

Hermetic Absorption Liquid Chillers

GENERAL

Standard 16JB machines are available for either steam or hot water application. Steam machines are available with either electronic or pneumatic controls. Hot water machines have pneumatic controls only.

Application of piping and system controls can be found in 16JB Application Data.

The following description of the electronic system applies to steam machines only. The pneumatic system applies to both steam and hot water machines.

Electronic Capacity Control — The capacity control valve is positioned by an electronically amplified signal to the valve motor actuator. A resistance chilled water thermostat signals the amplifier.

Pneumatic Capacity Control — The capacity control valve is positioned by a pneumatic operator which is controlled by a pneumatic thermostat.

Power Supply — Standard pump motors are rated at 208 thru 240 v or 416 thru 480 v (dual voltage), 60-Hz. Motors will operate satisfactorily at 10% above or 10% below nameplate voltage. If motor connections are field changed for higher or lower voltage, their factory-installed heaters and fuses must also be changed. Special motors are available for 550 thru 575 v and 600 v.

Control Circuit Power — Factory-supplied, multi-tap, 500-va control circuit transformer enables control power to be adjusted to 120 v from any primary voltage sources of 190 thru 600 v. The available power required for field connection of chilled water and condensing water pump starters and other auxiliaries is as follows: machine sizes 010 thru 068 have available 2100-va inrush, 300-va sealed; machine sizes 077 thru 124 have available 1900-va inrush, 250-va sealed.

Chilled Water Temperature Control — Capacity control valve operates thru a throttling range that allows leaving chilled water temperature (LCWT) to change in proportion to load changes. For example, with machine set up for 45 F LCWT and 3 F throttling range, LCWT will drop to 42 F at no load. Usually, a 3 F throttling range will provide good control without "hunting." For precise chilled water temperature control where 3 F throttling range is not satisfactory, the system may require additional storage volume to provide finer control.

Systems having large storage volumes of chilled water circulating thru the refrigeration machine transmit load changes slowly, making accurate chilled water temperature control relatively easy.

Small storage systems transmit load changes rapidly, making precise temperature control more difficult. For precise control, the chilled water system volume should be at least 10 times the design gpm flow thru the cooler. If a tank is added for extra storage volume, locate in the line from load to cooler.

SAFETY CONTROLS

The machine and chilled water system are protected by low-temperature cutouts, chilled water and condensing water pump interlocks, and automatic dilution cycle controls.

Low-Temperature Cutout — Cutout is field adjusted to open on low refrigerant temperature. When cutout opens, all pumps (except chilled water) stop, and capacity control valve closes immediately.

Chilled Water Interlock — Chilled water circuit should be interlocked with machine controls to ensure a flow of chilled water during machine operation. A chilled water flow switch is recommended. When flow switch opens, the capacity control valve closes and all machine pumps stop immediately.

Condensing Water Interlock — Condensing water circuit should be interlocked with machine controls to ensure condensing water flow during machine operation. A condensing water flow switch is recommended. When the flow switch opens, the capacity control valve closes.

Automatic Dilution Cycle — When machine is stopped by opening the START-STOP switch, the capacity control valve closes, but power is maintained to all pump starters through the shutdown dilution switch. The Cycle-Guard™ opens to dilute the solution. As the solution becomes more dilute, the evaporator level drops until a predetermined level is reached; the dilution switch opens and the machine shuts down.

MULTIPLE MACHINE CONTROL

Multiple machine installations generally fall into 2 main categories: (1) machines with chilled water flowing thru their coolers connected in series and (2) machines with chilled water flowing thru their coolers connected in parallel. In either case, their condensers are normally piped in parallel.

Coolers in Parallel — Capacity of each machine is controlled by a temperature controller (resistance element or pneumatic thermostat) located in its own leaving chilled water line.

Coolers in Series — The most efficient operation of machines connected in series results when each machine handles an equal proportion of the total load. This is accomplished by setting the throttling range of the high-side machine equal to the full load chilled water temperature rise of the low-side machine plus the low-side throttling range.

Example:

Design leaving chilled water temperature

High-side machine = 47 F

Low-side machine = 42 F

Chilled water temperature rise

Low-side machine = 47 F - 42 F = 5 F

Throttling Range

Low-side machine (normal) = 3 F

High-side machine setting = 5 F + 3 F = 8 F

CONTROL SYSTEM OPERATION

(Refer to Fig. 1 and 2)

Starting Sequence — Before start-up, the following switches should be at "On" or "Auto." position: Cycle-Guard™ switch (SW2), Solution Pump switch (SW3), Refrigerant Pump switch (SW4) and Capacity Control switch (SW5). All necessary safeties must be closed.

At initial start-up, with the START-STOP switch (SW1) in "Stop" position, the manual RESET switch (SW12) must be depressed momentarily. This momentary "On" condition energizes the HR4 holding relay, causing 2 sets of normally open HR4 contacts to close. One set of contacts is in the HR4 relay circuit, with the low-temperature cutout (LTCO). The other set of contacts is in the control circuit.

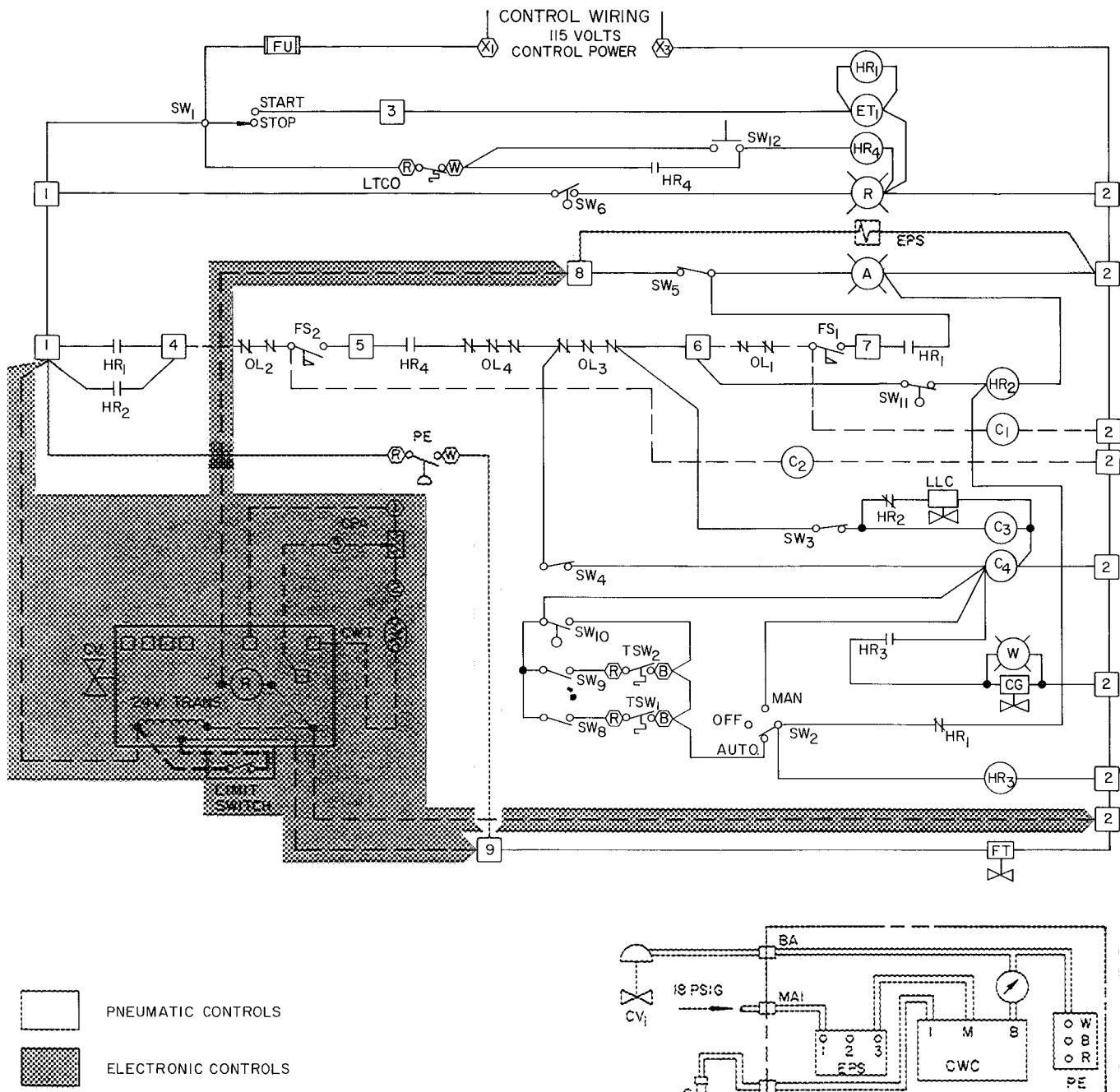
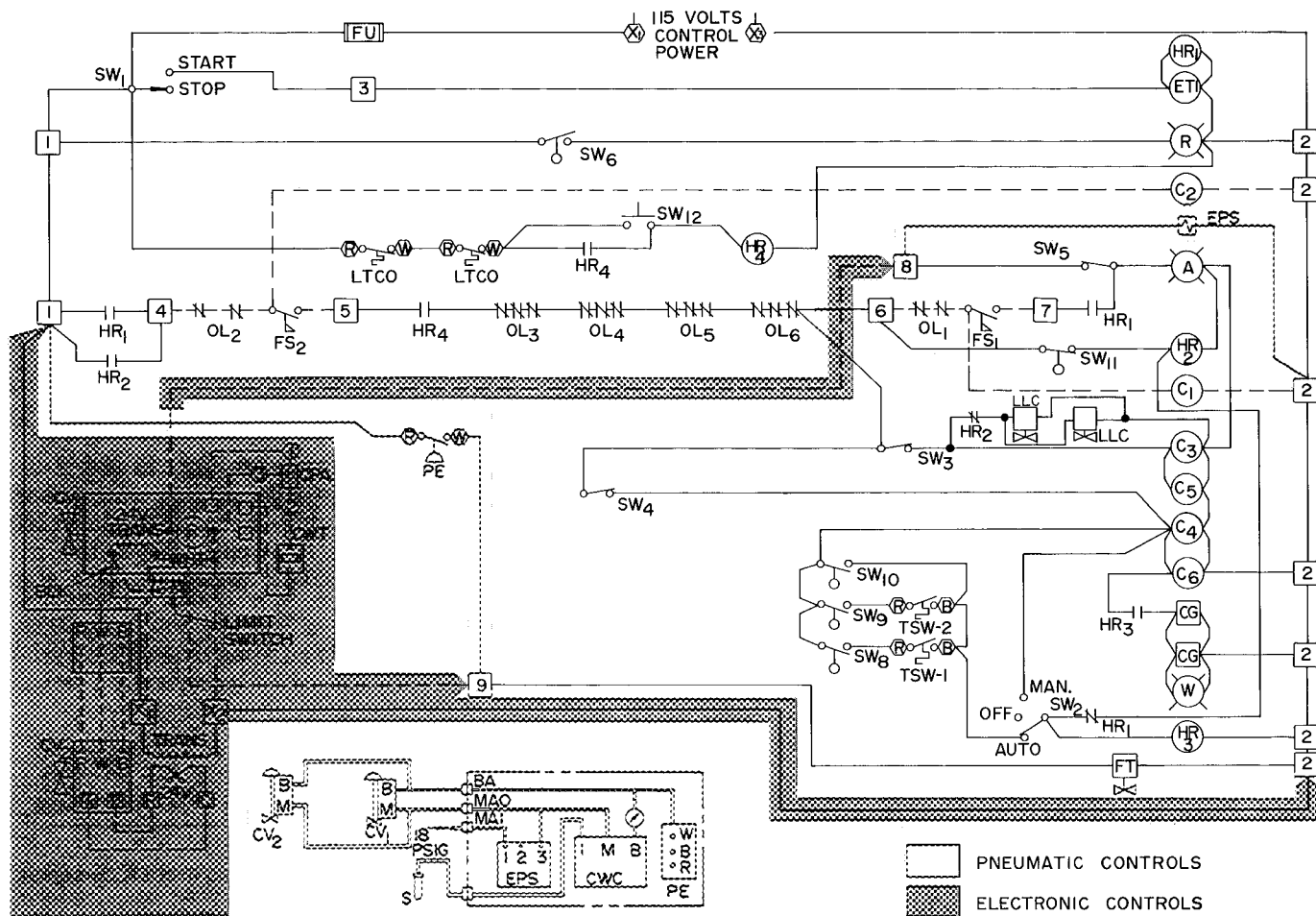


Fig. 1 — Pneumatic and Electronic Control Systems (16JB010 thru 068)

The control circuit can now be energized by placing the START-STOP switch (SW1) in "Start" position. This energizes the main holding relay (HR1) and the elapsed time indicator (ET1). Two sets of normally open HR1 contacts close and one set of normally closed contacts open. Now the control circuit is complete thru the chilled water pump starter (C2). The pump starts and flow

switch FS2 closes. The refrigerant, solution and condenser water pumps all start. Condenser water flow switch (FS1) closes and the capacity control valve is energized. The capacity control valve is modulated either by electronic or pneumatic control in response to leaving chilled water temperature changes, matching machine capacity to load. The machine is now in normal operation.



LEGEND
(For Fig. 1 and 2)

- | | | |
|--|--|---|
| Auto. — Automatic | ET1 — Elapsed Time Indicator | SW4 — Refrigerant Pump Switch |
| BA — Branch Air | FS1 — Condensing Water Flow Switch | SW5 — Capacity Control Switch |
| C1 — Condensing Water Pump Starter | FS2 — Chilled Water Flow Switch | SW6 — Purge Level Switch |
| C2 — Chilled Water Pump Starter | FT — Flotender™ | SW8 — |
| C3 — Solution Pump Contactor (no 1 on 077-124) | FU — Fuse | SW9 — |
| C4 — Refrigerant Pump Contactor (no 1 on 077-124) | HR — Holding Relay | SW10 — |
| C5 — Solution Pump Contactor (no 2 on 077-124) | LLC — Low Level Control | SW11 — Low-Level and Dilution Switch |
| C6 — Refrigerant Pump Contactor (no 2 on 077-124) | LTCO — Low-Temperature Cutout | SW12 — Reset Switch (momentary) |
| CG — Cycle-Guard™ | MAI — Main Air In | TSW — Thermo Switch (1 and 2) |
| CPA — Control Point Adjuster | MAO — Main Air Out | □ Terminal on Control Panel |
| CV — Capacity Control Valve | Man. — Manual | □ Terminal Strip |
| CWC — Chilled Water Controller | OI — Overload (OL1 - OL6 with C1 - C6 respectively) | ○ Component Connections (Marked) |
| CWT — Chilled Water Thermostat | PE — Pneumatic-Electric Switch | ○ Run Light |
| EPS — Electric-Pneumatic Switch | S — Sensor, Chilled Water | ○ Exhaust Purge Light |
| | SW1 — Start-Stop Switch | ○ Cycle-Guard Light |
| | SW2 — Cycle-Guard Switch | |
| | SW3 — Solution Pump Switch | |

Fig. 2 — Pneumatic and Electronic Control Systems (16JB077 thru 124)

The RESET switch must be depressed again only after interruption of main power, or after a low-temperature cutout.

Cycle-Guard™ Controls — A proprietary feature of the 16JB is complete control of solution concentration. This is done by sensing 3 upper levels of refrigerant in the evaporator; the intermediate level (SW9) and low-level (SW8) switches are in series with solution temperature thermostats. As the lithium-bromide (LiBr) solution becomes highly concentrated, refrigerant level in the evaporator will rise and the high-level switch (SW10) will close to energize holding relay HR3. Normally-open HR3 contacts close to energize Cycle-Guard (CG). Cycle-Guard opens to bypass water from refrigerant pump discharge to solution pump suction. When refrigerant drops to a safe level, SW10 opens to de-energize HR3 and Cycle-Guard closes. The controls operate in the same manner for the other 2 refrigerant levels except that a solution temperature is also sensed at each level.

When the START-STOP switch is pressed to "Stop," HR1 relay is de-energized. Two sets of HR1 contacts open and one set closes. This energizes HR3 relay and Cycle-Guard opens. Holding relay HR2 remains energized thru dilution switch (SW11) and power is maintained to the control circuit thru HR2 contacts. Refrigerant is bypassed into the LiBr solution, thus diluting the solution and lowering the refrigerant level in the evaporator. At a predetermined level, SW11 opens and the machine shuts down.

Low Level Control (LLC) — A second proprietary feature of the 16JB is complete control of the minimum level of refrigerant in the evaporator to prevent refrigerant pump cavitation at light loads, and to permit continuous machine operation with entering condenser water temperatures as low as 45 F. This is accomplished by the low-level and dilution switch (SW11). When the refrigerant drops to a predetermined level, normally closed SW11 opens; the Low Level Control (LLC) valve opens and a small quantity of weak solution is transferred to the refrigerant pump inlet. This ensures sufficient flow to the refrigerant pump to allow continuous safe operation. When the refrigerant in the evaporator returns to a safe level, SW11 closes and the LLC valve closes.

Part Load (For Sizes 010 thru 068) — At approximately 50% load, solution flow to the generator is throttled by Carrier's Flotender™ which is actuated thru the capacity control valve.

PNEUMATIC CONTROLS — As the load on the machine is reduced, chilled water temperature drops; branch air pressure decreases and capacity control valve (CV) closes. At a predetermined air pressure, corresponding to approximately 50% load, the pressure-electric (PE) switch opens and the Flotender is deactivated. Solution flow to the generator is throttled and steam consumption is reduced.

ELECTRONIC CONTROLS — As load decreases and chilled water temperature drops, chilled water

thermostat resistance increases and capacity control valve (CV) closes. At approximately 50% load, a limit switch is tripped deactivating the Flotender. Flow of weak solution to the generator is throttled and steam consumption is reduced.

Part Load (For Sizes 077 thru 124) — At part load, both steam valves operate simultaneously. The Flotender throttles flow of weak solution to the generator to increase part load economy.

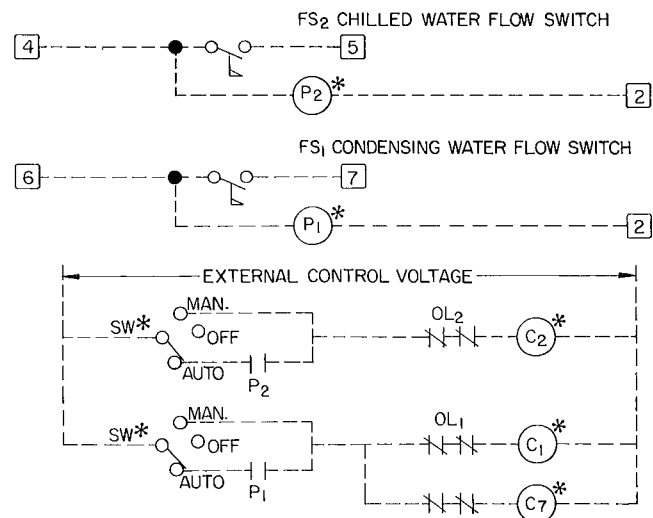
PNEUMATIC CONTROLS — As load is reduced and chilled water temperature drops, branch air pressure decreases and both capacity control valves close simultaneously. At a predetermined setting (approximately 50% load), pressure-electric (PE) switch opens and the Flotender is deactivated.

ELECTRONIC CONTROLS — As load is reduced and chilled water temperature drops, the chilled water thermostat resistance increases and both capacity control valves close simultaneously. At a predetermined point (approximately 50% load), a limit switch is tripped and the Flotender is deactivated. Flow of weak solution to the generator is throttled and steam consumption is reduced.

START-STOP OPERATION

Control systems shown in Fig. 1 and 2 are semiautomatic start-stop with chilled water pump and condensing water pump starters wired directly into the machine control circuit. When the machine is started manually, auxiliaries will start automatically.

Start-stop operation may be modified as follows (Fig. 3, 4, 5):



*Field supplied

See Legend on Fig. 1

P₁, P₂ — Pilot Relays

C₇ — Auxiliary Equipment Starter (Cooling Tower, etc)

NOTE:

Use this wiring in place of field wiring (for pump motors) shown in Fig. 1 and 2

Fig. 3 — Semiautomatic Start-Stop With Pilot Relays

Semiautomatic Start-Stop With Pilot Relays – When the machine is started manually, its auxiliaries will start automatically. If power requirements of chilled water pump and condensing water pump starters (or other auxiliary equipment) exceeds control circuit limitations, pilot relays may be used as shown in Fig. 3.

Semiautomatic Start-Stop With Manual Auxiliaries – The machine and its auxiliaries are started manually. Auxiliaries must be started before the machine will start. Modifications to Fig. 1 and 2 are shown in Fig. 4.

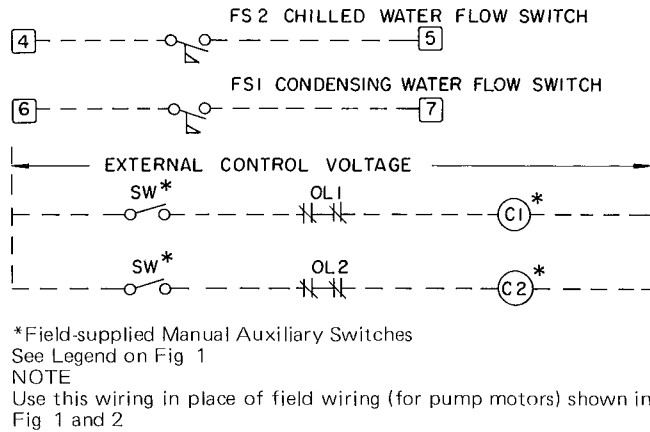


Fig. 4 – Semiautomatic Start-Stop With Manual Auxiliary Switches

Automatic Start-Stop – The machine and its auxiliaries are started automatically by a field-supplied thermostat or timer. Modifications to Fig. 1 and 2 are shown in Fig. 5.

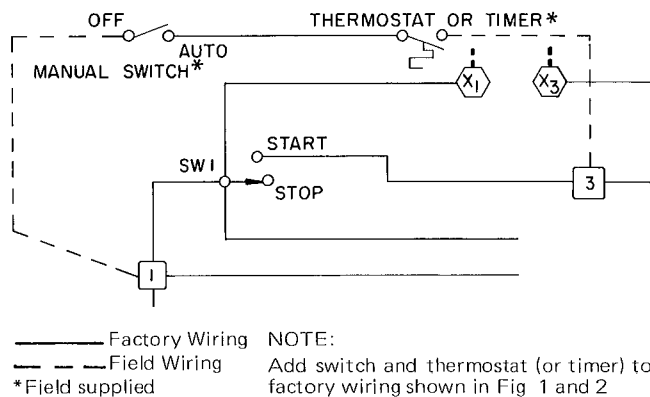


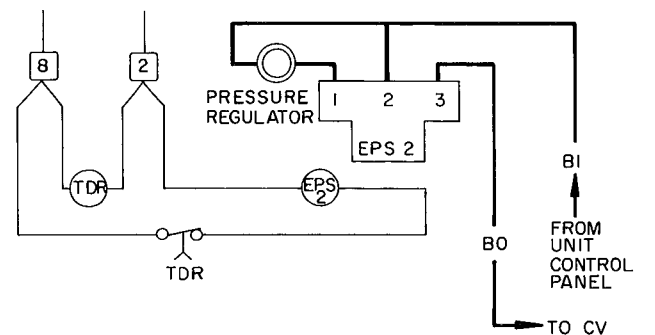
Fig. 5 – Automatic Start-Stop

STEAM DEMAND LIMIT CONTROL

If steam demand exceeds boiler capacity, it may be necessary to limit the demand by modifying the control system. This can be done with a factory-installed limit control or with a field-installed control. The condition may occur at start-up only or during machine operation, including start-up. The following modifications cover both pneumatic and electronic control systems.

At Start-Up Only PNEUMATIC CONTROLS

1. Factory-Installed Control (see Fig. 6) includes a variable time-delay relay (TDR), an electric-pneumatic relay (EPS2) and a variable pneumatic pressure regulator, with interconnecting tubing. The TDR may be set for a time delay from one to 30 minutes. The variable pressure regulator can be adjusted to have from 1% to 100% of full branch air pressure at the capacity control valve. The combined effect of the TDR setting and the reduced branch air pressure can control the initial steam surge at start-up to within 100% to 120% of design full load steam rate.

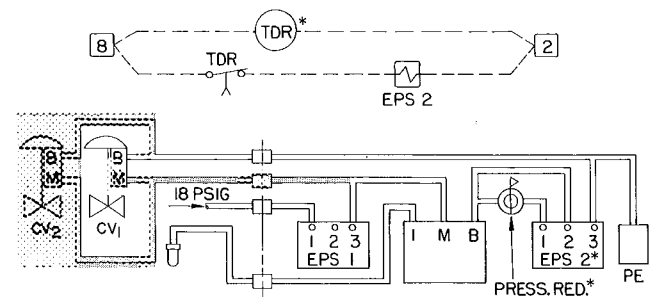


BI – Branch Air In
BO – Branch Air Out
CV – Capacity Control Valve

Wiring
Pneumatic Lines

→ **Fig. 6 – Factory-Wired Steam Demand Limit Control For Pneumatic Control System, Start-Up Only**

2. Field modification to obtain steam demand limit control consists of adding to the factory wiring a time-delay relay (TDR) and a second electric-pneumatic switch (EPS2). Also, a variable pressure regulator is added to the factory pneumatic piping and the piping is extended to include EPS2. See Fig. 7.



16JB077 thru 124 only

*Field supplied
See Legend on Fig. 1

NOTES

- 1 Add TDR and EPS2 to factory wiring shown in Fig. 1 and 2
- 2 Add pressure reducer and EPS2 to factory-installed pneumatic piping shown in Fig. 1 and 2
- 3 Typical EPS2: Honeywell RP403E1006.
Typical pressure reducer: Honeywell SP93A-1005
Typical TDR: Carrier HN67XJ012, or ATC319A016QIX, 20 min

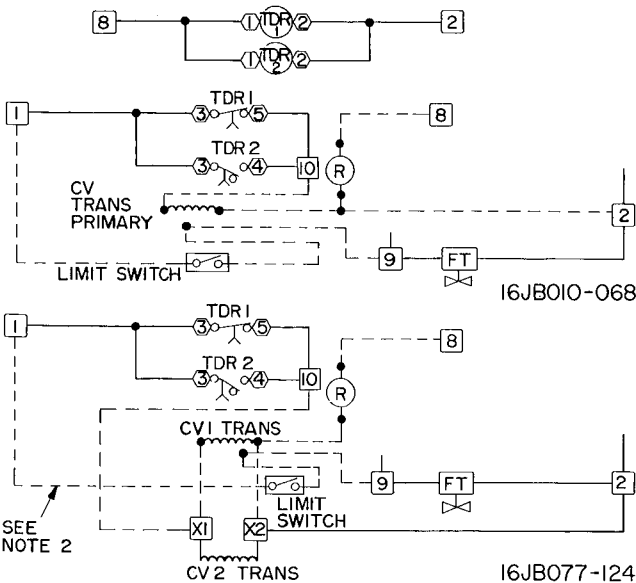
→ **Fig. 7 – Steam Demand Limit Control For Pneumatic Control System, Start-Up Only**

For factory and field installations:

When the machine starts, TDR and EPS2 are energized. Port no. 2 of EPS2 is closed. The branch air signal to the capacity control valve (CV) passes thru the pressure regulator and port no. 1 of EPS2. Reduced pressure limits the opening of CV. After a time interval, TDR contacts open and EPS2 is de-energized; port no. 1 closes and no. 2 opens. Branch air signal can now bypass the pressure regulator and actuate CV as required.

ELECTRONIC CONTROLS – Fig. 8 shows 2 factory-installed time-delay relays (TDR1 and TDR2), with the necessary field wiring to complete the hook-up. Fig. 9 is the wiring for field-supplied relays.

When machine starts, TDR1 and TDR2 are energized. Normally-closed TDR1 contacts remain closed for several seconds, allowing capacity control valve (CV) to partly open. When TDR1 contacts open, CV remains in the partly open position; this limits steam demand until normally-open TDR2 contacts close. Timer settings are determined by job requirements.



TDR – Time-Delay Relay
 Terminal on Control Panel Terminal Strip
 ——— Factory Wiring
 - - - - - Field Wiring

Also see Legend on Fig. 1

NOTES:

1. Except as shown, field wiring is same as in Fig. 1 and 2
2. On 16JB077 - 124 units, disconnect at X1 the factory wire running from unit terminal 1, and reconnect to limit switch as shown.

→ **Fig. 8 – Factory-Installed Steam Demand Limit Control For Electronic Control System, Start-Up Only**

At Start-Up and During Operation

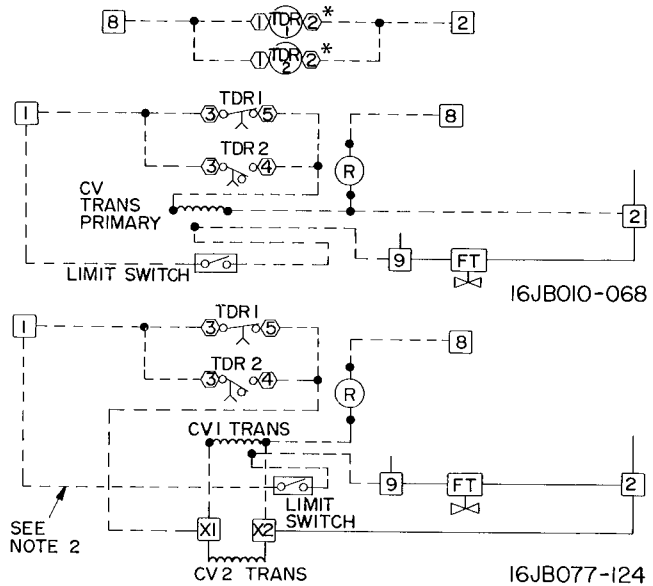
PNEUMATIC CONTROLS – Steam demand can be limited by using either on-off or modulating control of the capacity control valve (CV).

For on-off control, refer to Fig. 10. When machine is started, CV opens if added pressure-electric switch (PE) is closed. If supply steam pressure drops to PE cutout setting, CV closes to

limit steam demand. Cutout setting is determined by job requirements.

For modulating control, refer to Fig. 11. Branch air signal to CV is modulated by the added pressure controller whenever supply steam pressure is below the control point. A decrease in steam pressure causes the CV to partly close and limit steam demand. Pressure controller throttling range is determined by job requirements.

ELECTRONIC CONTROLS – Steam demand can be limited by on-off control of capacity control valve. Refer to Fig. 12. Operation is identical to on-off control for pneumatic controls.

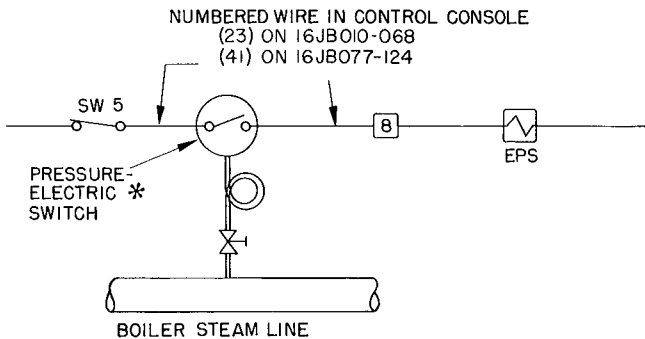


*Field supplied.
TDR – Time-Delay Relay
 Terminal on control panel terminal strip
 ——— Factory Wiring
 - - - - - Field Wiring
 Also see Legend on Fig. 1

NOTES

1. Except as shown, field wiring is same as in Fig. 1 and 2
2. On 16JB077 - 124 units, disconnect at X1 the factory wire running from unit terminal 1, and reconnect to limit switch as shown.

Fig. 9 – Field-Installed Steam Demand Limit Control For Electronic Control System, Start-Up Only

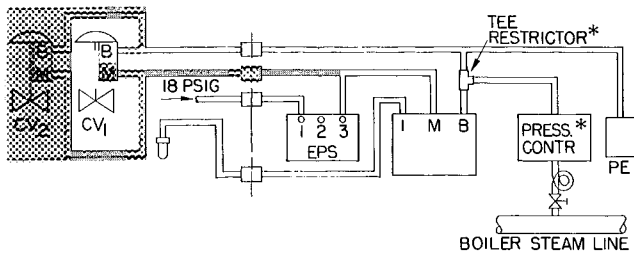


*Field supplied. See Legend on Fig. 1

NOTES:

1. Add pressure-electric sw to factory wiring shown in Fig. 1 and 2
2. Typical pressure-electric sw: Honeywell L404B1296 (2 - 15 psig)

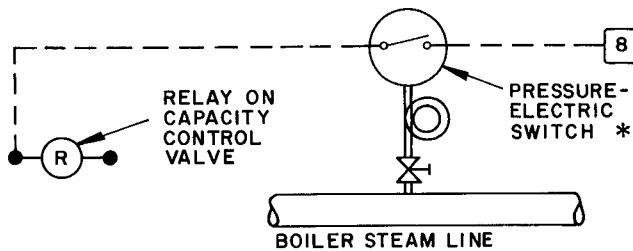
Fig. 10 – Steam Demand Limit Control For Pneumatic Control System, On-Off Control



16JB077 thru 124 only. *Field-supplied. See Legend on Fig. 1
NOTES:

1. Add pressure controller and tee restrictor to factory-installed pneumatic piping shown in Fig. 1 and 2
2. Typical pressure controller Honeywell PP97A

→ Fig. 11 — Steam Demand Limit Control For Pneumatic Control System, Modulating Control



*Field-supplied See Legend on Fig. 1

NOTES:

1. Use this wiring in place of field wiring from machine terminal 8 to relay on capacity control valve shown in Fig. 1 and 2
2. Typical pressure-electric sw: Honeywell L404B1296 (2 - 15 psig).

Fig. 12 — Steam Demand Limit Control For Electronic Control System, On-Off Control

EXPLOSION-PROOF MACHINES

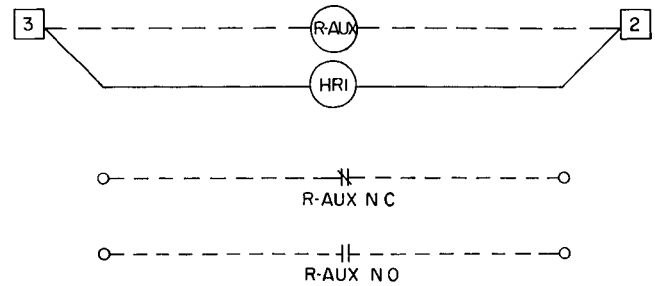
Machines with pneumatic control systems can be factory equipped, on special order, with explosion-proof motors for refrigerant and solution pumps, and electrical controls suitable for NEC Class 1, Group D, Div 2 hazardous locations. *The motor starters, disconnect switch and control transformer must be field supplied. These components must be field wired to the control panel.*

An explosion-proof control panel includes: A START-STOP switch and a RESET switch, holding relays, purge light, run light, Cycle-Guard™ switch, and provision for automatic start-stop operation. Pneumatic capacity control switch furnished with the standard panel. Explosion-proof Cycle-Guard, located outside the control panel, must be field wired to the panel. Cycle-Guard controls and purge level switches are furnished for explosion-proof duty.

SPECIAL PANEL WIRING

Application details cover special controls and control panels that may be connected to the standard 16JB panels. In the following electrical connection diagrams, the numbered terminals are those shown in the control wiring in Fig. 1 and Fig. 2. Subjects covered are Auxiliary Contacts, Alarm Circuits (single and multiple), Lead-Lag Controls, Emergency Power.

Auxiliary Contacts — Applications requiring auxiliary contacts, for use with remote panels, can be furnished for field connections. The panel wiring may be factory or field assembled. Fig. 13 shows the schematic for this option.



R-AUX — Relay-Auxiliary

NOTES

1. Add R-AUX to factory wiring (Fig. 1 and 2)
2. Typical R-AUX:
Carrier No. HN61ZL010
Barber-Coleman CYZP-442

Fig. 13 — Auxiliary Contacts

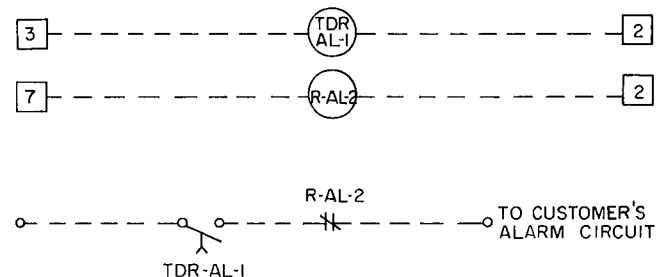
Alarm Circuits

SINGLE ALARM, ANY SAFETY DEVICE — Applications requiring one common alarm when any machine safety device is de-energized can be factory or field wired. Fig. 14 shows the schematic applicable for this device. The sequence of operation for this system is as follows:

Start-Up — TDR-AL-1 is energized and the contacts remain open momentarily so the alarm will not energize. R-AL-2 is energized and opens normally closed contacts. TDR-AL-1 contacts close after 10 seconds.

Operation — Safety device opens; R-AL-2 is de-energized and contacts close. Alarm sounds and TDR-AL-1 contacts remain closed.

Normal Operation — Machine is de-energized and TDR-AL-1 de-energizes. R-AL-2 is energized during the dilution cycle and de-energizes after the cycle is complete.



R-AL — Relay (Alarm)

TDR-AL — Time-Delay Relay (Alarm)

NOTES:

1. Add TDR-AL-1 and R-AL-2 to factory wiring shown in Fig. 1 and 2
2. Typical TDR-AL-1:
Carrier HN67FK003
Syracuse Electronics TIR-115A-10-2
Typical R-AL-2:
Carrier HN61ZL010
Barber-Coleman CYZP-442

Fig. 14 — Alarm Circuit — Single Alarm, Any Safety

SINGLE ALARM – INDIVIDUAL SAFETY DEVICES – For applications which require a factory-installed alarm system with individual safety identification, these controls are available on special order. Contact your local Carrier representative when this option is required.

Lead-Lag Controls – Multiple-machine installations may require a lead-lag starting procedure. This may be accomplished with a factory panel or one field fabricated. Fig. 15 shows the recommended connections for providing this control.

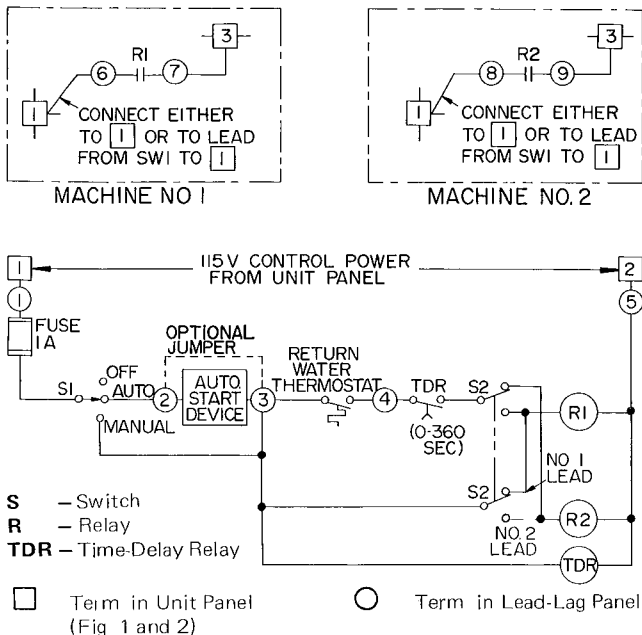


Fig. 15 – Lead-Lag Schematic

Emergency Power

DILUTION ONLY – For applications where emergency power is available on a limited basis, it may be utilized for dilution purposes in the event of a power failure.

Condenser water and chilled water pumps are not connected to emergency power.

Fig. 16A shows the control connections

Sequence of Operation – Power failure occurs and emergency power is energized. Relay R-1 energizes, closing normally open R-1 contacts. Time-delay relay TDR-1 is energized and after the delay interval, TDR-1 contacts open. HR1 de-energizes and the dilution cycle starts; machine dilutes and shuts off. When emergency power is de-energized, reset switch SW12 must be pressed for resumption of normal operation.

EMERGENCY POWER OPERATION – For applications where emergency power is available for machine operation, an automatic control for restarting is required. Fig 16B shows the recommended connections for this operation.

Sequence of Operation – Power failure occurs and emergency power is energized. Relays TDR-1 and R-1 energize, closing normally open R-1 contacts. Relay HR4 energizes and machine starts. After the

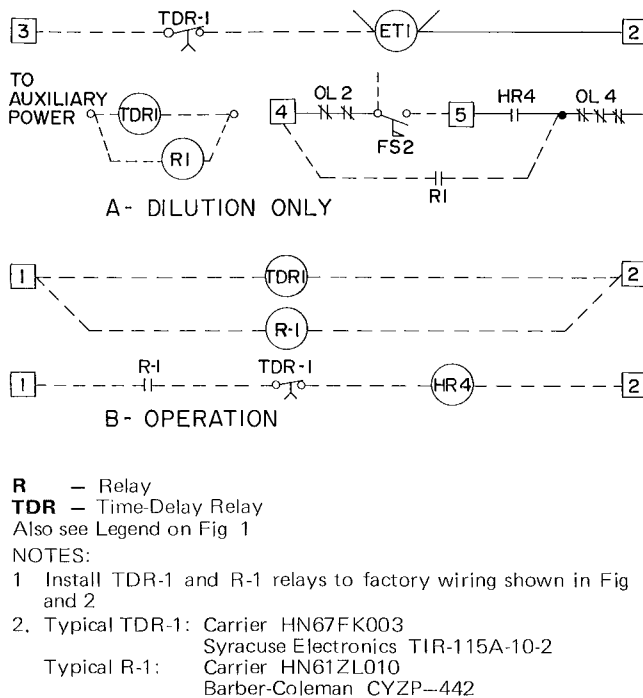


Fig. 16 – Emergency Power Connections

delay interval, TDR-1 contacts open. When normal power is restored, the sequence is repeated. When the low temperature cutout (LTCO) de-energizes, reset switch SW12 must be reset regardless of power source.

Automatic Start-Up After Power Interruption – In applications where automatic start-up after power interruption is required without defeating the function of the required safety devices, the necessary controls can be factory or field assembled. Fig. 17 shows the connections for this option.

Sequence of Operation – Power to main terminal block is interrupted and all control components are de-energized. Power is restored to main terminal block. Relays TDR and HR4 are energized and machine starts. After the delay interval, TDR contacts open and the machine is in normal operation, fully protected by the safety devices.

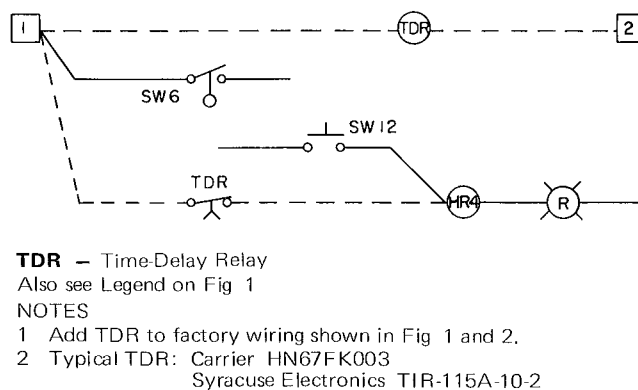


Fig. 17 – Automatic Start-Up After Power Interruption

Manufacturer reserves the right to change any product specifications without notice.

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