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DOE/NASA CONTRACTOR
REPORT

DOE/NASA CR-161355

INSTALLATION GUIDELINES FOR SOLAR HEATING SYSTEM,
SINGLE-FAMILY RESIDENCE AT NEW CASTLE, PENNSYLVANIA

Prepared from documents furnished by

Honeywell, Inc.
Energy Resources Center
2600 Ridgway Parkway
Minneapolis, Minnesota 55413

Under Contract NAS8-32093 with

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy



(NASA-CR-161355) INSTALLATION GUIDELINES
FOR SOLAR HEATING SYSTEM, SINGLE-FAMILY
RESIDENCE AT NEW CASTLE, PENNSYLVANIA (NASA)
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U.S. Department of Energy



Solar Energy

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16. ABSTRACT This document provides the Solar Heating System installer guidelines for each sybssystem and includes testing and filling the system. This single-family residential heating system is a solar-assisted, hydronic-to-warm-air system with solar-assisted domestic water heating. It is composed of the following major components: <ul style="list-style-type: none">o Liquid cooled flat plate collectorso Water storage tanko Passive solar-fired domestic water preheatero Electric hot water heatero Heat pump with electric backupo Solar hot water coil unito Tube-and-shell heat exchanger, three pumps, and associated pipes and valving in an energy transport moduleo Control systemo Air-cooled heat purge unit <p>This document also provides information on the operating procedures, controls, caution requirements, and routine and schedule maintenance. Information consists of written procedures, schematics, detail drawings, pictures and manufacturer's component data.</p>					
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SECTION 1
INTRODUCTION

SCOPE

This document provides a description to the Solar Heating System owner of each subsystem as well as testing and filling the system.

SINGLE-FAMILY RESIDENTIAL HEATING SYSTEM DESCRIPTION

The single-family residential heating system is a solar-assisted, hydronic-to-warm-air heating system with solar-assisted domestic water heating. The system is composed of the following major components:

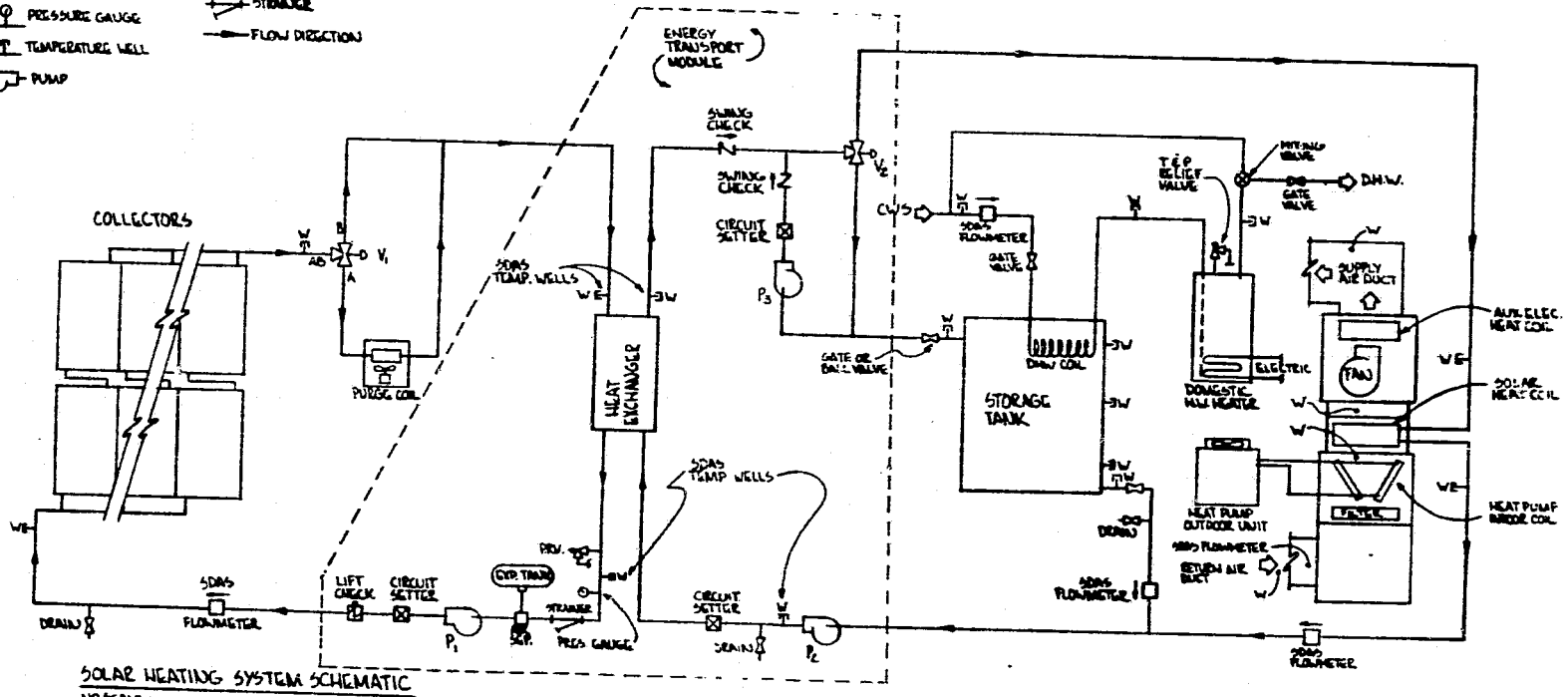
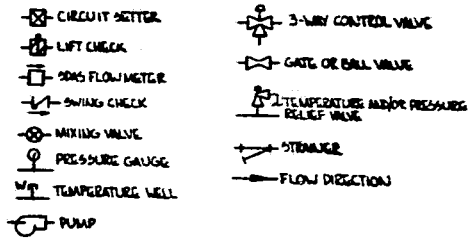
- Liquid cooled flat plate collectors
- A water storage tank
- A passive solar-fired domestic water preheater
- An electric hot water heater
- A heat pump with electric backup
- A solar hot water coil unit
- A tube-and-shell heat exchanger, three pumps, and associated pipes and valving in an energy transport module.
- A control system
- An air-cooled heat purge unit

The arrangement of components within the system is shown on Figure 1-1. The system consists of a glycol/water collector loop that interfaces with a water storage loop through a tube-and-shell heat exchanger. A domestic hot water pre-heat coil is located in the storage tank.

PART NO.

REVISIONS			
LTB	DESCRIPTION	DATE	APPROVED

LIST OF SYMBOLS



SOLAR HEATING SYSTEM SCHEMATIC
NO SCALE

YOUR HOUSE SELLER NOTES DTVS 0000		DATE 1/1/73	DESIGNED BY J. J. J.	DRAWN BY J. J. J.	DATE 1/1/73	HONEYWELL INC.	ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55412
MATERIAL		CONTRACT NO.		NEW CASTLE		SINGLE FAMILY RESIDENCE SYSTEM INTEGRATION	
HEAT PUMP	USED ON	HEATING ONLY		SIZE	CODE IDENT NO.	DRAWING NO.	5K-142106
APPLICATION	FINISH-SEE NOTE	HEATING ONLY		SCALE	1/4" = 1'-0"	SHEET 2 OF 3	
CONTROL				A			

Figure 1-1

The glycol/water collector loop consists of solar collectors, the shell side of the heat exchanger, the purge coil and pump P_1 , and a control valve as required for the different modes of operation.

The water side of the heat exchanger is a direct heating/storage loop consisting of the storage tank, control valve, pumps P_2 and P_3 , the tube side of the heat exchanger and the solar heating coil.

The system provides six modes of operation:

- Direct heating from collectors
- Heating from storage
- Auxiliary heating (insufficient solar)
- Storage charging
- Continuous domestic hot water preheating
- Purging excess energy

SYSTEM OPERATION

When space heating is required and solar energy from the collectors is available, the collectors supply heat directly to the system. Energy transfer is through the heat exchanger then via the solar hot water coil in the heat pump indoor section. Pump P_1 in the solar collector loop and P_2 in the water loop provide movement of the heat transport through valve V_2 to the heating coil. The blower moves the building air across this heating coil. Pumps P_1 and P_2 provide movement of the heat transport fluids to charge the storage tank. Storage charging occurs by circulating water from the tank bottom through the heat exchanger and returning the heated water to the top of the storage tank, thus taking advantage of stratification. During high solar insolation and low heating and storage demands, if surplus energy is collected, then valve V_1 diverts collector loop flow to the purge coil. The purge coil operates to maintain the system fluid temperatures below preselected values.

When space heating is required and direct solar energy is not available, thermal storage supplies the heat. Pump P₃ circulates the water from the top of the tank through the solar hot water coil and returns the cooler water to the bottom of the storage tank, taking advantage of tank stratification. If the storage tank temperature is not high enough to provide space heating, the control subsystem activates auxiliary space heating to maintain a comfortable building temperature. Auxiliary space heating will be provided by the heat pump and by the electrical resistance heating coil.

A description of each mode of operation and a complete system checkout procedure is contained in Appendix A.

SECTION 2
SOLAR HEATING SUBSYSTEMS AND COMPONENTS

The Solar Heating system consists of the following subsystems:

- Collector
- Storage
- Auxiliary Energy and Space Heating
- Domestic Hot Water
- Energy Transport
- Control
- Site Data Acquisition Subsystem

A description of each subsystem is given in the following sections. Information on the major components within each subsystem is provided in the Appendices.

COLLECTOR SUBSYSTEM

The collector subsystem consists of 28 Lennox LSC 18-1 solar collectors, a purge coil unit Lennox HRW-1-30, a diverting valve (V1), Honeywell Part Y534A, headers, supply/returns lines and isolation and balancing valves.

The solar collectors should operate without any special attention. However, excessive temperatures can be achieved if pumps P_1 and P_2 are in the off position and direct solar energy is available. Pump P_2 can be turned off and pump P_1 can be operated during daylight hours if flow is directed through the purge unit. Caution should be taken if pump P_1 is left running at night during below freezing conditions as the water in the tube side of the heat exchanger can be frozen and could rupture the unit.

Solar Collectors

The LSC 18-1 is a double glass cover, flat plate collector. The tempered, low-iron glass has an acid etched surface to reduce reflection. The steel absorber plate has a special black chrome coating for high solar absorptivity. The absorber plate is formed around the copper fluid tubes and is all encased in an insulated, formed, galvalume steel box.

Purge Coil Unit

The purge coil unit is a fin and tube coil and blower unit that is mounted outside the dwelling. It is used to evacuate excess heat energy from the collectors.

Diverting Valve

The diverting valve is a dual unit consisting of two valve bodies that are plumbed together. These are controlled by two powerheads that move each valve separately. This valve is used to divert the liquid coming from the solar collectors to the purge coil unit as required.

Collector Plate Temperature Sensor

A temperature sensor is mounted on the collector plate for control of the solar heating system.

Installation

See Figures 2-1, 2-2, and 2-3 for installation of above components.

Operation and Maintenance Data

See Appendix B for details on these components.

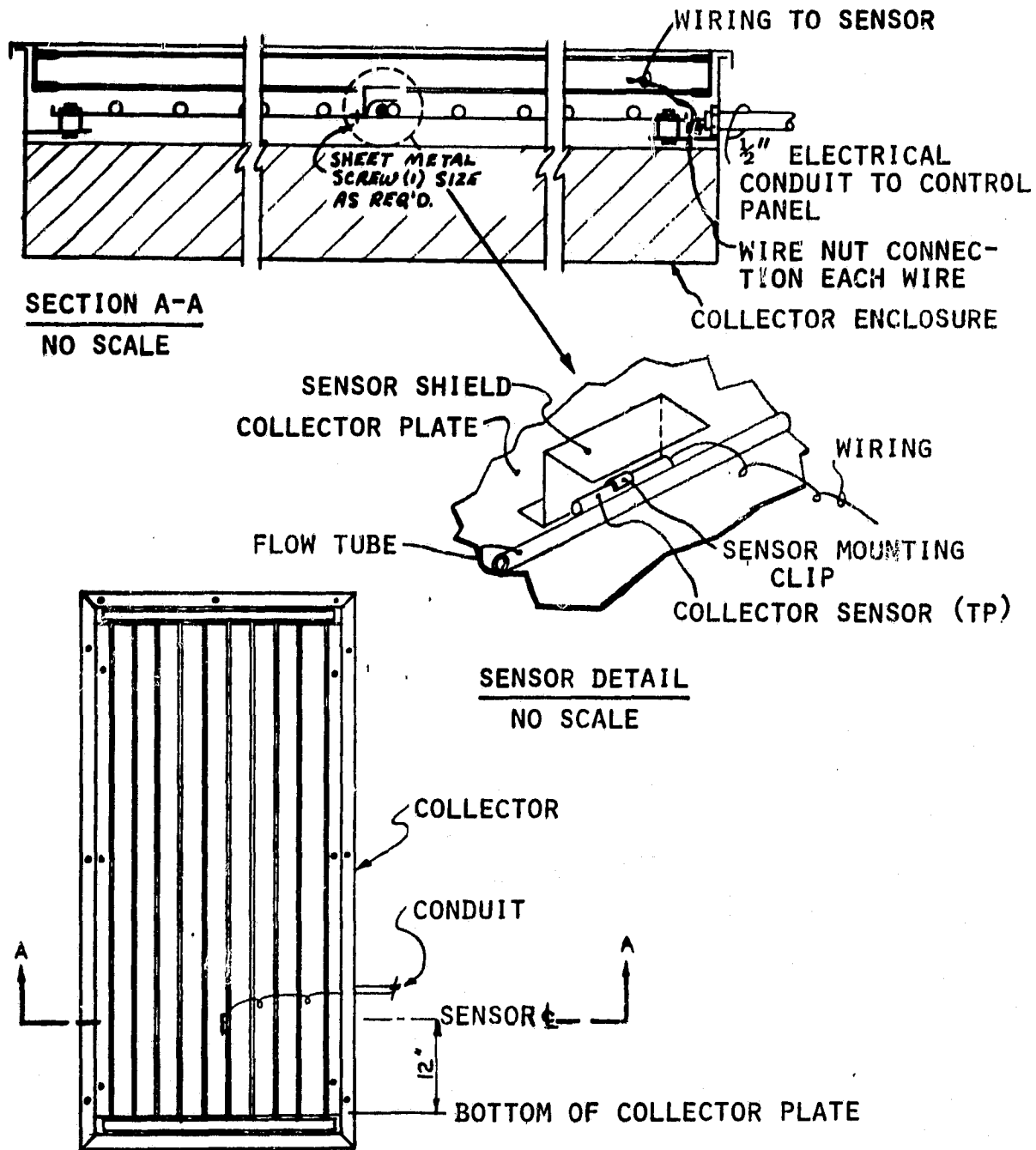


Figure 2-2. Collector Plate Sensor (Tp) Detail

PART NO.

PURGE COIL DESCRIPTION

Heat Capacity and Pressure Drop

Height of the coil = 25"
 Length of the coil = 30"
 No. of rows = 2
 No. of fans/loop = 15
 Outer dia. of tubes = 1/2"
 No. of circuits = 10
 Air flow rate = 2000 CFM
 HP of fan motor = 1/3

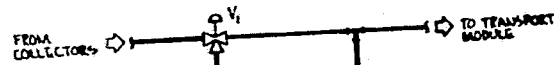
Assumed air temp. at the suction side of the fan = 80-120°F
 Calculated heat dissipated/hr = 101,000-156,000 Btu/hr. (Initial Fluid Temp. = 219°F 50% glycol solution)

Pressure drop (calculated) in the Purge coil = 9.0 R.
 = 3.9 PSI

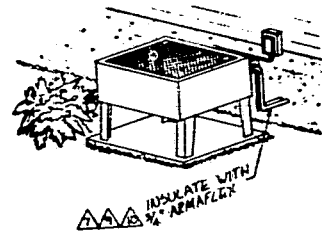
INSTALLATION NOTES

PLUMBING: Connect the inlet and outlet manifolds (1 5/8" O.D., copper tube) of the purge coil to the desired pipes in the collector loop.

ELECTRICAL: Connect the meter of the purge coil fan to the control panel.

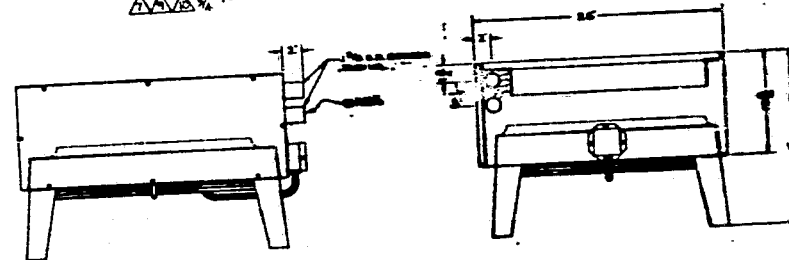
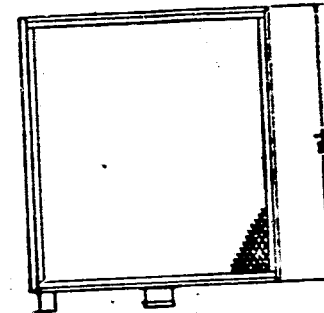


SCHEMATIC - PURGE
NO SCALE



INSULATE WITH 1/2" ARMAFLEX

REVISIONS			
LT#	DESCRIPTION	DATE	APPROVED



PURGE COIL UNIT (HEAT REJECTOR)
1/2" = 1'-0"

VOLVOVOX UNIT USE BEFORE OTHER MARKS		DATE	BY	REVISION	HONEYWELL ENERGY RESOURCES INC. SINGLE FAMILY RESIDENCE COLLECTOR SUBSYSTEM
SIZE C	CASE INVENT NO. 55513	DRAWING NO. SK-142101	NEW CASTLE		
SHEET NO. APPLICATION	USED ON FURNISH-SEE NOTE	SCALE 1/2" = 1'-0"	SHEET # OF # CONTROL A		

Figure 2-3.

2-5

STORAGE SUBSYSTEM

The storage subsystem consists of a 1000-gallon lined steel tank. The tank is designed to operate at ambient pressure and is vented to the space enclosing it. The water in the tank is neutralized with an inhibitor to reduce corrosion of system components.

The storage tank is filled to a level 6 inches from the top of the tank. Initial fill level is marked with a red band on the sight glass. If the water level is more than 3 inches below this level, additional water should be added to the storage tank. This is accomplished by removing a manhole cover, using a hose connected to the domestic water system until the level in the sight glass is up to the red band on the sight glass. Pumps P_2 and P_3 should be shut off during tank level checking and filling. For a description of the storage subsystem, see Figure 2-4.

AUXILIARY ENERGY AND SPACE HEATING SUBSYSTEMS

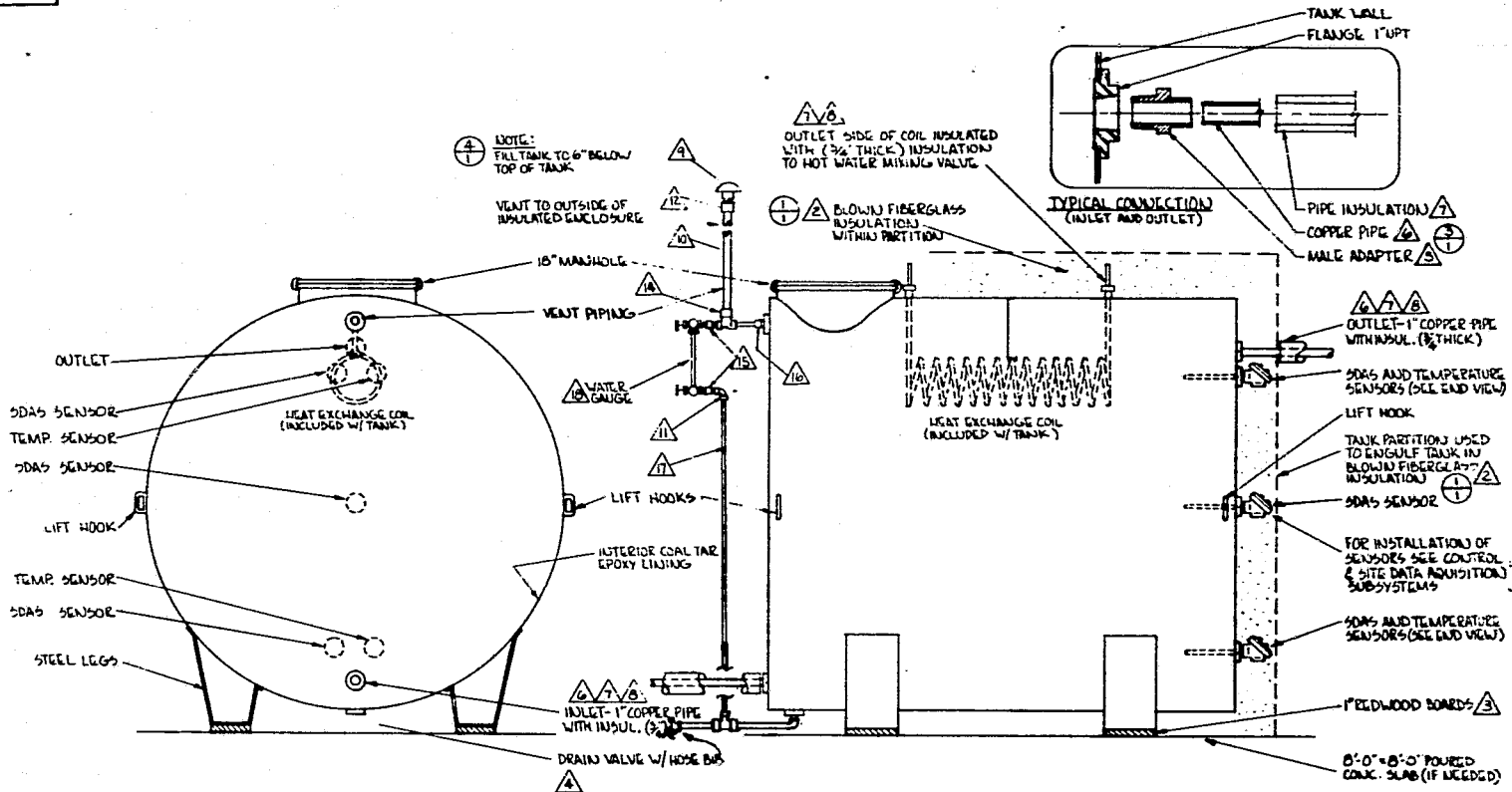
The Auxiliary Energy and Space Heating Subsystem consists of the Solar Heating System Space Heating Coil integrated with a conventional (non-solar assisted) electric-heat pump, and auxiliary electric heating coil.

The heat pump is a matched remote system consisting of an outdoor unit and an indoor unit. The Space Heating Coil is installed between the separable halves of the heat pump indoor unit. The auxiliary electric heating coil is installed in the heat pump indoor unit.

Various blower speeds are available on the indoor unit fan. However, a new speed that is lower than the initial speed set by the installer should not be used as this can result in less solar energy utilized and consequently higher auxiliary electric energy consumption.

PART NO.

REVISIONS			
LYR	DESCRIPTION	DATE	APPROVED



STORAGE TANK

1'-1'-0"

64" DIA. 72" LONG
1000 GALLONS

NOTE: FILL TANK APPROXIMATELY HALF FULL BEFORE INSTALLING GAUGE GLASS

		TITLE RANGES UNLESS NOTED OTHERWISE		DRAWN BY: <i>[Signature]</i> DATE: 6/2/77		HONEYWELL INC. ENERGY RESOURCES CENTER BOSTON, MASS. 02113		
DESIGNED BY	DATE	CHECKED BY	DATE	CITY ENGINEER	DATE	CONTRACT NO.		
ENG'G MGT		ENG'G MGT		ENG'G MGT		WILLIAM O'BRIEN	SIZE: C	
						NEW CASTLE	CODE IDENT NO. 55513	
							DRAWING NO. SK-142050	
NEXT ASSY	USED ON	APPLICATION	FINISH-SEE NOTE				SCALE 1'-1'-0"	
							SHEET 2 OF 2	
							CONTROL	A

Figure 2-4

The subsystem schematic denoting the unit model number is shown in Figure 2-5. Operation and maintenance data for each component are shown in Appendix C. The control subsystem outdoor thermostat is installed as shown.

DOMESTIC HOT WATER SUBSYSTEM

The domestic hot water subsystem installation consists of a conventional hot water heater with its outlet (hot) connected to the dwelling hot water line and the inlet (cold) connected to the preheat coil in the storage tank. This line should have a tempering valve installed in it. See Figure 2-6 for installation detail. The supply water (cold) is run to the preheat coil and the tempering valve. When hot water is utilized, make-up cold water from the domestic water supply flows through the preheat coil and undergoes an increase in temperature. If the storage tank temperature is below 150°F - 160°F , the preheated water will be below 140°F . The water heater will maintain water temperature at 140°F . If the storage tank temperature is greater than 160°F , then the preheated water may be over 140°F . In this case, the tempering valve then adds cold water to bring the water temperature down to 140°F before it enters the domestic hot water system.

The tempering valve setting should be kept at 140°F . Operation and maintenance data is contained in Appendix D.

ENERGY TRANSPORT SUBSYSTEM

The Energy Transport Subsystem consists of the Energy Transport Module (ETM) and the piping between it and the collectors, storage and heating subsystems. The ETM is shown in Figure 2-7.

Pumps 1, 2, and 3, located in the bottom section of the ETM, provide the required flow rates in the collector, heating and storage loops. DO NOT RUN PUMPS WITHOUT FLUID IN SYSTEM.

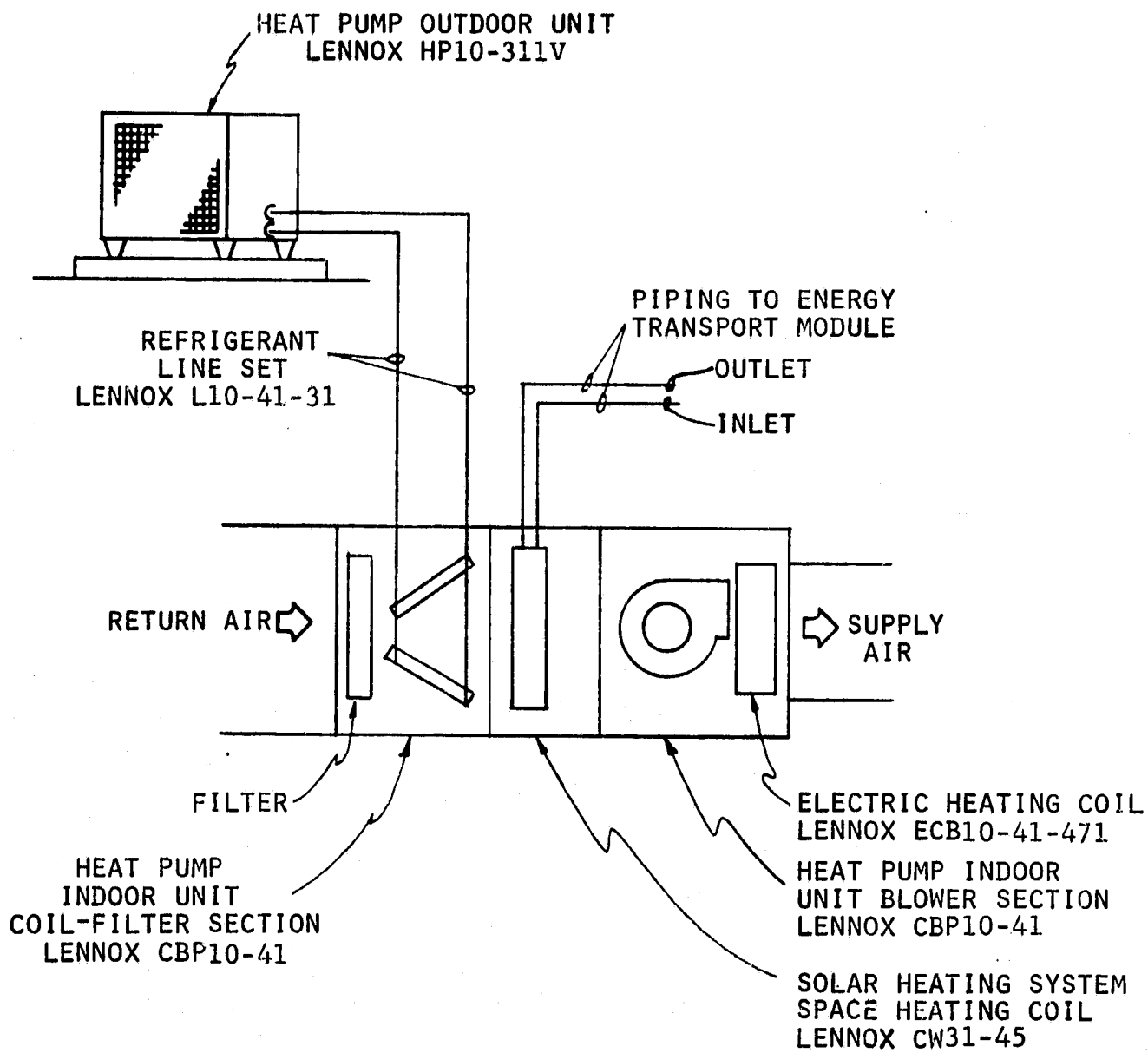
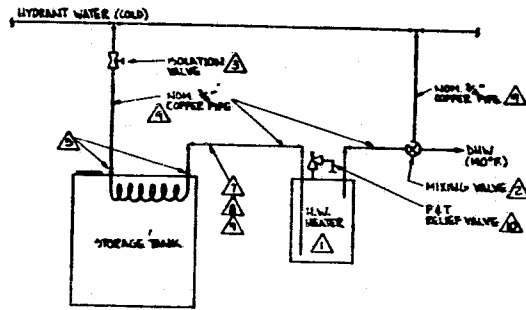


Figure 2-5. Auxiliary-Energy and Space Heating

PART NO.



SCHEMATIC DHW SUBSYSTEM
NO SCALE

INSTALLATION INFORMATION

- 1) DHW preheat coil will be previously installed in storage tank and has ends protruding from top of tank.
- 2) Tighten adapter on compression fitting.
- 3) Solder coil ends to copper tubing using coupling.

INSULATION INFORMATION

- 1) Insulate copper tubing from storage tank outlet to hot water mixing valve.

REVISIONS				REVISIONS			
LTN	DESCRIPTION	DATE	APPROVED	LTN	DESCRIPTION	DATE	APPROVED
C	ADD NOTE TO ITEM #1	10-28-77		A	REVISED INSULATION & ISOLATION OF TANK	7-14-77	
				B	IMPROVED PART #1, CORRECTED WATER TEMP. 50°F	3-11-77	

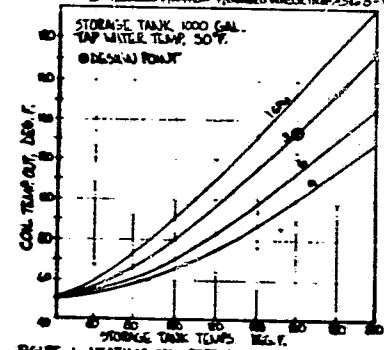


FIGURE 1. HEATING COIL PERFORMANCE

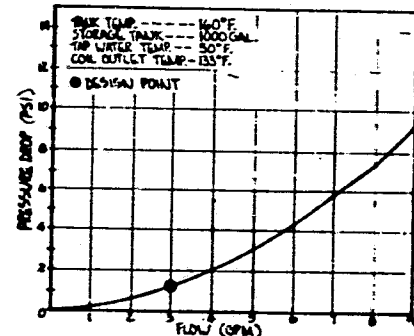


FIGURE 2. HEATING COIL PRESSURE DROP

2-10

MATERIAL SCHEDULE				
ITEM #	ITEM	MANUFACTURER	TYPE / PART NO.	QUANTITY
1	HOT WATER HEATER	LOCHINVAR	SEE NOTE →	1
2	3-WAY MIXING VALVE	WATTS REGULATOR CO.	70A - 3/4"	1
3	BALL VALVE	NIBCO	5-580 - 3/4"	1
4	COPPER TIG. NOM. 3/8" x 3/8"	GOULD-IMPERIAL CASTMAN	111 - 7/8	1
5	COPPER COUPLING W/ STOP NOM. 3/8"	GOULD-IMPERIAL CASTMAN	100 - 7/8	2
6	COPPER ELBOW NOM. 3/8" x 3/8"	GOULD - I.E.	107 - C - 7/8	AS REQD
7	INSULATION (3/4" THICK)	ARMSTRONG CORK CO.	ARMAFLEX STANDARD	AS REQD
8	INSULATION ADHESIVE	ARMSTRONG	520	AS REQD
9	COPPER PIPE 3/8" NOM.	BEVERE	M	AS REQD
10	PRESSURE & TEMP RELIEF VALVE	WATT'S PLUMBING SPEC.	40 XL	1

NOTE:
FOR ELECTRICAL INSTALLATIONS
USE PART NO. 52KP-10
FOR GAS INSTALLATIONS
USE PART NO. 400K3TC

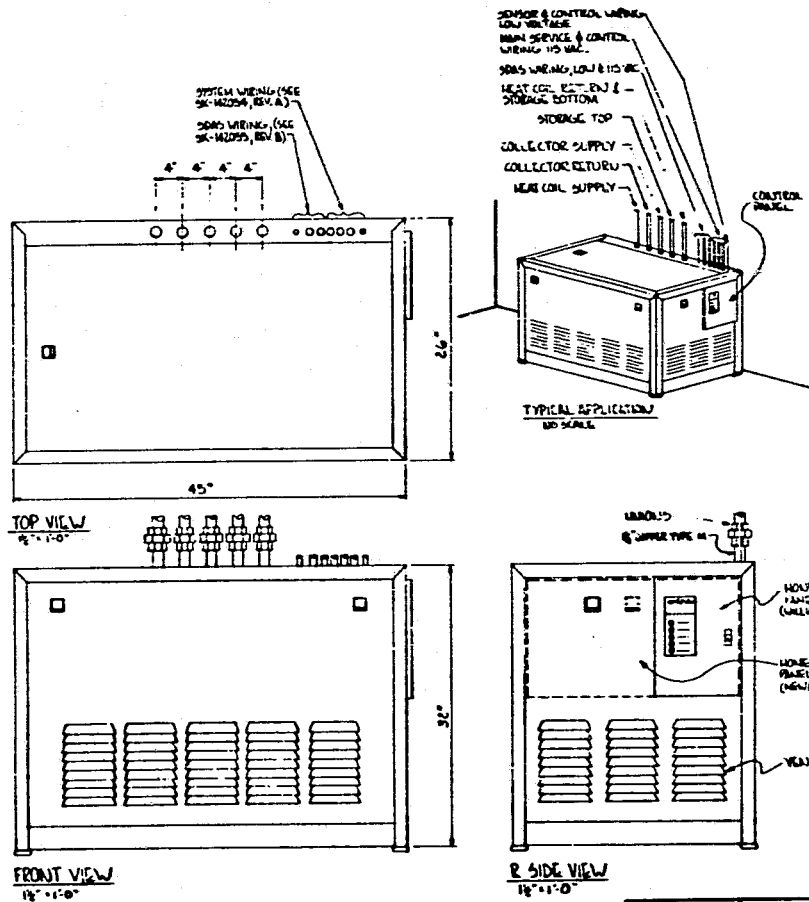
DOMESTIC HOT WATER (DHW)
Subsystem

The DHW subsystem consists of two hot water heaters in series. The 1st heater is the coil immersed in the storage tank, and the 2nd heater is a conventional domestic hot water heater. The storage tank is heated with the surplus solar energy not required for space heating. This stored heat is transferred to city water via a coil which preheats the water before it goes to the conventional hot water heater. When the storage tank is at its maximum temperature 140°F no additional heat will be required from the conventional heater at flow rates of 7 gpm or less. The capacity of preheat coil is shown in Figure 1 and 2. To limit the output of the heaters to 140° a self contained 3 way mixing valve tempers the hot water to the user with city water.

TOLERANCES UNLESS NOTED OTHERWISE		DRAWN BY	DATE	CHECKED	DATE	MONEYWELL INC.		ENERGY RESOURCE CENTER	
FIN.	± .005	W. O'BRIEN	10/27/77			MINNEAPOLIS, MINN. 55412			
AS-BUILT	± .010					SINGLE FAMILY RESIDENCE			
						HOT WATER SUBSYSTEM			
						WILLIAM O'BRIEN	SIZE	CODE IDENT NO.	DRAWING NO.
						NEW CASTLE	C	55513	5K-142052
							SCALE	NONE	SHEET 1 OF 2

Figure 2-6.

CONTROL A



REVISED			
REV.	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR CONSTRUCTION & ELECTRICAL PERMITS	7-14-77	J.P.
B	ADDED TO & REVISED WIRING REVISIONS	10-28-77	J.P.
C	CONTROL PANEL 295C	4-17-78	J.P.

ENERGY TRANSPORT MODULE (ETM) - SOLAR HEATING

The Energy Transport Module is a fully-assembled, pre-wired unit which provides the pumping power, control logic, and interface between subsystems in a residential hydronic solar heating system. It has a sturdy, rolled steel cabinet with an attractive, durable finish for installation within a building. Large, removable vented access panels are provided for system check-out and component servicing. The main system pump is capable of 12 gpm flow of water/ethylene glycol (mixure percentage is site specific) through collector arrays of 100-600 ft². Two smaller pumps move water through the heating and storage subsystems. Separating the freeze-protected collector loop from the heating/storage water loop in a high efficiency, water-to-water solar heat exchanger. Other hydronic components are located in the ETM, resulting in an efficient, quietly running system which requires minimal maintenance. An integrally mounted Honeywell Solar Control Panel which senses conditions throughout the system and requirements of the household (thermostat setting), provides ETM operational control.

Application
The basic ETM design (for gas furnace auxiliary heating solar system) can be adapted for use with heat pump auxiliary by replacing the W968A Control Panel with the SK-142103 control. See table below:

Auxiliary Heat	ETM Model	Control Panel
Gas Furnace	SK-142053-ETM-1	W968A
Heat Pump	SK-142053-ETM-2	SK-142103

Consult manufacturer for other application assistance.
Pressure drop within ETM (can be increased by adjusting stream cut-off):
Collector Loop (10% ethylene glycol) = 2.5 psig
Direct Heating (water) = 4.0 psig
Charge Storage (water) = 4.0 psig
Heat from Storage (water) = 1.0 psig

Conditions

Pressure (psig level)	Operating	Maximum	Minimum
Collector Loop	30-35 psig	45 psig	---
Storage/Heating	atmospheric	---	---
Temperature (deg F)			
Collector Loop	60-210° F	210° F	outside ambient
Storage/Heating	60-200° F	210° F	inside ambient

PROJECT INFORMATION		DRAWING INFORMATION		PROJECT INFORMATION		DRAWING INFORMATION	
PROJECT NO.	DATE	SCALE	SHEET NO.	PROJECT NO.	DATE	SCALE	SHEET NO.
WILLIAM O'BRIEN	NEWCASTLE	SCALE 1/2" = 1'-0"	SHEET 1 OF 2	WILLIAM O'BRIEN	NEWCASTLE	SCALE 1/2" = 1'-0"	SHEET 1 OF 2
HONEYWELL INC. SINGLE FAMILY RESIDENCE ENERGY TRANSPORT SUBSYSTEM				ENERGY RESOURCES CENTER 1000 W. 10TH ST.			
CONTROL A							

Figure 2-7. Energy Transport Subsystem

REV	DATE	BY
1	10-1-72	

- ETRs may be back-filled as indicated on shipping marks. Before sealing with valves closed, the low wall lower panels and pressure relief holding gas should be removed. Holding gas will allow drain under the ETR after the pressure relief has been removed from gas. ETRs can be manually back-filled after backfilling has been completed and valves closed. If backfilling is required, the backfilling procedure is described in the ETR manual. Backfilling procedure and Control Panel will be changed if required and is back-filled on the side or top. ETRs shall be 30" x 30" x 60" and weight 100 lbs. Improving weight to 80 lbs. Position on level surface (adjustable legs) provided near storage and open handling equipment. Control panel shall be 18" x 18" x 18" and shall be located above the collector array or storage tank.
- Control ETRs with the back towards wall. Back connections clearance is required around the unit. Two feet minimum is clear at the sides. Adequate clearance for service access through front, top and side panels shall be provided. Panels are mounted with a clamp retained pull on the rearward side.

- Three 1/8 inch brass mesh screens are provided for system piping connections (see drawing). DO NOT APPLY BRAY to ETR piping joints. Screen shall be fitted to the rearward side of ETRs according to ETR labels.
- Electrical bonding shall conform to applicable codes. Insulation/ Shielded cables and air ducts shall be installed, as necessary.

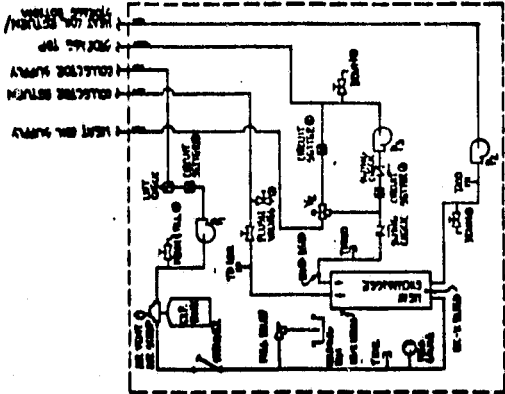
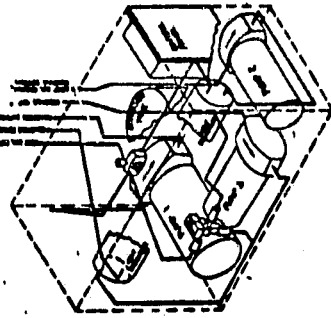
Special Comments

- ETRs to be manually gas-filled.
- Electrical wiring must conform to National Electrical Code and local codes. Low voltage supply to ETR shall be from properly shielded branch circuit and emergency protection device. The wire shall be for at least 60°C (140°F). Wiring diagrams are shown on this drawing and on EC-12004, Rev. A (Shielded Subsystem).
- Three 1/8 inch brass mesh screens are provided to Control Panel terminals for 115 VAC electrical service and the low voltage control wiring. Low voltage control wires may be run from the upper right side of the Control Panel through the end hole provided in cabinet top. (Additional openings are provided for the ETRs, with wiring diagrams shown on EC-12004, Rev. A.)

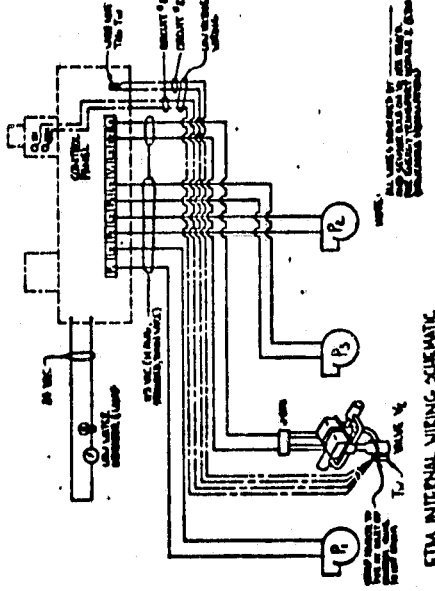
Electrical Power Supply ... 115 VAC, 60 Hz, 1 phase
 Minimum supply circuit conductor ... 18 awg
 Minimum supply circuit overcurrent protection ... 30 ampere
 1750 rpm, constant speed, open slip-ring motor,
 built to thermal overload protection.

Subsystem	Motor (hp @ 115 V)	Capacity (gal @ 115 V)	Full Load Current (amp)	Starting Current (amp)
Collector (C1)	1/2 hp	12 gal @ 24 ft	4.0 amp	12 amp
Storage (S1)	1/2 hp	8 gal @ 11 ft	2.5 amp	8 amp
Storage (S2)	1/2 hp	8 gal @ 11 ft	2.5 amp	8 amp

NOTE: A 1/2 hp motor, located outside the cabinet in the Pump Unit, is controlled and powered by the ETR Control Panel.



SCHEMATIC - ENERGY TRANSPORT MODALS
NO SCALE



ETM INTERNAL WIRING SCHEMATIC
NO SCALE

HONEYWELL ENERGY SERVICES CENTER	
SINGAL FAMILY RESIDENCE	
ENERGY TRANSPORT SUBSYSTEM	
SIZE (LOW VOLTAGE)	1/2-142053
DATE	10-1-72
CONTROL	
WILLIAM O'ROURKE	NEWCASTLE
DESIGNER	
CHECKED BY	
APPROVED BY	
DATE	

Figure 2-7. Energy Transport Subsystem (concluded)

The heat exchanger separates the freeze-protected collector loop from, and transfers energy to, the heating/storage water loop. Integrally plumbed and mounted into the top section of the ETM, it has no moving parts but is equipped with a manual air bleed and drain valve. Cleaning and flushing of the exchanger shell is possible without contaminating the entire collector loop.

The diaphragm expansion tank absorbs the expansion of the transfer fluid from fill temperature (50-60°F) to purge temperature (210°F). It is mounted in the center of the ETM, with the charging air valve accessible on its bottom (relief pan removal provides additional access to the valve). Tank air pressure should not drop below its initial 20 psi charge; it will increase as the system pressure increases. Removal of expansion tank is through the top panel, after removing the air separator and strainer.

Located in the upper section in the collector line is an air separator. With no moving parts, it separates entrapped air from the collector fluid as it circulates.

The automatic, float-type air vent attached to the air separator eliminates the purged air only. Then fluid fills the chamber, and the float closes the vent port. During system startup, this process may be expedited by removing the protective vent cap and manually depressing the vent stem. During operation, leave vent cap 2-1/2 turns open.

Two air bleeds located in the top section allow manual venting of air from the ETM piping and heat exchanger during system startup. A catch basin should be used when venting the air/fluid mixture from plumbing.

A pressure relief valve located in the top section of the ETM protects the collector loop from overpressure during a system pump failure. When system pressure reaches 45 psig, the valve will begin to open. The discharge is directed through the pressure relief line into the holding pan. DO NOT REMOVE ETM PANELS WHILE RELIEF VALVE IS FUNCTIONING. Fluid (water/ethylene glycol mixture) may be at 210°F.

The dual diverting control valve located in the lower section directs the water flow into various storage and heating modes. This electrically driven valve is controlled by the Solar Control Panel but does have manual override levers, one per powerhead. These levers should be in the unlocked position.

Three circuit setters located in the lower section are used to reduced flow rates to the correct level in the collector, charge storage, and heat from storage loops (there is no setter in the Direct Heating loop). The reduction is made by turning the large nut, thus adjusting the internal valve body. ETM is shipped with the setters in the "open" position; adjustment should be made during initial system startup. TURN PUMPS OFF AND SHIELD THEM AND THE ETM BASE FROM FLUID LEAKAGE WHEN CONNECTING OR DISCONNECTING PRESSURE METER FROM SETTER.

The lift check valve located in the collector supply line in the top section is used to prevent thermosyphoning (backward gravity flow) of cold collector fluid into the heat exchanger during cold, cloudy days. It is designed to prevent freezing of the heat exchanger water loop. During operation, the system pump (P_1) pushes liquid through the check valve, lifting the mechanism off the seat. When flow stops (the protect mode), the valve mechanism drops by gravity onto the seat, thus not allowing flow in the reverse direction. DURING OPERATION, THE VALVE MUST BE FIRMLY SCREWED DOWN ONTO THE SEAT.

Located in the bottom section are two swing check valves (like hinged doors) that allow flow in only one direction. Reversed flow causes the valve to seat more firmly. Check valves are a part of the overall flow control in the heating and storage loops.

Four drain/fill valves located in the ETM are used to flush, clean, and fill the system. These valves are similar to the drain on a residential hot water heater and have a standard garden hose threaded outlet. ANY SPILLED GLYCOL SOLUTION SHOULD BE IMMEDIATELY WIPED UP.

Located in the top section of the ETM (in the collector return line) is a ball valve, used during flushing of collector loop. The valve must be open (handle in-line) during system operation, thus allowing full flow through it. By opening and closing (handle perpendicular to supply line) the valve as stated in the operational instructions, the collector loop and heat exchanger shell can be independently flushed and cleaned.

A strainer located in the top section of the ETM (in the collector loop) removes most of the foreign matter from the fluid as it passes through the metal screen. Foreign material should be occasionally removed from the strainer. STRAINER SHOULD NOT BE OPENED PRIOR TO DRAINING OR ISOLATING THE COLLECTOR LOOP.

The low level indicator consists of an indicator lamp (mounted on the ETM) and the pressure gauge mounted in the top section of the ETM. After charging the system to 20 psig, the gauge contact pointer should be adjusted to the proper setting (17 psig). When the collector loop loses fluid, the pressure will drop from the nominal operating 20-36 psig to the 17 psig and the lamp will light. This indicates a possible system pressure leak, i.e., loss of fluid.

The lamp may also light if all collector fluid becomes very cold and contracts sufficiently to cause a drop in system pressure. If the lamp remains lit when the system pump (P₁) is automatically turned on, check for a leak.

NOTE: The indicator actually detects a pressure loss, and not a liquid level.

The Solar Control Panel located on the right side of the ETM senses conditions throughout the system and requirements of the household (thermostat setting) and provides ETM operational control. When opening the Control Panel, care should be taken to avoid damage to the door or cabinet finish. Switches should remain in the "AUTO" position. Secure the door after closing it with the screw provided.

The holding pan located on rails under the ETM is provided to catch and hold the overflow from the relief valve. To remove the pan, first disengage the relief line by twisting and sliding it up until it clears the holding pan. Then grasp the pan handles and pull from under the ETM.

Operation and maintenance of the Energy Transport Subsystem components are shown in Appendix E.

CONTROL SUBSYSTEM

The installation of the control subsystem consists of installing two aquastat controllers, the thermostat, a motorized valve, three temperature sensors, an outdoor thermostat, and a shield over the temperature sensor on the collector and connecting these units with the control panel on the ETM unit. The overall control system schematic is shown in Figure 2-8. A list of control subsystem components is shown in Table 2-1.

Electrical wiring from the control panel is shown in Figure 2-9.

Control subsystem checkout and a description of operating modes is described in the Solar-heat Pump Control Panel section of Appendix A.

Operation and maintenance data on all control subsystem components is described in Appendix A.

SITE DATA ACQUISITION SUBSYSTEM (SDAS)

To meet the data collection, performance evaluation, and data dissemination goals of the National Program for Solar Heating and Cooling, the solar heating system will include a comprehensive instrumentation subsystem.

Table 2-1. Control Components

FOR REFERENCE
ONLY, REMOUNTED
ON TRANSPORT
MODULE SK142053

MATERIAL LIST				
ITEM	QUAN.	DESCRIPTION	TYPE/PART NO.	MFR.
	1	SOLAR CONTROL PANEL	SK142183	HONEYWELL
T _{ST}	1	AQUASTAT CONTROLLER	L6008C1065	HONEYWELL
T _{CD}	1	AQUASTAT CONTROLLER	L6008A1010	HONEYWELL
	1	MULTISTAGE THERMOSTAT	T872R1131	HONEYWELL
	1	THERMOSTAT SUBBASE	Q672L1144	HONEYWELL
V ₁	1	MOTORIZED VALVE	Y534A1015	HONEYWELL
V ₂	1	MOTORIZED VALVE	Y534A1015	HONEYWELL
	2	IMMERSION WELL	122555B	HONEYWELL
	1	CASE ASSEMBLY	112892F	HONEYWELL
T _P , T _{SB} , T _{HP}	3	SENSOR	C773B1005	HONEYWELL
	1	COLLECTOR SENSOR SHIELD	SK142067	HONEYWELL
T-1	1	THERMOSTAT	LB29740BA	LENNOX
	1	MOUNTING BOX	PNM-1595	LENNOX
	1	BULB GUARD	107323A	HONEYWELL
T _w	1	SENSOR	C773B1005	HONEYWELL

Data Collection

The goal of ERDA's data collection activity is to provide the information necessary for evaluation of the performance and operation of solar systems and subsystems under different climatic conditions. The information generated as a result of this data collection activity will be utilized to stimulate industrial and commercial capability, including that of small business, to produce and distribute solar heating and cooling systems and, through widespread applications, to reduce the demand on conventional fuel supplies. This information will also be used to improve the general knowledge and understanding of solar energy systems, to develop definitive solar energy system performance criteria, to provide the basis for component system improvement and to estimate the economics of solar energy systems in reducing the consumption of conventional fuels. Results will be available for use by property owners, the building industry and related sections of the economy to compare costs and benefits of solar heating and cooling systems. This information will also provide the data base for design of new applications in the private sector. ERDA's Technical Information Center at Oak Ridge, Tennessee, will be the National Solar Heating and Cooling Data Bank and will be the focal point for distribution of this information.

Data System Overview

The Data System depicted in Figure 2-10 provides for the automatic gathering, conversion, transfer, reduction, and analysis of demonstration site data. This system is made up of three basic elements: installed sensors, a Site Data Acquisition Subsystem (SDAS), and a Central Data Processing System (CDPS).

The data will be gathered at each operational site at predetermined intervals of time and will be stored for transfer to the Central Processor. The collected data will be transferred via telephone communications upon request from the Central Data Processing Facility. At the Central Data Processing Facility, the collected data will be processed, analyzed, evaluated, and documented as Performance Evaluation Reports.

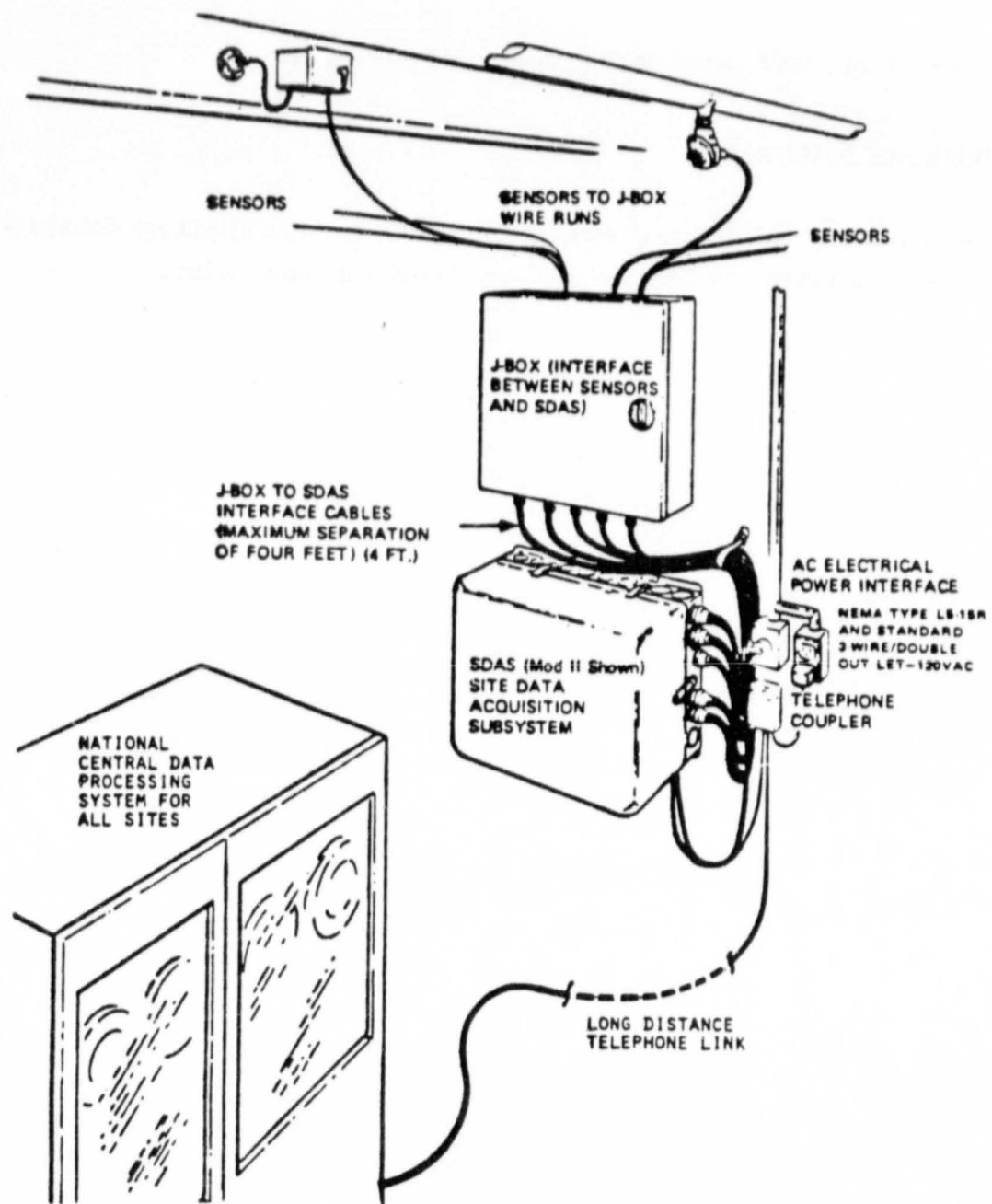


Figure 2-10. Site Instrumentation Interface Hardware

Sensor Locations

Locations of all SDAS sensors are shown in Figure 2-11.

Operation and Maintenance

All operation and maintenance work for the Site Data Acquisition Subsystem will be the responsibility of ERDA or its appointed representative.

SECTION 3
NEW CASTLE SYSTEM TEST AND FILLING

TESTING

As the hydronic loops are completed and before they are connected to the ETM, verify their integrity. Test piping and system as called for in the construction specification.

FLUSHING AND CLEANING

After testing of the hydronic loops is completed, the following cleaning procedures should be used.

CAUTION

- *DO NOT* run pumps when no liquid is present.
- Pressure should not exceed 40 psig. Maintain 20-35 psig during pump operation. Monitor pressure gauge periodically.
- With no isolation valves outside ETM, system must be drained before removing a hydronic component.
- Lift check valve knob must be turned clockwise to the fully-closed position for HX freeze protection.

Collector Loop

The collector loop and the space heat/storage loop are controlled by the ETM module.

- | | |
|---|--|
| ● Fill valve #4, drain valve #3, and HX drain | Remove side panel (opposite control box) |
|---|--|

- Ball valve, lift check valve, pressure gauge, and all bleed valves Remove top panel
- Drain valves #1 and #2 Remove front panel

Flushing and draining the collector loop must be done through fill valve #4 and drain valve #3. To clean collector loop:

- a. Set all switches on control panel to STOP
- b. Close ball valve and open balance valves in collector supply lines and air vents at collectors
- c. Connect fill line from drum with 50 gal. of water mixed with 1/2 gal. trisodium phosphate to fill valve #4.
- d. Open valve #4 and, using external pump
- e. Pump liquid into system.
- f. A drain hose should be connected to flush valve #3 and run to a large container (55-gal. drum) to catch the flushing fluid; open drain valve #3.
- g. Start pump by moving switch marked P1 to "ON."
- h. Continue feeding flushing fluid until it flows freely from drain hose.
- i. Close air vents at collector when air ceases to flow.
- j. Energize valve V1 (turn to ON position) and continue to feed fluid until it flows freely from drain hose.
- k. Open ball valve and close drain valve #3.
- l. Continue to supply fluid until pressure gauge read 20 psig.
- m. Bleed air from HX bleed valve, then
- n. Close fill valve #4. Shut external fluid supply and run system for 4 hours.

When cleaning is completed, drain total collector loop - HX fluid and measure volume so that correct amount of ethylene glycol can be mixed (see startup).

To completely drain collector loop, the Lift Check Valve must be opened (turn knob counterclockwise till it stops). Insure knob is returned to the fully closed position.

After system is totally drained, remove drain plug from HX to empty shell side and remove and clean strainer.

The collector loop should now be flushed with clean water for two hours. This may be accomplished using the water system. *Caution: Insure supply pressure does not exceed 40 psi. It should be connected to fill valve No. 4. Pump P₁ need not be energized, but ball valve must be closed. A drain hose should be connected to drain valve No. 3 and run outside to an appropriate area.*

The HX portion of the system should be flushed as follows:

- a. Close ball valve and drain valve 3.
- b. Open HX drain and connect drain hose to it.
- c. Pump fluid into fill valve #4 and out of HX drain.

Storage and Heating System Loop

The storage and heating system loop should be flushed and cleaned prior to filling.

- a. The storage tank should be flushed first. Connect hose to drain valve on bottom of tank and open valve. Drain hose should be run to appropriate floor drain. Remove manhole cover and, using hose connected to household water supply, flush interior of tank.

CAUTION: Do not enter tank with shoes as interior lining could be damaged.

To flush heat coil loop, connect a drain hose to drain valve #1 in ETM, open valve, and connect a hose from household cold water supply to drain valve #2 in ETM. Close both isolation valves on inlet and outlet of storage tank. With control valve V_2 "OFF," turn water on, and let water flow for 30 minutes. Next, connect drain hose to drain #2 and connect water supply to drain #1. With control valve V_2 "ON," turn water on and let flow for 10 minutes.

- b. When system is thoroughly flushed, shut off drain valve and fill tank to 6" below top of tank. Add inhibitor, 5 gallons (1200 mg/l) of Norman Chemical product no. 284, 1630 Carroll Ave., St. Paul, MN, or equal sodium nitrite based inhibitor.

BALANCING

Using a Bell and Gossett Delta Pressure readout kit or equivalent, adjust the Bell and Gossett Circuit Setter Balance Valves to the below listed values. Proceed per instructions included with readout kit and connect to Circuit Setter #1 in ETM (heat from storage). Manually start P3. Adjust flow to 8 GPM.

Repeat procedure with Circuit Setter #2 in ETM (storage charge loop). Run P2. Adjust flow to 8 GPM.

NOTE: If full flow is not attained through Circuit Setter 1, 2, and 3, leave in open position (zero setting).

Repeat procedure with Circuit Setters in supply line to two-high collector array. (Not in ETM) with P-1 operating. Adjust flow to 9.5 GPM.

Repeat procedure with circuit setter flow balance valve in supply line to one-high collector array (not in ETM) with P-1 running. Adjust flow to 2.5 GPM.

NOTE: Important to maintain the 9.5:2.5 ratio.

STARTUP

Collector Loop (approximately 30 gallons total)

Fill the collector loop with an aqueous ethylene glycol solution, 40% Dowtherm SR1 ethylene glycol. Mix the glycol and water in a 55-gallon drum. Connect fill hose to fill valve #4. Connect inlet of external pump to 55-gallon drum, open fill valve #4 and start pump. Open all air bleeds in the system and fill slowly. It is imperative not to fill the system too rapidly. Close air bleeds as they begin to leak. Precautions should be taken to prevent the glycol mixture from spilling onto the building or collector array.

System Pressurization

Once the system is full and purged of air, it may be pressurized to 20 psig as shown on low water/pressure gauge using external pump and 40/60 mixed solution. Energize the collector system pump P_1 manually. Air that is trapped will tend to be separated by the air separator as the fluid circulates. This will cause a decrease in the fluid level within the collector loop. It is important to watch this pressure level to see that it does not get too low. If it does, the low fluid warning light will come on. If the pressure gets low, add more fluid to the collector loop to maintain the 20 psig charge pressure. Low water/pressure gauge should be set to 15 psig.

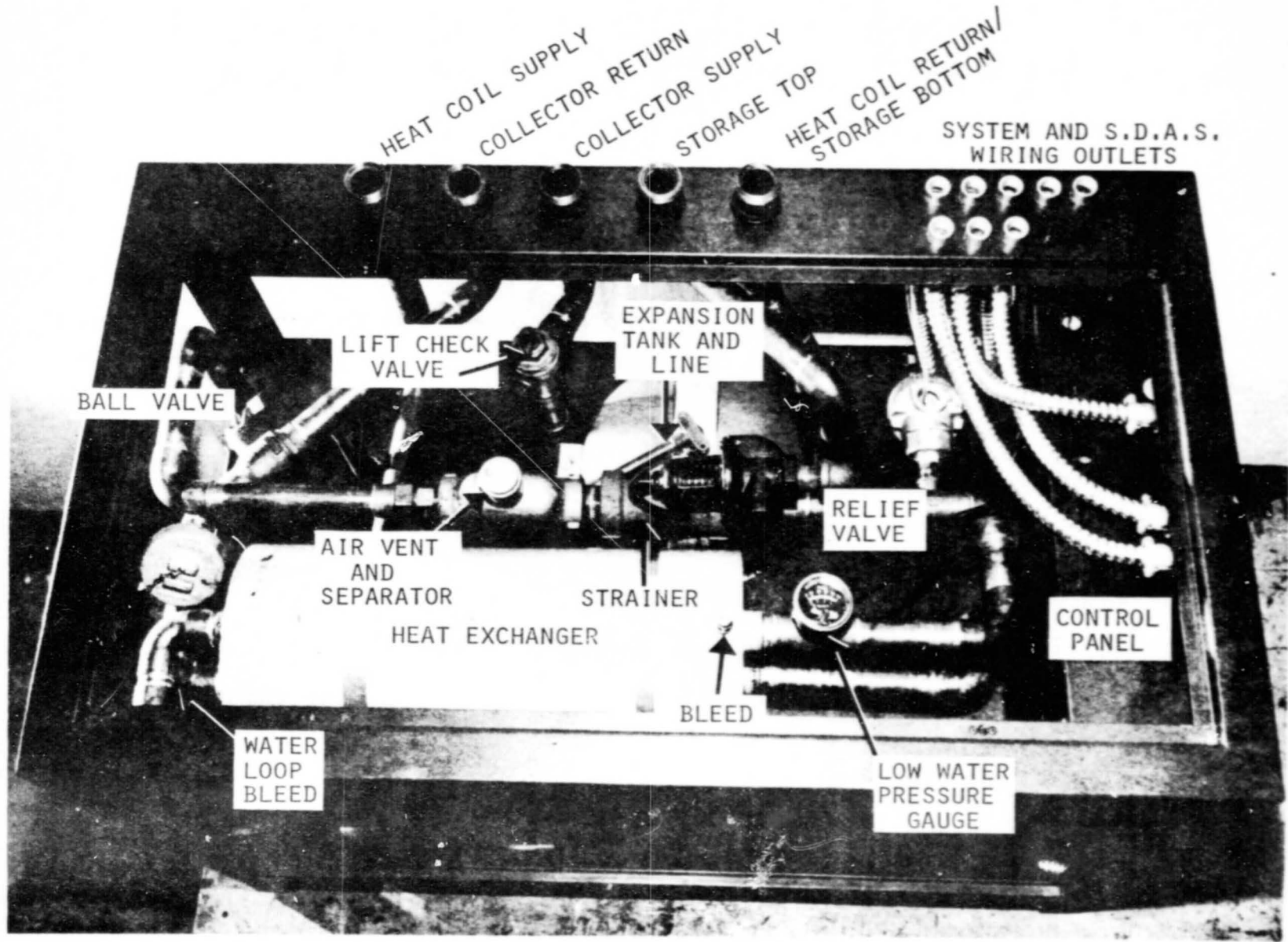
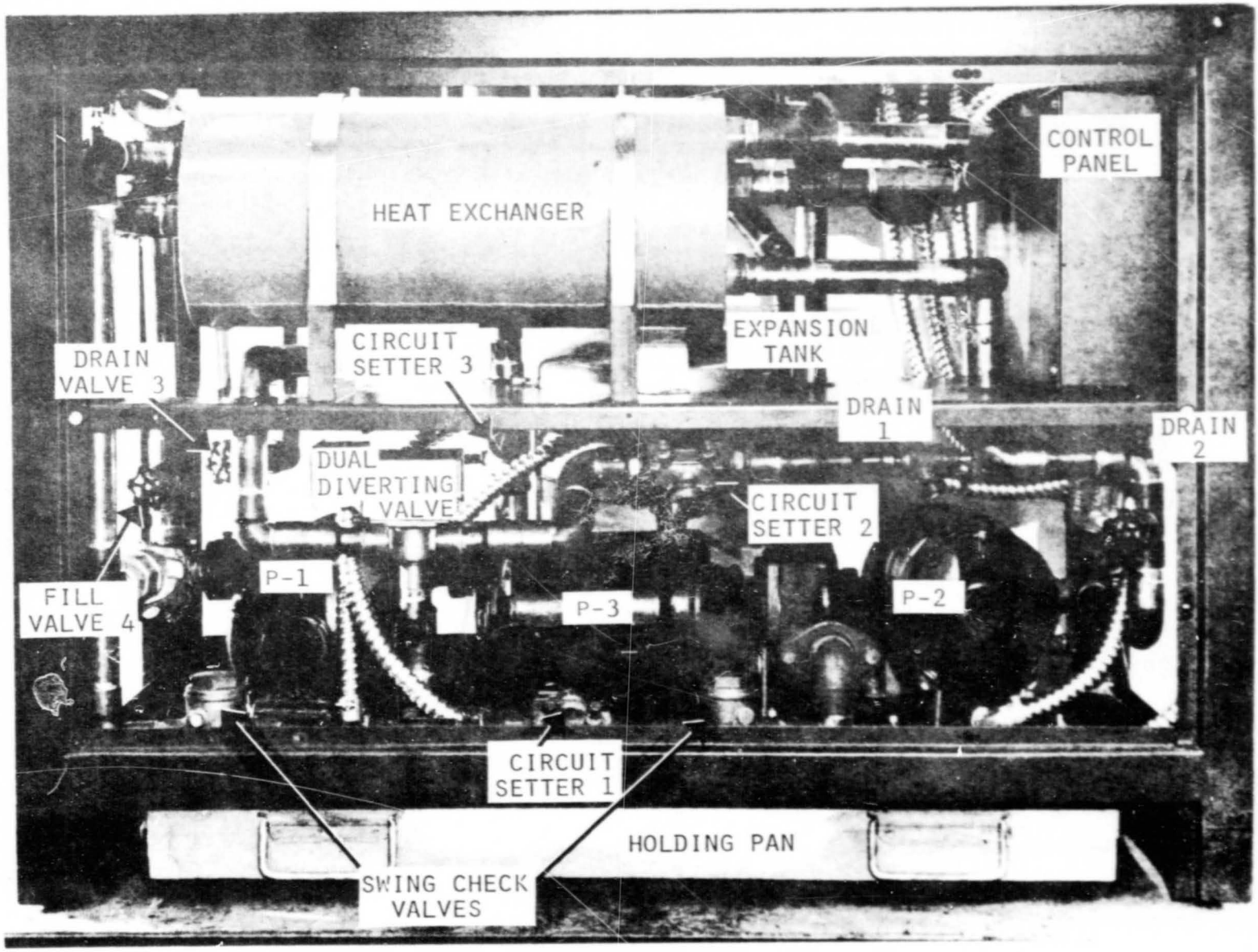


Figure 3-1. SK142065-ETM-2 Top View



3-7

Figure 3-2. SK142065-ETM-2 Front View

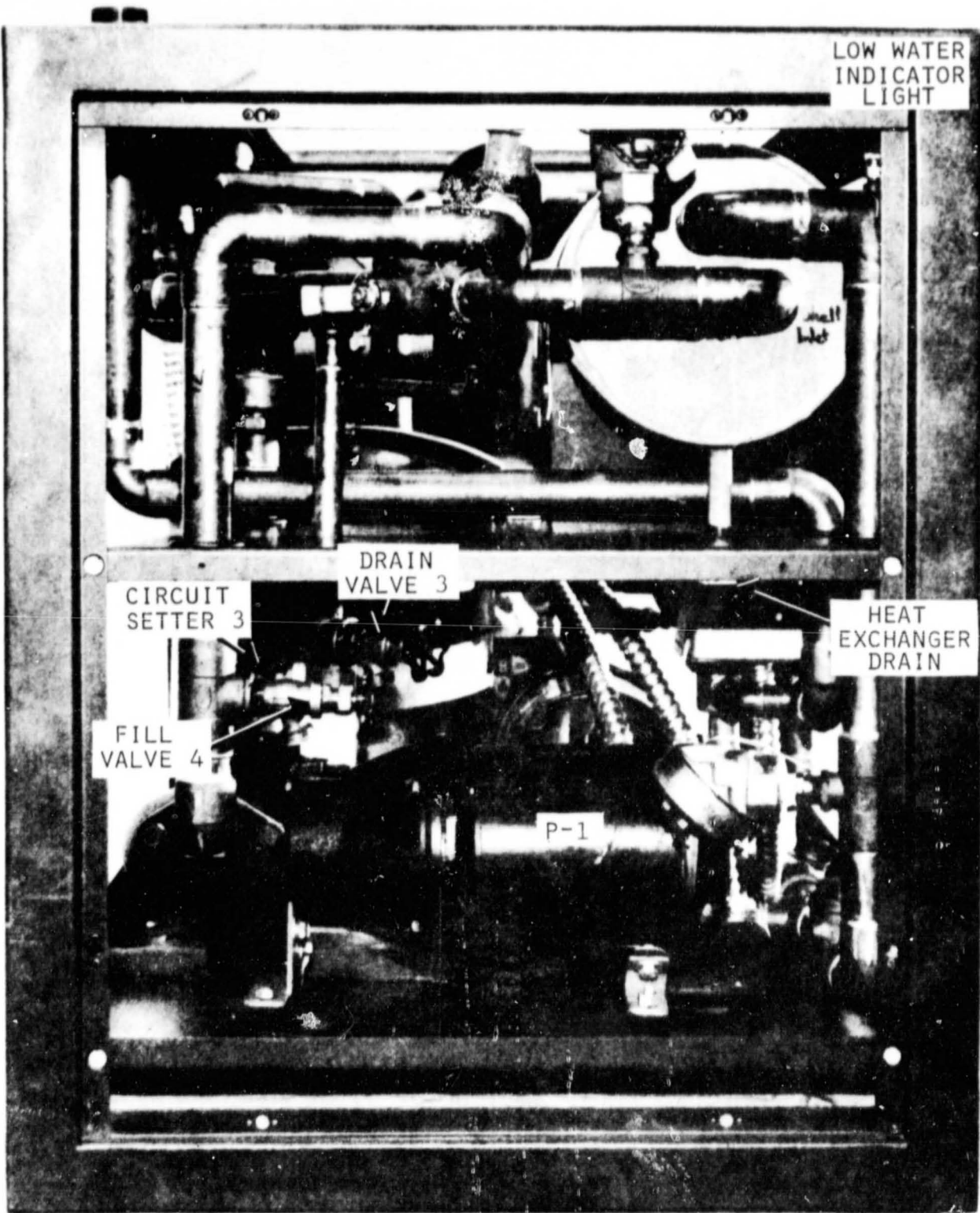


Figure 3-3. SK142065-ETM-2 Left Side View

Collector Loop Refilling Procedure

1. Drain and Refill system at night or at dusk only.

2. Drain collector loop if necessary according to following steps:
 - a. Note: Ethylene glycol is a toxic fluid, do not dump in floor drain, sewer or storm sewer. Dispose of properly.
 - b. Connect a hose to drain valve #3 and run into a 5 gallon pail.
 - c. Open drain valve #3 to drain collectors and piping.
 - d. Operate control valve V1 to drain fluid from piping to Purge Unit.
 - e. Remove drain pan under Energy Transport Module (ETM) and empty fluid, dispose of properly.

3. Flush system with clean water by the following steps:
 - a. Note: Dispose of flushing water properly as above.
 - b. Leave hose on drain valve #3, run to 5 gallon pail.
 - c. Open drain valve #3
 - d. Connect another hose from cold water faucet in house to fill valve #4.
 - e. Close ball valve in ETM (red handle).
 - f. Open cold water faucet, open fill valve #4 and run pump P1 to flush system.
 - g. Flush for several minutes.

- h. Operate control valve V1 to flush piping to Purge Unit.
 - i. Flush for several minutes
 - j. Open ball valve in ETM (red handle)
 - k. Flush for several minutes
 - l. Flush as above until water coming out of hose is clean
 - m. Stop pump P1
 - n. Close cold water faucet. Close fill valve #4 and remove hose.
4. Drain collector loop as in part 2 above.
5. Refill system with new ethylene glycol according to following steps:
- a. Make new collector loop solution by mixing new ethylene glycol with clean water in a barrel or garbage can to a mixture of 45% to 50% ethylene glycol by volume. After filling system pressurize with clean water to provide a final solution of 40% ethylene glycol by volume (approx.). Procure at least 20 gallons of ethylene glycol to make the required 38 gallons of solution. Add ethylene glycol and water to barrel periodically during filling according to above instructions.
 - b. Close drain valve #3.
 - c. Pump solution into collector loop by either of following methods:
 - 1. Procure a positive displacement pump having an available pump head of 50 feet minimum. Place pump and barrel in basement and pump solution thru a hose into fill valve #4.

OR

2. Procure a small submersible sump pump having an available pump head of 15 to 20 feet. Place solution barrel on second floor balcony of house, lower sump pump into barrel and run a hose from the pump discharge down to fill valve #4 in ETM.
- d. Using a ladder climb up onto lower roof at lower bank of 6 solar collectors. Remove flashing over top collector header at left end of collector bank at point A. Open vent valve.
- e. Using ladder climb up onto upper roof and climb up to the top of the upper bank of 22 solar collectors. Remove flashing over top collector header at left end of collector bank at point B. Open vent valve.
- f. Monitoring vent valve at point A, open fill valve #4 and start sump pump.
- g. Operate control valve V1 periodically to fill piping to Purge Unit.
- h. Vent air in ETM at air vent and heat exchanger periodically.
- i. Leave vent valve at point A open until solution starts coming out then close valve. Run pump P1 if necessary.
- j. Run pump P1.
- k. Monitor vent valve at point B. Leave open until solution starts coming out, then close valve. Open vent valve periodically to vent air in header.
- l. Let system circulate for 20-30 minutes.
- m. Vent air in system at vent valves periodically.

- n. Vent air in ETM at air vent and heat exchanger periodically.
- o. Operate control valve V1 periodically to fill piping and remove air in lines to Purge Unit.
- p. Repeat l. -o. until system is full of solution and all air has been removed. The system should require 36 to 38 gallons of solution.
- q. Close fill valve #4.
- r. Stop sump pump and remove hose
- s. Connect a hose from cold water faucet to fill valve #4
- t. Open cold water faucet and fill valve #4. Pressurize system to 25 psig on pressure gauge.
- u. Close fill valve #4, close cold water faucet and remove hose.
- v. Run pump P1 and operate control valve V1 periodically to verify that the system is filled and all air has been removed.
- w. Re-install flashing on roof at points A and B and re-caulk as required.

SECTION 4
ROUTINE MAINTENANCE

The Solar Heating System requires only a small amount of routine maintenance. The elements requiring maintenance are broken down by subsystems and are described below.

COLLECTOR SUBSYSTEM

The collector subsystem components requiring routine maintenance are the solar collectors and the purge unit.

Solar Collectors (LSC 18-1)

Normal rainfall will usually suffice for cleaning. However, inspect spring and fall for dirty cover glass. Clean glass using a soft clean cloth, mild soap or detergent and clean rinse water. Alkalies can stain the glass if allowed to remain in contact too long.

Purge Unit (HRW-1-30)

Inspect spring and fall for debris on coil. Clear debris from coil with brush - unit may be flushed with water hose if necessary. Lubricate motor in accordance with guide on motor.

STORAGE SUBSYSTEM

The water in the storage tank should have the inhibitor and the water condition checked annually. If the tank water has a pungent odor or dark discolorization,

drain tank and refill with clean water adding inhibitor as called out in Section 3.

The inhibitor pH level should be between 7.0 and 9.0. Draw a small amount of water from the storage tank drain valve. Using a pH test kit, dip a short piece of test paper in the fluid drainoff. Observe the color of the moistened portion and compare to color chart with kit. The desired pH is 8.0 or higher. If the pH is less than 8.0, add 5 gallons of Product No. 284 made by Normal Chemical Co., 1630 Carroll Ave., St. Paul, Minnesota, or equivalent to reach a value of 1200 mg/l. (1200 ppm) of nitrite base.

Adding inhibitor and filling tank may be done through the manhole in the tank top. Tank may be drained by connecting drain hose to tank drain on bottom of tank.

AUXILIARY ENERGY AND SPACE HEAT SUBSYSTEM

The heat pump indoor unit should have annual checks on the following:

- check and clean blower wheel
- lubricate blower motor
- replace filter media*
- check unit operation

*Filter should be checked monthly during heavy operation and replaced as needed.

HOT WATER SUBSYSTEM

To assure long life and efficiency, the water heater tank should have a small amount of water drained periodically. Once every month or two the drain valve should be opened and the water allowed to run until it flows clean. This will help prevent sediment buildup on the bottom of the tank.

ENERGY TRANSPORT SUBSYSTEM

The Energy Transport Module (ETM-1) has three pumps that should be lubricated every three months. Proper lubrication is the most important single factor in obtaining long life and trouble free operation. Each oil cup, two on motor and one on the pump, should be filled with #20 nondetergent motor oil.

Transfer Fluid (SR-1), the ethylene glycol and water mixture, contains corrosion inhibitors. An annual test of the fluid is necessary to avoid plumbing decay. DO NOT ADD CHROMATE INHIBITORS TO SYSTEM. Using a standard pH test kit, dip a short piece of test paper in a small amount of fluid drawn from drain valve #3 in ETM. Observe the color of the moistened portion and compare to color chart with kit. The desired transfer fluid pH is 8 or higher. If the pH is less than 8, acids are forming in the fluid. The dwelling owner should call the solar system man to add inhibitor to system. Use Figure 4-1 to determine the correct quantity of inhibitor to be added. After 30 minutes of system operation, recheck pH level for proper value.

If the pH is less than 8, the inhibitor is becoming depleted, and adding inhibitor to protect the system is recommended. Such inhibitor is readily available from the Dow Chemical Company in five-gallon lots. Since the inhibitors are specially designed for Dowtherm SR-1 heat transfer medium, other type inhibitors should never be mixed with this material.

CONTROL SUBSYSTEM

The control subsystem does not require any periodic maintenance. This subsystem can be used to check system operation, as shown in Appendix A.

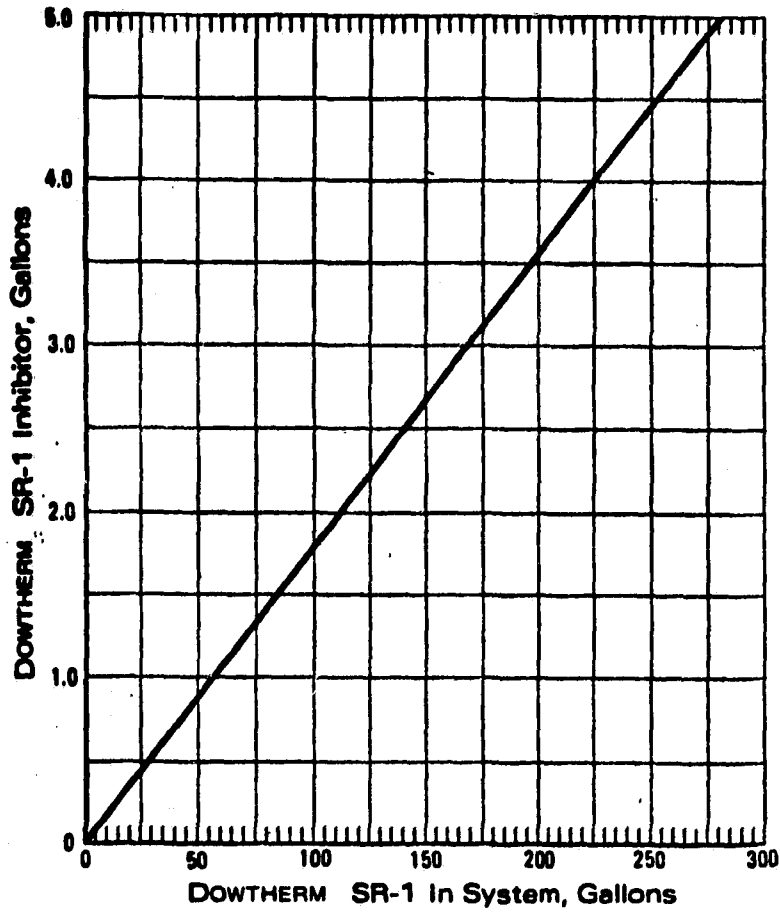


Figure 4-1. Quantities of Inhibitor for DOWTHERM to Recharge System Containing DOWTHERM

SECTION 5
MAINTENANCE SCHEDULE

Table 5-1 outlines the routine maintenance required for the single-family Solar Heating System.

Table 5-1. Routine Maintenance

Frequency	Activity	Reference	
		Section	Appendix
Quarterly every 3 monts	Check heat pump indoor unit air filter	-	E
	Hot water heater sediment drain	4	-
	ETM pump lubrication	-	E
Semi-Annual or Seasonal	Clean Collector Glass	4	B
	Clean purge unit	4	B
	Clean heat pump outdoor unit	-	E
Annual	Storage tank fluid check	4	-
	Service heat pump indoor unit	4	E
	Solar collector fluid check	3,4	-

APPENDIX A

CONTROL SUBSYSTEM

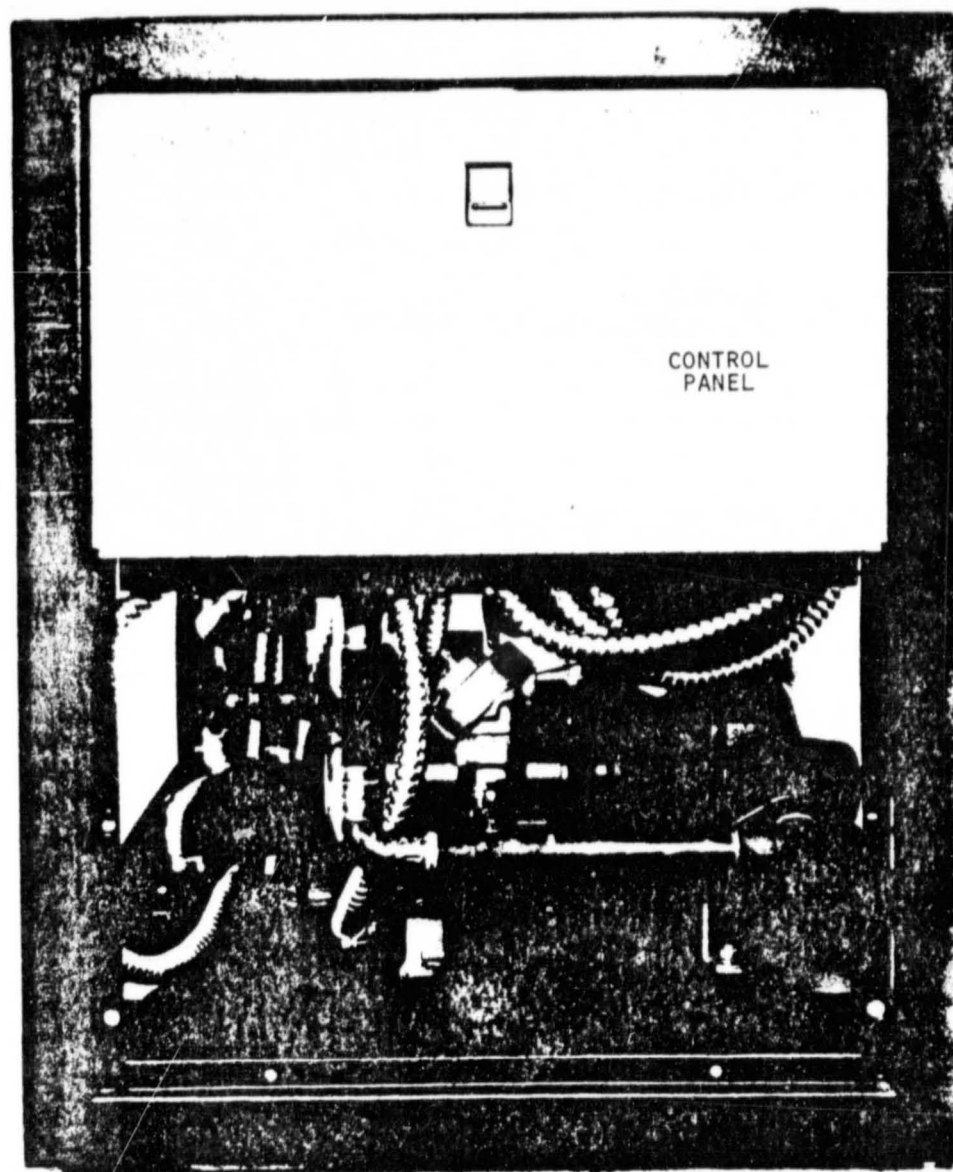
Control Panel

Thermostat

Aquastat Controllers

Honeywell

SOLAR-HEAT PUMP CONTROL PANEL



A-1

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

INSTALLATION

CAUTION

1. Installer must be a trained, experienced service technician.
2. Disconnect power supply before connecting wiring.
3. Conduct thorough checkout when installation is complete.
4. Shield the collector with sensor against possible over-temperature conditions prior to system operation.
5. Wire additions to the leadwire must be capable of withstanding a temperature of 450°F (232°C).

Install C773 as a collector sensor using the mounting clip provided and No. 8 or 10 screw. Install collector sensor shield.

Temperatures in excess of 450°F (232°C) will damage the sensor. Shield the collector with sensor against possible overtemperature conditions prior to system operation. *Do not mount collector sensor to collector fluid channels.*

MOUNTING ELECTRONIC TEMPERATURE SENSORS

Follow the system manufacturer's recommendations for the best location of the sensor. Each sensor should be located so that it experiences the most useful temperature for proper system operation.

Mount C773 in storage tank using an immersion well as follows:

1. Drain system fluid to a point below the sensor fitting.
2. Screw the well into the threaded fitting. Use an approved pipe dope or Teflon tape to seal the threads.
3. Refill system and check for leaks.
4. Insert the sensor probe into the immersion well until it bottoms.
5. Attach retainer clamp groove on well spud. Fit wires in clamp groove and lightly tighten screw. Do not overtighten. If a remote sensor wiring compartment is used, secure the sensor with the spring clip instead of the retainer clamp.

WIRING

All wiring must comply with applicable codes and ordinances. The ETM has three 1/2 inch conduit connections for control wiring. (See Figure 1.)

Pressure terminal connections are used for the wiring hookup.

If the amount of electronic temperature sensor cable used exceeds 100 feet (30.5 m), use No. 14 wire and grounded metallic conduit or shielded cable. Connect the shield to ground at the panel. Grounded metallic conduit and shielded cable (such as Belden 8762 or equivalent) minimize possible radio frequency signal interference. Wire additions to the leadwires must be capable of withstanding maximum collector stagnation temperatures if installed within the collector.

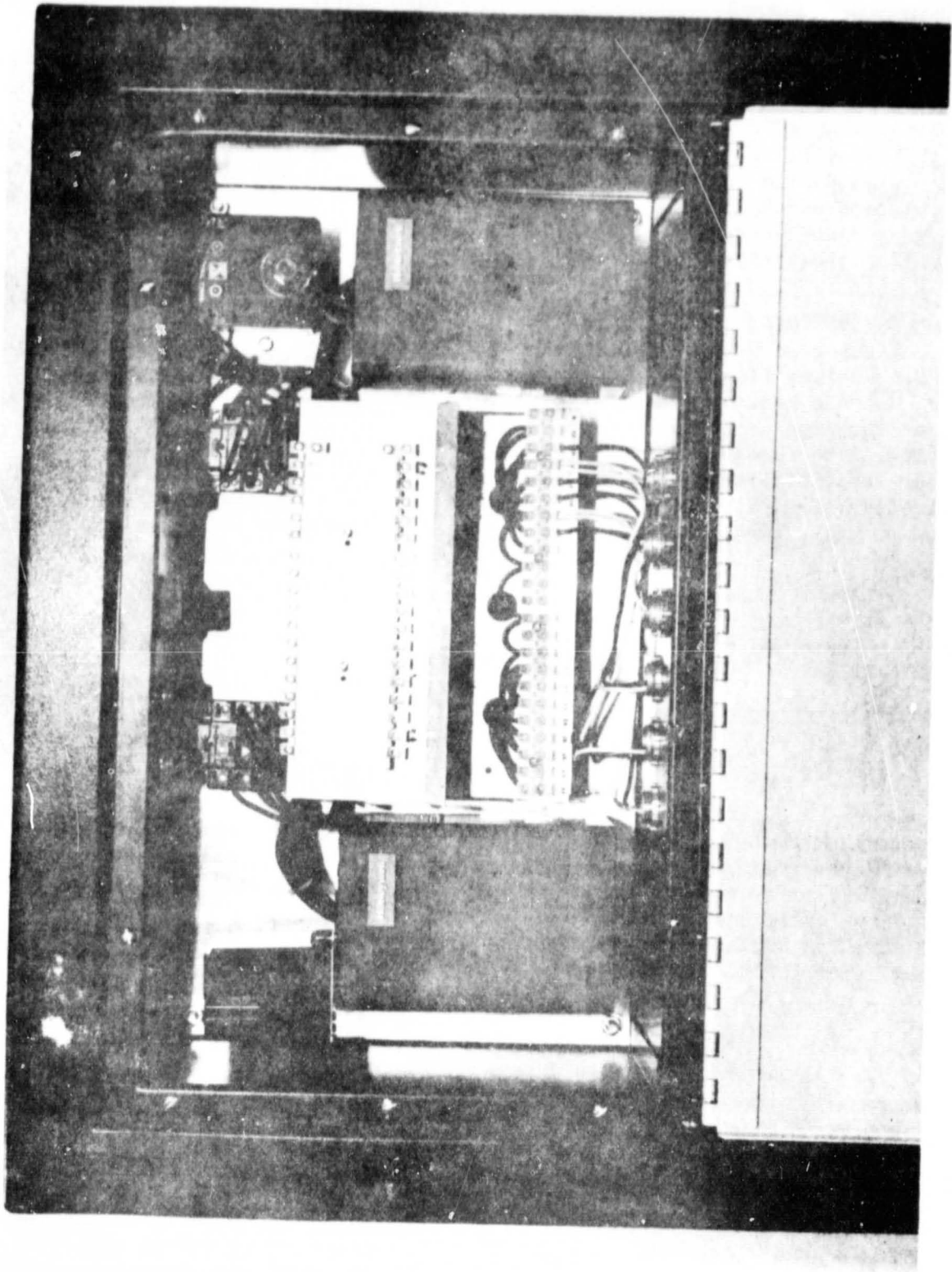


Figure 1. Control Panel Installed in Energy Transport Module

ADJUSTMENTS AND CHECKOUT

ADJUSTMENTS

AUTO-STOP-ON SWITCHES: For normal operation, the panel switches should remain in the AUTO position. The ON and STOP positions of these switches are useful during installation and calibration of the heating system. They may also be used for manually operating the system if necessary.

COLLECTOR SETPOINT POTENTIOMETER: The collector setpoint potentiometer establishes the minimum fluid temperature that the heating system will accept from the collector for direct heating of the house. Set the collector setpoint potentiometer to the desired setting; 105°F (40°C) is the recommended setting.

CHECKOUT

AUTO-STOP-ON SWITCHES: One by one, set the AUTO-STOP-ON switches in the ON position to check that the pumps and control valve have been wired correctly and that they are operating properly. Set to AUTO position for system checkout.

HEAT PUMP: Complete all electrical power wiring to heat pump outdoor unit, heat pump indoor unit and electric coil. Complete all control wiring to control panel.

PROCEDURE: Follow instructions in Table 1 for checkout of all modes of operation.

OPERATION

OPERATION

Space heating is controlled by a two-stage heating thermostat. First-stage heating utilizes solar energy if available, while second-stage heating will supply auxiliary energy. The system control logic is as follows:

- Collect solar energy when available. Store energy under no-load conditions.
- Provides energy directly to load on demand. Use direct solar energy before stored energy.
- Use storage energy when direct solar energy is not available.
- Use direct or stored solar energy before auxiliary energy.

DIRECT HEATING FROM COLLECTORS

Whenever the collector plate temperature T_p is greater than 105°F (adjustable) and there is a call for heating from the space thermostat, pumps P₁ and P₂ are activated. Valve V₂ is positioned to direct flow to the heating coil. The heat pump indoor unit fan is activated to provide warm air to the space.

An overtemperature limit on the heat pump indoor unit fan will cause valve V₂ to direct flow to the storage tank if the heating coil leaving air temperature exceeds 140°F. Direct heating operation will continue until the space thermostat is satisfied or until the collector plate temperature has dropped to 90°F.

Table 1. Cc Subsystem Checkout Procedure

CONTROL SUBSYSTEM CHECKOUT PROCEDURE												
OPERATING MODE	DIS-CONNECT	ADJUST	SPACE THERMOSTAT SETTING	SYSTEM RESPONSE (E = ENERGIZED, DE = DE-ENERGIZED)								
				PUMP P ₁	PUMP P ₂	PUMP P ₃	VALVE V ₁	VALVE V ₂	FAN	HEAT PUMP OUTDOOR UNIT	ELECTRIC COIL	PURGE UNIT
Direct Heating From Collectors	Collector Sensor, T _p at terminal HI	-	Energize First Stage Heating H1	E	E	DE	DE	DE	E	DE	DE	DE
	T _w Sensor at relay 7K terminal HI											
Direct Heating and Auxiliary Heating	Collector Sensor, T _p at terminal HI	-	Energize Second Stage Heating H2	E	E	DE	DE	DE	F	E	E (only after approx. (10 min.))	DE
	T _w Sensor at relay 7K terminal HI											
Heating From Storage	T _w Sensor at relay 7K terminal HI, Short Sensor T _p , jumper from Panel HI to CH	Storage Tank Aquastat T _{st} , set at minimum setting	Energize First Stage Heating H1	DE	DE	E	DE	DE	E	DE	DE	DE
Heating From Storage and Auxiliary Heating	T _w Sensor at relay 7K terminal HI, Short Sensor T _p , jumper from Panel HI to CH	Storage Tank Aquastat T _{st} , set at minimum setting	Energize Second Stage Heating H2	DE	DE	E	DE	DE	E	E	E (only after approx. (10 min.))	DE
First Stage Auxiliary Heating (No Solar)	Short Sensor T _p , jumper from Panel HI to CH	Storage Tank Aquastat T _{st} , set at maximum setting	Energize First Stage Heating H1	DE	DE	DE	DE	DE	E	E	DE	DE
First and Second Stage Auxiliary Heating (No Solar)	Short Sensor T _p , jumper from Panel HI to CH	Storage Tank Aquastat T _{st} , set at maximum setting	Energize Second Stage Heating H2	DE	DE	DE	DE	DE	E	E	E (only after approx. (10 min.))	DE
Charging Collected Solar Energy To Storage Tank	Collector Sensor, T _p at terminal HI	-	Set to OFF position	E	E	DE	DE	E	DE	DE	DE	DE
Purge Excess Energy (Heat Rejection)	Collector Sensor, T _p at terminal HI	Purge Aquastat T _{cd} , set at minimum setting	Set to OFF position	E	DE	DE	E	E	DE	DE	DE	E
Ventilation	-	-	Set Fan Switch to ON position	DE	DE	DE	DE	DE	E	DE	DE	DE
Cooling	-	-	Energize Cooling C1	DE	DE	DE	DE	DE	E	E	DE	DE

On a second stage call for heat, the heat pump is energized to provide additional heat to the space. A differential temperature controller senses the solar heating coil inlet water temperature, T_w , and the heat pump leaving air temperature, T_{HP} . If that ΔT is greater than 10°F , valve V_2 will permit solar water to flow thru the solar heating coil. If the ΔT falls below 5°F , valve V_2 will be energized to divert flow to the storage tank.

The auxiliary electric heating coil is available for additional auxiliary heating whenever the outdoor ambient temperature is below the normal heat pump balance point temperature, in this case 35°F . The auxiliary electric heating coil is also controlled by the second stage of the thermostat and is energized after a 9-1/2 minute time delay. The time delay enables the heat pump to satisfy the second-stage heating demand under most conditions.

HEATING FROM STORAGE

Whenever the collector plate temperature T_p is less than 90°F (adjustable), and there is a call for space heat, pump 3 is activated to use heat from the storage tank for space heating. Valve V_2 is positioned to direct flow to the heating coil. The heat pump indoor unit fan is activated to provide warm air to the space. Pumps P_1 and P_2 are not allowed to operate during this mode. The high temperature limit located on the fan functions as previously described.

The second stage of the thermostat controls auxiliary heat from the heat pump and the electric heating coil as described above.

STORAGE CHARGING

Storage charging is accomplished whenever there is no call for heat and the collector plate temperature T_p is greater than the storage tank temperature T_{SB} by 18°F (adjustable). Pumps P_1 and P_2 are activated, and valve V_2 is repositioned to direct flow to the storage tank. If this temperature difference falls to less than 3°F (adjustable), the storage charging mode is terminated.

AUXILIARY HEATING

Whenever solar heating is being utilized, either direct or stored, auxiliary heating is available through the second stage of the space thermostat as described above. When solar heat is not available, auxiliary heat is provided by the heat pump through the first stage of the space thermostat. Additional auxiliary heat is available from the electric heating coil through the second stage of the thermostat as described above. An emergency heat switch on the space thermostat bypasses the heat pump balance point thermostat, $T-1$, and enables the system to utilize the electric heating coil for auxiliary heat under all conditions in the event that the heat pump is shut down or removed for servicing.

VENTILATION

By placing the thermostat subbase fan switch in the "ON" position, the thermostat will automatically energize the fan in the heat pump indoor unit.

COOLING

Conventional direct expansion cooling is provided by the heat pump as controlled by the cooling section of the space thermostat.

HEAT REJECTOR

A purge control aquastat T_{CD} on the discharge of the collectors allows pump P_2 to run in direct heating or storage charging modes if there is no overtemperature condition. If the temperature of the collector loop fluid rises above 210°F (adjustable), pump P_2 is shut off, and valve V_1 is energized, diverting flow through the purge unit. The purge unit fan is energized forcing

outdoor air across the purge coil to cool the collector fluid.

DOMESTIC HOT WATER HEATING

Whenever domestic hot water is drawn from the water heater, it is replaced by preheated water from a coil in the storage tank. A thermostatic mixing valve is used to regulate the hot water supply from the water heater to 140°F .

TROUBLESHOOTING

When the Control Panel does not appear to be operating properly, the following steps may be taken to troubleshoot system problems:

1. Determine the temperatures at the differential temperature controller and solar aquastat controller sensors. For the differential temperature controller, use a high resistance ohmmeter to measure the resistance across the remote sensors. Refer to Figure 2 to convert the resistance measurement to a temperature reading.

Determine the temperature that the solar aquastat is experiencing by adjusting the set points with a screwdriver and listening for the relays to operate when the relay in the aquastat changes state. Observe temperature scale for temperature reading.

2. Read the OPERATION section to determine which mode(s) the heating system should be operating in based on sensor temperatures and the space temperature.

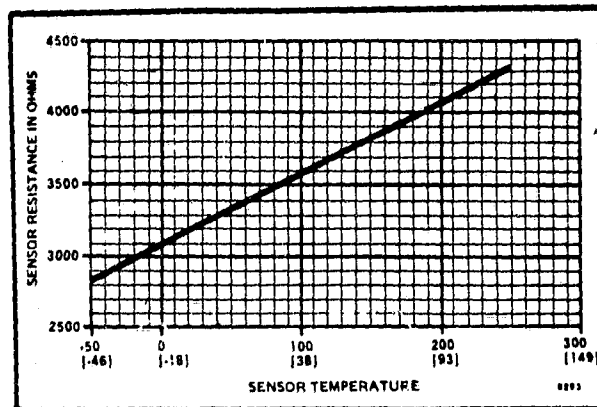


Figure 2. Converting Sensor Resistance into Degrees F (C).

3. Check the location of the sensors for the differential temperature controller and solar aquastat controller. Make certain that each sensor is located so as to measure the most appropriate temperature for proper system operation. If the sensors are not providing correct temperature readings, change the location and mount properly.

4. Check that the solar aquastat is operating properly by adjusting the control point of the aquastat limit controller and listening for the relays to operate. Reset to the proper temperature.

5. Check that the differential temperature controller relay is operating properly by disconnecting the wire to high temperature terminal HI. Relay should pull in. Reconnect sensor wire to high-temperature terminal HI and disconnect wire to low-

temperature terminal LO. Relay should drop out. Reconnect sensor wire to low-temperature terminal LO.

6. Check system operation on a mode-by-mode basis using the procedures of Table 1.

7. If necessary, check for proper relay operation. See Figure 3 for internal wiring schematic of control panel.

8. For replacement parts list, see Figure 4.

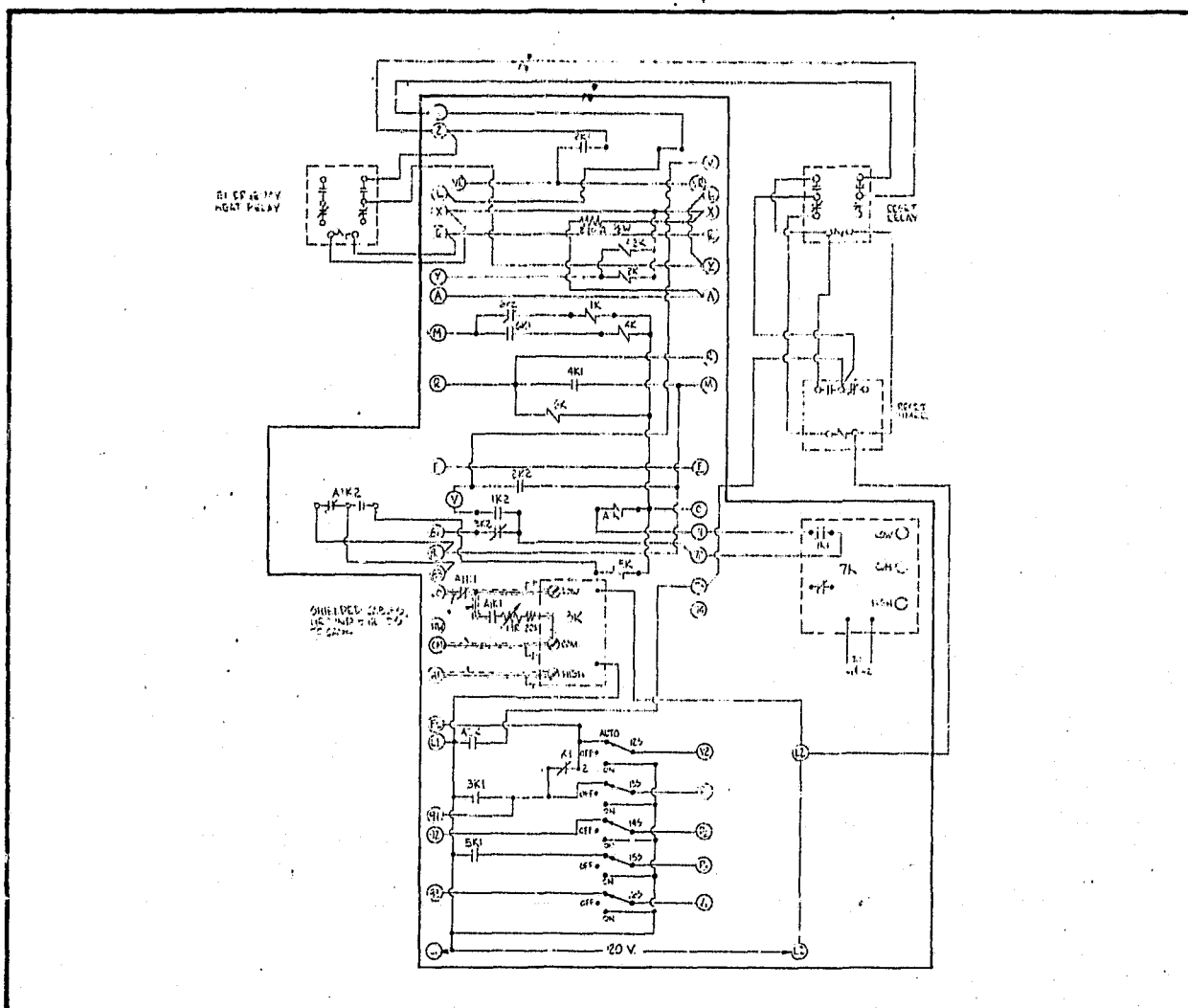
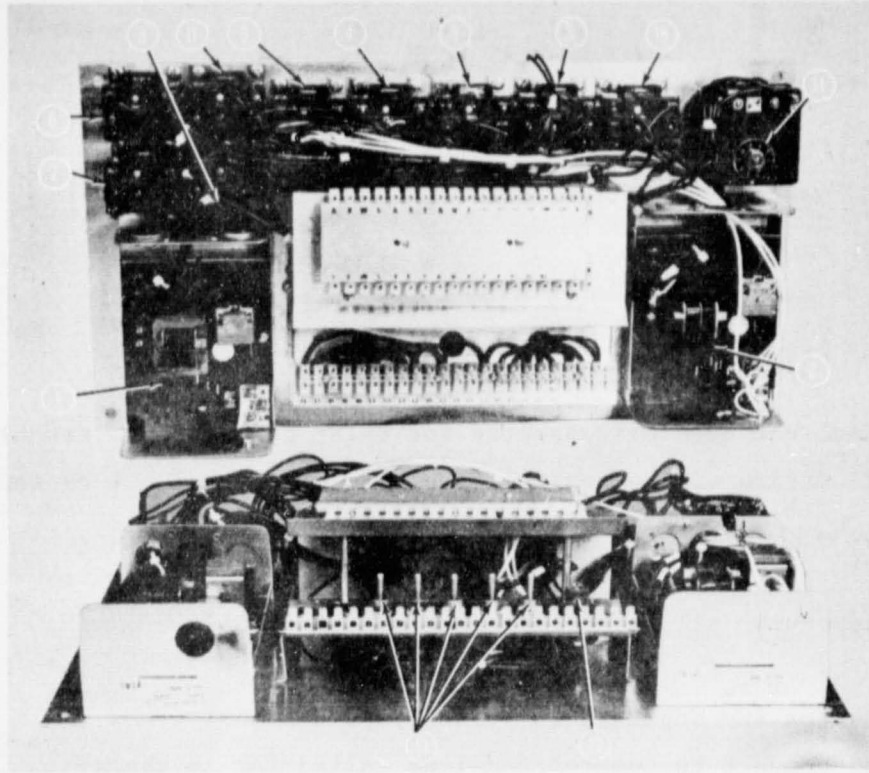


Figure 3. Control Panel Wiring Schematic



LOCATION	SYMBOL	DESCRIPTION	PART NO.	MANUFACTURER
1	7K	Differential Temperature Controller	R7412A1012	Honeywell
2	3K	Diff. Temp. Controller	R7412A1012	Honeywell
3	1K	Switching Relay	R8222V1003	Honeywell
4	A1K	Switching Relay	R8222N1011	Honeywell
5	2K	Switching Relay	R8222N1011	Honeywell
6	A2K	Switching Relay	R8222B1067	Honeywell
7	4K	Switching Relay	R8222N1011	Honeywell
8	5K	Switching Relay	R8222B1067	Honeywell
9	6K	Switching Relay	R8222N1011	Honeywell
10	RESET	Switching Relay	R4222N1002	Honeywell
11	EM.HT	Switching Relay	R8222N1011	Honeywell
12	19R	Potentiometer	105364F	Honeywell
12	20R	Resistor	802139DDCB	Honeywell
13	---	Manual Switch	113700	Honeywell
14	TIMER	Reset Timer	DA21004	General Time

Figure 4. Replacement Parts List

**SOLAR-HEAT PUMP
CONTROL PANEL
SK-142183**

INTERNAL WIRING CHECKOUT

If the control panel has been disconnected for relay replacement, trouble-shooting, etc., the internal wiring of the control panel can be checked out by the following procedure:

- 1.) Disconnect all field wiring to control panel.
- 2.) Provide two separate 24-volt AC, 40VA transformers and connect to control panel as called for in check-out procedure.
- 3.) Connect 120V power to L1 (line) and L2 (ground) as called for in checkout procedure.
- 4.) Check out each mode of operation as described in following checkout procedure.

ENERGY TRANSPORT MODULE CHECK-OUT (New Castle Site) ETM-2

SET-UP all switches in AUTO position, 120V to L1 and L2
24V between V and C, separate 24V between VR and X

NOTE: Disconnect all power after each test

1. DIRECT HEATING

- a.) Jumper V to M
- b.) CM and HI open, Jumper CM to LO
- c.) Jumper COM to LO on 7K
- d.) Jumper 91 to 92
- e.) OPERATION - P₁ and P₂ should run
- f.) Proceed to next test

2. FAN HIGH LIMIT

- a.)-d.) Same as 1a-d above, (simulate direct heating)
- e.) OPERATION - P₁ and P₂ should run
- f.) Jumper FL to L1
- g.) OPERATION - V₂ should operate
- h.) Remove jumper from FL to L1.
- i.) Proceed to next test

3. DIRECT HEATING WITH HEAT PUMP AND ELEC. HEAT ON SECOND STAGE CALL FOR HEAT

- a.
- b. Same as 1a, b, c, d above
- c.
- d.
- e.) OPERATION - P₁ and P₂ should run
- f.) Jumper L to L
- g.) Jumper VR to Y
- h.) OPERATION - 24V between M and C
 - Reset timer runs,
 - After 9 1/2 minutes (approx.) 24V between Y and X
- i.) Remove all jumpers for next test

4. HEAT FROM STORAGE

- a.) Jumper V to M
- b.) Jumper CM to HI
- c.) Jumper COM to LO on 7K
- d.) Jumper 81 to 83
- e.) OPERATION - P₃ should run
- f.) Proceed to next test

5. HEAT FROM STORAGE, HEAT PUMP COMES ON (SECOND STAGE)
AND STORAGE WATER TEMP. TOO LOW; HEAT FROM STORAGE
IS SHUT-OFF

- a.-d.) Same as 4 a-d. above
- e.) OPERATION - P₃ should run
- f.) Jumper VR to Y
- g.) OPERATION - 24V between M and C
- h.) Remove jumper COM to LO on 7K
- i.) Jumper COM to HIGH on 7K
- j.) OPERATION - P₃ should stop
- k.) Remove all jumpers for next test

6. STORAGE CHARGING

- a.) Jumper CM to LO
- b.) Jumper 91 to 92
- c.) OPERATION - P₁, P₂ and V₂ should operate
- d.) Proceed to next test

7. PURGE

- a.)-b.) Same as 6 a, b above, (simulate storage charging)
- c.) OPERATION - P₁, P₂ and V₂ should operate
- d.) Remove jumper 91 to 92
- e.) Jumper 91 to 93
- f.) OPERATION - P₂ should stop
 - P₁ and V₂ should continue to operate
 - 120V between V1 and L2
- g.) Remove all jumpers for next test

8. HEAT PUMP ON FIRST STAGE HEAT (NO SOLAR AVAILABLE)

- a.) Jumper V to M
- b.) Jumper CM to HI (COM to HIGH on 3K)
- c.) Jumper 81 to 82
- d.) OPERATION - 24V between M and C
- e.) Proceed to next test

9. HEAT PUMP ON FIRST STAGE HEAT (NO SOLAR AVAILABLE)
SECOND STAGE CALL FOR HEAT IS ELEC. HEAT

- a.)-c.) Same as 8-c. above
- d.) OPERATION 24V between M and C
- e.) Jumper L to L
- f.) Jumper VR to Y
- g.) OPERATION - after 9 1/2 minutes (approx.) between Y and X
- h.) Remove all jumpers

TESTING OF ETM CONTROL PANEL IS COMPLETE

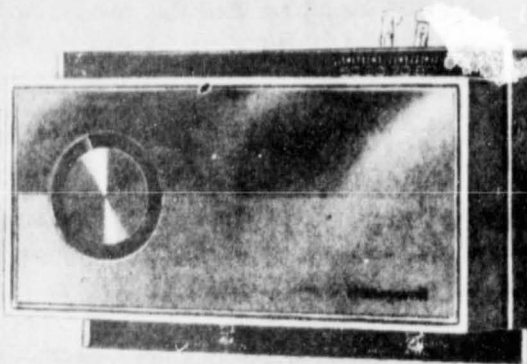
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Honeywell

THESE THERMOSTATS AND SUBBASES PROVIDE LOW VOLTAGE CONTROL OF MULTISTAGE HEATING AND COOLING SYSTEMS INCLUDING HEAT PUMP SYSTEMS.

- T872 Thermostat requires a Q672 Subbase.
- Q672 Subbase provides system and fan switching, wiring terminals, and mounting base for T872 Thermostat.
- T872 Thermostat has silent dust-free mercury switches operated by coiled bimetal elements.
- Q672 Subbase mounts on wall or horizontal outlet box.
- Adapter plate available for mounting Q672 Subbase on vertical outlet box.
- Heat anticipator(s) are adjustable or fixed; cooling anticipator(s) are fixed.
- External levers and scale for temperature setting located on top of thermostat case.
- Cover thermometer on most T872 Thermostat models.
- Locking cover and locking lever screws available for T872 Thermostats.
- Plastic thermostat guards available for T872 Thermostats.
- Key lock cover with tumbler lock available for T872 Thermostats.

MULTISTAGE THERMOSTAT AND SUBBASE



T872R,
Q672L

STANDARD MODELS

T872 THERMOSTATS

ELECTRICAL RATING: 24 to 30V ac.

SWITCHING: Coiled bimetal elements operate mercury switches.

TEMPERATURE ADJUSTMENT: Heating and cooling setting lever, with common scale located on top of thermostat base. Common lever for heating and cooling on T872R.

TEMPERATURE SCALE RANGE: 44 to 86 F [7 to 30 C], standard; optional ranges available.

THERMOMETER RANGE: 52 to 98 F [11 to 36 C].

CHANGEOVER DIFFERENTIAL: 3 F [2 C] minimum between heating and cooling.

INTERSTAGE DIFFERENTIAL:

Standard Models—mechanical differential is 1 F [0.6 C] between heating or cooling stages; operating differential is approximately 1.9 F [1 C] between stages in heating or cooling.

FINISH: Silver bronze.

MOUNTING MEANS: T872 Thermostat mounts on Q672 Subbase. Subbase mounts horizontally on wall or outlet box. Mounts on vertical outlet box with optional 130821A Adapter Plate Assembly. (See Fig. 1)

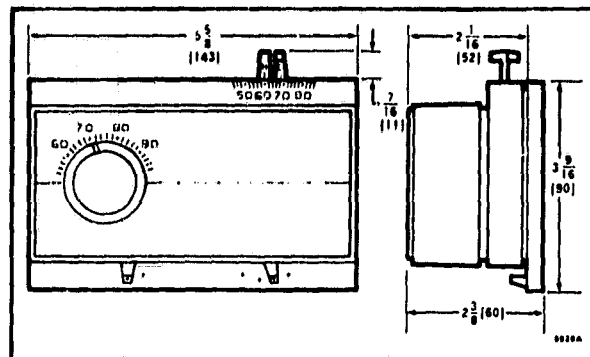


FIG. 1—DIMENSIONS OF T872 THERMOSTAT MOUNTED ON Q672 SUBBASE.

INSTALLATION

CAUTION

1. Installer must be a trained, experienced serviceman.
2. Disconnect power supply to prevent electrical shock and equipment damage.
3. Do NOT short across coil terminals on relay. This may burn out the heat anticipator.
4. Run wires as close to the subbase as possible. To prevent interference with the thermostat linkage, keep wire length to a minimum, and make certain wires do NOT protrude outward beyond standoffs (Fig. 4). Push excess wire back into the hole, and plug hole to prevent drafts from affecting thermostat operation.
5. Do NOT overtighten thermostat captive mounting screws. This may damage the threads in the subbase.
6. Always conduct a thorough checkout when installation is complete.

IMPORTANT

Thermostats are calibrated at the factory using subbases mounted at true level. Inaccurate subbase leveling will cause thermostat control deviation.

LOCATION

Locate the thermostat about 5 feet [1.5 metre] above the floor in an area with good air circulation at average temperature.

Do not mount the thermostat where it may be affected by—

- drafts, or dead spots behind doors and in corners.
- hot or cold air from ducts.
- radiant heat from the sun or appliances.
- concealed pipes and chimneys.
- unheated (uncooled) areas behind the thermostat.

SUBBASE MOUNTING

The subbase is designed for mounting on a wall or horizontal outlet box. (Adapter assembly, Part No. 130821B, with cover plate only is available for covering wall marks from old thermostat.) An adapter assembly, Part No. 130821A, with adapter ring and cover plate is available for mounting on a vertical outlet box. To mount subbase, proceed as follows:

1. At the location selected, prepare an opening for the thermostat wires.

2. Run low voltage thermostat wires to the location, and pull about 4 inches [100 millimetres] through the wall opening.

NOTE: Use color-coded thermostat cable for proper wiring.

3. If mounting the subbase on a vertical outlet box (Fig. 2), install the adapter ring with the 2 screws provided.

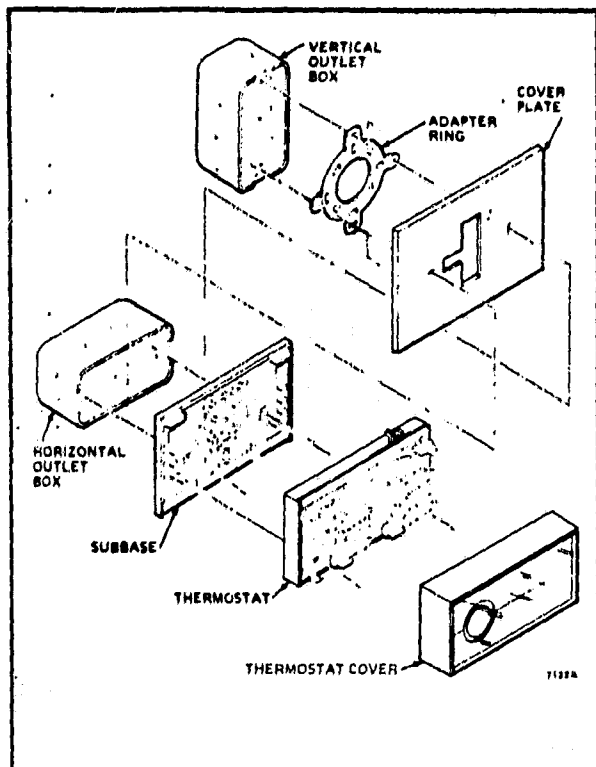


FIG. 2—INSTALLATION OF Q672 SUBBASE ON OUTLET BOX.

4. Pull thermostat cable through cover plate (if used) and subbase opening. Secure the cover plate and subbase with the 2 screws provided, but do not tighten.

Thermostats are calibrated at the factory using subbases mounted at true level. Inaccurate subbase leveling will cause thermostat control deviation.

5. The subbase mounting slots provide for minor out of level adjustments. Level the subbase using a spirit level, as shown in Fig. 3 and tighten subbase mounting screws.

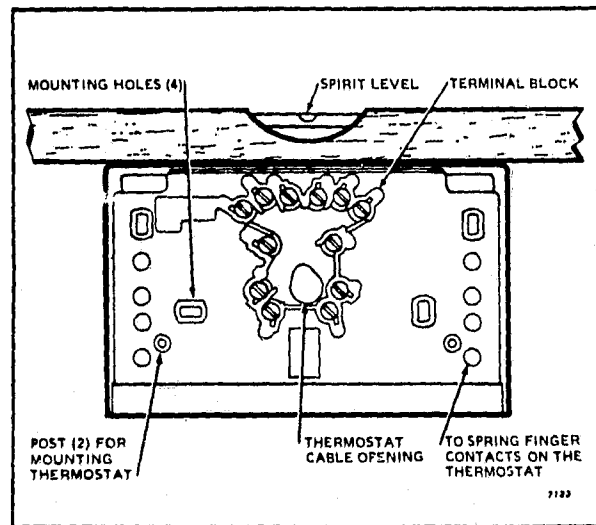


FIG. 3—LEVELING THE SUBBASE.

WIRING

All wiring must comply with local electrical codes and ordinances.

A letter code is near each terminal for easy identification. Typical terminal designation and wiring connections are listed in Tables 1 and 2.

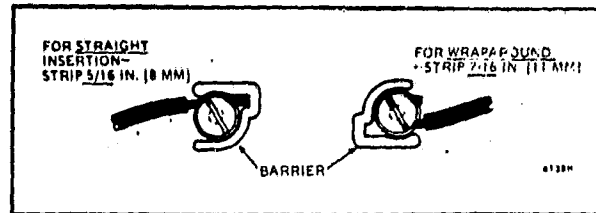


FIG. 4—BARRIER CONFIGURATION.

TABLE 1—TERMINAL DESIGNATIONS

TERMINAL	TYPICAL CONNECTION
B	Heating damper motor; changeover valve (if used).
E	Emergency heat relay.
G	Fan relay coil.
O	Cooling damper motor; changeover valve (if used).
R	Power connection to transformer (internally connected for cooling and heating).
RC	Power connection to cooling transformer.
RH	Power connection to heating transformer.
W ₁	Stage 1 heating control.
W ₂	Stage 2 heating control.
Y ₁	Stage 1 cooling control.
Y ₂	Stage 2 cooling control.
X-X ₁ -X ₂ -C	Clogged filter switch.

TABLE 2—ALTERNATE CONTROL CIRCUIT TERMINAL DESIGNATIONS

ALTERNATE DESIGNATIONS	STANDARD DESIGNATION	TYPICAL CONNECTION	
V	V	R	24 volt power supply
H ₁	—	W ₁	First stage heating
H ₂	Y	W ₂	Second stage heating
C ₁	M	Y ₁	First stage cooling
C ₂	—	Y ₂	Second stage cooling
F	F	G	Fan
—	—	B	Heating changeover
—	R	O	Cooling changeover

The shape of the terminal barrier permits insertion of straight or conventional wrap-around (Fig. 4) wiring connections. Either method is acceptable. When making connections, strip wire to the length specified in Fig. 5.

Follow the equipment manufacturer's wiring instructions, if available, when wiring the subbase. Figure 5 shows internal wiring schematic for this unit.

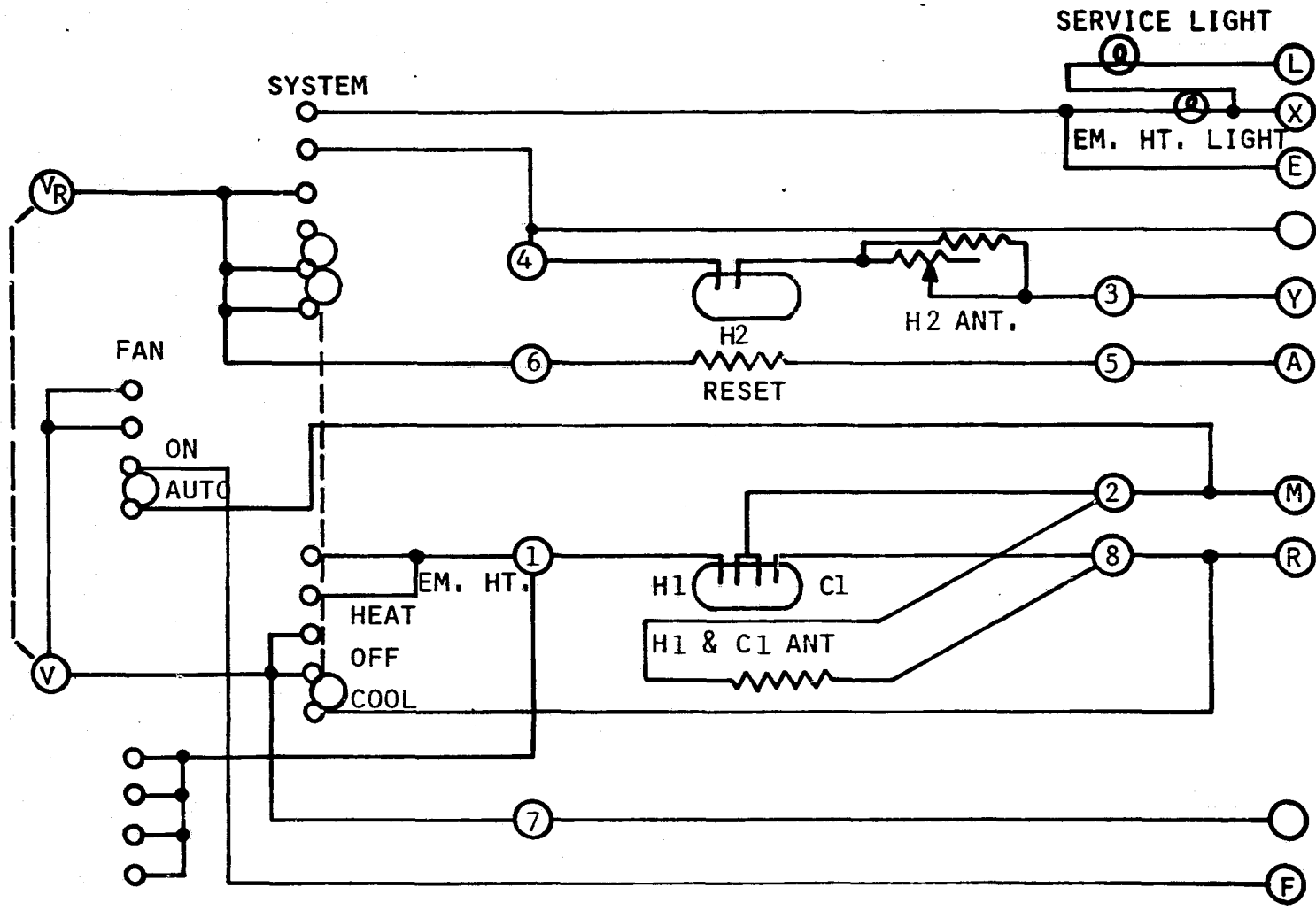


FIG. 5 - INTERNAL SCHEMATIC T872R1131/Q672L1144

SERVICE

CAUTION

Before servicing, disconnect power supply to prevent electrical shock or equipment damage.

THERMOSTAT

T872 Thermostats are accurately calibrated at the factory; **THEY DO NOT HAVE PROVISION FOR FIELD CALIBRATION.**

THERMOMETER

To calibrate the thermometer:

1. Remove thermostat cover by pulling up from the bottom until it clears the locking springs. If cover has optional locking screws, these must be backed out before cover can be removed.

2. Set the cover on a table near an accurate thermometer.

3. After allowing 5 or 10 minutes for stabilization, compare the readings. If they are the same, replace cover and put system into operation. If they are different, recalibrate the thermostat thermometer, step 4.

4. Insert a small screwdriver in the thermometer shaft (Fig. 8) and turn it until the thermometers read the same. When thermometer is calibrated, replace cover and place system and fan switches for desired operation.

NOTE: Hand heat will offset the thermometer reading.

After making each adjustment, wait 5 or 10 minutes for the thermometer to stabilize before comparing.

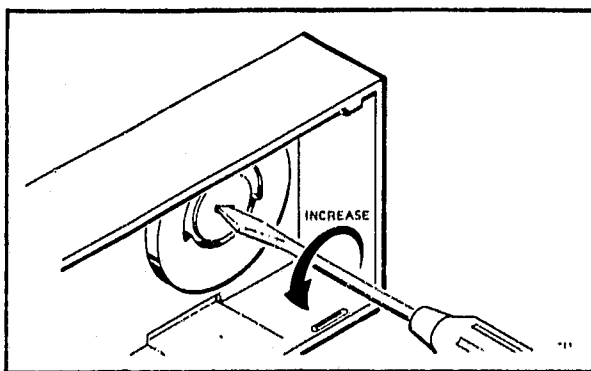


FIG. 8 - THERMOMETER CALIBRATION.

BULB REPLACEMENT

Before replacing bulb, shut off the power supply to prevent shorting out the transformer at the bulb terminals, or move subbase system switch to "OFF."

Replace bulb in subbases with optional malfunction light as follows.

1. Remove the thermostat from the subbase.
2. Remove the snap-on shield that covers the light.
3. Disconnect the field wire from the "X" terminal to prevent shorting out the transformer at the bulb terminals.
4. Snap out the old bulb and replace it with a new bulb, Part No. 129571. The bulb contact should seat in the depression in the socket base. The bulb may be screwed in farther, if necessary, for a better electrical connection. When installing bulb, use needlenose pliers.
5. Reconnect the field wire to terminal "X."
6. Replace the shield and mount the thermostat.

Honeywell

AQUASTAT CONTROLLERS ARE IMMERSION TYPE DEVICES FOR LIMITING OR REGULATING THE TEMPERATURE OF LIQUIDS IN BOILERS, STORAGE TANKS, AND OTHER APPLICATIONS WHERE TEMPERATURE CONTROL OF LIQUIDS IS REQUIRED. AS THE TEMPERATURE OF THE CONTROLLED MEDIUM RISES TO THE SET POINT, EXPANSION OF THE FLUID IN THE SENSING ELEMENT OPERATES THE INTERNAL SWITCH OR SWITCHES.

The L4006, 7, and 8 provide spst switching for high or low limit control of a burner.

The L4006G model has two spst switches that make and break in sequence to provide boiler sequencing.

The L6006 and 8 provide spdt switching for low limit and circulator control.

Models which break contact on a temperature rise to the set point are calibrated for high limit use. They are also suitable for low limit control if a separate high limit control is used.

Ambient compensated models are available to prevent control-point shift caused by temperature fluctuation at the case.

Visible control point scale and external adjustment screw permit easy setting.

Models are available for either horizontal or vertical insertion of the sensing element. The sensing element may be directly immersed or placed in an immersion well.

Remote bulb models are available if the controller must be mounted at a location away from the sensing element.

Remote bulb models may also be used to sense air temperature in ducts and in outside air sensing applications.

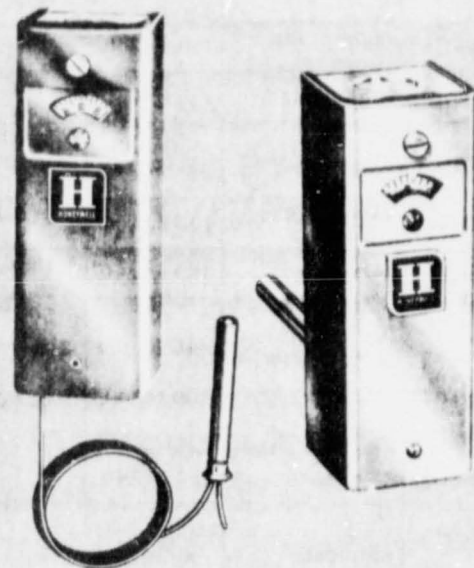
Totally enclosed Micro Switch snap-acting switches are used in all models.

S.K.

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AQUASTAT CONTROLLERS



L4006,7,8; L6006,8

Residential Div. Form Number

60-2104-1

SPECIFICATIONS

SPST MODELS:

MODEL	APPLICATION	RANGE (F)	MIDSCALE DIFFERENTIAL (F)	INSERTION ^a	SWITCHING ON TEMP. RISE	AVAILABLE OPTICNS
L4006A	high or low limit	40 to 180 or 100 to 240	2 or 5 fixed or 5 to 30 adj.	horizontal	breaks	Tradeline models which include well and tube of heat conductive compound. Plastic shield for covering well in water heater applications. 3/4 in. NPT brass spud. Centigrade scale markings. Factory set stops at 160 F, 185 F, 190 F, 200 F, or 220 F. Dial marked WARM, NORMAL, HOT. Insulation depths of 1-1/2, 3, or 5 inches.
L4006B	circulator	40 to 180 or 100 to 240	5 fixed or 5 to 30 adj.	horizontal	makes	3 inch insulation depth. 3/4 inch NPT brass spud.
L4006C	high or low limit	100 to 240	2 or 5 fixed	horizontal direct	breaks	10 in. element. Factory set stop at 205 F.
L4006Eb	high limit	110 to 250	manual reset	horizontal or vertical	breaks	3/4 in. NPT brass spud. 3 in. insulation depth.
L4006G	sequencing	100 to 240	5 fixed interstage 3-10 F adj.	horizontal or vertical	breaks two switches	_____
L4007A	high or low limit	100 to 240	2 or 5 fixed, 5 to 30 adj.	vertical	breaks	Centigrade scale markings.
L4007B	circulator	100 to 240	5 fixed or 5 to 30 adj.	vertical	makes	_____
L4008Aa	high or low limit	40 to 180 or 100 to 240	2 or 5 fixed, 5 to 30 adj.	remote bulb	breaks	5 ft.6 in., 8 ft.6 in. or 10 ft. remote capillary. Factory set scale stop at 120 or 200 F. External adjusting knob. Centigrade scale markings.
L4008Ba	circulator	100 to 240	5 fixed or 5 to 30 adj.	remote bulb	makes	8 ft.6 in. capillary.
L4008Ca	ambient compensated high limit	0 to 70 or 40 to 180	2 or 5 fixed	remote bulb	breaks	7 ft.6 in., 20 ft. capillary or fast response element. External adj. knob. 150 va rating at 120, 240v ac. High limit stamped on case scale lock.

L4008 models continued on page 3

^aCopper well or fitting is supplied with all models except remote bulb type. When ordering, specify boiler tapping size (1/2 or 3/4 inch) and insulation depth.

^bManual reset (trip-free)—Switchbreaks circuit and locks out when controlled medium reaches set point. Controlled temperature must drop 20 degrees below set point before contacts can be manually reset.

ORDERING INFORMATION

WHEN ORDERING REFER TO THE TRADELINE CATALOG OR PRICE SHEET FOR COMPLETE ORDERING SPECIFICATION NUMBER, OR...

SPECIFY —

1. MODEL NUMBER.
2. OPERATING RANGE.
3. DIFFERENTIAL; ADJUSTABLE, NONADJUSTABLE, OR MANUAL RESET.
4. CAPILLARY LENGTH.
5. BOILER TAPPING AND INSULATION DEPTH.
6. ACCESSORIES.

ORDER FROM —

1. YOUR USUAL SOURCE, OR
2. HONEYWELL
1885 DOUGLAS DRIVE, NORTH
MINNEAPOLIS, MINNESOTA 55422
(IN CANADA — HONEYWELL CONTROLS LIMITED
740 ELLESMERE ROAD
SCARBOROUGH, ONTARIO)

SPST MODELS CONTINUED:

MODEL	APPLICATION	RANGE (F)	MIDSCALE DIFFERENTIAL (F)	INSERTION ^a	SWITCHING ON TEMP. RISE	AVAILABLE OPTIONS
L4008D ^a	ambient compensated circulator	0 to 70 or 40 to 180	2 or 5 fixed	remote bulb	makes	Tradeline model available. Centigrade scale markings. Hot tinned 8 ft. capillary. Electrical rating: 2.3 amp at 120-240v ac, full load. Fast response, 10 ft. armored capillary with 3 ft. bulb. External adjustment knob. Factory set scale stops at 120, 220, or 250 F. Plastic shield for covering well in water heater applications.
L4008E ^{ab}	high limit	40 to 80 or 110 to 290	manual reset	remote bulb	breaks	Factory set scale stop at 250 F. 8 ft. 6 in. capillary.
L4008J ^a	high limit	100 to 240	5 fixed	remote bulb	breaks	All models less case and cover. 18 in. capillary and 1/2 in. well assy. Factory set scale stop at 220 F.
L4008K ^a	circulator	40 to 180	5 fixed	remote bulb	makes	All models less cover.

SPDT MODELS:

MODEL	APPLICATION	RANGE (F)	MIDSCALE DIFFERENTIAL (F)	INSERTION ^a	AVAILABLE OPTIONS
L6006A ^a	circulator and low limit or high limit	100 to 240 or 110 to 290	5 fixed or 5 to 30 adj.	horizontal	Tradeline model which includes well adapter and tube of heat conductive compound. 3/4 in. NPT brass spud, 3 in. insulation depth. Horizontal or vertical mount available on same models.
L6006B	circulator and low limit or high limit	100 to 240	5 fixed or 5 to 30 adj.	horizontal	3/4 in. brass bulb compression fitting.
L6008A ^a	circulator and low limit cooling	100 to 240 -30 to 70	5 fixed or 5 or 30 adj.	remote bulb	Tradeline model with 5 ft. capillary. Range of -30 to 70 F. Centigrade scale markings. Without cover.
L6008C ^a	dual fuel changeover	0 to 70 40 to 180	2 or 5 fixed	remote bulb. May be duct mounted.	Tradeline model. 150 va switch rating. Centigrade scale markings. 7 ft. 6 in. armored capillary. External adjustment knob. Lock type cover. 20 ft. element. Averaging element.
L6008E ^a	ambient compensated	40 to 180	5 fixed	remote bulb	All models less enclosure. Front mounted.

^aCopper well or fitting is supplied with all models except remote bulb type. When ordering, specify boiler tapping size (1/2 or 3/4 inch) and insulation depth.

^bManual reset (trip-free)—Switch breaks circuit and locks out when controlled medium reaches set point. Controlled temperature must drop 20 degrees below set point before contacts can be manually reset.

NOTE: The following specifications are standard. Variances, available as options, are noted in the preceding table.

ELECTRICAL RATING (AMPS):

Models with 2 F fixed differential—

	120v ac	240v ac
FULL LOAD	2.6	1.3
LOCKED ROTOR	15.6	7.8

Models with 5 F differential—

	120v ac	240v ac
FULL LOAD	8	5.1
LOCKED ROTOR	48	30.6
INDUCTIVE CURRENT	.25 at 1/4 to 12v dc	

PRESSURE RATING:

Capillary bulb (direct immersion)—200 psi.
 Immersion well—255 psi.

SENSING BULB MATERIAL: Copper.

SENSING BULB FULL: Liquid. Toluene or Silicone.

CAPILLARY LENGTH (including bulb): Remote bulb models—60 inches.

SENSING BULB DIMENSIONS (inches): 2-7/8 long, 3/8 diameter.

INSERTION DEPTH: 3-3/8 inches.

INSULATION: Brass. 1-1/2 or 3 inches. Specify when ordering.

PROVISION FOR WIRING: Screw terminals.

MOUNTING: Horizontal and vertical models mount directly to an immersion well installed in a boiler fitting. Remote bulb models have 3 mounting holes rear of case for screw mounting to a vertical surface.

FINISH: Gray.

INSTALLATION DIMENSIONS: See Figs. 1 and 2.

IMMERSION WELL DIMENSIONS: See Fig. 3.

BOILER FITTING AND BULB DIMENSIONS: See Fig. 4.

ACCESSORIES:

Weatherproof enclosure—Q615.

Immersion wells—

Copper, 1/2 NPT, 1-1/2 inch insulation—Part No. 121371A.

Copper, 1/2 NPT, 3 inch insulation—Part No. 121371L.

Copper, 3/4 NPT, 1-1/2 inch insulation—Part No. 121371B.

Copper, 3/4 NPT, 3 inch insulation—Part No. 121371M.

Copper, 3/4 NPT, 1-1/2 inch insulation, plastic sleeve—Part No. 12131K.

Copper, 3/4 NPT, 3 inch insulation, plastic sleeve—Part No. 121371N.

Stainless steel, 1/2 NPT, 1-1/2 inch insulation—Part No. 121371E.

Stainless steel, 3/4 NPT, 1-1/2 inch insulation—Part No. 121371F.

Bulb Compression Fittings (see Fig. 6) —

Brass, 1/2 NPT plug. 1-1/2 inch insulation—Part No. 104486B.

Brass, 3/4 NPT plug. 1-1/2 inch insulation—Part No. 104486C.

Capillary Compression Fittings (see Fig. 7) —

Copper, 1/2 NPT plug. 1-1/2 inch insulation—Part No. 104484C.

Copper, 3/4 NPT plug. 1-1/2 inch insulation—Part No. 104484B.

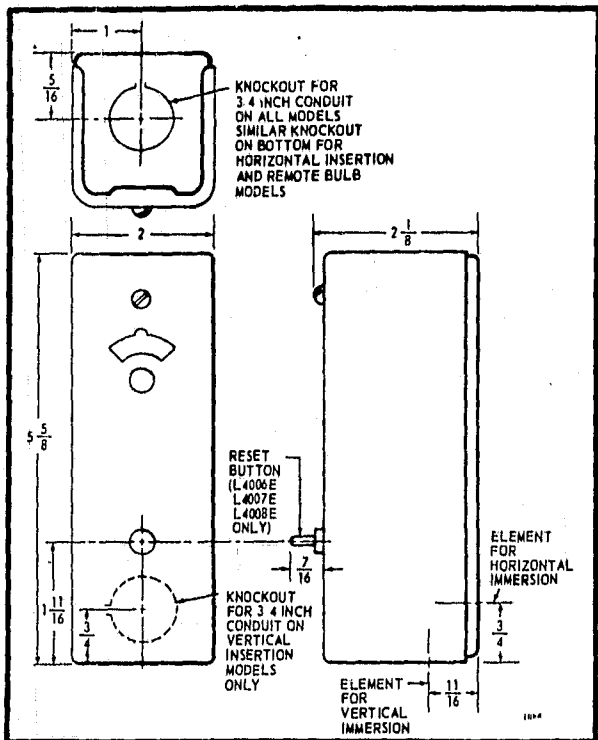


FIG. 1—INSTALLATION DIMENSIONS.

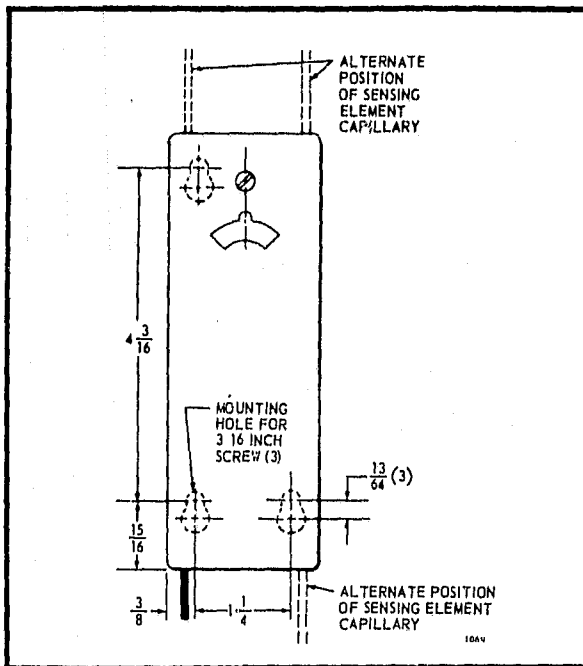


FIG. 2—INSTALLATION DIMENSIONS FOR REMOTE BULB MODELS. OTHER DIMENSIONS SAME AS FIG. 1.

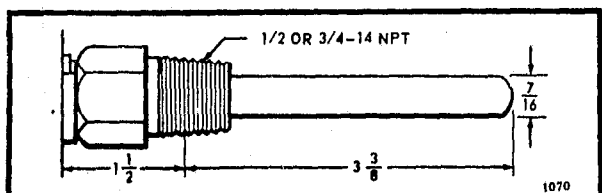


FIG. 3—IMMERSION WELL DIMENSIONS FOR ALL MODELS EXCEPT L4006C, L4007D, AND L6006B.

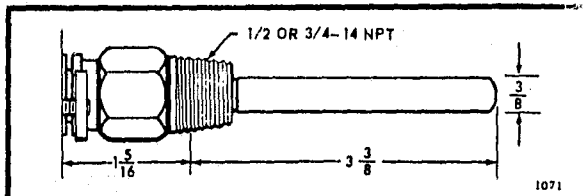


FIG. 4—BOILER FITTING AND BULB DIMENSIONS FOR L4006C, L4007D, AND L6006B.

INSTALLATION

The manufacturer usually provides a tapping for insertion of the controller's sensing element. This tapping is located at a point where typical water temperature can be measured. Depending on model, the element is inserted in an immersion well, through a boiler fitting, or directly immersed.

Installation should be made by a qualified serviceman. Follow the instructions furnished by the system manufacturer, if available. Otherwise, refer to appropriate procedure listed below.

IMPORTANT

Controller may be used with or without immersion well. Well, if used, must fit sensing bulb snugly for good thermal response. Insert bulb until it rests against bottom of well, then hold it there while tightening the tubing clamp.

MOUNTING REMOTE BULB MODELS

The remote temperature-sensing bulb can either be installed in an immersion well (Fig. 5) that extends into the boiler or tank, or it can be directly immersed in the liquid. For installations not using a well, secure the remote bulb with a bulb compression fitting (Fig. 6), or capillary compression fitting (Fig. 7).

Well, bulb compression fitting or capillary compression fitting must be ordered separately. Sizes available: 1/2 in., 3/4 in. NPT spud. Well, if used, must fit sensing bulb snugly for good thermal response. Insert bulb until it rests against bottom of well, then hold it there while tightening the tubing clamp. (See Fig. 5.)

The boiler manufacturer generally provides a tapping for the insertion of the Aquastat controller's sensing element. This tapping should be located at a point where typical water temperature can be measured. The bulb or protecting immersion well must never be located close to a hot or cold water inlet or a steam coil.

If the system is filled, drain system to a point below the boiler tapping, or wherever the sensing bulb is to be installed.

The bulb can also be installed in the supply line of an indirect water heater, in the direct water heater itself, or in the feed riser, about 6 in. above the boiler. If the riser is valved, the bulb can be installed between the boiler and the valve.

NOTE: Avoid making sharp bends or kinks in the capillary. Bends should be no sharper than 1 inch radius.

After installing, carefully coil excess capillary at the bottom of the controller case.

IMMERSION WELL MOUNTING

1. Screw the well into the boiler, tank, or pipe tapping.

2. Insert bulb in well, pushing tubing until bulb bottoms in well.

3. Attach retainer clamp to end of well spud. Loosen draw nut and spread jaws of clamp with screwdriver if necessary.

4. With retainer clamp attached to well spud (be sure jaws of clamp hook over ridge at end of spud, as shown at points "A"), adjust tubing to fit through retainer clamp groove, as shown at point "B."

5. Tighten draw nut so that retainer clamp is firmly attached to well spud and tubing is held securely in place.

CAUTION

Do not secure draw nut so tightly that retainer clamp could collapse tubing.

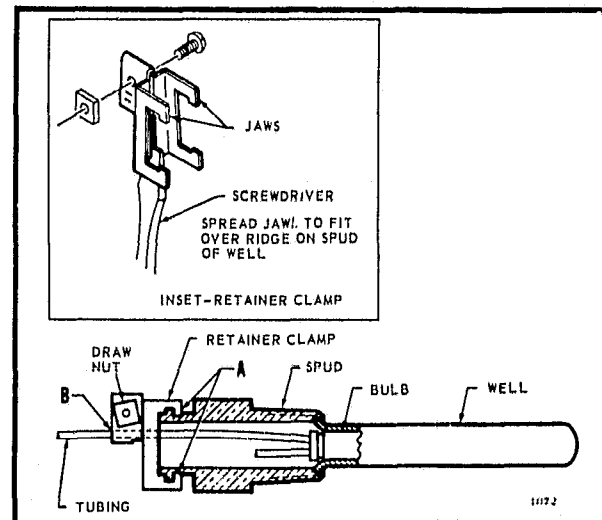


FIG. 5—IMMERSION WELL FITTING.

MOUNTING WITH BULB COMPRESSION FITTING

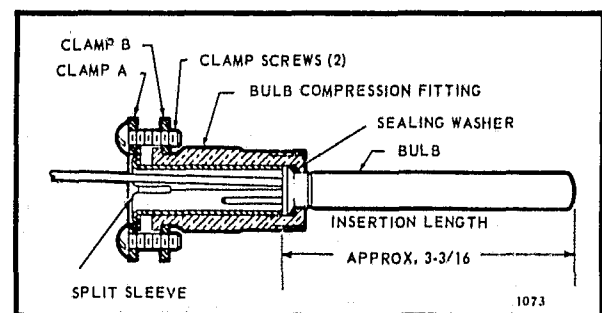


FIG. 6—BULB COMPRESSION FITTING. USE WITH MODEL L4008A,B,E,J, OR L6008A.

1. Screw the fitting into boiler or pipe tapping.
2. Slide sealing washer onto bulb.
3. Insert bulb into boiler fitting until bulb bottoms.
4. Slide split sleeve into fitting.
5. Place clamps A and B on assembly so that sleeve is drawn into fitting when screws are tightened. Note: make sure that nub on clamp A engages space between sleeve and clamp.
6. Tighten clamp screws evenly.

MOUNTING WITH CAPILLARY COMPRESSION FITTING

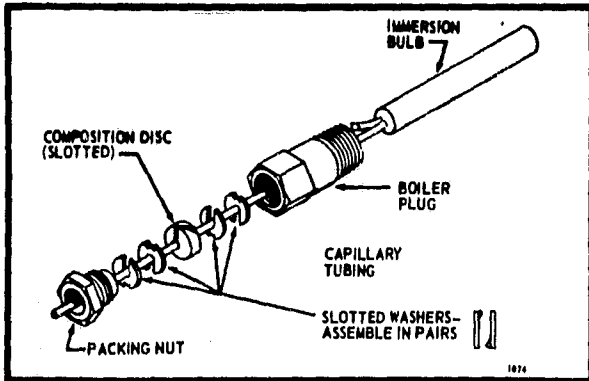


FIG. 7—CAPILLARY COMPRESSION FITTING. USE WITH MODEL L4008C,D,K, OR L6008C,E.

1. Screw fitting into boiler or pipe tapping.
2. Place packing nut on tubing.
3. Slide bulb completely through fitting.
4. Place composition disc and 4 slotted brass washers on tubing in the order shown in Fig. 7. Turn brass washers so that slots are 180 degrees apart.
5. Slide seal assembly into fitting and tighten packing nut.

DUCT MOUNTING

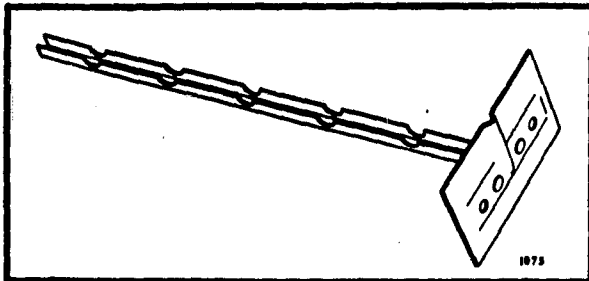


FIG. 8—BULB SUPPORT.

1. Drill a 3/4 inch hole in the duct wall large enough to admit the sensing bulb into the holder.
2. Using the holder as a template, mark and drill holes for bulb holder mounting screws.
3. Break holder to desired length (Fig. 9).

NOTE: Holder must be long enough to hold sensing bulb in freely circulating air away from duct wall. Neatly coil excess capillary at controller case or at bulb holder.

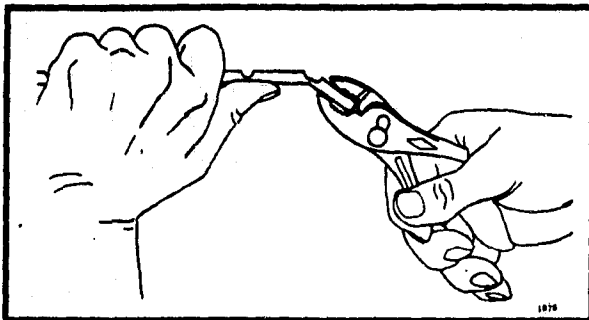


FIG. 9—REMOVING EXCESS BULB SUPPORT.

4. Place capillary in bulb holder channel. Pinch top edges of holder together at each segment (Fig. 10).

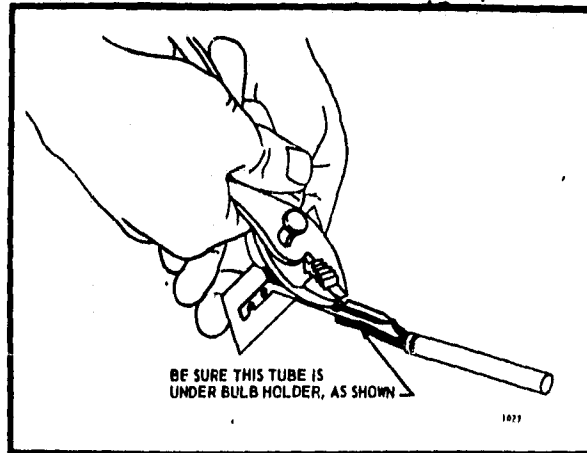


FIG. 10—SECURING CAPILLARY IN BULB HOLDER.

5. Insert bulb holder into controlled area through hole prepared in step 1 above.
6. Fasten bulb holder to duct wall with screws furnished.

MOUNTING DIRECT IMMERSION MODELS

FOR MODELS USING AN IMMERSION WELL

The well of the Aquastat controller must always be exposed to circulation of the medium under control, but must never be located close to a hot or cold inlet or steam coil. Where the tapping is on the side of the boiler, use an Aquastat controller with horizontal well. Where the tapping is on top of the boiler, use a model with a vertical well.

INSTALLING THE IMMERSION WELL

On existing installations, shut off the power and remove the old control. If the old immersion well appears suitable, and if the adapter clamp on the Aquastat controller fits the old well spud, the well need not be replaced.

1. If the system is filled, drain system to a point below the boiler tapping.
2. Remove plug (or old well) from boiler tapping.
3. Install the No. 121371 Immersion Well included with the controller. If boiler tapping is greater than 1/2 inch a reduction fitting must be used to adapt the boiler opening to the 1/2 inch threads that are standard with the well or fitting. Fittings with 3/4 inch threads are also available.
4. Fill the system. Make sure that the well is screwed in tightly enough to prevent leakage. Do NOT tighten or apply force to case after controller is secured to well.

INSTALLATION OF SENSING BULB IN IMMERSION WELL

a. Loosen screw (at top of case, above scale-setting), and remove cover. Loosen two screws that secure adapter clamp. See Fig. 11.

b. Insert the sensing element into the immersion well.

c. Fasten the case of the Aquastat controller to the well with the adapter clamp. Make certain that the clamp is properly positioned over the groove of the well spud. Also be sure the flange at the opening of the well fits snugly into the opening of the case. The sensing element bulb must bottom in the well.

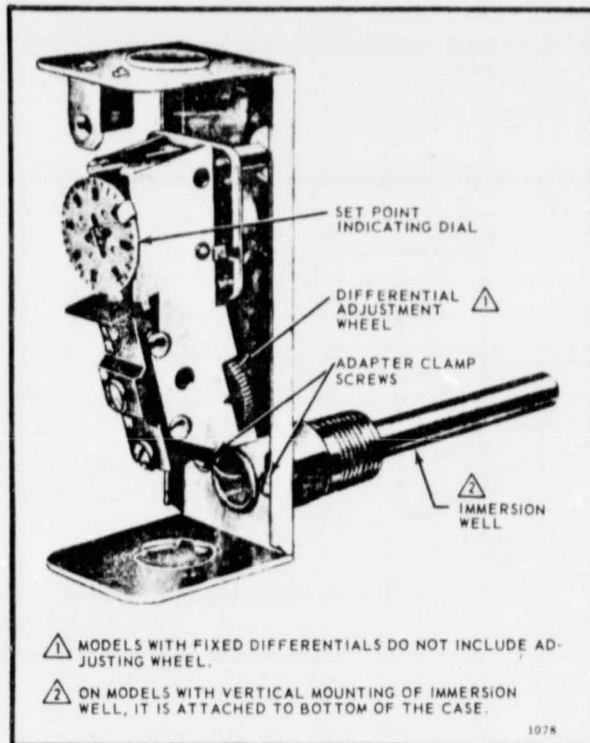


FIG. 11—INTERNAL VIEW OF L6006A.

MODELS DESIGNED FOR DIRECT IMMERSION (WITHOUT WELL)

Some models, which provide direct immersion of the sensing element into the boiler, include a No. 104486 bulb compression fitting assembly instead of an immersion well. Install fitting in boiler tapping. Be sure sealing washer is in place as shown in Fig. 12. Make sure that spud of bulb compression fitting is screwed in tightly enough to prevent leaking. Insert immersion bulb (sensing element) through bulb compression fitting. Adjust the adapter clamp so that it fits over the groove at the opening of the bulb compression fitting. Tighten adapter clamp screws so that Aquastat controller is firmly attached to bulb compression fitting.

MOUNTING DUAL FUEL CHANGEOVER MODELS

These models have a five foot capillary. This capillary establishes the maximum distance between the case and the outdoor mounting.

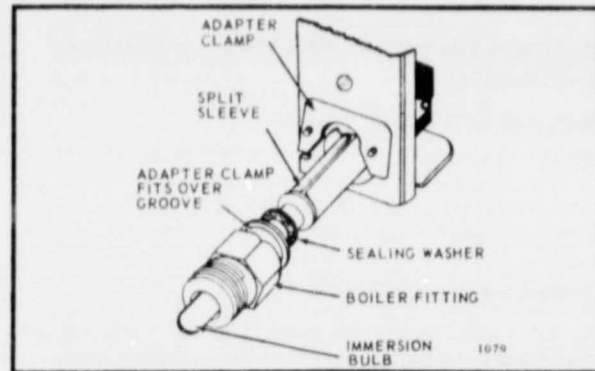


FIG. 12—DIRECT IMMERSION MODEL WITH BULB COMPRESSION FITTING PARTIALLY REMOVED.

The bulb should be installed on the outside of the building in the shield provided (see Fig. 13) where it will be exposed to representative air temperature, but not to direct sunlight. It should be mounted high enough so that accumulated snow, leaves, or other debris cannot obstruct circulation of air around it, and where children cannot reach it. Avoid vents from the building.

Install the case at the indoor location selected, fastening with screws through holes in back of the case. Bring the bulb and tubing out through a 3/4 inch hole in the outside wall. In uncoiling the tubing, carefully avoid sharp bends or kinks. Excess tubing should be left coiled near the case. Do not make sharp bends near the case or bulb.

Slip the bulb through the supports in the shield. Pinch the split supporting clip until it holds the bulb firmly in position. If the seal-off tube protrudes from under the shield, it may be bent under as shown in Fig. 13.

Hold the shield over the mounting position and form a small-radius bend in the tubing. Place the split plug around the tubing and move the shield into mounting location as a unit. Push the split plug into the hole until it is wedged securely in place. Fasten the shield in place on the wall with the screws provided.

NOTE: If the tubing is properly shaped and the split plug installed as directed, the shield will cover the split plug, and the hole in the wall will be hidden from sight.

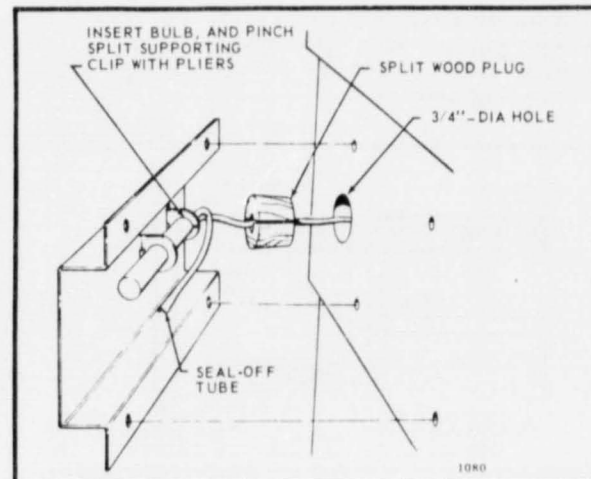


FIG. 13—MOUNTING BULB IN SHIELD OUTSIDE BUILDING.

MOUNTING THE L6008A REMOTE BULB COOLING THERMOSTAT

MOUNTING WITH GUARD BRACKET

Mount the bulb in the guard bracket as shown in Fig. 14. Locate the bulb and bracket combination in freely circulating air in the controlled area. With screws provided, fasten the bracket in place.

MOUNTING ON SUCTION LINE

1. In cooling units with more than one suction line, sensing bulb should be placed on the common line.
2. Make certain the bulb is at least 2 feet from the point at which the suction line leaves the cooler. This will prevent the outside temperature from being transmitted to the remote bulb through the copper tubing of the suction line.
3. Place the remote sensing bulb on the side of the horizontal suction line between the coil and trap (not on the trap).
4. Attach the sensing bulb to the suction line with clips or straps.
5. Coil the excess length of capillary tubing near the L6008A case.

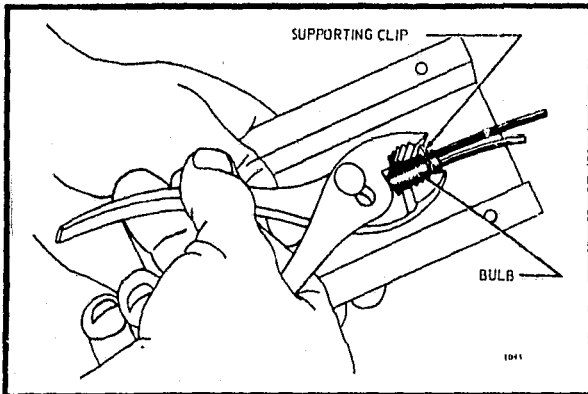


FIG. 14—SECURING REMOTE BULB IN CLIP.

WIRING

All wiring must comply with local codes and ordinances regarding wire size, type of insulation, enclosure, etc. Figures 16 through 23 show typical hook-up diagrams.

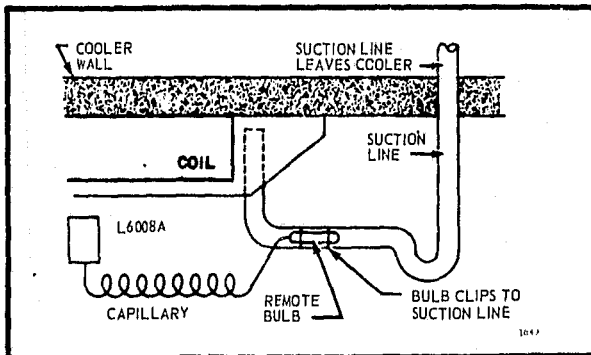


FIG. 15—ATTACHING REMOTE BULB TO HORIZONTAL SUCTION LINE.

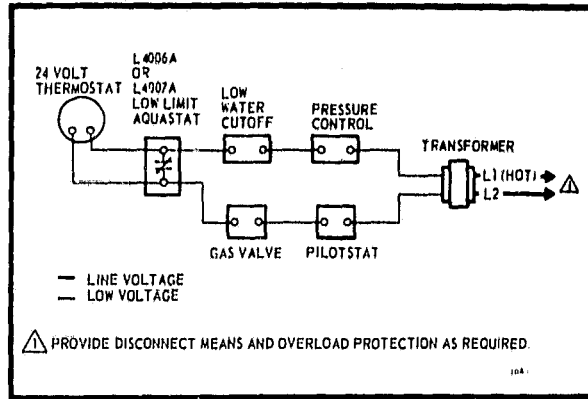


FIG. 16—TYPICAL GAS-FIRED SYSTEM WITH DOMESTIC HOT WATER.

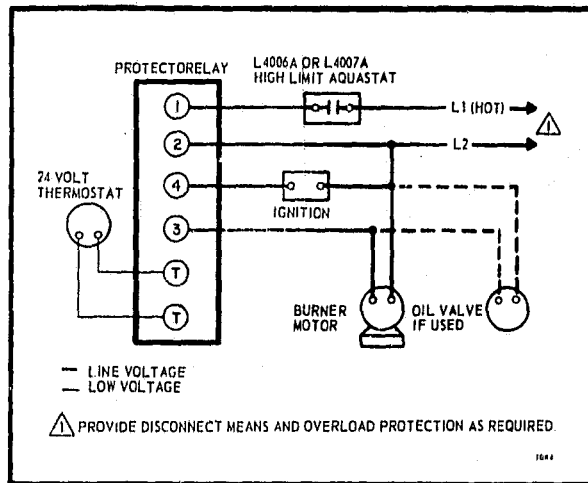


FIG. 17—TYPICAL OIL-FIRED GRAVITY SYSTEM.

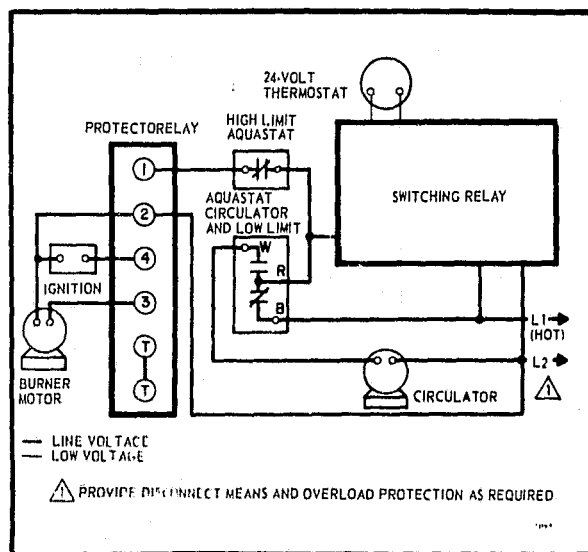


FIG. 18—TYPICAL OIL-FIRED HYDRONIC SYSTEM WITH DOMESTIC HOT WATER.

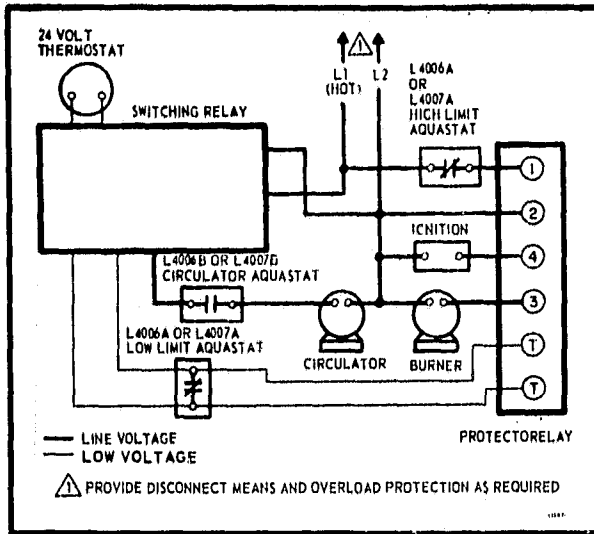


FIG. 19—OIL-FIRED SUMMER-WINTER HYDRONIC SYSTEM WITH DOMESTIC HOT WATER.

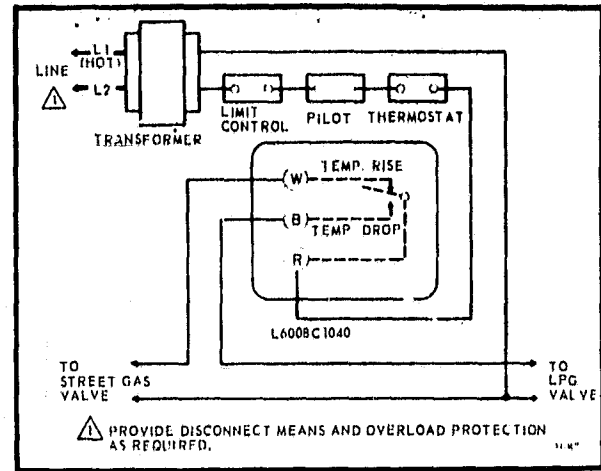


FIG. 21—TYPICAL WIRING DIAGRAM FOR L6008C1040 USED TO SWITCH STREET GAS TO LPG ON TEMPERATURE DROP.

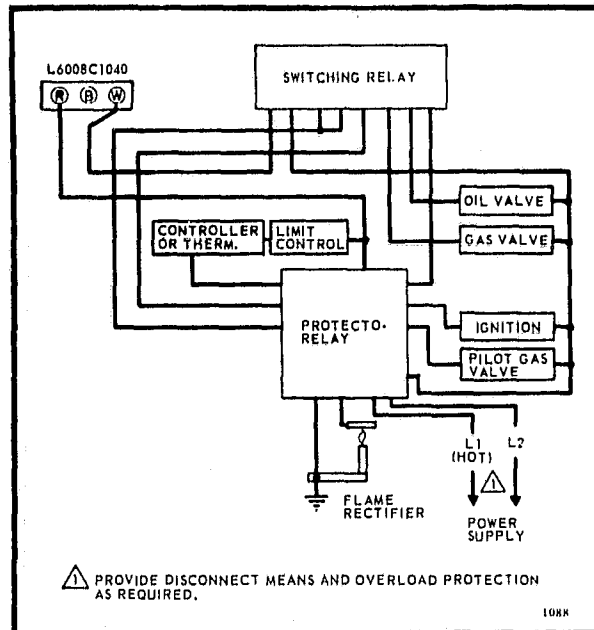


FIG. 20—TYPICAL WIRING DIAGRAM FOR L6008C1040 USED TO SWITCH FROM GAS TO OIL ON TEMPERATURE DROP.

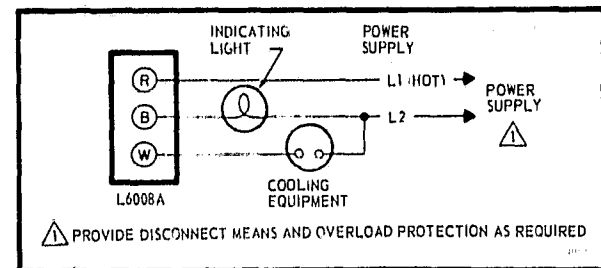


FIG. 22—L6008A USED TO CONTROL COOLING EQUIPMENT AND INDICATING LIGHT.

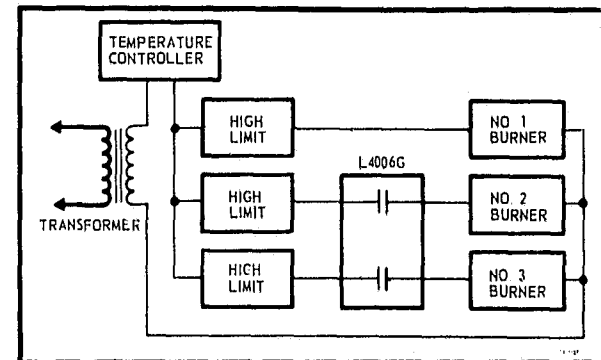


FIG. 23—TYPICAL HOOKUP FOR L4006G BOILER SEQUENCING AQUASTAT.

OPERATION

For proper selection of settings, follow the boiler manufacturer's recommendations.

HIGH LIMIT CONTROLLER

Shuts off burner if water temperature exceeds high limit setting. Burner restarts when temperature drops to high limit setting, less differential.

NOTE: On manual reset models, the reset button on the front of the case must be pushed in to allow the burner to operate after a high limit shutdown.

LOW LIMIT CONTROLLER

Maintains minimum boiler temperature for domestic hot water. Turns on boiler at temperature setting, minus differential.

CIRCULATOR CONTROLLER

Prevents circulation of water that is below the desired heating temperature. Breaks circulator circuit on temperature drop below setting minus differential, remakes on rise to setting.

ADJUSTING

Set the differential to correspond with the boiler manufacturer's recommendations. To adjust models with adjustable differential, rotate the wheel on the back of the snap switch until the desired reading is aligned with the "V" notch in the frame. The wheel provides an adjustment from 5 to 30 F. Replace the cover on the Aquastat controller.

Adjust the control point to correspond with the boiler manufacturer's recommendations. To adjust, insert a screwdriver in the slotted screw-type head located beneath the window in the cover. Turn the scale to the desired control point.

L6008A LOCATION DIFFERENTIAL CALIBRATION

The L6008A1093 is calibrated for applications with both the bulb and case located in the room in which the temperature is being controlled. A correction will be necessary if the temperature of the case is different from the desired dial setting.

1. If the case is at a higher temperature than the desired dial setting, raise the desired dial setting by the correction determined from the table at right.

2. If the case is at a lower temperature than the desired dial setting, lower the desired dial setting by the correction determined from the table below.

Temperature difference between desired room temperature and case temperature (F)	Correction (Degrees F)
0	0
5	3/4
10	1-1/2
15	2
20	2-3/4
25	3-1/2
30	4-1/4
35	5
40	5-3/4
45	6-1/2
50	7
55	8
60	8-1/2
70	10
80	11-1/2

CHECKOUT

Check to make certain that the Aquastat controller has been installed and adjusted properly. Put the system into operation and observe the action of the device through several cycles to make certain that it provides

proper control of the system as described under OPERATION. Further adjustments then can be made to meet more exact comfort requirements.

APPENDIX B

COLLECTOR SUBSYSTEM

LSC18-1	Solar Collectors
HRW-1-30	Purge Unit
Y534A	Diverting Valve

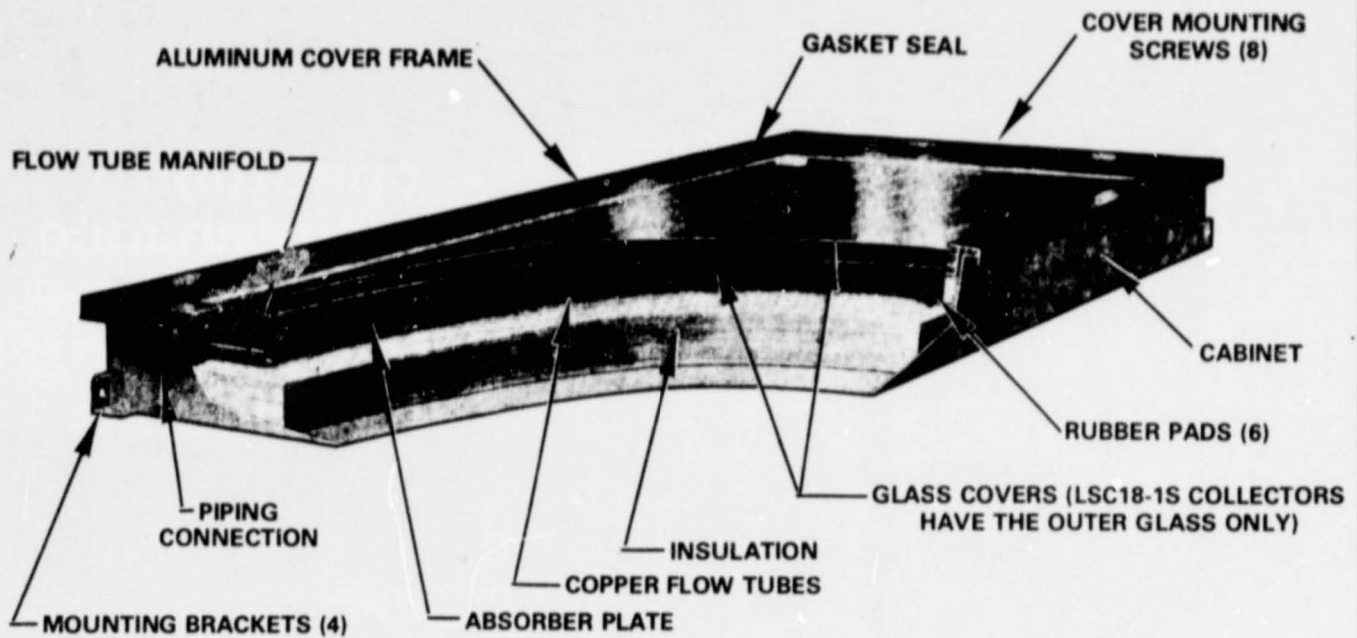
**operation
maintenance
and
installation
instructions**

LSC18-1 and LSC18-1S Solar Collectors

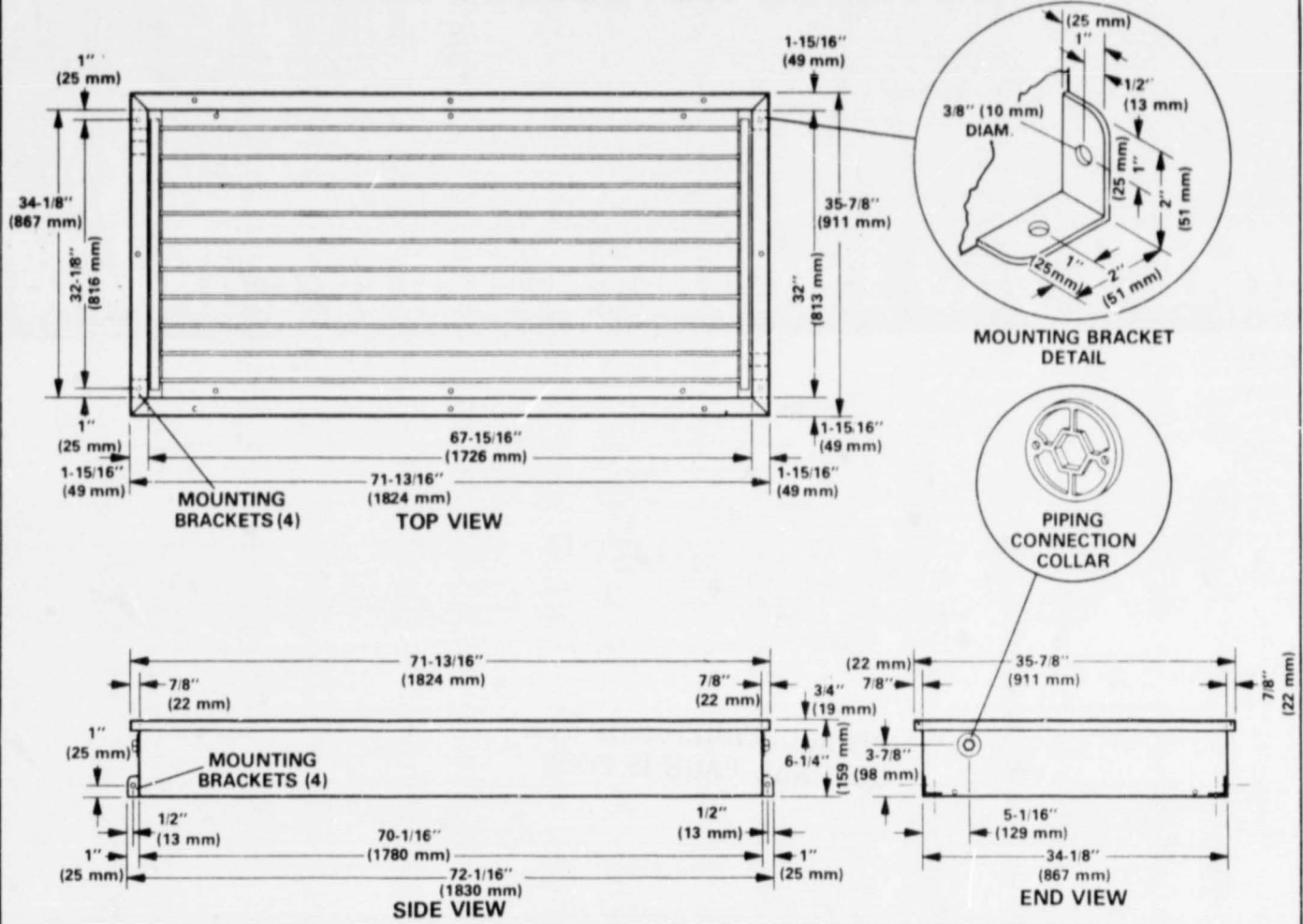
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REPRODUCIBILITY OF THE
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SOLAR COLLECTOR DIMENSIONS



FRAMING - FLASHING - COLLECTOR MOUNTING

I - SHIPPING AND PACKING LIST

Package 1 of 1 Contains

1 - Assembled solar collector

II - SHIPPING DAMAGE

Check unit for shipping damage. Contact the last carrier immediately if any damage is found.

III - GENERAL

These instructions are intended as a general guide and do not supersede local codes. Authorities having jurisdiction should be consulted before installation.

IV - APPLICATION

The consulting engineer, architect or dealer must determine the solar collector application including number required, placement,

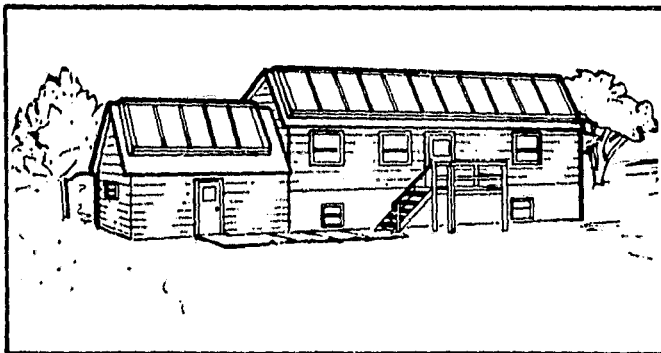


FIGURE 1

mounting angle and piping sequence. This instruction outlines one typical method of framing and installing the solar collectors. Other designs can be substituted if the basic guidelines within the instruction are followed. Figure 1 illustrates a typical residential application.

V - SOLAR COLLECTOR

The collectors must mount on a watertight roof. Roof construction must be adequate to support the collectors and mounting frame. Solar collectors must be installed with the flow tubes in the vertical

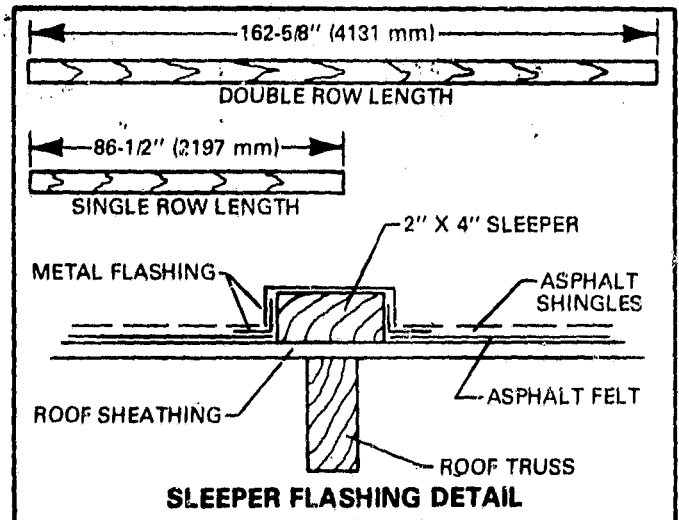


FIGURE 3

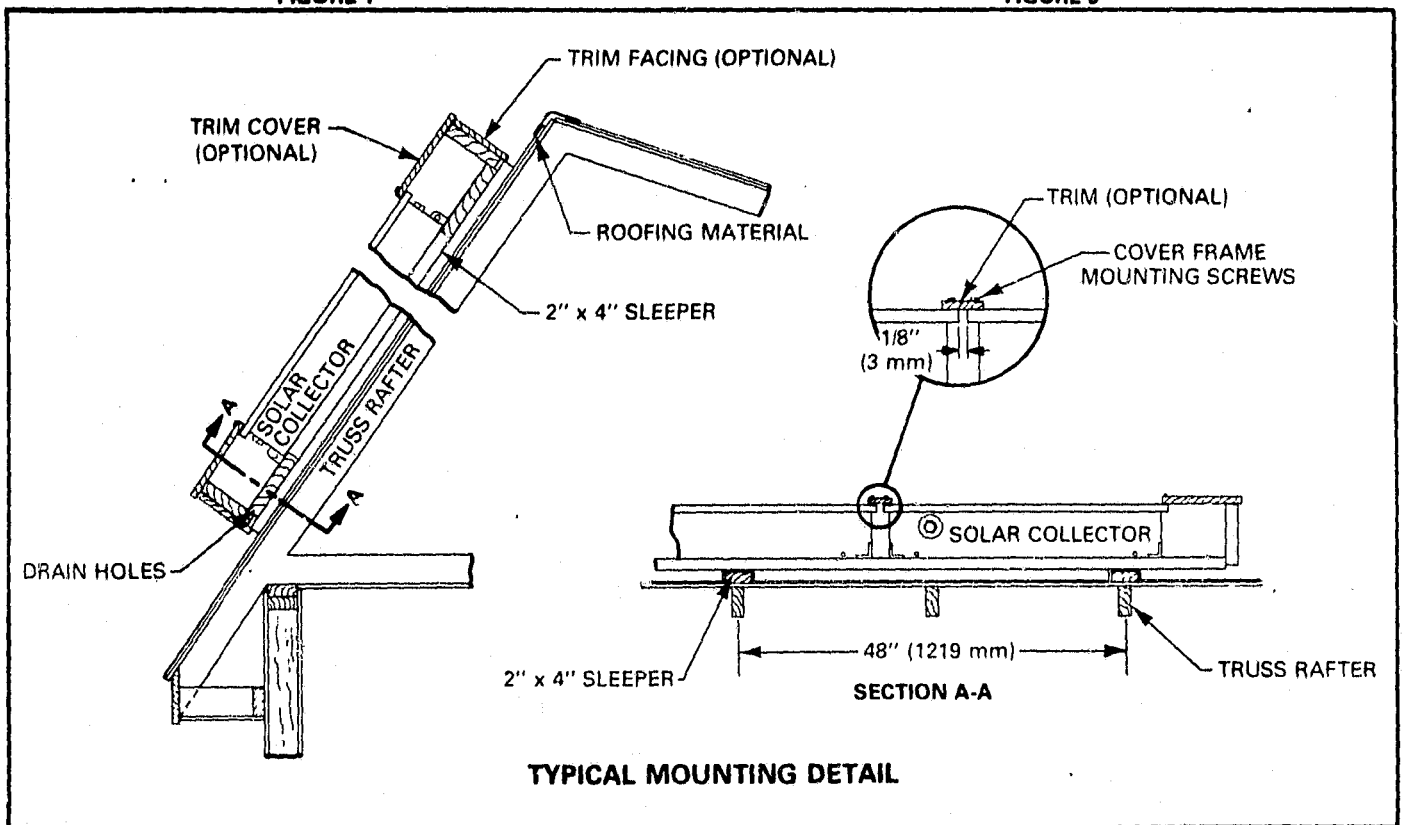


FIGURE 2

position. Figure 2 illustrates details for a typical mounting frame. Install the frame and solar collectors as follows:

- 1 - Center sleepers over trusses and secure to roof. Figure 3 shows the sleeper flashed into the roof.
- a - Length of sleepers required for a single row of collectors is 86-1/2 inches.

b - Length of sleepers required for two rows of collectors is 162-5/8 inches.

- 2 - Figure 4 illustrates typical framing construction for one row of collectors. Figure 5 illustrates construction for two rows of collectors. 2" x 8" dimensional lumber is utilized.

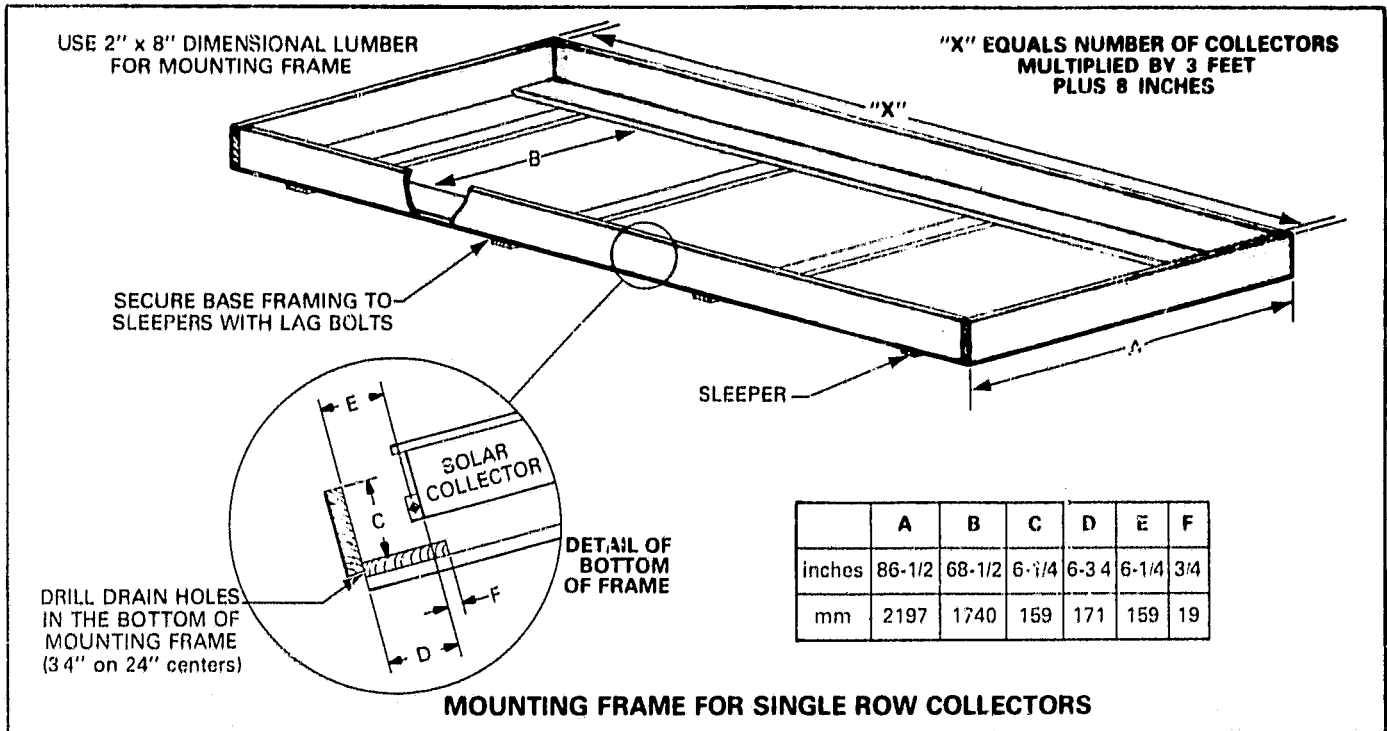


FIGURE 4

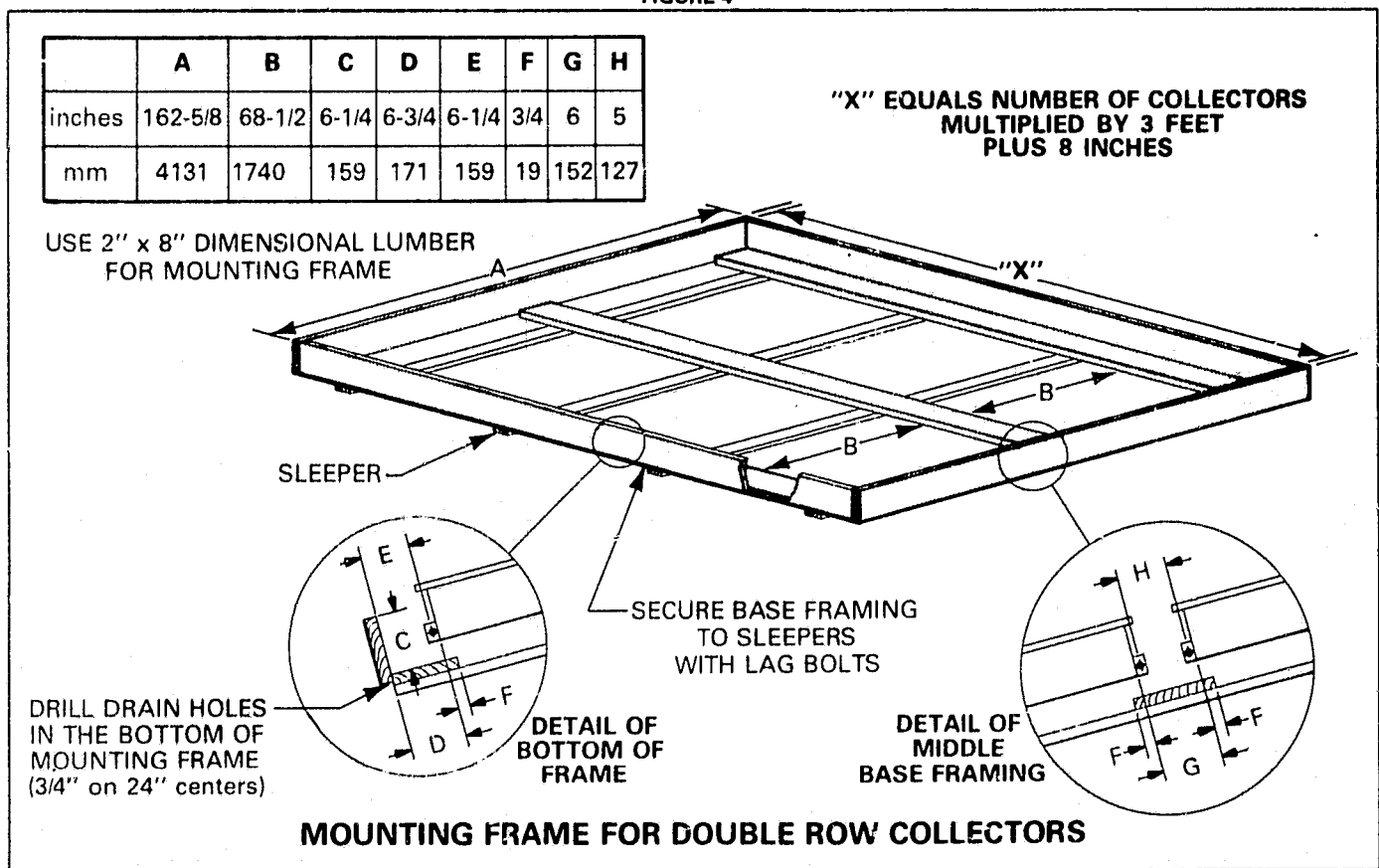


FIGURE 5

3 - Position first collector 4-7/8 inches from end of frame and then maintain 1/8 inch between remainder of collectors. Refer to Figure 6. Secure collectors to frame with lag bolts (4 per collector). If desired the inside spacing could enclose the supply and return header runs where they penetrate through roof.

NOTE - Solar collectors can be piped individually as they are set or if working area permits, piped after all collectors are set.

4 - The temperature control system has a sensor which secures

directly to one absorber plate. Remove the collector frame from desired collector and install the sensor in the center of absorber plate. Refer to manufacturer's installation instructions. Drill a hole through collector cabinet and route wiring to sensor.

5 - After the system has been leak tested and the insulation has been installed on outdoor piping, flash the frame and solar collectors as illustrated in Figure 7. This flashing prevents air flow around collectors minimizing convection losses. This trim can bolt directly to the collector frame.

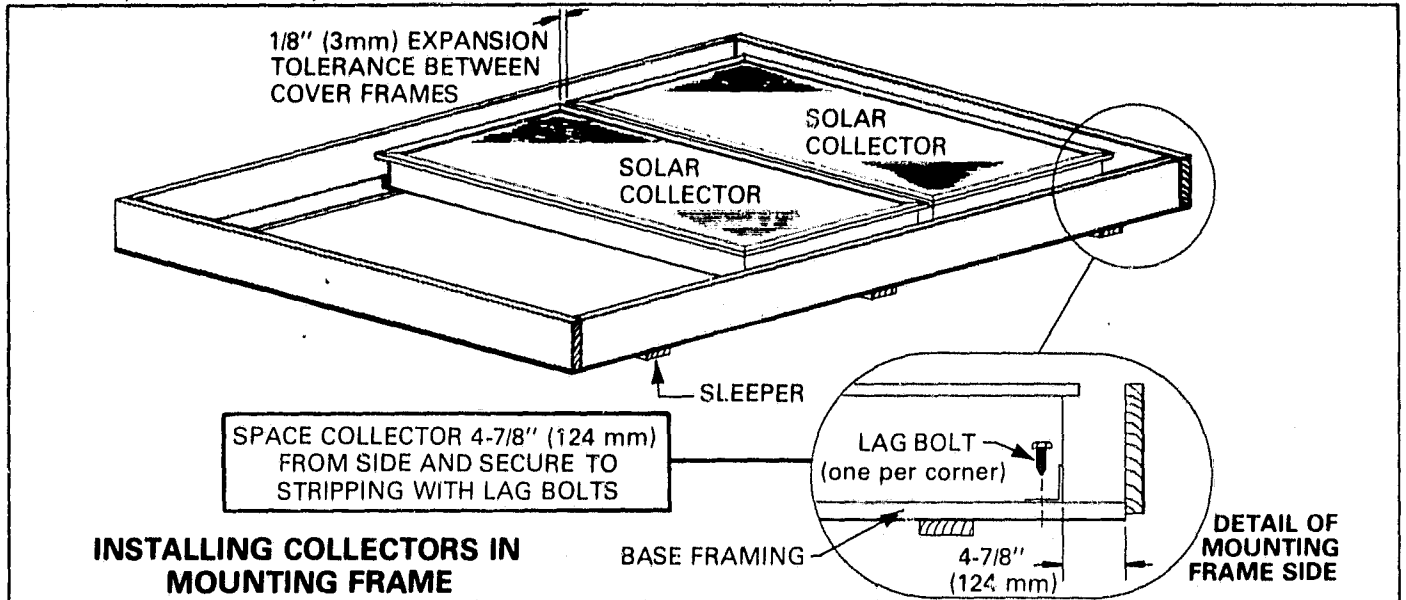


FIGURE 6

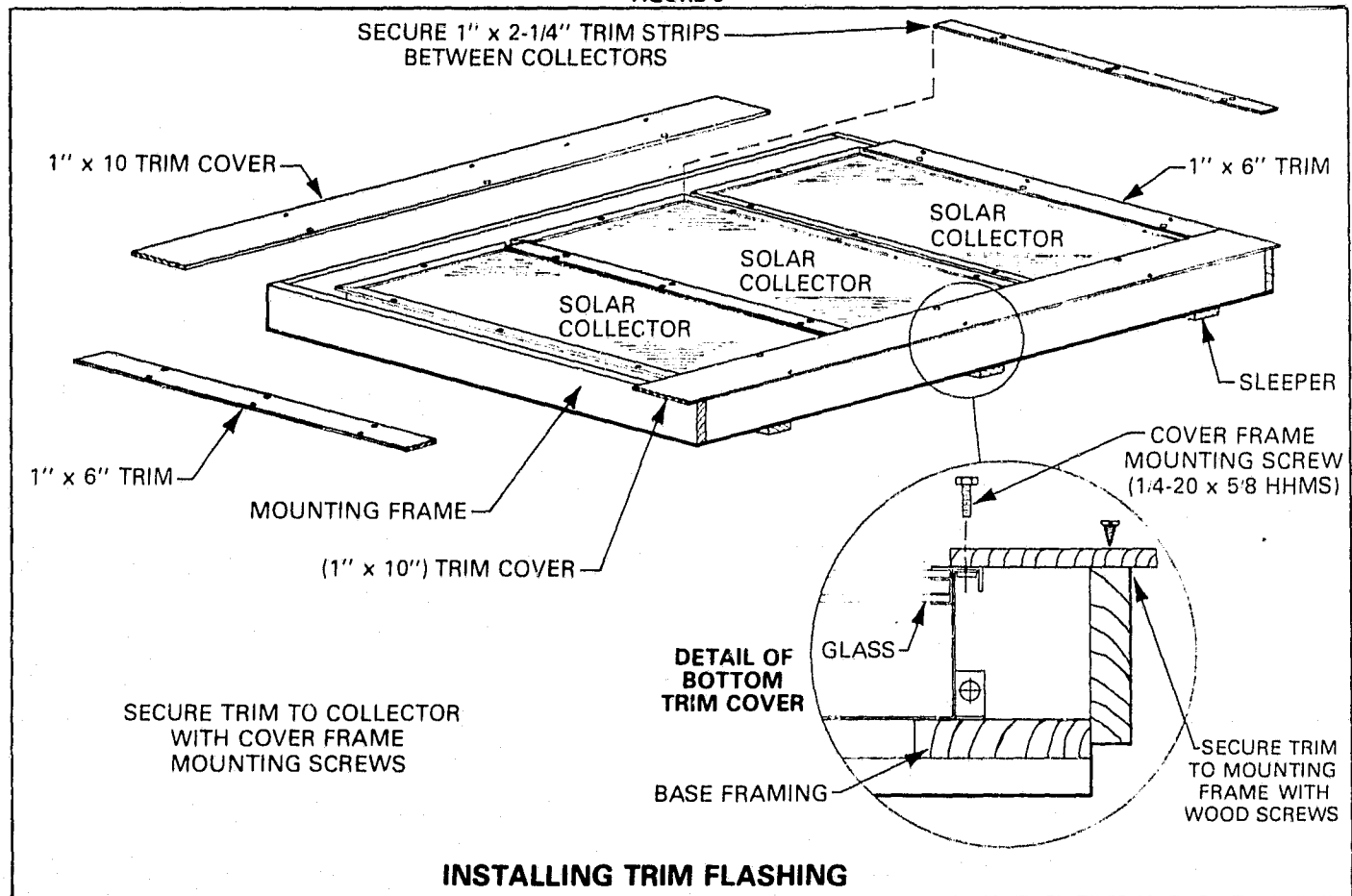


FIGURE 7

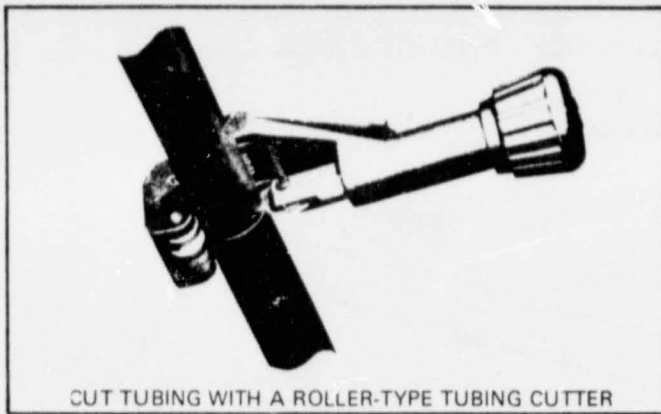
PIPING

VI - PIPING FOR SOLAR COLLECTORS

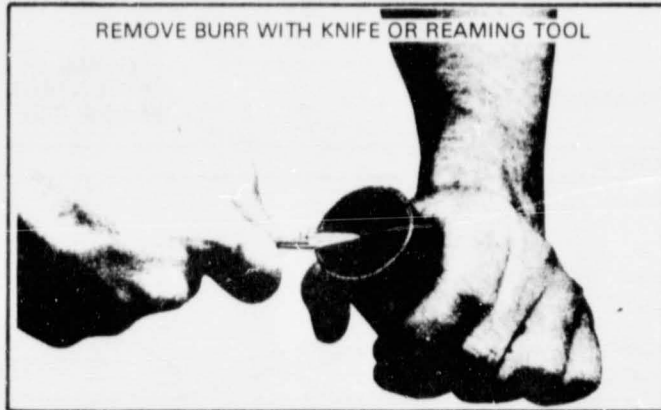
A - Basic Piping Fundamentals

1 - Flared Connections

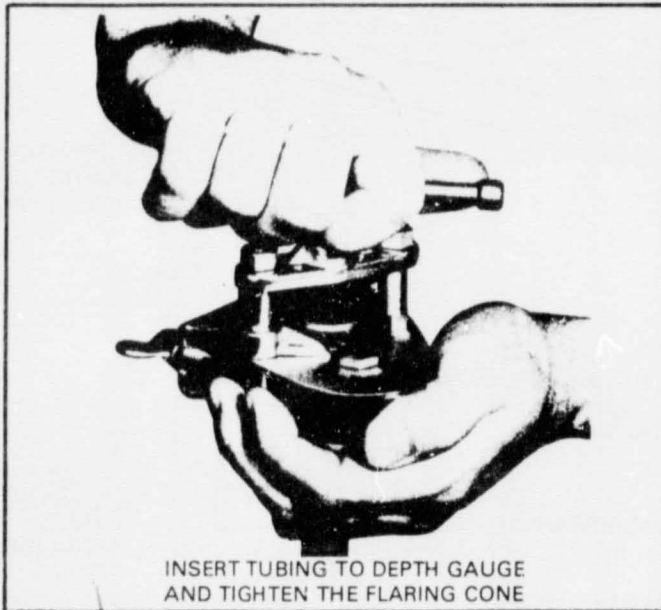
a - Cut pipe to size with a roller type tubing cutter. See Figure 8.



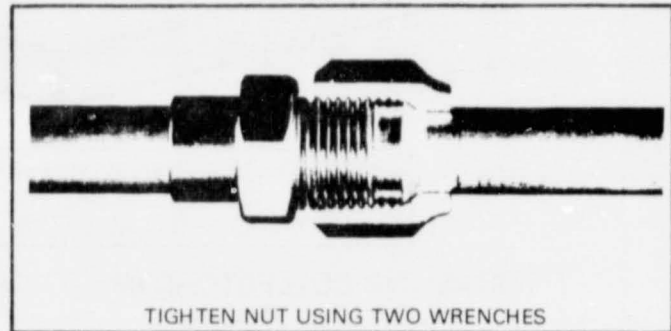
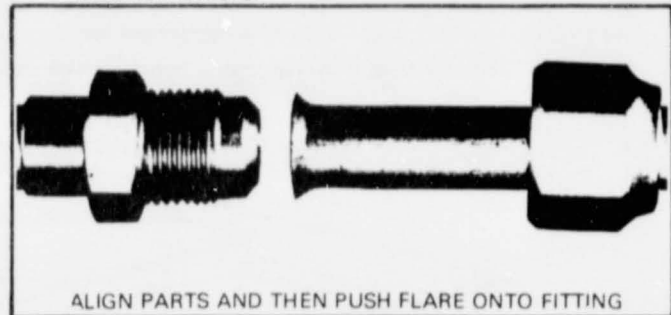
b - Remove any burrs with knife or reaming tool as shown in Figure 9.



c - Flare tubing with a flaring tool as illustrated in Figure 10.



d - Align parts as shown in Figure 11 and tighten using two wrenches to prevent twisting lines. Figure 12 shows cutaway of flared connections.



2 - Soldered Connections

a - Cut the pipe to size.

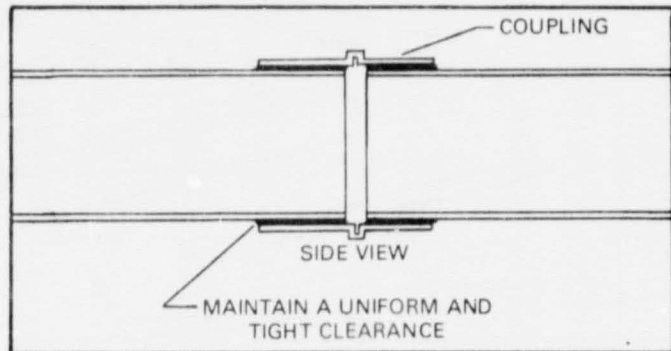
b - Remove burr.

c - Fit tubing into coupling maintaining a tight and proper clearance. See Figure 13.

d - Use *minimum* 95-5 rated solder.

e - Make joint using proper amount of heat to draw solder in joint.

f - Cool and clean the joint with wet cloth.



B - General Guidelines

1 - The solar collectors can be assembled in parallel, series or series-parallel combinations. Figure 14 illustrates various sequencing arrangements. **The supply header is always positioned at the bottom side of collectors while the return header is on the top.**

NOTE - For residential applications, no more than two collectors should be connected in series.

TABLE 1

APPLICATION	SIZE
Single family heating and heating/cooling	1-1/4" (38 mm)
Multi-family heating and heating/cooling	3" (76 mm)
Commercial heating and heating/cooling	4" (102 mm)

- 2 - Table 1 lists information for sizing headers.
 3 - Avoid dissimilar metals. Where copper piping connects to dif-

ferent piping materials, dielectric insulating couplers should be used to prevent corrosion.

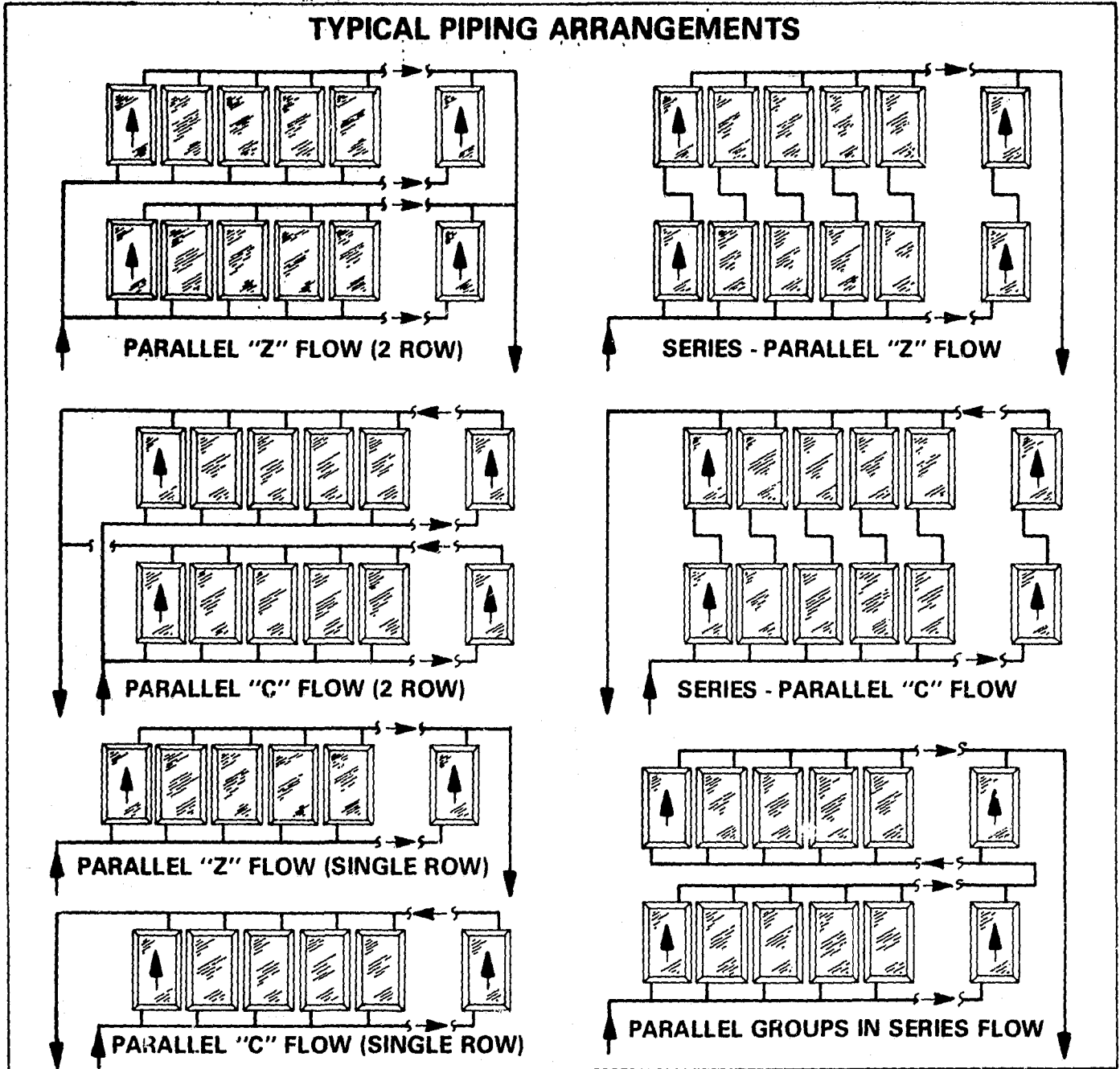


FIGURE 14

C - Installation of Piping

- 1 - Remove the plug from each end of solar collector.
- 2 - The collector either pipes to another collector or into a header. The 1/2 inch copper tubing must be field provided.
 - a - Figure 15 illustrates two solar collectors piped in series. Install a flare male elbow at the bottom collector and a flare male straight connection at the top collector.
 - b - A 3/8 inch sweat to 1/2 flare fitting must be soldered into each header at 36 inch intervals. Install a flare male elbow at the collector and connect piping as shown in Figure 16. In a two row parallel application, the return and supply headers can be piped according to Figure 17 to minimize collector spacing.
- 3 - Route the supply and return headers into the interior of building and then flash completely to waterproof the opening.

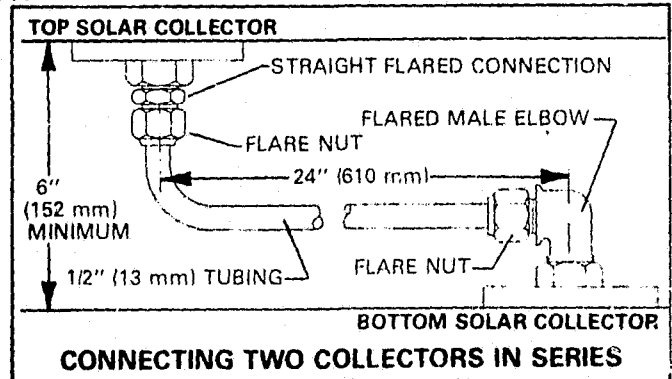


FIGURE 15

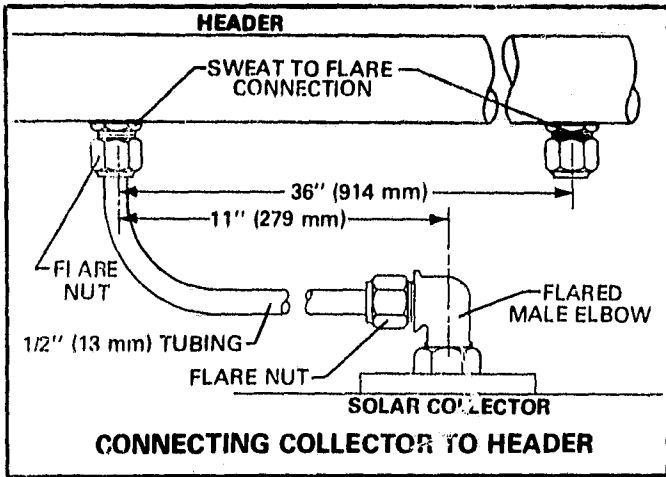


FIGURE 16

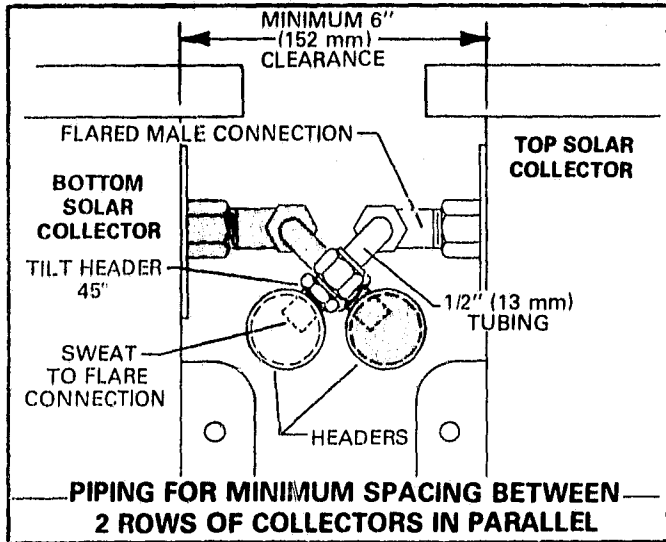


FIGURE 17

4 - An air bleed valve must be installed at each end of the return header for the top row of collector cells. Solder a sweat to flare fitting into the ends of return header. Connect a short length of 3/8 inch tubing to flared connection and then secure to a "B" valve with a nut and ferrule. Refer to Figure 18.

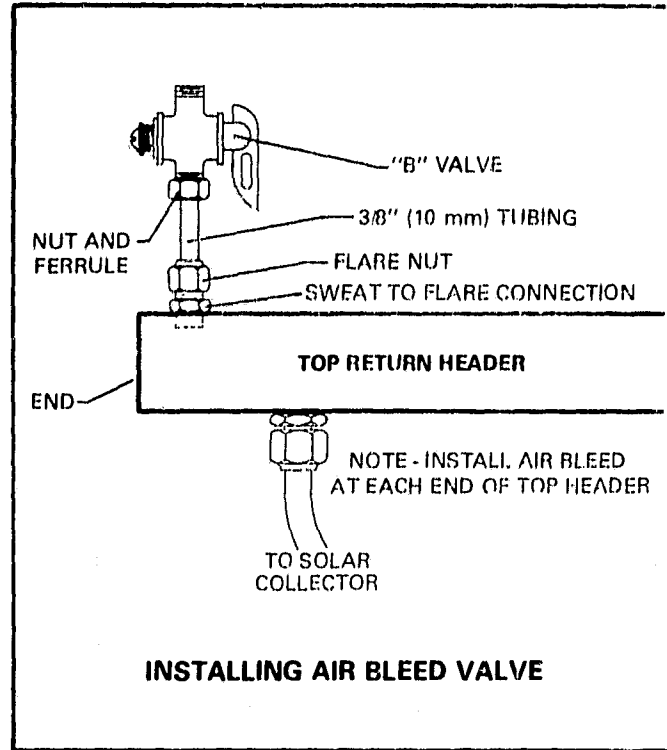


FIGURE 18

5 - Leak test the installation thoroughly and make any needed repairs. Insulate all outdoor piping with 3/4 inch thick foamed plastic insulation. Waterproof outdoor pipe insulation with two coats of plastic finish reinforced with glass mesh. Install per manufacturer's recommendations.

MAINTENANCE

VII - MAINTENANCE

1 - If the glass cover becomes dirty, clean the glass using a soft clean cloth, mild soap or detergent and clean rinse water. Alkalies can stain the glass if allowed to remain in contact too long.

NOTE - The collector surface temperature can burn. Handle solar collector with caution.

2 - Use rubber gloves when handling solar collector to avoid finger prints on glass.

3 - To replace the glass, remove the collector as shown in Figure 19 and dismantle according to Figure 20. To re-assemble frame, insert the glass sheets and new gaskets into side pieces making sure the glass is centered and the ends are even. Next insert the glass into the end pieces and secure with existing screws. Use

sealer compound on corner joints.

4 - To replace an absorber plate refer to following sequence and Figure 21.

a - Drain collector.

b - Remove collector frame.

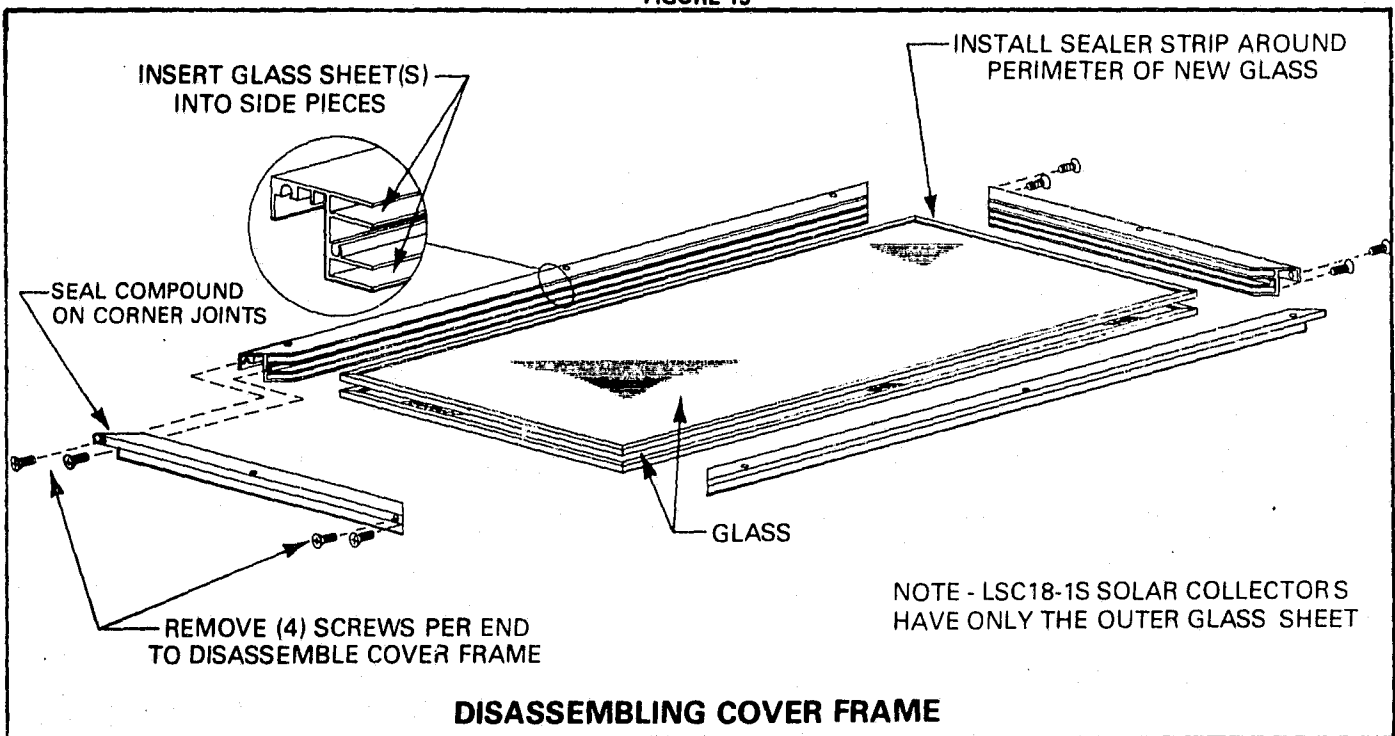
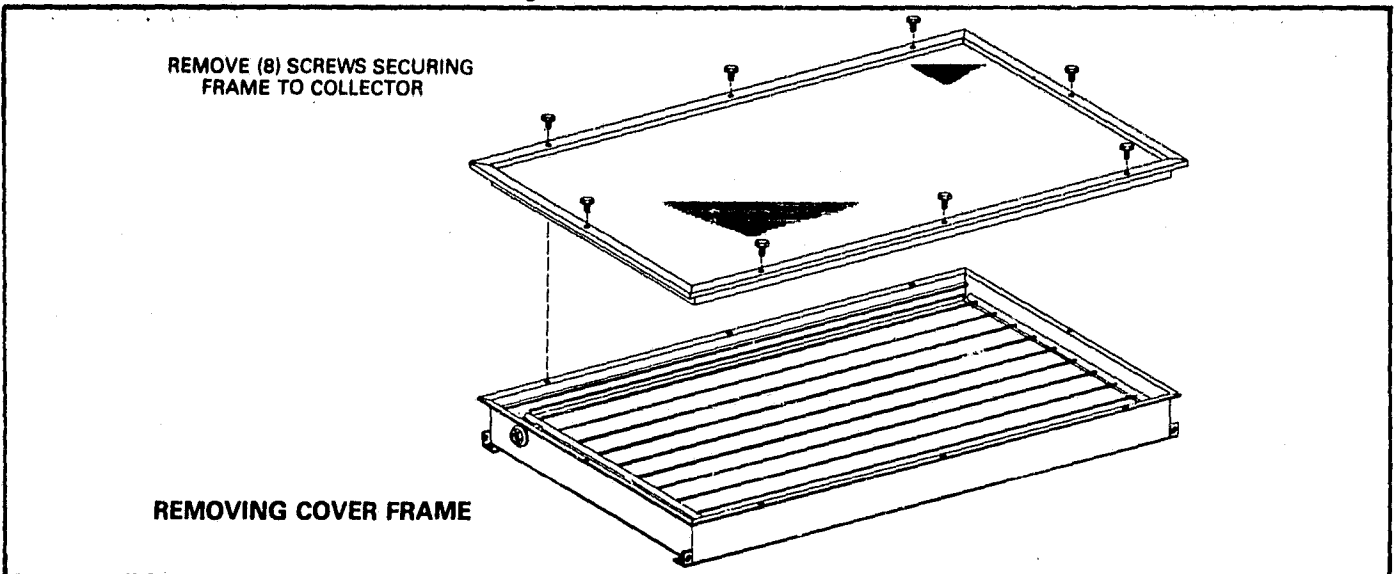
c - Remove plate seal and gasket on each end of collector.

d - Disconnect flare fitting on each end of collector.

e - Remove 6 screws securing absorber and left plate from cabinet. Avoid touching coating on plate.

f - When re-assembling absorber plate, tighten screws between 10 lbs and 15 lbs torque.

5 - The ethylene glycol/water mixture should be checked once a year by your Lennox service organization for proper freeze protection and inhibitor level.



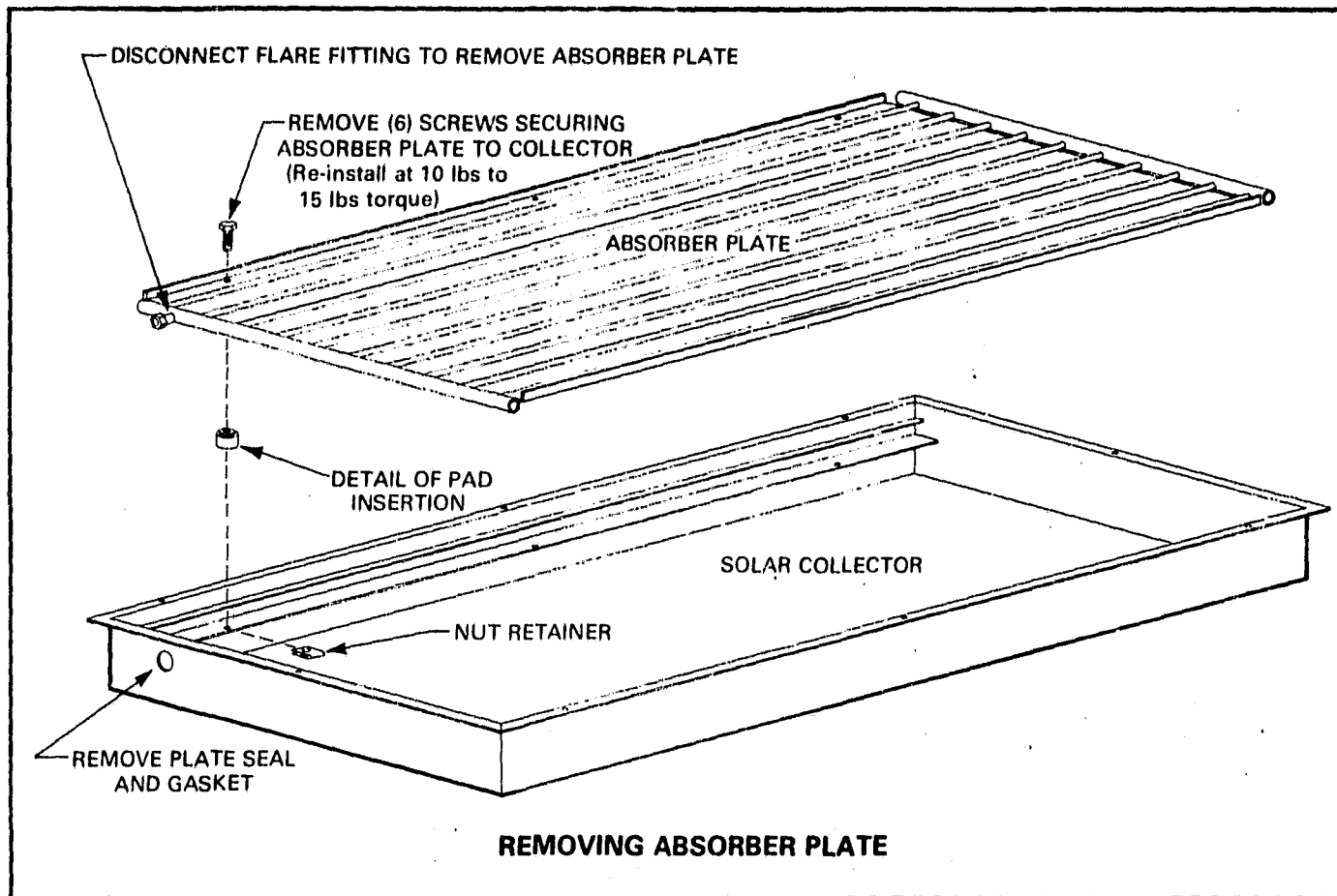


FIGURE 21

PURGE UNIT HRW-1-30

The HRW-1-30 is an air to water heat exchanger. The finned tube coil and the blower are mounted in a cabinet designed for outdoor installation. The air is drawn in through the bottom and exhausted out the top of the unit. When connected to the collector outlet line, the purge unit will lower the fluid temperature. The unit is rated at 2000 CFM and should dissipate 100,000 Btu's per hour.

Maintenance

At the beginning of each heating or cooling season the system should be cleaned as follows:

A. HRW-1-30 Unit

1. Clean and inspect both sides of coil. Coil may be flushed with water hose if necessary.
2. Oil outdoor fan motor: always relubricate motor according to manufacturers lubrication instructions on each motor. If no instructions are provided, use the following as a guide.
 - a. Motors With Oiling Ports - Prelubricated for an extended period of operation. For extended bearing life, relubricate with a few drops of SAE No. 10 non-detergent oil once every two years.
 - b. Motors Without Oiling Ports - Prelubricated and sealed. No further lubrication required.
3. Visually inspect all connecting lines, joints and coils for evidence of fluid leaks.
4. Check all wiring for loose connections.
5. Check for correct voltage at unit (unit operating).

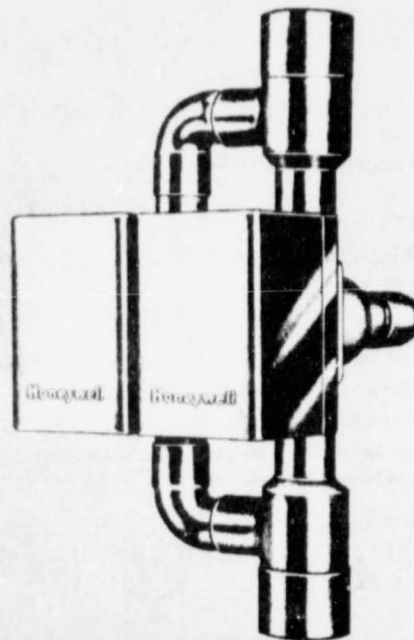
Honeywell

THE Y534A DUAL DIVERTING VALVE ASSEMBLY CONSISTS OF TWO VALVE BODIES WHICH ARE SWEATED TOGETHER AND TWO POWERHEADS WHICH CONTROL EACH VALVE BODY SEPARATELY. WHEN ASSEMBLED, THE Y534A OFFERS FLOW CHARACTERISTICS WHICH ARE COMPATIBLE WITH SOLAR ENERGY SYSTEMS.

- Available for line or low voltage applications (specify when ordering).
- Assembly provides a flow capacity of 14 Cv [12 kv].
- Sweat copper end connections may be installed without disassembling the valve.
- Manual opener for valve operation on power failure. Valve returns to automatic position when power is restored.
- Complete powerhead may be removed without breaking the line connections.
- Motor actuator may be replaced without removing the valve body or draining the system.

R.L.
9-77 (.05)

DUAL DIVERTING VALVES



Y534A

Form Number 60 2394

SPECIFICATIONS

IMPORTANT

THE SPECIFICATIONS GIVEN IN THIS PUBLICATION DO NOT INCLUDE NORMAL MANUFACTURING TOLERANCES. THEREFORE, THIS UNIT MAY NOT MATCH THE LISTED SPECIFICATIONS EXACTLY. ALSO, THIS PRODUCT IS TESTED AND CALIBRATED UNDER CLOSELY CONTROLLED CONDITIONS, AND SOME MINOR DIFFERENCES IN PERFORMANCE CAN BE EXPECTED IF THOSE CONDITIONS ARE CHANGED.

MODEL:

Y534A—2-position dual diverting valve. The two powerheads must be assembled to the two valve bodies which are shipped sweated together. Available for line or low voltage applications.

TEMPERATURE AND FLOW RATINGS:

Capacity Rating—14 Cv [12 kv].
Maximum Closeoff Pressure—10 psi [69 kPa].
Static Pressure Rating—125 psi [862 kPa].
Maximum Fluid Temperature—
Line voltage model—200 F [93 C].
Low voltage model—240 F [115 C].
Maximum Ambient Temperature—125 F [52 C].

ELECTRICAL RATINGS:

Line voltage models—
0.16 amps at 120V ac, 60 Hz.
0.08 amps at 220/240V ac, 50 Hz.
Low voltage model—
0.64 amps at 24V ac, 50/60 Hz.

WIRING PROVISIONS: 18 in. [457.2 mm] leadwires and 1/2 in. conduit openings.

LINE FITTINGS: 1-1/4 in. sweat (1-3/8 in. O.D.).

DE-ENERGIZED POSITION: Port A normally closed.

TIMING: Diverts flow in 30 seconds.

MANUAL OPENER: Allows valve to be opened in case of power failure. Valve returns to automatic position when power is restored.

DIMENSIONS: See Fig. 1.

UNDERWRITERS LABORATORIES INC. LISTING APPLIED FOR.

REPLACEMENT PARTS:

O-ring—Part No. 802344.

Powerhead—

Line voltage model—Part No. 130441ARG.

Low voltage model—Part No. 130441ARA.

DETERMINATION OF WATER FLOW CHARACTERISTICS: The pressure drop in psi [kPa], equivalent feet [metres] of pipe, or feet of water [kPa] may be determined by calculating the flow rate, referring to Fig. 2, and using the following procedures.

Pressure drop in psi [kPa]—

1. Locate the flow rate at the bottom of the graph in Fig. 2.
2. Draw a line upward from the flow rate until it intersects the curve on the graph.
3. Draw a line from the intersection to the left-hand edge of the graph and read the pressure drop in psi [kPa].

Pressure drop in equivalent feet [metres] of pipe—

1. Locate the flow rate at the bottom of the graph in Fig. 2.
2. Draw a line vertically to the top of the graph. Read the pressure drop in equivalent feet [metres] of pipe on the 3/4 in. pipe scale.

Pressure drop in feet of water [kPa]—

1. Locate the flow rate at the bottom of the graph in Fig. 2.
2. Draw a line upward from the flow rate until it intersects the curve on the graph.
3. Draw a line from the intersection to the right-hand edge of the graph and read the pressure drop in feet of water [kPa].

continued on page 14

ORDERING INFORMATION

WHEN PURCHASING REPLACEMENT AND MODERNIZATION PRODUCTS FROM YOUR TRADELINE WHOLESALE OR YOUR DISTRIBUTOR, REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING NUMBER, OR SPECIFY—

1. Order number (specify line voltage or low voltage model).
2. Replacement part, if required.

IF YOU HAVE ADDITIONAL QUESTIONS, NEED FURTHER INFORMATION, OR WOULD LIKE TO COMMENT ON OUR PRODUCTS OR SERVICES, PLEASE WRITE OR PHONE:

1. YOUR LOCAL HONEYWELL RESIDENTIAL DIVISION SALES OFFICE (CHECK WHITE PAGES OF PHONE DIRECTORY).
2. RESIDENTIAL DIVISION CUSTOMER SERVICE
HONEYWELL INC., 1885 DOUGLAS DRIVE NORTH
MINNEAPOLIS, MINNESOTA 55422 (612) 542-7500

(IN CANADA—HONEYWELL CONTROLS LIMITED, 740 ELLESMERE ROAD, SCARBOROUGH, ONTARIO M1P 2V9)
INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

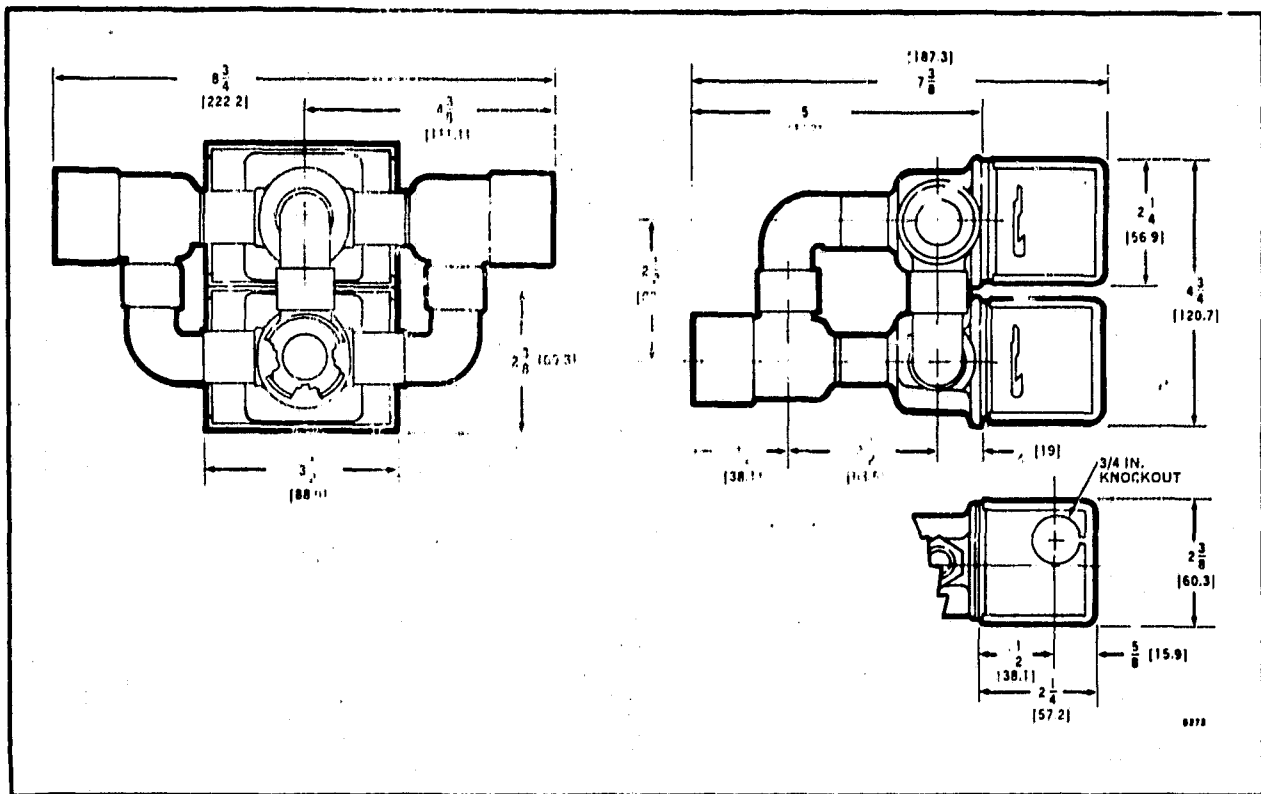


FIG. 1—Y534A DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

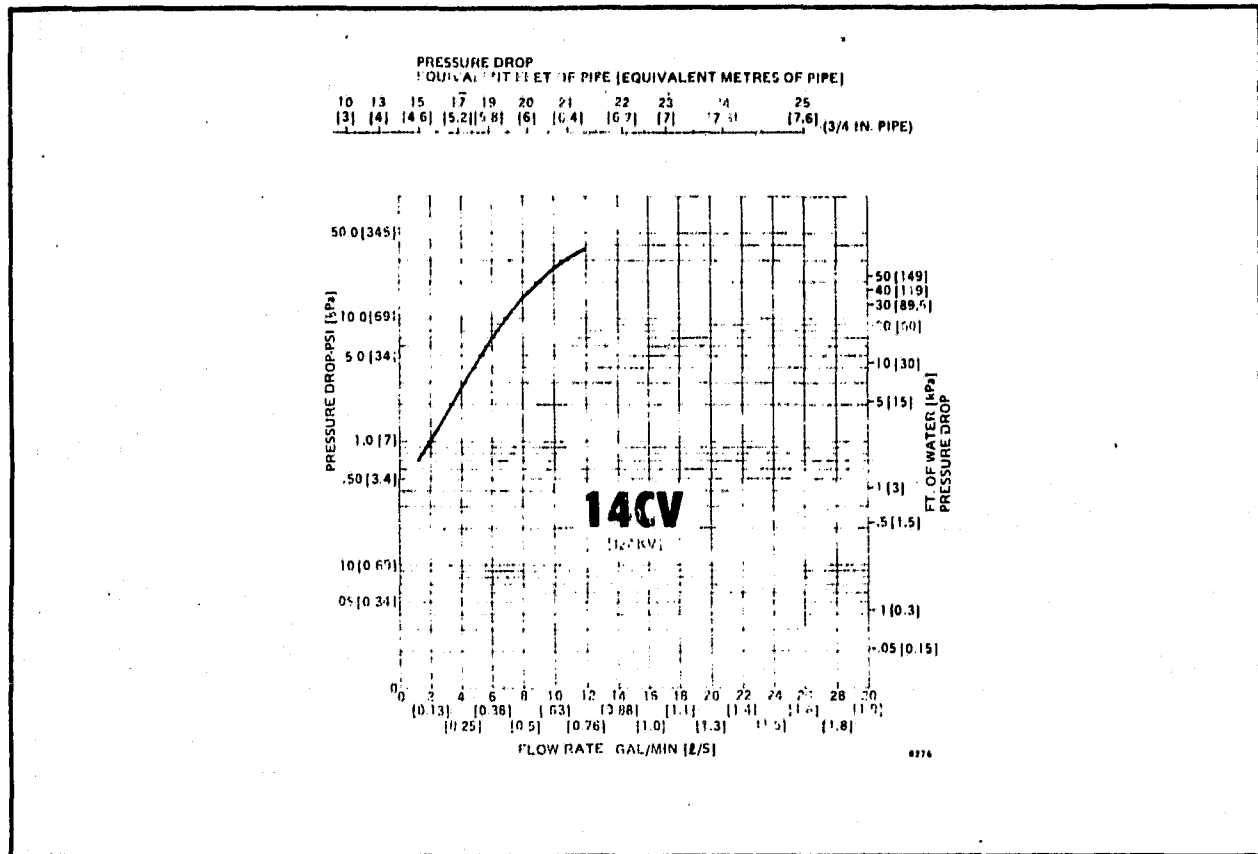


FIG. 2—FLOW CHARACTERISTICS OF Y534A DUAL DIVERTING VALVES.

INSTALLATION

CAUTION

1. Installer must be a trained, experienced service technician.
2. Disconnect power supply before connecting wiring to prevent electrical shock and equipment damage.
3. Always conduct a thorough checkout when installation is complete.

ASSEMBLY

Each powerhead controls each valve body separately. To assemble a powerhead to a valve body, place an O-ring in the circular slot on the top of the valve body (Fig. 3). Assemble the powerhead to the valve body by placing the manual opening lever on the powerhead in the MAN. OPEN position.

Align the powerhead by fitting the hex head screw on the bottom of the powerhead into the hole on the top of the valve body. The guide pins and the positioning pin in the powerhead should fit the holes in the valve body. Tighten securely and repeat this procedure for the other powerhead and valve body.

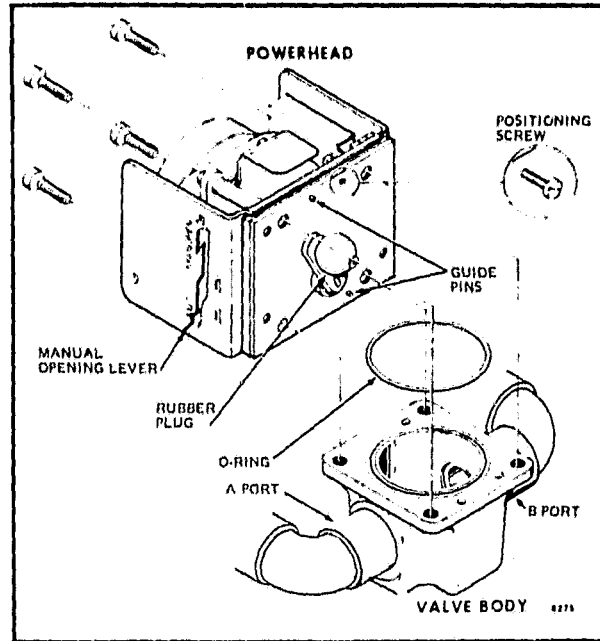


FIG. 3—POWERHEAD MUST BE ALIGNED SO THAT THE GUIDE PINS AND THE POSITIONING PIN IN THE POWERHEAD FIT THE HOLES IN THE VALVE BODY.

MOUNTING

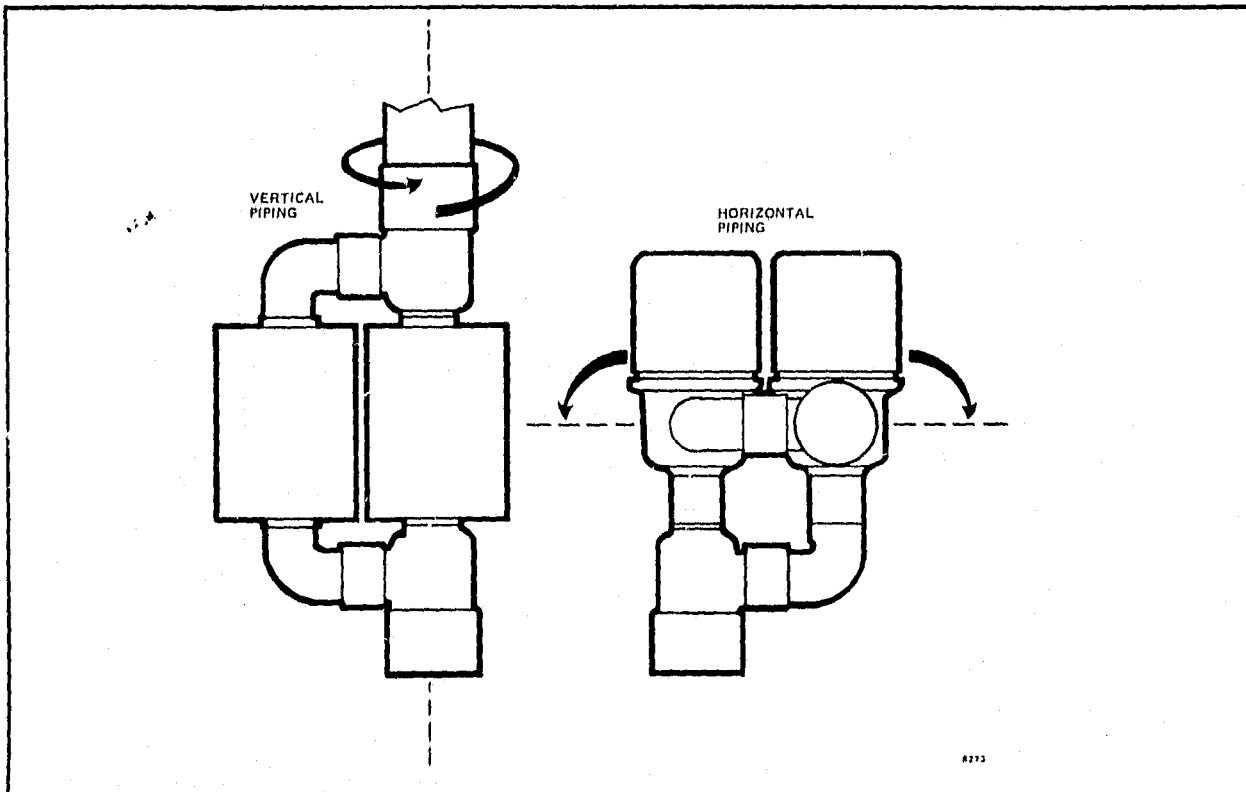


FIG. 4—MOUNTING POSITIONS.

The valve may be mounted in any position on a vertical line. If valve is mounted horizontally, the powerhead must be even with or above the center line of the piping. Make sure that enough room is provided above the powerhead to remove the cover for servicing. See Fig. 4.

The 3 fittings or ports of the dual diverting valves are labeled on the bottom of the valve body castings. Port A is connected to the purge coil piping and is closed when the valve is de-energized. Port B is connected to the system bypass and is open when the valve is de-energized. Port AB is the inlet and is open at all times. See Fig. 4.

SWEAT COPPER MODELS

1. Use new, properly reamed pipe, free from dents or corrosion.
2. Place valve onto the pipe. Set the manual opener lever to MAN, OPEN before applying heat. This will protect the plug inside the valve by removing it from the heat.
3. Sweat joints keeping the outer surface free from solder. DO NOT use silver solder because of the high melting temperatures required.

TO INSTALL REPLACEMENT POWERHEAD

IMPORTANT

Installation of new powerhead does not require the removal of the valve body from the pipe line. It is, however, necessary to drain the water from the system before beginning the installation.

1. Disconnect the valve from the electrical power source and remove the conduit connections if fitted.
2. Place the manual opening lever on the old powerhead in the MAN, OPEN position.
3. With the cover off, remove the 4 screws securing the powerhead to the valve body. Remove the old O-ring from the valve body.

4. Place the new O-ring in the circular slot on the top of the valve body.

5. Install the new powerhead—

--Place the manual opening lever on the new powerhead in the MAN, OPEN position.

--Align the powerhead by fitting the hex head screw on bottom of powerhead into the hole on top of valve body (see Fig. 3).

6. Reconnect electrical connections.

Inspect the powerhead installation and the valve body to insure that all connections and adjustments have been correctly made. Adjust the thermostat or controller connected to the valve so the valve runs through its cycle. Make sure the valve runs smoothly and positively from closed to open to closed again.

WIRING

All wiring must agree with local codes and ordinances. See Fig. 5 for a typical wiring hookup.

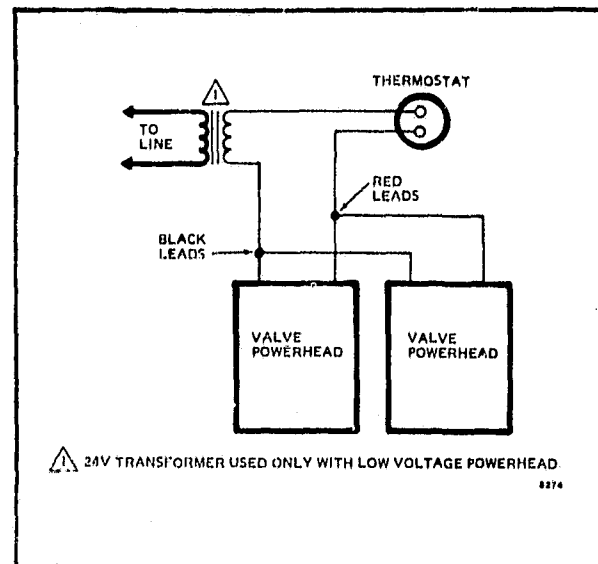


FIG. 5--TYPICAL WIRING FOR Y534 DUAL DIVERTING VALVES.

OPERATION AND CHECKOUT

CAUTION

On 24 volt systems, never jumper the valve coil terminals, even temporarily. This may burn out the heat anticipator in the thermostat.

OPERATION

AUTOMATIC OPERATION

When the valve is energized, port B, the bypass, closes and port A opens. Port A closes by integral spring return when the valve is de-energized.

MANUAL OPERATION

The motorized dual diverting valves (two with each assembly) can be opened manually by lifting the manual opener lever over the stop and pushing slowly and firmly to the MAN. OPEN position. The stop permits the valve to be locked in the open position. The valve will return to automatic position when the valve is energized.

CHECKOUT

1. Lower the set point of the high limit controller below the temperature of the collector fluid.
2. Observe that port A of the valve should be open and port B of the valve should be closed.
3. Raise the set point of the high limit controller above the collector fluid temperature.
4. Observe that port A of the valve should close and port B of the valve should be open.

SERVICE

This valve should be serviced by a trained, experienced service technician.

1. If the valve is leaking, check to see if the O-rings need to be replaced.
2. If the gear train is damaged or the motor is burned out, it is necessary to replace the entire powerhead assembly. See INSTALLATION.

NOTE: Honeywell zone valves are designed and tested for silent operation in properly designed and installed systems. However, water noises may occur as a result of excessive water velocity or piping noises may occur in high temperature (over 212 F [100 C]) systems with insufficient water pressure.

APPENDIX C

AUXILIARY ENERGY AND SPACE HEATING SUBSYSTEMS

HP10 Heat Pump Outdoor Unit

CBP10 Heat Pump Indoor Unit

ECB10 Electric Heating Coil

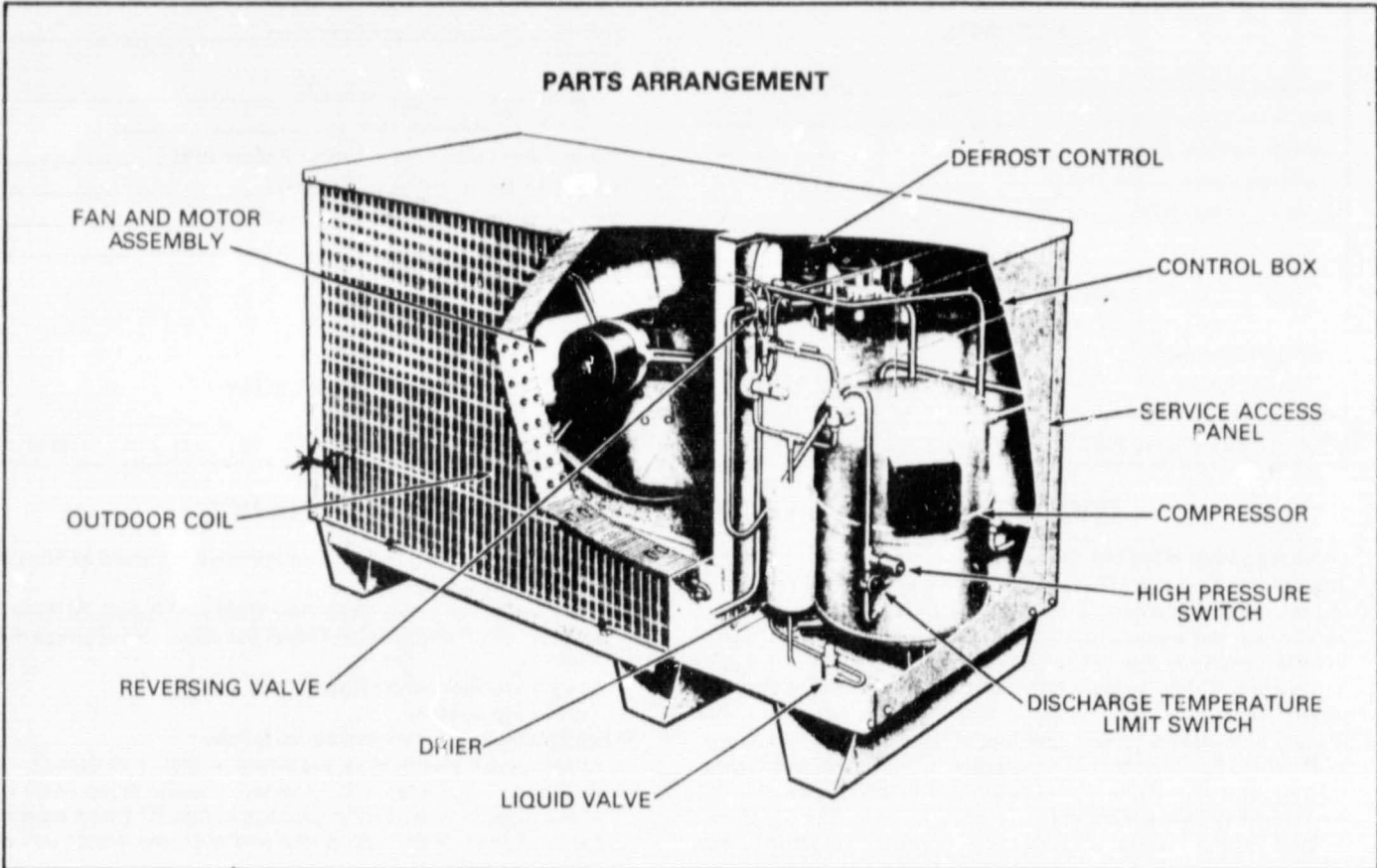
CW31-45 Solar Heating Coil

Outdoor Thermostat Kit

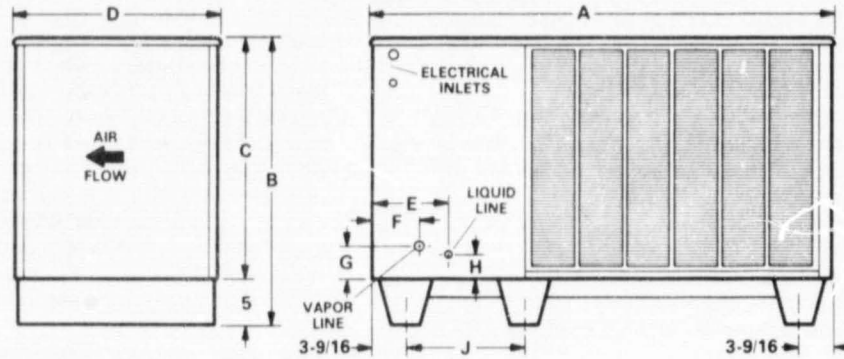
C-2

INSTALLATION OF HP10 SERIES UNITS

PARTS ARRANGEMENT



UNIT DIMENSIONS



UNIT DIMENSIONS

UNIT MODEL NUMBER	A		B		C		D		E		F		G		H		J	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
HP10-311V	48-1/8	1222	30-1/2	775	25-1/2	648	21-3/8	543	7	178	4	102	3-1/4	83	2-1/2	64	12-1/2	318
HP10-410V	48-1/8	1222	30-1/2	775	25-1/2	648	21-3/8	543	3	203	5	127	3-1/4	83	2-1/2	64	12-1/2	318
HP10-510V	59	1499	35-1/2	902	30-1/2	775	27-1/16	687	17	432	15	381	2	51	1-3/8	35	15	381

ORIGINAL PAGE IS
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START-UP AND PERFORMANCE CHECK LIST

Job Name _____ Job No. _____ Date _____
 Job Location _____ City _____ State _____
 Installer _____ City _____ State _____
 Unit Model No. _____ Serial No. _____ Serviceman _____

ELECTRICAL

Nameplate Voltage _____
 Minimum Circuit Ampacity _____
 Maximum Fuse Size _____
 Electrical Connections Tight?
 Supply Voltage (Unit Off) _____

Voltage with Compressor Operating _____
 Amps:
 Supply _____ Outdoor Fan _____
 Compressor _____
 Indoor Filter Clean? Indoor Blower RPM _____
 S.P. Drop Over Indoor Coil (Dry) _____
 Outdoor Coil Entering Air Temperature _____
 Discharge Pressure _____ Suction Pressure _____

HEAT PUMP SECTION

Refrigerant Lines:
 Leak Checked Properly Insulated
 Service Valves Backseated
 Outdoor Fan Checked

THERMOSTAT

Calibrated Level

PROCESSING — START-UP — OPERATION — MAINTENANCE

1 - PROCESSING PROCEDURE

The HP10 unit is factory charged with the amount of R-22 refrigerant indicated on the unit rating plate. This charge is based on a matching indoor coil and outdoor coil with a 25 foot (7.62 m) line set. For varying lengths of line set refer to Table 1 for refrigerant charge adjustment. A blank space is provided on the unit rating plate to list actual field charge. All units are factory leak tested and evacuated making it necessary to keep unit free of dirt, moisture and air.
WARNING - Do not open (back-seat) valves on unit until leak testing, purging, and evacuating of line sets has been completed.

A - Attaching Gauge Manifold

- 1 - Leak Testing, Purging or Evacuating - Connect high pressure side of gauge manifold to gauge port on liquid line service valve. Connect suction side of gauge manifold to gauge port on vapor line service valve.
- 2 - Cooling Cycle, Checking Charge or Charging - Connect high pressure side of gauge manifold to gauge port on liquid line service valve. Connect suction side of gauge manifold to vapor line gauge port. Refer to Figure 1.
- 3 - Heating Cycle, Checking Charge or Charging - Connect high pressure side of gauge manifold to gauge port on vapor line service valve. Connect suction side of gauge manifold to compressor suction service port. Refer to Figure 2.

B - Leak Testing Installed Line Set

- 1 - Attach gauge manifold as explained in Step 1 of Section "A - Attaching Gauge Manifold." Connect an upright refrigerant (R-22) drum to center port of gauge manifold. Open refrigerant drum valve and manifold high pressure gauge valve to pressurize line set and indoor coil of system.

- 2 - Close manifold high pressure gauge valve and check all lines and connections for leaks.
- 3 - Close drum valve and disconnect from center port. Release refrigerant into the atmosphere through suction side of gauge manifold.
- 4 - Correct any leaks and recheck.

C - Evacuating System

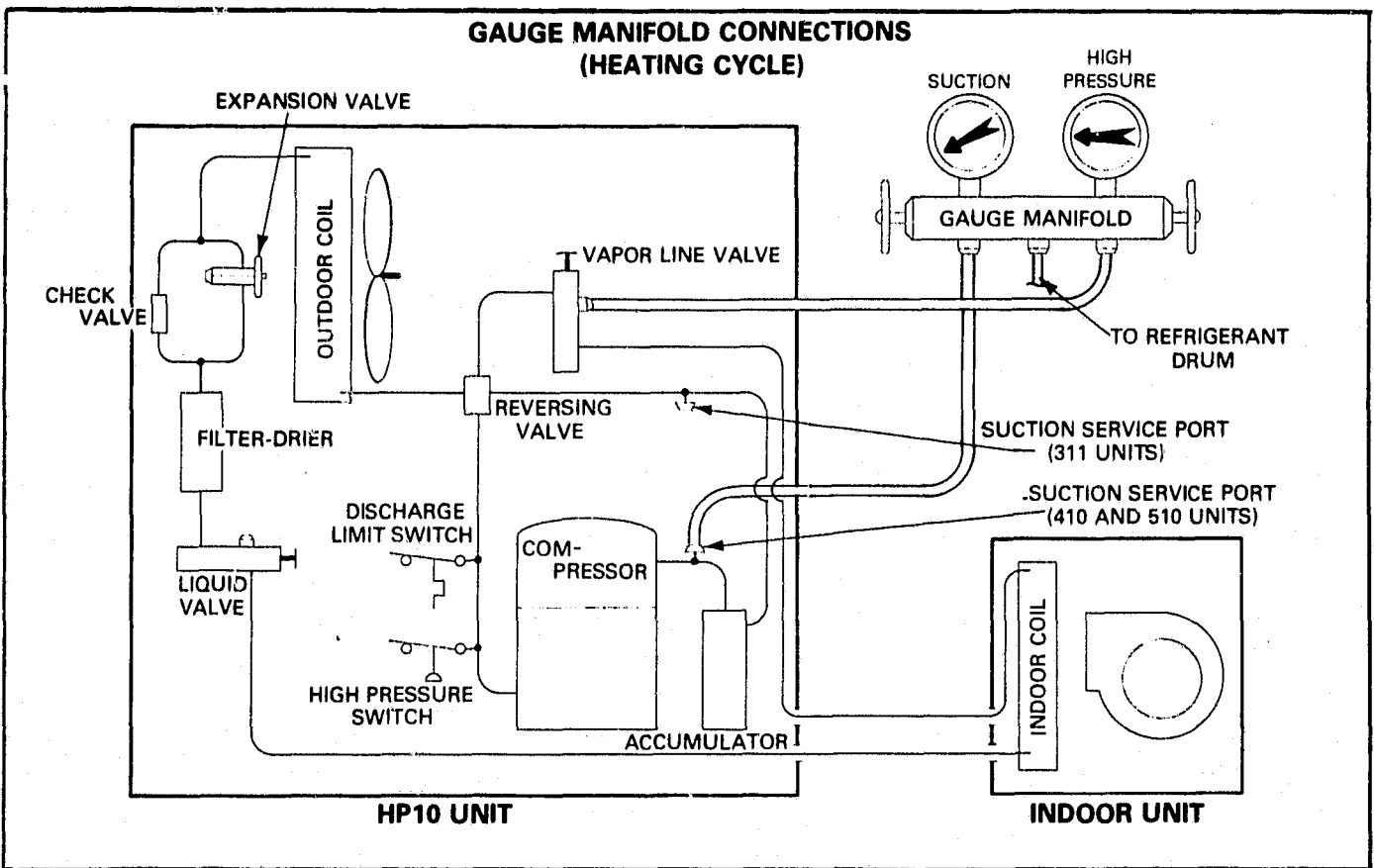
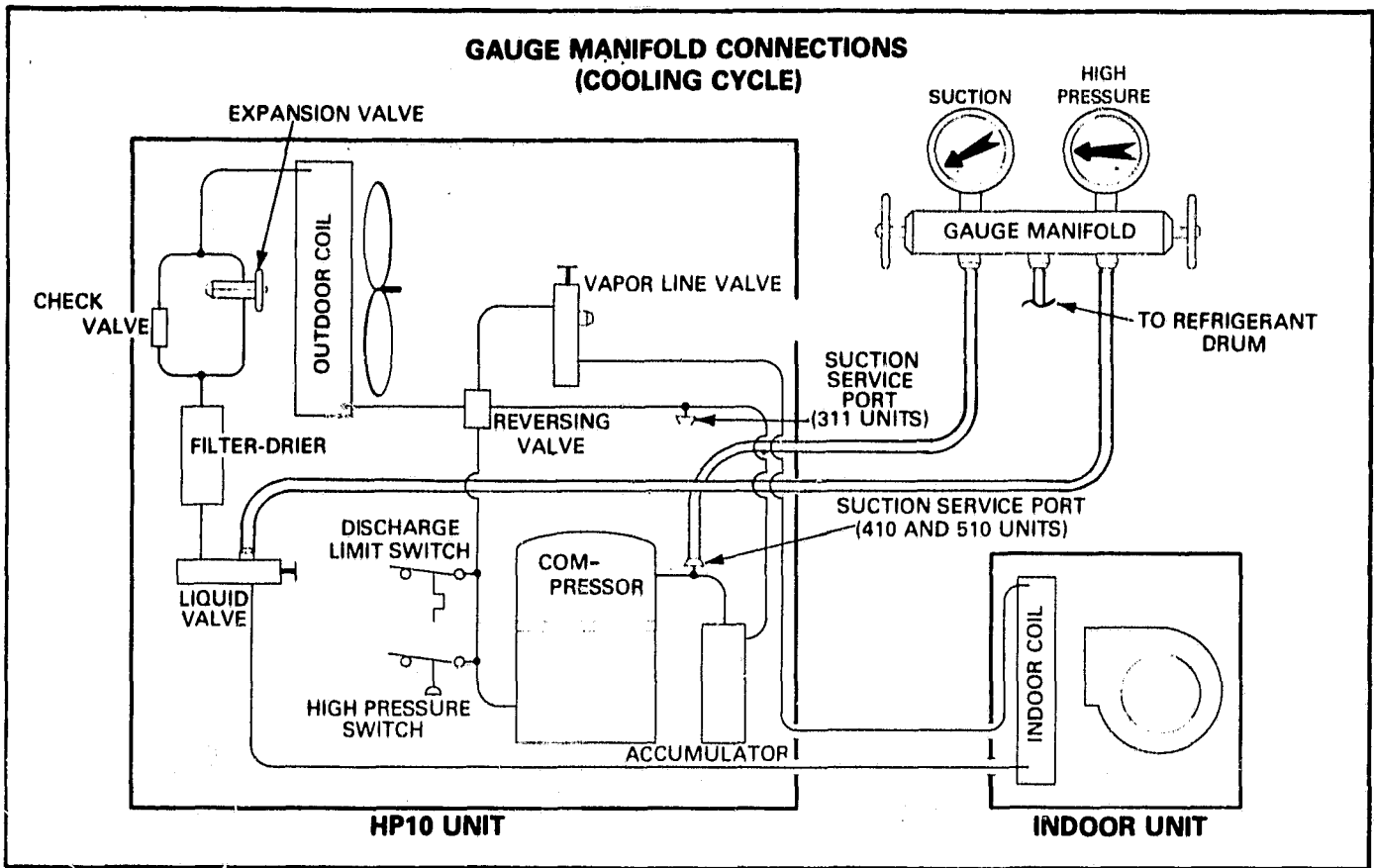
When required, evacuate system as follows:

- 1 - Attach gauge manifold as explained in Step 1 of Section "A - Attaching Gauge Manifold." Connect vacuum pump (with vacuum gauge) to center port of gauge manifold. With both manifold service valves open, start pump and evacuate indoor coil and refrigerant lines.
NOTE - A temperature vacuum gauge, mercury vacuum (U tube), or thermocouple gauge should be used. The usual Bourdon tube gauges are not accurate enough in the vacuum range.
- 2 - Evacuate the system to 29 inches (737 mm) vacuum. During the early stages of evacuation, it is desirable to stop the vacuum pump at least once to determine if there is a rapid loss of vacuum. A rapid loss of vacuum would indicate a leak in the system and a repeat of Section "B - Leak Testing" would be necessary.
- 3 - After system has been evacuated to 29 inches (737 mm), close manifold valves to center port, stop vacuum pump, and disconnect from gauge manifold. Attach an upright R-22 drum to center port of gauge manifold and open drum valve slightly to purge line at manifold. Break vacuum in system with refrigerant pressure by opening manifold high pressure valve. Close manifold high pressure valve to center port.
- 4 - Close drum valve and disconnect from gauge manifold center port. Purge refrigerant from system through suction side of gauge manifold.
- 5 - Reconnect vacuum pump to gauge manifold center port. Evacuate system through manifold service valves until vacuum in system does not rise above 29.7 inches (754 mm) mercury (5 mm absolute pressure) within a 20 minute period after stopping vacuum pump.
- 6 - After evacuation is completed, close manifold service valves, disconnect vacuum pump from gauge manifold center port, and connect refrigerant drum. Pressurize system slightly with refrigerant to break vacuum.

TABLE 1

Line Set Dia.		Ounce per foot adjustment * from 25 foot line set
Suction	Liquid	
7/8	3/8	1 ounce
3/4	3/8	1 ounce
1-1/8	1/2	1-3/4 ounce

*NOTE - If line set length is greater than 25 feet, add this amount. If line set length is less than 25 feet subtract this amount.



D - Start-Up Procedure

- 1 - Rotate fan to check for frozen bearings or any binding.
- 2 - Inspect all wiring (both factory and field installed) for loose connections.
- 3 - Open liquid and vapor line service valves to release refrigerant charge (confined in heat pump unit) into the system.
- 4 - Check voltage supply at disconnect switch; voltage must be within the range listed on unit nameplate. If voltage is not in this range, do not start the equipment until the power company has been consulted and the voltage condition corrected.
- 5 - Set thermostat for a demand. Turn on power to indoor coil blower and close heat pump disconnect switch to start unit.
- 6 - Recheck unit voltage with unit running. Power must be within range shown on unit nameplate. Check amperage draw of unit. Refer to unit nameplate for correct running amps.

E - Charging

It is desirable to charge the system in the cooling cycle if weather conditions permit. However, if the unit must be charged in the heating cycle, the charge should be re-checked in the cooling cycle when outdoor conditions permit. This assures a complete and efficient charge.

If system is completely void of refrigerant, the recommended and most accurate method of charging is to weigh the refrigerant into the unit according to the total amount shown on the unit nameplate. Refer to the "Lennox Cooling Service Handbook" for procedure. If weighing facilities are not available or if unit is just low on charge, use the following procedure:

- 1 - Connect gauge manifold as explained in Step 2 or Step 3, depending upon season, of Section "A - Attaching Gauge Manifold." Connect an upright R-22 drum to center port of gauge manifold.
- 2 - Start unit, open drum valve, and charge a quantity of refrigerant gas into the system through the suction port. Close refrigerant drum valve and allow unit to run for a few minutes to stabilize operating pressures.

F - Checking Charge

Refrigerant charge is checked by the use of a "Normal Operating Pressure Curve" that is mounted on each HP10 unit and also appears on pages 5 and 6 in this instruction. Liquid pressure is read at the liquid line service valve during the cooling cycle and vapor pressure at the vapor line service valve during the heating cycle.

- 1 - Three factors are needed to use the pressure curve: (1) outdoor coil entering air temperature, (2) suction pressure, and (3) liquid pressure during cooling cycle or vapor pressure during heating cycle.
- 2 - Read curve from correct suction pressure, over to outdoor coil entering air temperature and then down to liquid pressure (vapor pressure).
- 3 - A liquid pressure (vapor pressure) gauge reading within 3 psig (21 kPa) of the table value indicates a properly charged unit. When pressure is not within 3 psig (21 kPa) unit is not properly charged. Refer to Section "E - Charging."
- 4 - When system is operating properly, make sure all service valves are open (back-seated) and disconnect gauge manifold. Replace all gauge port caps and tighten. Set thermostat at desired setting.

II - COMPRESSOR OIL CHARGE

Refer to "Lennox Cooling Service Handbook" for correct procedure to check and add compressor oil.

III - HIGH PRESSURE SWITCH

All units are equipped with a high pressure switch (manual reset type) mounted on the compressor discharge line. This switch has a "cut-out" point of 410 psig (2827 kPa) and must be manually reset when discharge pressure drops below 180 psig (1241 kPa).

IV - DISCHARGE TEMPERATURE LIMIT SWITCH

The discharge temperature limit switch is a factory installed option mounted on the compressor discharge line. It shuts off the system if discharge temperature exceeds 260°F (127°C). The limit switch must be manually reset when discharge temperature drops to 225°F (107°C) or below.

V - DEMAND DEFROST SYSTEM

The HP10 unit utilizes an air pressure differential defrost system. A pressure sensor mounted on the division panel between the outdoor coil and the orifice panel senses the buildup of static air pressure, caused by coil icing, across the outdoor coil. Refer to Figure 3. When static buildup exceeds .5 in. w.c. (12.7 mm w.c.) set point, the defrost cycle is activated; this stops condenser fans and activates the reversing valve. The temperature sensor bulb, located near the outdoor coil distributor, terminates the defrost cycle when liquid refrigerant temperature increases to 65°F (18°C). The defrost control is factory set and should not be adjusted from these points.

IMPORTANT - It is important that the placement and cleanliness of the defrost pressure sensor be maintained for proper unit operation. Inspect both sides of the outdoor coil periodically and remove any grass, leaves, or other obstructions.

The defrost system may be checked for proper operation by blocking the air flow through the outdoor coil on the outlet side. The defrost cycle should be activated when approximately 85% of the coil is blocked. The following procedure should be used when checking the defrost control system.

A - Field Checking Air Pressure Defrost Control (Heating Cycle)

- 1 - Cut a piece of cardboard to cover approximately 85% of outdoor coil surface and remove front condenser guard.
- 2 - Mark position of defrost termination sensing bulb on refrigerant line; remove bulb from line and immerse in ice bath.
- 3 - Start unit by adjusting room thermostat to call for heat.
- 4 - Block coil inlet with cardboard from Step 1. Unit should start defrost cycle.
- 5 - After unit starts defrost cycle, remove sensing bulb from ice bath and warm bulb by holding in hand or immersing in warm water bath. Unit defrost cycle should terminate.
- 6 - After termination of defrost cycle, re-mount sensing bulb on refrigerant line in original location and secure clamp. Use caution to avoid damaging sensing bulb when installing.
- 7 - If defrost control fails to operate properly, remove entire control and replace with a new control.

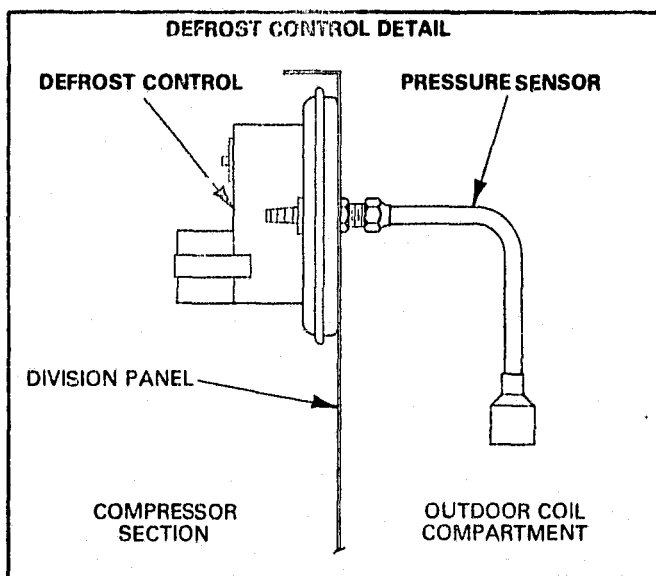
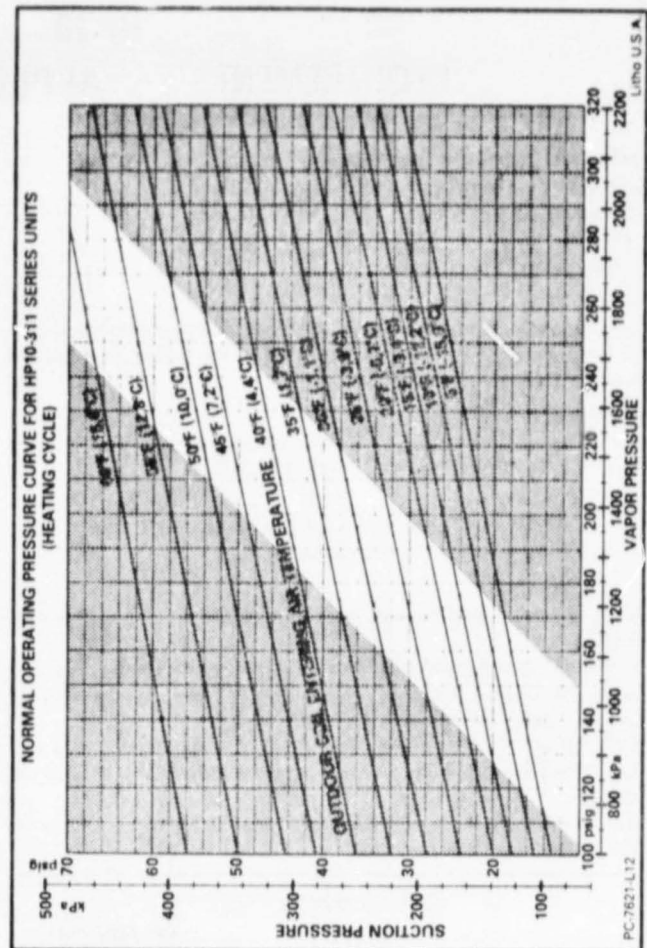
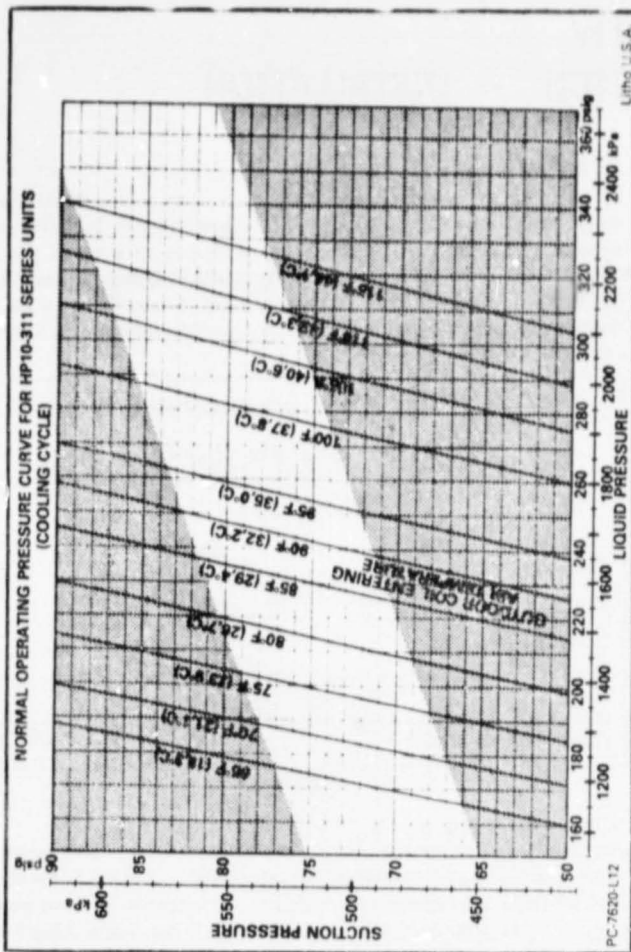


FIGURE 3



VI - CRANKCASE HEATERS

All units are provided with crankcase heaters (oil rectifiers). This heater must always be energized to prevent compressor damage as a result of slugging. A warning sticker (provided with instructions) should be applied to the main disconnect switch at the time of installation.

VII - FILTER-DRIER

CAUTION - The refrigerant filter drier in this system has two way flow (refrigerant flows in either direction depending upon unit operating mode). If replacement is required, the filter drier should only be replaced with one of like design and capacity. Order from Lennox Part Center.

VIII - MAINTENANCE

At the beginning of each heating or cooling season the system should be cleaned as follows:

A - HP10 Heat Pump Unit

- 1 - Clean and inspect both sides of outdoor coil. Coil may be flushed with water hose if necessary.
- 2 - Clean and inspect defrost pressure sensors.
- 3 - Oil outdoor fan motor: always relubricate motor according to manufacturers lubrication instructions on each motor. If no instructions are provided, use the following as a guide.
 - a - Motors With Oiling Ports - Prelubricated for an extended period of operation. For extended bearing life, relubricate with a few drops of SAE No. 10 non-detergent oil once every two years.
 - b - Motors Without Oiling Ports - Prelubricated and sealed. No further lubrication required.
- 4 - Visually inspect all connecting lines, joints and coils for evidence of oil leaks.

- 5 - Check all wiring for loose connections.
- 6 - Check for correct voltage at unit (unit operating).
- 7 - Check amp - draw on heat pump fan motor.

Unit nameplate _____ Actual _____

NOTE - If insufficient heating or cooling occurs, the unit should be gauged and refrigerant charge checked.

B - Indoor Coil

- 1 - Clean coil if necessary.
- 2 - Check connecting lines, joints and coil for evidence of oil leaks.
- 3 - Check condensate line and clean if necessary.

C - Indoor Unit

- 1 - Clean or change filters.
 - 2 - Lubricate blower motor:

Always relubricate motor according to manufacturers lubrication instructions on motor. If no instructions are provided, use the following as a guide.

 - a - Motors Without Oiling Ports - Prelubricated and sealed. No further lubrication required.
 - b - Direct Drive Motors With Oiling Ports - Prelubricated for an extended period of operation. For extended bearing life, relubricate with a few drops of SAE No. 10 non-detergent oil once every two years. It may be necessary to remove blower assembly for access to oiling ports.
 - 3 - Adjust blower speed for cooling. The pressure drop over the coil should be checked to determine the correct blower CFM. Refer to the "Lennox Cooling Service Handbook" for pressure drop tables and procedures.
 - 4 - Check all wiring for loose connections.
 - 5 - Check for correct voltage at unit.
 - 6 - Check amp draw on blower motor.
- Motor nameplate _____ Actual _____

HP10 - 311V REQUIREMENTS - APPLICATION - INSTALLATION

I - SHIPPING AND PACKING LIST

Package 1 of 1 contains:

- 1 - Assembled unit
- 1 - Thermostat
- 1 - Compressor Warning Sticker

II - GENERAL

These instructions are intended as a general guide and do not supersede local codes in any way. Authorities having jurisdiction should be consulted before installation.

III - SHIPPING DAMAGE

Check unit for shipping damage. The receiving party should contact last carrier immediately if any damage is found.

IV - APPLICATION

HP10-311V, 410V and 510V units are mated to CBP10 indoor coils with matching Lennox L10 line sets.

V - CLEARANCES

Refer to Figure 1 and provide service and air flow clearances as follows:

- 1 - Coil inlet - A minimum of 18 inches (457 mm) should be provided between the coil inlet and any building surfaces, fences or other vertical obstructions.
- 2 - Coil outlet - Provide at least 4 feet (1.22 m) between the coil outlet and any building surfaces, fences or other vertical obstructions.
- 3 - Service access - Allow a minimum of 3 feet (0.91 m) clearance on the service access end of unit.

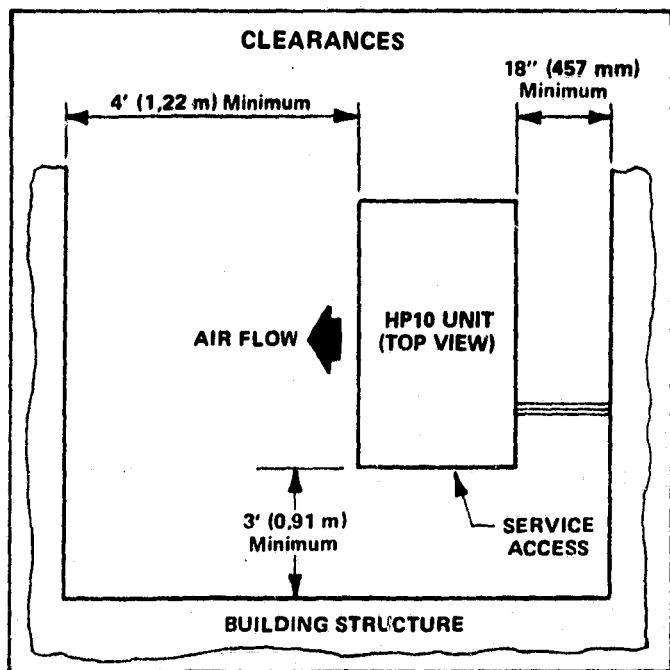


FIGURE 1

VI - SETTING THE UNIT

A sound absorbing material, such as Isomode, should always be used under unit if installed in a position or location that will transmit sound or vibration to the living area or adjacent buildings.

A - Slab Mounting

When installing unit at grade level, mount on a slab high enough above the grade to allow adequate drainage of water. Top of the slab should be located so run-off water from higher ground will not collect around unit. Slab should have a slope tolerance away from the building of 2 degrees or 2 inches per 5 feet (51 mm per 1,5 meters). This will prevent ice build-up under the unit during a defrost cycle. Refer to Figure 2.

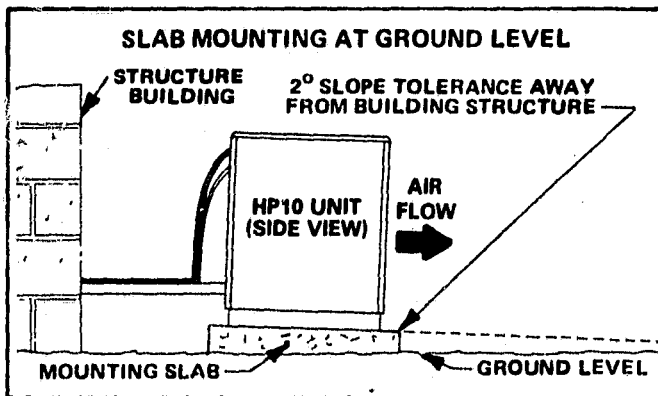


FIGURE 2

B - Roof Mounting

When unit is installed in areas where low ambient temperatures exist, it should be placed so winter prevailing winds are not in direct line with the heat pump coil. If this is not possible, a wind barrier should be constructed. Size barrier at least the same height and width as unit and mount barrier 24 inches (610 mm) from the coil inlet side of unit in the direction of prevailing winds. Refer to Figure 3.

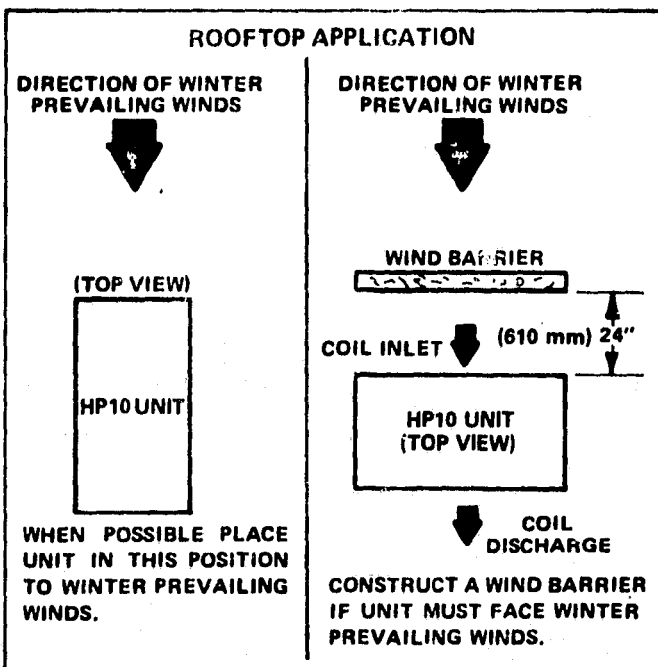


FIGURE 3

VII - ELECTRICAL

Wiring must conform to the National Electric Code (NEC) and local codes. Application diagrams are included at the back of this instruction and in indoor unit instructions.

Refer to unit rating plate for minimum circuit ampacity and maximum fuse size.

1 - Provide line voltage power supply to HP10 unit from a properly sized disconnect switch.

WARNING - Be sure line voltage connections are made as shown in this instruction. Do not close disconnect switch or apply power to this unit until advised to do so by these instructions.

2 - Install room thermostat (provided with HP10 unit) in the conditioned area. Locate where it will not be affected by sunlight, drafts, or vibration. Do not install on an outside wall. A position approximately 5 feet (1.5 m) from the floor and near the center of the conditioned area is most desirable.

3 - Provide low voltage wiring from HP10 to indoor unit and from thermostat to indoor unit as indicated on the field wiring diagram in this instruction.

4 - Ground unit either through supply wiring or with an earth ground.

5 - Mount compressor warning sticker on unit disconnect box.

VIII - REFRIGERANT PIPING

Field refrigerant piping consists of liquid and vapor lines from the HP10 unit to the indoor coil. Use applicable Lennox L10 series line sets as shown in table. These line sets may be shortened in the field when necessary.

A - Piping Connections at Outdoor Unit

HP9 units are equipped with stub type connections and field installer will determine connection type to use.

B - Piping Connections at Indoor Coil

Refer to indoor coil installation instructions for proper refrigerant line connection procedure.

TABLE 1

Outdoor Unit Model	L10 LINE SETS										
	Line Set Numbers	Length		Suction Line Connections				Liquid Line Connections			
				Outdoor Unit (Stub)		Indoor Coil		Outdoor Unit (Stub)		Indoor Coil (Flare)	
				in	mm	in	mm	in	mm	in	mm
HP10-311 HP10-410	L10-41-20	20	6.1	3/4	19.1	3/4	19.1	3/8	9.5	3/8	9.5
	L10-41-30	30	9.1	3/4	19.1	3/4	19.1	3/8	9.5	3/8	9.5
	L10-41-40	40	12.2	3/4	19.1	3/4	19.1	3/8	9.5	3/8	9.5
	L10-41-50	50	15.2	3/4	19.1	3/4	19.1	3/8	9.5	3/8	9.5
HP10-510	L10-65-30	30	9.1	7/8	22.2	3/4*	19.1	3/8	9.5	3/8	9.5
	L10-65-40	40	12.2	7/8	22.2	3/4*	19.1	3/8	9.5	3/8	9.5
	L10-65-50	50	15.2	7/8	22.2	3/4*	19.1	3/8	9.5	3/8	9.5

*The L10-65 series of line sets must have the 3/4 in. (19.1 mm) reduction removed before matching to the 1-1/8 in. (28.6 mm) stub fitting on the indoor coil.

LENNOX

Industries Inc.

INSTALLATION INSTRUCTIONS

501,165M
6/77

Supersedes 3/76

Litho U.S.A.

BLOWER COIL UNITS

CB10 AND CBP10 SERIES UNITS

INSTALLATION INSTRUCTIONS FOR CB10 and CBP10 SERIES UNITS

I - SHIPPING AND PACKING LIST

Package 1 of 2 contains:

1 - Assembled blower cabinet

Package 2 of 2 contains:

1 - Assembled coil cabinet

1 - Drip shield (C10-51/65 only - taped to coil)

3 - Drive cleats

1 - Roll gasketing

3 - Rubber drain plugs

1 - 90° Adapter fitting (C10 & CP10-41 refig. piping only)

II - SHIPPING DAMAGE

Check contents for shipping damage. If damage is found, contact last carrier immediately.

III - GENERAL

These instructions are intended as a general guide and do not supersede local codes. Authorities having jurisdiction should be consulted before installation.

IV - REQUIREMENTS

Installation of Lennox blower coil units with electric heat must conform with standards in National Fire Protection Association (NFPA)

“Standard for Installation of Air Conditioning and Ventilating Systems NFPA No. 90A,” “Standard for the Installation of Residence Type Warm Air Heating and Air Conditioning Systems NFPA No. 90B,” Manufacturer’s installation instructions and local municipal building codes. Unit is approved for installation at clearance to combustible materials as listed below:

0" to cabinet

1" to plenum and outlet duct within 3' of unit

Accessibility and service clearances must take precedence over combustible material clearances.

V - APPLICATION

These units are designed for indoor installations only. CBP10 units are designed for installation with matching HP10 heat pump units. Units may be installed for up-flo, down-flo or horizontal air discharge. Refer to Figure 1 for stacking arrangement. Units are intended for use with specific Lennox sections of heat pumps.

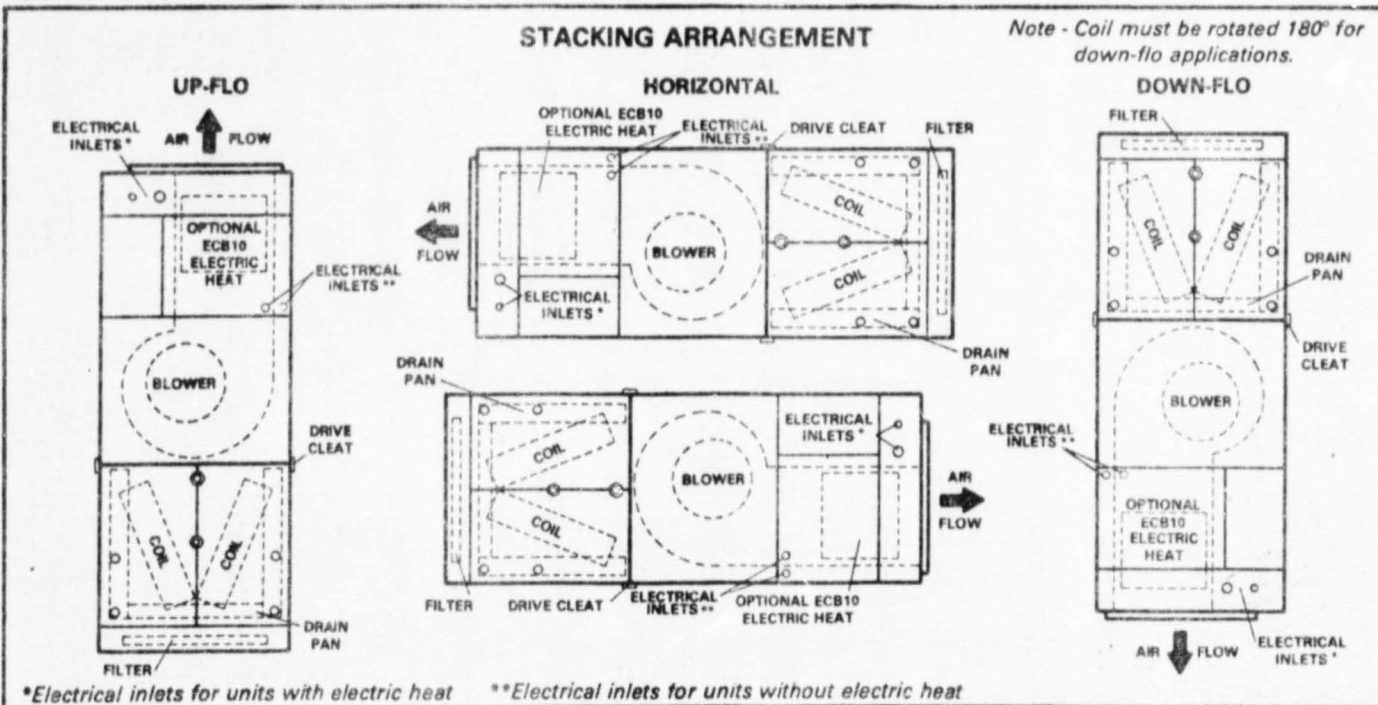


FIGURE 1

VI - UNIT DIMENSIONS

Refer to Figure 2 for dimensions of coil/filter and blower sections.

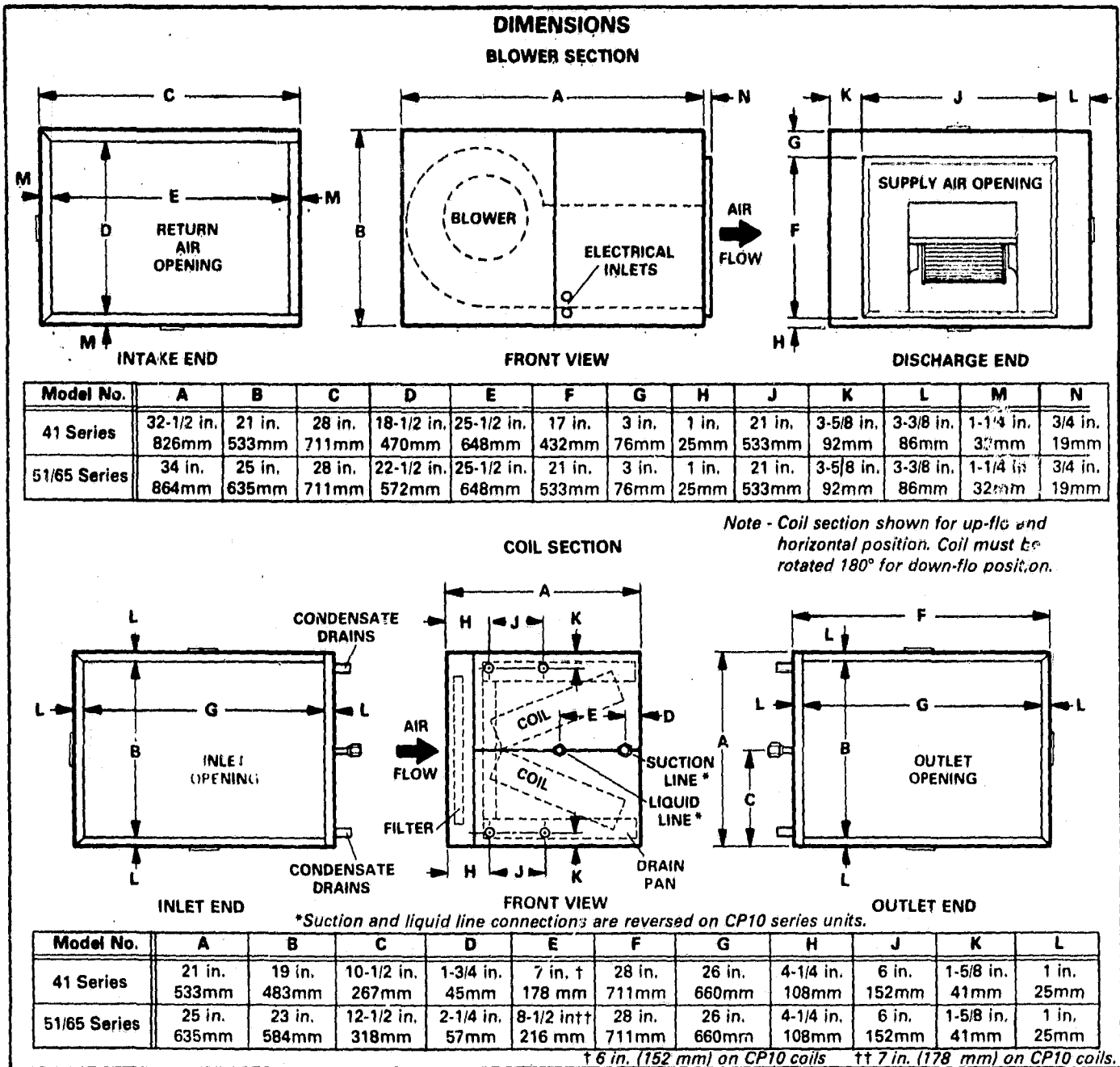


FIGURE 2

VII - INSTALLATION

See Figure 1 for stacking arrangements for up-flo, down-flo and horizontal air discharge. **NOTE** - For some applications blower motor must be rotated so oilers are positioned up.

A - Up-flo

NOTE - For up-flo applications, an optional adaptor base (RAB10) is available to provide side return air entry into the unit. Refer to instructions provided with adaptor base for assembly and installation.

- 1 - Place coil cabinet in desired location.
- 2 - Install gasketing (provided) around outlet opening of coil cabinet.
- 3 - Set blower cabinet above coil cabinet and secure cabinets to-

gether with drive cleats provided.

- 4 - Connect supply and return ducts as required. If return air opening of unit is installed flush with wall or other type barrier, the coil and filter must be removed from cabinet, and duct connections secured to the inside duct flange of cabinet opening. After duct connection is made, replace coil and filter.

B - Down-flo

On down-flo applications using ECB10 electric heat, an additive base is required when unit is installed on combustible flooring. The additive base is not provided and must be ordered separately. Table 1 lists units applicable to each additive base.

TABLE 1

Unit Model No.	Additive Base Model No.	Additive Base Catalog No.
41 Series	CBA10-41	LB-26029BA
51 Series 65 Series	CBA10-51/65	LB-26029BB

1 - Cut discharge air opening in floor. See Figure 3 for dimensions of floor opening when additive base is used. If additive base is not required, refer to Figure 2 for unit discharge opening.

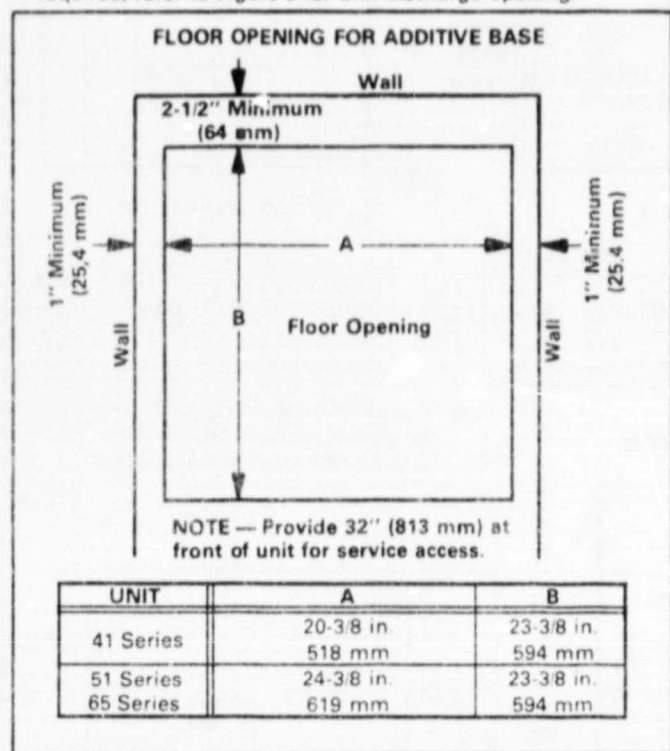


FIGURE 3

- 2 - Install additive base in floor opening (if required).
- 3 - Set blower cabinet over discharge opening.
- 4 - Remove (2) front access panels from coil cabinet and slide coil/drain pan assembly from cabinet. Rotate cabinet 180° and slide coil/drain pan assembly back into cabinet. Refer to Figure 1 for position of coil in down-flo applications.
- 5 - Install gasketing (provided) around outlet opening of coil cabinet.
- 6 - Set coil cabinet above blower cabinet and secure cabinets together with drive cleats provided.
- 7 - Connect duct work as required.

C - Horizontal

Units in the horizontal position may be arranged for right or left air discharge. If unit is to be suspended it is recommended that a support frame be constructed as shown in Figure 4. The frame may be constructed with angle iron, as shown, or other suitable material. This frame will prevent unit sagging which may cause access panels to bind.

- 1 - Place coil cabinet in desired location.
- 2 - Install gasketing (provided) around outlet opening of coil cabinet.
- 3 - Set blower cabinet next to coil cabinet and secure cabinets together with drive cleats provided.
- 4 - Connect supply and return air ducts as required. If return air opening of unit is installed flush with wall or other type barrier, the coil and filter must be removed from cabinet and duct connections secured to the inside duct flange of cabinet opening. After duct connection is made, replace coil and filter.

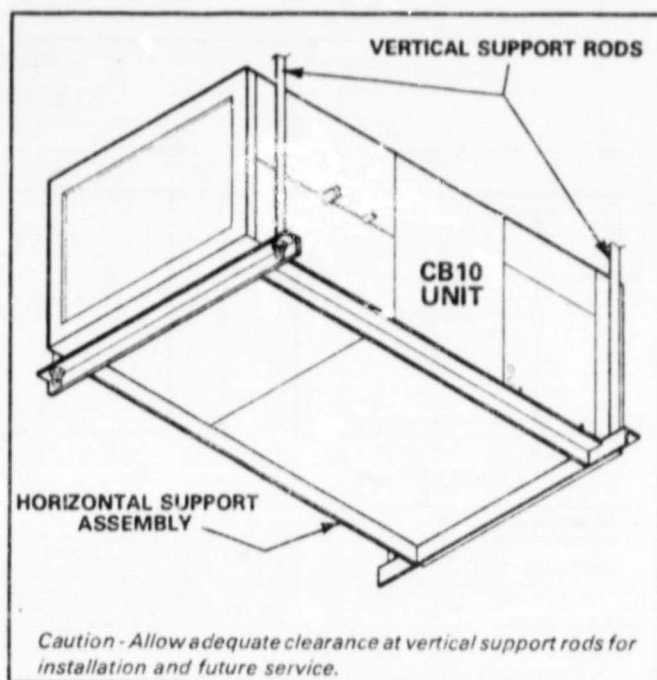


FIGURE 4

Drip Shield (Horizontal installations only)

A drip shield is provided to prevent moisture blow-off from coil to blower section in C10-51/65 units only. Shield is taped to coil for shipping.

- 1 - Slip standing seam of drip shield over lower edge of drain pan in coil section.
- 2 - Crimp securely with pliers if necessary. See Figure 5.

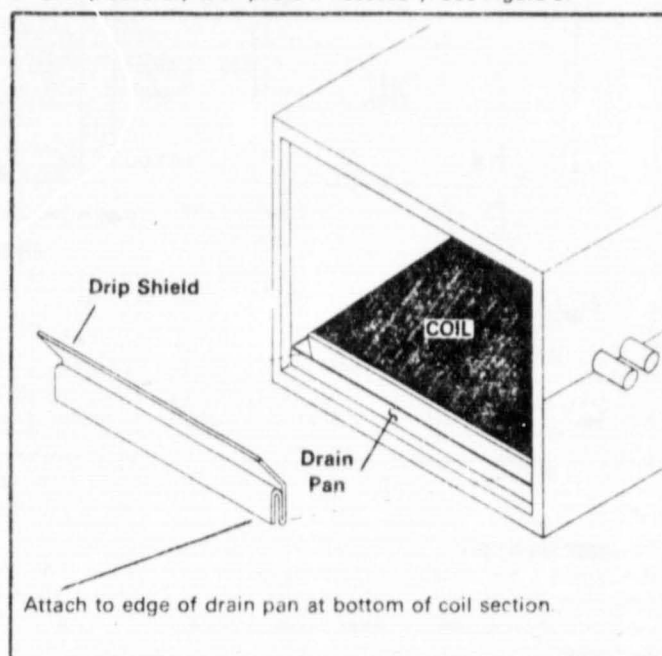


FIGURE 5

VIII - REFRIGERANT PIPING

Suction and liquid lines are equipped with flare fittings on -41 model. Liquid line has flare fittings and suction line requires sweat connections on -51 and -65 models. C10 units may be applied with either Lennox L10 lines sets or field fabricated lines. CP10 units may only be applied with Lennox L10 line sets. Refer to outdoor unit installation instructions for proper application, installation and refrigerant charge for particular systems.

IX - CONDENSATE DRAIN

Two sets of drains are provided, 3/4" threaded pipe main drain and 3/4" plain pipe auxiliary drain. Always use lower set of drains. Install the rubber plug (with hole in center) in the auxiliary drain before connecting drain lines. Plug the (2) upper unused drain connections with the solid rubber plugs provided.

- 1 - Drain piping should not be smaller than the drain connections at drain pan.
- 2 - A trap in the drain line is recommended when drain is on the negative side of the blower system.
- 3 - The trap must be deep enough to offset the difference in static pressure between drain pan and atmosphere. Generally 2" (51 mm) inches is satisfactory for medium static applications.
- 4 - Horizontal runs must be pitched 1 inch per 10 feet of drain line to offset line friction.
- 5 - An open vent in drain line will sometimes be required due to line length, friction and static pressure.
- 6 - Drains should be constructed in a manner to facilitate future cleaning.

X - FIELD WIRING CONNECTIONS

Wiring must conform to National Electrical Code (NEC) and local codes. Refer closely to application wiring diagram in this instruction for wiring make-up. Field high voltage wiring must terminate at the handy box provided in blower section. If EMT or rigid conduit is used, special fitting may be required. Low voltage connections are to be made external to unit.

XI - CHECKING UNIT AIR VOLUME

Refer to Table 2 for coil pressure drop readings and corresponding unit CFM.

NOTE - Table 2 lists one set of coil pressure drop readings for coils in the horizontal or up-flo position and one set of readings for coils in the down-flo position. Use the applicable column as indicated in the

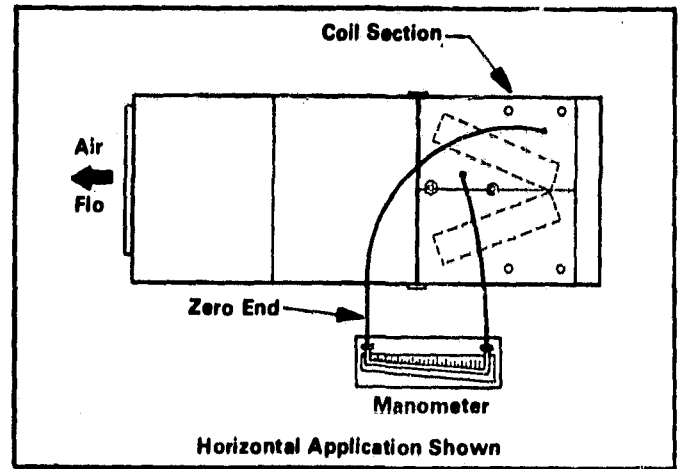


table when taking readings. Checks are made with a clean filter in place, unit panels in place and a dry evaporator coil (blower only operating). Test holes are provided in coil section.

- 1 - Remove snaphole plugs from unit test holes. Insert manometer hoses 1/4 inch (6.4 mm) past the inside edge of cabinet insulation. Seal around hoses with permagum or sealing compound. Connect zero end of manometer to entering air side of coil. Refer to Figure 6.
- 2 - With only the indoor blower operating, observe manometer reading. If reading is above air volume required, decrease blower speed. See Table 2 for required air volumes. Refer to application wiring diagram in this instruction for changing blower speed.
- 3 - After required draft gauge readings are obtained, insert snaphole plugs in air test holes.

TABLE 2

UNIT SIZE	DRAFT GAUGE READING (DRY EVAPORATOR)					
	AIR VOLUME**		*READING (Horizontal or Up-flo)		*READING (Down-flo)	
	CFM	m ³ /s	in. water	mm water	in. water	mm water
-41 Units	900	.425	.085 - .09	2.16 - 2.29	.05 - .058	1.27 - 1.47
	1000	.472	.09 - .095	2.29 - 2.41	.06 - .065	1.52 - 1.65
	1200	.566	.125 - .13	3.18 - 3.30	.09 - .095	2.29 - 2.41
	1400	.661	.17 - .18	4.32 - 4.57	.11 - .12	2.79 - 3.05
	1500	.708	.195 - .2	4.95 - 5.08	.13 - .135	3.30 - 3.43
-51 Units	1400	.661	.045 - .05	1.14 - 1.27	.075 - .08	1.91 - 2.03
	1600	.755	.055 - .06	1.40 - 1.52	.08 - .085	2.03 - 2.16
	1800	.849	.06 - .065	1.52 - 1.65	.095 - .1	2.41 - 2.54
	2000	.944	.07 - .075	1.78 - 1.91	.115 - .12	2.92 - 3.05
	2200	1.04	.085 - .09	2.16 - 2.19	.125 - .13	3.18 - 3.30
-65 Units	1800	.859	.07 - .075	1.78 - 1.91	.1 - .12	2.54 - 3.05
	2000	.944	.08 - .09	2.03 - 2.29	.13 - .135	3.30 - 3.43
	2200	1.04	.09 - .095	2.29 - 2.41	.155 - .16	3.94 - 4.06
	2400	1.13	.095 - .1	2.41 - 2.54	.185 - .19	4.70 - 4.83
	2500	1.18	.11 - .12	2.79 - 3.05	.2 - .21	5.08 - 5.33

*These are pressure drop readings across the coil only, not total resistance readings.

**Minimum air volume for heat pumps application is 400 CFM/ton of unit capacity.

ELECTRIC UNITS

ECB10 SERIES HEATERS

INSTALLATION INSTRUCTIONS FOR ECB10-41 AND ECB10-51/65 SERIES ELECTRIC HEAT SECTIONS

I - SHIPPING AND PACKING LIST

- 1 - Assembled electric heat section

II - SHIPPING DAMAGE

Check heater for shipping damage. If damage is found, contact last carrier immediately.

III - GENERAL

These instructions are only intended as a general guide and do not supersede local codes. Authorities having jurisdiction should be consulted before installation.

IV - REQUIREMENTS

Installation of Lennox blower coil units with electric heat must conform with standards in National Fire Protection Association (NFPA) "Standard for Installation of Air Conditioning and Ventilating Systems NFPA No. 90A," "Standard for the Installation of Residence Type Warm Air Heating and Air Conditioning Systems NFPA No. 90B," Manufacturer's installation instructions and local municipal building codes. Metal duct must be used in down-flow applications with no discharge openings directly below the unit. Unit is approved for installation at clearance to combustible materials as listed below:

- 0" to cabinet
- 1" to plenum and outlet duct within 3' of unit

Accessibility and service clearances must take precedence over combustible material clearances.

V - APPLICATION

ECB10 Series heaters are designed to provide field installed electric heat for CB10 Series coil/blower units.

VI - INSTALLATION

When installing ECB10 heaters in CB10 down-flow applications on combustible floors, an additive base is required. Base model number

CBA10-41 (LB-26029BA) is required for CB10-41 models and base CBA10-51/65 (LB-26029BB) for CB10-51 and CB10-65 units. The additive base is not provided and must be ordered separately. Refer to CB10 installation instructions for installing additive base.

- 1 - Disconnect and remove power supply to CB10 unit. Remove low voltage strain relief bushings.
- 2 - Remove blower access panel and power-in access panel covering blower duct extension. Discard the power-in access panel and save the sheet metal screws. See Figure 1.
- 3 - Remove and discard front and rear filler panels from blower duct extension. Refer to Figure 1. Save the 1/4-20 machine screws from front filler panel.

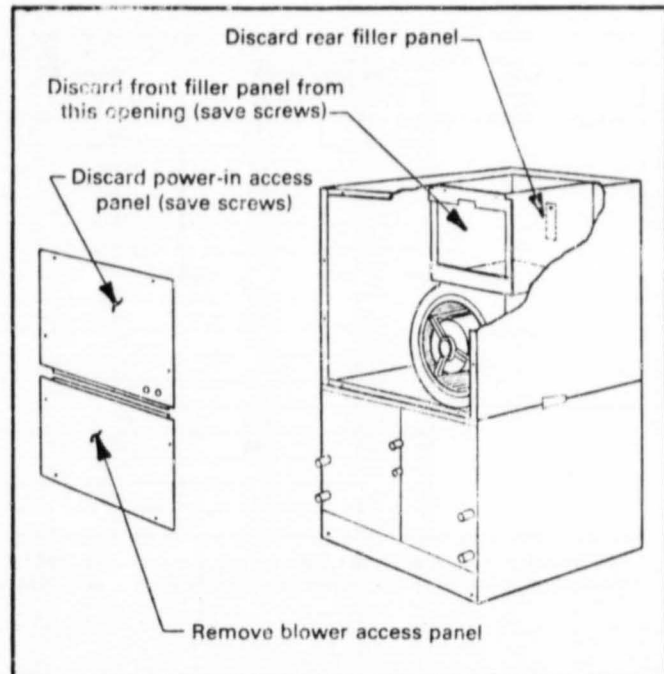


FIGURE 1

- 4 - Remove ECB10 access cover. Slide heater into duct extension opening making sure back of heater aligns with rear duct extension opening.
- 5 - Secure heater to duct extension with (2) 1/4-20 machine screws and to outside of blower cabinet with (2) sheet metal screws. Use the screws which were removed from blower access panel and duct extension front filler panel. Refer to Figure 2.

VII - FIELD WIRING CONNECTIONS

Wiring must conform to National Electrical Code (NEC) and local

codes. Refer closely to application wiring diagram in this instruction for low voltage wiring make-up and to wiring diagram in ECB10 unit for line voltage make-up. See ECB10 rating plate for minimum circuit ampacity and maximum rating of over-current protective devices. Connect blue low voltage blower relay leads to black and yellow low voltage leads. Select appropriate blower speed and make connections as shown on application wiring diagram. After all wiring is completed, replace ECB10 access cover and blower access panel.

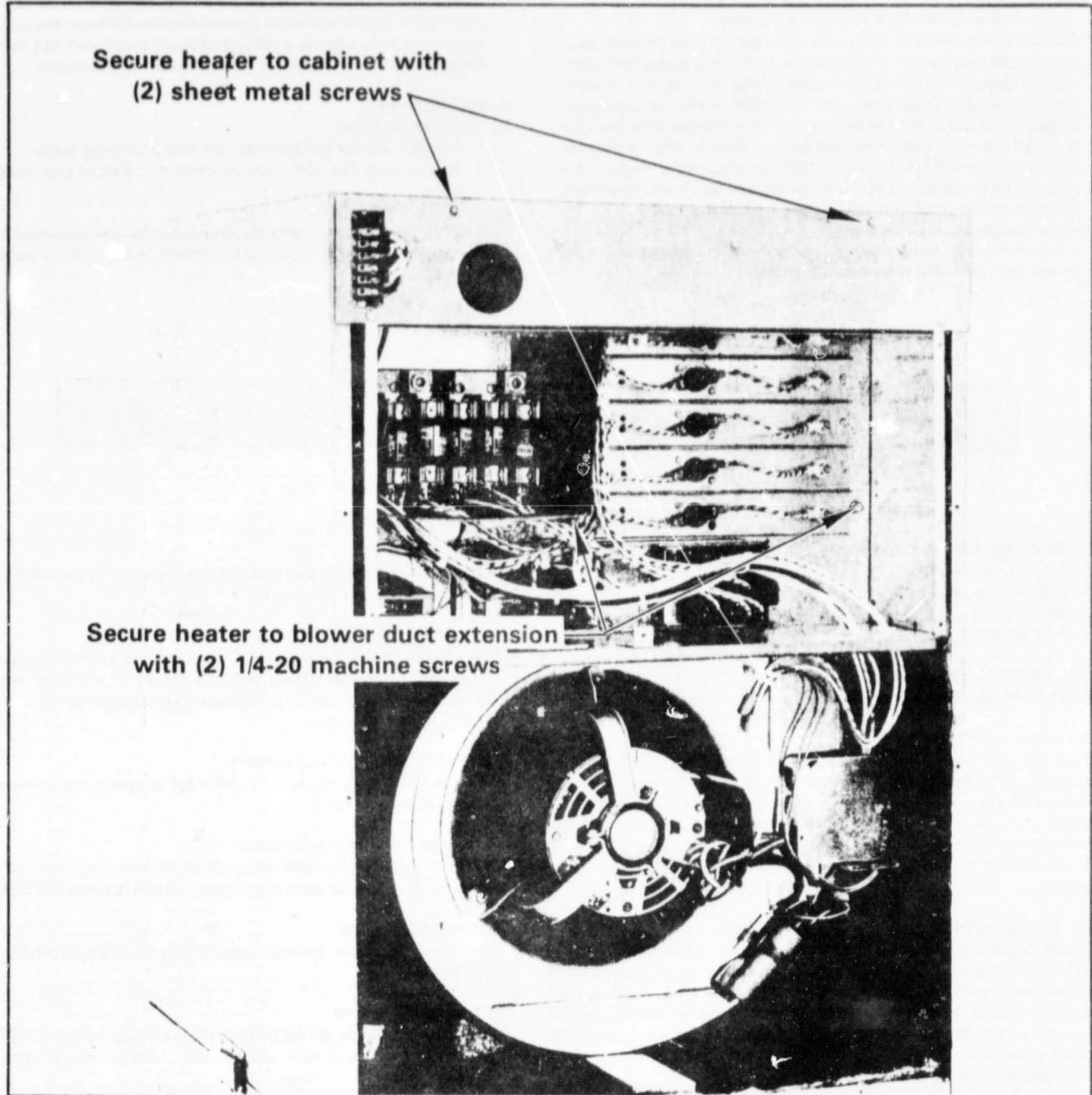


FIGURE 2

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OPERATION AND MAINTENANCE OF CW31-45

I. OPERATION

A - Water Coil and Auxiliary Energy Subsystem

The CW31-45 space heating coil allows a transfer of solar provided heat into the conditioned area. In normal operation, solar heated liquid in the coil is the first stage heat source. As the room thermostat demands heat, solar heated water is circulated through the CW31-45 coil and the system blower circulates air through the coil. If solar heated air is sufficient the thermostat requirement will be met. If sufficient heat is not available from the coil, the thermostat will activate the second and third stage heat sources as required to meet heating demand.

B - High Temperature Limit Switch

A high temperature limit switch located on the downstream side of the coil provides overheating protection for the subsystem

blower motor. If the temperature of air leaving the coil reaches 140°F (60°C) the limit switch stops waterflow through the coil. No additional heat will be available from the coil and the blower motor will not be subjected to excessive temperatures.

II. MAINTENANCE

A - CW31-45 Coil Unit

1. Inspect unit for evidence of coil and plumbing leaks.
2. Inspect coil. The coil must be clean and free of any obstruction.

B - Auxiliary Energy Unit

Refer to the Operation and Maintenance manual accompanying the auxiliary energy unit for its proper maintenance requirements.

APPLICATION AND INSTALLATION

I - SHIPPING AND PACKING LIST

Package 1 of 1 contains:

- 1 - Coil/cabinet assembly
- 3 - Drive cleats
- 1 - Roll gasketing

II - SHIPPING DAMAGE

Contact the last carrier immediately if any shipping damage is found.

III - APPLICATION

The CW31-45 coil is designed to provide solar heat in CB10 series units. Refer to the total system instructions for solar heat collection and connecting plumbing information. The solar coil installs between the evaporator coil cabinet and the blower coil cabinet. Use these instructions only as a general guide, they in no way supersede any local codes. Consult authorities having jurisdiction before installation.

IV - INSTALLATION (Refer to Figure 1 and 2)

Install gasketing (provided) around the blower side of the CW31-45 cabinet. Position CW31-45 unit between evaporator coil cabinet and blower cabinet. Tapered cabinet securing cleats should match with straight cleats. Also, the high temperature limit will be facing the blower compartment. When properly aligned, secure evaporator cabinet to CW31-45 cabinet and CW31-45 cabinet to blower cabinet with provided drive cleats.

Assembled CB10 unit with CW31-45 coil should be installed so that the drain plugs are accessible.

V - PLUMBING CONNECTION

The solar heated water connections are 5/8" (15.9 mm) nominal, 3/4" (19 mm) O.D. copper tubing. Refer to Figure 1 for proper inlet and outlet identification. Refer to the total system instruction for proper plumbing specifications.

VI - ELECTRICAL CONNECTIONS

Refer to the total system instruction for proper connection of the high temperature limit.

VII - HIGH TEMPERATURE LIMIT

The high temperature limit stops water flow through the coil if the temperature of the air discharged from the coil reaches 140°F (60°C).

VIII - DRAIN PLUGS

Two drain plugs, one for each internal header, are provided to drain the CW31-45 coil.

IX - BLOWER SPEED

The CB10 blower MUST BE SET TO RUN AT MEDIUM-HIGH SPEED. Use the orange "common" and brown "med-hi" motor taps. Individually tape unused motor wires.

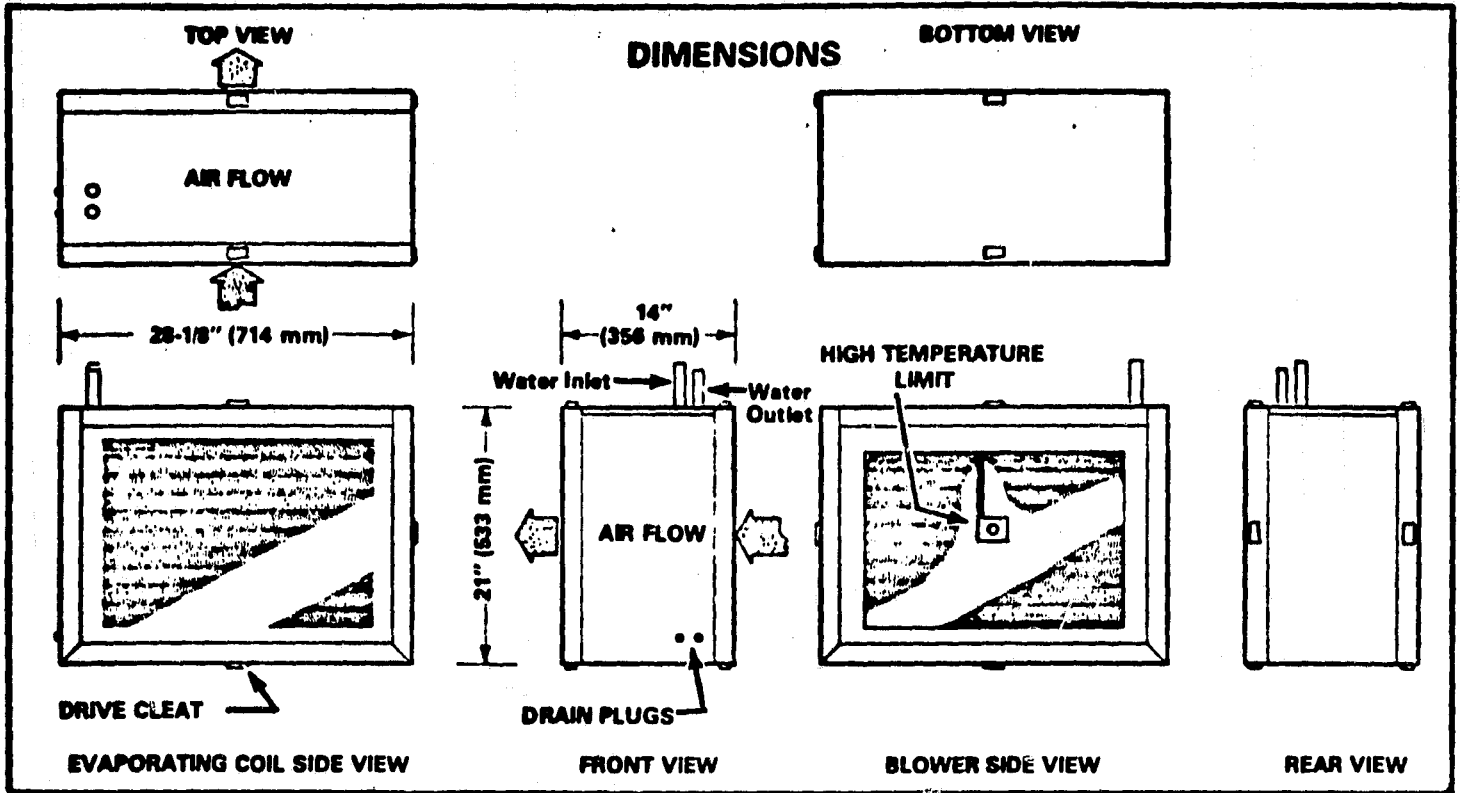


FIGURE 1

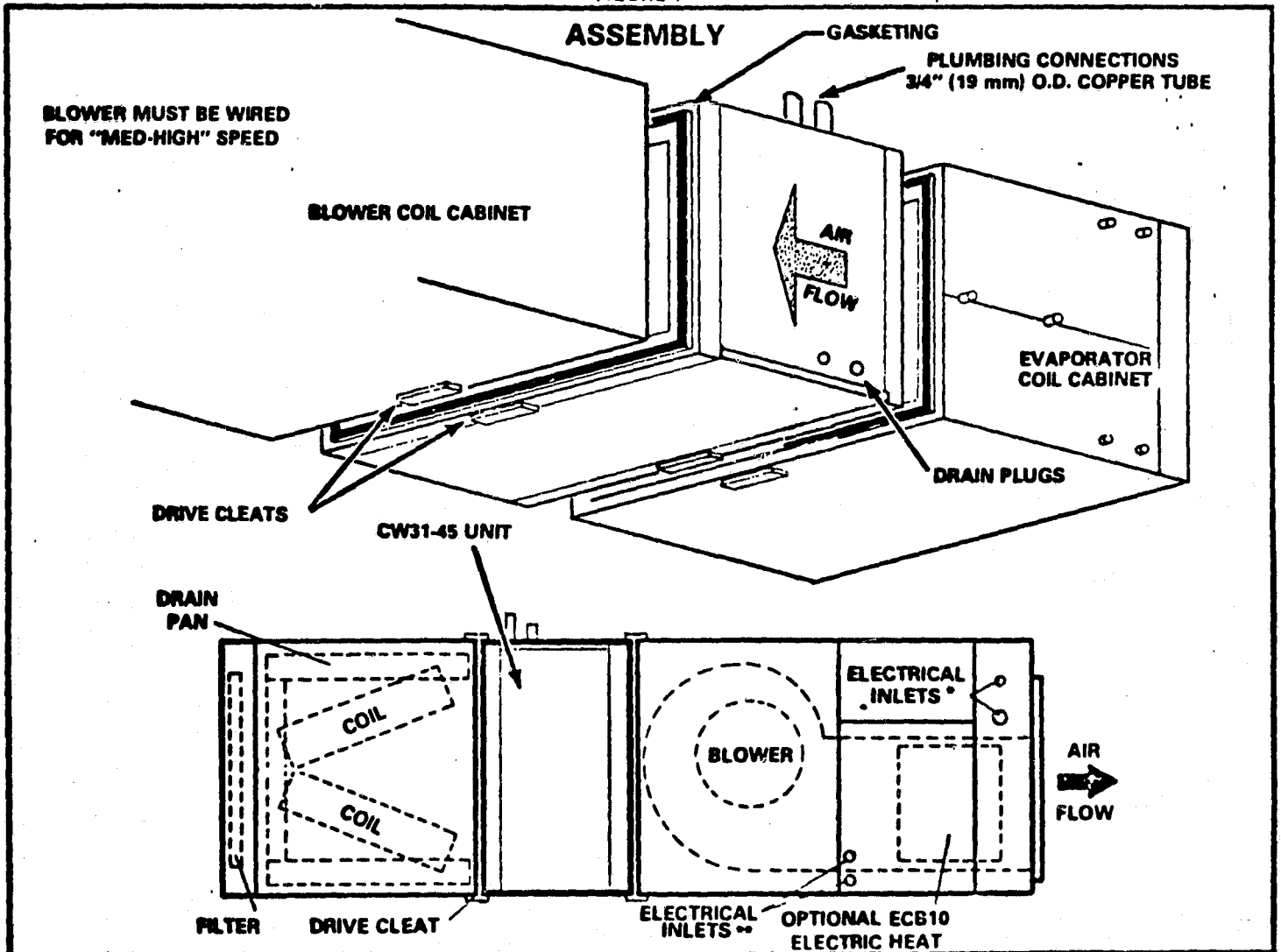


FIGURE 2

LENNOX
Industries Inc.

INSTALLATION INSTRUCTIONS

501,117M
5/74

Supersedes 500,975M

Litho U.S.

ELECTRIC UNIT ACCESSORIES

OUTDOOR THERMOSTAT

INSTALLATION INSTRUCTIONS FOR OUTDOOR THERMOSTAT KIT (LB-44376BA), OUTDOOR THERMOSTAT (PR-231) AND MOUNTING BOX (M-1595) USED WITH ELECTRIC HEAT

- I — SHIPPING AND PACKING LIST**
OUTDOOR THERMOSTAT KIT (LB-44376BA)
Package 1 of 1 Contains
1—Outdoor thermostat
1—Mounting bracket
2—Tubing clamps
Miscellaneous sheet metal screws

- OUTDOOR THERMOSTAT (PR-231)**
Package 1 of 1 Contains
1—Outdoor thermostat

- OUTDOOR THERMOSTAT MOUNTING BOX (M-1595)**
Package 1 of 1 Contains
1—Outdoor thermostat mounting box
2—Tinnerman clamps
2—Sheet metal screws

The outdoor thermostat kit (LB-44376BA), outdoor thermostat (PR-231) and outdoor thermostat box (M-1595) are listed and ordered separately. If mounting provisions are included in the outdoor unit, only the outdoor thermostat (PR-231) is needed. An outdoor thermostat kit (LB-44376BA) installs thermostat in outdoor units without mounting facilities. When thermostat is mounted in an outdoor location, the mounting box (M-1595) is used to house the thermostat.

II — GENERAL

These instructions are only intended as a general guide and do not supersede local codes in any way. Authorities having jurisdiction should be consulted before installation.

III — SHIPPING DAMAGE

Check items for shipping damage. The receiving party should contact the last carrier immediately if any shipping damage is found.

IV — APPLICATION

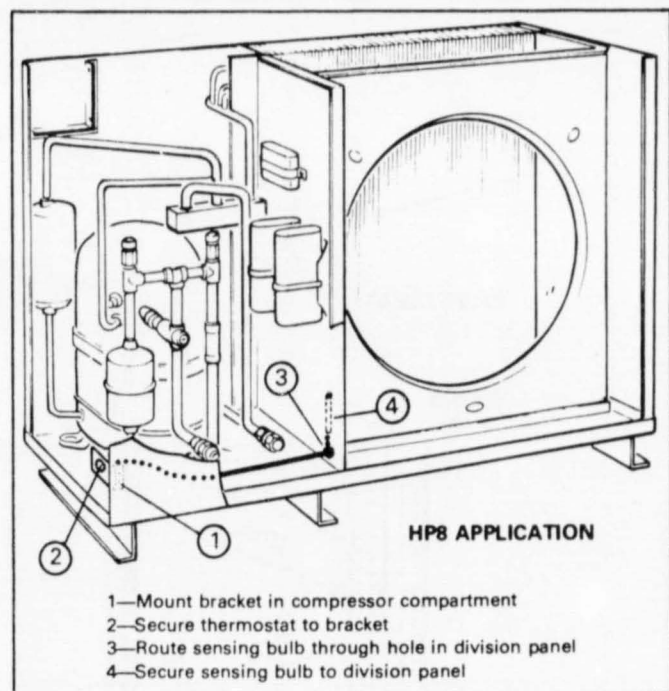
The purpose of the outdoor thermostat is to keep the total

power load off the line until it is actually required. In heat pump applications, it will keep the heating load on the heat pump as long as possible thereby obtaining more Btuh per watt of power input. In straight electric heating applications, it keeps the heating load on low power input as long as possible.

V — INSTALLATION

A—Outdoor Thermostat Kit (LB-44376BA)

- 1—Mount thermostat bracket in a convenient location in compressor compartment which will allow the sensing bulb to extend into the outdoor fan area for sensing out-



- 1—Mount bracket in compressor compartment
2—Secure thermostat to bracket
3—Route sensing bulb through hole in division panel
4—Secure sensing bulb to division panel

FIGURE 1

door temperatures. Sensing bulb must not be in direct sunlight or wind.

- 2—Sheet metal screws are provided for mounting bracket and clamps for securing sensing bulb. Figure 1 illustrates a typical HP8 application.
- 3—Remove adjustment knob and mounting screws from thermostat. Insert thermostat behind mounting plate of box with shaft extending through the slot. Line up mounting holes and replace mounting screws. Replace adjustment knob.

B—Outdoor Thermostat (PR-231) And Mounting Box (M-1595)

If an outdoor unit has mounting provisions, secure outdoor thermostat (PR-231) in place.

If the outdoor thermostat(s) is installed in outside location, the mounting box should be used to house thermostat(s). Before thermostat(s) are installed in thermostat box, remove the (2) screws on thermostat and install on opposite side of terminals. This must be done so wiring can be connected to terminals when thermostat is mounted in thermostat box. See Figure 2.

- 1—Remove cover from thermostat box and insert thermostat through grommetted hole in bottom of box.
- 2—Remove adjustment knob and mounting screws from thermostat. Insert thermostat behind mounting plate of box with shaft extending through the slot. Line up mounting holes and replace mounting screws. Replace adjustment knob.
- 3—Secure thermostat sensing bulb to bottom of box with Tinnerman clamps and sheet metal screws provided.
- 4—Mount box outdoors in a sheltered location where direct sun and strong winds will not affect temperature reading.

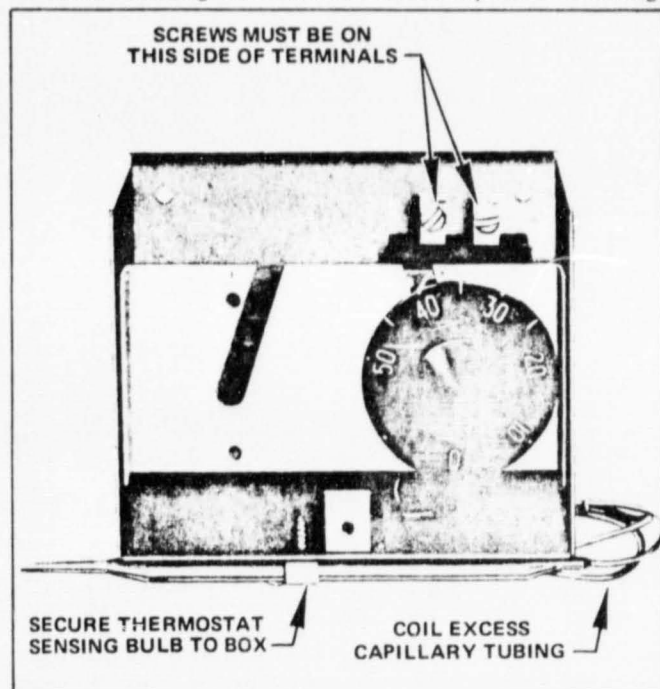


FIGURE 2

VI — WIRING

Refer to correct application wiring diagram in this instruction for thermostat connections. Class 2 type wire may be used for low voltage wiring.

CAUTION—Outdoor thermostat(s) should never be wired to control the entire auxiliary electric heat section applied to heat pumps. Some auxiliary heat must automatically be energized by the heat pump during a defrost cycle to control indoor air. Wire first stage as indicated on application diagram.

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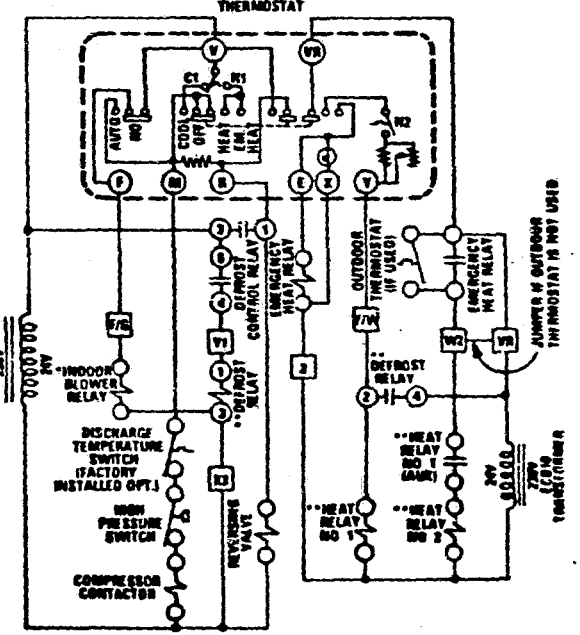
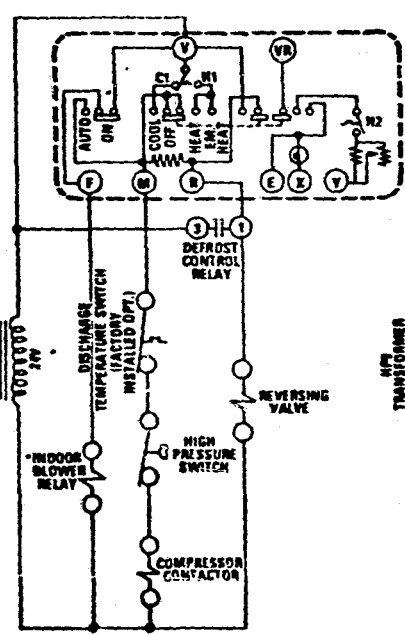
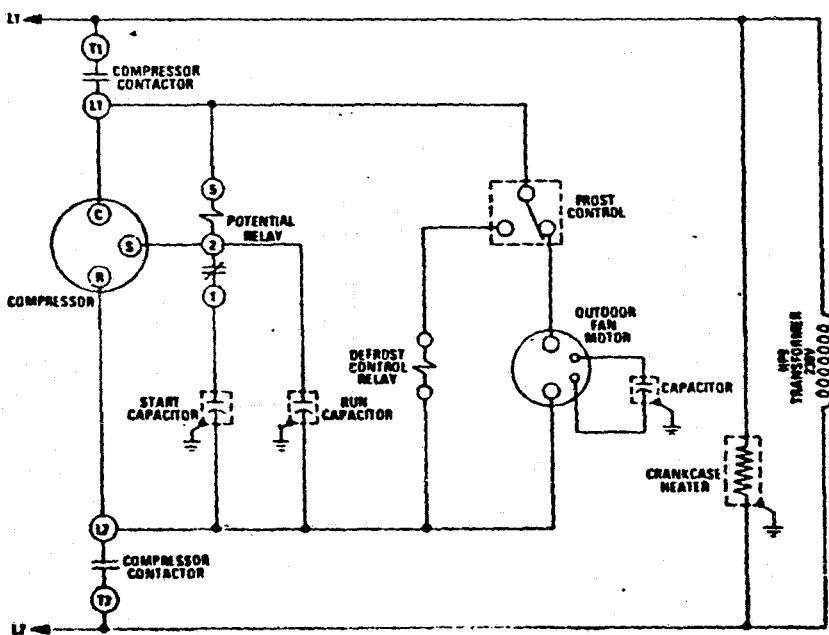
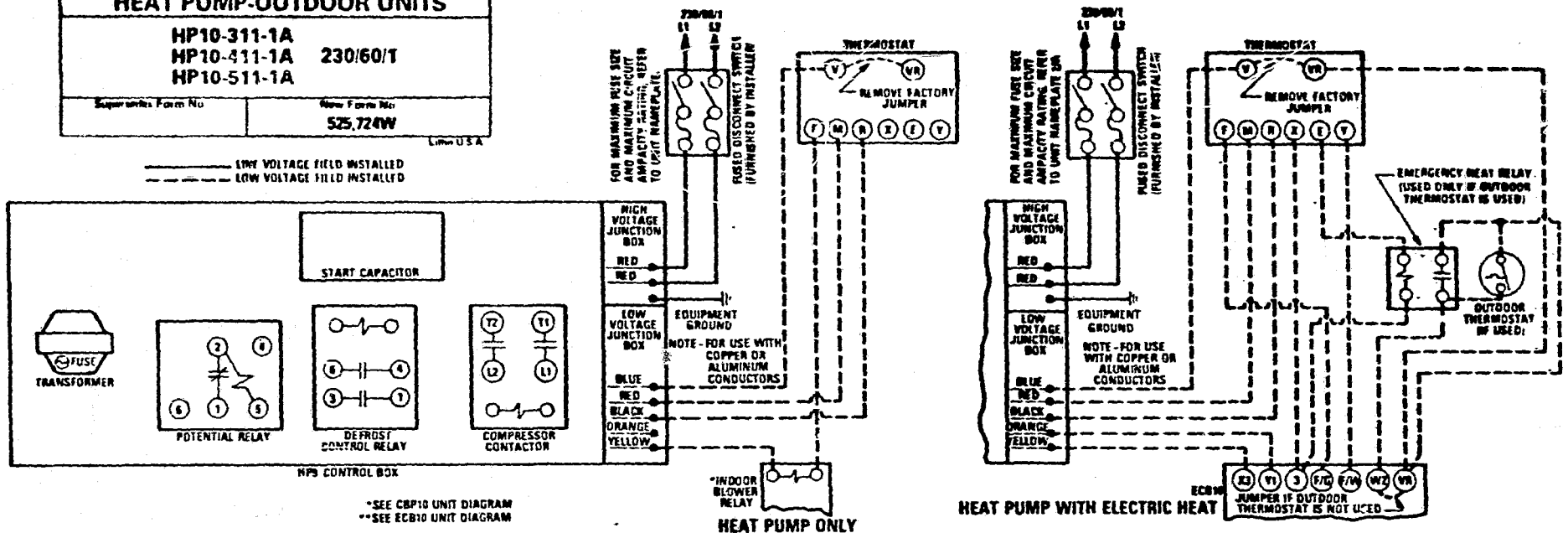
HEATING PUMP WIRING DIAGRAMS

The internal electrical wiring diagrams of the heat pump outdoor unit, indoor unit and electric heating coil are shown on the following pages.

For all external or field wiring see control wiring diagram, Figure 2-19.

LDX Industries Inc.		WIRING DIAGRAM	877
HEAT PUMP-OUTDOOR UNITS			
HP10-311-1A		230/60/1	
HP10-411-1A		230/60/1	
HP10-511-1A		230/60/1	
Supplies Form No.	New Form No. 525.724W		

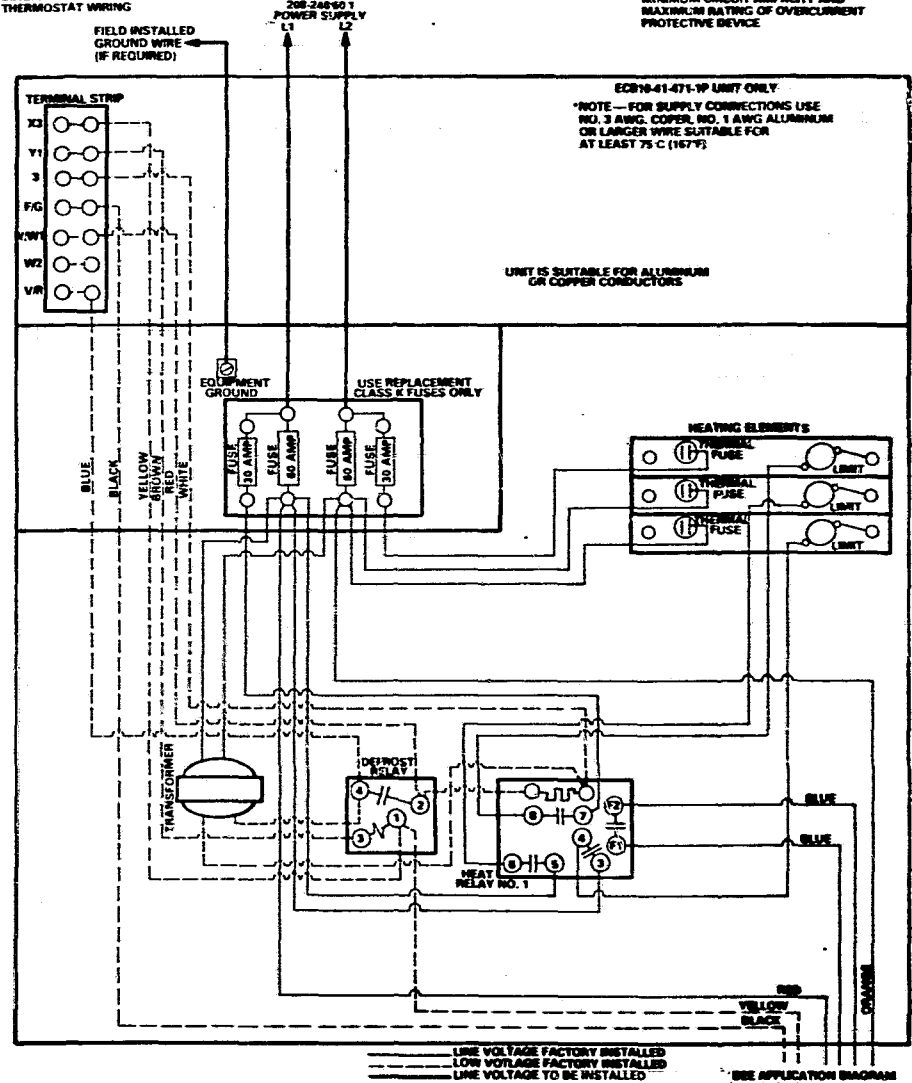
————— 115V VOLTAGE FIELD INSTALLED
 - - - - - LOW VOLTAGE FIELD INSTALLED



C-19.

SEE CB10/ECB10 APPLICATION DIAGRAM IN CB10 FOR THERMOSTAT WIRING

REFER TO UNIT RATING PLATE FOR MINIMUM CIRCUIT AMPACITY AND MAXIMUM RATING OF OVERCURRENT PROTECTIVE DEVICE



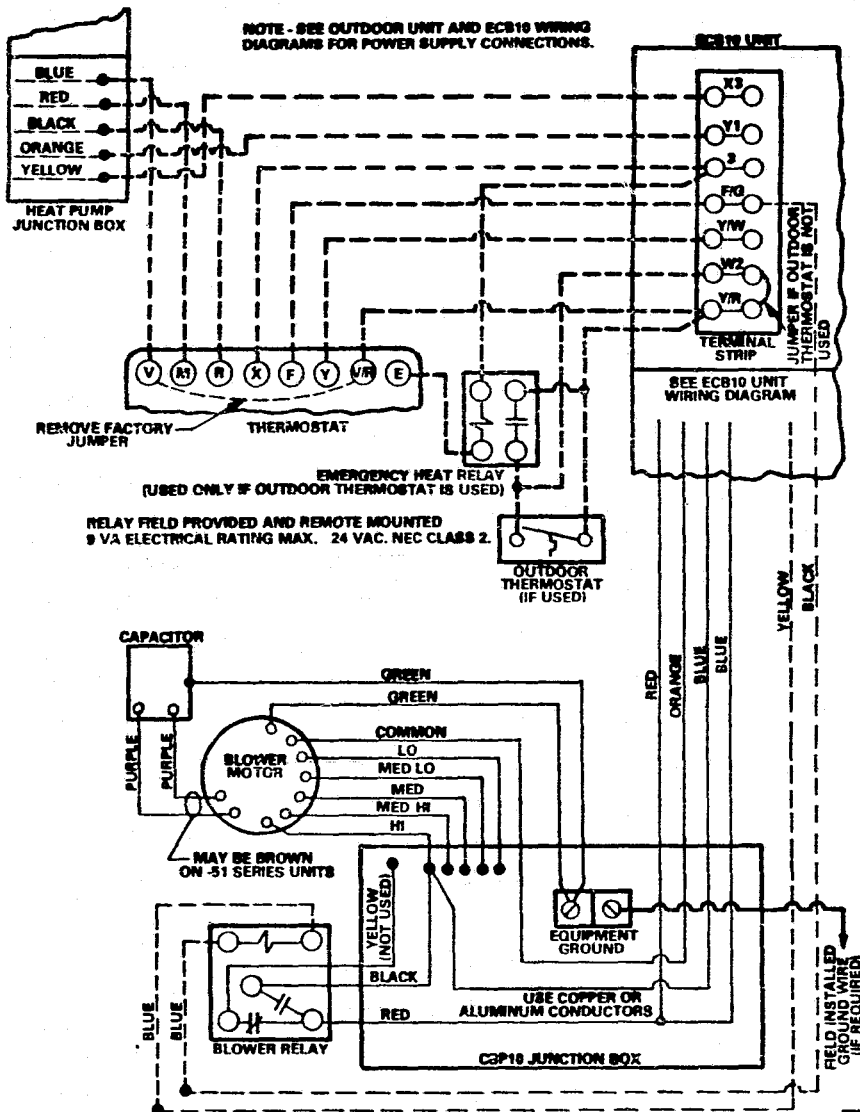
ECB10-41-471-1P UNIT ONLY
 *NOTE - FOR SUPPLY CONNECTIONS USE NO. 3 AWG. COPPER, NO. 1 AWG ALUMINUM OR LARGER WIRE SUITABLE FOR AT LEAST 75 C (167°F)

UNIT IS SUITABLE FOR ALUMINUM OR COPPER CONDUCTORS

— LINE VOLTAGE FACTORY INSTALLED
 - - - - - LOW VOLTAGE FACTORY INSTALLED
 LINE VOLTAGE TO BE INSTALLED

SEE APPLICATION DIAGRAM FOR BLOWER MOTOR WIRING

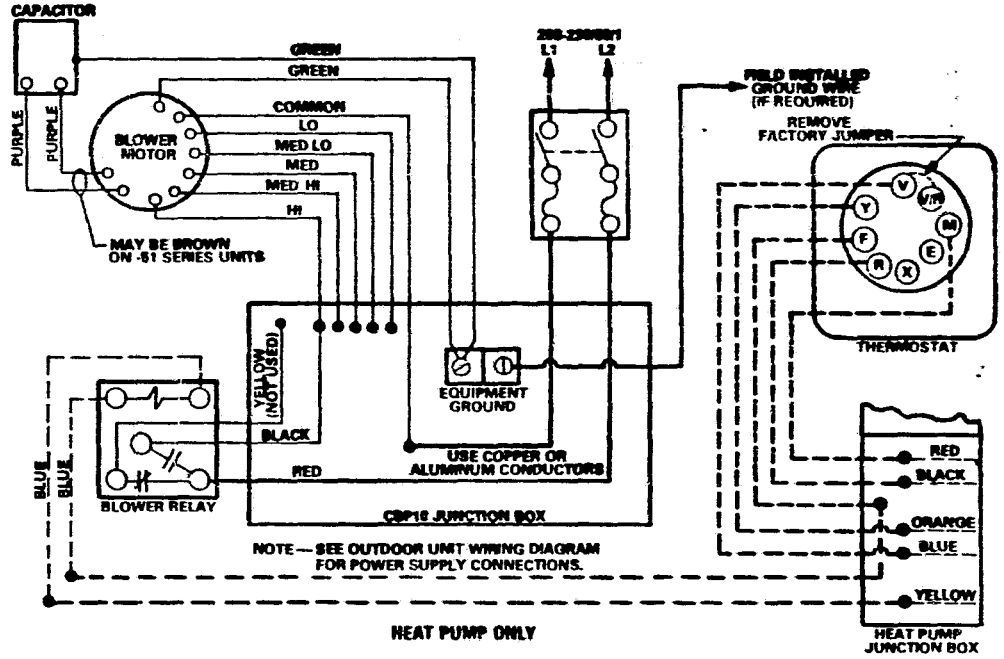
LEYNIX Industries Inc.	WIRING DIAGRAM	10/75
HEATING UNITS - ELECTRIC		
*ECB10-41-471-1P ECB10-51/65-471-1P		
Supplement Form No.	New Form No. 524,834W	



NOTE - WHEN CHANGING BLOWER MOTOR SPEED, THE BLUE LEAD FROM THE ELECTRIC HEAT SECTION ALONG WITH THE BLACK LEAD FROM THE BLOWER RELAY MUST BE WIRED IN COMMON WITH THE BLOWER SPEED SELECTED. SEE MINIMUM BLOWER SPEED TABLE FOR MINIMUM OPERATING SPEED WITH ELECTRIC HEAT.

HEAT PUMP WITH ELECTRIC HEAT & EMERGENCY HEAT

LEAD	BLOWER MOTOR LEAD COLORS		
	41	51	61
COM	ORANGE	ORANGE	ORANGE
LO	RED	RED	RED
MED LO	YELLOW	YELLOW	YELLOW
MED			BLUE
MED HI	BROWN		BROWN
HI	BLACK	BLACK	BLACK



NOTE - SEE OUTDOOR UNIT WIRING DIAGRAM FOR POWER SUPPLY CONNECTIONS.

HEAT PUMP ONLY

- LINE VOLTAGE FACTORY INSTALLED
- LOW VOLTAGE FACTORY INSTALLED
- LINE VOLTAGE FIELD INSTALLED
- LOW VOLTAGE FIELD INSTALLED

UNIT MODEL NO	MINIMUM BLOWER SPEEDS FOR OPERATION WITH ELEC HEAT		
	311 HEAT PUMP	410 HEAT PUMP	...
ECB10 41 241	MED HI	HI	...
ECB10 41 311	MED HI	HI	...
ECB10 41 471	MED HI	HI	...
ECB10 41 631	MED HI	HI	...
ECB10 41 791	HI	HI	...
UNIT MODEL NO	460 HEAT PUMP	510 HEAT PUMP	650 HEAT PUMP
	ECB10 51 85 311	HI	HI
ECB10 51 85 471	HI	HI	MED HI
ECB10 51 85 631	HI	HI	MED HI
ECB10 51 85 791	HI	HI	MED HI
ECB10 51 85 941	HI	HI	MED HI
ECB10 51 85 943	HI	HI	MED HI
ECB10 65 1051			MED HI
ECB10 65 1113			MED HI

LENNOX Industries Inc. WIRING DIAGRAM 677

COOLING UNITS-COILS-BLOWER COILS UNITS

HP10 HEAT PUMP APPLICATION DIAGRAM FOR CBP10/ECB10 SERIES UNITS

Supersedes Form No. New Form No. 525,725W

Lennox USA

APPENDIX D

INSTALLATION OF DOMESTIC HOT WATER SUBSYSTEM

Electric Hot Water Heater

Tempering Valve

DHW Preheat Coil

ELECTRIC WATER HEATER Installing and Operating Instructions

THE WARRANTY ON THIS WATER HEATER IS IN EFFECT ONLY WHEN THE HEATER IS INSTALLED AND OPERATED IN ACCORDANCE WITH THESE INSTRUCTIONS. THE MANUFACTURER OF THIS HEATER WILL NOT BE LIABLE FOR ANY DAMAGE RESULTING FROM FAILURE TO COMPLY WITH THESE INSTRUCTIONS. READ THESE INSTRUCTIONS THOROUGHLY BEFORE STARTING.

LOCATION: Select a location accessible to water lines and power supply where the floor is level. Do not locate the heater where water lines could be subjected to freezing temperatures. It is recommended that the heater be located near the center of greatest hot water usage to prevent heat loss through the pipes. Locate the heater so that access panels and drain valves are accessible.

WARNING: Do not use or store gasoline or other flammable liquids in the vicinity of this heater.

THE HEATER SHOULD BE LOCATED IN AN AREA WHERE LEAKAGE OF THE TANK OR CONNECTIONS WILL NOT RESULT IN DAMAGE TO THE AREA ADJACENT TO THE HEATER OR TO LOWER FLOORS OF THE STRUCTURE. WHEN SUCH LOCATIONS CAN'T BE AVOIDED, A SUITABLE DRAIN PAN SHOULD BE INSTALLED UNDER THE HEATER. SUCH PANS SHOULD BE AT LEAST 2" DEEP, HAVE A MINIMUM LENGTH AND A WIDTH AT LEAST 2" GREATER THAN THE DIAMETER OF THE HEATER, AND SHOULD BE PIPED TO AN ADEQUATE DRAIN.

NOTE: Before proceeding with the installation, close the main water supply valve, open a water faucet to relieve the house pressure and then close the faucet.

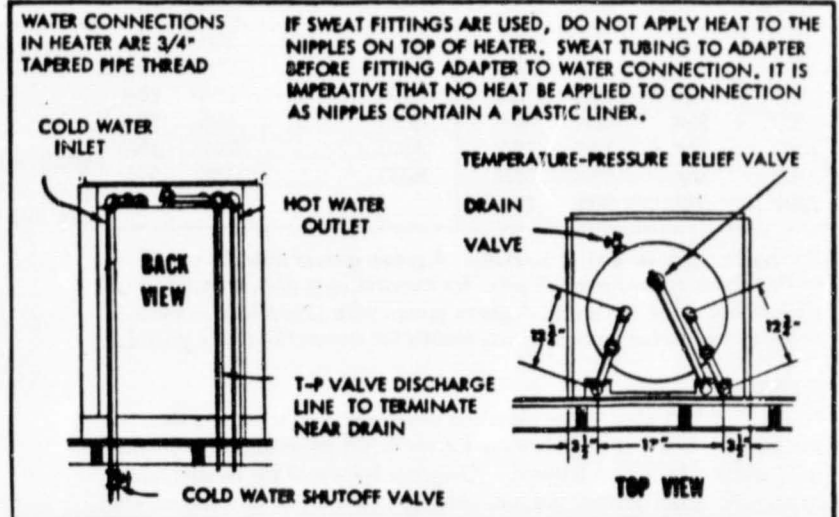
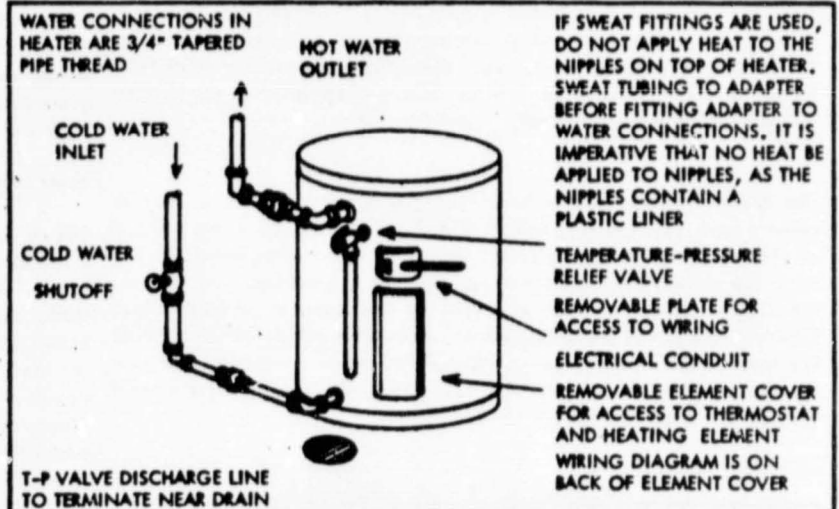
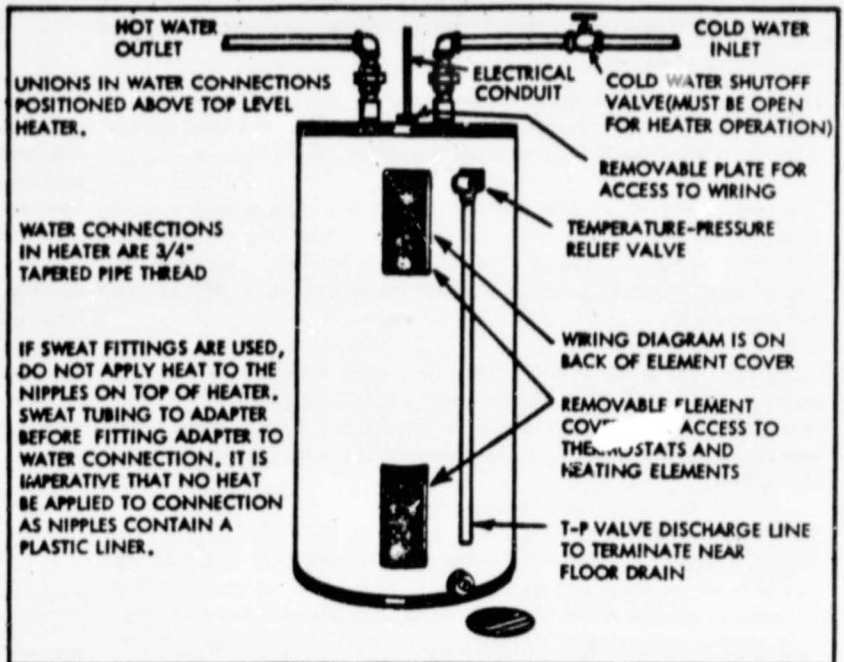
CAUTION

DO NOT TURN ON ELECTRICAL CURRENT TO WATER HEATER UNTIL TANK HAS BEEN COMPLETELY FILLED WITH WATER. OPEN SEVERAL HOT WATER FAUCETS TO ALLOW AIR TO ESCAPE FROM THE SYSTEM WHILE THE HEATER IS FILLING. THE HEATING ELEMENTS WILL BURN OUT IF NOT IMMERSSED IN WATER.

UPRIGHT MODELS: The hot and cold water connections are identified on the top of the heater. Connect the hot and cold water lines to the installed nipples using unions. Install a listed temperature-pressure relief valve in the opening on the side of the heater.

UTILITY MODELS: The hot and cold water connections are identified on the side of the heater. Connect the hot and cold water lines to the installed nipples using unions. Install a listed temperature-pressure relief valve in the opening on the side of the heater.

TABLE TOP MODELS: The hot water outlet and cold water inlet are identified on the back panel of the heater. Remove the porcelain top by sliding it forward and lifting it off the cabinet. Care should be taken in handling the porcelain top to prevent chipping of the porcelain. Remove the four front panel screws; two at the top flange. Check drain valve to make sure that it is closed. Remove the top fiberglass insulation to allow access to the plumbing and electrical connections. Connect the cold water supply line and hot water outlet lines using elbows, nipples and unions as shown in the diagrams. Install a listed temperature-pressure relief valve in the remaining fitting. Replace the top fiberglass insulation in its original location.



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FAILURE TO INSTALL AN APPROVED (AGA OR ASME) 3/4" x 3/4" TEMPERATURE-PRESSURE RELIEF VALVE WILL RELEASE THE MANUFACTURER FROM ANY CLAIM WHICH MIGHT RESULT FROM EXCESSIVE TEMPERATURES AND PRESSURES.

Do not install a check valve or other devices that would prevent reverse flow of water unless required by local codes. A closed system will result and frequent operation of the relief valve will occur.

The end of the relief pipe opening should terminate near the floor drain or other suitable location not subject to blocking or freezing. DO NOT thread, plug or cap the relief pipe opening. Leave an air gap of approximately 6 inches between the end of the relief pipe and the floor drain.

After the installation of all water lines, open the main water supply valve and fill the heater. Open several hot water faucets to allow air to escape from the system while the heater is filling. When water passes through the faucets, close them and check for possible leaks in the system.

ELECTRICAL CONNECTIONS:

NOTE: Before any electrical connections are made, be sure that the heater is full of water and that the valve in the cold water supply line is open. Check the rating plate and wiring diagram before proceeding. This electric water heater was built and wired in accordance with the Underwriters' Laboratories' testing approvals requirements. The temperature limiting device of the manual reset, trip-free type has been factory installed to interrupt all ungrounded power supply conductors in the event of thermostat failure. Thermostats are factory set at 150° F. and wired in accordance with the wiring diagram fastened to the inside of the top access panel.

The dealer in your area ordered this heater wired at the factory to comply with existing area codes, but local utility codes may require or allow other circuitry. Consult your local power company to determine the correct electrical hook-up in order to meet local utility and building codes and in order to obtain the most economical rates. Also check to find out if you are required to obtain a permit before starting the installation. The following chart shows the recommended fuse size for the maximum heater wattage. The maximum wattage and rated voltage are shown on the heater data plate.

MAX. WATTS	RECOMMENDED FOR AMPERAGE			MAX. WATTS	MAX. VOLTS		
	120V	208V	240V		120V	208V	240V
500	10A	5A	5A	3500	40A	20A	20A
1000	15A	10A	10A	4000		25A	25A
1250	15A	10A	10A	4500		30A	25A
1500	20A	10A	10A	5000		35A	30A
2000	25A	15A	15A	5500		35A	35A
2500	30A	15A	15A	6000		40A	35A
3000	35A	20A	20A				

The heater must be well grounded. A green ground screw is provided at the electrical connection point for connecting a ground wire to the upright and table top units. A green ground wire is provided at the electrical connection point on utility models for connections to a ground.

OPERATION:

NOTE: Before closing the switch to allow electric current to flow to the heater, make certain that the heater is full of water and that the cold water inlet valve is open. Complete failure of the heating elements will result if they are not completely immersed in water at all times. When the switch is closed, the operation of this electric water heater is automatic.

The temperature of the water can be changed by adjusting the thermostat. Before any work is done on the heater, disconnect all power to the heater by opening the switch at the main electrical panel. Remove the access panels, or front panel on Table Tops, fold the insulation outward away from the controls. Set the thermostats to the desired water temperature using a screw driver to move the thermostat pointer, replace the insulation making sure that the controls are well covered and that the plastic terminal shield has not been displaced; then replace the access panel, or front panel. The heater is now ready for operation and the main switch can be closed.

When necessary to completely drain the heater, shut off the electric power supply to heater, close cold water inlet valve, open a hot water faucet to allow air to enter the system and open the drain valve, which is threaded to receive a standard hose coupling. On Table Top models, the front panel must be removed to gain access to the drain valve.

MAINTENANCE: Shut off the electric power whenever the water supply is turned off.

Shut off the electric power, water supply and drain the heater completely to prevent freezing whenever the building is left unoccupied during the cold weather months.

In order to insure efficient operation and long tank life, drain the heater through the drain valve until water runs clear. Drain it at least once a month. Failure to do this may result in noisy operation and lime and sediment build up in the bottom of the tank. At the same time, check the temperature-pressure relief valve by raising the the lever at the top of this valve to make certain that waterways are clear.

SERVICE: The manual reset, trip-free temperature limiting devices on this heater will cut off all power to heater if temperature of water exceeds 190° F. If there is no hot water after a reasonable period of time, check the main fuse box. In the event that the fuses have not blown, call a serviceman; have him check the entire circuit including the elements and thermostats before resetting the temperature limiting device. Heater must be disconnected from power supply before servicing switch. Consult the plumber or electric service company in your area for all service, replacement parts or any questions you might have regarding this heater. Insist on factory inspected and approved replacement parts.

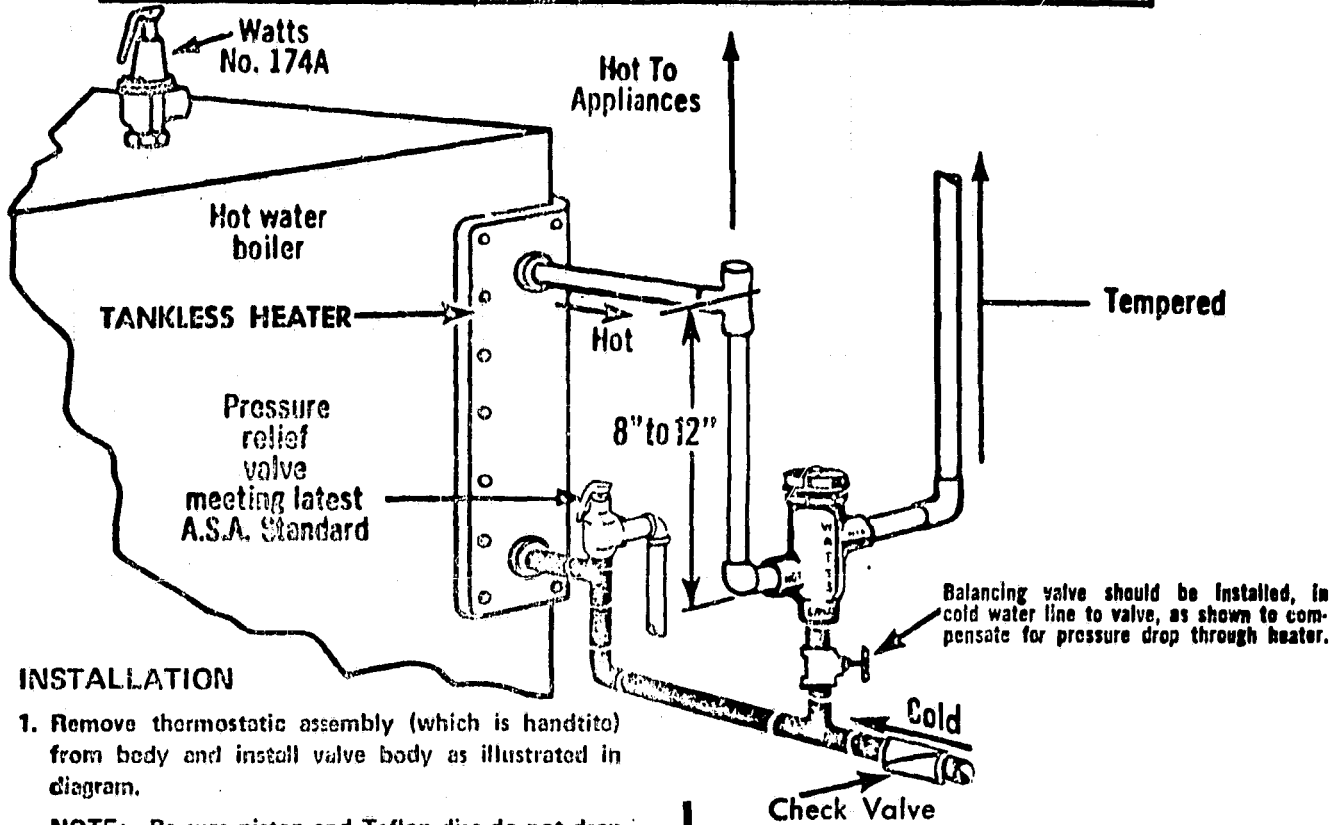
REMOVAL OF THE MAGNESIUM ANODE WILL TERMINATE THE WARRANTY.

READ THE WARRANTY ATTACHED TO THIS WATER HEATER FOR A FULL EXPLANATION OF THE TIME PERIOD THAT PARTS AND HEATER ARE WARRANTED.

INSTRUCTIONS FOR INSTALLING WATTS No. 70A SERIES Adjustable Water Tempering Valves

IMPORTANT

BE SURE TO REMOVE THERMOSTATIC ASSEMBLY from valve before sweating connections. Otherwise it will become damaged.



INSTALLATION

1. Remove thermostatic assembly (which is handtito) from body and install valve body as illustrated in diagram.

NOTE: Be sure piston and Teflon disc do not drop out of thermostat, when removing thermostatic assembly.

2. Re-insert thermostatic assembly in body and tighten securely.

ADJUSTMENT

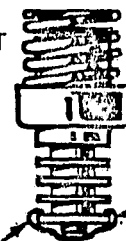
The No. 70A features a new adjustment means which permits you to "dial" a desired temperature, quickly and conveniently. To increase or decrease the water temperature, simply turn the adjusting cap as indicated by the arrow. The adjustment temperature range is 120° to 160°F.

REPLACEMENT PARTS

RENEWABLE THERMOSTAT AND SPRING

FOR 70A-70A-T
Part No. SAN70A3

FOR L70A-L70A-T
Part No. SAN70A3-LT



DISCARD PLASTIC PROTECTOR

NOTE: Replacement thermostats are furnished with a plastic protector which serves to hold the piston and Teflon disc. Be sure to discard this plastic protector when installing assembly. See note under installation.

L70A SERIES

NOTE: For lower tempered water requirements at or below 130°F., use low temperature Model L70A Series which provides adjustment temperature range between 100° - 130°F.

WATTS

The name that protects your name

WATTS REGULATOR COMPANY

LAWRENCE, MASS., U.S.A.

PART NO.

LTR	DESCRIPTION	DATE	APPROVED
A	STRAIGHTENED ENDS OF COIL	8/3/77	

NOTES

- 1) The seller will inspect each coil to the requirements of this specification and for evidence of poor workmanship.
- 2) The heat coils shall be packaged in suitable protective containers that prevent damage to coil when shipped by United Parcel Service.

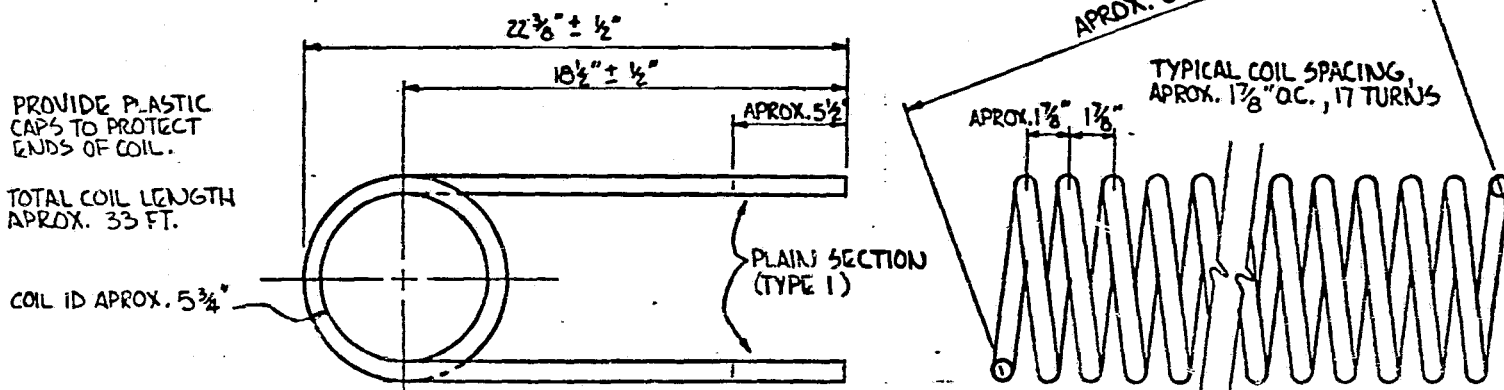
Approved Source

Vender/PN
Wolverine Tube Division
17200 Southfield Rd.
Allen Park, Michigan 48101

Truffin Type W/H
Catalog No. 66-116038-01
With type 1 ends

Specifications

Material - copper alloy-ASTM-B359-B111
Length - approx. 33 feet
No. of Coils - 17
Coil I. D. - 5 3/4" (+ 1/8")
Tubing Diam. - nom. 3/4"



D-4

		TOLERANCES UNLESS NOTED OTHERWISE		DRAFTSMAN Donahue 8/3/77	HONEYWELL INC.	ENERGY RESOURCES CENTER MINNEAPOLIS, MINN. 55413
		90° FORMED ANGLES +20 -10		CHECKER		
		.XX + .XXX +		DEV ENGR	HOT WATER COIL	
		MATERIAL		ENGRG MGT		
				CONTRACT NO.		
				SOURCE CONTROL	SIZE A	CODE IDENT NO. 55513
						DRAWING NO. SK-142047
NEXT ASSY	USED ON	FINISH-SEE NOTE			SCALE NONE	SHEET 1 OF 1

DWG NO. SK-142047

CONTROL A

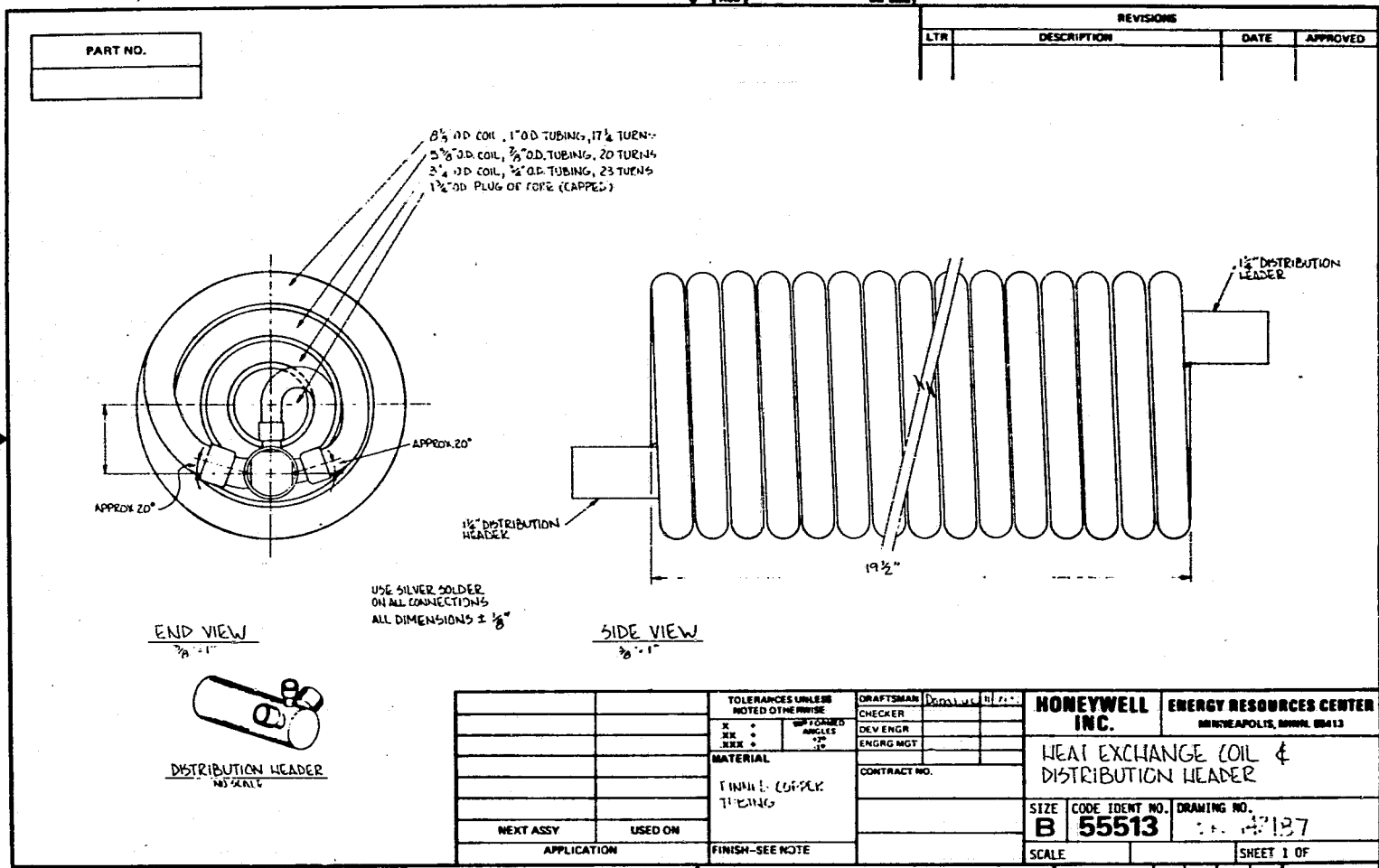
APPENDIX E

ENERGY TRANSPORT SUBSYSTEM

Energy Transport Module Replacement Parts

NO.	ITEM	MANUFACTURER	TYPE/PART	QUANTITY
1	Pump 1	Bell & Gossett	60-11S, 1 1/4AA	1
2	Pump 2 & 3	Bell & Gossett	PR-1 1/4, 1/6 hp	2
3	Heat Exchanger	Honeywell	SK-142187	1
4	Expansion Tank	Amtrol	30, Diaphragm	1
5	Air Separator	Amtrol	444-1 1/4	1
6	Air Vent	Amtrol	690	1
7	Air Bleed	Hammond	1/8 Radiator	2
8	Relief Valve	Bell & Gossett	480-45 psi	1
9	Control Valve, Dual Diverting	Honeywell	V4331-A1003, (115 VAC)	1
10	Circuit Setter Balancing Valve	Bell & Gossett	CB-1 1/4	3
11	SDA Sensor Wells	Mueller	Bronze, 1 1/4	4
12	Lift Check Valve	Bell & Gossett	BA - 1 1/4	1
13	Swing Check Valve	Stockham	B-309-1 1/4	2
14	Drain/Fill Valve	Hammond	710-3/4	1
15	Ball Valve	Hammond	Sweat-1 1/4	1
16	Strainer	Strong	S-1 1/4	1
17	Low Level Indicator	F.W. Murphy	20-PC, 50 psi, 24 VAC	1
18	Indicator Lamp		24 VAC	1
19	Solar Control Panel	Honeywell	SK-142183	1

E-2



Bell & Gossett instruction sheet S16946 revision 3 pertaining to PD Boosters & Series "60" In-Line Centrifugal Pumps installation and operation instructions has been removed due to copyright.

Bell & Gossett submittal A-120 revision 9 pertaining to Iron & Bronze
Booster Pump has been removed due to copyright.

Bell & Gossett instruction manual sheet S17630 replaces SD-1239-CA revision 4 pertaining to Booster Circulating Pumps installation, operation and service instructions has been removed due to copyright.

Selection Data

BOILER NET OUTPUT IN 1000's OF BTU/HR	TYPE OF RADIATION								SYSTEM CONTENT IN GALLONS											
	Finned Tube Baseboard or Radiant Panel		Convectors or Unit Heaters		Radiators—Cast Iron		Baseboard Cast Iron		Average System Temp. °F	Extrol Model 15		Extrol Model 30		Extrol Model 60		Extrol Model 90		Extrol Model SX-30		
	SW	CS	SW	CS	SW	CS	SW	CS		SW	CS	SW	CS	SW	CS	SW	CS	SW	CS	
25	15	15	15	15	15	15	15	15	15											
50	15	15	15	15	15	30	15	30	15											
75	15	30	15	30	30	30	30	60	30											
100	15	30	15	30	30	60	30	60	30											
125	15	30	30	60	30	60	30	90	30											
150	30	30	30	60	30	90	60	90	60											
175	30	60	30	60	60	SX-30	60	SX-30	60											
200	30	60	60	60	60	SX-30	60	SX-30	60											
250	30	60	60	90	60	SX-30	90	SX-40	90											
300	60	90	60	SX-30	90	SX-30	90	SX-40	90											
350	60	SX-30	60	SX-30	90	SX-40	SX-30	SX-60	SX-60											
400	60	SX-30	90	SX-40	SX-30	SX-40	SX-30	SX-60	SX-60											
										100		133		305		500		734		1102
										110		101		232		380		557		835
										120		80		183		300		440		660
										130		65		149		244		358		537
										140		54		125		204		298		447
										150	62	47	141	106	230	174	338	256	473	384
										160	58	40	134	92	219	150	321	220	449	330
										170	55	34	127	78	208	128	306	187	428	289
										180	53	30	121	68	198	111	291	163	407	245
										190	51	26	116	60	190	98	278	144	389	216
										200	49	23	111	52	182	86	266	126	372	189
										210	47	21	106	48	174	78	256	114	358	171
										220	45	19	102	43	167	71	246	103	344	155
										230	43	17	98	39	161	64	236	94	330	141
										240	41	16	95	35	155	58	228	86	316	129

SW indicates Summer—Winter hook up where boiler is used for heating, and supplying domestic hot water. Minimum boiler water temp. of 150°F. is required.
 CS indicates cold start hook up where boiler is used for heating only. MAXIMUM WORKING PRESSURE 75 PSI — OPERATING TEMP. 40°-240°F
 #15 EX-TROL = 109 FILL-TROL #30 EX-TROL = 110 FILL-TROL #60 EX-TROL = 111 FILL-TROL #90 EX-TROL = 112 FILL-TROL

Dimensional Data

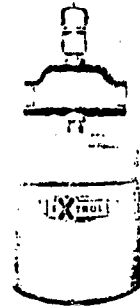
EX-TROL TANKS

Model No.	Diameter Inches	Length Inches	Shipping Wt. Lbs.
15	8	11½	5
30	11	14	9
60	11	23	14
90	15	21	23



EX-TROL COMBINATION PACKAGES

Model No.	INCLUDES			Shipping Wt. Lbs.
	EX-TROL	Purger *	Vent	
1500	15	1"		9
3000	30	or	#700	13
6000	60	1¼"		19



*Specify type and size required

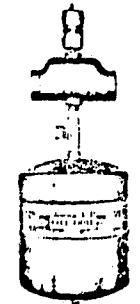
EX-TROL WITH FILL-TROL

Model No.	Diameter Inches	Length Inches	Shipping Wt. Lbs.
109	8	14½	6
110	11	17	10
111	11	26	15
112	15	23½	24



FILL-TROL COMBINATION PACKAGE

Model No.	INCLUDES			Shipping Wt. Lbs.
	FILL-TROL	Purger *	Vent	
109-P	109	1" or 1¼"		11
110-P	110	1" or 1¼"	#700	14
111-P	111	1¼"		18



*Specify type and size required

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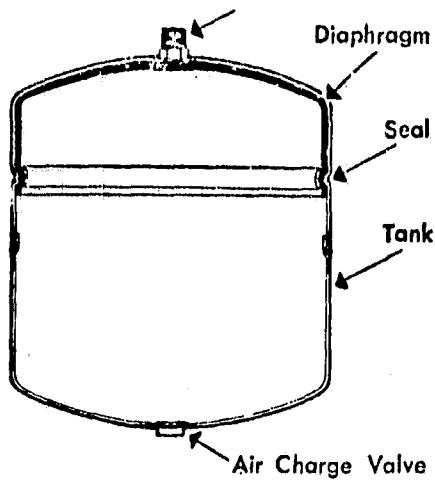


Fig. 2 Extrol tank construction

The EX-TROL Tank is a modern, pressurized diaphragm-type expansion tank for all hot water heating systems.

It is of welded steel construction; compact and neat in appearance. A rugged, flexible diaphragm of a material specially compounded for long life in hydronic service is the heart of the EX-TROL tank.

This diaphragm separates system water from the (standard 12-lb.) air charge, assuring a permanent air cushion. Because the diaphragm permits the tank to be pressurized, the EX-TROL tank can be smaller than conventional units.

The EX-TROL Tank may be installed into a tee or any other suitable tapping anywhere on a hot water heating system.

It may also be remotely located and piped to convenient point on the system.

An ideal EX-TROL installation is to screw it into the bottom of an American Air Purger. A single 1/2" nipple serves as both pipe connection and mounting.

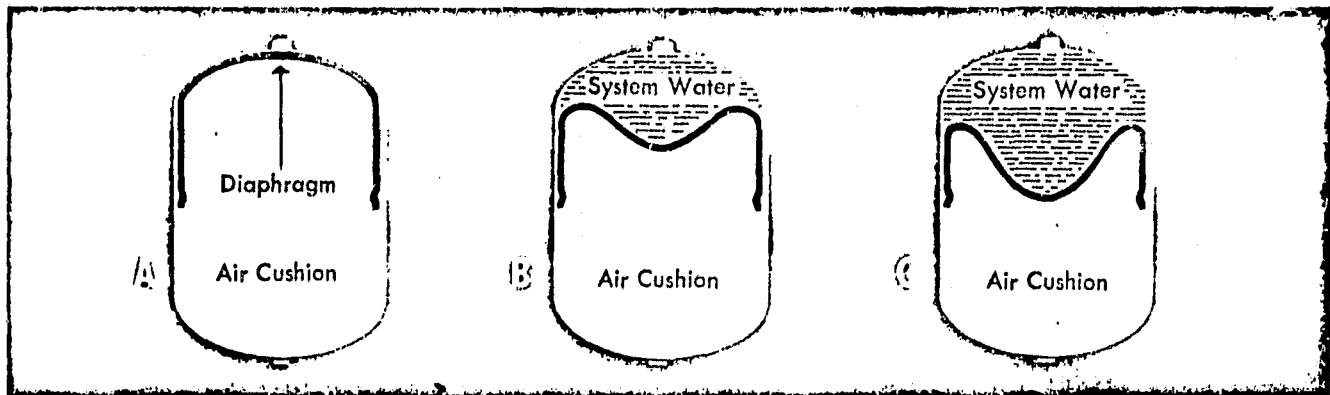


Fig. 3 Extrol tank operation

The EX-TROL Tank controls expansion of heating system water. See Figure 3

- When the system is first filled to the setting of the automatic fill valve, no water enters the EX-TROL Tank because of the charge pressure behind the diaphragm.
- When the system comes up to temperature, the EX-TROL tank receives the expanded volume of water.
- When the boiler water temperature rises to its maximum, the EX-TROL diaphragm simply flexes against the air cushion.

The American Air Purger continuously separates air from heating system water.

It is a one-piece cast iron chamber with two passages through which boiler water flows. Internal contours and baffles are designed for low flow resistance characteristics and efficient separation of the air from the water.

The Air Purger should be installed horizontally on the main as close to the boiler as possible. It must be installed so that water flows through it in the direction indicated by the arrow.

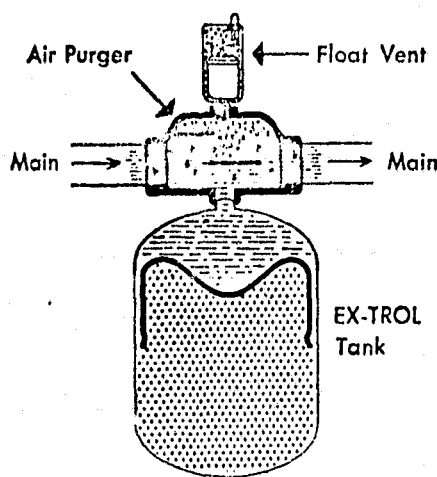


Fig. 4 System view illustrating continuous purging and venting.

All models have tappings for installation of #700 Float Vents to provide complete continuous purging and venting. Spare tappings are also provided for easy mounting of an EX-TROL for expansion control or FILL-TROL for combining automatic fill valve and expansion control.

EX-TROL system venting

After initial purging and venting of air from the system more air will be released from the water as it is heated. The American #700 Float Vent is an advanced type valve designed for venting all hydronic heating and cooling systems. It has a unique construction which insures: Fastest Venting — Positive shut off — Venting through the complete pressure range (0-45) — Long continuous operation — Trouble free performance — No spitting or unsightly stains from leaking. No separate air chamber is required.

Even with Air Purger and Float Vent installed on the main or mains, it is recommended the American #700 Float Vent to be installed on each return at the elbow that drops to the circulator.

While seldom required, it is also recommended that manual (key or coin type) air vents be installed at high points on the radiation.

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AMTROL INC.

1400 DIVISION ROAD • WEST WARWICK, R. I. 02893

BULLETIN 100-1
INSTALLATION INSTRUCTIONS
EX-TROL® EXPANSION TANKS
MARCH, 1974

This product represents the most recent development in providing for the expansion of water in a hydronic heating system.

The unique proven design of this tank, incorporating a flexible diaphragm that keeps the system water from contacting the (standard 12-lb.) tank charge, lets this considerably smaller size give more positive, permanent system protection.

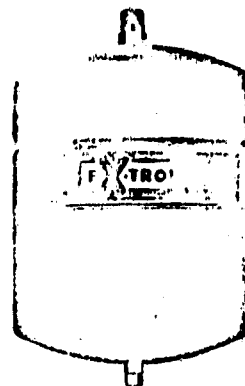
HOW IT WORKS

Heated water expands, and in a closed hot water heating system, provision must be made for this expansion. The flexible diaphragm in the EX-TROL® provides for water expansion without permitting absorption of the air cushion by the water.

TO INSTALL

EX-TROL® may be installed into a tee or any other suitable tapping anywhere on a hot water heating system. It may be placed in a vertical or horizontal position. It may also be remotely located and piped to convenient point on the system.

An ideal EX-TROL® installation is to screw it into the bottom of an American Air Purger located on the main. This combination offers both a mounting tapping and continuous automatic air removal from the system.

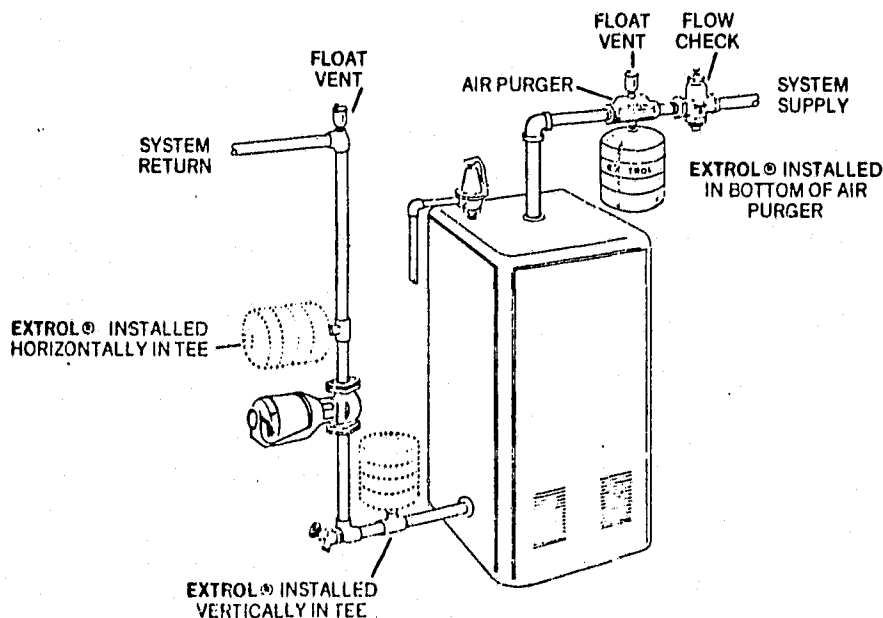


No. 15 EX-TROL®

After installing EX-TROL® on the system:

1. Fill system.
2. Vent air from system (for purging methods, refer to AMTROL data sheet on Purgers)
3. Bring system up to shut-off temperature.
4. If a smaller EX-TROL® is being used instead of that for which the system is sized, system water must be drawn from the boiler to maintain the proper system pressure. Generally a smaller than normal tank will cause a higher system pressure than is desirable.

Note: Never let air from EX-TROL® tank. Air charge should always equal setting of reducing valve (12-lb. standard).

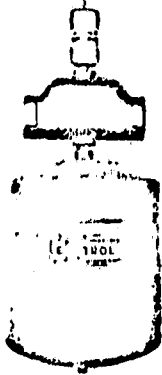


U.S. PAT. NOS. 2,695,753
3,035,614
OTHERS PENDING IN U.S.
& OTHER COUNTRIES

(over)

SYSTEM VENTING AND PURGING

After initial venting and purging of air from the system, more air will be released from the water as it is heated. Therefore, it is recommended that an American Air Purger and #700 Float Vent be installed on the main.



No. 1500 EX-TROL © Pkg.

If the system has multiple loops or zones, the supply water for all loops and zones must pass through the Air Purger for complete and continuous air removal. In case the piping arrangements does not permit the installation of a single Air Purger on the main, Air Purgers and #700 Float Vents should be installed on each loop or zone. In this event, only one EX-TROL® is required for the system.

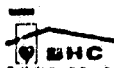
Even with American Air Purger and Float Vent installed on the main or mains, it is recommended the American #700 Float Vent be installed on each return at the elbow that drops to the circulator.

While seldom required, it is also recommended that manual (key or coin type) air vents be installed at high points on the radiation.

SERVICE HINTS

1. If system is shut down for long periods, or emptied for any reason, it may be necessary to repeat steps 2, 3 and 4 under INSTALLATION.
2. If the system pressure is too high:
 - a.) Check gauge calibration to make certain that the indicator needle has not slipped.
 - b.) Check to see if EX-TROL® has lost its air charge.

Note: To get an accurate reading with any tire gauge when checking EX-TROL® air pressure, either:
 - 1.) disconnect the EX-TROL® from the system or,
 - 2.) draw off system water until boiler pressure reads zero.
 - c.) Check for faulty fill valve operation. First, close manual shut-off before the fill valve; then, draw system pressure down to 12 PSI (or other pre-set pressure) and observe system for pressure build-up several hours later.
 - d.) Check for service water entering system from any other source of leak, such as tankless heater. Use same procedure as above after shutting off possible water source.
3. If pressure relief valve drips water:
 - a.) first, check system pressure. If too high, follow steps 2. b.), c.) and d.) above.
 - b.) If pressure relief valve continues to drip water, even at reduced pressure, flush relief valve by quickly raising lever several times. If drip continues, it may be necessary to replace relief valve.
 - c.) If multiple EX-TROLS® are installed in the system, check pressure of each for possible air leaks. Be sure red plastic air valve caps are on tight.



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AMTROL INC.
 WEST WARWICK, R. I. 02893
 (401) 884-6300

BULLETIN 400-C
TECHNICAL and INSTALLATION DATA
AMERICAN AIR PURGERS and PURGER-TROL®
 JUNE, 1975

PURGING DEVICES FOR HOT WATER HEATING SYSTEMS

The water that is used initially to fill a hot water heating system contains dissolved air. Make-up water subsequently added will similarly have a high air content. Heating this water releases the air and permits it to be circulated in the system, from which it must be vented.

The purpose of the American Air Purgers and Purger-Trols is to continuously separate and collect any air from the water as it circulates so that it may be vented automatically by an American #700 Float Vent, without the necessity for frequent manual venting.

DESCRIPTION:

Each Air Purger or Purger-Trol is a one-piece cast iron chamber with two passages through which boiler water flows. Internal contours and baffles are designed for low flow resistance characteristics and efficient separation of the air from the water.

All models have tapplings for installation of #700 Float Vents to provide complete purging and venting. Spare tapplings are also provided for easy mounting of an EX-TROL® for expansion control or FILL-TROL for combining automatic fill valve and expansion control.

Purger-Trol models have additional tapplings for the optional mounting of pressure relief valve and pressure-altitude-temperature gauge, which groups all items in one location, saving space and providing a neater installation.

OPERATION:

While the circulating pump is operating, system water continuously flows through the purger. The more dense water flows at nearly maximum velocity through the lower passage of the purger and directly to the system piping. The less dense water, containing dissolved air, moves into the upper channel. This area is so designed as to free the air or gases and to accumulate them at the venting port. The water thus freed of its air content rejoins the main flow.

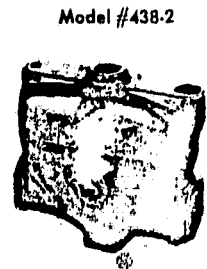
INSTALLATION:

The Air Purgers and in-line Purger-Trol should be installed horizontally on the main as close to the boiler as possible. These units must be installed so that water flows through them in the direction indicated by the arrow. An American #700 Float Vent should be screwed into the opening marked "Vent". (Be sure the air valve cap on the Float Vent is loose to permit air to escape.)

The angle-type Purger-Trol should be installed horizontally and preferably on a nipple in the boiler supply tapping. Flow from the Purger-Trol may be either right or left or in both directions from the boiler into the main.

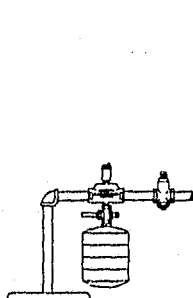


Model #443

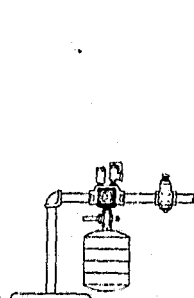


Model #438-2

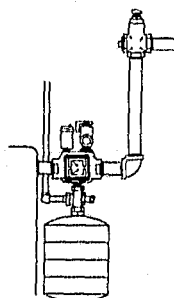
Typical Installations with FILL-TROL



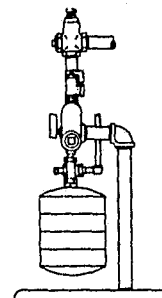
Model #443
with top outlet
boiler



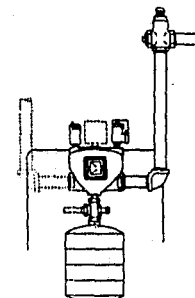
Model #440
with top outlet
boiler



Model #440
with side outlet
boiler



Model #438
with top outlet
boiler



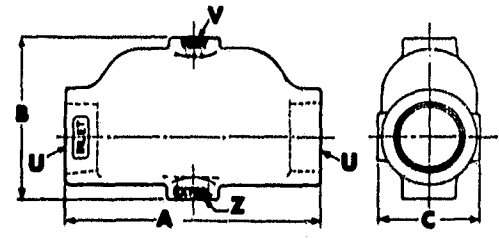
Model #438
with side outlet
boiler

SPECIFICATIONS:

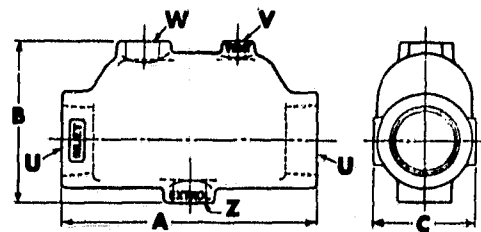
Material: Close-grained cast-iron, 90 lb. ASA rating.

DIMENSIONS & SHIPPING WEIGHTS:

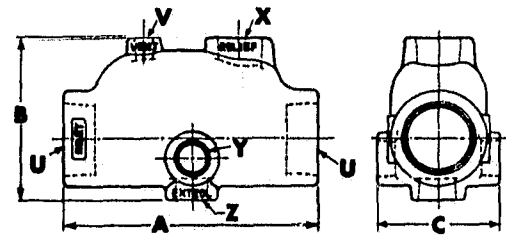
Model No.	Size	Dimensions			Tappings - NPT			Ship. Wt. Lbs.
		A	B	C	U	V	Z	
443	1"	6"	4"	2½"	1"	½"	½"	4
444	1 ¼"	6"	4"	2½"	1 ¼"	½"	½"	5
445	1 ½"	8"	5"	3½"	1 ½"	½"	½"	9
446	2"	8"	5"	3½"	2"	½"	½"	10
447	2 ½"	10"	6"	5"	2 ½"	½"	½"	19
448	3"	10"	6"	5"	3"	¾"	½"	20



Model No.	Size	Dimensions			Tappings - NPT				Ship. Wt. Lbs.
		A	B	C	U	V	W	Z	
450	1"	6"	4"	2½"	1"	½"	½"	½"	4
451	1 ¼"	6"	4"	2½"	1 ¼"	½"	½"	½"	5

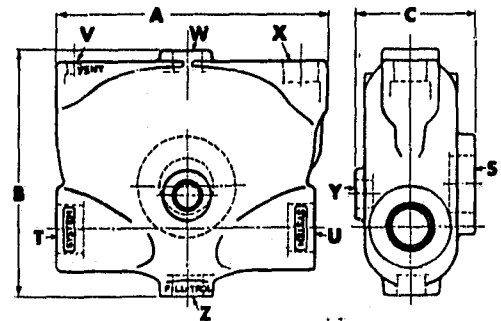


Model No.	Size	Dimensions			Tappings - NPT					Ship. Wt. Lbs.
		A	B	C	U	V	X	Y	Z	
440	1"	6"	4"	2½"	1"	½"	¾"	½"	½"	4
441	1 ¼"	6"	4"	2½"	1 ¼"	½"	¾"	½"	½"	5



Model No.	Size	Dimensions				Typical Tappings - NPT								Ship. Wt. Lbs.
		A	B	C	S	T	U	V	W	X	Y	Z		
438-2	1 ¼"	7 ¾"	6 ¾"	3 ¼"	1 ¼"	1"	1"	½"	¾"	¾"	½"	½"	½"	9
439-1	1 ½"	7 ¾"	6 ¾"	3 ¼"	1 ½"	1 ¼"	1 ¼"	½"	¾"	¾"	½"	½"	½"	9
452-1	1 ½"	8"	8 ½"	3 ¾"	1 ½"	1 ½"	1 ½"	½"	½"	¾"	—	½"	½"	14
453-1	2"	8"	8 ½"	3 ¾"	2"	1 ½"	1 ½"	½"	½"	¾"	—	½"	½"	14

Other tapping combinations available.



SUMMATION:

Purging of air from system water must be a continuing process. While the major part of the air removal is accomplished on the initial filling of the system, smaller troublesome amounts of air and gases must be removed continuously.

American Air Purgers and Purger-Trols are designed for maximum effective air removal together with minimum pressure drop and turbulence.

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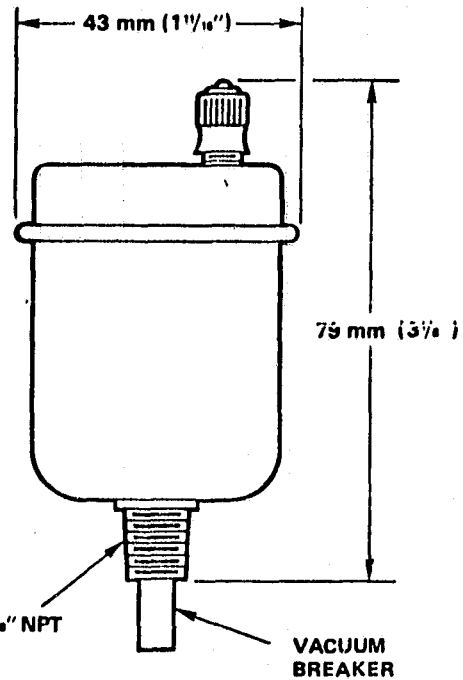
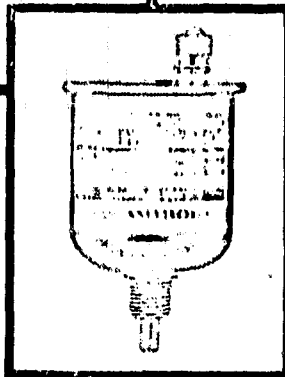
1400 DIVISION ROAD
W WARWICK, RHODE ISLAND 02893
(401) 884-6300

Form SA-AV-690

SUBMITTAL DATA

**MODEL 690
FLOAT-TYPE AIR VENT**

JANUARY 1977



**Maximum Working Pressure: 310 kPa (45 PSI)
Maximum Operating Temperature: 116°C (240°F)**

**Material: Stamped brass body and cover;
solid, non-metallic float**

JOB NAME: _____

LOCATION: _____

ENGINEER: _____

CONTRACTOR: _____

CONTRACTOR P.O. NO. _____

SALES REPRESENTATIVE: _____

MODEL NO. ORDERED: _____

DATE SUBMITTED: _____



AMTROL INC.

WEST WARWICK, R. I. 02893

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**BULLETIN 700-I
INSTALLATION INSTRUCTIONS
AMERICAN AIR VENTS**

July 1973

American #690 and #700 Series FLOAT VENTS are advanced type Air Valves designed for venting all Hydronic Heating and Cooling Systems. They have unique construction which insures - fast venting - positive shutoff - venting through the complete pressure range - (Models 690, 700 and 702 (0-45 PSI) (Models 701 and 703 (0-100 PSI) - trouble free performance - no spitting or unsightly stains from leaking.

No separate air chamber is required.

HOW IT WORKS:

Air entering the vent chamber lowers the water level, causing the float to fall and open the air valve. As the air is released, the water level rises, raising the float and closing the air valve.

WHERE TO INSTALL:

1. In EX-TROL® systems, there are two preferred locations for the #700 FLOAT VENT.

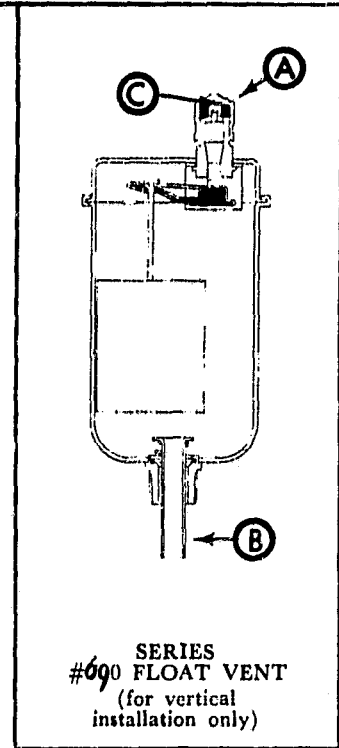
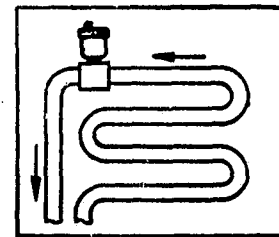
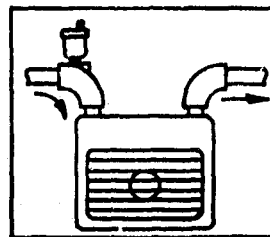
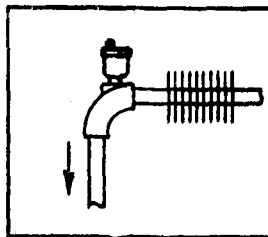
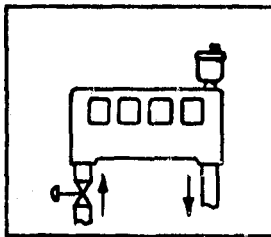
a.) Mounted on an American Air Purger (for best results, use an EX-TROL package) on the main from the boiler.



b.) In a vent ell on the return main to the boiler from each zone, before the circulating pump.



2. In other types of hydronic systems, the general rule is to install the #700 FLOAT VENT in the high points of the system - convectors, baseboard radiation, unit heaters or radiant panels.



HOW TO INSTALL:

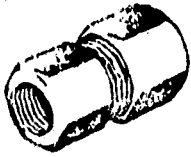
1. If system is full of water, draw off enough to reduce pressure on gauge to "0" or to lower water level to below point where FLOAT VENT is to be installed.
2. Screw into 1/8" I.P. tapping in vertical position, with cap (A) screwed on tight and vacuum breaker tube (B) free.
3. Tighten by hand - use of a wrench is not necessary.
4. Fill the system with water.
5. When system is filled with water, loosen cap (A) slowly so that dirt and scale are not deposited on the valve seat by the escaping air.
6. Screw cap down tight to close valve.
7. Open two turns for normal venting.

Suggestions:

Should dirt or scale lodge on the valve seat causing it to leak, remove cap and push the valve core (C) in by hand to permit water to flush the seat clean. Release quickly and replace cap, open one turn for normal venting.

(OVER)

air vents



**712
CONNECTOR**

712 CONNECTOR

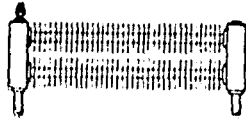
Where a safe waste connector is required the #712 connector replaces the regular valve cap and provides an attachment for a copper tube drain line. Only required if written in engineer specifications.



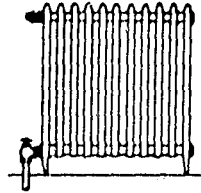
**710
WATER VENT**

710 DISC TYPE VENT FOR WATER

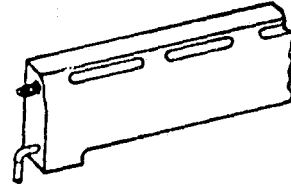
Installation is recommended up to 30 PSI W.P. For normal automatic venting open valve 1 to 1/4 turns after making connection.



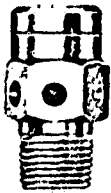
Convectors



Radiators



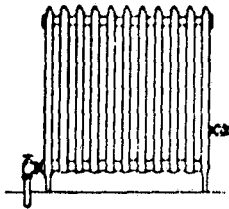
Baseboards



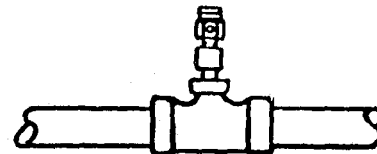
**711
STEAM VENT**

711 DISC TYPE VENT FOR STEAM

Installation is made in steam radiators and steam mains. Maximum working pressure steam 10 PSI. No adjustment is necessary for operation.



Steam Radiators



Steam Mains

Bell & Gossett submittal sheet A-434 revision 2 pertaining to Relief Valves-ASME valves and fittings has been removed due to copyright.

Honeywell

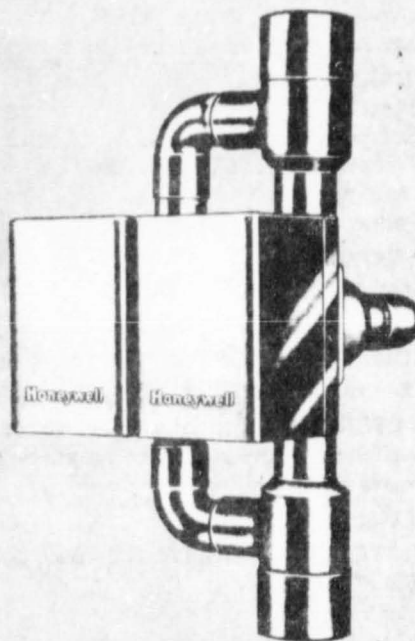
THE Y534A DUAL DIVERTING VALVE ASSEMBLY CONSISTS OF TWO VALVE BODIES WHICH ARE SWEATED TOGETHER AND TWO POWERHEADS WHICH CONTROL EACH VALVE BODY SEPARATELY. WHEN ASSEMBLED, THE Y534A OFFERS FLOW CHARACTERISTICS WHICH ARE COMPATIBLE WITH SOLAR ENERGY SYSTEMS.

- Available for line or low voltage applications (specify when ordering).
- Assembly provides a flow capacity of 14 Cv [12 kv].
- Sweat copper end connections may be installed without disassembling the valve.
- Manual opener for valve operation on power failure. Valve returns to automatic position when power is restored.
- Complete powerhead may be removed without breaking the line connections.
- Motor actuator may be replaced without removing the valve body or draining the system.

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R.L.
9-77 (.05)

DUAL DIVERTING VALVES



Y534A

Form Number

60 2394

SPECIFICATIONS

IMPORTANT

THE SPECIFICATIONS GIVEN IN THIS PUBLICATION DO NOT INCLUDE NORMAL MANUFACTURING TOLERANCES. THEREFORE, THIS UNIT MAY NOT MATCH THE LISTED SPECIFICATIONS EXACTLY. ALSO, THIS PRODUCT IS TESTED AND CALIBRATED UNDER CLOSELY CONTROLLED CONDITIONS, AND SOME MINOR DIFFERENCES IN PERFORMANCE CAN BE EXPECTED IF THOSE CONDITIONS ARE CHANGED.

MODEL:

Y534A—2-position dual diverting valve. The two powerheads must be assembled to the two valve bodies which are shipped sweated together. Available for line or low voltage applications.

TEMPERATURE AND FLOW RATINGS:

Capacity Rating—14 Cv [12 kv].
Maximum Closeoff Pressure—10 psi [69 kPa].
Static Pressure Rating—125 psi [862 kPa].
Maximum Fluid Temperature—
Line voltage model—200 F [93 C].
Low voltage model—240 F [115 C].
Maximum Ambient Temperature—125 F [52 C].

ELECTRICAL RATINGS:

Line voltage models—
0.16 amps at 120V ac, 60 Hz.
0.08 amps at 220/240V ac, 50 Hz.
Low voltage model—
0.64 amps at 24V ac, 50/60 Hz.

WIRING PROVISIONS: 18 in. [457.2 mm] leadwires and 1/2 in. conduit openings.

LINE FITTINGS: 1-1/4 in. sweat (1-3/8 in. O.D.).

DE-ENERGIZED POSITION: Port A normally closed.

TIMING: Diverts flow in 30 seconds.

MANUAL OPENER: Allows valve to be opened in case of power failure. Valve returns to automatic position when power is restored.

DIMENSIONS: See Fig. 1.

UNDERWRITERS LABORATORIES INC. LISTING APPLIED FOR.

REPLACEMENT PARTS:

O-ring—Part No. 802344.

Powerhead—

Line voltage model—Part No. 130441ARG.

Low voltage model—Part No. 130441ARA.

DETERMINATION OF WATER FLOW CHARACTERISTICS:

The pressure drop in psi [kPa], equivalent feet [metres] of pipe, or feet of water [kPa] may be determined by calculating the flow rate, referring to Fig. 2, and using the following procedures.

Pressure drop in psi [kPa]—

1. Locate the flow rate at the bottom of the graph in Fig. 2.
2. Draw a line upward from the flow rate until it intersects the curve on the graph.
3. Draw a line from the intersection to the left-hand edge of the graph and read the pressure drop in psi [kPa].

Pressure drop in equivalent feet [metres] of pipe—

1. Locate the flow rate at the bottom of the graph in Fig. 2.
2. Draw a line vertically to the top of the graph. Read the pressure drop in equivalent feet [metres] of pipe on the 3/4 in. pipe scale.

Pressure drop in feet of water [kPa]—

1. Locate the flow rate at the bottom of the graph in Fig. 2.
2. Draw a line upward from the flow rate until it intersects the curve on the graph.
3. Draw a line from the intersection to the right-hand edge of the graph and read the pressure drop in feet of water [kPa].

continued on page 3

ORDERING INFORMATION

WHEN PURCHASING REPLACEMENT AND MODERNIZATION PRODUCTS FROM YOUR TRADELINE WHOLESALE OR YOUR DISTRIBUTOR, REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING NUMBER, OR SPECIFY—

1. Order number (specify line voltage or low voltage model).
2. Replacement part, if required.

IF YOU HAVE ADDITIONAL QUESTIONS, NEED FURTHER INFORMATION, OR WOULD LIKE TO COMMENT ON OUR PRODUCTS OR SERVICES, PLEASE WRITE OR PHONE:

1. YOUR LOCAL HONEYWELL RESIDENTIAL DIVISION SALES OFFICE (CHECK WHITE PAGES OF PHONE DIRECTORY).
2. RESIDENTIAL DIVISION CUSTOMER SERVICE
HONEYWELL INC., 1885 DOUGLAS DRIVE NORTH
MINNEAPOLIS, MINNESOTA 55422 (612) 542-7500

(IN CANADA—HONEYWELL CONTROLS LIMITED, 740 ELLESMERE ROAD, SCARBOROUGH, ONTARIO M1P 2V9)
INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

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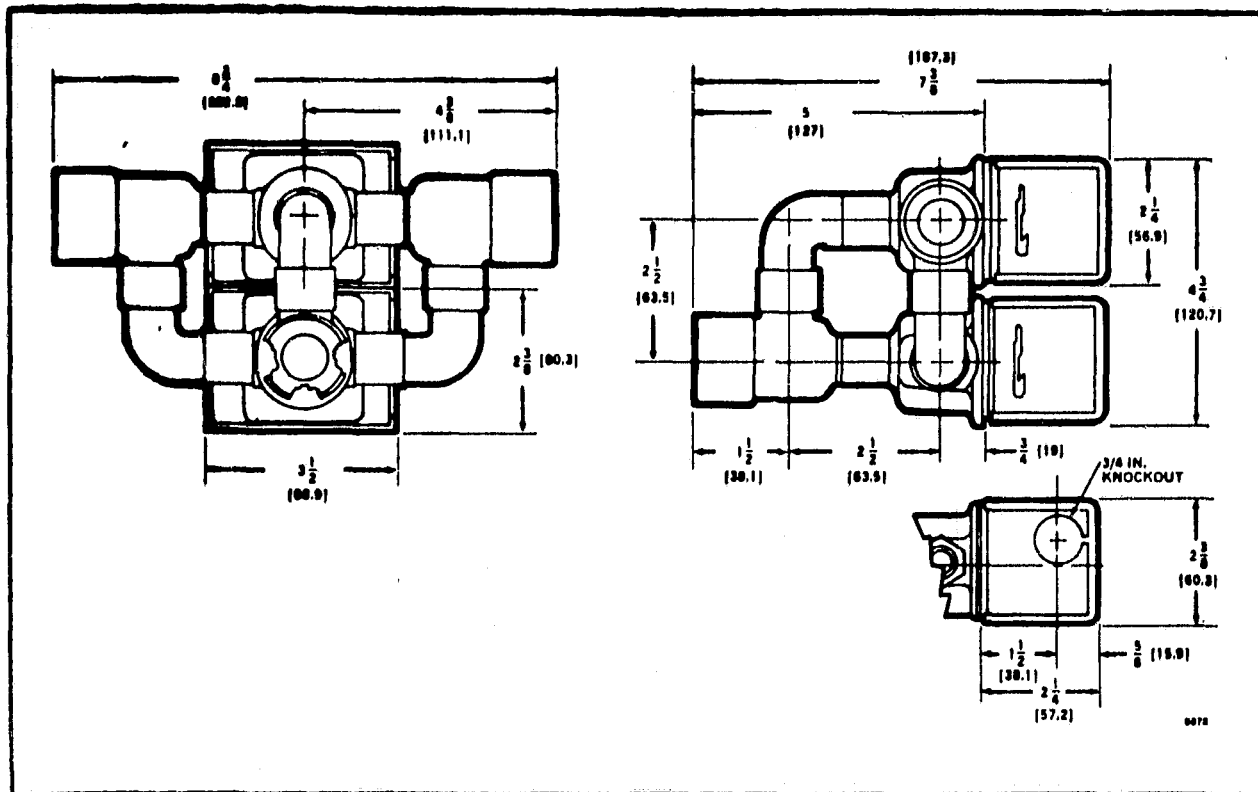


FIG. 1-Y534A DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

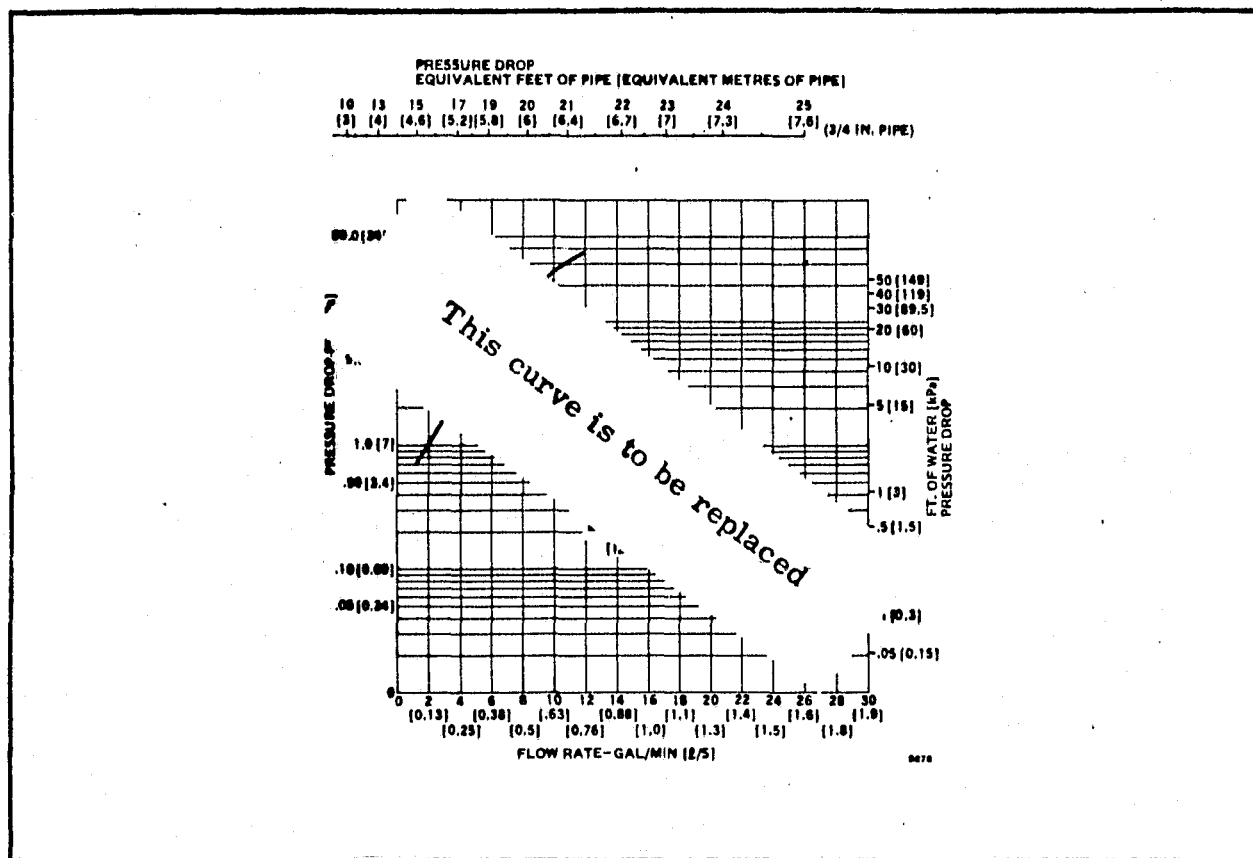


FIG. 2-FLOW CHARACTERISTICS OF Y534A DUAL DIVERTING VALVES.

INSTALLATION

CAUTION

1. Installer must be a trained, experienced service technician.
2. Disconnect power supply before connecting wiring to prevent electrical shock and equipment damage.
3. Always conduct a thorough checkout when installation is complete.

ASSEMBLY

Each powerhead controls each valve body separately. To assemble a powerhead to a valve body, place an O-ring in the circular slot on the top of the valve body (Fig. 3). Assemble the powerhead to the valve body by placing the manual opening lever on the powerhead in the MAN. OPEN position.

Align the powerhead by fitting the hex head screw on the bottom of the powerhead into the hole on the top of the valve body. The guide pins and the positioning pin in the powerhead should fit the holes in the valve body. Tighten securely and repeat this procedure for the other powerhead and valve body.

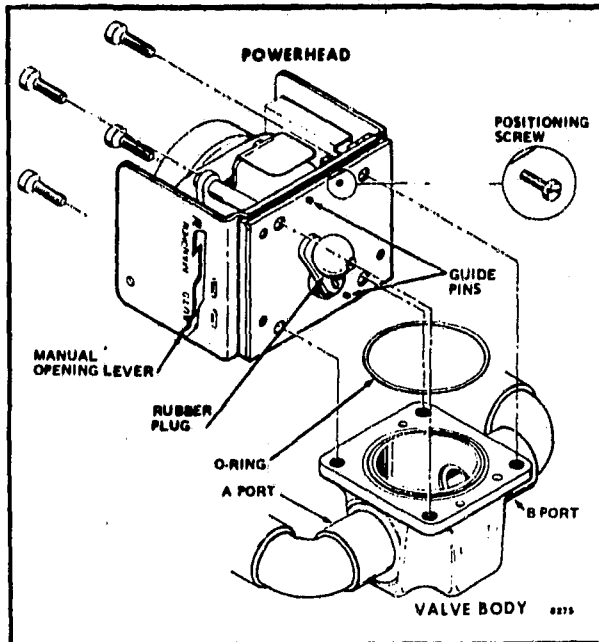


FIG. 3—POWERHEAD MUST BE ALIGNED SO THAT THE GUIDE PINS AND THE POSITIONING PIN IN THE POWERHEAD FIT THE HOLES IN THE VALVE BODY.

MOUNTING

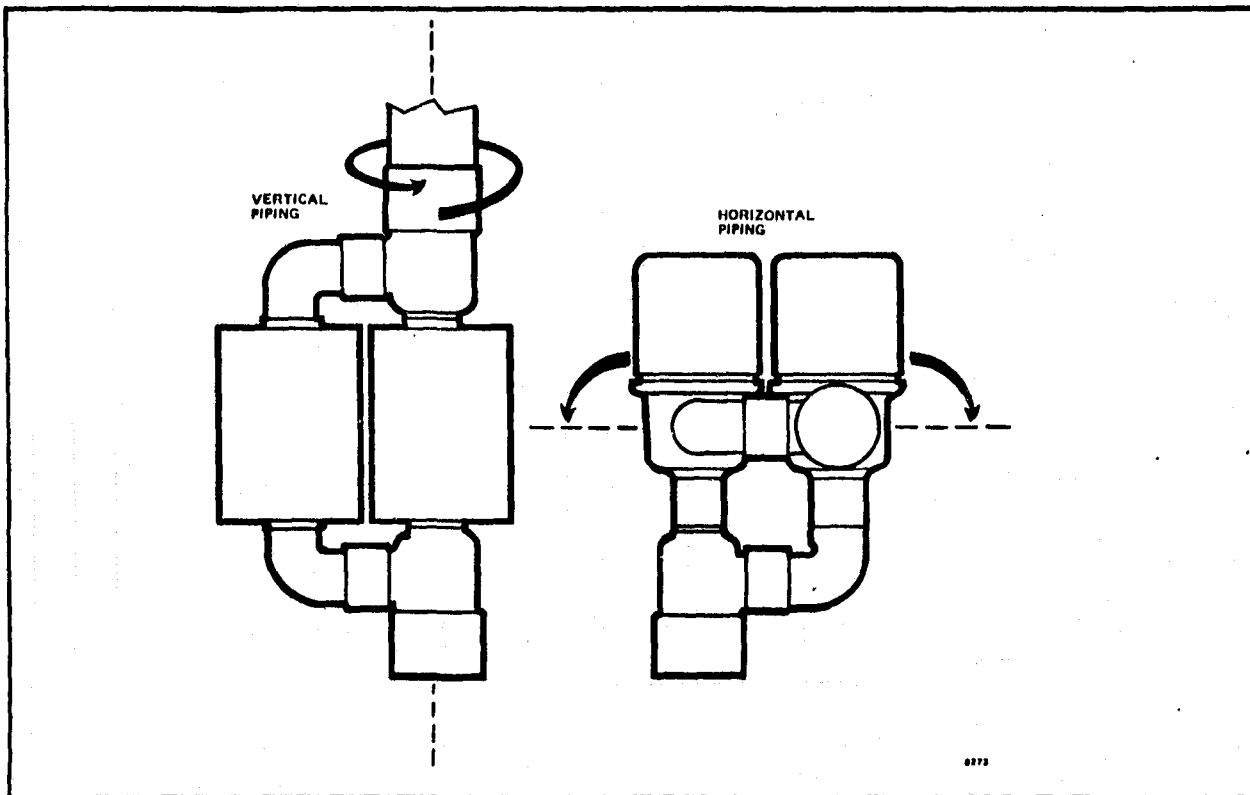


FIG. 4—MOUNTING POSITIONS.

The valve may be mounted in any position on a vertical line. If valve is mounted horizontally, the powerhead must be even with or above the center line of the piping. Make sure that enough room is provided above the powerhead to remove the cover for servicing. See Fig. 4.

The 3 fittings or ports of the dual diverting valves are labeled on the bottom of the valve body castings. Port A is connected to the purge coil piping and is closed when the valve is de-energized. Port B is connected to the system bypass and is open when the valve is de-energized. Port AB is the inlet and is open at all times. See Fig. 4.

SWEAT COPPER MODELS

1. Use new, properly reamed pipe, free from dents or corrosion.
2. Place valve onto the pipe. Set the manual opener lever to MAN. OPEN before applying heat. This will protect the plug inside the valve by removing it from the heat.
3. Sweat joints keeping the outer surface free from solder. DO NOT use silver solder because of the high melting temperatures required.

TO INSTALL REPLACEMENT POWERHEAD

IMPORTANT

Installation of new powerhead does not require the removal of the valve body from the pipe line. It is, however, necessary to drain the water from the system before beginning the installation.

1. Disconnect the valve from the electrical power source and remove the conduit connections if fitted.
2. Place the manual opening lever on the old powerhead in the MAN. OPEN position.
3. With the cover off, remove the 4 screws securing the powerhead to the valve body. Remove the old O-ring from the valve body.

4. Place the new O-ring in the circular slot on the top of the valve body.

5. Install the new powerhead—

—Place the manual opening lever on the new powerhead in the MAN. OPEN position.

—Align the powerhead by fitting the hex head screw on bottom of powerhead into the hole on top of valve body (see Fig. 3).

6. Reconnect electrical connections.

Inspect the powerhead installation and the valve body to insure that all connections and adjustments have been correctly made. Adjust the thermostat or controller connected to the valve so the valve runs through its cycle. Make sure the valve runs smoothly and positively from closed to open to closed again.

WIRING

All wiring must agree with local codes and ordinances. See Fig. 5 for a typical wiring hookup.

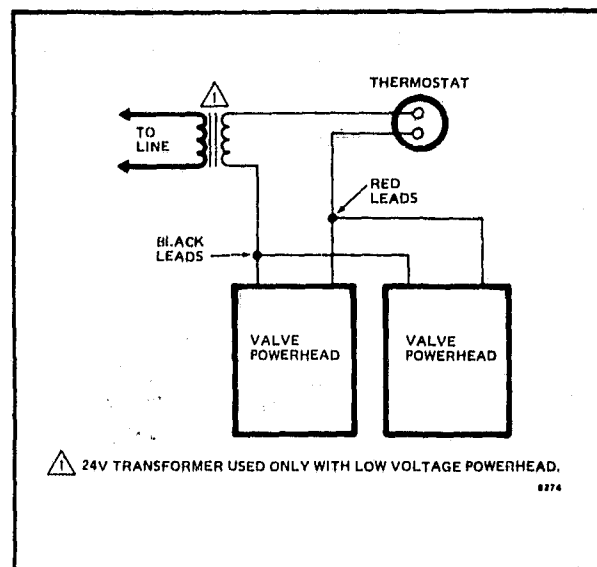


FIG. 5—TYPICAL WIRING FOR Y534 DUAL DIVERTING VALVES.

OPERATION AND CHECKOUT

CAUTION

On 24 volt systems, never jumper the valve coil terminals, even temporarily. This may burn out the heat anticipator in the thermostat.

OPERATION

AUTOMATIC OPERATION

When the valve is energized, port B, the bypass, closes and port A opens. Port A closes by integral spring return when the valve is de-energized.

MANUAL OPERATION

The motorized dual diverting valves (two with each assembly) can be opened manually by lifting the manual opener lever over the stop and pushing slowly and firmly to the MAN. OPEN position. The stop permits the valve to be locked in the open position. The valve will return to automatic position when the valve is energized.

CHECKOUT

1. Lower the set point of the high limit controller below the temperature of the collector fluid.
2. Observe that port A of the valve should be open and port B of the valve should be closed.
3. Raise the set point of the high limit controller above the collector fluid temperature.
4. Observe that port A of the valve should close and port B of the valve should be open.

SERVICE

This valve should be serviced by a trained, experienced service technician.

1. If the valve is leaking, check to see if the O-rings need to be replaced.
2. If the gear train is damaged or the motor is burned out, it is necessary to replace the entire powerhead assembly. See INSTALLATION.

NOTE: Honeywell zone valves are designed and tested for silent operation in properly designed and installed systems. However, water noises may occur as a result of excessive water velocity or piping noises may occur in high temperature (over 212 F [100 C]) systems with insufficient water pressure.

Bell & Gossett hydronic specialties specification and submittal sheet
A-551 revision 2 pertaining to Circuit Setter Balance Valves with
NPT, flanged and solder connections has been removed due to copy-
right.

Bell & Gossett ITT Fluid Handling Division, Circuit Setter Balance
Valve sheet has been removed due to copyright.

Bell & Gossett hydronic specialties specification and submittal sheet
A-422 revision 3 pertaining to Flo-Control Valves has been removed
due to copyright.

**CLASS 125
BRONZE
SWING
CHECK
VALVES**

**FIGS:
B-309
B-319**

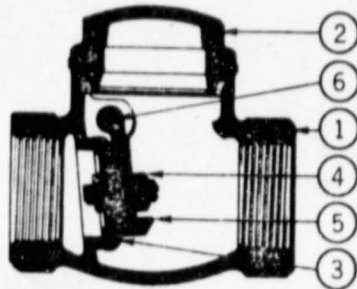
SCREWED CAP

BRONZE VALVES

SEE PAGE 36 FOR PRESSURE-TEMPERATURE RATING. (copyright info.)

SERVICE FEATURES

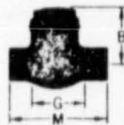
Recommended for prevention of backflow in general services. • Solder ends recommended for non-flammable liquids or gases with Types K, L, and M copper tubing.



NO.	DESCRIPTION	MATERIAL	ASTM SPEC.
1	BODY	BRONZE	B-62
2	CAP	BRONZE	B-62
3	DISC	BRASS (1/4-1/2)	B-16
		BRONZE (1/4-3)	B-62
4	DISC NUT	BRASS	B-16
5	HINGE	BRONZE	B-62
6	HINGE PIN	BRASS	B-16
* 7	SIDE PLUG	BRASS	B-16

*Not Shown

B-319



†B-309, SOLDER ENDS

SIZE	WGT.	B	G*	M
3/8	.4	1 13/32	1 1/16	2 1/16
1/2	.5	1 19/32	1 7/16	2 7/16
3/4	.9	1 9/64	1 3/4	3 1/4
1	1.4	2 1/4	2	3 13/16
1 1/4	2.0	2 19/32	2 5/16	4 1/4
1 1/2	3.4	3 1/32	2 11/16	4 7/8
2	4.8	3 1/2	3 5/16	6

†Saturated Steam Pressure for Solder End Valves Should Not Exceed 15 PSI.

*Piping Make-Up Dimension



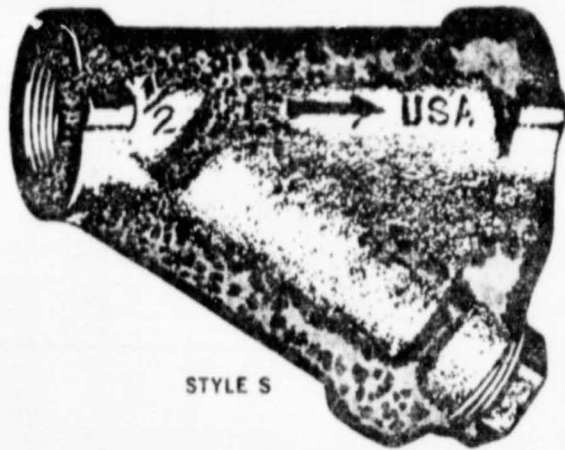
B-319, THREADED

SIZE	WGT.	B	M
1/4	.5	1 13/32	2 1/16
3/8	.5	1 13/32	2 1/16
1/2	.7	1 19/32	2 7/16
3/4	1.1	1 29/32	2 13/16
1	1.7	2 1/4	3 3/16
1 1/4	2.7	2 19/32	3 3/4
1 1/2	3.9	3 1/32	4 3/16
2	6.1	3 1/2	5 1/8
2 1/2	11	4 9/32	6 3/16
3	17	4 13/16	7 1/8

STRONG

Semi-Steel Y-Type Strainers

High Tensile Semi-Steel Body ASTM A126 Class B.



STYLE S



STYLE SG

SIZES 1/4" thru 3"

OPERATING PRESSURES AND TEMPERATURES:

Steam	250 psi at 406°F.
Water, Oil, Gas	400 psi at 150°F.

STANDARD SCREENS:

Service	Connections & Sizes	Screen Openings	Screen Material
Liquid	Screwed 1/4" thru 2" 2 1/2" thru 3"	20 mesh 045 perf.	Stainless Steel
Steam	Screwed 1/4" thru 2" 2 1/2" thru 3"	20 mesh 045 perf.	Stainless Steel

BLOW-OFF OUTLETS:

N.P.T. tapped in sizes specified on dimension table. Not normally furnished plugged.

CONSTRUCTION:

Constructed of high-tensile ASTM A126 Class B semi-steel with blow-off connections and easily removable cylindrical screens. A tapered seat allows the screen to be self-aligning and assures a perfect fit. 2 1/2" and 3" sizes have a flanged blow-off cover. Strainer with gasketed blow-off plug and straight thru ad available in 1/4" thru 2" size. 18-8 stainless steel screens.

MILITARY SPECIFICATIONS:

Model with gasketed blow-off plug conforms to MIL-S-16293E, Type 1, Style Y, Class 250 when equipped with a brass plug in the blow-off connection. State service when ordering.

PACKAGING:

Screwed strainers in sizes thru 2" can be packaged in multiple unit cartons for certain industries. Write for specific information.

DIMENSIONS:

Size	A	B	Size Blowoff NPT	Ship Weight lbs.	Screen Area In ²
1/4	2 5/8	1 3/4	1/4	1 1/4	3.0
3/8	2 5/8	1 3/4	1/4	1 1/4	3.0
1/2	3 13/32	2 1/8	3/8	1 3/4	5.4
3/4	4	2 3/4	3/8	2 1/2	7.4
1	4 5/8	3 1/4	1/2	4	12.7
1 1/4	5 3/8	3 1/2	3/4	6 1/4	18.1
1 1/2	6 1/16	4	3/4	8 1/4	25.3
2	7 1/2	5	1	14 1/2	39.2
2 1/2	9	6 3/4	1 1/4	22 1/2	49.3
3	10	7 7/8	1 1/4	35 1/4	64.8

Pressure Monitoring SWICHGAGES®

These rugged, pressure monitoring SWICHGAGES® are designed for any critical pressure control function.

Recommended specifically for safety shutdown on oil field, irrigation and industrial engines or as alarm systems on construction equipment, trucks and marine engines.

Offers constant visual indication.

These instruments offer a constant visual indication of the condition of your lubrication system, or any other vital pressures on your equipment. Their precision construction meets the specifications of those applications which require a higher degree of accuracy and dependability than is available in most standard 2" diameter instruments.

A SWICHGAGE® performs the job of two ordinary instruments (a gauge and a switch), thus this instrument greatly reduces necessary inventory and installation time.

In addition, each instrument is available with a lockout feature to hold the indicating pointer away from the shut-down contact for start-up. When the oil pressure reaches the normal operating level, the lockout is automatically disengaged.

Durability

The entire working mechanism of the SWICHGAGE® is assembled completely independent from the case and therefore is not affected by case damage or abuse in normal operation. Also, all moving parts are machined to close tolerance and many parts are interlocking to retard damage from vibration or shock. The unique design of the diaphragm and bearing plate prevent normal overpressures from harming the accuracy of the instrument.

Model 20-P-7

This model features a "tamperproof" front adjustable contact which can be set with an Allen-Head wrench (also available with standard screwdriver adjustment — specify), and a pushbutton for lockout.

Model 20-P-27

A side mounted micrometer — adjustment type contact screw and convenient side lockout are features of this model. It also has a stand-off ring which holds the instrument away from the panel to give access to the contact adjustment and lockout pushbutton.

Warranty

Like all Murphy instruments, Pressure SWICHGAGES® carry a full one year warranty against defective materials and workmanship. Consult the Murphy Service department for product repairs.

CONTACT RATINGS: 2 amp. @ 30 v.a.c., 2 amp. @ 30 v.d.c.

SHIPPING WEIGHTS: 20-P-7 7.8 Oz.—20-P-27 13 Oz.

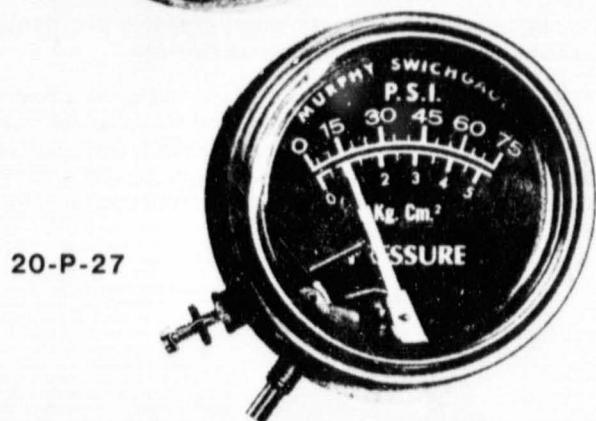
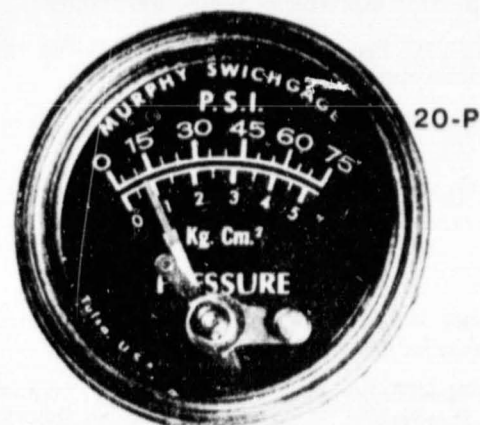
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Model 20-P
20-P-27

- An accurate indicating gauge & safety switch
- Features adjustable front/side switch contact

Patent no. 3375718

murphy

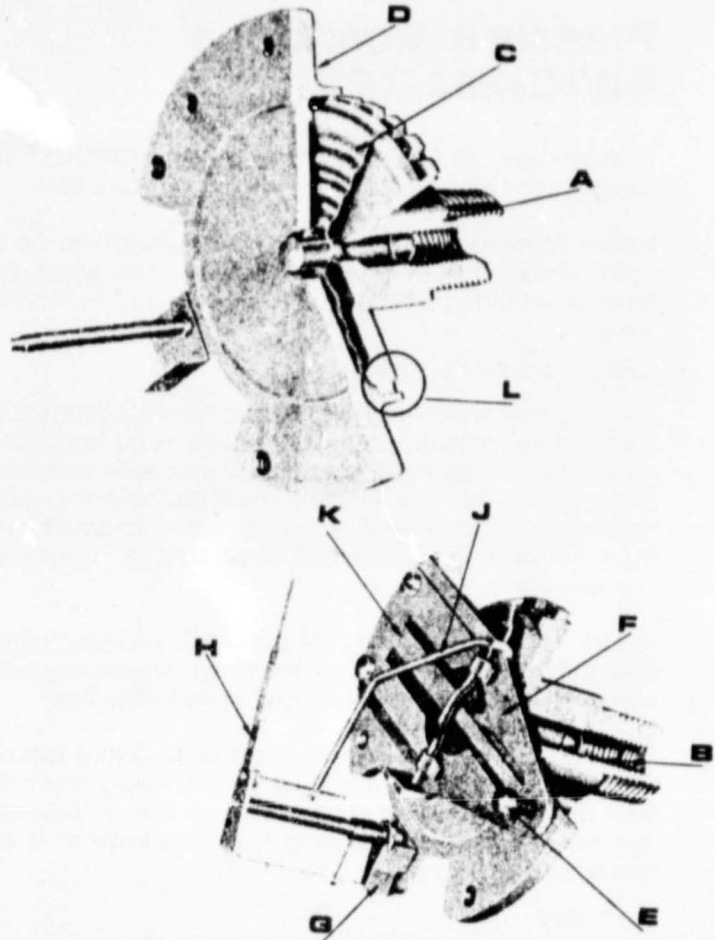


COMPATIBILITY: These simple one-wire to ground SWICHGAGES® are compatible with all Murphymatic® Controls and can be used with any Murphy "Nerve Center."

- To interrupt ignition circuit — Section 25
- To start and stop engines — Section 40
- To start and stop elec. tric. motors — Section 45
- For fuel shut-off — Section 55

SPECIFICATIONS

- A. PORT:** Machined from brass bar stock. It is accurately threaded for connection to the pressure line. Together with the diaphragm, it forms the pressure chamber.
- B. PULSATION DAMPENER:** A restricting orifice designed to minimize hydraulic shock within the pressure transmitting fluid, preventing undesirable pointer chatter. It is accessible for cleaning, or removal.
- C. DIAPHRAGM:** Beryllium copper, procured to very close physical and metallurgical specs. The material is die formed and close control heat treated to insure consistent reliability. Each pressure range is designed to operate well below its maximum capability in order to maintain long life and consistent reliability.
- D. MOUNTING PLATE:** Machined from brass bar stock. The mounting plate performs threefold function. First, together with the port, clamps back diaphragm in position. Second, it provides a strong back stop for the diaphragm, thereby preventing damage should the gauge experience high over pressure. Lastly, it also provides a stable platform upon which to mount the pointer post and the mechanism which amplifies the diaphragm movement into pointer travel.
- E. RECAL SCREW:** Provides a measure of adjustment to compensate for wear or disturbances that may result if gauge is operated in unusually severe environment.
- F. BRIDGE PLATE:** Tempered nickel silver provides corrosion resistance and dimensional stability.
- G. SPRING ANCHOR & POINTER ZERO STOP:** Stainless Steel.
- H. POINTER:** Tempered nickel silver for strength and corrosion resistance. It is mounted on a machined brass post. The return spring is helically wound of spring temper stainless steel.
- J. CRANK ARM:** K-Monel. Senses and amplifies diaphragm movement and transmits it to the pointer.
- K. BEARING PLATE:** Beryllium copper. Provides fulcrum for crank arm. It is free to lift off the bridge plate should the pointer be restrained by stationary contacts, etc. It returns to original position when strain is relieved.
- L. JOINT AND SEAL:** The carefully designed peripheral edges of the diaphragm and port, and the radiused channel in the mounting plate provide consistently accurate parts alignment. The annular solder channel provides optimum conditions for producing a combination structural joint, and seal, with maximum integrity.



DESCRIPTION	MODEL NO.	RANGES
2" Dia. Pressure SWITCHGAGE* Front Contact — No Lockout	20-P	0-30, 0-75, 0-100 p.s.i. 0-150, 0-200, 0-300 p.s.i.
20-P w/Front Lockout	20-P-7	All Ranges
2" Dia. Pressure SWITCHGAGE* Side Contact — No Lockout	20-P-75	0-30, 0-75, 0-100 p.s.i. 0-200, 0-300 p.s.i.
20-P-75 w/side Lockout	20-P-27	All Ranges
2" Dia. Vacuum SWITCHGAGE* Hi-Lo Contacts — No Lockout	20-V-2 20-V-3	0-20 inches Vacuum 0-30 inches Vacuum

OPTIONAL EXTRAS

Additional Contact (except 20-V)	add-HL	All Ranges
"C" Contacts — 2 wire ungrounded (Not avail. w/Lockout)		
Circuit (rated 1 amp @ 125V A.C.)	add-C	All Ranges
Illumination slots. (Front contact only)	add-1	All Ranges

Also available in explosion proof case — see bulletin No. EX-5828. Available on front contact models only.

murphy

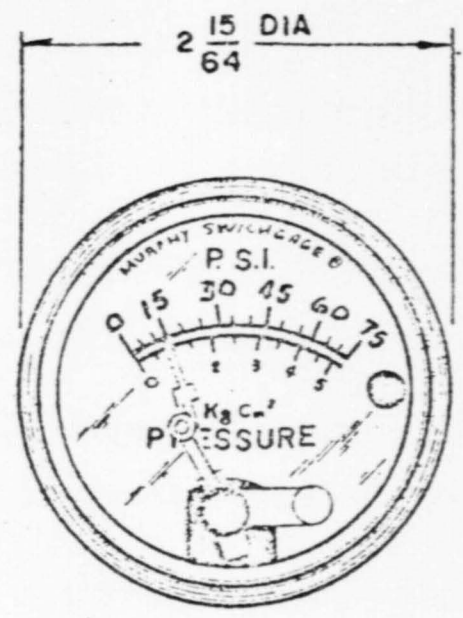
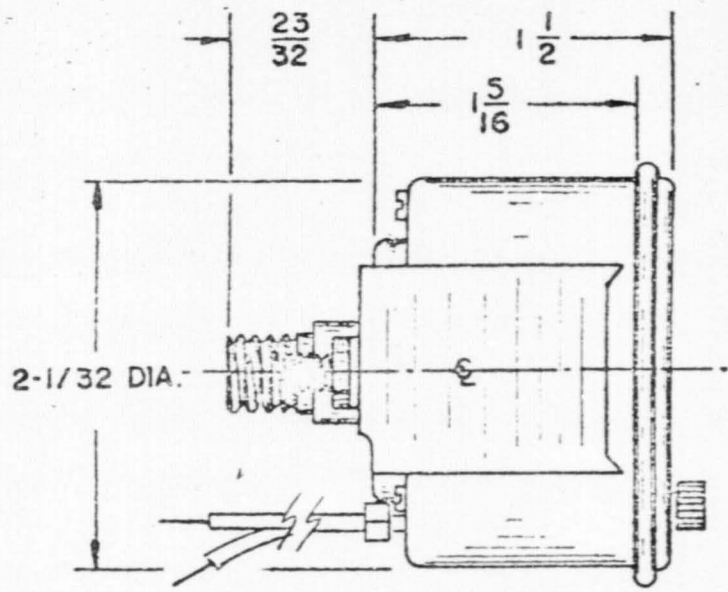
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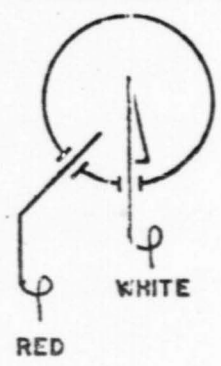
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RANGES AVAILABLE	CONTACT SETTING
■ 0-15 PSI	3 PSI
■ 0-30 "	7 "
■ 0-50 "	10 "
*■ 0-75 "	15 "
■ 0-100 "	20 "
▲ 0-150 "	30 "
▲ 0-200 "	50 "
▲ 0-300 "	75 "

*STANDARD

WIRING DIAGRAM



RATING-1 AMP 120VAC - 2 AMP 30V AC/DC
 WIRE - (1) RED, (1) WHITE, 12" X 18 GA
 CONTACT SETTING - SEE ABOVE
 TYPE ADJUSTMENT - NYLON KNOB
 DIAL - WHITE ON BLACK
 CLAMP - LONG P/N 05 05-789
 MOUNTING HOLE - 2-1/16 DIA.
 MAX PANEL THICKNESS - 1/4"
 PORT - BRASS 1/8-27 NPT
 MAX PRESSURE - (□=300PSI)(▲=500PSI)
 PULSATION DAMPENER - BUILT IN (REMOVABLE)
 BEZEL - STAINLESS STEEL
 CASE - STEEL, CAD & IRIDITE
 CRYSTAL - LEXAN
 STUDS - 10-24 NC

CALIBRATION CONFORMS TO USAS CLASS B - FIRST & LAST 1/3 OF SCALE
 ±3%, MIDDLE OF SCALE ±2%

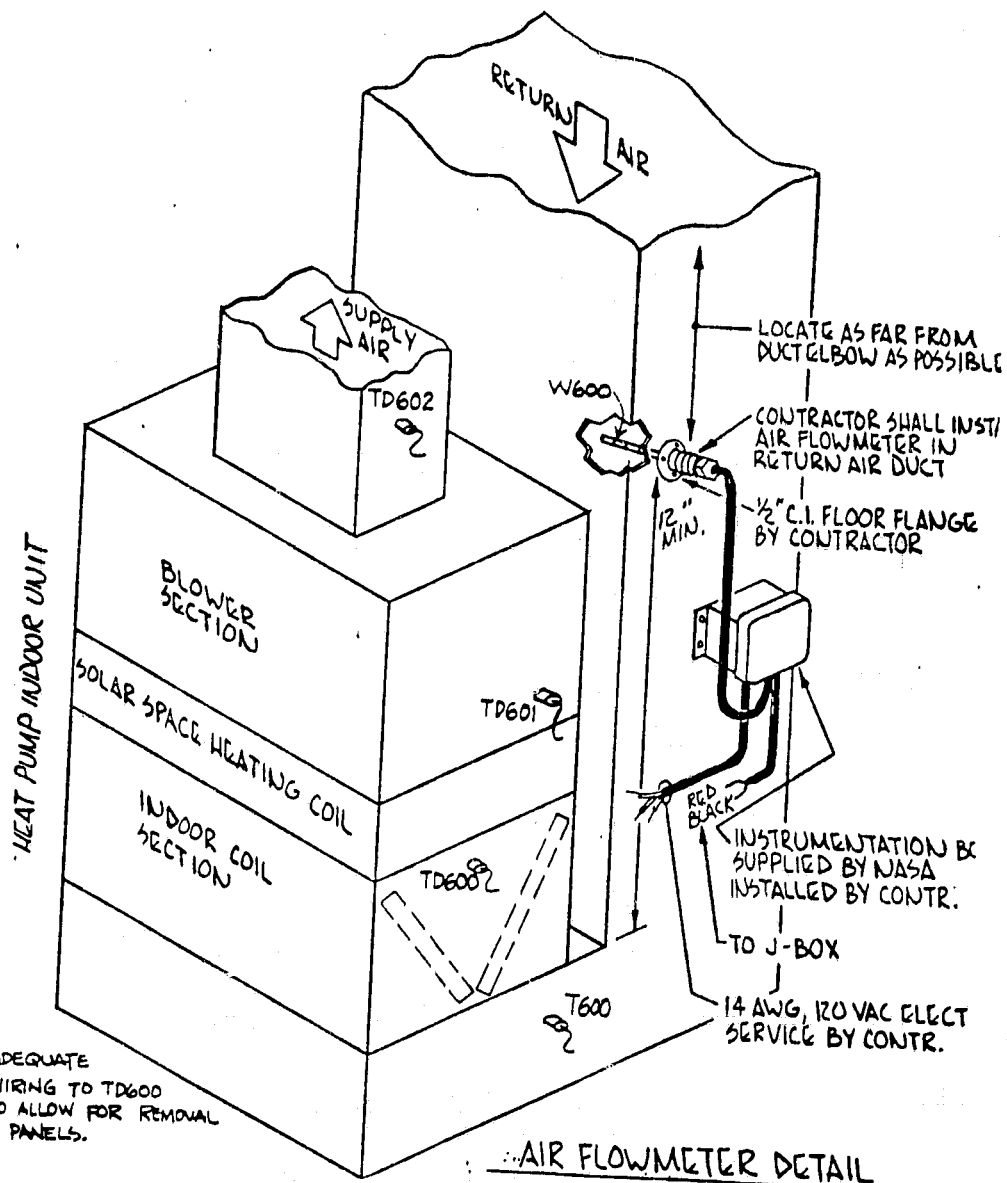
NOTE: NO CUSTOMER REPLACABLE PARTS

REVISION	
FRANK W. MURPHY, MFR., INC. MURPHY SAFETY SWITCH TULSA, OKLAHOMA	
DRN BY <i>BURRIS</i>	APPD BY <i>[Signature]</i>
DATE <i>11-1-78</i>	CHKD BY <i>[Signature]</i>
MODEL	20 PC
SWITCHGAGE®	
DWG. NO.	05 02-108

E-29

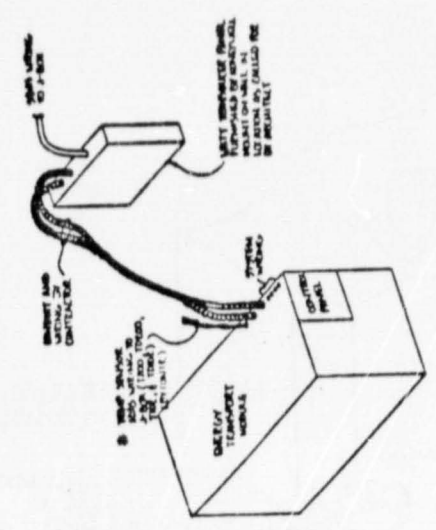
APPENDIX F

SDAS SENSOR INSTALLATION



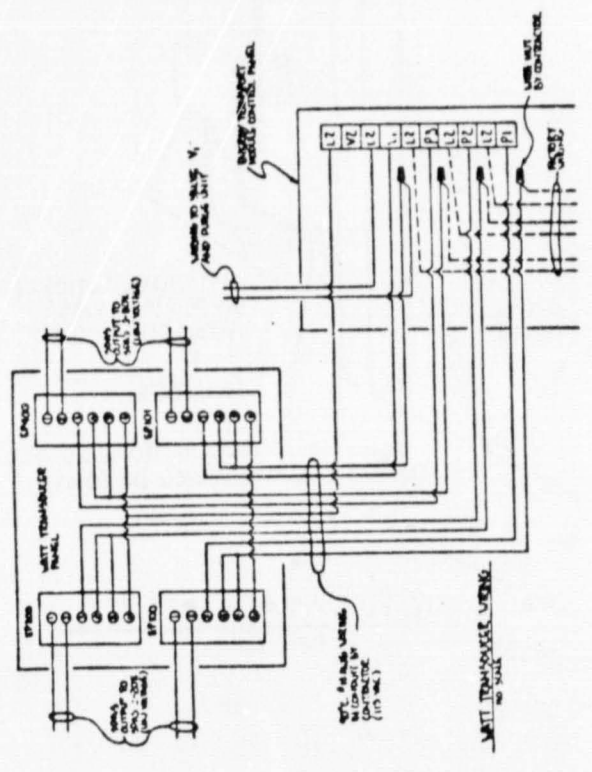
NOTE: PROVIDE ADEQUATE LENGTH WIRING TO TD600 & TD601 TO ALLOW FOR REMOVAL OF ACCESS PANELS.

AIR FLOWMETER DETAIL
NO SCALE



MATI TEMPERATURE PANEL INSTALLATION
NO SCALE

1. WIRE THE TEMPERATURE PANEL TO THE DATA TRANSMITTER MODULE AND THE CONTROL PANEL.
2. WIRE THE DATA TRANSMITTER MODULE TO THE CONTROL PANEL.



HONEYWELL		TEMPERATURE CENTER	
INC.		TEMPERATURE CENTER	
SIGNAL FAMILY TELEPHONE - SITE			
DATA ACQUISITION SUBSYSTEM			
UNIT	UNIT NO.	DATE	REVISION
C	55513	7-1-14/055	
SCALE 1:1		UNIT 4 OF 4	
CONTROL			

APPENDIX G

GENERAL SDAS INSTALLATION

INSTRUMENTATION INTERFACE REQUIREMENTS

To transmit data from each sensor to the Central Data Processing System, the hardware components shown in Figure 1 are utilized at each site. A typical layout of the work space required around the SDAS mounting area is shown in Figure 2.

NOTE: All ERDA responsibilities will be performed by NASA.

Hardware Components

1. Sensor wire (supplied and installed by site contractor)
2. Junction box (supplied by ERDA and installed by site contractor)
3. Junction box/SDAS interface cables (supplied and installed by ERDA)
4. Site Data Acquisition Subsystem (SDAS) (supplied by ERDA and installed by site contractor)
5. SDAS telephone interface (supplied by ERDA)
6. SDAS and telephone electrical power interface (supplied by site contractor)

Sensor to Junction Box Wiring

All wiring from sensors to junction box (J-box) terminal block connections shall be performed by the site contractor in accordance with these guidelines utilizing wire procured by the site contractor and prepared for each sensor according to instructions in Figure 3. The wire size and number of conductors required for each sensor is specified in Table 1. The sensor-to-junction-box wire shall be color-coded, audio and instrumentation grade cable to minimize noise problems. Conduit shall be used only in accordance with local codes.

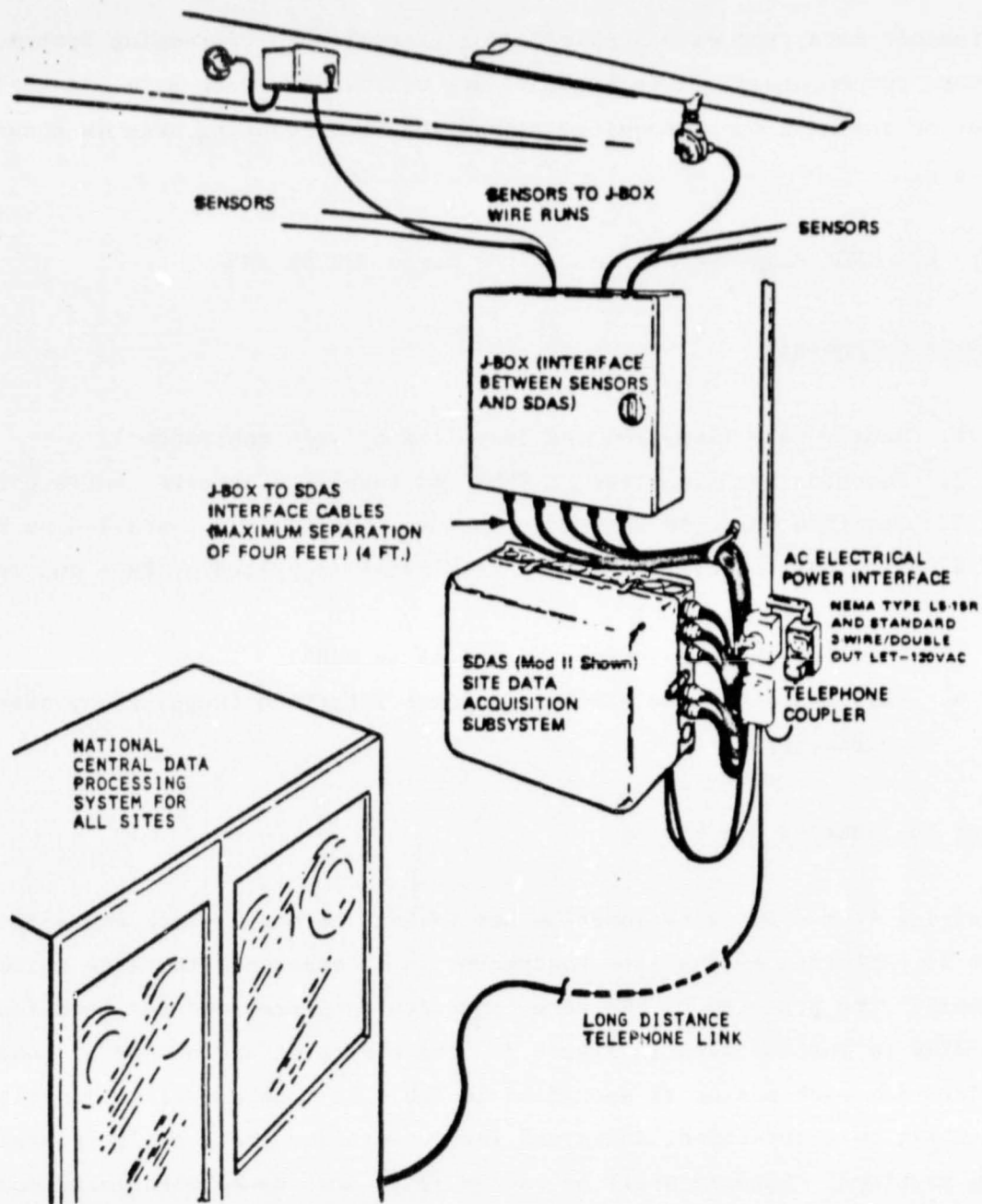
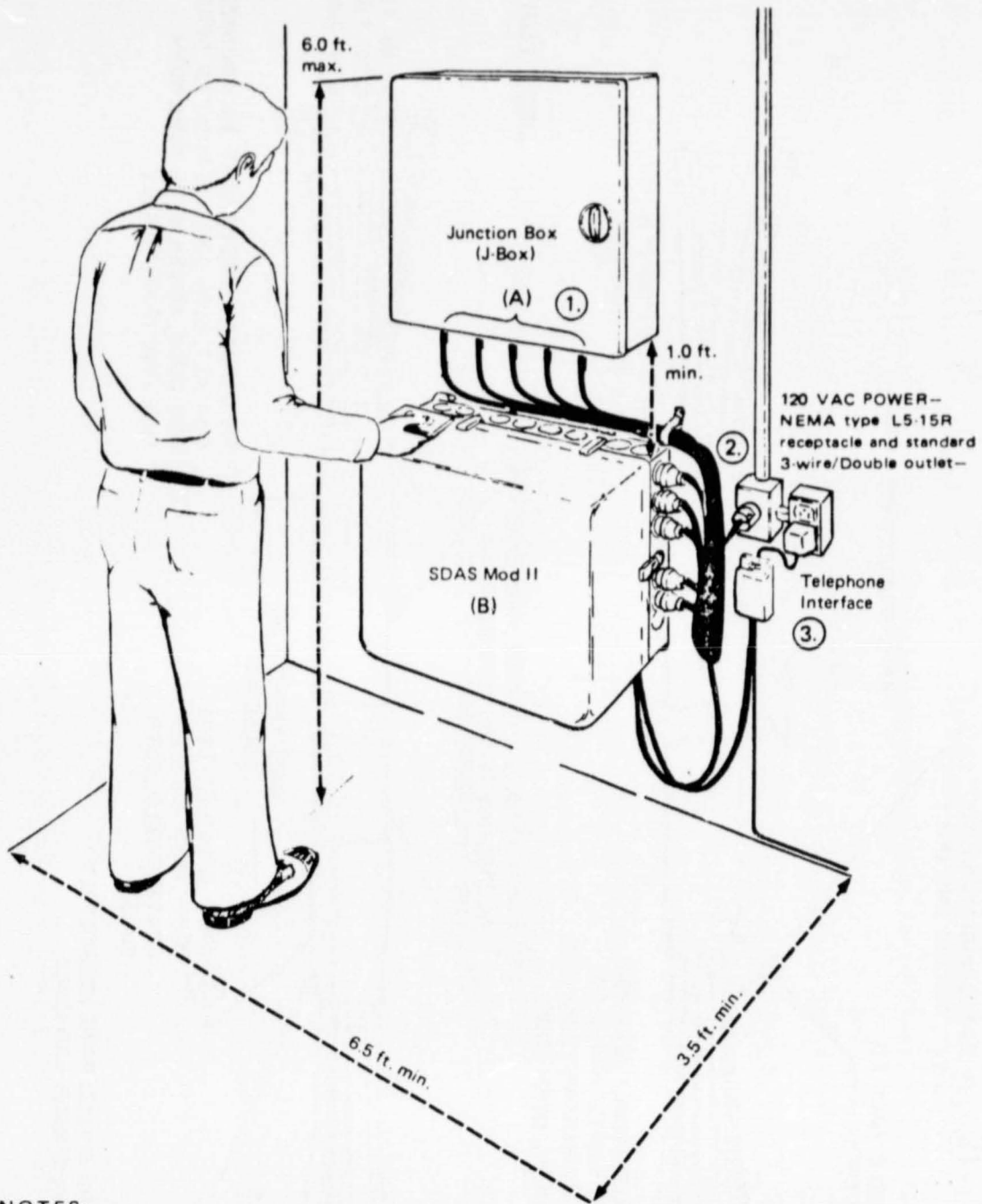


Figure 1 . Site Instrumentation Interface Hardware



NOTES:

- ① J-Box (A) is to be located within a cable run of 4 ft. of the SDAS (B)
- ② NEMA type L5-15R receptacle to be within 6 ft. of SDAS (B)
- ③ Telephone Interface (Coupler) is located within 3 ft. of SDAS (B)

Figure 2. Typical SDAS Installation Layout Profile

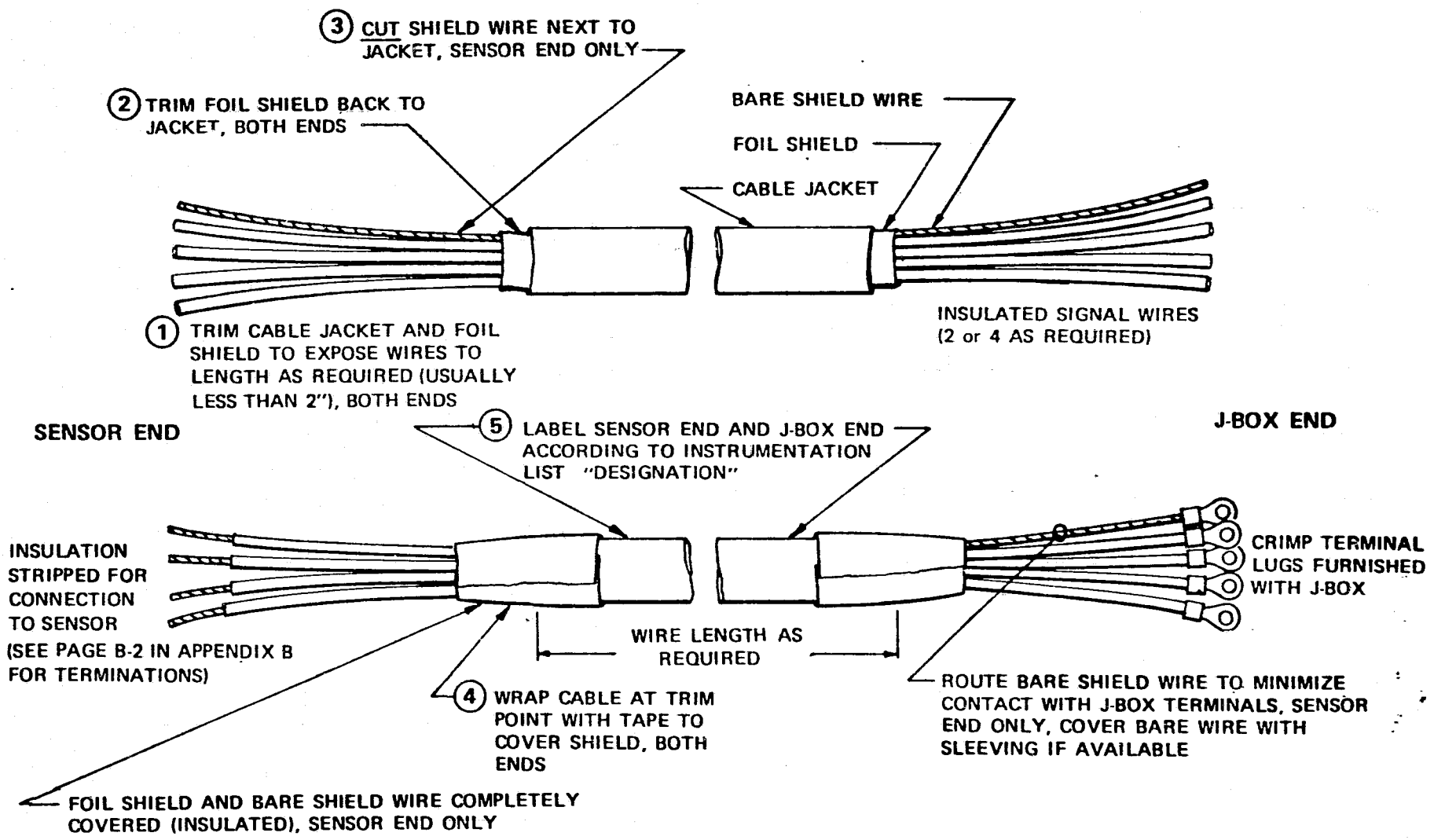


Figure 3. Sensor Wire Preparation Procedure

Table 1. Sensor Wire Requirements

SENSOR TYPE	CONDUCTORS	AMERICAN WIRE GAUGE
Temperature		
- Single element RTD	3 + shield	#18-3
- Dual element RTD	3 + shield (2)	#18-3
Flow rate (liquid)	4 + shield	#18-4
Air velocity	2 + shield	#18-2
Solar radiation	2 + shield	#18-2
Electric power	2 + shield	#18-2

NOTE: 1. Typical wire part numbers include:

- Alpha P/N 2422-18 gauge, 2 conductor or equivalent
- Alpha P/N 2423-18 gauge, 3 conductor or equivalent
- Alpha P/N 2424-18 gauge, 4 conductor or equivalent
- Dearborn P/N 971804-18 gauge, 4 conductor or equivalent
- Dearborn P/N 971803-18 gauge, 3 conductor or equivalent
- Dearborn P/N 971802-18 gauge, 2 conductor or equivalent
- Manhattan P/N M3242-18 gauge, 2 conductor or equivalent
- Manhattan P/N M3243-18 gauge, 3 conductor or equivalent
- Manhattan P/N M3244-18 gauge, 4 conductor or equivalent

2. Two (2) cables required for dual element RTDs.

3. Wire exposed to the outdoor environment or buried shall be in conduit.

4. Rigid conduit runs to all sensors shall be terminated with flexible conduit. All connections shall be made watertight.

CAUTION

AC POWER LINES AND OTHER POTENTIAL NOISE INDUCING LINES SHOULD NOT BE PLACED IN THE SENSOR WIRING CONDUIT OR ROUTED NEAR THE INSTRUMENTATION CABLES. ALSO, THE INSTRUMENTATION CABLES SHOULD NOT BE ROUTED NEAR NOISE GENERATING EQUIPMENT.

Junction Box

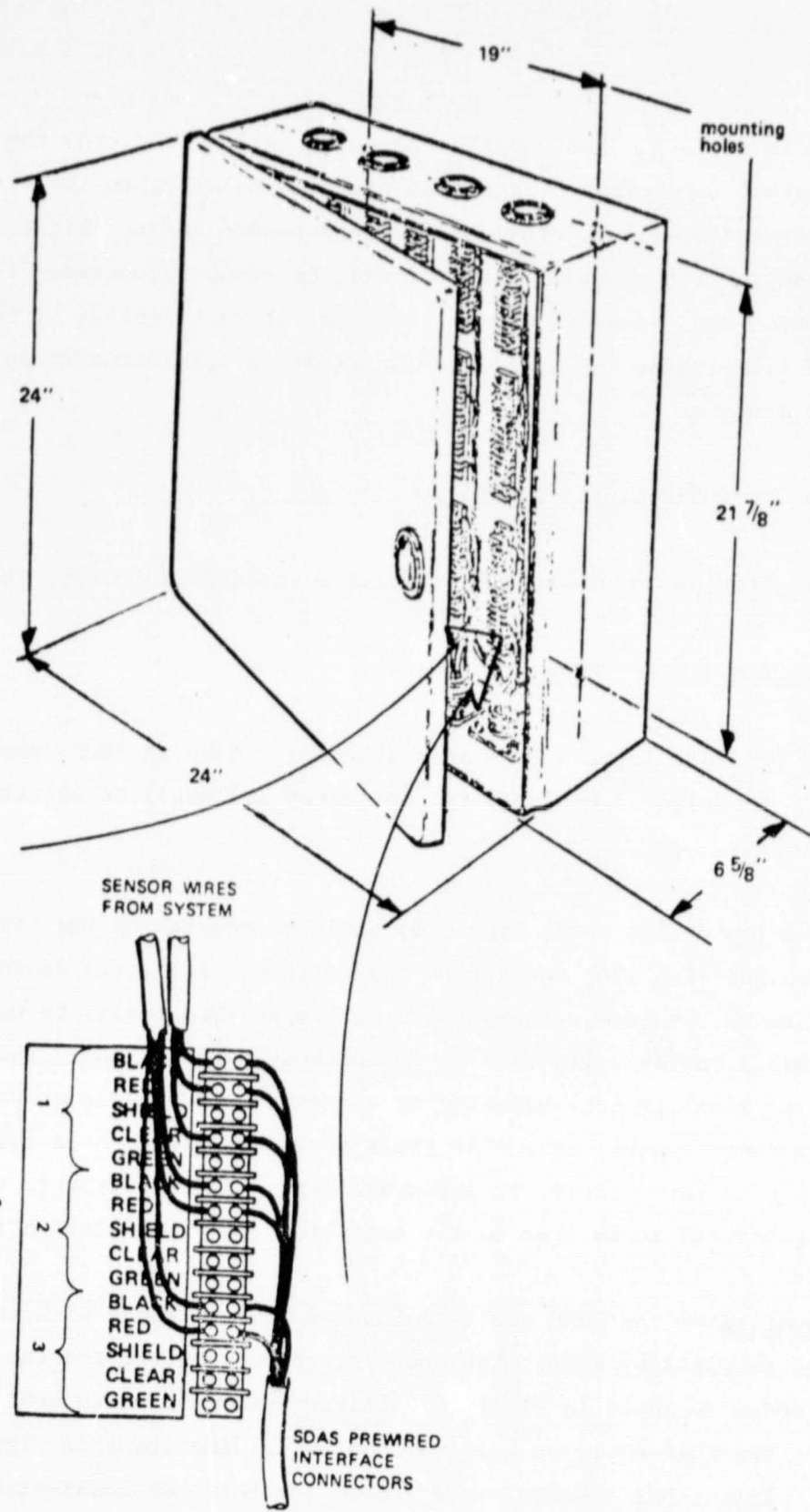
ERDA will provide a junction box (Figure 4) to the site contractor for installation in a central location with respect to the solar energy system. The installation location shall be selected by the site contractor and shall be specified in the ISPI.

As defined by ERDA, noise suppression may be required at the sensor, J-Box or both to provide acceptable data. Remote signal conditioning may be required to improve the signal-to-noise ratio that would improve data accuracy.

Junction Box Location -- The junction box, Figure 4, shall be mounted by the site contractor so that it is accessible for wiring connections from the sensors and is within four feet of the SDAS location on the same side of the wall.

Junction Box Mounting -- At the predefined mounting location, the junction box shall be mounted by the site contractor using the four mounting holes located at the back of the unit. Figure 4 provides the dimensional information for mounting. Depending on the characteristics of the mounting surface, Molly bolts, wood screws, or bolt/nut combinations shall be used to mount the unit. The junction box shall be installed in a top-up orientation.

Junction Box Interfaces -- ERDA will establish the wire run list which identifies where each sensor wire attaches to the junction box terminal strips. This wire run list will be a part of the AIP which the site contractor will implement. A typical example of a wire run list and the connection of typical measurements



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OF POOR QUALITY

Figure 4. Junction Box/SDAS Interface with typical Sensor connection

is shown in Table 2. The junction box will be prewired from the terminal strips to the output connectors of the SDAS prior to delivery to the site. Five conductor terminals will be provided for each sensor input. Either two, three, or four conductor (18 gauge) and shield will be connected between the sensors and the junction box depending on the interface characteristics of the sensors. Figure 5 illustrates the sensor-to-junction-box interconnections for each of the approved sensors.

Junction Box/SDAS Interface Cables

ERDA will provide and install the junction box/SDAS interface cables.

Site Data Acquisition Subsystem

The Site Data Acquisition Subsystem (SDAS) location at each demonstration project will be selected by the site contractor and shall be specified in the ISPI for approval.

SDAS Location -- The SDAS, Figure 5, shall be mounted by the site contractor in a central position with respect to the solar energy system sensors. It shall be located in an indoor environment having temperature limits between 32°F and 100°F and relative humidity limits of 5-80% without condensation. The SDAS shall be located to minimize contamination by elements such as dust or other pollutants. To the extent possible, the SDAS shall be located in an area that minimizes the variations in temperature, relative humidity, and vibration to the SDAS. The SDAS shall be located in an area easily accessible for installation and maintenance.

SDAS Mounting -- The SDAS shall be mounted in accordance with the installation drawings supplied by ERDA. The mounting space required for the SDAS is dependent on the model as shown in Figure 6. Either unit will weigh approximately 70 pounds. The SDAS shall be wall mounted using dimensions in Figure 6 both top and bottom. Either Molly bolts, wood screws, or bolt/nut combination shall be used.

Table 2. Typical Wire Run List for J-Box Terminal Connection

SITE <u>IIG</u>		WIRE LIST <u>XXXXXXX</u>				DATE _____	SHEET <u>X</u> OF <u>XX</u>		
SENSOR NUMBER	REF. MEAS. NUMBER	SENSOR CONNECTION	SENSOR/J-BOX WIRE COLOR	TERMINAL STRIP NO.	INTERNAL FROM	JUMPER TO	SDAS CHANNEL	LEVEL	
T100	T100	RED	RED	TB1-6			2	LO	
		WHITE*	CLEAR	TB1-7			2	HI	
		WHITE*	BLACK	TB1-9			2	3RD	
	TD100L	SHIELD	SHIELD	TB1-8S					SHIELD
		YELLOW*	BLACK	TB2-4				4	3RD
		YELLOW*	CLEAR	TB2-4				4	3RD
TD100	TD100H	BLUE	RED	TB2-1			4	LO	
			SHIELD	TB2-3S					SHIELD
		RED	RED	TB2-2				4	HI
		WHITE*	BLACK	TB2-5				4	3RD
		WHITE*	CLEAR	TB2-5				4	3RD
			SHIELD	TB2-3S					
W100	W100	1	RED	TB1-15			3	+5 VDC	
		2	CLEAR	TB1-12				3	HI
		3	GREEN	TB1-11				3	LO
		4	BLACK	TB1-14				3	GND
I001	I001		SHIELD	TBL-13S				SHIELD	
		B	RED	TB3-2				7	HI
		A	BLACK	TB3-1				7	LO
D001	D001		SHIELD	TB3-3S				SHIELD	
		G	RED	TB11-5				31	+5 VDC
		E	CLEAR	TB11-2				31	HI
		F	BLACK	TB11-1				31	LO/GND
EP101	EP101		SHIELD	TB11-3S				SHIELD	
		2	RED	TB13-2				34	HI
		1	BLACK	TB13-1				34	LO
F300	F300		SHIELD	TB13-3S				SHIELD	
		1	RED	TB2-10				8	+5 VDC
		2	CLEAR	TB3-7		TB3-6**	TB2-9**	8	HI
V001	V001	3	BLACK	TB3-6			8	LO/GND	
			SHIELD	TB3-8S					
		A	RED	TB9-2				25	HI
W400	W400	B	BLACK	TB9-1			25	LO	
			SHIELD	TB9-3S					SHIELD
		1	RED	TB11-2				31	HI
RH001	RH001	2	BLACK	TB11-1			31	LO	
			SHIELD	TB11-3S					SHIELD
		BROWN	RED	TB14-15				39	+3.6 VDC
		PURPLE	BLACK	TB14-14				39	GND
		YELLOW	CLEAR	TB14-12				39	HI
D101	D101	GREEN	GREEN	TB14-11			39	LO	
			SHIELD	TB14-13S					SHIELD
		RED 1	RED	TB5-15				15	5 VDC
		BLACK 3	BLACK	TB5-14				15	GND
		YELLOW 2	CLEAR	TB5-12			15	LO/GND	
								HI	

*EITHER WIRE

**JUMPER ADDED PRIOR TO SHIPMENT

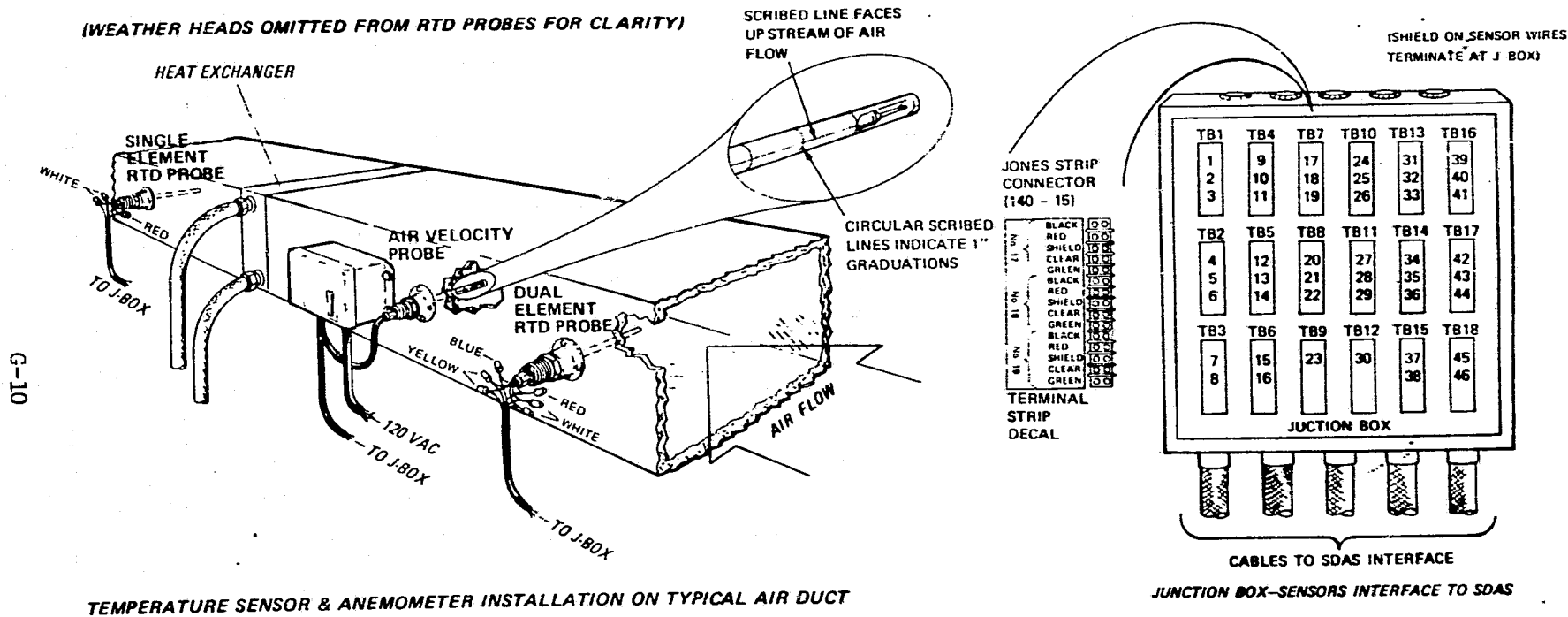


Figure 5. Typical Sensor to J-Box Interconnection

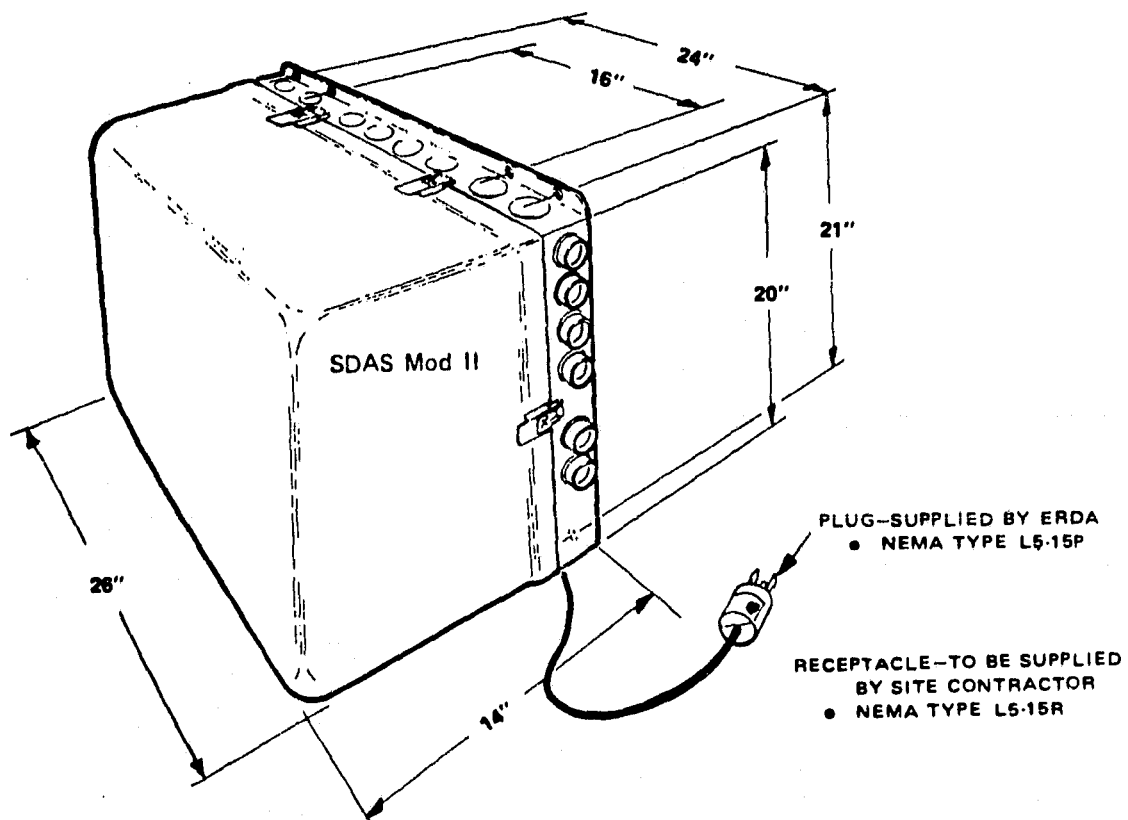


Figure 6. Site Data Acquisition Subsystem

to mount the unit depending on the characteristics of the mounting surface. The SDAS shall be mounted between two feet and four feet above floor level measured from the bottom of the SDAS.

SDAS Telephone Interface

ERDA will arrange for the telephone installation required for the SDAS. The SDAS shall interface with a standard Bell System CBS Data Access Arrangement (DAA), Series 5 or later, or equivalent. The DAA shall be located within three feet of the SDAS on the same side of wall. The DAA connection with the SDAS shall be performed by ERDA. The site contractor shall provide a standard 120 VAC three (3) wire receptacle for power to the coupler.

SDAS Electrical Interface

The SDAS interfaces with 110-125V, 60 Hertz, 1 phase, 3 amp service. A standard 3 wire interface (safety ground, power and return) with a standard power cord and twist lock connector shall be provided on the SDAS. A 120 VAC three pin twist lock outlet (actual receptacle should be NEMA Part Numbers L6-15R, 250V, 15 amps for Mod I and L5-15R, 120V, 15 amps for Mod II) shall be provided by the site contractor and located within six feet of the SDAS.