company Henry Vogt Machine Co. was founded as a small machine shop in Louisville, Kentucky in 1880. In 1938, Vogt built the first Tube-Ice ® machine and revolutionized the ice-making industry. Our first "sized-ice" machine quickly replaced the old can-ice plants, which required much hard labor and large amounts of floor space for freezing, cutting, and crushing ice by hand.

Today, TUBE ICE®, LLC carries on the tradition as one of the world's leading producers of ice-making equipment.

Vogt Energy-Saving Tube-Ice Machines Are Cost Effective Today, Vogt Tube-Ice® machines enjoy a well-earned reputation as the most energy efficient, dependable ice-making equipment in the world.

Using as little as one-half to one-third the energy required by competitors' icemakers, Tube-Ice ® machines produce the same amount of ice--in restaurants, sports arenas, packing plants, and wholesale operations around the globe--at great savings.

In addition, Tube-Ice® machines are renowned for their long life, giving many customers more than 35 years of dependable service. Ask someone who owns one.

Preview All the skill in engineering and fabrication that we have learned in over a century of experience is reflected in the 03TA model Tube-Ice ® machines. Since Vogt introduced Tube-Ice® machines in 1938, the process of making Tube-Ice ® ice has been widely recognized as the most economical means of production. The machine's economic and reliable operations have been proven over and over again, in a network of varied types of installations throughout the world.

Furnished with your machine is the "Certificate Of Test"--the report of operating data that is a record of the unit's satisfactory operation on our factory test floor. It is evidence of our desire to deliver to you "the finest ice-making unit ever made."

This manual is designed to assist you in the installation, start-up, and maintenance of your unit. Your Tube-Ice® machine will give you a lifetime of service when you install it, maintain it, and service it properly.

Please read your manual carefully before attempting installation, operation, or servicing of this professionally designed piece of equipment.

If you have additional questions, please call your distributor. Also, feel free to phone the factory direct at **(502) 635-3000** or **1-800-853-8648**.

INTRODUCTION

Important Safety Notice This information is intended for use by individuals possessing adequate backgrounds of electrical, refrigeration and mechanical experience. Any attempt to repair major equipment may result in personal injury and property damage. The manufacturer or seller cannot be responsible for the interpretation of this information, nor can it assume any liability in connection with its use.

Special Precautions To Be Observed When Charging Refrigeration Systems Only technically qualified persons, experienced and knowledgeable in the handling of refrigerant and operation of refrigeration systems, should perform the operations described in this manual. All local, federal, and EPA regulations must be strictly adhered to when handling refrigerants.

If a refrigeration system is being charged from refrigerant cylinders, disconnect each cylinder when empty or when the system is fully charged. A gage should be installed in the charging line to indicate refrigerant cylinder pressure. The cylinder may be considered empty of liquid R-22 or R- 404a refrigerant when the gauge pressure is 25 pounds or less, and there is no frost on the cylinder. Close the refrigerant charging valve and cylinder valve before disconnecting the cylinder. Loosen the union in the refrigerant charging line--carefully to avoid unnecessary and illegal release of refrigerant into the atmosphere.

! CAUTION !
Immediately close system charging valve at commencement of defrost or thawing cycle if refrigerant cylinder is connected. Never leave a refrigerant cylinder connected to system except during charging operation. Failure to observe either of these precautions can result in transferring refrigerant from the system to the refrigerant cylinder, over-filling it, and possibly causing the cylinder to rupture because of pressure from expansion of the liquid refrigerant.
! CAUTION !

Always store cylinders containing refrigerant in a cool place. They should never be exposed to temperatures higher than 125 °F and should be stored in a manner to prevent abnormal mechanical shocks.

Also, transferring refrigerant from a refrigeration system into a cylinder can be very dangerous and is not recommended.

! CAUTION !
It is not recommended that refrigerant be transferred from a refrigeration system directly into a cylinder. If such a transfer is made, the refrigerant cylinder must be an approved, CLEAN cylinder--free of any contaminants or foreign materials--and must be connected to an approved recovery mechanism with a safety shutoff sensor to assure contents do not exceed net weight specified by cylinder manufacturer or any applicable code requirements.
! CAUTION !

Safety Symbols & What They Mean Prior to installation or operation of the Tube-Ice ® machine, please read this manual. Are you familiar with the installation, start-up, and operation of a Tube-Ice ® machine? Before you operate, adjust or service this machine, you should read this manual, understand the operation of this machine, and be aware of possible dangers.

These Safety Symbols will alert you

when special care is needed.

Please heed.

! DANGER !
Indicates an immediate hazard and that special precautions are necessary to avoid severe personal injury or death.
! DANGER !

! WARNING !
Indicates a strong possibility of a hazard and that an unsafe practice could result in severe personal injury.
! WARNING !

! CAUTION !
Means hazards or unsafe practices could result in personal injury or product or property damage.
! CAUTION !

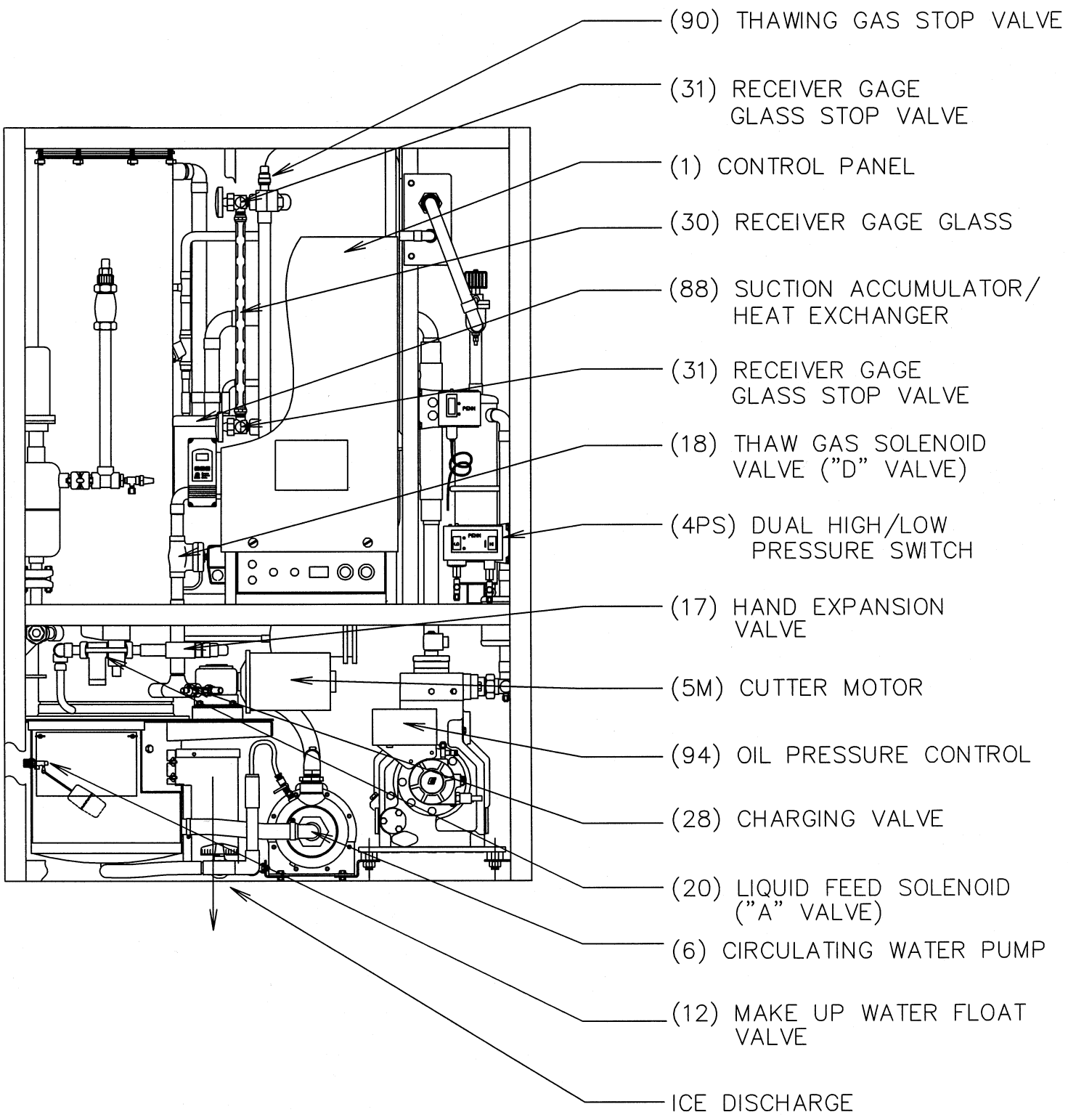


FIGURE 1-1
Assembly (Air-Cooled)
Front View

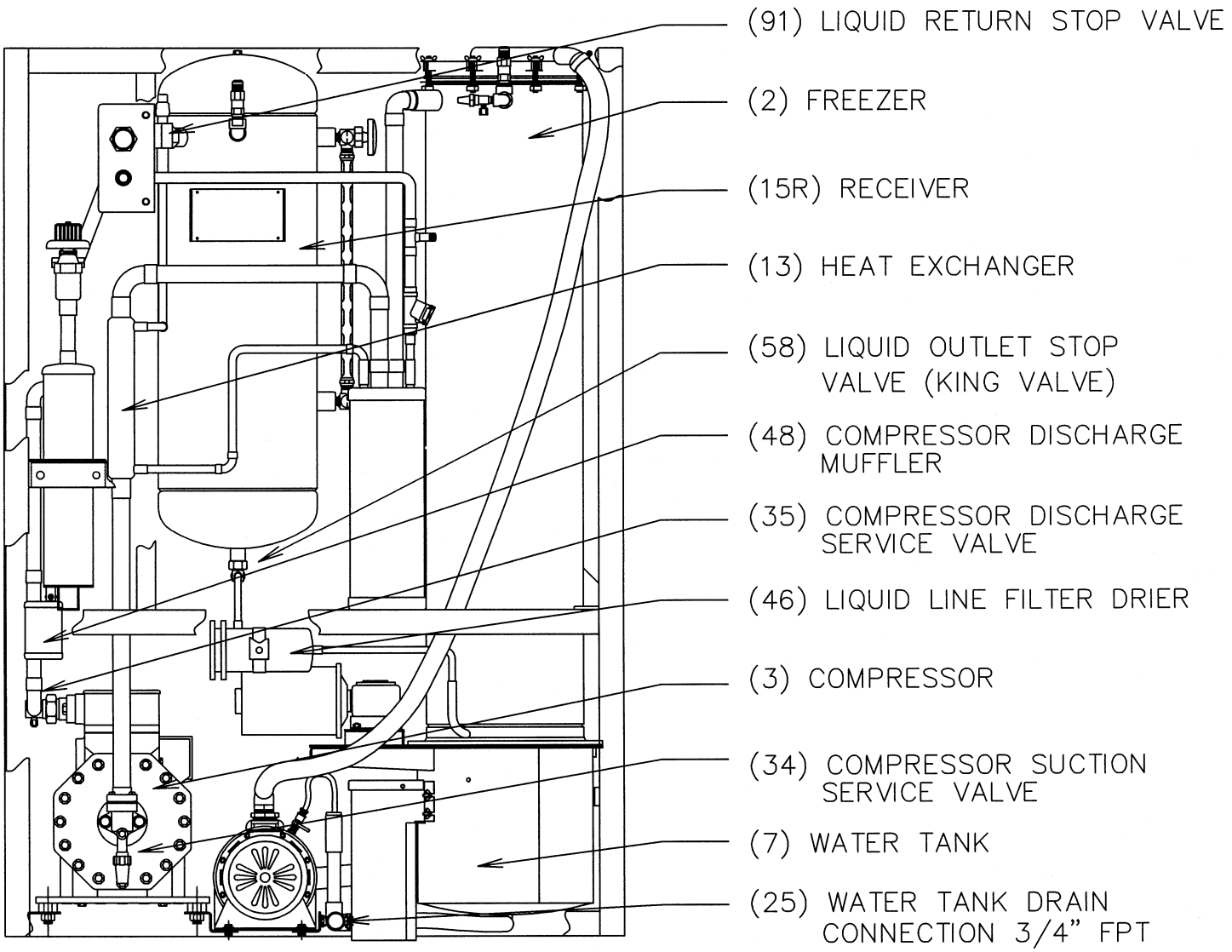


FIGURE 1-2
Assembly (Air-Cooled)
Rear View

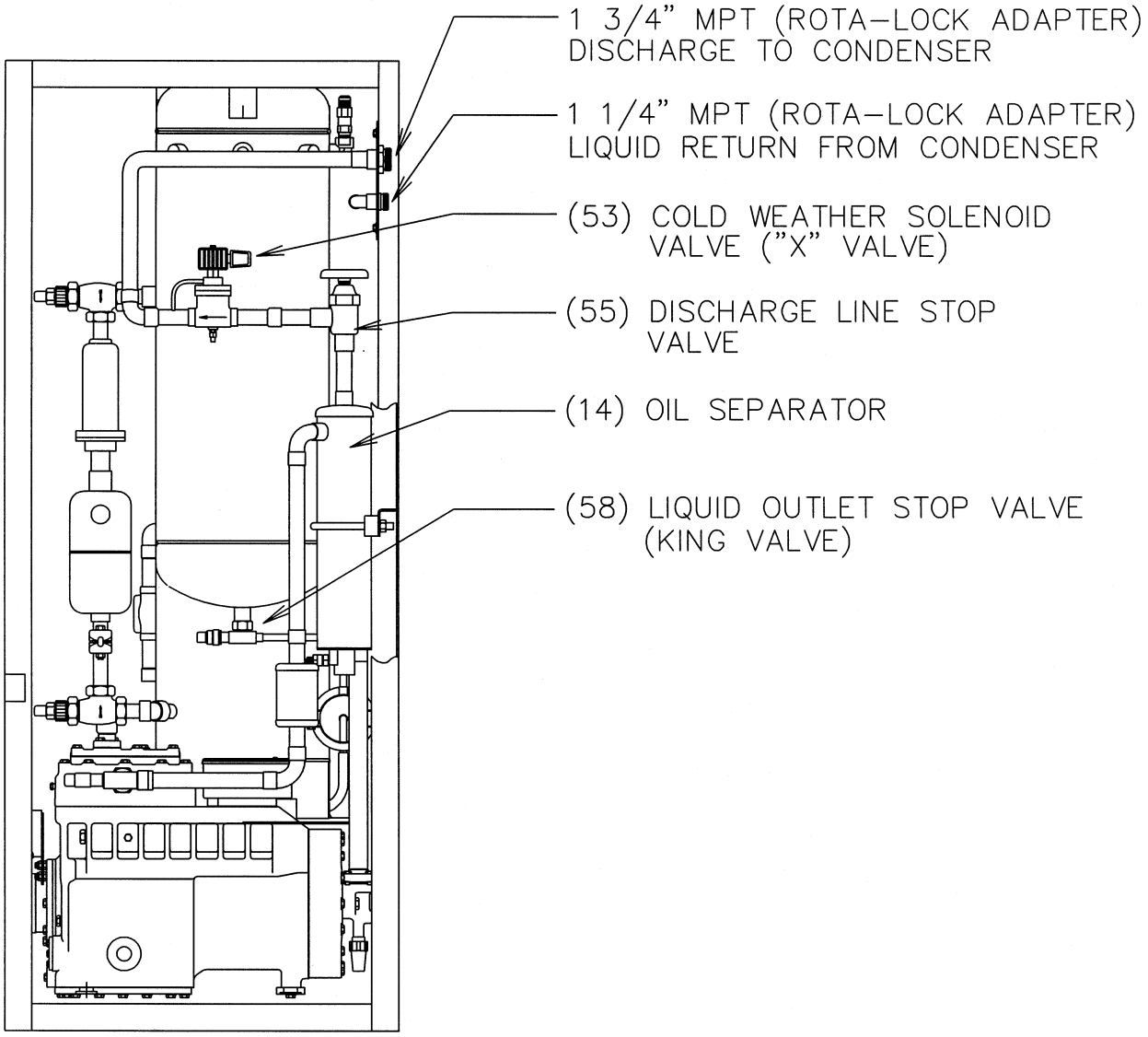


FIGURE 1-3
Assembly (Air-Cooled)
Right Side View

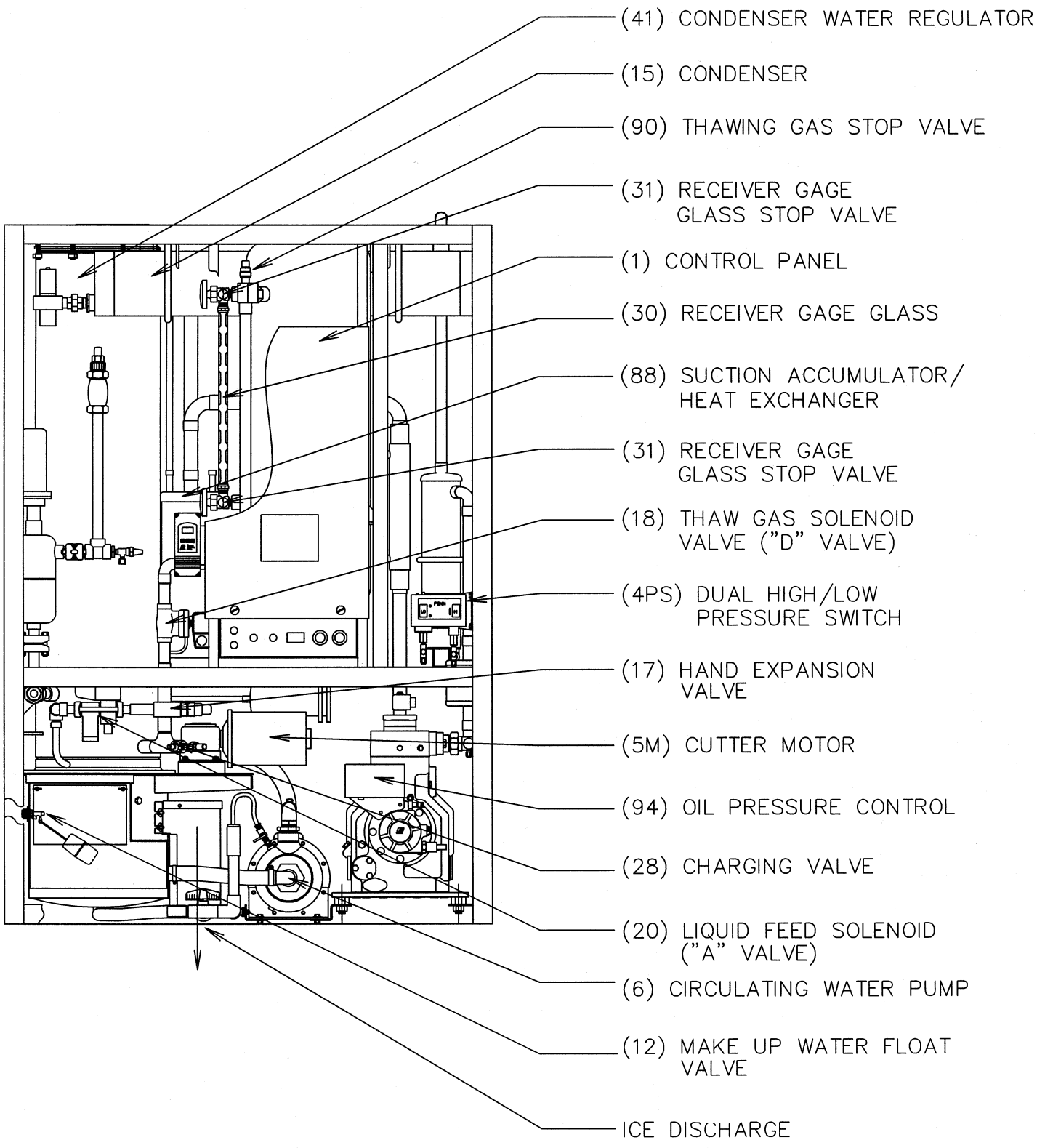


FIGURE 1-4
Assembly (Water Cooled)
Front View

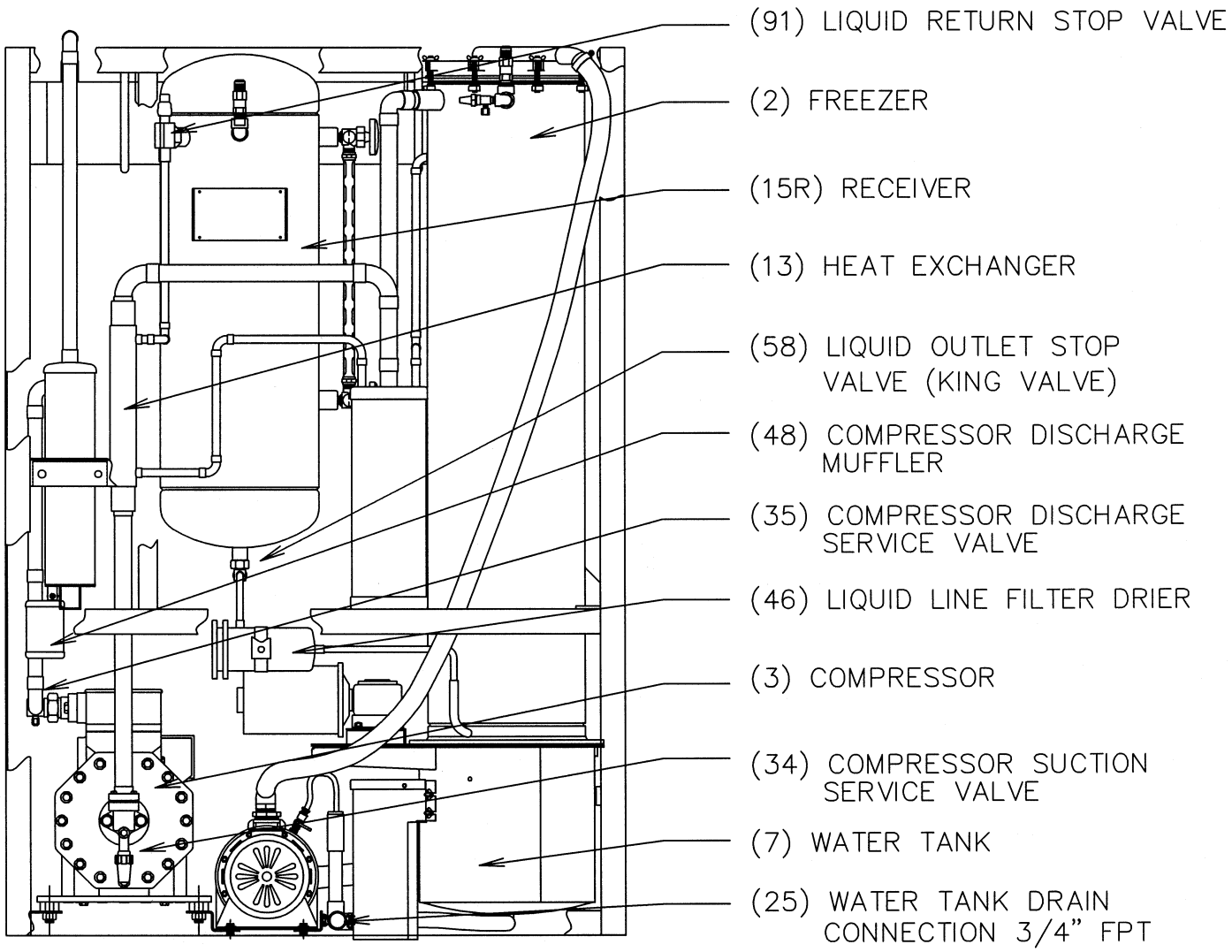


FIGURE 1-5
Assembly (Water Cooled)
Rear View

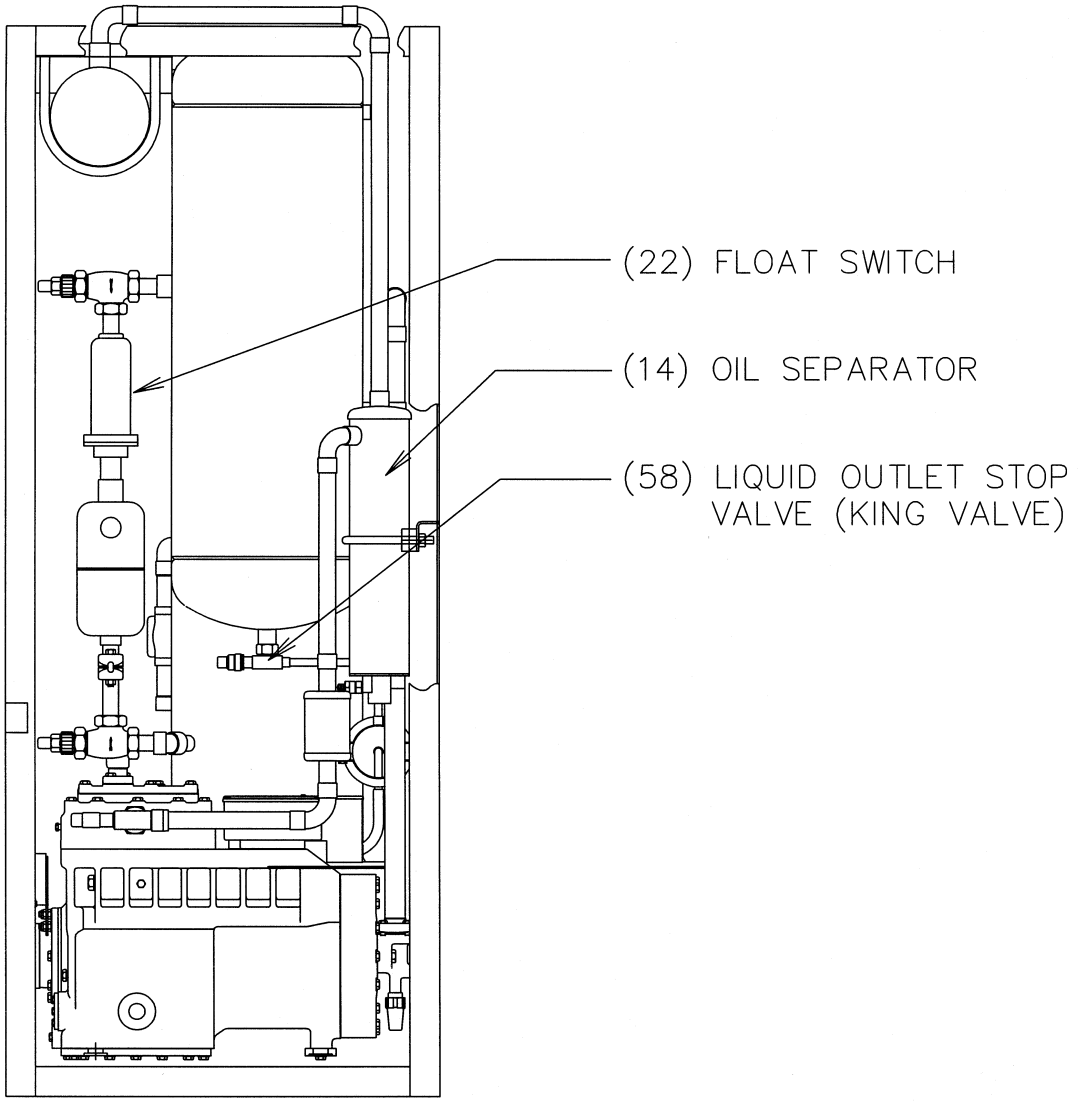


FIGURE 1-6
Assembly (Water Cooled)
Right Side View

2. Receipt Of Your Tube-Ice Machine

! WARNING !
Only service personnel experienced in refrigeration and qualified to work with high voltage electrical equipment should be allowed to install or work on this Tube-Ice® machine.
! WARNING !

Inspection As soon as you receive your machine, inspect it for any damage. If damage is suspected, note it on the shipper's papers (i.e., the trucker's Bill of Lading). Immediately make a separate written request for inspection by the freight line's agent. Any repair work or alteration to the machine without the permission of TUBE ICE ®, LLC can void the machine's warranty.

The machine was shipped with a full charge of refrigerant stored in the receiver. Visually check all lines for mechanical damage. If a leak is suspected, check all joints with a Halogen Leak Detector. All leaks should be reported to TUBE ICE ®, LLC to obtain authorization for repair.

! CAUTION !
The approximate weight of the machine is 2000 pounds. Always use equipment with adequate load carrying capacity.
! CAUTION !

The machine frame has lifting lugs at each corner in the top for eyebolts and hooks to be used for lifting purposes if desired. Lifting lugs should be used whenever possible.

! CAUTION !
The Tube-Ice® machine is top heavy. Secure to avoid tipping.
! CAUTION !

If a forklift is used, make sure its capacity is sufficient. The forks must be wide enough apart to prevent tipping sideways and must extend beyond the extremities of the frame base structure. The machine needs to be bound in place to prevent tipping.

Safety Valves Two safety pressure relief valves are an integral part of the packaged Tube-Ice ® machine. One is located in the low-side of the system on the freezer, and one is in the high side of the system on the receiver. Vent each of the pressure relief valves to the atmosphere in such a manner as to comply with local and national codes.

RECEIPT OF YOUR TUBE-ICE MACHINE

Machine Room The machine must be located inside a suitable building and must not be subjected to ambient temperatures below 50°F (10°C) or above 110°F (43.3°C). Heat from other sources (sunlight, furnaces, condenser, etc.) and unusual air currents may affect the operation of the machine and should be avoided. The electrical components of the Tube-Ice® machine are rated NEMA 1. Therefore, the machine should not be located in a hazardous area or sprayed with water. The machine should be installed on a drainable condensate drip pan or in an area where water will not stand but will readily drain away from the machine. See Space Diagram for clearances and utility connections, FIGURES 3-1 and 3-2.

Storage (prior to installation or start-up) The machine must not be stored or installed in an area that may reach temperatures 115°F (46.1°C) or above.

! CAUTION !
This equipment contains HCFC-22 or HFC-404a refrigerant under pressure. Do not store in an area exposed to temperatures above 115°F (46°C) or in direct sun at temperatures above 105°F (40°C).
! CAUTION !

3. Installing Your Tube-Ice® Machine

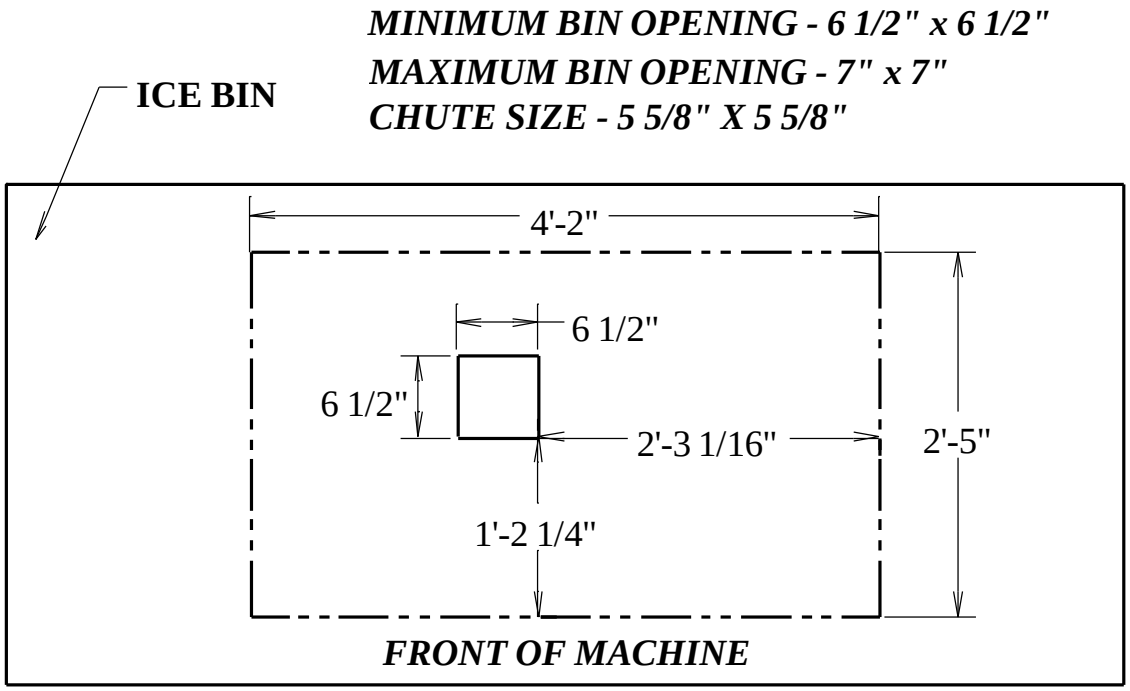
! WARNING !
Only service personnel experienced and certified in refrigeration and qualified to work with high voltage electrical equipment should be allowed to install or work on this Tube-Ice® machine.
! WARNING !

Important Notice.

The Warranty Registration / Start-Up Form must be completed and returned to Vogt Tube-Ice® to initiate and assure a full warranty. A postage paid envelope is provided or you may fax the report to 800-770-8648.

Bin Installation Set the bin on solid, level footing. Inside the bin you will find the four legs. Screw these legs to the bottom of the bin. You can make MINOR leveling adjustments by using these legs as leveling screws, as outlined in the manufacturer's instructi ons.

Setting the ice machine on the ice bin Once the ice storage bin is level, the Tube -Ice® machine can be elevated and placed on the bin top. Using the dimensions in FIGURE 3 -1 below, mark the machine footprint on the bin top by measuring over from the ice chute opening.



PLAN

FIGURE 3-1
Ice Chute Location/Machine Footprint

INSTALLING YOUR TUBE-ICE® MACHINE

FIGURES 3-2 & 3-3 illustrate two methods of lifting & setting Tube-Ice® machine on an ice storage bin.

! CAUTION !
The approximate weight of the machine is 2000 pounds. Always use equipment with adequate load-carrying capacity.
! CAUTION !

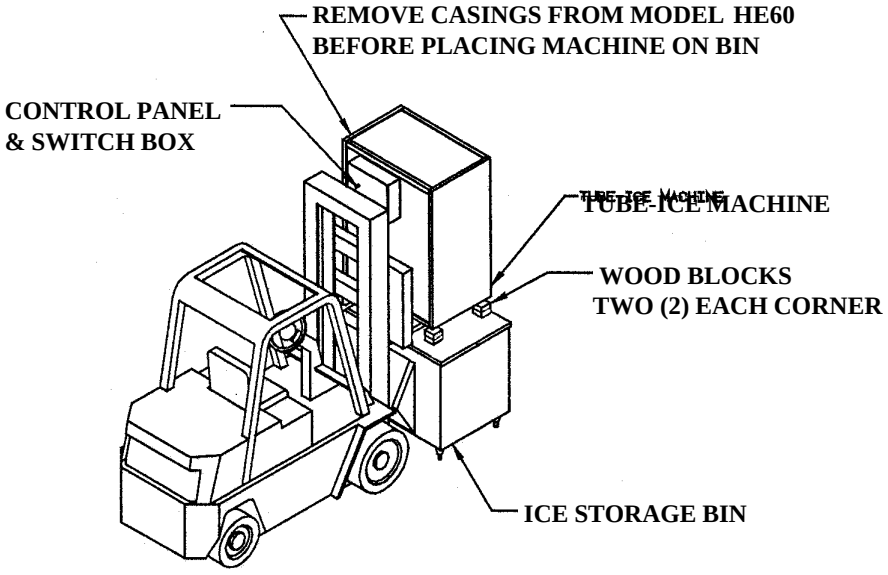


FIGURE 3-2
Forklift-&-Blocks Method

You need:

- forklift truck with adequate load and height capacities
- (8) 2X4 wood blocks 8 in. long
- (2) wooden 2X4's measuring 3-ft. long
- pry bar

Step 1. Position Tube-Ice® machine on forks.

Step 2. Stack wood blocks in each corner of the drip pan on top of the ice storage bin.

Step 3. Lift and set Tube-Ice® machine on wood blocks.

Step 4. Remove forklift.

Step 5. Stack 3-ft. long 2X4's beside drip pan, overlapping front and back of bin.

Step 6. Using a pry bar with fulcrum on 2X4's, raise side of machine enough to remove TOP wood blocks.

! CAUTION !
Do not remove top AND bottom blocks at the same time.
! CAUTION !

Step 7. Repeat steps 5 and 6 on other side.

Step 8. With machine sitting on one (1) block under each corner, repeat steps 5, 6, and 7 remove remaining blocks. Drip pan flanges may bend slightly.

Step 9. Straighten bent drip pan flanges.

Step 10. Check alignment of ice chute to bin opening.

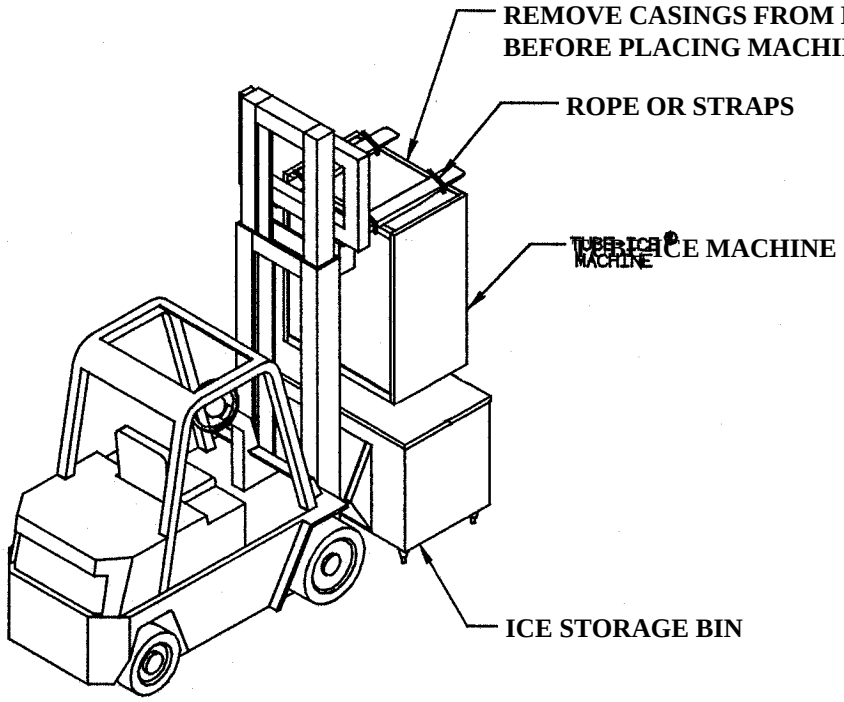


FIGURE 3-3
Forklift-&-Rope or Lifting Straps Method

You need:

- extra head room
- forklift with adequate load and height capacities
- 1/2” rope or four lifting s traps to bind forks to top angles

Step 1. Remove front, rear, and top access panels.

Step 2. Position fork truck so that forks are resting flat on top angles of Tube-Ice® machine.

Step 3. Use the rope or straps to securely bind forks to the top angles.

! CAUTION !
Be sure the bin is level and is set in its proper location. See the space diagram, FIGURE 6.
! CAUTION !

Step 4. Lift Tube-Ice® machine and set into drip pan of bin.

Step 5. Remove rope or straps and fork truck.

Step 6. Check alignment of ice chute to bin opening.

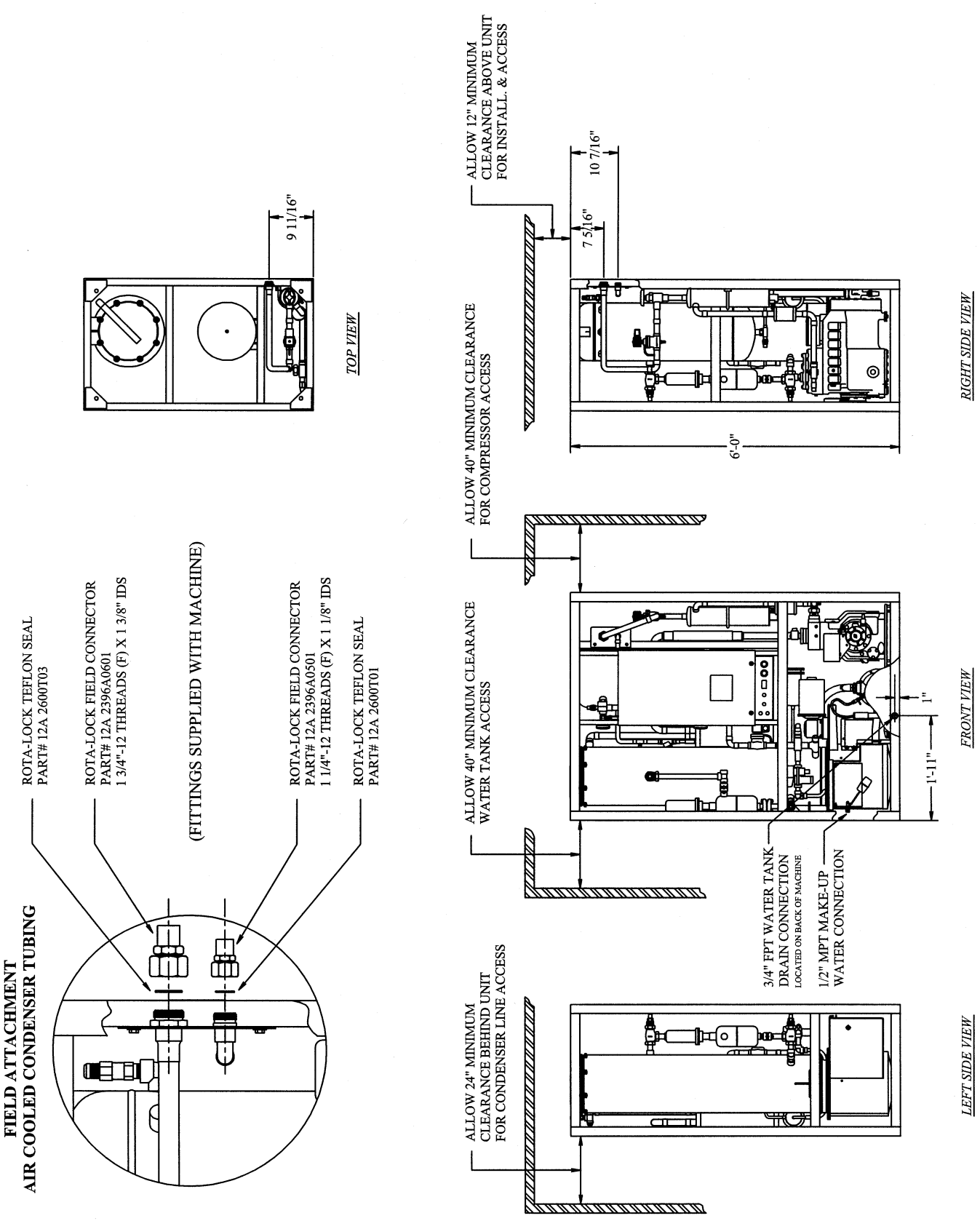


FIGURE 3-4
Connections and Space Diagram (Air Cooled Machine)

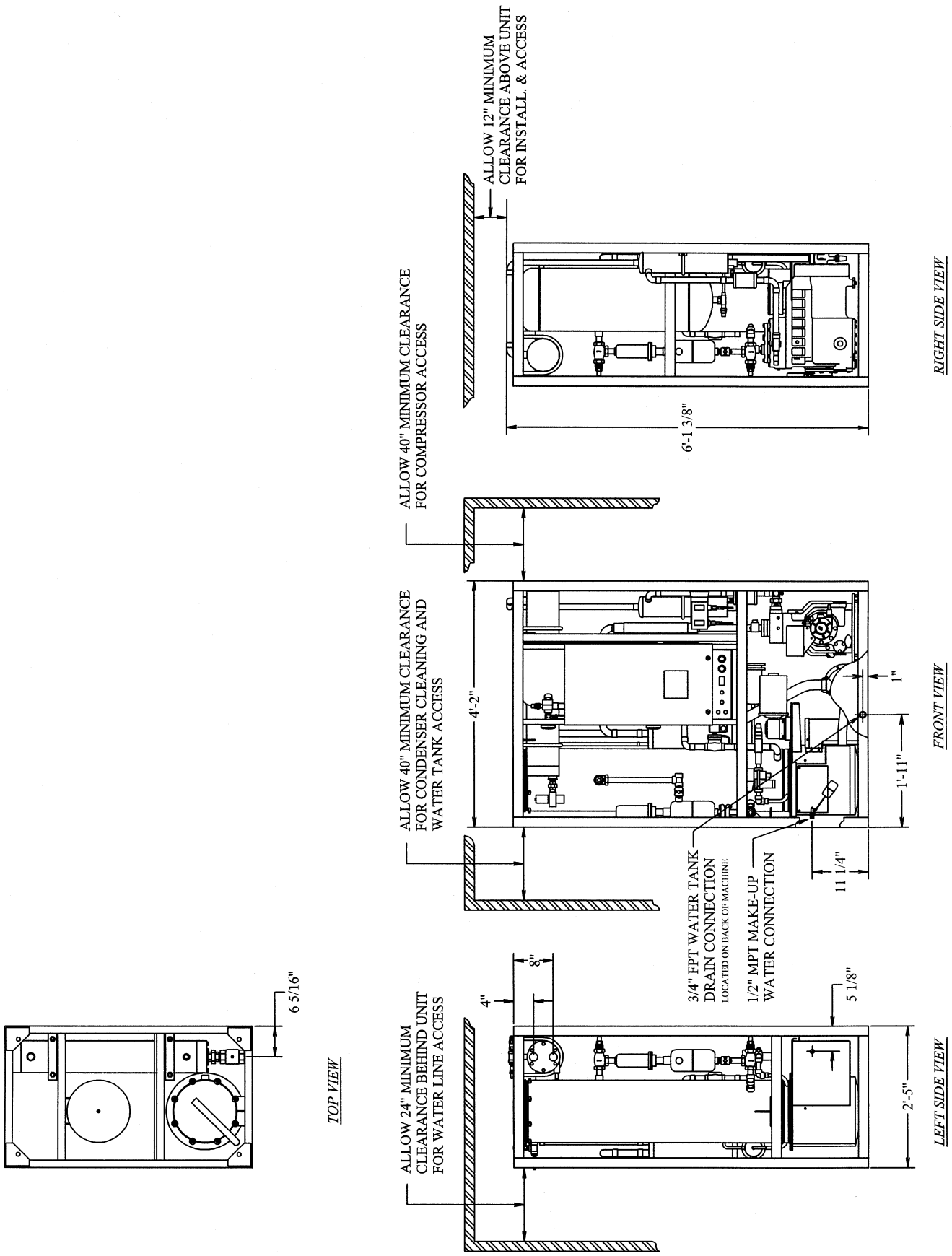


FIGURE 3-5
Connections and Space Diagram (Water Cooled Machine)

Piping and Drain Connections

Figure 3-4 (Air Cooled) and 3-5 (Water Cooled) show locations and sizes for all connections.

! CAUTION !
External shut-off valves must be provided in the water inlet lines. The minimum inlet water pressure for satisfactory operation of the machine is 30 psig. The maximum allowable pressure is 100 psig.
! CAUTION !

Make-up Water In	Water Tank Drain*	Condenser Water In	Condenser Water Out*
1/2" MPT	3/4" FPT	1 1/4" FPT	1 1/4" FPT

TABLE 3-1
Water Supply and Drain Sizes

***** The condenser water outlet and water tank drain connections must be extended to an open drain or sump, arranged for visible discharge. **Do not trap the water tank drain line**, as this will interfere with the operation of the automatic blowdown system. A 20 mesh strainer, supplied with the machine, should be installed in the supply line to the condenser.

! CAUTION !
These lines must NOT be connected into a pressure tight common header due to the possibility that warm condenser water may back up into the water tank. The condenser water outlet MUST be piped separately to the drain.
! CAUTION !

Cooling Tower.

For water cooled machines only. When selecting a cooling tower, careful attention must be given to operating wet bulb conditions. It is advisable to check with your local cooling tower distributor for their recommendations based on actual operating conditions in your area. An average wet-bulb of 78?F is typical in the U.S. but many localities have design wet-bulbs as low as 72?F or as high as 82?F.

The cooling tower water pump must be capable of delivering the required volume of water through the condenser. Due to cooling tower location and pressure drop through water lines and water regulating valves, the pump must be sized for each installation. Refer to TABLE 11-4 for condenser water requirements. The water piping for the cooling tower and the installation of the pump must be in accordance with the manufacturer's instructions.

Proper water treatment for the prevention of mineral and foreign matter accumulation in the condenser or cooling tower is recommended. A water analysis should be obtained to determine the proper chemicals to use.

Wiring and Electrical Connection

! WARNING !
Only service personnel experienced in refrigeration and qualified to work with high voltage electrical equipment should be allowed to install or work on the Tube-Ice® machine.
! WARNING !

Refer to TABLE 3-2 below to properly size wiring connections. A fused disconnect must be provided near the Tube-Ice® machine. Connect 3 phase power to terminals L1, L2, L3 for operation of the Tube-Ice® machine and its controls. Rotation checking of cutter motor and water pump is required (see following section). Also, if one leg of the 3 phase power is higher or lower ("Wild"), then it should be connected to terminal #L2. Connect the "Ground" wire to the "Ground" lug provided.

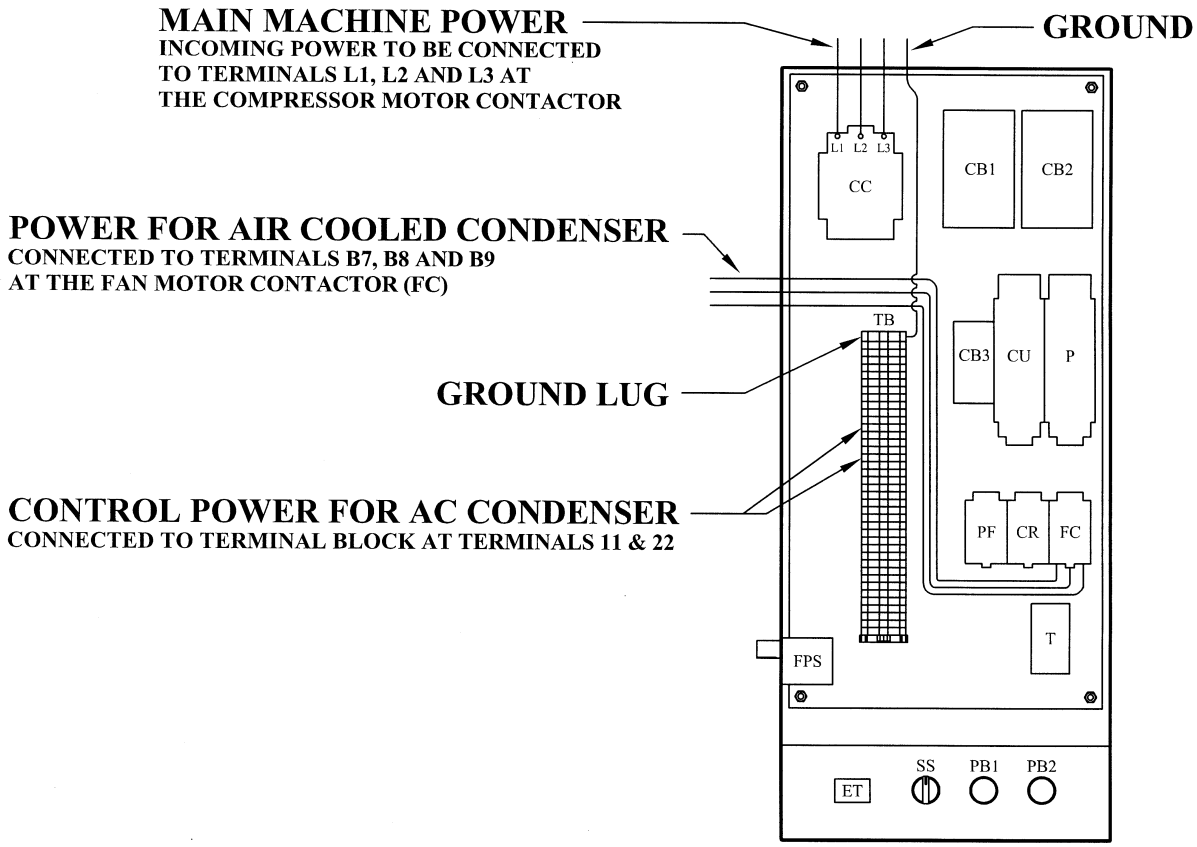


FIGURE 3-6
Control Panel Power Connections

Standard Voltages	Water Cooled			Air Cooled		
	F.L.A.	Min. Ampacity	Max. Fuse	F.L.A.	Min. Ampacity	Max. Fuse
208/230, 3ph, 60 Hz	66.9	81.8	145	76.9	91.8	155
460, 3ph, 60 Hz	32.7	39.9	70	37.2	44.4	75
200, 3ph, 50 Hz	73.3	89.8	160	83.3	99.8	170
400, 3ph, 50 Hz	37.2	45.4	80	42.2	50.4	85

TABLE 3-2

Electrical Specifications

Phase Check

! CAUTION !
DO NOT attempt to start machine without priming pump and insuring proper rotation of both cutter and pump. Refer to FIGURE 3-1 & 3-2 (space diagram) for connection locations.
! CAUTION !

Cutter and pump motor rotation are factory synchronized but **must** be checked at installation. For ice production, the cutter disc, as viewed at the ice discharge opening should turn from left to right (crushed rotation should be from right to left). The pump rotation should match the marking on the pump housing. The pump will need to be primed by starting the machine in the clean mode and allowing it to run for several minutes. To change direction of rotation for both, cutter and pump, disconnect power and reverse L1 and L3 (incoming power wires) at the compressor motor contactor.

Voltage Unbalance Voltage unbalance can cause motors to overheat and fail.

The maximum voltage unbalance between any two legs should be no greater than 2%.

Example: Supply Voltage = 230-3-60
Voltage Readings: AB = 220 Volts
BC = 225 Volts Average = (220 + 225 + 227)/3 = 224 Volts
AC = 227 Volts

(AB) 224-220 = 4 Volts (Highest Deviation)
(BC) 225-224 = 1 Volts % Voltage Unbalance = 100 x (4/224) = 1.78% "Acceptable"
(AC) 227-224 = 3 Volts

Important: If the supply voltage phase unbalance is more the 2%, contact your local electric utility company.

Current Unbalance Voltage unbalance will cause a current unbalance, but a current unbalance does not necessarily mean that a voltage unbalance exists. A loose terminal connection or a buildup of dirt or carbon on one set of contacts would cause a higher resistance on that leg than on the other two legs. Current follows the path of least resistance, therefore if terminal connection L1 is loose or dirty, L2 and/or L3 will have higher current. Higher cu rrent causes more heat to be generated in the motor windings.

The maximum acceptable current unbalance is 10%.

Example:
Current Readings: L1 = 96 Amps
L2 = 91 Amps Average = (96 + 91 + 98)/3 = 95Amps
L3 = 98 Amps

(L1) 96-95 = 1 Amps
(L2) 95-91 = 4 Amps (Highest Deviation) % Current Unbalance = 100 x (4/95) = 4.2% "Acceptable"
(L3) 98-95 = 3 Amps

Air-Cooled Condenser Installation Instructions

! WARNING !
These installation guidelines must be followed to obtain reliable operation from air cooled ice machines. IF THESE GUIDELINES ARE NOT FOLLOWED THE COMPRESSOR WARRANTY WILL NOT BE HONORED.
! WARNING !

1. Use only Vogt approved condensers. Any exceptions to this policy must be obtained in writing from Vogt prior to installation and operation of the ice machine.

2. Outdoor condensers **must** be installed with vertical air flow. Indoor condensers used for heat recovery may be installed with either horizontal or vertical air flow.

3. The condenser **must** be mounted above the ice machine.

4. Horizontal runs in the liquid return line should slope 1/4" per foot with liquid refrigerant draining freely in the direction of normal operating flow (back to the ice machine) with no traps in the liquid line.

5. Horizontal runs in the discharge line should slope 1/4" per foot in the normal direction of flow (away from the ice machine).

6. Traps must be installed in discharge lines at the base of all vertical risers. There should be no intentional traps in liquid lines. Trap volume should be kept to a minimum. Long vertical rises should have traps every 20 feet. Typical details are shown in FIGURE 3-7.

7. Flooding head pressure controls such as Alco Headmaster are not to be used since they cause excessive subcooling of the returned liquid refrigerant and interfere with reliable ice harvest.

8. The discharge and liquid lines must be insulated with 1/2" thick Armaflex insulation or equal.

9. Use only ACR grade copper pipe, Type L. Recommended line sizes are shown in TABLE 3-3.

10. For field attachment instructions, see FIGURE 3-4.

11. Distance between ice machine and condenser must not exceed 150 equivalent feet. Refer to Condenser Equivalent Line Size worksheet (see TABLE 3-4).

12. Condensers must be provided with a cold weather valve kit per FIGURE 3-8. These valves allow one-half of the condenser to be disabled in cold weather. Running the ice machine with one-half of the condenser in cold weather makes it easier to maintain minimum necessary condensing pressure particularly in windy conditions.

13. Condensers with multiple fans must be provided with a thermostat to turn off unneeded fans in cold weather. Turning off unneeded fans reduces on-off cycling of the fan(s) and allows for a steadier condensing pressure and more consistent warm gas for ice harvesting.

INSTALLING YOUR TUBE-ICE® MACHINE

14. When extreme cold conditions are expected or encountered (temperatures below 0?F and wind greater than 15 MPH), it may be necessary to install a protective enclosure around the condenser. Apparatuses such as louvers may also be used for varying conditions. Contact the factory for suggestions.

15. After installation, the field installed lines are to be evacuated to a vacuum of 500 microns or less and held for at least one hour. After the vacuum pump is removed, vacuum should hold at 500 microns or less for at least 5 minutes.

16. The machine is shipped with a full operating charge of refrigerant sufficient to fill the condenser and connecting lines. If the condenser piping is longer than 50 feet (one way), additional R-22 or R-404a may need to be added to retain enough refrigerant in the receiver for thawing purposes (see table. Refer to the operating level mark on the receiver and charge accordingly. Each 1" of liquid level in the receiver equals approximately 5.5 pounds of R-22 or R-404a.

Liquid Line Size	75 ft.	100 ft.	125 ft.	150 ft.
1/2"	none	None	None	2
5/8"	none	2	4	6
7/8"	none	4	8	12
1-1/8"	none	6	12	18

TABLE 3-3
Pounds of R-22 to Add vs. Liquid Line Length

17. All piping must be done in accordance with applicable local and national codes. Such codes may include "The Safety Code For Mechanical Refrigeration" (ANSI B9.1) and "The Code For Refrigerant Piping" (ANSI B31.5).

18. The following installation guidelines are strongly suggested. While they do not affect the machine warranty, they may be required for safe operation and to comply with all applicable electrical and mechanical codes:

    a. Local electrical code must be checked for wiring method.
    b. The installer must provide a disconnect switch(s) adjacent to the condenser.
    c. Electrical connections between the condenser and the Tube-Ice® machine require minimum 12 ga. wire.
    d. All electrical fittings and components exposed to the weather must be suitable for outdoor installation.

The design total heat rejection for each Tube-Ice® machine, the recommended air-cooled condenser, and condenser physical and electrical data are shown on the next page. Specified energy efficiency ratings of the ice machines are based on use of the recommended condenser and approved piping practices.

Recommended condensers provide the indicated total heat rejection at 90?F ambient, 100?F condensing. Tube Ice, LLC is not responsible for head pressure problems if other than the recommended condensers are used. For continuous operation at ambient temperature above 105?F, consult the factory about using a larger condenser.

Ice Machine Model	03TA	03TA
Electrical Frequency, Hz.	60	50
Recommended Condenser	DD-231	DD-231
Total Heat Rejection (BTU/hr)	128,100	128,100
Fans:		
Number	3	3
HP, Each	1/2	1/2
Total CFM	15,000	15,000
Full Load Amps (FLA):		
3 ph., 208/230V, 60 hz.	6.0	--
3 ph., 460V, 60 hz.	3.0	--
3 ph., 200V, 50 hz.	--	6.0
3 ph., 380V, 50 hz.	--	3.0
Locked Rotor Amps (LRA):		
3 ph., 208/230V, 60 hz.	19.8	--
3 ph., 460V, 60 hz.	9.8	--
3 ph., 200V, 50 hz.	--	19.8
3 ph., 380V, 50 hz.	--	9.8
Weight, lbs.:		
Net	400	400
Shipping	500	500
Operating (Maximum flooded) R-404a	430	430
Condenser Dimensions, inches (See Fig. 3-7)		
A (Width)	41 3/8”	41 3/8”
B (Length)	105”	105”
C (Height)	36 1/8”	36 1/8”
D (Leg centerline)	40 3/8”	40 3/8”
E (Leg centerline)	94”	94”
F (Clearance below)	11 3/4”	11 3/4”
Recommended Line Sizes, OD		
Liquid		
All lengths and orientations	1 1/8”	1 1/8”
Discharge Gas		
Vertical Up, all lengths	1 1/8”	1 1/8”
Horiz. or Down, < 75 ft.	1 1/8”	1 1/8”
Horiz. or Down > 75 ft.	1 3/8”	1 3/8”
Connections (Cond. & Ice Mach.):		
Liquid (ODF)	1 1/8”	1 1/8”
Discharge Gas (ODF)	1 3/8”	1 3/8”

TABLE 3-4
Air-Cooled Condenser Data

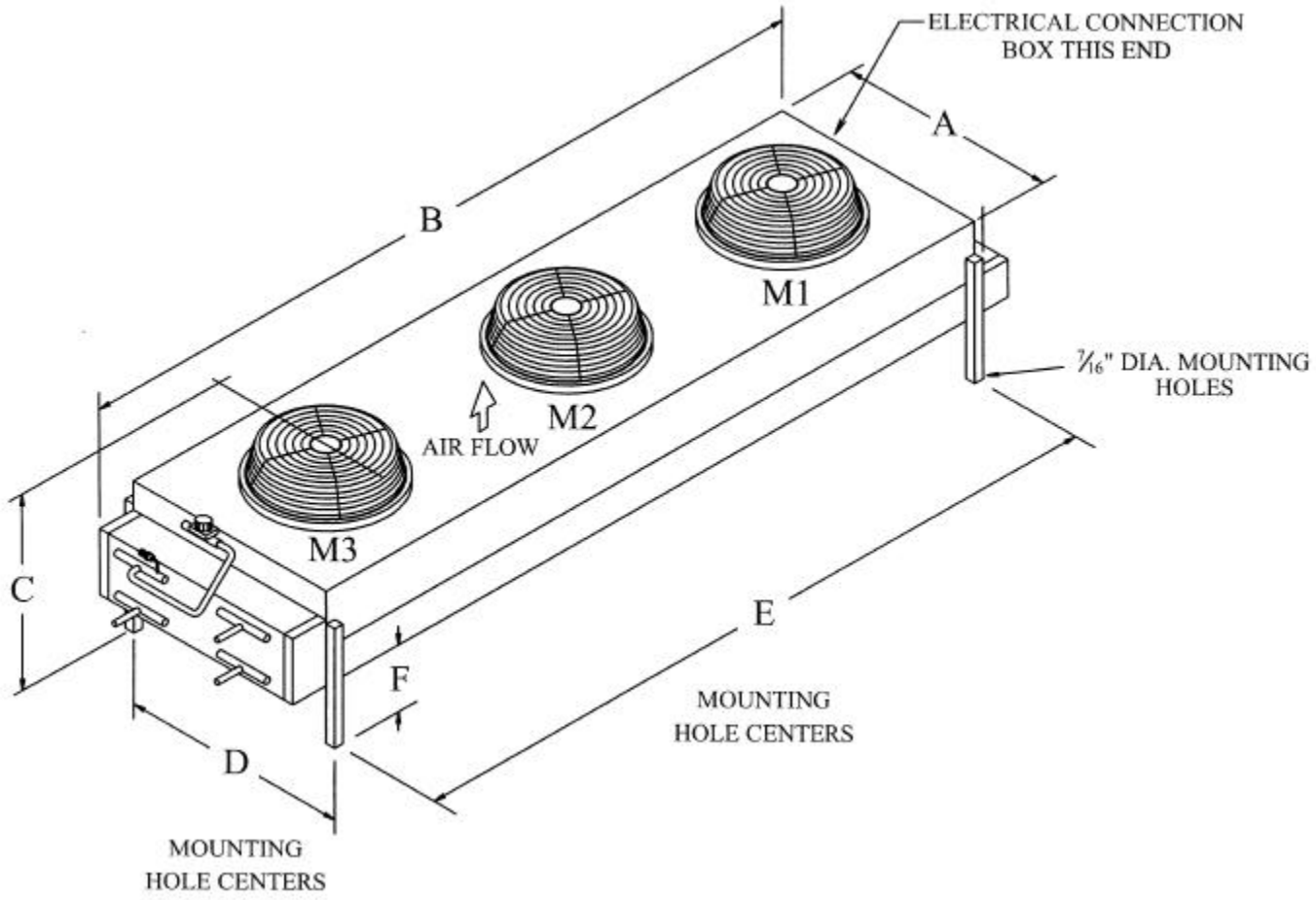


FIGURE 3-7
Condenser Dimensions (Condenser pictured: DD-231)
Note: Dash lines indicate customer supplied piping.

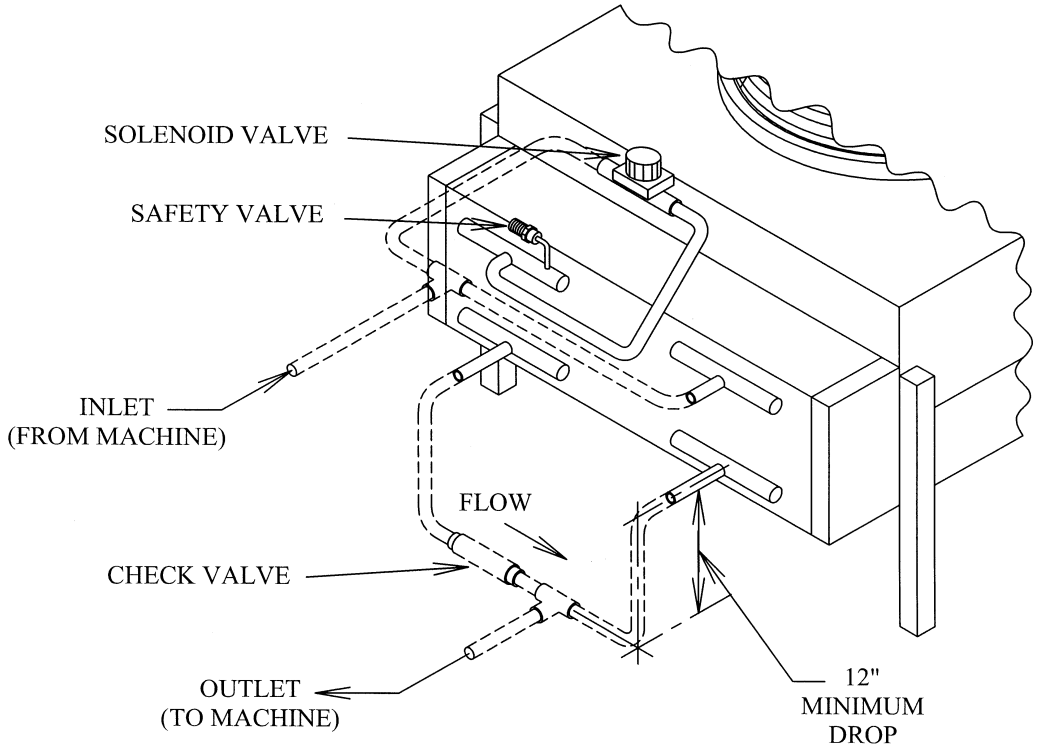


FIGURE 3-8
Condenser Field Piping (Cold Weather Valve Kit)

CONDENSER EQUIVALENT LINE SIZE WORKSHEET

Discharge Gas Line O.D. _____

Fitting Type	Number Used	Factor	Total
Globe Valve (open)			
Angle Valve (open)			
90? Elbow			
45? Elbow			
Tee			

Feet of Straight Copper Used	
Total Fitting Factor	
Total Equivalent Feet	

Copper Tubing Type "L"	1 1/8" O.D.	1 3/8" O.D.	1 5/8" O.D.	2 1/8" O.D.
Globe valve (open)	28	36	42	57
Angle valve (open)	15	18	21	28
90° Elbow	3	4	4	5
45° Elbow	1.5	2	2	2.5
Tee (90? turn through)	6	8	9	12
Tee (straight through)	2	2.5	2.8	3.5

TABLE 3-5
Equivalent Feet Due To Friction

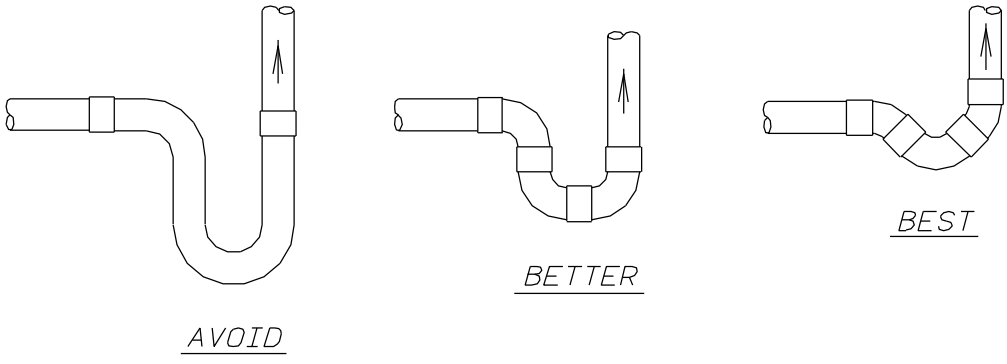
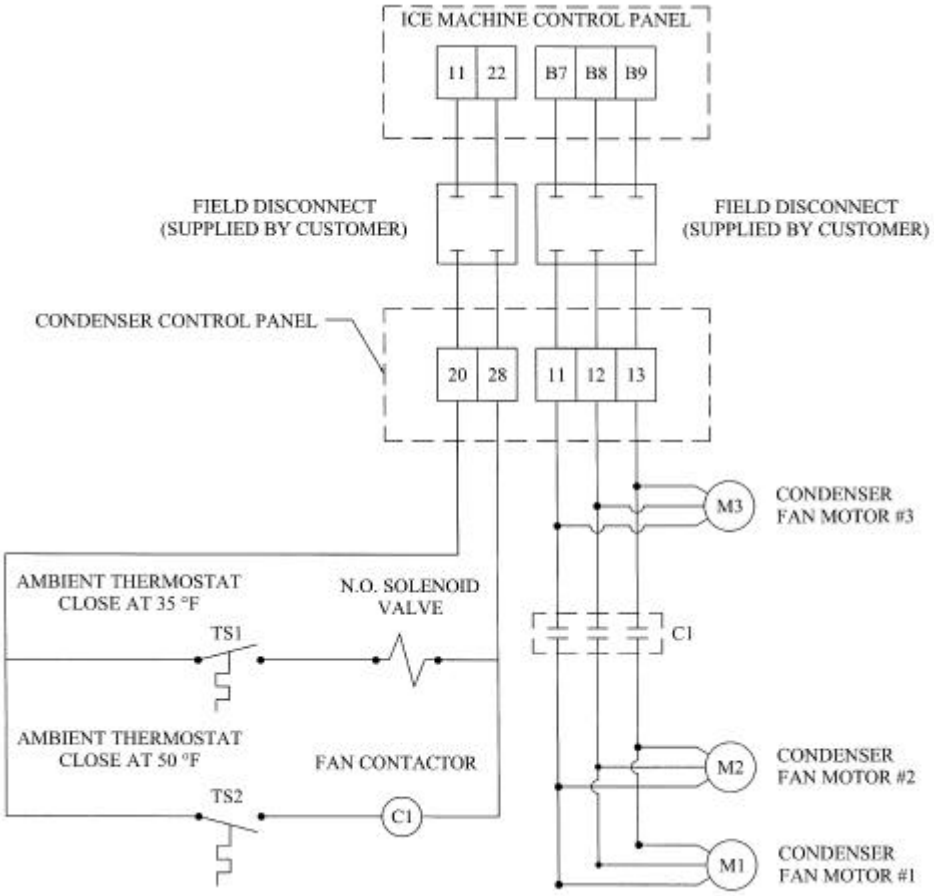


FIGURE 3-9
Minimum Traps For Discharge Lines

*Note: Each recommended line size is based on use of Type "L" copper tubing at a maximum equivalent distance of 150 feet. See TABLE 3 -5 for equivalent feet of valves and fittings.

Air-Cooled Condenser Wiring

FIGURE 3-10



Wiring For #DD-231 and #DD-261 Condenser
(3 phase motors)

Air-Cooled Connections (See FIGURE 3-4 for connection sizes)

Follow these procedures to make a tight joint:

1. Silver solder or braze condenser tubing ends to the female Rota-lock connectors.

2. Remove dust caps if used, making sure that component plastic seals are intact.

3. Wipe off connector and spud threaded surfaces with a clean cloth to prevent the inclusion of dirt or any foreign material in the system.

4. Connector coupling nut should be screwed onto Rota-lock spud using the proper amount of torque.

Spud Size	Amount of Torque
7/8”	50-60 FT LBS
1 1/8”	80-100 FT LBS
1 3/8”	100-110 FT LBS

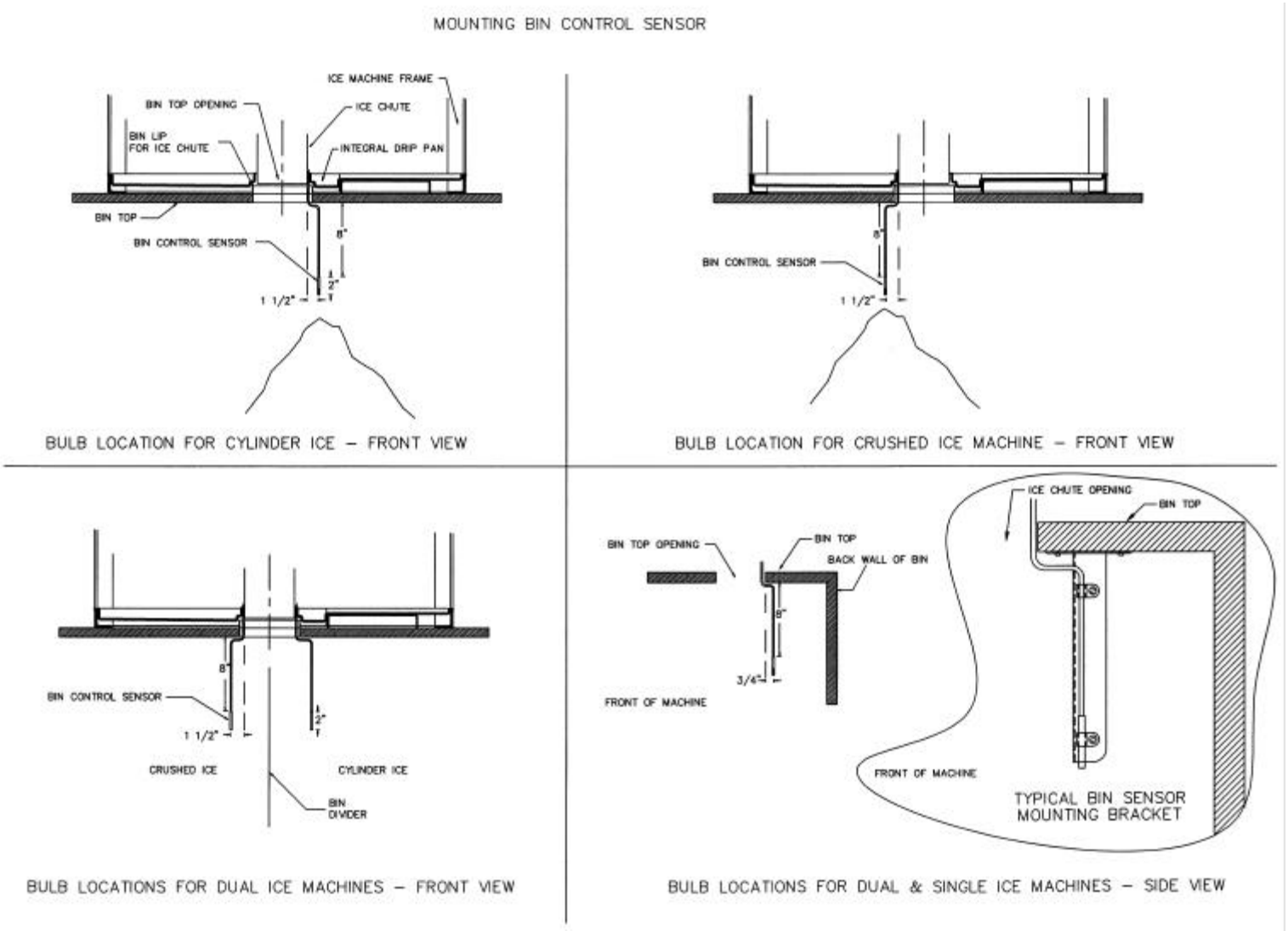
TABLE 3-6
Rota-lock Connector Torque Ratings

Ice Bin Thermostat Sensor Installation Each machine is equipped with an electronic ice bin thermostat. To assure proper protection for the machine, the sensor of the ice bin thermostat must be located so that ice will contact it when the bin is full (See FIGURE 3 -11). The distance between the ice chute and the sensor allows space for the machine to make an additional discharge of ice AFTER the ice contacts the probe WITHOUT the ice building up into the discharge opening of the chute.

Note: The probe should also be mounted on the back side of the bracket, opposite of the front of the bin to reduce the possibility of damage from ice removal equipment.

The control panel is electrically connected so that the bin thermostat will stop the machine only upon the completion of a harvest period.

When both cylinder and crushed ice are produced and separately stored in a divided bin, the control sensor of thermostat BT2 is placed in the crushed ice section of the storage bin (left side) and the control sensor of thermostat BT1 is placed in the cylinder ice section (right side of bin).



Note: Drip loop not necessary for Electronic Thermostat

FIGURE 3-11

Ice Bin Thermostat Location

Programming the Electronic Bin Thermostat

INSTALLING YOUR TUBE-ICE® MACHINE

The electronic bin thermostat has an LCD readout that displays the temperature in the bin at the sensor. **The control has been preset and locked out at the factory to shut the machine down at 38?F and to re-start at 40?F.** The control retains the program even if power is cut to the machine. Under special conditions, the settings may need to be changed. The lockout switch is located on the inside of the control. Removal of the four screws on the face of the control will reveal the lock-switch.

Follow the instructions below to reset the switch.

1. Press the "SET" button to enter the sensors setup mode
2. Select between "C"- Celsius and "F" - Fahrenheit
   Use the up ? or down ? key to select "F"
3. Press the "SET" button to set the Set point (S1 will be blinking)
   Use the up ? or down ? key to set the temperature at 38?F
4. Press the "SET" button to set the Differential (DIF 1 will be blinking)
   Use the up ? or down ? key to set the differential at 2 ?F
5. Select between "C1"- Cooling mode and "H1" - Heating mode
   Use the up ? or down ? key to select "C1"

Machine will shut off when temperature drops to 38°F and come on when temperature reaches 40°F.

Note: The sensor will automatically exit the programming mode if no keys are depressed for a period of thirty seconds. Any settings that have been input to the control will be accepted at that point.

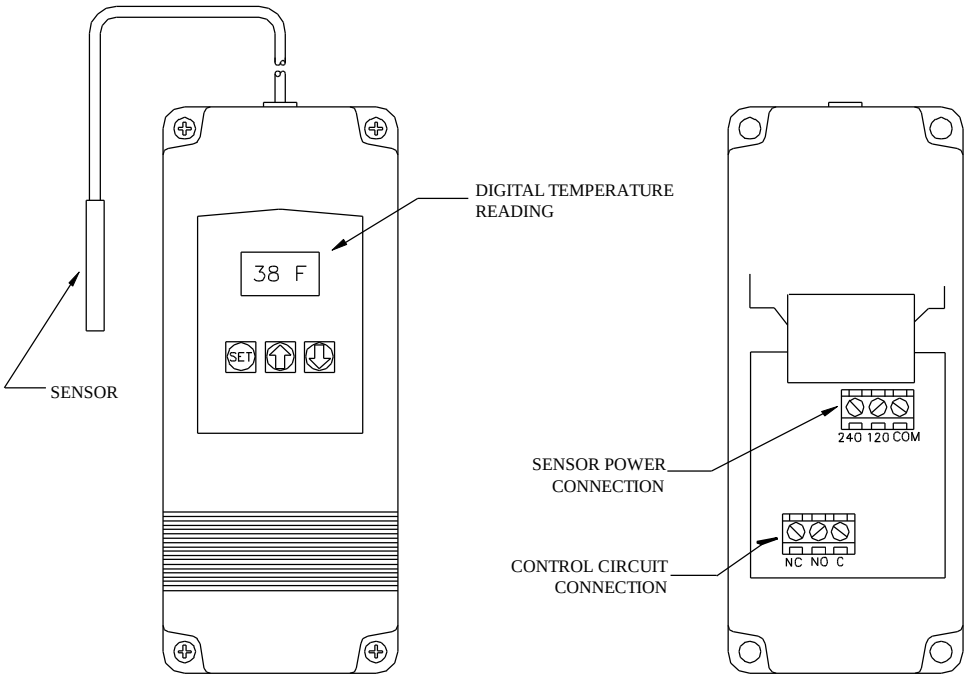


FIGURE 3-12
Electronic Thermostat

Note: If damaged, the sensor can be replaced without replacing enti re unit.
Replacement sensor part #12A 2117G0901. Electronic temperature control part #12A 2117G09. Sensor cable can be extended up to 400 feet. For more information, consult Tube-Ice® Technical Service Department.

4. How Your Tube-Ice® Machine Works

Principle of Operation For a detailed description of the functions of each control panel component, see Section 6. Operation of the machine is controlled by "Ice/Clean", "On/Off", "Start" and "Stop" switches located in the control panel of the freezing unit. Automatic operation is controlled by an ice bin thermostat which will automatically stop and start the ice maker by the level of the ice in the storage bin (NOTE: See FIGURE 3-11, "Ice Bin Thermostat Location" for instructions on installation of the control sensor of the ice bin thermostat(s)). The type ice produced (cylinder or crushed) is determined by how the machine cutter is set-up (cylinder is standard, crushed is optional). The control wiring is arranged so that the unit will stop only upon the completion of a thawing period whether by action of the "Off" switch or the ice bin thermostat.

The "Ice/Clean" switch must always be set in the "Ice" position during normal ice-making operation. It is set in the "Clean" position only when the equipment is to be cleaned as outlined in the "Cleaning Procedure" (Section 7) and instructions attached to the machine.

If it should become necessary to instantly stop the machine, push the "Stop" button. To restart the machine, push the "Start" button. The machine will restart in a harvest, to clear out any ice remaining in the freezer, if stopped during a freeze period.

FIGURES 4-1 & 4-2 illustrate the piping diagram of the refrigerant and water circuits of the Tube-Ice® machines with numbers for easy reference. Throughout this manual, the numbers you see in parentheses refer to the numbers in this piping schematic.

The freezer (2) is a shell and tube-type vessel. During the freezing period, water is constantly recirculated through the vertical tubes of the freezer by a centrifugal pump (6). Make-up water is maintained by a float valve (12) in the water tank (7). The liquid feed solenoid valve (20), sometimes referred to as the "A" valve, is open and the thawing gas solenoid valve (18), sometimes referred to as the "D" valve, is closed.

Refrigerant gas from the top of the freezer (2) passes through the suction accumulator (88), the heat exchanger (13), and to the compressor (3). Here the cool gas is compressed to a high temperature, high pressure gas which discharges through the oil separator (14) and into the condenser (15). In the condenser, heat is removed and the gas is condensed to a high temperature, high-pressure liquid. The high-pressure liquid goes through the accumulator boil out coil (88) and suction line heat exchanger (13) where it is gives up heat to the suction gas for compressor protection. In addition, this liquid is subcooled and carried to the receiver (15R). Condensed liquid refrigerant from the receiver flows through the filter/drier (46), thawing chamber (16), liquid feed solenoid valve ("A" valve) (20) and hand expansion valve (17) into the freezer. The float switch (22) is wired to the "A" solenoid valve (20). The float switch energizes and de-energizes the "A" solenoid in response to the level of refrigerant in the freezer. The cold liquid refrigerant enters the freezer where it absorbs heat from the circulating water. This cool gas is pulled out of the freezer at the suction outlet thereby completing the circuit.

The freezing period is completed by action of the freezer pressure switch in the control panel. The water pump (6) is stopped and solenoid valve "A" (20) is closed. The thawing period then begins. Solenoid valve "D" (18) is opened, the cutter motor (5M) is started and the harvest (thaw) timer is activated. Warm gas from the receiver is discharged into the freezer through valve (18), thereby

slightly thawing the outer edge of the ice, which drops on the rotating cutter for sizing. See "Freeze Period and Harvest Period" in this section for a more detailed description of these operations.

Air-cooled machines have a solenoid valve (53), sometimes referred to as the "X" valve, in the compressor discharge line, and a check valve (101) in the liquid return line to the receiver. These valves prevent the migration of refrigerant to the compressor when the machine is not operating.

Freeze Period The Tube-Ice® is frozen inside the stainless steel tubes in the freezer (2) by the direct application of refrigerant to the shell side (outside) of the tubes. The ice is produced from constantly recirculating water during the freeze period. As the ice thickness increases, the freezer suction pressure decreases. At a set pressure, the freezer pressure switch initiates the harvest period.

Harvest Period When the freezer pressure switch (56, FPS) contact closes, a control relay (CR) is energized. The "CR" relay stops the water pump and starts the cutter motor. The "A" (liquid line) solenoid valve closes, the "D" (thaw gas) solenoid valve opens and the thaw timer (T) is energized. As the ice releases and drops through the rotating cutter and onto the cutter disc, it is discharged through the side opening of the water tank. The harvest timer (T) is to be set for the time required to discharge all the ice plus 30 seconds longer (usually 2 1/2 minutes).

! CAUTION !
Make sure all the ice clears the freezer with at least 30 seconds to spare before the next freeze period begins. This is to prevent refreezing.
! CAUTION !

Item No.	Description	Item No.	Description
1	Control Panel	31	Gage Glass Stop Valve
2	Freezer	32	A/C Condenser Service Connection
3	Compressor	34	Compressor Suction Service Valve
4PS	Dual High/Low Pressure Switch	35	Compressor Discharge Service Valve
5M	Cutter Motor	37	Oil Charging/Drain Valve
5R	Gear Reducer	39	Water Tank Drain Valve
6	Water Pump	40	Automatic Water Tank Blowdown
6A	Water Pump Check Valve	41	Condenser Water Regulator (W/C Machines Only)
7	Water Tank (includes cutter assembly)	41A	Condenser Pressure Control (A/C Machines Only)
8	Water Distributing Chamber	43	Liquid Feed Solenoid Valve Strainer
12	Make-up Water Float Valve	46	Filter Drier
13	Heat Exchanger	48	Muffler
14	Oil Separator	50	Receiver Safety Valve
15	Condenser	51	Freezer Safety Valve
15R	Receiver	52	Condenser Safety Valve
16	Thawing Chamber	53	Cold Weather Solenoid Valve "X" (A/C Machines Only)
17	Hand Expansion Valve	55	Discharge Line Stop Valve (A/C Machines Only)
18	Thawing Gas Solenoid Valve ("D" Valve)	56	Freezer Pressure Switch
20	Liquid Feed Solenoid Valve ("A" Valve)	58	Liquid Outlet Valve (King Valve)
22	Float Switch	69	Freezer Pressure Stop Valve
23	Condenser Water Inlet (W/C Machines Only)	88	Accumulator/Heat Exchanger
24	Condenser Water Outlet (W/C Machines Only)	90	Thawing Gas Stop Valve
25	Water Tank Drain Connection (3/4" FPT)	91	Receiver Liquid Return Stop Valve
28	Refrigerant Charging Valve	94	Compressor Oil Pressure Safety Control
30	Receiver Gage Glass	101	Check Valve

TABLE 4-1
Piping Nomenclature

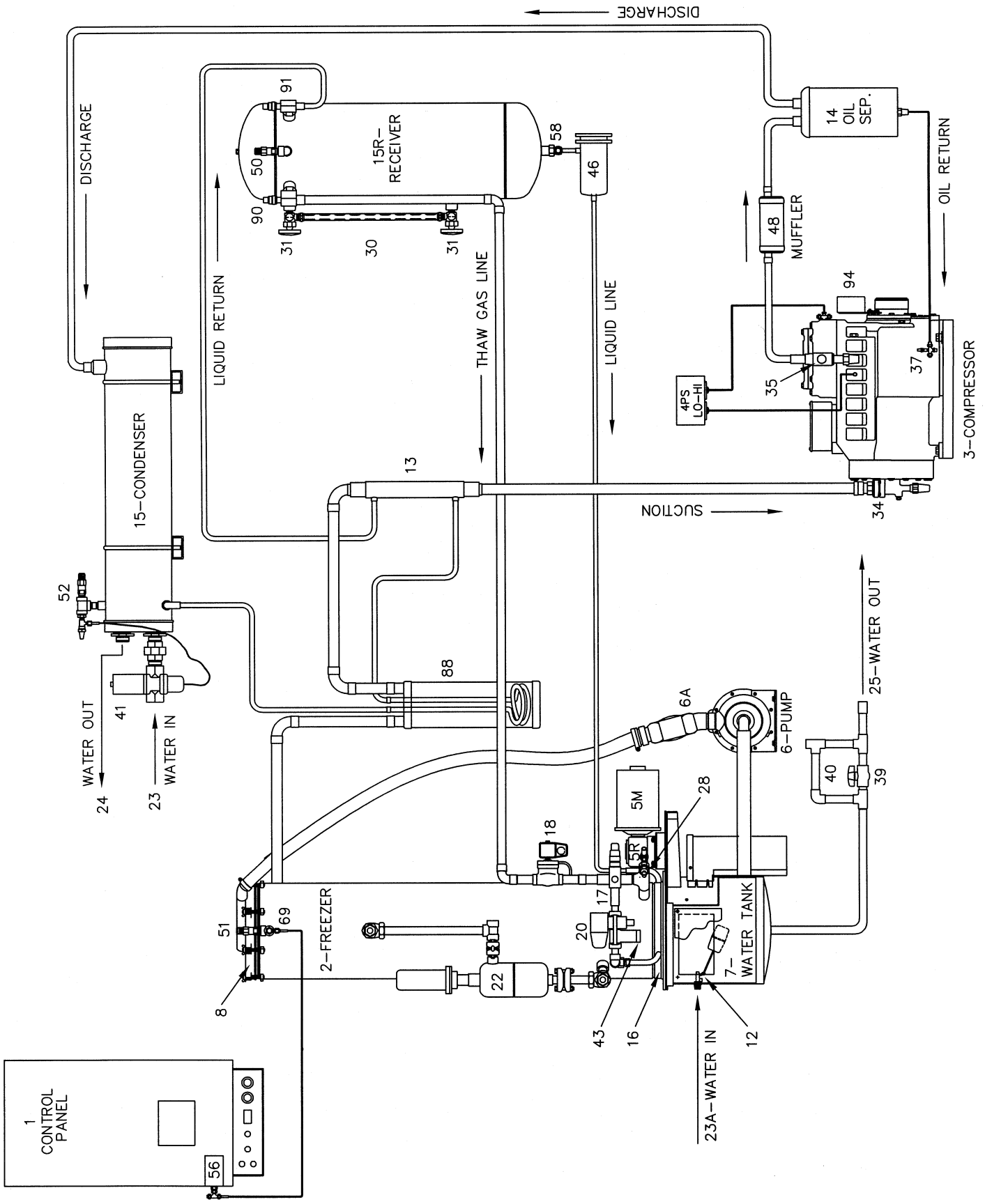


FIGURE 4-1
Water-Cooled Piping Schematic

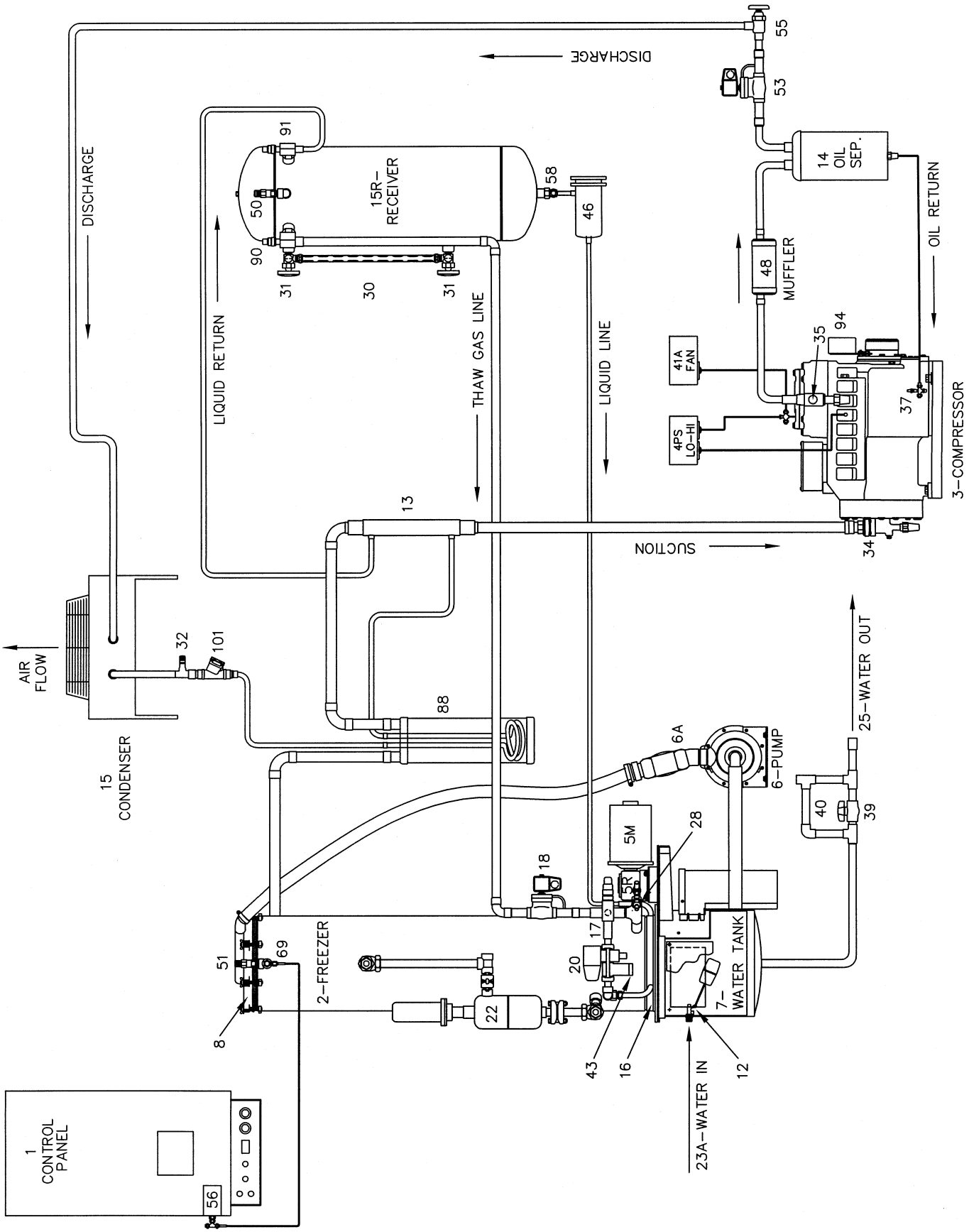


FIGURE 4-2
Air-Cooled Piping Schematic

5. Start-Up and Operation

Refrigeration System Review The refrigeration system uses R-22 or R-404a refrigerant, a compressor, a refrigerant float switch, a flooded evaporator (freezer), and warm gas defrost. Following the schematic, notice that during th e freeze period of the machine's cycle, the condenser discharge gas leaves the compressor and goes to the condenser where it is condensed into liquid by the removal of heat by either air or water passing through the condenser. A reservoir of liquid is accumulated in the receiver and flows as required, passing through the filter/drier, the thawing chamber (a lower separate section of the freezer) and the liquid feed solenoid valve (the "A" valve) and through the hand expansion valve and into the freezer. T he position of the "A" valve during the freeze cycle allows the liquid to feed based on the position of the float switch and the feed rate at which the hand expansion valve is set. The "A" valve opens and closes in response to the refrigerant level in the freezer. Wet refrigerant floods the evaporator and is in contact with the outside of the ice-making tubes in which water is being circulated. The heat contained in this water passes through the wall of the tubes, lowering the temperature of the water, c ausing it to freeze and form a long tube of ice that adheres to the inside of each of the freezer tubes. The flowing water keeps the accumulated ice clear by washing separated solids down into the sump area of the water tank.

The wet suction gas leaves t he freezer and any remaining liquid droplets are removed by the accumulator and suction line heat exchanger. The dry gas enters the compressor and is compressed then discharged to the condenser completing the cycle.

As the ice is formed in the freezer, t he suction pressure steadily reduces until it causes the freezer pressure switch to close, initiating the harvest period.

During the harvest period, the thawing gas solenoid valve (the "D" valve) is open allowing the warm high pressure gas to enter the fr eezer. This heat melts a thin film from the outside of the ice, reducing the diameter and letting it fall free from the freezer tubes. This period lasts approximately 2 1/2 minutes.

Refrigerant Charge Included with the machine is the required charge (a pproximately 150 lbs.) of R-22 or (approximately 180 lbs) of R-404a, depending on the model, which has been isolated in the receiver (15R). Before shipment of the machine, the compressor service valves (34), (35), and the stop valves in the various lines to the condenser and receiver have been closed. These valves are tagged with instructions that the valves are to be opened prior to start-up of the machine. Before opening these valves, it is advisable to check all joints for leaks that may have develop ed during shipment. If no leaks are present, a positive pressure should show on the suction and discharge pressure gages. They should indicate a pressure approximately equal to the ambient temperature. This pressure can be found using the pressure temperature chart for R-22 or R-404a (as applicable), TABLE 11-7.

If it should ever become necessary to add refrigerant to the system, charging valve (28) is provided for this purpose. Through this valve, refrigerant can be added in liquid form. See "Adding Refrigerant." The compressor crankcase heater must be energized for a minimum of two hours prior to starting and running the compressor.

Adding Refrigerant Check the refrigerant level after the machine has operated for a few cycles. It should be slightly above the minimum operating level, as indicated on the receiver gage glass, a few minutes prior to start of a thawing period. If this level is low at this time, sufficient refrigerant should be added to the system to raise the level above this point. Add only a small quantity (10 lbs. or less) at a time and operate the machine several cycles to check the level before adding additional refrigerant. Refrigerant may be added as a liquid through the charging valve (28) only while the machine is operating. It is important that no air or other non-condensable gas enter the system when charging refrigerant into the unit. It is also possible to check the refrigerant level by pumping machine down (See page 9-11). When the machine is pumped down, a liquid level should be observed in the gage glass on the receiver. The maximum pump down level is the top of gage glass.

! CAUTION !
If it should become necessary to add refrigerant to the system, charging valve (28) is provided for this purpose. Be sure to follow all local and federal regulations regarding the handling of refrigerants and their illegal emission into the atmosphere.
! CAUTION !

When adding refrigerant, it is necessary for the following procedure to be followed:

1. Make connection between charging valve and refrigerant cylinder using hose or pipe suitable for R-22 or R-404a service. See instruction card attached to refrigerant cylinder.

2. Open valve on R-22 or R-404a cylinder and purge air out of charging line at the charging valve connections using applicable methods.

3. Open charging valve.

4. Refrigerant can be added only during the freeze cycle. The charging valve must be closed when the freezer is in a harvest.

! DANGER !
Immediately close system charging valve at commencement of defrost or thawing cycle if refrigerant cylinder is connected. Never leave a refrigerant cylinder connected to system except during charging operation. Failure to observe either of these precautions can result in transferring refrigerant from the system to the refrigerant cylinder, overfilling it, and possibly causing the cylinder to rupture because of pressure from expansion of the liquid refrigerant.
! DANGER !

In order to check the total charge in the system, it is necessary to transfer all refrigerant to the receiver. A total pumpdown procedure should be performed.

See the name plate for the approximate refrigerant charge for the machine. Remember that the total charge will vary for air-cooled machines with remote air-cooled condensers.

OPERATING TIPS

?? If the operation of your machine is not controlled by a timer, bin level control or some other mechanism to automatically start and stop ice production, you should use ONLY the "Clean/Off/Ice" selector switch to start and stop machine.

By turning the "Clean/Off/Ice" selector switch "Off", the machine will stop after the next harvest cycle.

?? **DO NOT** use the "Stop" pushbutton or the machine disconnect for normal shutdown of the machine.

?? Throw the "Disconnect" only in an emergency or for safety when performing certain service or repairs to the machine. The compressor crankcase heater is de-energized when the disconnect is thrown.

?? The "Start" push button can be used to initiate a harvest cycle. When it is pushed during a freeze cycle, it will immediately initiate a harvest cycle.

When the machine is stopped with no power to the control circuit and the "Start" button is pushed, the machine will begin in a harvest cycle when operation is resumed. It makes no difference what position the "Clean/Off/Ice" switch is in at the time the "Start" button is pushed.

6. Electrical Controls

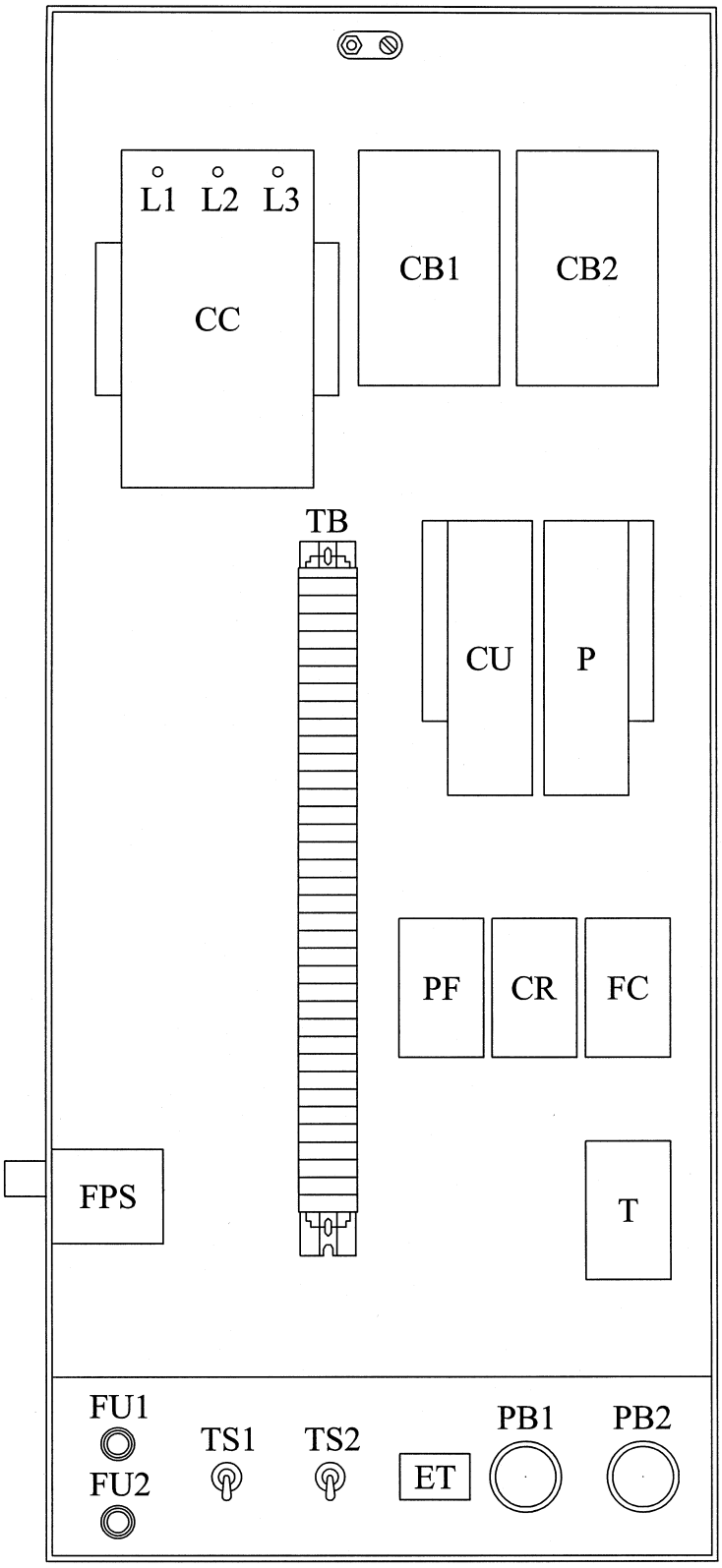


FIGURE 6-1
Control Panel (Cover Removed)

* (CC) Compressor Motor Contactor Provides power to the compressor motor. Continuously energized during freezing and thawing. Auxiliary contact to provide power to P, CU, T, A-Solenoid, D-Solenoid, and FC.
* (CB1) Pump/Cutter Circuit Breaker Secondary pump/cutter motor protection.
* (CB2) Air Cooled Condenser Circuit Breaker Air-cooled condenser fan motor protection.
* (CR) Control Relay For making and breaking various circuits concerning freezing and thawing. Energized during the thaw period.
* (CU) Cutter Motor Contactor With Overload Relay Stops operation of cutter motor in the event of a mechanical or electrical malfunction resulting in excessive motor amperes.
* (P) Pump Motor Contactor with Overload Relay Stops operation of water pump motor in the event of a mechanical or electrical malfunction resulting in excessive motor amperes.
* (PF) Power Failure Relay Stops the machine when there is a power failure or interruption. Also, it stops the machine when the high/low pressure switch, oil failure pressure switch, pump overload, cutter overload, compressor overload or the control circuit fuses fail. If the “Stop” button was pushed, any of the safeties tripped, or there was a power outage, the machine must be manually restarted by pushing “Start” button.
* (T) Thawing Timer Controls the time of the thawing period.
* (FC) Fan Contactor Cycles the fan motor(s) of air-cooled condenser on and off. Activated by the condenser pressure switch (air-cooled machines only).
* (TS1) Ice/Clean Toggle Switch Two position toggle switch to operate machine in ice making mode or clean mode. When in clean position, only the water pump will run. This allows cleaner to be circulated through the freezer without making ice.
* (TS2) On/Off Toggle Switch Two position switch used to stop machine at the end of the harvest and restart the machine in a freeze cycle.
* (ET) Elapsed Time Indicator Indicates hours of machine operation. Energized when compressor is operating.
* (PB1) Stop Push Button (Red) Used to stop machine immediately.
* (PB2) Start Push Button (Green) For starting machine or manually harvesting. Will initiate a harvest cycle whenever pushed with “Ice/Clean” switch in “Ice” position.
* (TB) Terminal Block Numbered for multiple wire connections and ease of troubleshooting.
* (FU1, FU2) 2.5 Amp Fuses Overload and short circuit protection for crankcase heater and the control circuit.
* (FPS) Freezer Pressure Switch For regulating the ice thickness by sensing freezer pressure switch and initiating the thaw period.

TABLE 6-1
Description of Control Panel Parts

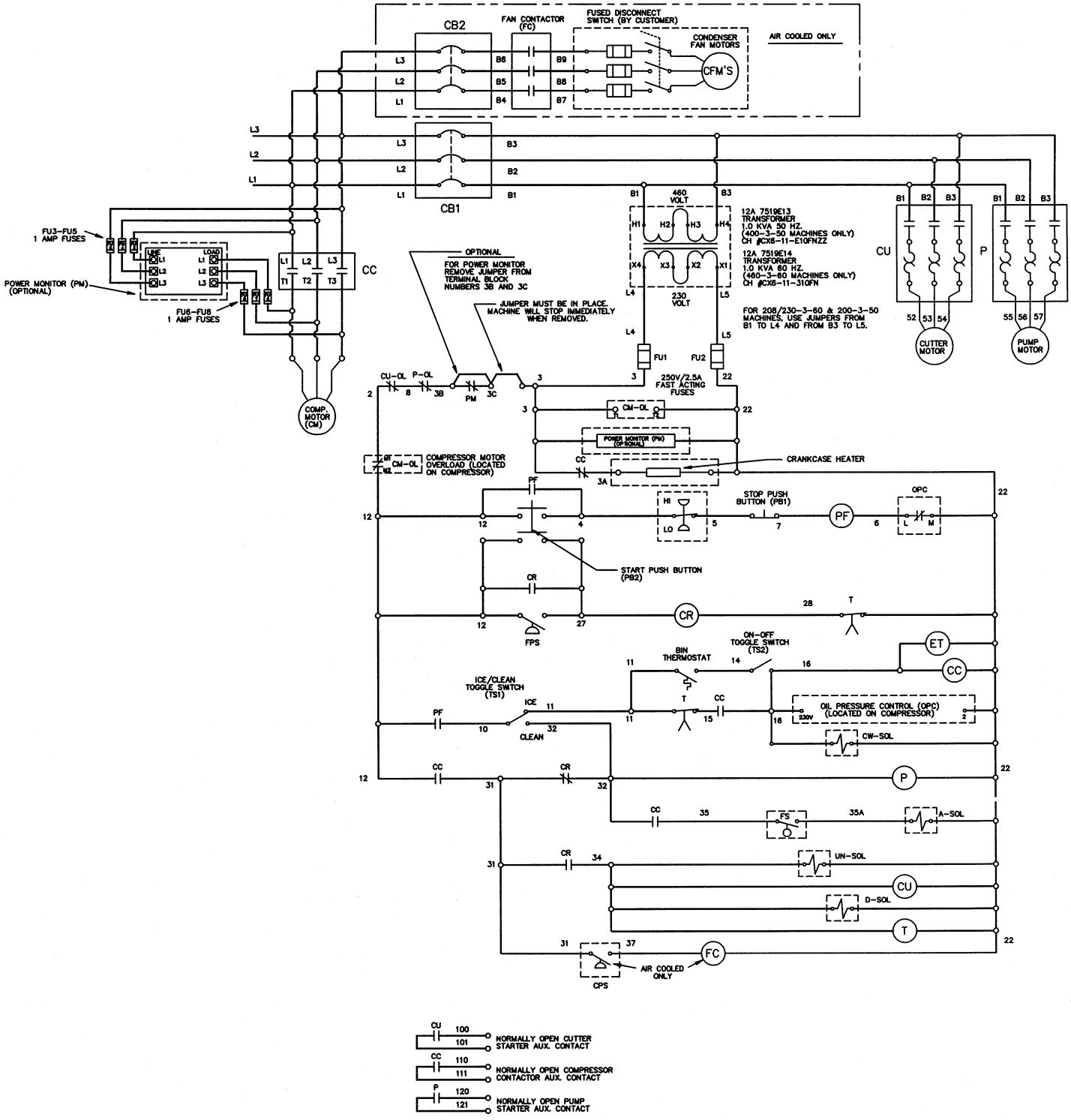


FIGURE 6-2
Electrical Schematic All Voltages, 50-60 Hz.

7. Maintenance

Ice Making Section The ice-making section of the Tube-Ice® machine should be cleaned at least twice a year (more often if water conditions cause mineral build-up). Use an approved food-grade ice machine cleaner. The water pump is used to circulate the cleaner through the system by setting the "Clean/Off/Ice" selector switch (SS) to "Clean," and starting and stopping the pump by the "Start" (PB2) and "Stop" (PB1) push buttons. For complete instructions, refer to the "Cleaning Procedure" attached to the equipment and duplicated here.

Cleaning Procedure

1. Before cleaning any Tube-Ice machine, make sure the crankcase heater is working properly. When the crankcase heater is not working, there is a possibility for refrigerant evaporated by warm circulating water to migrate to the compressor during the cleaning operation.

2. Set "Clean/Off/Ice" selector switch (SS) to the "Off" position. If the machine is running, it will shut down on completion of the next ice harvest period.

3. Remove ice from storage area or cover opening into it.

4. Shut off water supply and drain water tank (7) by opening drain valve (39). Remove any loose sediment from tank.

5. Close drain valve (39) and fill water tank (approximately 6 gallons) with warm water. Close the petcock on the water pump during the cleaning period.

6. Add 16 ounces (8 ounces per 3 gallons) of Calgon? ice machine cleaner or equivalent (a food grade liquid phosphoric acid) to water tank during the refill period.

7. To run the pump only, set the selector switch to the "Clean" position and press "Start".

8. Circulate cleaning solution until deposits are dissolved or solution is neutralized. Repeat cleaning if necessary.

9. Press "Stop" button to stop pump, then drain and flush water tank with fresh water. Open water supply to machine.

10. Drain and flush tank and then refill with fresh water.

11. Clean inside of ice storage area and remove any solution that entered during the cleaning process. Remove cover if one was installed over opening into storage area.

12. Start ice-making cycle by setting the "Clean/Off/Ice" selector switch to "Ice" and pressing the "Start" button. Check for water leaks around the freezer cover and tighten nuts if needed.

13. Adjust setting of pump petcock per instructions under "Adjustable Blowdown" in Section 9.

Water Distributors The water distributors are located under the freezer cover (8) at the top of the freezer. There are 78 distributors used in the models that have a 1" suffix (i.e., Models HE60S and P112-1), 48 distributors in models with 1 1/4" suffix (i.e., Models HE60M and P112 -1 1/4). These distributors may require occasional or periodic cleaning to remove solids and foreign particles accumulated from the make-up water. The frequency of this cleaning operation will depend on the characteristics of the water supply. The cleaning operation is needed when the inside diameter of a large proportion of the ice becomes irregular (due to channeling of water), or if some of the ice is opaque, or if there is a noticeable decrease in ice capacity. It is recommended that the distributors be removed and cleaned when the machine is cleaned. Material which is loosened during cleaning may block distributor orifices (two per distributor).

To clean distributors, stop the unit and remove the freezer cover (8) on top of the freezer. The water distributors (one in each tube) may then be removed with pliers for cleaning. Use pliers on the distributor's top part with a twisting upward motion.

Water Tank The production of opaque ice can indicate that the water in the water tank contains a concentrated amount of solids or salts.

Remove cover plate. Open drain valve (39). Clean tank thoroughly by flushing out with a hose and scrubbing with a stiff brush. Fill the water tank with fresh water.

When restarting the machine, be sure that the water pump is circulating water. It is possible that air may have collected in the pump impeller housing and the pump may have to be stopped and started several times to expel the air.

Water-Cooled Condensers

Checking Operation Scheduled maintenance for water-cooled condensers is based primarily on the operating conditions found at the machine. The condenser should be inspected at least annually and cleaned as required. For extreme operating conditions where water quality is poor the condenser may need to be cleaned several times a year. .

Proper operation of cooling towers will considerably increase the interval between cleaning. The tower overflow rate should be checked frequently. If a tower is operated with insufficient overflow, nominal 1-1/2 to 3 gallons per hour bleed depending on water quality, the resulting mineral concentration in the water can cause rapid and heavy fouling inside the condenser tubes, requiring excessively frequent cleaning. Also, these conditions often lead to severe corrosion.

Chemical additives, including those to stop algae and related growths, should be obtained only from a reputable, established supplier, and used specifically according to directions. Excessive treatment of the water can cause more harm than good and the condensers, pumps, piping, and the towers themselves may be damaged.

It is advisable to double-check the system to make sure that fouling is actually causing the trouble. High head pressure alone does not mean a fouled condenser.

The following possibilities should always be checked before cleaning is undertaken:

1. Non-condensables in system or faulty head pressure gauge? Check standby pressures against refrigerant tables.

2. Incorrectly set or defective water regulator valve? Check its setting and operation.

3. Partly closed compressor discharge service valve? Check its setting. Stem should be backseated.

4. High water temperatures entering condenser? Check tower fan and system.

After the above possibilities have been eliminated, determine the temperature difference between the water leaving the condenser and the refrigerant condensing temperature (saturation temperat ure, from pressure-temperature chart, corresponding to head pressure). If this difference is more than 10 ?F, cleaning is indicated because this difference indicates a good heat exchange is not being made. If this difference is less than 8 ?F, something other than a fouled condenser may be causing the high head pressure. In normal operation, this difference will stay between 5 ?F and 10?F regardless of water inlet temperature when the water flow is regulated by a pressure operated water valve. If this difference is less than 5 ?F, restricted water flow or a low supply pressure is indicated. A restriction can occur with foreign matter in the condenser, but it is also likely to be somewhere else in the system.

Draining Draining of water-cooled condensers is recommended in preparation for the winter cold where units may be left exposed to ambient temperatures below 32?F. Theoretically, it is easy to drain a condenser. In practice, the problem can be complex.

Despite the fact that a condenser my have vent and drain fittings, the opening of these fittings is not sufficient for a natural gravity flow. Water will be retained in a tube due to (1) surface tension and (2) the normal curvature between tube supports. Our experience shows that as much as 20% of the water in the condenser can be retained. To break the surface tension on the tubes and to drain all tubes completely, it is necessary to remove the back plate and actually tilt the condenser a minimum of 5 degrees. Whether water left in the tubes will cau se damage during a freeze-up will be dependent upon how quickly the freeze occurs and the location of the water inside the condenser.

In the field it is recommended that the tubes be blown out individually with air. Alternatively, a minimum of 25% ethylene glycol in the system will also prevent a freeze, which can rupture the tubes.

Water-Cooled Condenser Cleaning

! CAUTION !
The following directions and precautions should be observed when cleaning is undertaken. The warranty on condensers is void if they are damaged by improper cleaning tools or methods. If harsh chemicals are used, be sure to follow the manufacturer's recommendations regarding safety in handling those solutions.
! CAUTION !

Chemical Cleaning Vogt Tube-Ice? makes no recommendation for any particular chemical preparation. The same chemical may not be effective for all situations.

a) Use only preparations from an established, reliable source.

b) Follow directions exactly, particularly regarding amounts to use, and flushing or neutralizing procedure after cleaning.

c) Close the water supply stop valve. Remove the condenser water regulating valve (41).

d) Circulate the solution through the condenser until it is considered clean.

e) Flush the condenser according to directions.

f) Install the water regulating valve and connecting piping.

g) Open the water supply stop valve and check for leaks.

Mechanical Cleaning Part I.

a) Close the stop valve in the water supply line.

b) Drain the water from the condenser.

c) Remove water regulating valve (41) and attached piping to the condenser.

d) Remove the cover plate on the side of the frame to expose the condenser end plate.

e) Remove the nuts, water plates, and gaskets from both ends of the condenser. If the gasket does not lift off with the end plate, do not try to pry it off. The seal surface may be damaged, which would cause a water leak. To free a sticking gasket, replace the water plate and tap it on the outside face with a mallet or a block of wood. After a few taps, the gasket will spring free and will then slip off with the water end plate.

f) Gaskets need only be rinsed in running water: rust, scale or dirt will not stick to gasket material. A rag or soft brush is all that is required to remove any foreign matter.

Mechanical Cleaning Part II.
The inside of the water end plates and the outer tube sheet surfaces should be cleaned only with clear water and a rag or a soft bristle brush. A worn paintbrush is excellent.

These surfaces have been coated with a special material that will give y ears of protection against corrosion unless damaged. Never use a wire brush or a strong caustic on these surfaces.

Flush condenser tubes clear with air, water, or a piece of rag on a stick or wire. In many cases this is all that is required. If the ins ide surfaces are smooth, even though discolored, further cleaning is not necessary. It is not necessary to get a bright copper surface on the inside of the tubes. They will discolor almost immediately in service and the condenser has been designed with an adequate reserve for moderate fouling on these surfaces.

If, however, a rough coating remains inside the tubes after flushing and wiping, further cleaning is desirable. The color of this coating varies with water conditions, but roughness indicates clea ning tools should be used.

Any type tool to be considered should be tried first on a piece of copper tubing held in a vise or flare block. Nylon, brass, or copper brushes are recommended. If any flakes of copper appear or if score marks are made inside the tube, the tool should not be used. Never use anything with sharp or rigid edges which could cut into the copper tubing.

Lubrication

Compressor When starting and charging the unit, the oil sight glass (33) in the crankcase of the compressor should be watched carefully for the first hour to make certain the proper lubrication is being maintained. The oil may become low in the crankcase on an initial start -up if electrical current has been interrupted to the machine, thus de-energizing the compressor crankcase heater.

Before starting the machine again, the heater should be energized for a time period of at least two hours to evaporate refrigerant that may have condensed in the crankcase during the shutdown period. If the level is low after start -up, it should begin to return after a short period of operation.

The oil level should be checked frequently, particularly during the start -up operation, to see that a sufficient amount of oil remains in the crankcase. While it is important to observe the oil splash during operation, the true level can be obtained only when the compressor is stopped. With the compressor idle, the oil level should be at a height of 1/4 to 1/2 of the sight glass but never out of sight above it.

Although the machine was shipped with the oil charge, which was originally added for the test operation, it may be necessary to add some oil when or if new refrigerant is added to the system.

An oil pump should be used to force any oil that may be required into the system. Oil may be added to the compressor through the low pressure test connection adjacent to the high/low pressure switch or through the compressor suction service valve. The compressor suction service valve should be “backseated” to shut off pressure to the gauge port when connecting the oil pump. Air should be purged from the oil pump discharge line by forcing some oil through the line before tightening the charging connection.

Use "Dual Inhibited Sunisco 3GS" (Viscosity 150) or equal for R-22 machines (**Do not use a synthetic substitute).** Use Mobil EAL Arctic 22CC POE (Polyol Ester Oil) or equal for R-404a machines (**Do not use a mineral oil)**. Mixing mineral oil and POE will reduce machine capacity and inhibit oil return to the compressor.

Cutter Gear Reducer The oil level for the gear reducer should be checked if there is evidence of a leak. It should be level with the plugged opening in the side of the gear housing. Use Mobile 600W cylinder oil or equal. Change oil once a year.

Preventive Maintenance A careful inspection of the Tube-Ice® machine's refrigeration system for leaks and correct operational functions at the time of installation will start its long satisfactory life of service. In order to insure this degree of dependability, a systematic maintenance program is recommended. Therefore, the following schedule is suggested as a minimum.

(A) Daily
1. Check "ice-out" time (maintain 30 second free running after last ice is out).
2. Check clarity of ice produced and hole size.
3. Check compressor oil level.
4. Check refrigerant charge by observing operation level in receiver gage glass (30).

(B) Weekly
1. Check system for leaks with suitable leak detector for the first four weeks of operation.
2. Check oil level and condition.

(C) Monthly (in addition to weekly checks)
1. Check calibration and operation of all controls (high and low pressure switches, oil pressure switch, etc.).
2. Check cooling tower for scaling and algae (consult water treatment suppliers for corrective measures).
3. Check water distributors in freezer for scale accumulation.
4. Check water tank for solids to be removed.
5. Check all motor drive units (compressor, cutter and pump motors, cooling tower fan and pump, etc.) for abnormal noise and/or vibrations.
6. Check oil level in gear reducer.

(D) Yearly (in addition to weekly and monthly)
1. Check entire system for leaks (see "B").
2. Drain water from condenser and cooling tower and check condenser tubes. Check closely for damage by corrosion or scale.
3. Remove all rust from all equipment, clean, and paint.
4. Check all motors for shaft wear and end play.
5. Check operation and general condition of all electrical controls, relays, motor starters, and solenoid valves.
6. Check freezing time, ice release time, and ice out time.
7. Change oil in gear reducer box once a year.

For The Manager Who Depends Upon This Machine For Efficient Operation.

"Preventive Maintenance" simply means that you or a delegated employee makes a daily visual check of your Tube-Ice® machine. Here is what to look for and why:

Daily checklist:

1. Is the machine running or is the bin full
2. Bin doors kept closed
3. Thermostat sensor in bracket
4. Ice quality (clarity and uniformity)
5. Does all ice discharge during harvest
6. Cleanliness
7. Unusual noises

Why? When you make these simple observations on a daily basis, you insure the smooth production of ice for your facility. When you are aware of the proper operating conditions and observe them on a daily basis, changes in these conditions can alert you to changes in the operation of the machine which may require maintenance--long before a service situation arises.

"An ounce of prevention is worth a pound of cure!"

Note To Manager or Owner

The following page is a complete Preventive Maintenance Schedule that should be performed each 90 days. The Preventive Maintenance page may be copied and given to your service person. It should be signed, dated, and returned to you for permanent record.

Preventive Maintenance Program

This form can be removed and duplicated for keeping accurate records.
Model # _____ Serial # _____ Date _____
Customer/Address _____

_____

Mgr. Name _____ Service Tech Name _____
The following service performed and checked:
_____ Last maintenance performed (approx. date)
_____ Scale condition of water tank & tubes (good - fair - poor)
_____ All drains freely draini ng (water tank, drip pan, ice bin)
_____ Water distributors cleaned
_____ Ice machine cleaner circulated through system
_____ Condenser clean (if applicable)
_____ Voltage at machine (actual reading) _____, _____, _____
_____ Compressor amps (halfway through the freeze cycle) _____, _____, _____
_____ Cutter motor amps (cutting ice) _____, _____, _____
_____ Water pump amps _____, _____, _____
_____ AC condenser motor amps (if applicable) _____, _____, _____
_____ Crankcase heater heating
_____ Refrigerant leak (okay - high - low)
_____ Leak checked system _____ leaks found & repaired
_____ Compressor oil level (i.e., 1/4 - 1/2 - 3/4 - low - high)
_____ Gear reducer oil (okay - low)
_____ PSIG, low pressure switch set @
_____ PSIG, high pressure switch set @
_____ Bin stat(s) installed and operating properly
_____ Make-up water float valve adjusted okay
_____ Adjustable blowdown adjusted for clear ice
CYL_____ CRU_____ Suction PSIG at end of freeze
CYL_____/____ CRU____/____ Suction PSIG during harvest (high/low)
CYL_____ CRU_____ Discharge PSIG at end of freeze
_____?F/?C at machine _____?F/?C outside ambient (at condenser if applicable)
_____?F/?C make-up water temperature
_____ Freeze cycle time (minutes)
_____ Harvest cycle time (minutes)
_____ First ice out (seconds)
_____ All ice out (seconds)
_____ Pounds of ice per cycle
Capacity check: ice weight per cycle _____ X 1440 = _____ lbs. (24 hr. capacity)
total cycle time (min) _____
Remarks:_____

_____

8. Troubleshooting

NOTE: With the exception of bin control, anytime the machine stops, it must be manually re-started by pushing the "Start" push-button. If it stopped while in a freeze cycle, it will then start in a thawing cycle.

Always check the machine **thoroughly** after remedying the problem to prevent the same cause from reoccurring.

SYMPTOM: Machine won't run.

POSSIBLE CAUSE	POSSIBLE REMEDY
Power failure ++ Intermittent power interruption	Check electrical fused disconnect or circuit breaker supplying power to the machine. If power has been off, make sure the compressor crankcase heater is energized, the crankcase is warm, and there is no liquid refrigerant in the crankcase prior to running the machine. Push the "Start" button to initiate startup in a thawing cycle.
Compressor motor overload (CMS-OL) trips.	Check for a loose connection on all motor contactor and compressor terminals, which could have caused excessive amp draw. Check amperage, power supply, and head pressure.
Compressor cylinder head temperature switch (TS-OL) trips.	The thermal switch will reset automatically after the motor has cooled sufficiently. Excessive temperature may be caused by gas leakage between suction and discharge port of the compressor. Check for broken cylinder head gasket or valve assemblies. Replace broken or defective parts. Restart the machine and check motor amps and temperature of compressor body.
One of the 2.5 amp control circuit fuses (FU-1 or FU-2) in the control panel burnt out.	Check compressor crankcase heater, coils of relays, contactors, starters, solenoid valves, and thawing timer for a ground. Repair or replace any defective part, and replace fuse. Make sure there is no liquid refrigerant in the compressor crankcase prior to re-starting the machine.
High/Low safety pressure switch tripped.	If the machine stops by low pressure cut-out, the switch will reset automatically when the pressure raises to the " cut-in " setting. If it stops by high pressure cut-out, the switch will have to be manually reset after the pressure drops below the " cut-in " setting. Check switch settings and push the "Start" push button to start the machine in a thawing cycle. Check the head pressure during the next freeze cycle. See FIGURE 9-2, Section 9, (High/Low Pressure Switch).

SYMPTOM: Machine won't run (CONT.)

POSSIBLE CAUSE	POSSIBLE REMEDY
Low oil pressure switch tripped.	If the machine stops by low oil pressure cut-out, the switch will have to be manually reset. Check the crankcase oil level. Restart the machine by pushing the "Start" push button. Check the oil level and net oil pressure (net oil pressure = pressure reading at the oil pump end bearing housing minus suction pressure). The oil level should be 1/4 - 3/4 level in the glass. If above 3/4, drain some oil out. See page 9-9, Section 9 (Oil Pressure Sensor).
Cutter motor overload tripped.	Check and clear the cutter area and ice discharge path of all ice. Check voltage and overload range adjustment against motor rating. Reset the switch and restart the machine by the "START" push button. Check the cutter operation and motor amp draw. If tripping repeats, but ice is not jammed, check the cutter bearing for wear, the gear reducer for resistance, and the motor for defect or single phasing.
Pump motor overload tripped.	Check voltage and overload range adjustment against motor rating. Reset the switch, set the "Ice/Clean" switch to the "Clean" position and restart the machine by the "Start" push button. Check the pump operation and motor amps. If tripping repeats, check for a defective overload, defective motor, or single phasing.
Bin thermostat or bin level control stops machine.	Adjust or replace the bin stat or level control. Make sure bin stat bulb or level control is located properly in the bin. See FIGURE 3-7, Section 3 (Bin Thermostat).
Defective control panel component such as, PF, CMS, PB1, FU-1, FU-2, T, Etc.	See FIGURE 6-2, Section 6 (Wiring Schematic). Check for open circuit. Refer to FIGURE 6-1, Section 6 (Control Panel) to identify parts. Replace defective part, restart machine and check power supply and current draw.

SYMPTOM: Freeze-up due to extended freeze period.

POSSIBLE CAUSE	POSSIBLE REMEDY
Freezer pressure switch setting too low.	Adjust freezer pressure switch, or replace if defective. See FIGURE 9-1, Section 9.
Water tank drain valve (39) open or leaking, or make-up water float valve (12) stuck open.	Close valve, repair, or replace as necessary.
Thawing gas solenoid valve (18) leaking through during the freeze cycle.	Check the manual opening stem to make sure it is in the automatic position (stem screwed out). Check for leakage through the valve by sound and temperature difference. Close the stop valve (90) at the receiver to confirm suspicion of leakage. Repair or replace the valve as needed.
Float switch stuck or failed in the closed position.	Check to make sure the float switch is opening and closing.
"A" valve stuck open	Check to make sure the "A" Valve is not in the manual open position. Disassemble valve and inspect for debris that could hold the valve open.

SYMPTOM: Freeze-up due to ice failing to discharge.

POSSIBLE CAUSE	POSSIBLE REMEDY
Insufficient heat for thawing because of low condensing pressure, non-condensables (usually air) in system, low refrigerant charge, or thaw gas solenoid valve + stuck closed.	The head pressure should be maintained at approximately 210 PSIG for R-22 or 250 PSIG for R-404a, which relates to 105 ^{o}F (37.8 C). This is done by a water regulating valve (water-cooled units) FIGURE 9-3A, Section 9, or a Fan cycling switch (air-cooled units) FIGURE 9-3B, Section 9. If non-condensables are present with the refrigerant, the saturated temperature will not relate to the pressure reading at the receiver. The refrigerant level in the receiver should be near the operating mark at the end of a freezing cycle to provide enough volume for harvesting. (1" = approx. 5.5 lbs. of R-22 or R-404a).
Thawing time too short.	Check the thaw timer (T) which should be adjusted to allow all the ice to clear the cutter and ice discharge opening with at least 30 seconds to spare.
Cutter or cutter disc does not turn.	Check cutter reducer and drive gear for proper operation and alignment. Check for broken cutter disc or drive pin and replace as necessary.
Ice backs up into cutter or discharge opening, jamming cutter	Ice mushy due to concentration of solids in the water tank. Perform "Cleaning Procedure" and check automatic and adjustable blowdown. If the machine discharges ice into a chute, it should slope at an angle of 30 degrees for cylinder ice and 45 degrees for crushed ice. Check bin stat or level control to make sure it will stop the machine before ice backs-up into the cutter.
Extended freeze period.	Check freezer pressure switch adjustment, see FIGURE 9-1, Section 9, (Freezer Pressure Switch) and TABLE 11-6, Section 11 (Operating Vitals).
Compressor not unloading.	Check compressor amps during harvest. A noticeable drop in amperage should occur. Check unloader solenoid coil. If coil is okay, replace unloader head assembly.

SYMPTOM: Low ice capacity.

POSSIBLE CAUSE	POSSIBLE REMEDY
Low refrigerant charge.	Check for and repair leaks, and add refrigerant.
Restriction in liquid line.	Check for a partially closed valve or an obstruction at the drier, strainer, solenoid valve, or expansion valve. The liquid line will normally have frost on the downstream side of a restriction, especially as the suction pressure decreases.
Float switch stuck or failed in open position	Make sure the float switch is opening and closing. Make sure the "A" valve is getting power.
Thawing gas solenoid valve (18) leaking through during the freeze cycle.	Check the manual opening stem to make sure it is in the automatic position (stem screwed out). Check for leakage through the valve by sound and temperature difference. Close the stop valve (90) at the receiver to confirm suspicion of leakage. Repair or replace the valve as needed.
Water distributors at top of freezer may be stopped up.	Remove freezer cover and clean the distributors. See Water Distributors, Section 7.
Inadequate water for ice making.	Check water pressure (30 PSIG minimum recommended). Check for a restriction in the water supply line or at the make-up water float valve.
Make-up water float valve (12) stuck open, adjusted too high, or water tank drain valve (15) open or leaking	Repair, replace or adjust float valve, or close, repair, or replace water tank drain valve.
Controls for regulating freezing and thawing cycles not adjusted properly.	For highest capacity, cylinder ice should have a small hole and crushed ice should be about 3/16" thick. Check the freezer pressure switch and thaw timer for proper adjustment, Section 9.
Excessively high head pressure.	Check water regulating valve or fan control adjustment. Check to make sure the WC or AC condenser is clean. Check refrigerant tables for pressure/temperature relation.
Warm make-up water for ice making.	Capacity of the machine is proportional to ice making water temperature. Warmer water will reduce the ice making capacity. See Section 10, Capacity Table.
Drain valve (12) open.	Close drain valve (12).

SYMPTOM: Low compressor oil level.

POSSIBLE CAUSE	POSSIBLE REMEDY
Oil separator not returning oil.	Check oil separator float and oil return stop valve (70) and line for a restriction. The oil return line should be above ambient temperature most of the time as it returns oil. It may be cooler at the start of a freeze cycle. Repair or replace defective parts.
Repeated short cycling (refrigerant carrying oil out of compressor).	Usually caused by freeze-up, low refrigerant charge, low head pressure, faulty timer, faulty pressure switch or expansion valve clogged. Use process of elimination.
Worn piston rings.	This condition is hard to detect without dismantling the compressor and checking piston ring tolerances. Normally there will be a little puddle of oil laying on top of the piston when the head and valve plate are removed. It is best to replace the compressor.

SYMPTOM: Poor ice quality.

POSSIBLE CAUSE	POSSIBLE REMEDY
Excessive concentration of solids in the water tank usually indicated by a build-up of mineral deposits on the sides and bottom of the tank.	Perform a cleaning procedure as well as removing the freezer cover and cleaning the water distributors. Adjust continuous blowdown.
Insufficient water supply indicated by a low level in the tank.	Check water pressure, 30 PSIG is recommended minimum. Check for a water line restriction, partially closed valve, or defective make-up water float valve. Make sure the water tank drain valve is closed.
Water pump rotation wrong direction.	Check rotation in relation with arrow on pump housing, and reverse two wires at the motor if necessary.
Low refrigerant charge.	Check refrigerant level mark on the receiver, and on the painted portion of the gage glass guard. Perform a pumpdown if necessary. Be sure to close the gage glass cocks after checking the level.
Insufficient blowdown during harvest	Check for proper operation of the blowdown siphon and restrictions or traps in the water tank drain assembly.

SYMPTOM: High head pressure. (Water-cooled machine)

POSSIBLE CAUSE	POSSIBLE REMEDY
Misadjusted or defective water regulating valve	Adjust or replace the valve. Never adjust the valve stem as far open as it will turn, because it will not close when the head pressure drops.
Insufficient water supply.	Check size of water line and pump output at the condenser. Refer to the specification sheet for water requirements. Check cooling tower sump level and make-up water supply.
Cooling tower needs maintenance.	Check cooling tower fan belt and tighten or replace as needed. Check spray nozzles and sump screen and clean as needed.
Non-condensables (usually air) in system.	Check refrigerant tables for correct pressure/temperature relation. If non-condensables are present, Perform a total pumpdown, let stand for at least 6 hours, allowing non-condensables to gather in the upper part of the receiver. Evacuate the freezer and attach a recovery unit to the top receiver purge valve (59). Open the valve and recover the vapor for about five minutes. When the freezer is evacuated, open the thaw gas solenoid valve manually for about 15 seconds letting the top vapor in the receiver blow into the freezer. Close the solenoid valve and evacuate the freezer again. Evacuate to 500 microns and restart the machine.
Fouled (dirty) condenser.	Follow the diagnostic procedure outlined on page 7-3, Section 7, and clean the condenser per instructions under Condenser Cleaning,

SYMPTOM: High head pressure (Air-cooled machine).

POSSIBLE CAUSE	POSSIBLE REMEDY
Condenser fan(s) not running.	Defective motor, fan control switch, fan contactor, or tripped circuit breaker in control panel (CB2) Replace defective part. Check condenser fan disconnect for thrown switch, or blown fuse. Replace fuse and reset switch. If the condenser is split, check the normally open solenoid valve to make sure it is open, also check the fan sequencing thermostats and fan motor contactors to make sure they are functioning properly. Replace any defective parts.
Dirty condenser causing restricted airflow.	Visually inspect condenser and clean as necessary.
Non-condensables (usually air) in the system.	Follow same procedure as specified for removing non-condensables from Water Cooled machine**, except** evacuate the air-cooled condenser also.

9. Service Operations

Adjustable Blowdown (for clearer ice) A petcock is installed on the overflow of the water pump to provide means for obtaining blowdown from the water tank during the freezing period. The petcock was set at the factory to discharge enough water during the freeze cycle to produce clear ice. After installation it should be adjusted to the minimum rate required to maintain clear ice and checked after a few days of ice making.

Automatic Blowdown (Harvest Cycle) A feature of this machine is the automatic blowdown (40) which is provided to eliminate or reduce the necessity for frequent flushing or cleaning of the water tank (7) and to remove accumulated salts or solids in the water as a result of the freezing action. During the harvest water returning from the freezer raises the tank level and causes an overflow of water, which creates a siphon to remove a fixed amount of water from the tank.

Make-up Water Float Valve PART NO 12A-4200H0401 The make-up float valve (12) maintains the proper pumping level in the water tank for ice making. The valve should be set to maintain a water level in the water tank during the freezing period, so that there will be a quantity of by-pass or blowdown only during the thaw mode. The water level during the freeze mode should always be below the by-pass piping to prevent excessive waste of cold water, resulting in loss of ice capacity.

If it should become necessary to clean the float valve, close the stop valve in the make-up water line to the machine and remove the float valve. After the valve has been cleaned and reinstalled, check to ascertain if the proper water level is being maintained. After the machine is stopped and the water in the tank seeks its normal level, there should be no water flow through the float valve or drain by-pass.

It is advisable to install a large area strainer in the water supply line to protect the float valve from dirt or solids in the water, which would necessitate frequent cleaning. A strainer of 40 mesh screen is usually satisfactory.

Float Switch The float switch is installed on a header assembly that is attached to the freezer shell. Valves are PART NO 12A-7500E22 provided for isolation of the float switch assembly if replacement or servicing is necessary. The float switch closes as the level of refrigerant in the freezer rises and opens as the level falls.

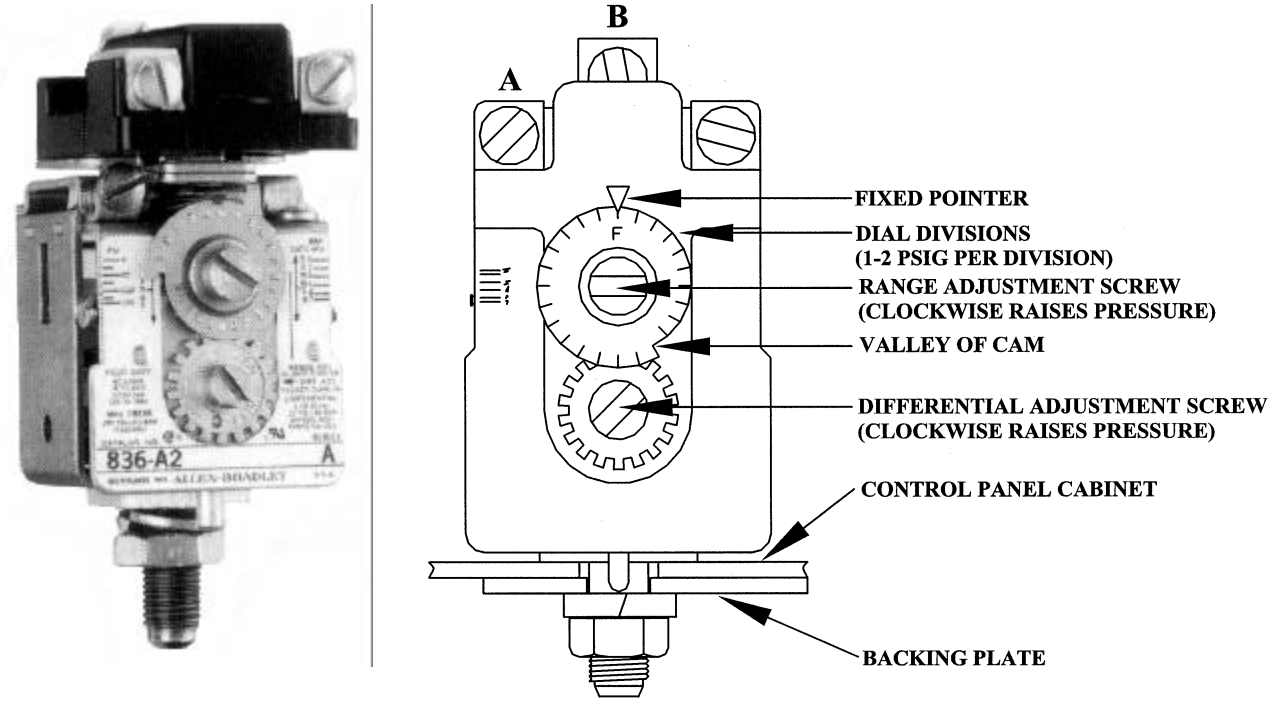
The float switch is connected to the liquid feed solenoid valve ("A" valve) coil. This is the solenoid valve directly before the hand expansion valve. Therefore when the refrigerant level in the freezer drops, the float switch opens, thereby deenergizing the normally open liquid feed solenoid until sufficient level has been reached to close the float switch. The float switch has a fixed 1/2" differential.

The float switch is installed at the correct height at the factory and should not need to be adjusted. The float switch is installed at the position that provides highest capacity. The correct height will produce compressor superheat which climbs throughout the freeze cycle to a minimum of 30° F.

Hand Expansion Valve PART NO 12A-4200C0406 The hand expansion valve is located after the liquid feed solenoid valve ("A" Valve). This valve should be set at a point where the float switch is open for a length of time approximately equal to the time it is closed. The factory setting is about 2 turns from full open.

Freezer Pressure Switch The freezer pressure switch (FPS), located inside the control panel, controls the freezing time period for the production of cylinder or crushed ice.

This switch was set at the factory to produce ice of recommended thickness. Look at the "Certificate of Test" which was provided with the machine for a sample set of pressure readings with corresponding time periods and water temperatures. Also see TABLE 11-6, Operating Vitals for typical settings. Do not make adjustments until several ice discharging cycles have been completed.



PART NO 12A-2117E04

FIGURE 9-1
Freezer Pressure Switch

The following procedure is recommended for initially setting a freezer pressure switch that has **not** been previously adjusted (See FIGURE 9-1):

1. Turn the bottom screw (differential) approximately 1/2 turn to the Left (counter clockwise). The pointer arrow, which is at the top middle of the switch, will be at the "F" setting.

2. Turn the top screw (range adjustment) approximately 4 1/2 turns to the Left (counter clockwise). The pointer on the range setting will be between 40 psi and 50 psi.

3. After the machine is running, the range adjustment (top screw) will have to be fine-tuned to get the proper ice thickness. (Clockwise = Thinner Ice) (Counter Clockwise = Thicker Ice)

The freezing time can be such that a small percentage of the ice is frozen solid. If so, some ice from the top and bottom of the freezer should have a small hole in the center to insure that the freezing time has not been extended to where a loss in capacity would result.

It is preferable that the freezing cycle be such that a small diameter hole remains in the center of the ice cylinder. (1/16" diameter for 7/8" diameter ice, 1/8" diameter for 1 1/8" diameter ice) This insures that the freezing cycle is not extended unnecessarily and eliminates a possible opaque core in the center of the ice.

When crushed ice is produced, the freezer pressure switch (FPS) (FIGURE 9-1) should be set to produce ice having a wall thickness of approximately 3/16".

High-Low Pressure Switch The high-low pressure switch (HPS) (FIGURE 9-2) is a two pole dual function switch. Located in the machine mounted to the frame near the compressor. It protects the machine from possible damage due to abnormal pressure during operation.

! CAUTION !
When this switch causes the machine to stop, the cause should be identified and corrected before resuming normal operation.
! CAUTION !

The **LOW** pressure cut-in should be set at 40 psig and the cutout set at 20 psig for R-22
The **LOW** pressure cut-in should be set at 52 psig and the cutout set at 28 psig for R-404a.
After tripping at the cutout setting, the switch will reset automatically when the pressure rises to the cut-in setting.

The **HIGH** pressure cutout should be set at 300 psig for R-22 and 350 psig for R-404a. After tripping, reset the switch manually.

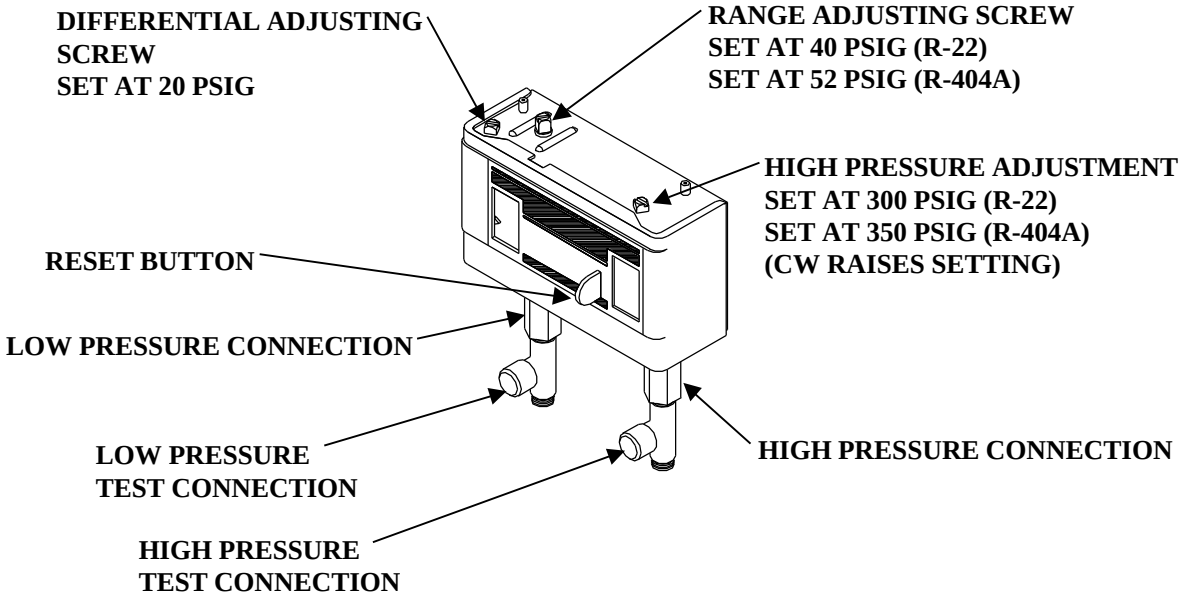


FIGURE 9-2
High-Low Pressure Switch
PART NO 12A-2117D02

If it becomes necessary to install a new high/low pressure switch, the following procedure is recommended for its adjustment:

Turn the adjusting screws PART NO 12A-7509E12 clockwise to raise the pressure setting. Turn counter-clockwise to lower the setting. Adjust the switch to the indicated pressure settings and test with an accurate gage to be sure the switch functions properly before installation.

Head Pressure The head pressure should be maintained at 190-210 psig for R-22 and 230-250 psig for R-404a during the freeze cycle. This pressure can be checked at the test connection in the high pressure line near the high-low pressure switch.

Water-Cooled Units A water regulating valve (FIGURE 9-3A) located in the condenser water inlet line is used to control the water flow through the condenser. This valve should be adjusted to maintain a head pressure of 200 psig for R-22 and 235 psig for R-404a. Increasing the water flow lowers the head pressure and decreasing the water flow raises the head pressure. The valve is adjusted during the factory test. The valve stem should not be opened as far as it will go or the valve will not close fully when the head pressure drops below its setting.

Air-Cooled Units The condenser fan switch mounted to the frame (lower right side) (FIGURE 9-3B) (CPS) is used to regulate the head pressure. This is an adjustable pressure switch located on the right-hand front of machine. It controls the operation of the condenser fan motor(s) through a contactor (FC) (FIGURE 6-1) located in the control panel. The switch is set to cycle the fan motor(s) "On" at 210 psig and "Off" at 190 psig for R-22 and "On" at 250 psig and "Off" at 230 psig for R-404a. Higher settings may be necessary for 0°F and below ambient conditions to assure there is enough warm gas for ice harvesting.

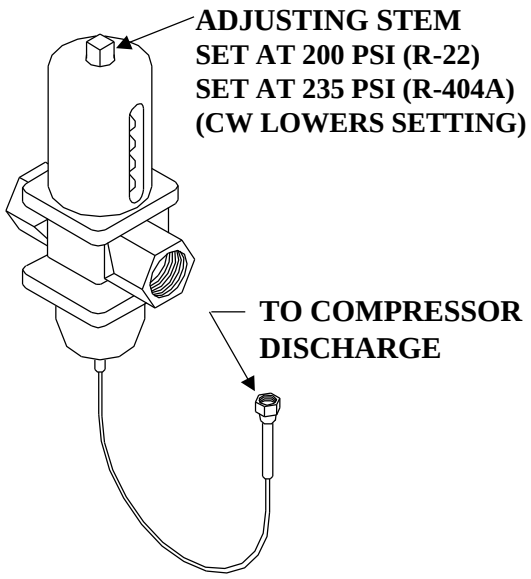


FIGURE 9-3A
Water Regulating Valve
PART NO 12A-4200E1001

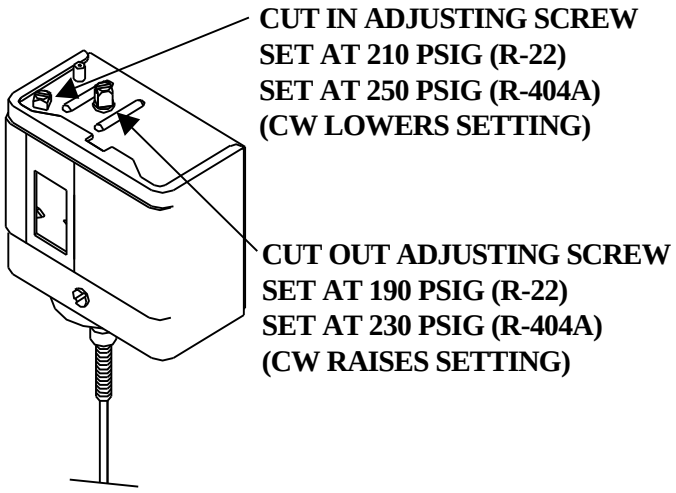


FIGURE 9-3B
Condenser Fan Switch
PART NO 12A-2117F05

Compressor Crankcase Heater When electrical power is supplied to terminals L1, L2 & L3 of the control panel, the crankcase heater is energized when the machine is not operating. It is de-energized when the compressor is operating.

Compressor Motor Protector, Electronic Copeland compressors using solid state protection have PTC (Positive Temperature Coefficient) internal sensors with an avalanching resistance in the event of high temperatures. The sensors are calibrated for proper motor protection.

The solid state sensor protectors provide excellent protection against high motor temperatures resulting from locked rotor, loss of charge, or motor overload. The combination of low voltage sensing and time delay provide positive protection against low voltage conditions which can occur in the pilot circuit in the event of a single phase condition on a three phase circuit.

The low voltage protection feature removes the compressor from the line in the event of low voltage ("brown-out") conditions. The module locks the compressor off the line until the voltage rises to the cut-in setting. The time delay provides a two-minute delay before restarting each time the power circuit is opened. Pressing the start button before the two-minute delay will have no effect. Service and test personnel must be alert to this feature since it is possible in checking the compressor or system, power may be applied, disconnected, and reapplied in less than two minutes. In such case the time delay feature will prevent operation until the time delay has expired and this may be misinterpreted by service personnel as a module malfunction.

The time delay would be energized in the event of a discharge pressure or short circuit protector trip, low voltage, or a break in the power supply to the module. The time delay is not energized on opening of the high or low pressure switches.

There are two major components in the protection system.

1. The protector sensors are mounted internally in the motor windings. The characteristics of the sensor are such that a change in temperature causes a change in the sensor's electrical resistance.

2. The control module is a sealed enclosure containing a relay or triac, transformer, and several electronic components. Leads from the internal motor sensors are connected to the module as shown on the wiring diagrams. While the exact internal circuitry is quite complicated , basically the module senses the change in resistance of the sensors. As the motor temperature rises or falls, the resistance also rises or falls, triggering the action of the control circuit at predetermined opening and closing settings.

Protector modules have two terminals on the module marked "T1-T2" or "L1-L2". These are to be connected to a power source of the proper voltage, normally the line terminals on the compressor motor contactor or the control circuit transformer as required.

The control circuit is to be connected to the two terminals marked "control circuit". When the proper voltage is present and the motor temperature is within limits, the "M1-M2" circuit is closed and the pilot circuit is energized after the two-minute off-cycle time delay. If the motor temperature rises beyond safe limits, the resistance of the motor sensors rises, causing the control circuit to open. The solid state module cannot be repaired in the field, and if the cover is opened or the module physically damaged, the warranty on the module is voided. No attempt should be made to adjust or repair this module, and if it becomes defective, it must be returned intact for replacement.

Electronic Motor Protector High-Potential Testing The solid state sensors and the electronic components in the solid state module are delicate and can be damaged by exposure to high voltage.

Under no circumstances should a high potential test be made at the sensor terminals with the sensor leads connected to the solid state module. Even though the power and pilot circuit leads are not connected, the module can be damaged.

Electronic Motor Protector Field Trouble Shooting In the event the motor compressor is inoperable or is not operating properly, the solid state control circuit may be checked as follows:

1. If the compressor has been operating and tripped on the protector, allow the compressor to cool for at least one hour before checking. This allows time for the motor to cool and the control circuit to reset.

! WARNING !
Before checking the TI31AA model for its attached wiring sensor, be aware that the sensor terminal "C" has the same voltage as terminal L1.
! WARNING !

2. Disconnect control circuit power to deenergize the module. Connect a jumper wire across the "control circuit" ("M1-M2") terminals on the module control circuit terminal board. This will bypass the "control contact" of the module.

3. Reconnect control circuit power. If the compressor will not operate with the jumper wire installed, then the problem is external to the solid state protection system. If the compressor operates with the module bypassed, but will not operate when the jumper wire is removed, then the control circuit relay or triac in the module is open.

4. If after allowing time for motor cooling, the protector still remains open, the motor sensors may be checked as follows.

   a) Disconnect control circuit power to deenergize the module. Remove the jumper of Step 2. Remove wiring connections from the sensor and common terminals on the module control circuit terminal board.

   b) CAUTION: Use Ohmmeter with a maximum of 9 VAC for checking. The sensors are sensitive, easily damaged, and no attempt should be made to check continuity through them with other than an ohmmeter. Any external voltage or current applied to the sensors may cause damage requiring compressor replacement.

   c) Measure the resistance from each sensor terminal to the common terminal. The resistance should be in the following range:
   500 ohms (cold) to 20,000+ ohms (hot. compressor tripped)

   Resistance readings in this range indicate the sensors are good. A resistance approaching zero indicates a short; a resistance approaching infinity indicates an open connection. Proper operation of the control system is dependent on a continuous parallel circuit through all three sensors with no individual resistance reading higher than 10,000 ohms. On initial start-up, and after any module trip due to high temperatures, the resistance of the sensors must be below the module reset point before the module circuit will close. Reset values are 2700-4500 ohms.

5. If the sensors have the proper resistance, and are below 2700 ohms resistance, the compressor will run with the control circuit bypassed, but will not run when connected properly, the solid

state module is defective, and must PART NO 12A-2117A05 be replaced. The replacement module must be the same voltage and be compatible with the original module on the compressor.

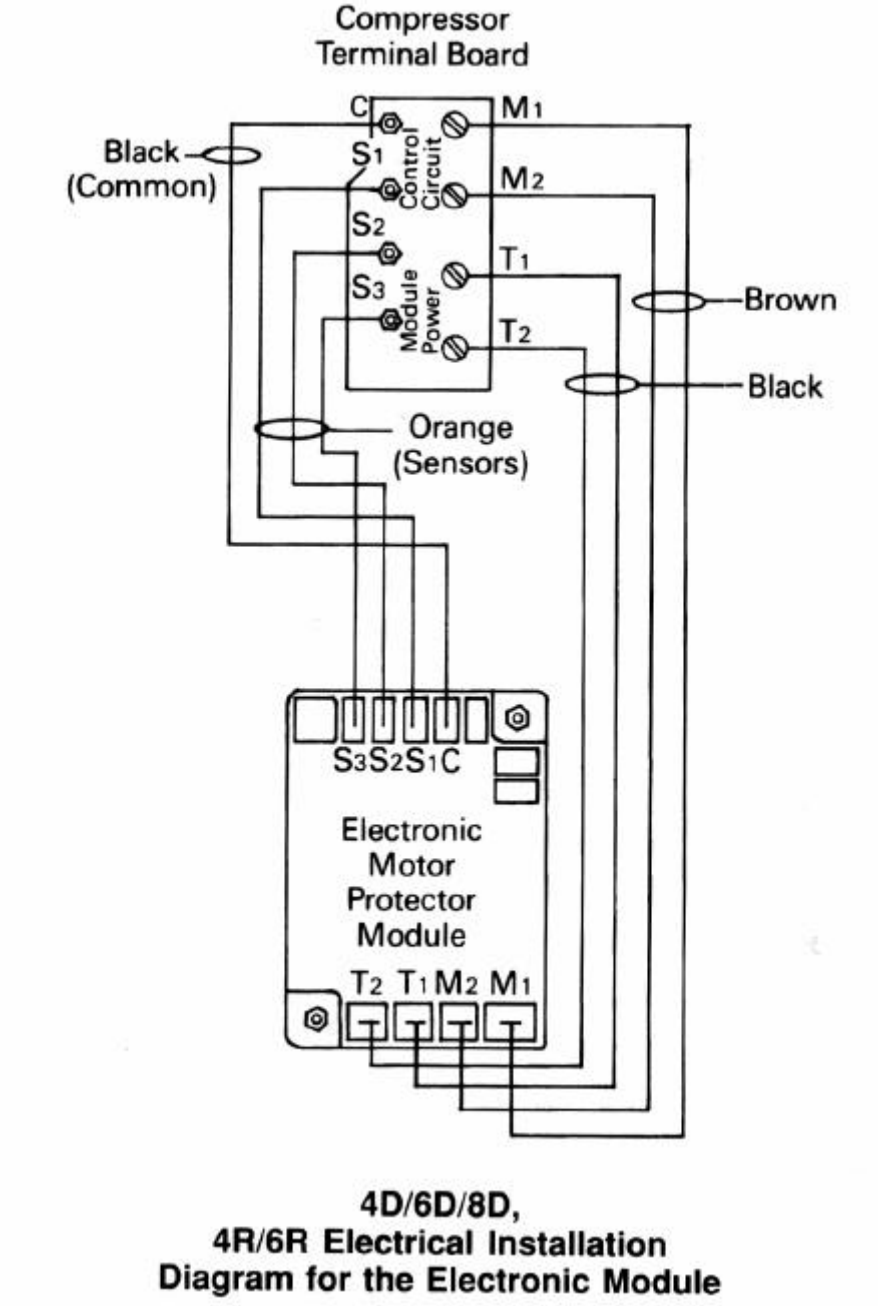


FIGURE 9-4
Electronic Module and Compressor Terminal Board Connections (Copeland Compressor)

Sentronic Oil Pressure Safety Control The Sentronic utilizes a pressure sensor and an electronic control module to precisely measure oil pump differential pressure. The main advantage of Sentronic is the elimination of the traditional capillary tubes, bellows, and pressure connections that mechanical

pressure switches require to measure differential oil pressure. These require careful handling and are known to be a source of leaks in refrigeration systems.

A second advantage of Sentronic is in the use of a precise electronic clock for the two-minute time out circuit. Traditional mechanical controls use resistance heaters to provide the time to trip in the event of low oil pressure. 208 volt systems, low ambient temperatures or brown-out type conditions cause the heater output to be reduced, thus increasing the time out period from two minutes to three or four minutes when low oil pressure conditions exist. With the electronic clock, the time out will always be the same.

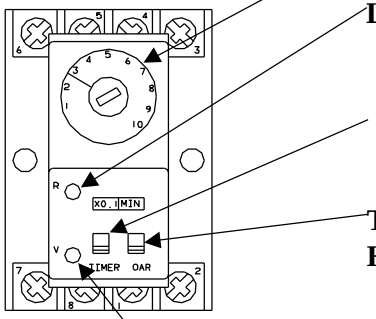
As a result of the elimination of the capillary tube measuring system and a more precise timing circuit, Sentronic will improve the overall reliability of the refrigeration system. As in the past, all new and replacement Copelametic compressors equipped with oil pumps require the use of a Copeland approved oil pressure safety switch. Failure to use an approved oil pressure safety switch will be considered as misuse of the compressor, and can adversely affect warranty replacement of the compressor should a lubrication connected failure occur.

Sentronic Sensor The same oil pressure sensor is used for all Sentronic Oil Pressure Controls. It mounts directly into the oil pump. The sensor measures oil pump differential pressure. It has an internal contact that opens on low oil pressure and signals the Sentronic electronic control module to begin time out. The same contact closes when proper oil pressure is present and stops the module time out. Should oil pressure fall below 7-9 PSID for a period of two minutes, the Sentronic module will open the control circuit, using its Normally-Closed (N) contact, and shut the compressor off.

Approximate oil pressure can be measured in the field. Oil pumps are furnished with a Schrader valve mounted on the oil pump discharge port. To measure oil pressure, subtract crankcase pressure from discharge oil pressure. Tripping of the oil pressure safety switch is a warning that the system has been without proper lubrication for too long a time. Repeated trips of the oil pressure safety control are a clear indication that something in the system requires immediate remedial action.

Sentronic Module The Sentronic has in addition to the (N) contact, used for compressor shutdown, a Normally Open (N.O.) contact that can be used in an alarm circuit (See Diagram 4A). The Single Pole Double Throw (S.P.D.T.) contact of Sentronic can be electrically isolated from the control circuit power supply, and used to control a circuit with a different voltage (See Figure 6-2). The Sentronic has a timing circuit that actually compares the amount of time with good oil pressure to that with insufficient oil pressure. The module memory will shut the compressor down after a period of more than two minutes if the compressor has a "history" of oil pressure fluctuations with more unacceptable than acceptable pressures.

Sentronic also has a memory that retains the compressor oil pressure "history" for up to one minute in the event of a power loss. Sentronic uses a permanent magnet integral with the reset button to reset its output control relay in the event of a trip. When the reset button is depressed, it magnetically pulls the Sentronic relay's armature to its original, reset position. Sentronic needs no voltage present to reset.



PART NO 12A-7503E22

FIGURE 9-5
Thawing Timer

Thawing Timer The thawing timer governs the ice thawing period. It is located inside the control panel (FIGURE 6-1). It is started by action of the freezer pressure switch (FPS) which energizes the "CR" relay. This timer is set prior to shipment for approximately a two minute period.

Set the thawing period for at least 30 seconds longer than the time required to harvest the entire discharge of ice. If it should be necessary to change the setting of the timer, turn the adjustment screw clockwise to increase the time or counter-clockwise to decrease the time. Check thaw time after each adjustment.

Control Circuit Protection PART NO 12A-7504E1 The electrical control circuit of the machine is protected by two 2.5 amp fuses. If either of these fuses should open, the machine will immediately stop. Before replacing a fuse, open the disconnect switch to machine and set the "On/Off" switch to the "off" position. If the machine was off for an extended time the crankcase heater must be energized for a minimum of two hours before restarting the machine. When ready to restart the machine, depress the "Start" button. The machine will automatically return to a freeze cycle upon completion of the harvest cycle.

Condenser Cleaning See "Water Cooled Condensers", "Maintenance", Section 7.

Air-Cooled Condenser Visual inspection will indicate if dirt is accumulating and clogging the fin face of the condenser. A vacuum cleaner, compressor air or a brush may be used to remove an accumulation of dirt from the fin section of the condenser.

Cutter Gear Reducer PART NO 12A-4030R07 The oil level for the gear reducer should be checked if there is evidence of a leak. It should be level with the plugged opening in the side of the gear housing. Use Mobile 600W cylinder oil or equal. Change oil once a year. The motor bearings are prelubricated and require no further lubrication. For additional information, refer to manufacturer's instructions.

Pumpdown The function of the pumpdown is to transfer all the liquid refrigerant from the freezer (evaporator) into the receiver. Pumpdown should only be performed when the freezer is clear of ice. Its main purposes are:

1. To check the total refrigerant charge.
2. To perform service or repair work on the machine.
3. To winterize the machine.
4. To prepare the machine for disconnecting and moving.
5. Before cleaning

To perform a pumpdown, follow this procedure:

1. Push manual harvest button to clear the freezer of all ice and stop operation.
2. Close the liquid stop valve (king valve) (58) at the receiver.
3. Open the water tank drain valve partially to allow a continuous flow of warm make-up water into the water tank, and still maintain a good level in the tank. An auxiliary supply of warm water (not to exceed 100°F) may be used if available. Warmer wate r affords a more complete pumpdown.
4. Start the machine and allow it to operate and complete one harvest
5. During the thaw cycle, close the 1/4" valve (69) at the top of the freezer to isolate the freezer pressure switch and prevent another thaw cycle.
6. Allow the machine to operate until the low-pressure switch stops the machine @ 20 PSIG. If a lower pressure is desired, it can be accomplished by jumping the low-pressure switch and starting and stopping the machine by the "Start" and "Stop" push buttons. Continually observe the oil level to make sure the oil is not carried from the compressor while operating at a low pressure.
7. Close the thawing gas stop valve (90), the receiver liquid return stop valve (91), the compressor suction valve (34), the compressor discharge valve and the oil return stop valve (70).

Removal Of Refrigerant From The Machine To transfer the refrigerant charge from the machine into a separate container, proceed as instructed above under “Pumpdown”. This will isolate most of the refrigerant in the receiver and the recovery unit can be connected to the access port (44) of the hand stop valve (58) at the bottom of the receiver. Open the valve access port by turning the valve stem in (front seat) and operate the recovery unit until the system is considered empty.

! WARNING !
Approved recovery equipment, hoses, gages, and refrigerant containers must be used to comply with all local and federal EPA regulations.
! WARNING !

! WARNING !
Follow these instructions carefully. Severe personal injury can result from improper discharge of refrigerant.
! WARNING !

! WARNING !
It is not recommended that refrigerant be transferred from a refrigeration system into a cylinder. If such a transfer is made, the refrigerant cylinder must be an approved CLEAN cylinder-- free of any contaminants or foreign materials--and must be weighed continuously to assure contents do not exceed net weight specified by cylinder manufacturer or any applicable code requirements.
! WARNING !

Refrigerant Leaks In addition to testing the machine for leaks as instructed under "Refrigerant Charge", it is advisable to again make a leak test after the unit has been in operation approximately one week. Any noticeable change in operating conditions, other than shown on the "Certificate of Test" may indicate a loss of refrigerant due to a leak. Always remove the refrigerant pressure from the vessel or tubing before repairs are attempted.

Non-condensable Gases Satisfactory operation of the machine is not possible if non-condensable gases (usually air) are present in the system. Excessive condensing pressure is an indication of such gases. Excessive condensing pressure in water-cooled condensers may also be due to the accumulation of scale in the cooling coil or due to insufficient cooling water or excessive water temperature. See "Water Cooled Condensers", Section 7.

Compressor Motor Burnout There are several causes of compressor motor burnout. Some of these are described below.

1. Low line voltage. A compressor motor is designed to operate within the range of plus or minus 10% of its nameplate voltage. Low voltage requires the motor windings to carry more current at the same compressor load. When this current gets too high or is applied for an extended period, the motor windings overheat, resulting in a failure or burnout.

2. Loss of refrigerant. The hermetic compressor motor is maintained at proper operating temperature by passing cool suction gas over the motor windings. A loss of refrigerant can cause the winding to overheat resulting in a failure or burnout.

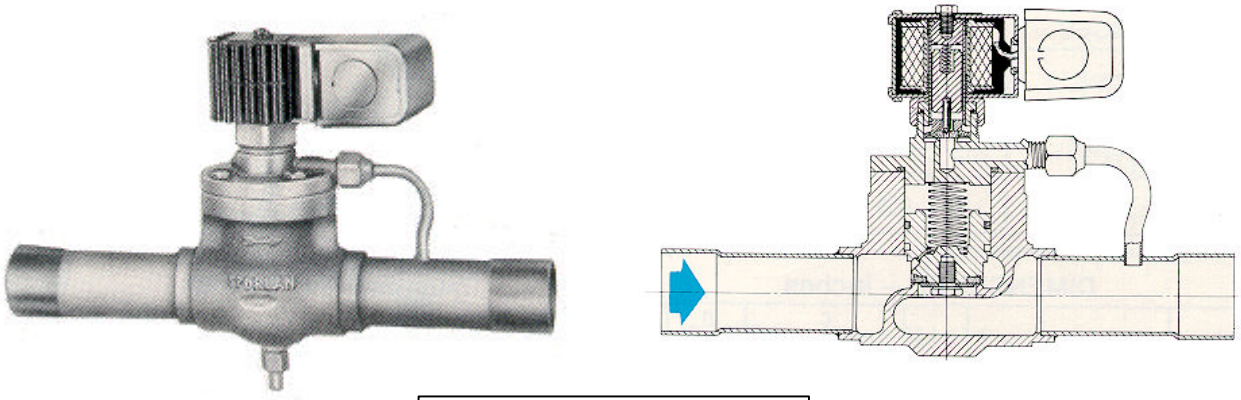
3. High head pressure. The system is designed to operate at 200 psig. Excessive head pressure adds refrigerating load on the compressor that can cause the windings to overheat and result in a failure or burnout.

4. Moisture. Moisture in contact with refrigerant oil and the presence of heat will form hydrochloric or hydrofluoric acid. The acid will destroy the insulation on the motor winding causing a short circuit which can increase motor temperature in excess of 3000 °F. This extreme temperature will also create a sludge or black residue in the system.

5. Mechanical failure. Mechanical failure has been determined as a major cause of motor burnout. Bearing wear or wipe-out may allow rotor to drag--overheating the windings and burnout.

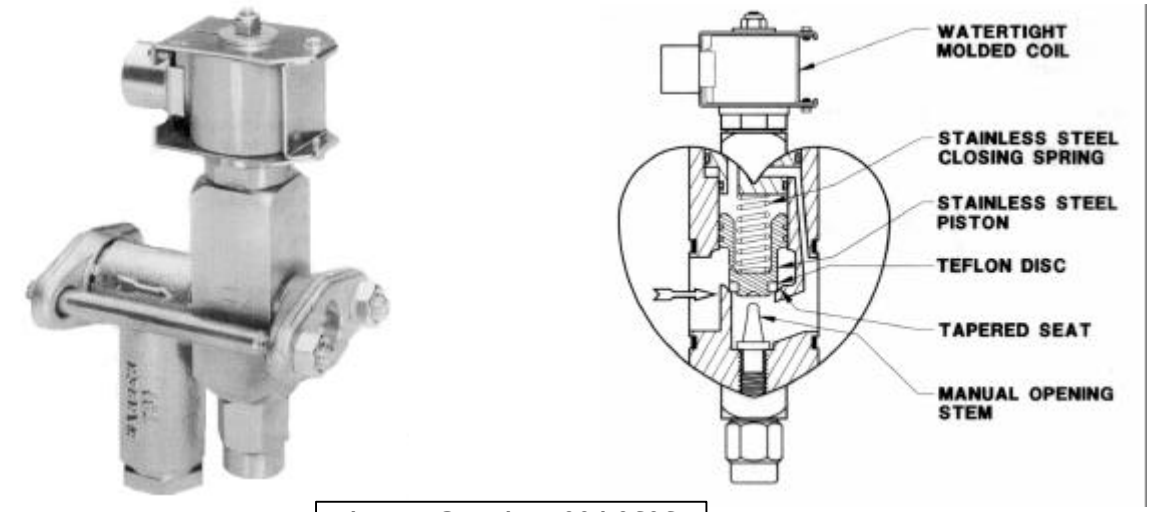
Whenever there is a compressor failure due to a motor burnout, it is important that they system be thoroughly cleaned before replacing the damaged compressor or otherwise the new compressor may also be damaged.

Solenoid Valves All solenoid valves are pilot operated with "floating" type diaphragms. For satisfactory operation, be sure that the manual opening stem is in the closed or automatic position. This means the stem is backed all the way out. Correct direction of stem rotation should be labeled on the stem seal nut.



PART NO 12A-4200A0904

FIGURE 9-6A
Thawing Gas Solenoid Valve ("D" Valve)



PART NO 12A-4200A0606

FIGURE 9-6B
Liquid Feed Solenoid Valve ("A" Valve)

Circulating Water Pump Motor PART NO 12A-4020G01 The motor bearings are prelubricated and sealed. They require no further lubrication. The pump should operate with the water level above the impeller housing. The pump is equipped with a mechanical seal that is self-adjusting and requires no lubrication. However, the pump should not be operated unless circulating water. The pump manufacturer recommends that a mechanical seal be kept as a spare. When ordering a seal, specify pump size, type, serial number, and manufacturer's name as indicated on the nameplate.

Capacity Control Valve (Internal Construction) A schematic illustration of the internal valve operation is shown in FIGURE 9-7.

In the normal (full capacity) operating position with the solenoid valve de-energized, the needle valve is seated on the lower port, and the unloading plunger chamber is exposed to suction pressure through the suction port. Since the face of the plunger is open to the suction chamber, the gas pressures across the plunger are equalized, and the plunger is held in the open position by the spring.

When the solenoid valve is energized, the needle valve is seated on the upper port, and the unloading plunger chamber is exposed to discharge pressure through the discharge pressure port. The differential between discharge and suction pressure forces the plunger down, sealing the suction port in the valve plate, thus preventing the entrance of suction vapor into the unloaded cylinders.

The seal on the unloading plunger minimizes any leakage in pressure so that a pumpdown cycle may be used with the valve either energized or de-energized without excessive compressor cycling.

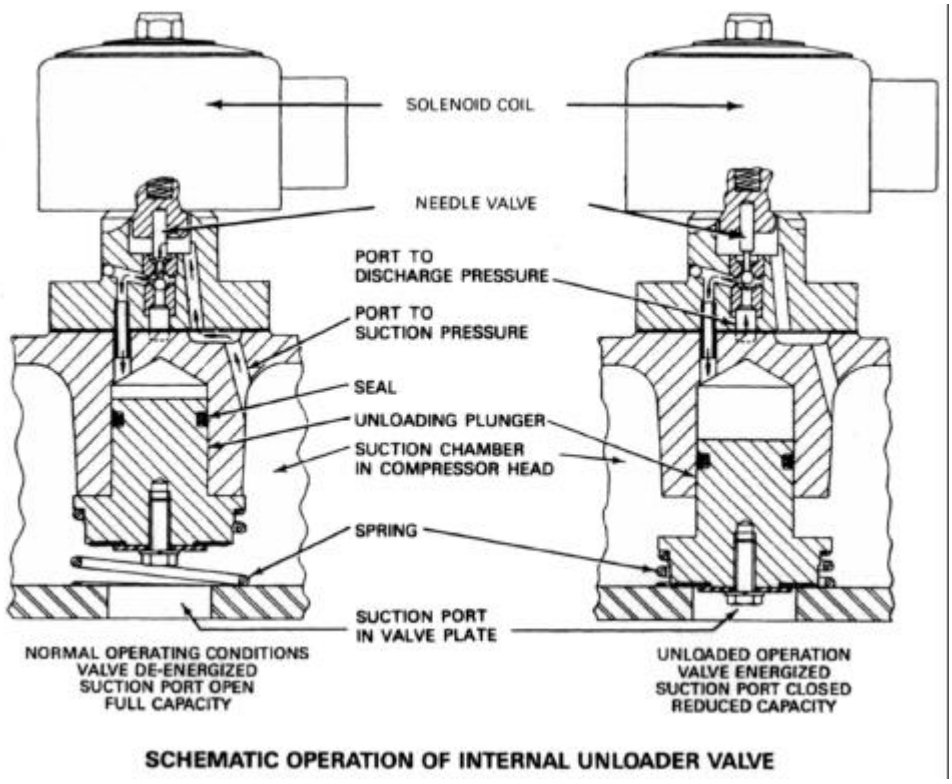


FIGURE 9-7
Copeland Compressor Unloader Valve

Loaded Operation (during freeze) This capacity control valve is controlled by an electric solenoid. When the solenoid is de-energized, the valve loads the cylinder bank (2 cylinders) as shown in the above figure.

Unloaded Operation (during thaw only) During the thaw cycle, the solenoid coil is energized. The needle valve is seated on the upper port, and the unloading plunger chamber is exposed to discharge pressure through the discharge pressure port. The differential between discharge and suction pressure forces the plunger down, sealing the suction port in the valve plate, thus preventing the entrance of suction vapor into the unloaded cylinders.

Component Removal and Replacement Operations

Cutter Motor The cutter motor's bearings are prelubricated and sealed and require no further lubrication. If the motor needs replacing, proceed as follows:

1. Turn power off and lockout disconnect.
2. Check terminals with voltmeter to confirm power is off.
3. Remove motor terminal cover and disconnect wires. Mark wires for ease of replacement.
4. Remove four cap screws around the motor flange and separate the motor from the reducer. Watch for shaft key that must be reinstalled later.
5. Check the motor electrically to confirm it is defective.
6. Apply Anti-Seize lubricant to the shaft of the replacement motor.
7. Position the shaft key in the motor keyway, align it with the re ducer keyway and install the motor. Make sure the key stays in position as shaft is.
8. Install the four cap screws to hold the motor in place on the reducer.
9. Connect the wires and install the terminal cover.
10. Check motor rotation to make sure the cutter turns in the proper direction. Reverse two wires at the motor if necessary to change rotation direction.

Cutter Gear Reducer To remove the gear reducer, proceed as follows: (See FIGURE 9-10)

1. Turn power off and lockout disconnect.
2. Remove motor from reducer.
3. Loosen (slightly) the four bolts and nuts holding the gear reducer in place.
4. Remove the four bolts holding the mounting plate to the water tank gear enclosure and remove the reducer and mounting plate from the tank.
5. Measure the distance between the top of drive gear and the mounting plate for future reference.
6. Remove the three cap screws from the gear and hub and install two 1/4" -20 x 2" long all thread set or cap screws in the threaded holes of the drive gear. These two screws can be used as jacking bolts to remove the gear from the tapered split hub.
7. In necessary, the split hub can be removed by driving a screwdriver in the split and sliding the hub off the shaft.
8. The new gear reducer can then be installed by reversing the removal procedure.
9. Be sure the gear and hub is properly positioned on the shaft so it will have a full vertical mesh with the cutter ring gear.
10. Final gear meshing should be adjusted so there is only a slight amount of play between the ring gear and drive.
11. Make sure all bolts are tighten ed securely and there is no excessive gear noise when the cutter motor is running.

Water Tank Removal

1. Turn off and lock out power to the machine.
2. Turn off water supply and disconnect lines from the tank.
3. Drain the tank and disconnect pump suction tube and drain line tubing and water lines.
4. Disconnect the ice discharge chute.
5. Loosen bolts holding the tank to the cutter assembly until the tank rests on the bars.
6. Loosen bolts holding the tank supports.
7. The tank can then be removed to the side of the machine.
8. Make sure the rubber gasket is in place and aligned properly when the tank is installed and bolted to the freezer.

Cutter and Bearing Removal/Installation

Refer to FIGURES 9-8, 9-9, & 9-10 for parts identification and location.

1. Turn off and lock out power to the machine.
2. Remove the cutter motor from the reducer.
3. Remove the water tank assembly and then the cutter assembly.
4. With a 1/4" or slightly smaller punch, reach in through the ice discharge opening, drive the spiral pin out of the disc hub and cutter shaft, and push or drive the disc off the shaft.
5. Lift the cutter assembly out of the bearing surface of the cutter. The surface should be smooth and free from nicks or burrs.
6. Inspect the bearing for wear. There should be no side movement between the shaft and bearing and the bearing thrust flange should be no thinner than 3/16" (it is 1/4" thickness new).
7. Before removing the bearing, reference mark the location of the bearing support on the side of the tank.
8. Loosen and remove the three cap screws from the bearing support ends and lift the support out of the water tank.
9. Drive the 3/16" x 1/2" pin located in the side of the support hub in and through the bearing wall.
10. Now the bearing can be pressed or driven out of the support hub.
11. Try the new bearing on the cutter shaft to make sure it turns easily.
12. Press or drive the new bearing into the hub. Be careful not damage the bearing surfaces (the old bearing may be used as a driver).
13. Drill a 3/16" hole through the bearing wall, using the original hub hole as a pilot. Insert and drive the 3/16" pin flush with the outside of the hub, making sure the pin doesn't extend beyond the inner surface of the bearing.
14. Slide the new bearing and support onto the cutter shaft to make sure it spins freely. If it is tigh t, ream the bearing inner surface slightly until it turns free.
15. Install the bearing support in the tank, using the reference marks as a guide.
16. Slide the cutter and shaft into the bearing and check the cutter alignment. By laying a straight edge across the tank top flange, there should be 0" to 1/16" clearance between the rim of the cutter and the top of the tank flange. Loosen the bearing support cap screws and drive the support arms up or down for the proper alignment.
17. Tighten the support screws securely and finish assembly of the cutter and cutter disc.
18. Install the tank and other parts, reversing the procedure of removal.

1	19T2615R01	Cutter Ring Gear
2	12A3040S02	Spring Pin
3	19T2160C0101	Cast Cutter
4	12A2226F1108	1/4” Flat Head Screw
5	19T2010A01	Cutter Adapter Plate
6	19T4090S01	Cutter Shaft
7	12B2020R01	UHMW Cutter Bearing
8	19T2025B0103	Bearing Support
9	12A3040S02	Spring Pin
10	12A2250A1070	1/4” Cut Washer
11	12A2215F1206	1/4” Cap Screw
12	12A4071S03	Rivet For Ice Deflector
13	19T2170D01	Ice Deflector
14	19T2163D0101	Cutter Disc Assembly
15	12A3040S01	Spirol Pin
16	12A2600G12	Water Tank Gasket
17	12A4030R07	Gear Reducer
18	12B2165M0101	Gear Reducer Mounting Bracket
19	12A2160H0101	Gear Hub
20	19T2615D01	Drive Gear
21	12A2240A1108	5/16” Hex Nut
22	12A2250B108	5/16” Lockwasher
23	12A2900M0508	Motor, 1/2 Hp, 208/230/460-3-50/60 Hz
24	12A2250A108	5/16” Cut Washer
25	12A2215G1108	5/16” X 3/4” Hex Head Cap Screw
26	12A2250B107	1/4” Lockwasher
27	12A2215F1112	1/4” Hex Head Cap Screw
28	19T1501S0505	Float Box Cover Assembly
29	12A4200H0401	Roberts Float Valve, #RM214
30	19T4500S112	Water Tank Assembly
31	12A4181T07	1 1/4” I.D. Tygon Tubing
32	12A2450E17	Elbow, 1 1/4” MPT X Insert
33	12A2450B12	2” X 1 1/4” Bushing
34	12A4020G01	Water Pump, Gould NPE-3ST
35	12A2450B02	Bushing 1 1/2” X 1 1/4”
36	12A4181T06	1 1/4” I.D. Tygon Tubing
37	12A2450E17	Elbow, 1 1/4” MPT X Insert
38	19T2090C07	Ice Chute Assembly

Table 9-1
Cutter/Tank Assembly Nomenclature

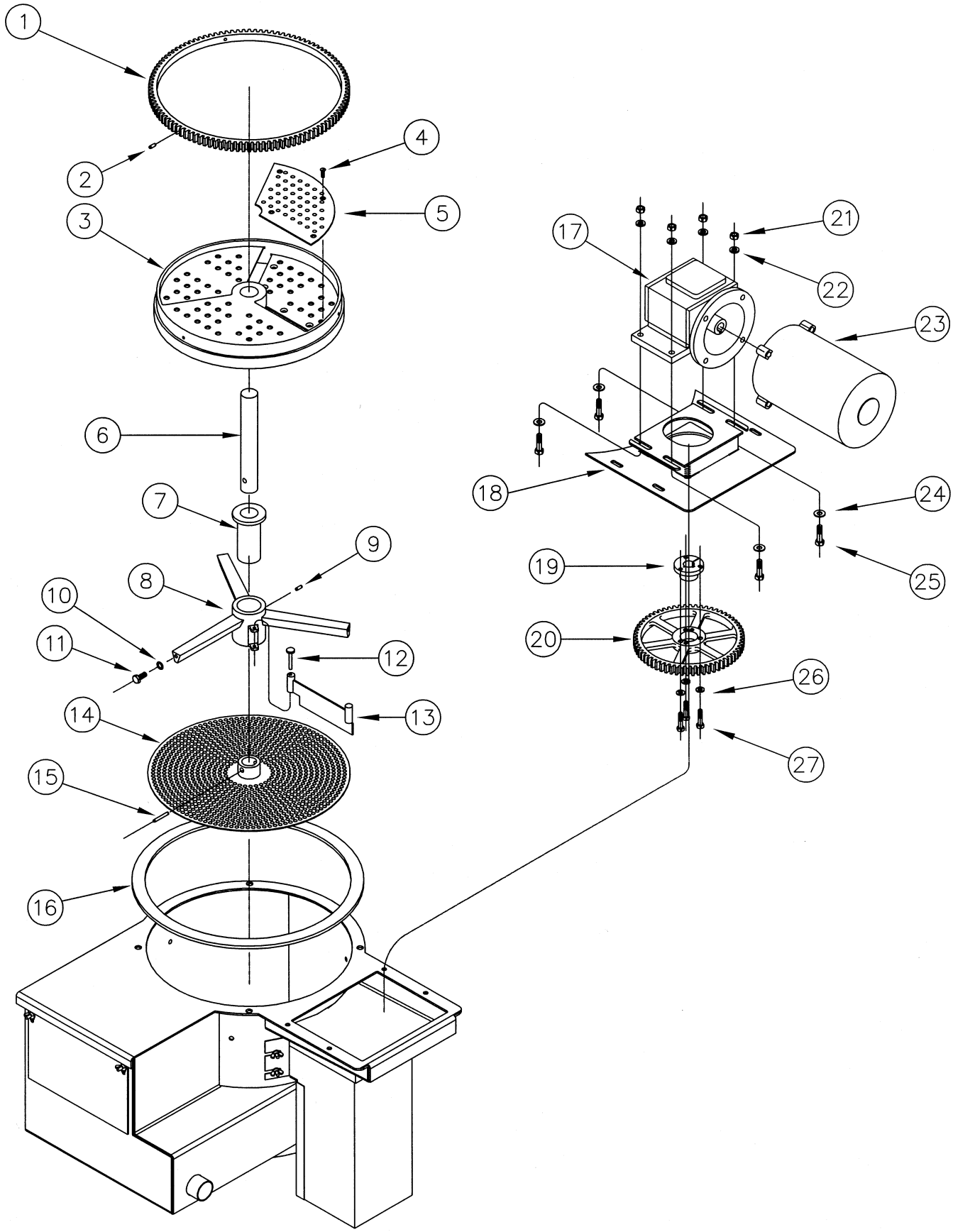


FIGURE 9-8
Cutter, Water Tank and Drive Gear Assembly

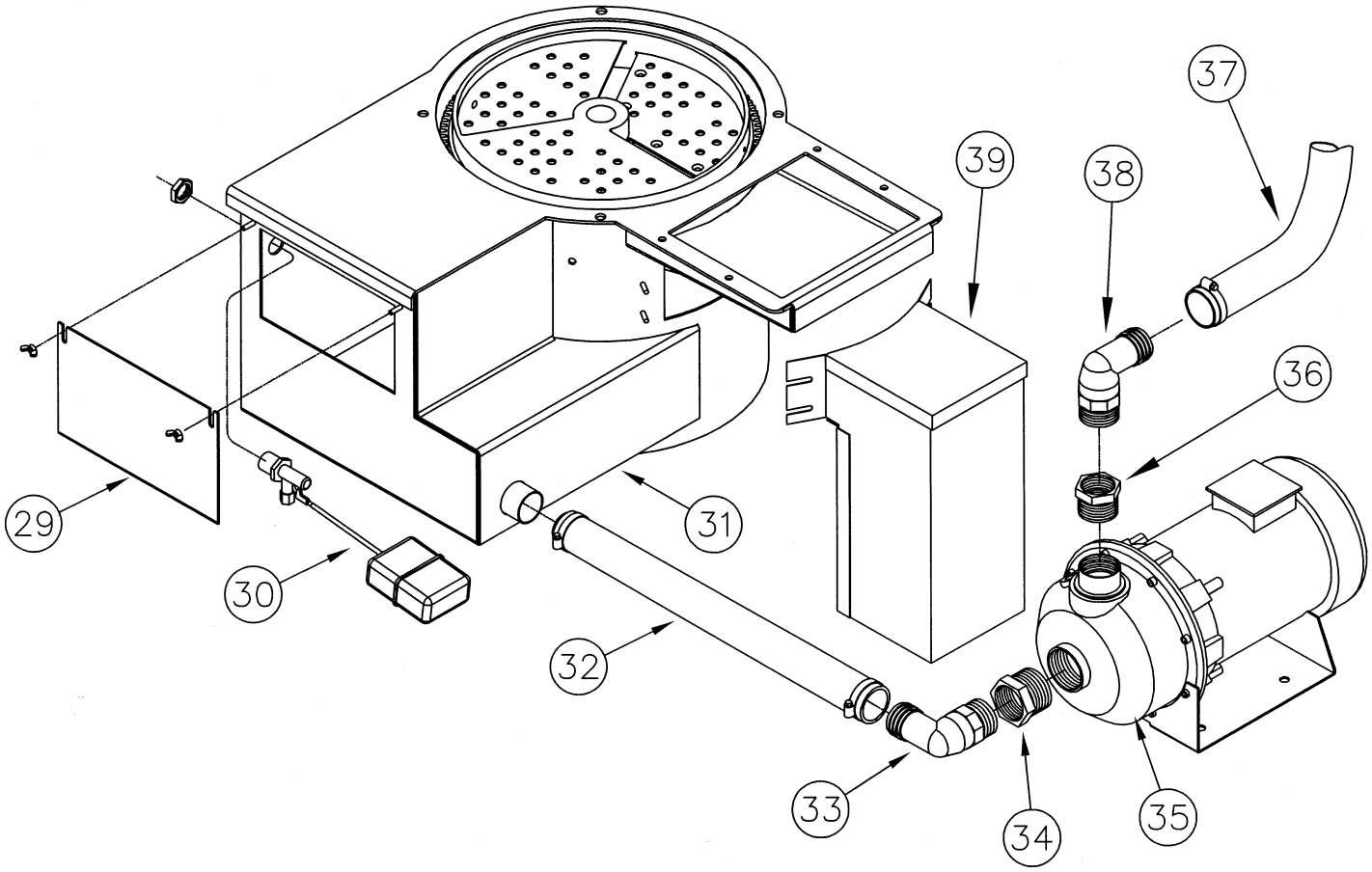


FIGURE 9-9
Water Tank and Pump Assembly

Crushed Ice Production Your 03TA Tube-Ice® machine is capable of producing crushed ice with no loss of capacity. However, there are certain changes to be made in order to convert to crushed ice production.

Modifications Required:

1. Reverse cutter direction by switching 2 of the 3 leads at the cutter motor (connections 52, 53 and 54).

2. Set the freezer pressure switch at 38 psi to make ice 3/16" thick (average). The freezer harvest pressure may need to be adjusted by± 1-3 psi to get the required thickness of ice.

This conversion process should normally be accomplished by two people in 1-2 hours (or less). It is recommended that you have good quality water when attempting to produce crushed ice. If the ice is opaque and cloudy, the cutter mechanism may become clogged, restrict ice discharge and bind the cutter. In addition, you should not attempt to produce crushed ice when the make-up water temperature is below 50°F (10°C). Colder water can cause a build-up of ice fines in the tank and eventually result in "short-cycling" which can damage the compressor.

Complete detailed instruction for converting to crushed ice production can be obtained through your distributor.

10. Options and Accessories

PLC (Programmable Logic Controller)

This section of the service manual applies only to 03TA models equipped with a Mitsubishi Fx_{on} programmable controller and 10DUE operator interface. The PLC version of the 03TA enhances the operation of the standard version by providing: Selectable automatic restart after a power failure, choice of timed or pressure switch controlled freeze cycles, diagnostic indicators, power failure indication, alarm relay, built in cutter delay, programmable conveyor control contacts, estimated ice production display, and a total cycle counter.

The Mitsubishi Programmable controller contains 14 inputs and 10 outputs. The power supply for the unit can be 100-240VAC, 50/60 Hz and is internally fused for 3A. The inputs are 24VDC internally fused for 5-7mA. All 24VDC control wiring is blue in color and is distinguished from the red 240VAC control wiring. The outputs are externally fused for 2A. Outputs 0, 1 and 2 are dry contacts used for sequencing and conveyor control. Outputs 3-11 are relay type with 200/240 V connections.

FIGURE 10-1 shows the Mitsubishi PLC installed in the 03TA. The LED indicators on the right hand side of the Mitsubishi PLC indicate the power, run and error status of the PLC. When power is on to the PLC and the run/stop switch is in the run position the power and run indicators will be illuminated. If an error is indicated contact the factory immediately. The LED indicators on the left-hand side of the Mitsubishi PLC indicate the input and output status of the PLC. If the input (X#) indicator is illuminated, then the PLC is receiving the input. If the output (Y#) indicator is illuminated, then the PLC is sending the output. Use of these LED's will be helpful in troubleshooting the machine.

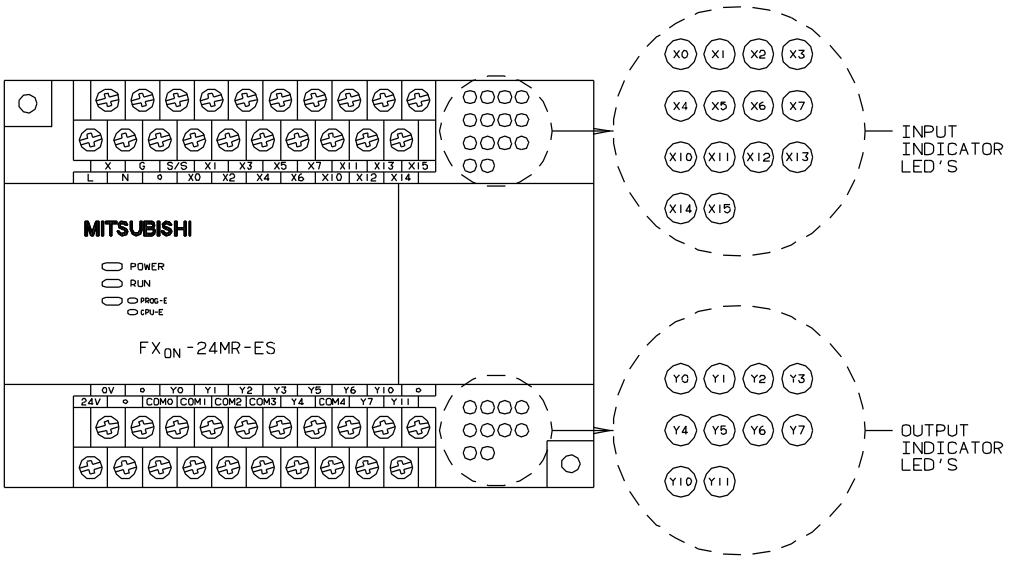


FIGURE 10-1

Mitsubishi Programmable Logic Controller

KEY FEATURES

Automatic Restart

03TA machines are equipped with a power failure relay. This relay prevents the machine from automatically restarting in the event of a power failure. The machine should have power on the crankcase heater for a minimum of two hours before it is restarted with the start switch. The PLC allows the user to select between having to restart the machine manually or restarting automatically, two hours after power is restored.

Timed Freeze Cycle

The normal mode of operation for the length of the freeze cycle is determined by the freezer pressure switch setting. The freezer pressure switch will automatically compensate for variations in water temperature and operating conditions to provide consistent ice thickness. The PLC allows the leng th of the freeze cycle to be a fixed time. The freeze time will have to be adjusted as water temperature and operating conditions change, however this method of control can prove helpful when sequencing two or more machines to avoid simultaneous harvest cycles.

Diagnostic Indicators The PLC provides text messages in the event of a malfunction or fault. The PLC will alert the user in the event of the following conditions.

?? high or low pressure

?? short cycling (three consecutive freeze cycles five minutes or less in duration)

?? long cycle (a freeze cycle lasting more than 60 minutes)

?? water pump overload

?? cutter motor overload

?? compressor overload

?? loss of oil pressure

?? power failure

Cutter Delay

PLC equipped machines delay start of the cutter motor for eight seconds after the water pump has stopped. This allows water to drain from the freezer and cutter assembly before the cutter assembly starts turning, thereby reducing the amount of water that can be splashed out the ice discharge opening.

Alarm Relay

The PLC equipped machines have an alarm output relay that can be used to initiate external alarms such as a siren, light, telephone dialer or modem (see FIGURE 10 -4).

KEY FEATURES (Cont.)

Conveyor Control Contacts

Control contacts are provided for starting and stopping conveyors in sequence with the ice machine. Normally the contacts are closed during the entire harvest cycle and open during the freeze cycle. In many cases it is necessary to run the conveyors for a period of time longer than the harvest cycle to allow the conveyor to finish delivering the ice. The PLC allows the user to set the duration of the conveyor run cycle independently of the harvest cycle. The user can also set a delay between the start of the harvest cycle and the conveyor start.

Estimated Ice Production

The PLC allows the user to enter the weight per cycle of ice being produced. This weight will depend on how the machine has been set up to run and the size of the hole in the ice, however the weight per cycle should remain relatively constant from cycle to cycle. The PLC uses this information coupled with the freeze and harvest times to report the capacity based on the last cycle in lbs of ice per day. The PLC will also track total accumulated ice production in lbs. over a period of time. This value can be reset to zero by the user.

The operator interface shown in FIGURE 10-1, provides two 16 character lines of text which are used to report faults, operating conditions, and programming information to the user. The keypad is used to enter or modify values in the PLC. Operation of the interface is menu driven. Basic directions for operation are displayed on the operator interface.

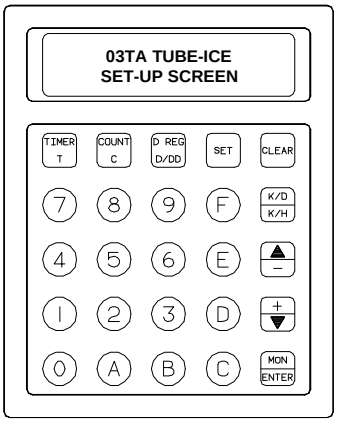


FIGURE 10-2, Operator Interface
PLC (Programmable Logic Controller)

PLC OPERATION

The operator interface displays two lines of text, however the message or instructions may be longer than can be displayed on two lines. The rest of the text can be accessed by pressing the up and down arrows (scrolling). Scrolling progresses down the screen one line at a time.

When power is first connected to the unit or restored after a power interruption, the interface will display the message shown below.

With the control switches in the "ICE" and "O N" positions the machine will begin a harvest cycle when the start button is depressed. The machine starts in the harvest cycle to clear any ice from the freezer if a power failure has occurred.

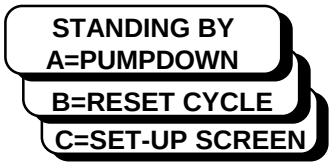
The interface will display the current harvest time and the previous cycle harvest time during the harvest cycle.

Upon completion of the harvest cycle the machine will begin the freeze cycle.

The interface will display the current freeze time and the previous cycle freeze time during th e freeze cycle.

Upon completion of the freeze cycle the machine will begin the harvest cycle.

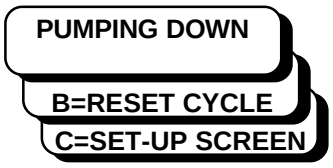
If the on/off switch is moved to the "OFF" position (or the ice level sensor opens) the machine will complete the current ice making cycle then stop. The interface will indicate that the machine is standing by. This message will be displayed anytime the machine is turned off. If the machine is off because of a fault (safety) or power interruption a different message will be displayed.



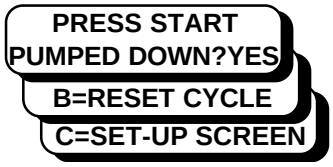
Pressing "A" on the operator interface at this point will cause the machine to begin a pumpdown sequence.

PLC OPERATION (Cont.)

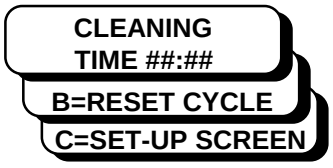
When the machine is pumping down the operator interface will indicate "PUMPING DOWN". During the pumpdown sequence the compressor is running and the liquid feed valve (A-Valve) is closed. The machine will complete one harvest cycle then the compressor will continue to run until the freezer pressure reaches the low pressure safety switch setting. The pumpdown sequence will move most of the refrigerant from the freezer to the receiver for servicing operations. It is recommended that the king valve be closed during servicing of the ice machine.



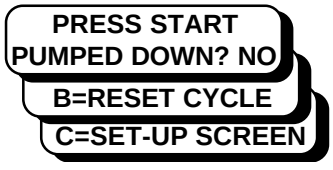
Upon completion of the pumpdown sequence the interface will display the message shown below. It will be necessary to press the start button to resume operation. This screen will also appear upon completion of a clean cycle or after a fault has been detected and reset. The words "PUMPED DOWN? YES" will appear if the machine is pumped down.



When the switches are in the "ON" and "CLEAN" positions the machine will begin a clean cycle after completing the current ice making cycle. The interface will display the time that the machine has been in a clean cycle. During the clean cycle the water pump will run. To stop the water pump (clean cycle) move the on/off switch to the "OFF" position. To restart the water pump (clean cycle) return the switch to the "ON" position and press the start button.

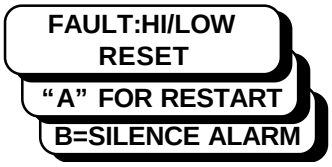


The machine will automatically exit the clean cycle after a 2 hour period. At the completion of the clean cycle, the interface will always return to the start up display, requiring that the start button be depressed

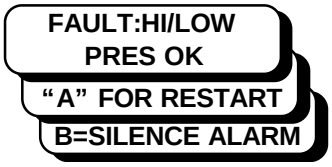


MACHINE FAULTS

Hi/Low Pressure. The interface will display the message shown below if the combination high/low pressure safety switch opens. The machine will stop immediately.

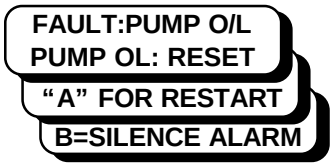


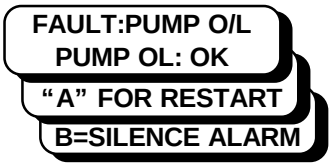
When the low pressure switch resets or the manual reset button for the high pressure safety is depressed and the pressure is in the acceptable range, the interface will display "PRES OK".



After the safety switch is reset it will be necessary to press the "A" button on the operator interface to return to the start up screen. Pressing "B" on the operator interface at this time will open the alarm contacts. Button "C" will always change the display to the set-up screen when a fault screen is displayed.

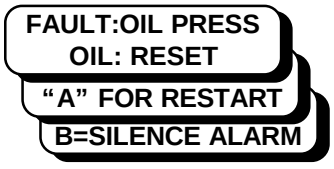
Cutter or Pump Overload. The interface will display the message shown below if the water pump overload protection trips open. The machine will stop immediately, and the overload reset button located on the motor starter must be depressed.

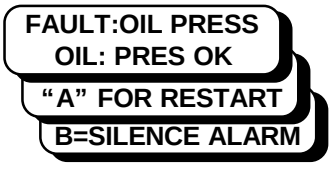




When the overload has been reset the interface will display "PUMP OL: OK". It will be necessary to press "A" on the operator interface to restart the machine. The cutter overload fault displ ay operates identically to the pump overload displays.

Low Oil Pressure: The interface will display the message shown below if the compressor oil pressure safety switch opens. The machine will stop immediately, and the oil pressure switch must be reset manually, by depressing the red button located on the front of the oil pressure safety switch.

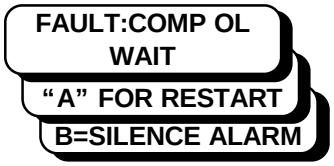


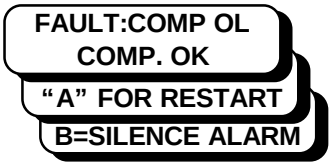


When the oil pressure safety switch has been reset the interface will display "OIL: PRES OK". It will be necessary to press "A" on the operator interface to restart the machine.

MACHINE FAULTS (Cont.)

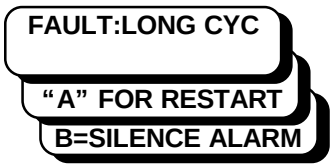
Compressor Overload: The interface will display the message shown below if the compressor motor safety overload switch opens. The machine will stop immediately. The compressor overload will reset automatically after the compressor has time to cool off.

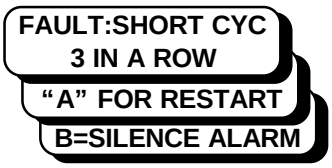




When the compressor overload resets the interface will display "COMP. OK". It will be necessary to press "A" on the operator interface to restart the machine.

Long or Short Cycle Safety: The interface will display the messages shown below if there is a long or short cycle condition. The machine will stop upon indication of either of these conditions. A long cycle is defined as a freeze cycle that lasts for a period of one hour. An open drain valve, leaking hot gas valve or defective compressor could cause this. The short cycle safety will stop the machine after three consecutive freeze cycles of less than five minutes duration. Short cycling can be caused by a restriction in the liquid line, inadequate make-up or circulating water, or a defective freezer pressure switch.



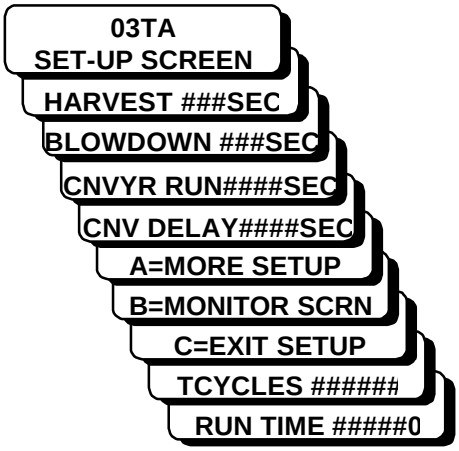


It will be necessary to press "A" on the operator interface to restart the machine.

! CAUTION !
When the operator interface indicates a fault, something has gone wrong. Every effort should be made to discover the reason for the fault. Do not simply reset the fault and resume operation. The underlying cause will likely reoccur, interrupt ice supply and potentially damage equipment.
! CAUTION !

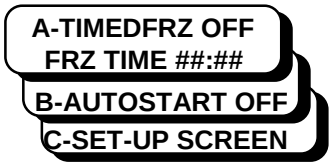
CHANGING THE SETUP VALUES

Several operating parameters of the machine can be modified. The set up screen must be accessed to make any modifications. The set up screen can be accessed by pressing the "C" button on the operator interface. When in the setup screen the interface will display the information shown below. The arrow buttons can be used to scroll through the lines of the screen.



To change the value of a variable, scroll to that variable on the screen, press the "SET" button on the interface, enter the new value using the numeric key pad and press "ENTER". The only variables that can be changed from this screen are the harvest time, blowdown time, conveyor run time, and conveyor delay time. The last two lines of the display report total cycles and run time of the machine.

Pressing "A" on the operator interface while in the set up screen will allow you to access a second set up screen where the autostart and the timed freeze cycle features can be turned on or off. The display will be as shown below.



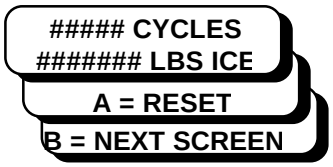
Pressing "A" from this screen will toggle the timed freeze feature from off to on. If the display reads "A-TIMEDFRZ ON" the timed freeze feature is active.

Pressing "B" from this screen will toggle the auto -restart feature from off to on. If the display reads "B-AUTOSTRT ON" the automatic restart feature is activated.

The user can also set the freeze time from this screen.

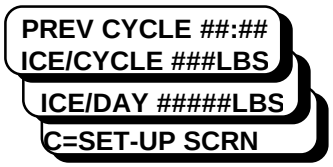
MONITORING FUNCTIONS

From the set up screen two additional screens can be displayed by pressing "B" on the operator interface. These two screens are refereed to as monitor screens. The first screen displays the cycles and lbs of ice produced since the operator has reset the counter. The screen is shown below.



Pressing " A" from this screen will reset the cycle count and pounds of ice produced to zero. This will not reset the total cycles displayed on the main set up screen.

Pressing "B" from this screen will call the second monitor screen. The second monitor screen displays the previous total cycle time, lbs of ice produced per cycle and lbs of ice produced per day based on the last cycle time. The screen is shown below.



The user can set the pounds of ice per cycle from this screen. The capacities and ice production totals calculated on these two screens are based on the user input number for pounds of ice per cycle. This depends on how thick the ice is and how the machine is set up. For best results, the number used here should be the average actual measured weight from two or more consecutive cycles.

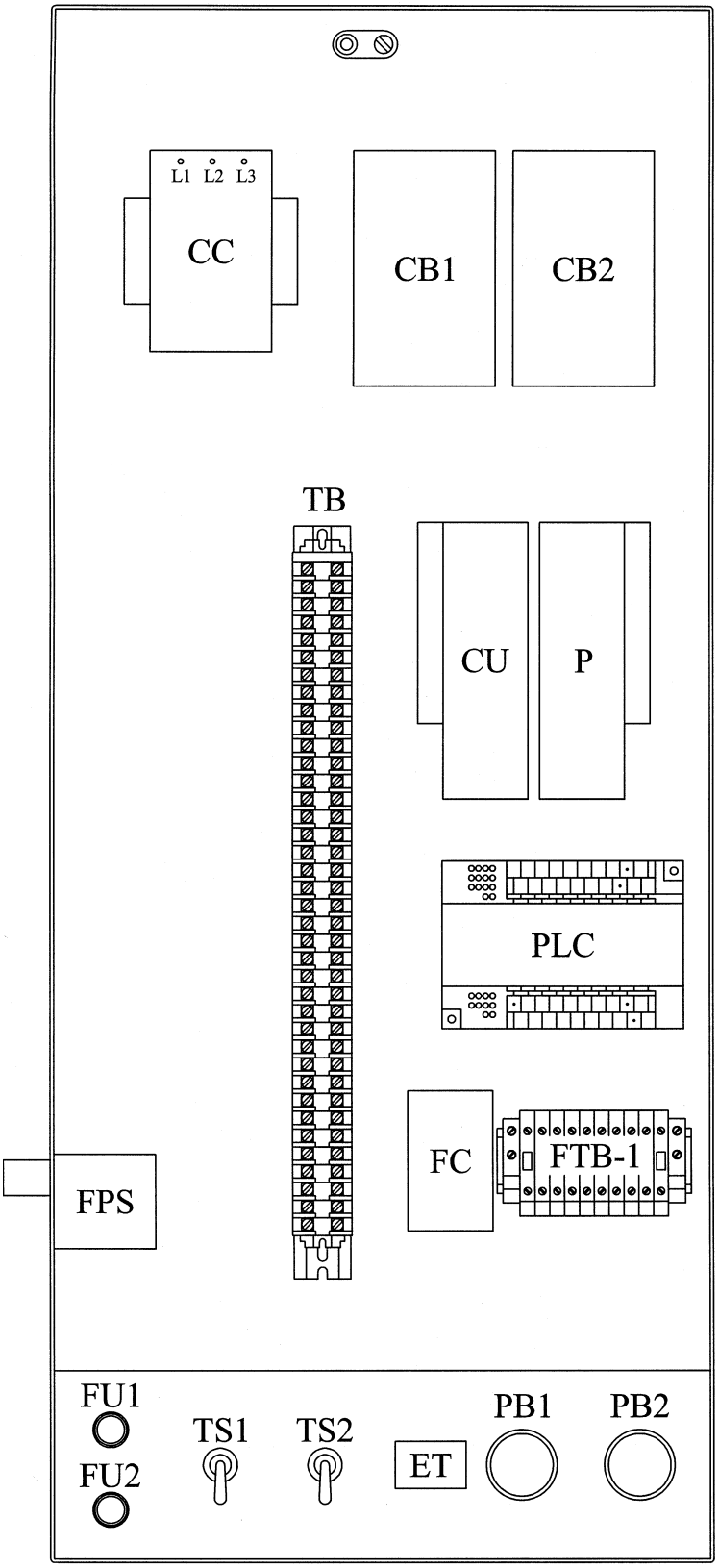


FIGURE 10-3
Control Panel Component Layout with PLC

* (CC) Compressor Contactor Provides power to the compressor motor. Continuously energized during freezing and thawing. Auxiliary contact to provide power to oil pressure control and de-energize crankcase heater.
* (CB1) Pump/Cutter Circuit Breaker Secondary pump/cutter motor protection.
*(CB2) Air Cooled Condenser Circuit Breaker Air-cooled condenser fan motor protection.
*(CU) Cutter Motor Contactor With Overload Relay Stops operation of cutter motor in the event of a mechanical or electrical malfunction re sulting in excessive motor amperes.
*(P) Pump Motor Contactor With Overload Relay Stops operation of water pump motor in the event of a mechanical or electrical malfunction resulting in excessive motor amperes.
*(PLC) Programmable Logic Controller For monitoring, sequencing, and controlling various functions of machine operation.
*(FTB-1) Fused Terminal Block Overload and short-circuit protection for PLC outputs.
*(FC) Fan Contactor Cycles the fan motor(s) of air-cooled condenser on and off. Activated by the condenser pressure switch (air-cooled machines only).
*(TS1) Ice/Clean Toggle Switch Two position toggle switch to operate machine in ice making mode or clean mode. When in clean position, only the water pump will run. This allows cleaner to be circu lated through the freezer without making ice.
*(TS2) On/Off Toggle Switch Two position switch used to stop machine at the end of the harvest and restart the machine in a freeze cycle.
*(ET) Elapsed Time Indicator Indicates hours of machine operation. Ener gized when compressor is operating.
*(PB1) Stop Push Button (Red) Used to stop machine immediately.
*(PB2) Start Push Button (Green) For starting machine or manually harvesting. Will initiate a harvest cycle whenever pushed with “Ice/Clean” switch in “Ic e” position.
*(TB) Terminal Block Numbered for multiple wire connections and ease of troubleshooting.
*(FU1, FU2) 2.5 Amp Fuses Overload and short circuit protection for crankcase heater and the control circuit.
*(FPS) Freezer Pressure Switch For regulatin g the ice thickness by sensing freezer pressure switch and initiating the thaw period.

Table 10-1
Control Panel Part Nomenclature

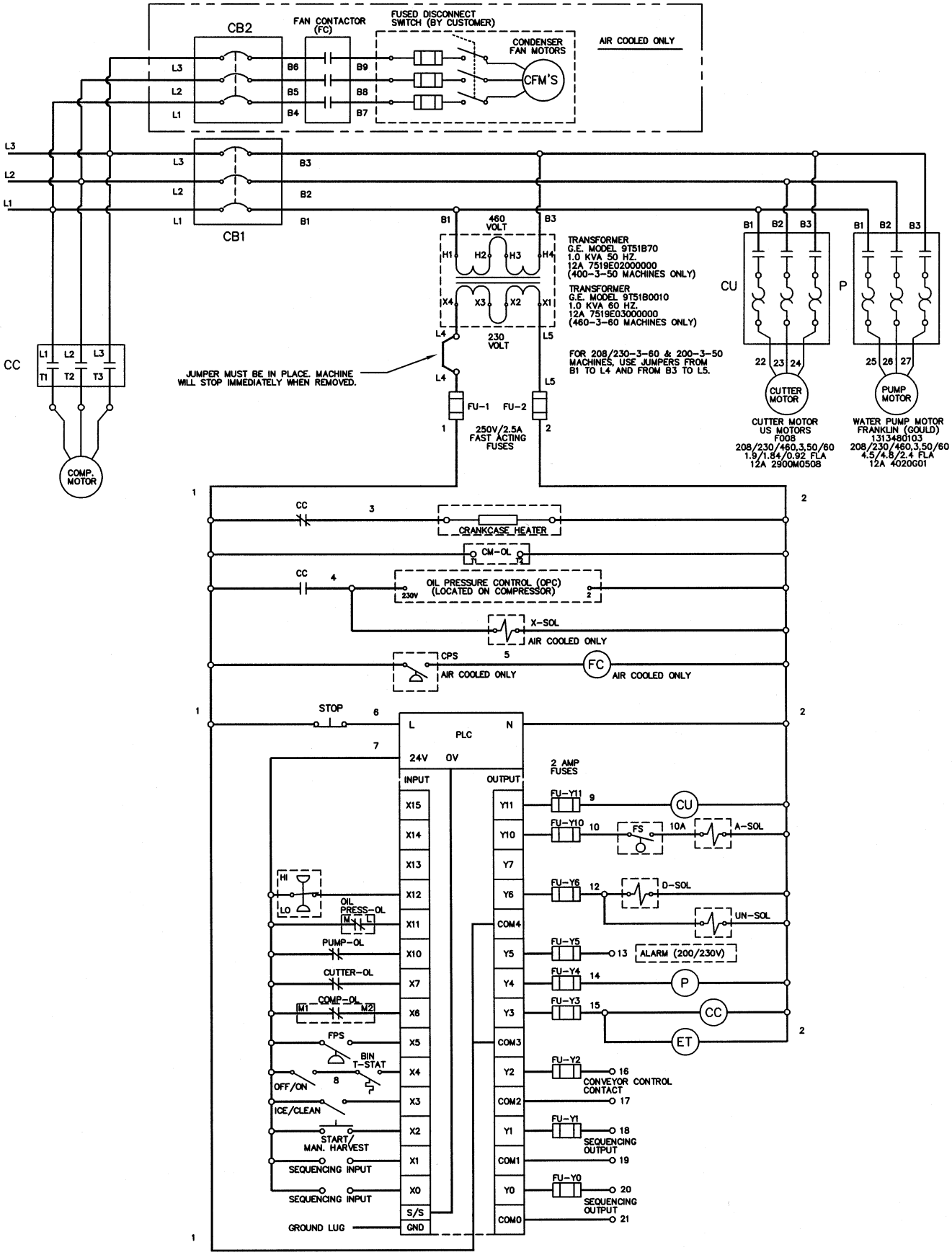


FIGURE 10-4
PLC Wiring Schematic

Power Monitor

All Vogt Tube-Ice machine models are available from the factory with a three phase line voltage power monitor with LCD display. The units are also available for after market or retrofit installation. These units monitor line voltage inputs from 190 to 610 volts and provide protection against line voltage variances that can damage or destroy the compressor motor. Features include automatic system shutdown and restart based on current line conditions, a voltmeter, and a non-volatile system memory so settings are retained even if power is lost. If machine is ordered with this option the power monitor can be factory set to customer specifications. The Vogt Part number for a power monitor retrofit kit is 12A-7700K010000.

Operation

Parameters

Press Setup Key to enter Setup Mode. Holding the Setup key down for 2 seconds will place all settings at their defaults. To change settings press the Setup Key repeatedly to step through each menu item, changing settings where required. As you step through the Setup Menu, the unit will remain on line, monitoring your system and logging any faults in memory for you to review after you leave the setup mode. The Setup LED will stay on during setup operations. When you have passed the last parameter in the setup menu the setup LED will extinguish and you will be returned to the SYSTEM ON LINE display.
NOTE: The power monitor has no on and off switch so the unit will power up a few seconds after power is applied.

Nominal Voltage

Set this value at the Incoming Line Voltage. Use the arrow keys to change voltage. 190 - 610 Voltage Adjustment. Default voltage is 208.

Voltage Range

Use the arrow keys to set the under/over percentage (2 to 25%) of incoming voltage. This will turn off equipment for a specified time if incoming voltage exceeds set percentage. The recommended voltage range is 10%. Default is 10%.

Delay On Break

Ranges from Off to 10 minutes in .1 minute increments. Use the arrow keys for adjustment. “Delay On Break” is energized when the Load Relay is deactivated, and the load will remain off until the specified time has elapsed. Default is .5 minute.

Delay On Make

Ranges from Off to 10 minutes in .1 minute increments. Use the arrow keys for adjustment. “Delay On Make” is energized when the control voltage is reactivated, and the load will remain off until the specified time has elapsed. Default is .1 minute.

Phase Unbalance
Use the arrow keys to set the Phase Unbalance percentage (2 to 20%) of incoming 3 Phases. This will turn off equipment for a specified time if incoming Phase Unbalance exceeds set percentage. The Default is 5% which is the recommended value for normal operation.

Delay On Fault
Ranges from Off to 15 seconds in .1 second increments. Use the arrow keys for adjustment. "Delay On Fault" is energized when any line fault occurs. The fault must be pres ent set time in order to be registered or acted upon. Default is 2.0 seconds.

Contactor Test
Selectable number of Contactor Retries (1 to 10 or OFF) on Contactor Fault. Use the arrow keys to adjust the number of times the contactor will be operated in order to seal the contacts. Setting retries to OFF means do not check load side. Any input to the load inputs will be ignored. Default is off.

Reset Mode
(Manual/Automatic) Choose whether to let the unit automatically reset or to wait for you to manually reset it. The recommended setting is automatic because faults must be cleared in order to reset from the manual mode. To reset from a fault condition in the manual mode press and hold the fault button for two seconds. Default is manual reset.

Control Mode
This setting allows you to select the control source. Pressing the arrow keys in this setup mode takes you through ON, OFF and EXTERNAL. The normal setting would be EXTERNAL. With the control set to EXTERNAL, the unit will respond to the signal con nected to the CONTROL input. With the control mode set to ON, the unit will turn on its output relay if line parameters are within setup parameters. Setting the control mode to OFF causes the unit to ignore the control input and keep its output relay off. Default is external.

Read Mode
For reading individual phase to phase voltages, pressing the read key will enter read mode. Press the read key to step through the voltages. Read voltages in the following order.
Voltage A to B. -- Voltage A to C. -- Voltage B to C.
Pressing the read key again will exit read mode.

Fault Mode
Recalls faults (from most recent to the oldest in order). Press the FAULT key to enter fault mode. FAULT #1 is the most recent fault. Press the fault key again to step to the next fault. Pressing the fault key at the last fault will exit fault mode. Press and hold fault key down for two seconds to clear fault from memory and reset the unit.

Contrast Adjustment

When the SETUP, READ and FAULT LED's are all off the unit is in the monitor mode. While in the monitor mode the UP and DOWN arrow keys will control the display contrast.
NOTE: LCD display contrast will vary with changes in ambient temperature, and under extreme temperature conditions the LCD display may be dark or clear. If this occurs simply use the arrow keys as described above to adjust the display to a visible condition. LCD contrast adjustments are stored in the permanent memory and will remain constant once set.

Locking Out Setup Menu

In some field installations it may be desirable to lock out unwanted changes from being made to the programmed parameters. This can be achieved by using the lock feature. The setup menu can be viewed but not changed when the lock is on.

TO LOCK out operator adjustments:
Hold the FAULT key down until "FAULTS CLEARED" appears on the Display. While holding the FAULT key down, press the ARROW UP key once. This will turn the Setup Lock on.

TO UNLOCK the panel and allow operator adjustments:
Hold the FAULT key down until "FAULTS CLEARED" appears on the Display. While holding the FAULT key down, press the ARROW DOWN key once. This will turn the Setup Lock off.

When the operator adjustments are locked out, the ability to load default parameters is also locked. To use the "press and hold the setup key to load default values" function, you must first unlock the setup menu as explained above.

Wiring

The power monitor should be wired to the "line" and "load" side of the compressor contactor with 1 amp fused connections. The connections labeled "control" should be wired to a 230 volt power source. "Com" and "Run" connections should be wired in series with the system control circuit. Note that specified connections are for 05TA models only. Consult factory for other models.

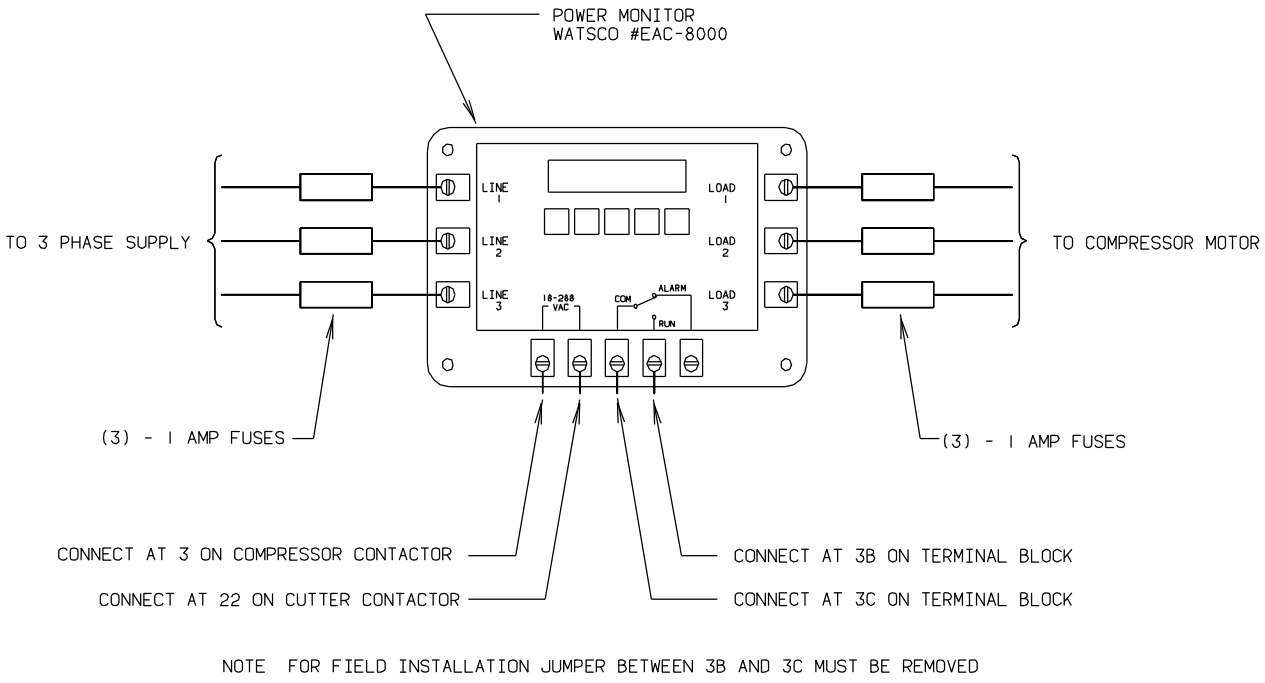


FIGURE 10-6

Phase Protector, wiring schematic.

Troubleshooting

SYMPTOM	DISPLAY	LED's	SOLUTION
Load will not energize.	System on line.	LOAD LED not lit.	Check control input.
Parameters will not change when arrows pressed.	Indicates parameters when SETUP is pressed.	Normal.	Parameters are locked out. See "Locking Out Setup Menu".
LEDS blink periodically but unit never comes up.	Occasional Flash.	Blinking.	Line voltage too low and/or phase missing.
Control LED does not go out when control is off.		CONTROL LED always on.	Control input is very sensitive. Insure control voltage < 2 volts for off condition.
System trips out on low or high line voltage.		FAULT LED flashes (due to fault).	Check normal line voltage using READ feature. Re-adjust voltage range as required.
Output relay never turns on.			Control Mode setting is "OFF". Press setup to get to Control Mode then use arrow keys to set mode to EXTERNAL.
Unit makes whistling or sizzling sound.	Normal.	Normal.	Some sound coming from the unit is normal and may vary with input voltage.

11. Tables & Charts

03TA SPECIFICATIONS		208-230 Volt-3 Phase- 60Hz		200 Volt-3 Phase 50Hz	
Model Number		**HE60S/P112-1**	**HE60M/P112-1 1/4**	**HE60S/P112-1**	**HE60M/P112-1 1/4**
Tube Size	**inches** (cm)	**1** (2.54)	**1 1/4** (3.17)	**1** (2.54)	**1 1/4** (3.17)
Nominal Capacity [1]	**lbs/day** (Kg/day)	**6,024** (2,732)	**5,725** (2,597)	**5,904** (2,678)	**5,611** (2,545)
Overall Dimensions (LxWxH)	**inches** (meters)	**50 x 29 x 72** (1.3x0.74x1.8)	**50 x 29 x 72** (1.3x0.74x1.8)	**50 x 29 x 72** (1.3x0.74x1.8)	**50 x 29 x 72** (1.3x0.74x1.8)
Shipping Weight	**lbs** (Kg)	**1800** (816)	**1800** (816)	**1800** (816)	**1800** (816)
Operating Weight	**lbs** (Kg)	**1830** (830)	**1830** (830)	**1830** (830)	**1830** (830)
Refrigerant Charge (HFC-404a)	**lbs** (Kg)	**130** (59)	**130** (59)	**130** (59)	**130** (59)
Total FLA Water Cooled[2]		**48.3**	**48.3**	**50.9**	**50.9**
Total FLA Air Cooled[2]		**58.6**	**58.6**	**56.9**	**56.9**
Maximum Fuse	**WC / AC**	**100/110**	**100/110**	**110/115**	**110/115**
Minimum Ampacity	**WC / AC**	**60/65**	**60/65**	**65/70**	**65/70**
Water Requirements					
-makeup[3]	**gpm** (L/m)	**0.6** (2.3)	**0.6** (2.3)	**0.6** (2.3)	**0.6** (2.3)
-condenser[4]	**gpm** (L/m)	**30** (114)	**30** (114)	**30** (114)	**30** (114)
Connection Sizes					
-makeup water	**FPT**	**3/8"**	**3/8"**	**3/8"**	**3/8"**
-tank drain	**FPT**	**3/4"**	**3/4"**	**3/4"**	**3/4"**
-condenser water inlet	**FPT**	**1 1/4"**	**1 1/4"**	**1 1/4"**	**1 1/4"**
-condenser water outlet	**MPT**	**1 1/4"**	**1 1/4"**	**1 1/4"**	**1 1/4"**
-AC condenser inlet	**ODC**	**1 3/8"**	**1 3/8"**	**1 3/8"**	**1 3/8"**
-AC condenser outlet	**ODC**	**1 1/8"**	**1 1/8"**	**1 1/8"**	**1 1/8"**
Compressor -HP/KW/FLA		**7.5 / 5.6 / 41.0**	**7.5 / 5.6 / 41.0**	**10 / 7.5 / 43.6**	**10 / 7.5 / 43.6**
Water Pump -HP/KW/FLA		**1.5 / 1.9 / 4.8**	**1.5 / 1.9 / 4.8**	**1.5 / 1.9 / 4.8**	**1.5 / 1.9 / 4.8**
Cutter Motor -HP/KW/FLA		**0.5 / .37 / 2.2**	**0.5 / .37 / 2.2**	**0.5 / .37 / 2.2**	**0.5 / .37 / 2.2**
THR	**Btu/hr** (kW)	**122,000** (35.7)	**122,000** (35.7)	**122,000** (35.7)	**122,000** (35.7)
Marley Cooling Tower[5]		**4821**	**4821**	**4821**	**4821**
-dim. (LxWxH)	**ft** (meters)	**4 x 5 x 6.5** (1.2x1.5x2.0)	**4 x 5 x 6.5** (1.2x1.5x2.0)	**4 x 5 x 6.5** (1.2x1.5x2.0)	**4 x 5 x 6.5** (1.2x1.5x2.0)
-shipping weight	**lbs** (Kg)	**650** (336)	**650** (336)	**650** (336)	**650** (336)
-operating weight	**lbs** (Kg)	**999** (608)	**999** (608)	**999** (608)	**999** (608)
-connections (inlet x outlet)	**NPT**	**4" x 4"**	**4" x 4"**	**4" x 4"**	**4" x 4"**
-fan (HP/KW/FLA)		**1 / 0.8 / 3.6**	**1 / 0.8 / 3.6**	**1 / 0.8 / 3.6**	**1 / 0.8 / 3.6**
Tower Pump					
-flow	**gpm** (m^3/Hr)	**30** (6.81)	**30** (6.81)	**30** (6.81)	**30** (6.81)
-TDH minimum	**ft** (m)	**80** (24.4)	**80** (24.4)	**80** (24.4)	**80** (24.4)
-connections (inlet x outlet)	**FPT**	**1" x 1.25"**	**1" x 1.25"**	**1" x 1.25"**	**1" x 1.25"**
-HP/KW/FLA		**1 / 0.8 / 3.6**	**1 / 0.8 / 3.6**	**1 / 0.8 / 3.6**	**1 / 0.8 / 3.6**
-shipping weight	**lbs** (Kg)	**65** (29.5)	**65** (29.5)	**65** (29.5)	**65** (29.5)
Kramer Air-Cooled Condenser[6]		**DD-231**	**DD-231**	**DD-231**	**DD-231**
- # of Fans / HP		**3 / 0.5**	**3 / 0.5**	**3 / 0.5**	**3 / 0.5**
-total KW/FLA		**1.1 / 5.4**	**1.1 / 5.4**	**1.1 / 5.4**	**1.1 / 5.4**
-inlet connection	**ODC**	**1 5/8"**	**1 5/8"**	**1 5/8"**	**1 5/8"**
-outlet connection	**ODC**	**1 1/8"**	**1 1/8"**	**1 1/8"**	**1 1/8"**
-shipping weight	**lbs** (Kg)	**520** (463)	**520** (463)	**520** (463)	**520** (463)
-operating weight	**lbs** (Kg)	**560** (499)	**560** (499)	**560** (499)	**560** (499)

(1) Nominal capacity is based on 70°F make-up water, 100°F condensing temperature, and 90°F ambient temperature.

(2) FLA for 460 and 380 Volt models is approximately 1/2 that of 230 and 200 Volt models. Total FLA does not include cooling tower.

(3) Makeup water is maximum value and includes 10 gallons per cycle blowdown.

(4) Condenser flow rate is for 85°F entering water temperature and 100°F condensing.

(5) Tower sized for 80°F wet bulb temperature.

(6) Recommended air-cooled condenser is based on 15°F TD.

03TA Capacity Ratings

Makeup Water Temp. Deg. F	Rated Capacity (lbs/day)							
	60Hz				50Hz			
	Cylinder		Crushed		Cylinder		Crushed	
	1"	1 1/4"	1"	1 1/4"	1"	1 1/4"	1"	1 1/4"
40	6955	6592	7233	6856	6816	6460	7088	6719
41	6925	6564	7202	6826	6786	6432	7058	6690
42	6895	6535	7171	6796	6757	6404	7027	6660
43	6865	6506	7139	6767	6727	6376	6997	6631
44	6835	6478	7108	6737	6698	6348	6966	6602
45	6805	6449	7077	6707	6668	6320	6935	6573
46	6775	6421	7045	6677	6639	6292	6905	6544
47	6744	6392	7014	6648	6610	6264	6874	6515
48	6714	6364	6983	6618	6580	6236	6843	6486
49	6684	6335	6952	6588	6551	6208	6813	6457
50	6686	6347	6953	6601	6552	6220	6814	6469
51	6652	6312	6918	6564	6519	6186	6780	6433
52	6619	6277	6884	6528	6487	6151	6746	6398
53	6585	6243	6848	6493	6453	6118	6711	6363
54	6552	6208	6814	6456	6421	6084	6678	6327
55	6518	6173	6779	6420	6388	6050	6643	6292
56	6484	6139	6743	6385	6354	6016	6608	6257
57	6451	6104	6709	6348	6322	5982	6575	6221
58	6417	6070	6674	6313	6289	5949	6540	6187
59	6384	6035	6639	6276	6256	5914	6507	6151
60	6350	6000	6604	6240	6223	5880	6472	6115
61	6318	5973	6571	6212	6192	5854	6439	6088
62	6285	5945	6536	6183	6159	5826	6406	6059
63	6252	5918	6502	6155	6127	5800	6372	6032
64	6220	5890	6469	6126	6096	5772	6339	6003
65	6187	5863	6434	6098	6063	5746	6306	5976
66	6155	5835	6401	6068	6032	5718	6273	5947
67	6122	5808	6367	6040	6000	5692	6240	5920
68	6089	5780	6333	6011	5967	5664	6206	5891
69	6057	5753	6299	5983	5936	5638	6173	5863
70	6024	5725	6265	5954	5904	5611	6140	5835
71	5997	5697	6237	5925	5877	5583	6112	5806
72	5969	5669	6208	5896	5850	5556	6084	5778
73	5942	5641	6180	5867	5823	5528	6056	5749
74	5914	5613	6151	5838	5796	5501	6028	5721
75	5887	5585	6122	5808	5769	5473	6000	5692
76	5860	5557	6094	5779	5743	5446	5973	5664
77	5832	5528	6065	5749	5715	5417	5944	5634
78	5805	5500	6037	5720	5689	5390	5916	5606
79	5777	5472	6008	5691	5661	5363	5888	5577
80	5750	5444	5980	5662	5635	5335	5860	5549
81	5723	5418	5952	5635	5609	5310	5833	5522
82	5696	5393	5924	5609	5582	5285	5805	5497
83	5669	5367	5896	5582	5556	5260	5778	5470
84	5643	5341	5869	5555	5530	5234	5751	5444
85	5616	5316	5841	5529	5504	5210	5724	5418
86	5589	5290	5813	5502	5477	5184	5696	5392
87	5562	5265	5784	5476	5451	5160	5669	5366
88	5535	5239	5756	5449	5424	5134	5641	5340
89	5509	5213	5729	5422	5399	5109	5615	5313
90	5482	5188	5701	5396	5372	5084	5587	5288

Capacity rating based on 70°F ambient conditions, 100°F SDT temperature.

Capacity rating is average for the model. Individual machines may vary up to 5% above or below.

Capacity rating is for clear ice production with makeup water containing no more than 200ppm total dissolved solids.

Table 11-3

03TA Condenser Water Usage

Condensing Temp. °F	Entering Water Temp. °F	Leaving Water Temp. °F	Water Flow GPM	Pressure Drop	Average Total Heat of Rejection
100	50	92	4	1	122,000
100	55	92	5	1	122,000
100	60	92	7	1	122,000
100	65	92	8	1	122,000
100	70	93	10	1	122,000
100	75	93	13	2	122,000
100	80	94	18	2	122,000
100	85	94	29	6	122,000
105	90	95	46	11	122,000
110	95	100	50	11	122,000

Table 11-4

03TA Make-up Water Usage (gpm)

Make-up Water Temp. °F	Cylinder Ice		Crushed Ice	
	Tube Size		Tube Size	
	1”	1 ¼”	1”	1 1/4”
40	0.69	0.66	0.71	0.69
50	0.66	0.63	0.68	0.65
60	0.62	0.59	0.65	0.61
70	0.60	0.56	0.62	0.59
80	0.56	0.53	0.59	0.55
90	0.54	0.50	0.56	0.53

Includes 15% Blowdown

Table 11-5

03TA Normal Operating Vitals

			Suction Pressure (psig)		Discharge Pressure (psig)		Harvest Times (sec)			Ice per cycle	Freeze Time (minutes)				
			End of Freeze	End of Thaw	End of Freeze	End of Thaw	First Ice	All Ice Out	Total Harvest	Average (lbs)	Water Temperature (°F)				
											90	80	70	60	50
60 HZ	**CYL**	**1"**	33	70	195	150	15	90	120	64	15.5	14.5	13.4	12.4	11.4
		1 1/4"	32	70	195	150	15	90	120	59	17.9	16.5	15.3	14.3	12.9
	CRU	**1"**	35	70	195	150	15	90	120	48	14.1	13.3	12.5	11.8	11.1
		1 1/4"	34	70	195	150	15	90	120	44	15.8	14.8	14.0	13.2	12.2
50 HZ	**CYL**	**1"**	33	70	195	150	15	90	120	62	15.5	14.5	13.4	12.4	11.4
		1 1/4"	32	70	195	150	15	90	120	57	17.9	16.5	15.3	14.3	12.9
	CRU	**1"**	35	70	195	150	15	90	120	46	14.1	13.3	12.5	11.8	11.1
		1 1/4"	34	70	195	150	15	90	120	43	15.8	14.8	14.0	13.2	12.2

Table 11-6

RECOMMENDED SPARE PARTS LIST

Vogt Model 03TA Tube-Ice® Machine

QTY	PART NUMBER	DESCRIPTION
1	12A-2117E04000000	Freezer pressure switch
1	12A-7503E22000000	Thawing timer
1	12A-7517E18000000	CR Relay, 208/230v, 50/60hz.
1	12A-7516E09000000	PF Contactor, 208/230v, 50/60hz.
1	12A-7530E11000000	CU/P Starter, 208/230v, 50/60hz.
1	12A-7516E22000000	Compressor Contactor, 208/230v, 50/60hz.
1	12A-2900M05080000	Cutter motor, 1/2 HP
2	12A-4200H04010000	Make-up water float valve
1	12B-2020R04000000	Cutter bearing
78	12B-2185N11000000	Water Distributors (1”)
48	12B-2185N21000000	Water Distributors (1 1/4”)
1	12A-2600G01000000	Gasket for freezer cover
1	12A-2600G12000000	Gasket for water tank
1	12A-7509E12000000	Crankcase heater, (Copeland Discus Compressor)
1	12A-7500E22000000	Float Switch
1	12-6229 000000	Coil for Hansen solenoid valve

TO ORDER SPARE PARTS, PLEASE CONTACT YOUR DISTRIBUTOR.

TEMPERATURE - PRESSURE CHART FOR COMMON REFRIGERANTS

DegF	R-12	R-22	R-502	R-134a	MP-39	R-404a	HP-80
-50	-7.6	-3.0	0.2	-9.0	-9.1	0.0	1.2
-48	-7.2	-2.4	0.7	-8.7	-8.7	0.8	2.1
-46	-6.8	-1.7	1.5	-8.3	-8.3	1.6	2.9
-44	-6.3	-1.0	2.3	-8.0	-7.9	2.5	3.9
-42	-5.8	-0.2	3.2	-7.6	-7.4	3.4	4.9
-40	-5.4	0.5	4.1	-7.1	-7.1	5.5	5.9
-38	-4.9	1.3	5.0	-6.7	-6.6	6.5	6.9
-36	-4.4	2.2	6.0	-6.3	-6.1	7.5	8.0
-34	-3.8	3.0	7.0	-5.8	-5.6	8.6	9.2
-32	-3.3	4.0	8.1	-5.3	-5.2	9.7	10.3
-30	-2.7	4.9	9.2	-4.8	-4.4	10.8	11.6
-28	-2.1	5.9	10.3	-4.2	-4.1	12.0	12.8
-26	-1.5	6.9	11.5	-3.8	-3.4	13.2	14.1
-24	-0.8	7.9	12.7	-3.0	-2.9	14.5	15.5
-22	-0.1	9.0	14.0	-2.4	-2.2	15.8	16.9
-20	0.6	10.1	15.3	-1.8	-1.7	17.1	18.4
-18	1.3	11.3	16.7	-1.1	-1.0	18.5	19.9
-16	2.1	12.5	18.1	-0.4	-0.2	20.0	21.5
-14	2.8	13.8	19.5	0.3	0.4	21.5	23.1
-12	3.7	15.1	21.0	1.1	1.4	23.0	24.8
-10	4.5	16.5	22.6	1.9	2.2	24.6	26.5
-8	5.4	17.9	24.2	2.8	3.1	26.3	28.3
-6	6.3	19.3	25.8	3.6	3.9	28.0	30.2
-4	7.2	20.8	27.5	4.5	4.8	29.8	32.1
-2	8.2	22.4	29.3	5.5	5.7	31.6	34.1
0	9.2	24.0	31.1	6.5	6.7	33.5	36.1
2	10.2	25.6	32.9	7.5	7.7	35.6	38.1
4	11.2	27.3	34.9	8.5	8.8	37.4	40.4
6	12.3	29.1	36.9	9.6	9.9	39.4	42.6
8	13.5	30.9	38.9	10.8	11.0	41.6	44.9
10	14.6	32.8	41.0	12.0	12.2	43.9	47.3
12	15.8	34.7	43.2	13.1	13.4	46.0	49.7
14	17.1	36.7	45.4	14.4	14.6	48.3	52.2
16	18.4	38.7	47.7	15.7	15.9	50.7	54.8
18	19.7	40.9	50.0	17.0	17.2	53.1	57.5
20	21.0	43.0	52.5	18.4	18.6	55.6	60.2
22	22.4	45.3	54.9	19.9	20.0	58.2	63.0
24	23.9	47.6	57.5	21.4	21.5	59.9	65.9
26	25.4	49.9	60.1	22.9	23.0	63.6	68.9
28	26.9	52.4	62.8	24.5	24.6	66.5	72.0
30	28.5	54.9	65.6	26.1	26.2	69.4	75.1
32	30.1	57.5	68.4	27.8	27.9	72.3	78.3
34	31.7	60.1	71.3	29.5	29.6	75.4	81.6
36	33.4	62.8	74.3	31.3	31.3	78.5	85.0
38	35.2	65.6	77.4	33.2	33.2	81.8	88.5
40	36.9	68.5	80.5	35.1	35.0	85.1	92.1
42	38.8	71.5	83.8	37.0	37.0	88.5	95.7
44	40.7	74.5	87.0	39.1	39.0	91.9	99.5
46	42.7	77.6	90.4	42.0	41.0	95.5	103.4
48	44.7	80.7	93.9	43.3	43.1	99.2	107.3
50	46.7	84.0	97.4	45.5	45.3	102.9	111.4

DegF	R-12	R-22	R-502	R-134a	MP-39	R-404a	HP-80
50	46.7	84.0	97.4	45.5	45.3	102.9	111.4
52	48.8	87.3	101.0	47.7	60.0	109.0	120.0
54	51.0	90.8	104.8	50.1	62.0	113.0	124.0
56	53.2	94.3	108.6	52.3	65.0	117.0	129.0
58	55.4	97.9	112.4	55.0	68.0	121.0	133.0
60	57.7	101.6	116.4	57.5	70.0	125.0	138.0
62	60.1	105.4	120.4	60.1	73.0	130.0	142.0
64	62.5	109.3	124.6	62.7	76.0	134.0	147.0
66	65.0	113.2	128.8	65.5	79.0	139.0	152.0
68	67.6	117.3	133.2	68.3	82.0	144.0	157.0
70	70.2	121.4	137.6	71.2	85.0	148.0	162.0
72	72.9	125.7	142.2	74.2	89.0	153.0	168.0
74	75.6	130.0	146.8	77.2	92.0	158.0	173.0
76	78.4	134.5	151.5	80.3	95.0	164.0	179.0
78	81.3	139.0	156.3	83.5	99.0	169.0	184.0
80	84.2	143.6	161.2	86.8	102.0	174.0	190.0
82	87.2	148.4	166.2	90.2	106.0	180.0	196.0
84	90.2	153.2	171.4	93.6	109.0	185.0	202.0
86	93.3	158.2	176.6	97.1	113.0	191.0	208.0
88	96.5	163.2	181.9	100.7	117.0	197.0	214.0
90	99.8	168.4	187.4	104.4	121.0	203.0	220.0
92	103.1	173.7	192.9	108.2	125.0	209.9	227.0
94	106.5	179.1	198.6	112.1	129.0	215.0	234.0
96	110.0	184.6	204.3	116.1	133.0	222.0	240.0
98	113.5	190.2	210.2	120.1	138.0	229.0	247.0
100	117.2	195.9	216.2	124.3	142.0	235.0	254.0
102	120.9	201.8	222.3	128.5	146.0	242.0	261.0
104	124.7	207.7	228.5	132.9	151.0	249.0	269.0
106	128.5	213.8	234.9	137.3	156.0	256.0	276.0
108	132.4	220.0	241.3	142.8	160.0	264.0	284.0
110	136.4	226.4	247.9	146.5	165.0	271.0	292.0
112	140.5	232.8	254.6	151.3	170.0	279.0	299.0
114	144.7	239.4	261.5	156.1	175.0	286.0	307.0
116	148.9	246.1	268.4	161.1	180.0	294.0	316.0
118	153.2	252.9	275.5	166.1	185.0	302.0	324.0
120	157.7	259.9	282.7	171.3	191.0	311.0	332.0
122	162.2	267.0	290.1	176.6	196.0	319.0	341.0
124	166.7	274.3	297.6	182.0	202.0	328.0	350.0
126	171.4	281.6	305.2	187.5	207.0	336.0	359.0
128	176.2	289.1	312.9	193.1	213.0	345.0	368.0
130	181.0	296.8	320.8	198.9	219.0	354.0	377.0
132	185.9	304.6	328.9	204.7	225.0	364.0	387.0
134	191.0	312.5	337.1	210.7	231.0	373.0	396.0
136	196.2	320.6	345.4	216.8	237.0	383.0	406.0
138	201.3	328.9	353.9	223.0	243.0	392.0	416.0
140	206.6	337.3	362.6	229.4	250.0	402.0	426.0
142	212.0	345.8	371.4	235.8	256.0	412.0	436.0
144	217.5	354.5	380.4	242.4	263.0	423.0	447.0
146	223.1	363.4	389.5	249.2	269.0	434.0	458.0
148	228.8	372.3	398.9	256.0	277.0	444.0	468.0
150	234.6	381.5	408.4	263.0	283.0	449.0	479.0

TABLE 11-7

All pressures are in lbs/in^2 gage (psig).

REFERENCE INFORMATION

CONVERSION FACTORS: English to Metric

To Convert	From	To	Multiply by
Area	ft^2	m^2	9.2903e-2
	in^2	m^2	6.416 e-4
Energy	BTU	Joule (J)	1054.48
	Hp	BTU/Hr	2546.2
	kW	hp	1.34
Length	ft.	m.	0.3048
	in.	m.	0.0254
Pressure	lbf/ft^2	Pa	47.88
	lbf/in^2 (psi)	Pa	6894.76
	in. Hg	psi	0.491
	in H_2O	psi	0.03612
Temperature	?F	?C	$T_C=5/9*(T_F - 32)$
	?C	?F	$T_F=(9/5*T_C) + 32$
Volume	ft^3	m^3	2.8317e-2
	gal(U.S.)	m^3	3.7854e-3
	ft^3	gal(U.S.)	7.48

TABLE 11-8

CONSTANTS

Specific heat of Water	1 BTU/(lbm ?F)
Specific heat of Air	4.19 kJ/(kg ?C) 0.24 BTU/(lbm ?F)
Tube-Ice Density	32-35 lbs/ft^3
Ice Latent Heat	144 BTU/hr
Water Sensible Heat	1 BTU/(lb ?F)
Ice Melting Effect (IME) 1 Ton Refrigeration	12,000 BTU/hr
Atmospheric pressure	14.7 psia
Weight of Water	62.4 lbs/ft^3 8.33 lbs/gal
1 gpm water	12013 lb/day
Weight of air	0.0749 lbs/ft^3 0.0100 lbs/gal
1 Horsepower	2545.6 BTU/hr
1 Kilowatt	1.34 horsepower
Gravitational acceleration	9.81 m^2/sec

TABLE 11-9

12. Index

INDEX

V

W

X

Y, Z