COO-4412-16

SOLAR HOT WATER SPACE HEATING SYSTEM

TECHNICAL PROGRESS REPORT

WORK PERFORMED UNDER
CONTRACT EG-77-C-02-4412.A000

JORDAN COLLEGE
360 W. PINE STREET
CEDAR SPRINGS, MICHIGAN 49319

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DISCLAIMER

COO-4412-16

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AUGUST 13 , 1979

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RSA

JORDAN COLLEGE TECHNICAL PROGRESS REPORT

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PURPOSE

The purpose of this report is to document the completed solar installation on Madison Hall at Jordan College, Cedar Springs, Michigan.

The project was funded as part of the National Solar Heating and Cooling Demonstration Program.

There are two objectives of this installation. The first objective is to demonstrate the feasibility of using flat plate solar collectors with a hot water baseboard radiation system in the Western Michigan Area. The second objective is to provide an educational opportunity for the general public to see a commercially available operational solar heating system.

JORDAN COLLEGE TECHNICAL PROGRESS REPORT

EXECUTIVE SUMMARY

As part of the National Heating and Cooling Demonstration Program a retrofit solar heating system was installed on Madison Hall at Jordan College, Cedar Springs, Michigan.

The solar system provides heating energy and domestic hot water preheating energy for a campus dormitory type building. The solar system is directly integrated with the existing hot water baseboard radiation system. Freeze protection is provided by draining the collectors when solar energy is not available.

The system was installed and operating within ten (10) months of award notification. Operation was halted due to a major freeze-up that occured soon after the system was completed. The extent of the freeze damage was compounded by a make-up water line that flooded the collectors during freezing weather conditions.

Solar system operation was resumed after repairs were made. Consistant performance of the system has been minimized due to problems encountered during operation. The problems include unwanted energy transfers between the day tank and the storage tank, system leaks, filming on the collectors and constant air circulation between the expansion tanks and the day tank.

Performance evaluation of the solar system will become available as historical data is developed.

Visibility of the solar system has been implemented by the College. Conducted tours for the public, student work study opportunities, seminars and a week long annual open house provide the opportunity for many to observe the installation.

Recommendations based upon the installation and operation of the solar system include: additional funds for modifications, use of thermographic devices for trouble-shooting, analysis of the effects of collector shading and inclusion of energy metering devices in future projects.

JORDAN COLLEGE TECHNICAL PROGRESS REPORT

DESCRIPTION OF BUILDING AND SOLAR SYSTEM

The solar system is a retrofit to an existing building. The existing building is a one story, slab on grade, frame construction with flat roof. The flat roof is constructed of built up 2 x 4 trusses on 24" centers. The building is located on a mostly tree free rolling farmland type of campus site. The building provides dormitory space with thirteen student rooms, a Guest Room, House Parents Apartment Lounge and necessary toilets, showers, laundry and other support facilities.

The building was constructed for energy conservation. The frame walls have full thickness (3-5/8") insulation. The ceiling has 8" of blown-in insulation. Double pane weather stripped windows were used throughout.

Building heating is by the original baseboard fin tube hydronic system. Fin tube is located around the perimeter of the building and zone thermostats control hydronic valves to maintain the desired zone temperatures. Hot water is continuously available to the fin tube. The hot water temperature is reset by the outdoor air temperature. A night thermostat controls the building at a lower night time temperature.

The auxiliary heating source is the original gas fired hot water boiler. The boiler is activated when solar heated hot water is not available to satisfy the heating requirements.

The solar heating source is 104 double glazed flat plate collectors in eight (8) rows of thirteen (13) collectors mounted on the roof. Freeze protection is by a siphon drain down method. Hot water generated in the collectors is available for direct use in the fin tube heating system. The entire system (collectors, storage tanks, hot water boilers, fin tube) is pressurized.

Energy storage is provided by two tanks. A large 5,000 gallon tank for longer term energy storage and a smaller 300 gallon "day tank". The day tank provides short term energy storage and rapid temperature increases for use in the fin tube hydronic heating system.

DESCRIPTION OF BUILDING AND SOLAR SYSTEM (CONT'D)

Solar energy absorbed by the collectors is transported to the "day tank" and is elevated to the desired temperature. From the day tank heat energy is extracted and utilized for space heating directly through the baseboard fin tube radiators and for domestic hot water heating. If surplus heat is available in the day tank it is transferred to an insulated 5,000 gallon storage tank. During periods of no solar insulation heat energy stored in the 5,000 gallon tank is transferred to the day tank for used as required.

Domestic hot water storage is provided by two (2) 80 gallon tanks. The auxiliary energy source for the domestic hot water is the original gas fired water heater.

JORDAN COLLEGE TECHNICAL PROGRESS REPORT

CONSTRUCTION PROGRESS

Contract award for the installation of a solar system was made in March of 1977. Preliminary plans for construction were implemented according to the proposal documents included in PON DSE-76-2.

Major long lead components were ordered in June, 1977. These items include the 5,000 gallon storage tank, 300 gallon day tank and 104 solar collectors.

Minor short lead components were ordered during July and August, 1977. These items included the controls, pumps, domestic hot water preheat tanks and hydronic specialties.

Design reviews with DOE personnel were held in August and September, 1977. Two changes from the original proposal were initiated as a result of the reviews. One change was to place the 5,000 gallon storage tank inside the solar equipment room rather than below ground or outside. The size of the equipment room was increased to accomodate the tank. The second change involved the design of a passive condensate trap. (See Appendix A). The trap minimizes vapor migration between warm storage tanks and cold collectors during the drained down mode.

Construction began during August, 1977. Collector supports were assembled and installed on the roof. The solar equipment room was begun.

Component deliveries began with the arrival of the collectors in September, 1977. Tanks were delivered in October. Construction continued with the installation and piping of these items.

Final construction details were completed in December, 1977. The control system was tested and verified. Initial testing and balancing of the hydronic systems was completed. The system was placed in complete operation for heating, domestic hot water preheating and storage of solar heated hot water.

Structural analysis of the building was also completed in December, 1977. Refer to Appendix B. The analysis concluded that the added weight of the collectors, supports and piping would not exceed the structural strength of the building provided that the corridor walls were utilized as load bearing walls. The structural recommendations to tie the corridor walls to the roof load were implemented by College personnel.

CONSTRUCTION PROGRESS (CONT'D)

On December 26, 1977 a major setback occured. Due to a failure in the system the solar collectors were flooded during freezing weather conditions. As a result, fifty (50) of the one hundred four (104) collectors were damaged. The solar system was de-activated and the auxiliary hot water boiler utilized as the primary heating source.

The freeze-up was precipitated by a loss in system pressure. The problem was compounded through subsequent flooding by the pressurized make-up water line. The make-up water line is associated with the existing hot water boiler and is a standard feature of hydronic heating systems.

The location and cause of the original leak is unknown. The resultant flooding and extensive damage prevented making an exact analysis of the cause of the freeze-up.

Winter weather conditions delayed repairs until April, 1978. Each damaged collector was disassembled, repaired, tested for leaks and replaced in the system. Several collectors were damaged during the repair period. Some as a result of the repairs and others as a result of high winds flipping the collectors from their mountings while waiting to be repaired. The cost to repair the latter collectors was covered by the contractor's insurance.

The system was placed in temporary operation in May, 1978 minus the damaged collectors. The make-up water line was de-activated. The connection from the solar system to the heating system also remained closed. Useful solar energy was collected for domestic hot water preheat. A rotating alarm beacon is activated on loss in system pressure or a rise in system water level.

During the repair period it was noticed that many of the collectors were developing a film coating on the inside of the inner glass cover. The film seemed to be the result of out gassing with subsequent condensing on the glass surface. The collector manufacturer was consulted to determine the cause and potential effect upon the system operation.

Samples of the glass were sent to the manufacturer for analysis. Chemical testing was inconclusive regarding the origin of the film. Analysis of the sample residue indicated that it possibly may not be from a substance used in the collector manufacturing process.

CONSTRUCTION PROGRESS (CONT'D)

A representative of the collector manufacturer visited the job site in August, 1978. His observation was that the film is a volatile driven off the absorber paint by heat created by the soldering process during installation. This was based on the fact that the most visible filming occurs in the lower left corner near the supply connection. A record was made of the filming for future comparison to determine if the filming changes.

The manufacturer agreed to furnish four (4) new collectors. The new collectors to replace four (4) example collectors with the greatest amount of filming. The collectors were returned to the manufacturer for further analysis.

The manufacturer also agreed to replace four (4) defective collectors. The defect being a seal failure between the glass covers.

Replacements for the collectors damaged during the repair process were also ordered at this time. All collectors were delivered and installed in October, 1978.

Testing of the siphon drain down system was performed in early November, 1978. This was facilitated by the installation of sight glasses at strategic locations. The sight glasses allow observation of what takes place inside the piping. The following observations were made:

- The system drains completely when the drain down is initiated.

- The drain down begins as a siphon action, but as soon as the air reaches the high points in the system, the water returns by gravity.

Re-testing of the hydronic balancing was performed at this time also. This information is included with the Acceptance Test Plan included in this report.

DESIGN CHANGES

During the course of construction, operation, freeze-up, repairs, etc. several unanticipated problems developed. The solution to these problems resulted in changes to the original design. The following is a description of the problems and solution:

Control Modifications

Observation of the solar system in operation revealed that the controls were not performing satisfactorily. The Solar Collection Pump P3 was short cycling and starting at inconsistant times.

The controls were modified to insure positive start-up and shut-down which is critical to a drain down system. The modification included the addition of a latching relay and another time delay relay. On a call to start, the Solar Collection Pump P3 remains on for a minimum of fifteen (15) minutes. When no solar energy is available, P3 is turned off and will remain off for a minimum time period of fifteen (15) minutes. This insures complete system fill up on Start and complete system drain down on Stop.

Observation of the solar system in operation also revealed that there was unwanted thermal exchange between the day tank and the storage tank. This occurs when the 5,000 gallon storage tank is cool (70°F) and the day tank is hot (120°F - 130°F).

The objective of the smaller day tank is to provide usable hot water in a short period of time. The thermal exchange was limiting the temperature increase in the day tank by transferring warm water to the storage tank. The day tank temperature would not increase sufficiently for heating use.

To stop the thermal exchange control wiring of two automatic N.O. valves were modified. The N.O. valves are located in the transfer pipe connection between the day tank and the storage tank. The automatic valves, Pumps P4 and P7, check valves and piping function to provide two direction energy transfer between the day tank and the storage tank. Prior to the wiring change there was an open path between the two tanks. The wiring change eliminated the open path by holding the automatic valves closed until needed for directing energy transfer.

DESIGN CHANGES (CONT'D)

Air Circulation

During operation of the Solar Collection Pump P3 it was observed that air was continuously recirculating between the top of the expansion tank and the day tank. The design of a drain down system requires an air connection and an air trap from the top of the expansion tanks to the return line from the collectors. The air connection initiates the drain down and the air trap facilitates air exchange during start-up.

The continuously circulating air was found to be caused by suction pressure in the return line. The suction pressure induced air flow from the expansion tanks into the return line. The air would then travel into the day tank and bubble up to the expansion tanks.

There are two side effects caused by this problem. One, the bubbling between the day tank and the expansion tank tended to keep the water in the expansion tanks hot. And two, the bubbling continuously aerated the water in the system.

This problem was resolved by adding a check valve and a solenoid valve in the circuits between the expansion tanks and the collector return line. The N.O. solenoid was wired in parallel to Pump P3 to stop air circulation when the pump is on. The check valve provides one direction flow of air through the air trap.

Air Leaks

Considerable time and effort has been spent to make the complete system air tight. Due to the nature of a pressurized drain down system of this size, it is difficult to make all joints, fittings, valves, etc. completely free of air leaks. Precautions were taken during the design and installation phase of the project to minimize the air leakage. The persistance of the problem required that an air compressor be provided to maintain the minimum system pressure.

The original proposal included a nitrogen charge to replace the air in the system. The purpose of the nitrogen is to minimize corrosion of metal surfaces that would normally be in contact with some oxygen.

The use of an air compressor to maintain system pressures prevents the use of a nitrogen charge. In the event that system pressure is stabilized at some future date, the nitrogen charge will be implemented.

ACCEPTANCE TEST PLAN

The Acceptance Test Plan is presented in detail in this section. Included in this section is the Test Report.

The hydronic systems were tested under simulated normal operating conditions, i.e. all primary and secondary pumps were functioning properly and all valves were positioned for full flow.

The flow generated by each pump was determined by establishing shut-off head and thereby identifying the actual operating curve. This flow was corroborated with what was measured with the flow indicators where applicable.

Flow measurements were made and necessary throttling for balance was accomplished with circuit setters or balance valves.

General Work

Set and adjust all flow rates within plus or minum 10% of specified values. After achieving proper distribution to all hydronic components, mark position of valves. Set memory rings where applicable.

Report to the Control Contractor any control malfunctions uncovered during the course of testing.

Test Report

The Test Report includes but is not necessarily limited to the following general items:

Design Conditions:

- Water flow rates
- Pump TDH and speed
- Motor horsepowers and brake horsepowers

Installed Equipment:

- Equipment Manufacturer
- Equipment model numbers, sizes, types, etc.
- Motor types, sizes and characteristics
- Equipment ratings if different than design

Field Test Data:

Initial and Final Test Readings for:

- Pump pressures at full flow and at shut-off
- Pump motor operating voltages and amperes at full flow
- Flow rates through all flow indicators

ACCEPTANCE TEST PLAN (CONT'D)

Test Procedures

Check all automatic valves for proper positions.

Verify pumps' performance by means of system flow meter and pump head measurements.

Balance system components in all modes of operation normally experienced by the system.

Begin with maximum heating operation and proportionally set all balancing devices for design flow.

Recheck flows in all modes of operation.

Remeasure pump delivery after system is balanced.

Record equipment pressure and temperature drops, where applicable.

Systems' Shake Down

Simulate necessary conditions to verify proper operation of all pertinent automatic controls.

Check operation of equipment interlocks, pump sequencing, temperature reset, temperature and pressure readouts, mode switches and pressure control.

Determine points of best temperature representation in thermowells of storage tanks.

Coordinate test efforts with Control Contractor.

Equipment Used

Voltage and ampere readings were made with an Amprobe Model RS-3 Instrument.

Hydronic flow rates were measured utilizing Bell & Gossett Circuit Setters and/or Ellison Annubar Type 730 Insertion Elements. Hydronic flow rates were measured with a Bell & Gossett Circuit Setter Meter and/or a Ellison Eagle Eye Flow Meter.

ACCEPTANCE TEST PLAN (CONT'D)

Results

Test results are reported in the following data sheets. The hydronic systems and control systems appear to be performing satisfactorily at last check.

FAIRBROTHER & GUNTHER, INC. THE ENVIRONMENTAL ENGINEERS GRAND RAPIDS, MICHIGAN	HYDRONIC BALANCE DATA SHEET	
SYSTEM: JORDAN COLLEGE SOLAR	TEST DATE: 12/13/77 & 11/1/78	PAGE: 1 of 4

SPECIFIED DATA			TEST DATA							
I. D. NO.	CIRCUIT/BRIDGE DESCRIPTION	REQ'D GPM	INITIAL GPM		No. 1 CHANGE GPM		No. 2 CHANGE GPM		FINAL GPM	
SIZE		P. D.	P. D.	VALVE POSITION	P. D.	VALVE POSITION	P. D.	VALVE POSITION	P. D.	VALVE POSITION
1	Circuit Setter	6	8		6.0		6.1		6.1	
1"			4.5'	0°	5.75'	12°	7.5'	15°	7.5'	15°
2	Circuit Setter	6	7.3		6.3		6.1		6.1	
1"			3.75	0°	5.75'	11°	7'	14°	7.0'	14°
3	Circuit Setter	6			6.0		6.0		6.0	
1"			3.3	0°	4.25'	8°	4.8'	10°	4.8'	10°
4	Circuit Setter	6	6.7		6.1		6.1		6.1	
1"			3.1	0°	3.5'	5°	4'	7°	4.0'	7°
5	Circuit Setter	6	6.3		6.1		6.1		6.1	
1"			3.75	0°	3.0'	2°	3.4'	4°	3.4'	4°
6	Circuit Setter	6	6.3		6.0		6		6.0	
1"			2.75	0°	2.75'	1°	3'	3°	3'	3°
7	Circuit Setter	6					6		6.0	
1"				0°		0°	2.6'	0°	2.6'	0°
8	Circuit Setter	6					5.8		5.8	
1"				0°		0°	2.3'	0°	2.3'	0°

FAIRBROTHER & GUNTHER, INC. THE ENVIRONMENTAL ENGINEERS GRAND RAPIDS, MICHIGAN	CIRCULATING PUMP DATA SHEET	
SYSTEM: JORDAN COLLEGE SOLAR	TEST DATE: 12/13/77 & 11/1/78	PAGE: 2 of 4

UNIT NO.	P1 (Exist.)	P2	P3
LOCATION	Exist. Boiler Room	Solar Room	Solar Room
AREA SERVED	Exist. Bld. Rad.	Dom. Water Preheat	Collector Circuit
MANUFACTURER	B & G	B & G	B & G
MODEL NO.	2" 189101 GN 2" Pipe	B & G Series 100 BNFI 1-1/2" Pipe	60 Series 2" 19T 172552 2-1/2" Pipe

PUMP DATA	DESIGN	INITIAL TEST	FINAL TEST	DESIGN	INITIAL TEST	FINAL TEST	DESIGN	INITIAL TEST	FINAL TEST
TOTAL GPM		1.8" 23	1.8" 23	12	0.6 7.5	0.5" 6.8	48	7.5" 67	4.5" 52
T. D. H.				7'			32'		
PRES. DIFF. (P. S. I.)		8'	8'		8'	7.8'		30'	33'
SUCT. PRES. (P. S. I.)		28'	28'		30	64'		35'	36'
DISCH. PRES. (P.S.I.)		36'	36'		38'	74'		65'	69'
SUCT. TEMP.									
SHUT-OFF HD.		37'	37'		38'	38'		38'	38'
DISCH. VALVE SETTING									
						System 30 PSI			

MOTOR DATA	RATED	INITIAL TEST	FINAL TEST	RATED	INITIAL TEST	FINAL TEST	RATED	INITIAL TEST	FINAL TEST
H. P.	1/6			1/12			1		
(1) V./PHASE	115-1ø			115-1Ø			230/115-1Ø		
(2) V./PHASE									
(3) V./PHASE									
(1) AMPERAGE	3.3		3.0	1.7 FLA		1.5	6.5/13.0		11.3
(2) AMPERAGE							FLA		
(3) AMPERAGE									
MOTOR MFG.	B & G			B & G			Century		
SERV. FACTOR	-			-			1.25		
MOTOR RPM	1725			1725			1725		
HTR. SIZE									
NO. HTRS.									

FAIRBROTHER & GUNTHER, INC. THE ENVIRONMENTAL ENGINEERS GRAND RAPIDS, MICHIGAN	CIRCULATING PUMP DATA SHEET 11/1/78
SYSTEM:	TEST DATE: 12/13/77 & PAGE: 3 of 4

UNIT NO.	P-4			P-5			P-6		
LOCATION	Solar Equipment Rm.			Boiler Room			Solar Equipment Rm.		
AREA SERVED	Transfer Energy to Storage Tank			Aux. Energy Supply to System			Solar Supply Circuit		
MANUFACTURER	B & G			B & G			B & G		
MODEL NO.	2" Series 102214 EU 2" Pipe			2" Series 102214 BU 2" Pipe			2" Series 102214 BU 2" Pipe		
PUMP DATA	DESIGN	INITIAL TEST	FINAL TEST	DESIGN	INITIAL TEST	FINAL TEST	DESIGN	INITIAL TEST	FINAL TEST
TOTAL GPM	40	5.6" 40	4.3" 36	20	7.0" 44	1.5" 21	20	6.3" 42	1.5" 21
T.D.H.	8'			10'			10'		
PRES. DIFF. (P.S.I.)		10'	8'		8'	11'		8'	11'
SUCT. PRES. (P.S.I.)		30	48'		23'	27'		20'	24'
DISCH. PRES. (P.S.I.)		40'	54'		31'	38'		28'	35'
SUCT. TEMP.									
SHUT-OFF HD.		42'	42'		40'	40'		38'	37'
DISCH. VALVE SETTING									
			System 21 PSI Air						
MOTOR DATA	RATED	INITIAL TEST	FINAL TEST	RATED	INITIAL TEST	FINAL TEST	RATED	INITIAL TEST	FINAL TEST
H.P.	1/6			1/6			1/6		
(1) V./PHASE	115-1ø			115-1ø			115-1ø		
(2) V./PHASE									
(3) V./PHASE									
(1) AMPERAGE	3.2		3.4			3.0	3.2		3.2
(2) AMPERAGE									
(3) AMPERAGE									
MOTOR MFG.	B & G			B & G			B & G		
SERV. FACTOR	--			--			--		
MOTOR RPM	1725			1725			1725		
HTR. SIZE									
NO. HTRS.									

FAIRBROTHER & GUNTHER, INC. THE ENVIRONMENTAL ENGINEERS GRAND RAPIDS, MICHIGAN	CIRCULATING PUMP DATA SHEET	
SYSTEM:	TEST DATE: 11/1/78	PAGE: 4 of 4

UNIT NO.	P-7								
LOCATION	Solar Equipment Rm.								
AREA SERVED	Transfer Energy from Storage Tank								
MANUFACTURER	B & G								
MODEL NO.	102 - 214 B.U. 2"								
PUMP DATA	DESIGN	INITIAL TEST	FINAL TEST	DESIGN	INITIAL TEST	FINAL TEST	DESIGN	INITIAL TEST	FINAL TEST
TOTAL GPM	40 GPM	4.4/2" 36 GPM	36 GPM						
T. D. H.	8'		8'						
PRES. DIFF. (P. S. I.)		8'	8'						
SUCT. PRES. (P. S. I.)		33'	52'						
DISCH. PRES. (P. S. I.)		41'	60'						
SUCT. TEMP.			148°F						
SHUT-OFF HD.		44'	44'						
DISCH. VALVE SETTING			0°						
			System 21 PSI Air						
MOTOR DATA	RATED	INITIAL TEST	FINAL TEST	RATED	INITIAL TEST	FINAL TEST	RATED	INITIAL TEST	FINAL TEST
H. P.									
(1) V./PHASE	115-1ø		115-1ø						
(2) V./PHASE									
(3) V./PHASE									
(1) AMPERAGE	3.2		3.2						
(2) AMPERAGE									
(3) AMPERAGE									
MOTOR MFG.	B & G								
SERV. FACTOR	--								
MOTOR RPM	1725								
HTR. SIZE									
NO. HTRS.									

ACCEPTANCE TEST PLAN (CONT'D)

DIFFERENTIAL TEMPERATURE CONTROLS

DATA SHEET

	DESIGN		MEASURED	
I.D.	ON AT	OFF AT	ON AT	OFF AT
DT-1	10°F	2°F	10°F	2°F
DT-2	10°	3°	10°	3°
DT-3	20°	2°	20°	2°
DT-4	5°	2°	5°	2°
DT-5	5°	2°	5°	2°
DT-6	20°	4°	20°	4°

The above measurements were made with a Honeywell Sensor Simulator. (At this date the simulator is not commercially available, but was provided by Honeywell to test the differential temperature controllers).

CONCLUSIONS AND RECOMMENDATIONS

The installed solar system is in the middle of its second winter season. During the first winter season the solar system was not operational from December 26, 1977 to May, 1978. The inoperation was due to a major system freeze-up. From May, 1978 through September, 1978 the solar system provided domestic hot water preheating. From October, 1978 to the present the solar system has periodically provided space heating energy.

Consistant use of the solar system for space heating has been limited by several factors. Persistant system pressure loss has required that the solar system be isolated from the space heating system. Periodic collector freeze-ups have compounded the system pressure losses. Thermal circulation between the day tank and the storage tank has minimized the temperature increases of the day tanks during periods of limited sunshine.

To date, minimal system performance data is available. Historical data will be generated for future analysis as consistant stable operation is maintained.

The original project proposal stated that analysis would be made to determine percentage of solar contribution to the building loads. The basis of the analysis was to be past consumption of energy. This will not be a valid approach due to changes in building use. Past building use was a dormitory for fifteen (15) to twenty (20) women. Present building use is a dormitory for forty-two (42) men and conferences for four hundred (400) to five hundred (500) people per month.

It is therefore recommended that provisions for devices to measure energy yields and distribution be included in future projects. The devices should measure the solar energy collected and measure the total energy input to the building. This would provide valid data for the analysis of solar contribution to building loads.

Solar system visibility has been very successful. The College has initiated and conducted many guided tours for interested parties. Solar seminars and an annual open house have brought solar energy to many people. Work study opportunities have been made available to campus and off campus students.

CONCLUSIONS AND RECOMMENDATIONS (CONT'D)

This project has demonstrated that solar systems need not be exotic. All components are commercially available over-the-counter items. An exception to that would be the storage tank, the day tank and the condensate trap which were shop fabricated items. Smaller scale systems would would be able to use commercially available tanks. The condensate trap is experimental.

Future demonstration projects should have provision for funds over and above the initial grant amount. These funds should be made available to make system changes from the original design. The changes would be based upon experience gained from operating a solar system or solar industry technological changes applicable to an installed system. Funds should also be available for system experimentation aimed at improving performance and/or operation.

Thermographic instruments should be made available to analyze collector performance. Liquid collector arrays can have inconsistant efficiencies due to flow imbalance. Thermography can be used to detect the inconsistancy so that liquid flow problems can be corrected. Balanced fluid flows will optimize system efficiency.

Experience gained through system operation indicates that under certain conditions collector shading may cause liquid freeze-ups. Further study and testing is required to analyze the effect that shading has on collectors. This study should consider such variables as ambient temperature, wind, fluid flow, fluid temperature, amount of collector shaded, etc.

A study should be made of the effectiveness of the condensate trap. The condensate trap (See Appendix A) is a new idea for drain down systems. Such a device does not presently exist in the market place and no data exists as to its performance capabilities or usefulness.

CONDENSATE
TRAP

APPENDIX A

Condensate Trap

Preliminary design considerations considered the need for removal of water vapor from within the system. In the drained down mode water vapor and moisture laden air from the top of the warm water surfaces in the expansion tanks and pipe water lines will migrate to the cold pipe surfaces of the exposed piping and collectors. The driving potential for the migration is the vapor pressure difference and total pressure differences created between the warm areas and the cool areas within the system. When freezing weather conditions exist, the water vapor condenses, freezes and could accumulate sufficiently to block and rupture water passages.

Design solutions included complicated valving systems, a refrigerated air dryer, thermal traps and a passive condensate trap at the roof line. In order to keep the drain down system as uncomplicated as possible it was decided to use a condensate trap of our own design in conjunction with thermal traps. Refer to the attached Detail D-1.

The condensate trap provides a condensing surface to stop the moisture migration at the roof line. A section of exposed pipe passively cools an expanded section in the return line from the collectors. The condensed liquid drains down into the system.

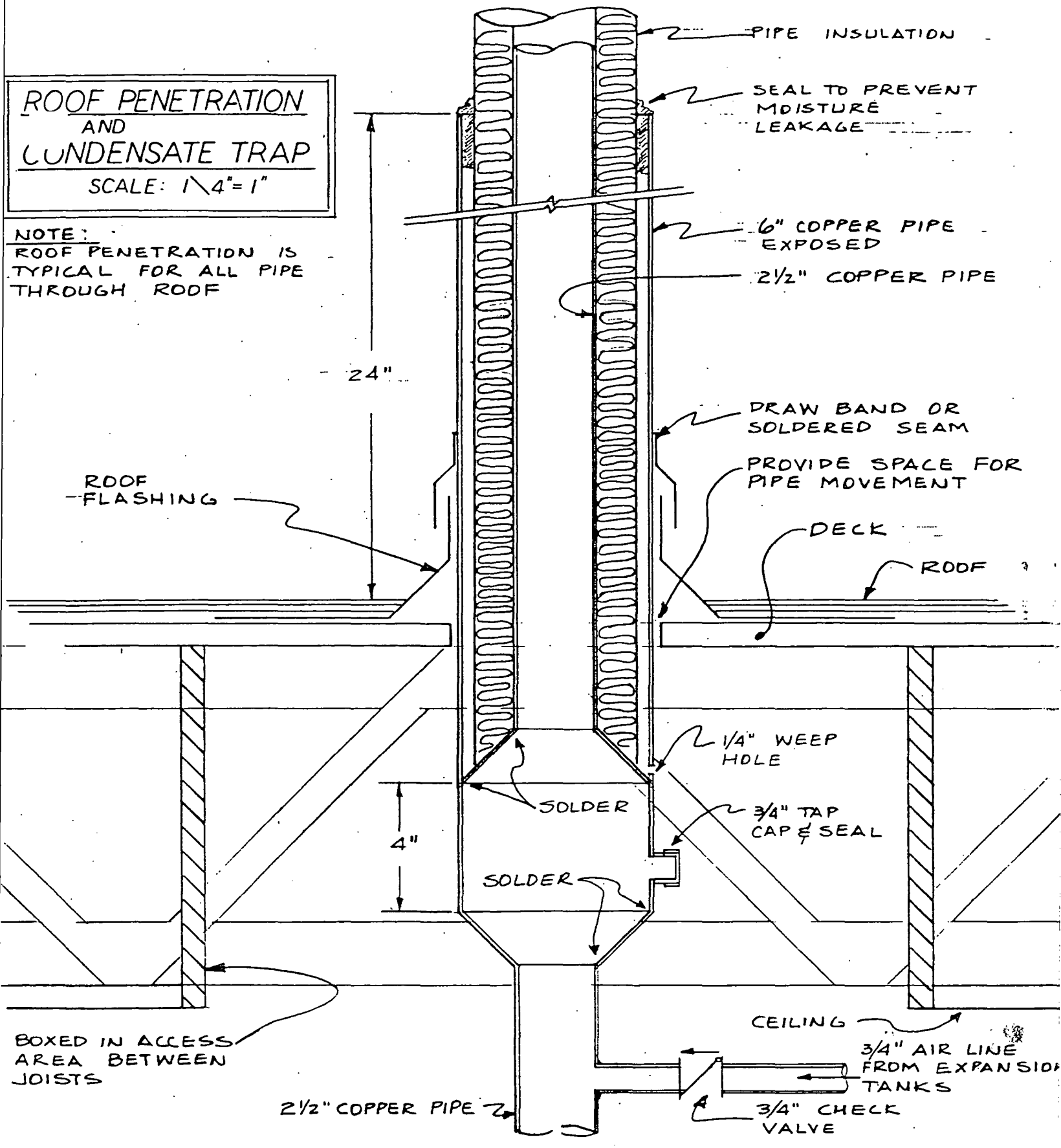
In connection with the condensate trap, thermal traps were utilized. The thermal traps are installed above the water line in the collector supply and return lines and between the day tank and the expansion tank. The purpose of the thermal trap is to minimize the temperature difference (driving potential) between the collectors and the water surfaces exposed to the collectors.

The condensate trap is a new idea for drain down systems. Testing is required to determine the effectiveness of such a device. Testing is also required to identify the effects of moisture migration in drain down systems.

ROOF PENETRATION AND CONDENSATE TRAP

SCALE: 1\4"= 1"

NOTE:
ROOF PENETRATION IS TYPICAL FOR ALL PIPE THROUGH ROOF



FAIRBROTHER & GUNTHER, INC.

THE ENVIRONMENTAL ENGINEERS

325 FULLER N E GRAND RAPIDS MICHIGAN 49503

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STRUCTURAL ANALYSIS

APPENDIX B

STRUCTURAL ANALYSIS

PREIN & NEWHOF
ENGINEERS - PLANNERS
3000 EAST BELT LINE AVE., N.E. GRAND RAPIDS, MICHIGAN 49505 PHONE (616) 364-8491

H. EDWARD PREIN P.E., R.L.S
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DENNIS P. LARKIN P.C.P.
WILSON D. McQUEEN P.E.
MICHAEL S. BERGSTROM P.E.
LARRY D. WILSON P.E.
DAVID P. SHERMAN P.E.
LAWRENCE J. DOYLE P.E.
MICHAEL S. FULLER P.E.
PHILIP C. GLUPKER P.E.
BURT WICKHAM JR. R.L.S.

December 21, 1977
77178

Fairbrother & Gunther
325 Fuller Avenue, NE
Grand Rapids, Michigan 49505

Attention: Kenneth Gunther, P.E.

Re: Solar Collectors-Jordan College

Gentlemen:

At your request, we have investigated and analyzed the wood trusses supporting the roof of the women's dormitory at Jordan College in Cedar Springs, Michigan. The investigation was performed to determine if the roof trusses had sufficient capacity to support the additional loads which result from placing the eight solar collector units on the roof. This additional loading includes the dead load of the Solar Collectors and their supporting structure. Also, an increase in the snow loading was used in the analysis as the Solar Collectors may act as a snow fence resulting in a snow build-up on the roof.

The roof trusses were "job built" and consists of 2 X 6 top and bottom chords and 2 X 4 web members connected with one-half inch plywood gusset plates. It was assumed the gusset plate connections were both nailed and glued together.

The trusses were analyzed in two ways using the flowing loading and stresses:

Dead Load		
Roofing	2	lbs. per sq. ft.
Insulation	1-1/2	lbs. per sq. ft.
Deck	2	lbs. per sq. ft.
Ceiling	4	lbs. per sq. ft.
Mech. & Elect.	2	lbs. per sq. ft.
Trusses	2-1/2	lbs. per sq. ft.
TOTAL Dead Load	14	lbs. per sq. ft.
Snow Load with Build-Up	40	lbs. per sq. ft.
TOTAL Load	54	lbs. per sq. ft.

TOTAL Load Solar Collectors And Supports 23500#

The analyses were made based on the applicable methods and stresses recommended by the National Lumber Manufactures Association in their publication "National Design Specification For Stress Grade Lumber And Its Fastenings".

The trusses were first analyzed based on a 49-foot span assuming they were supported at each end by the exterior walls. This analysis indicated that under the total design load, four members would be loaded well beyond the stress at which failure would occur.

The trusses were then analyzed a second time based on a 21-foot span. This analysis assumed that the corridor walls were load bearing and would support the trusses at these intermediate points. The results of this analysis indicated that none of the truss members would be overstressed due to the design loads. The stud partition walls were also analyzed based upon the above assumptions and were found to have the capacity to support the truss loads imposed upon them.

It is our recommendation, from the analyses of this structure, that the corridor walls be used as bearing walls. This shortens the clear span of the trusses considerably and provides a structurally sound roof system.

If this recommendation is followed, all the roof trusses should be checked and shims installed, where required, to fill the gap between the top of both corridor walls and the bottom chords of the roof trusses.

Also, if the gusset plate connections were not glued, further nailing will be required. A nailing schedule will be provided if requested.

If you have any questions or need any further information, please contact me.

Very truly yours,

PREIN & NEWHOF

Wilson McQueen

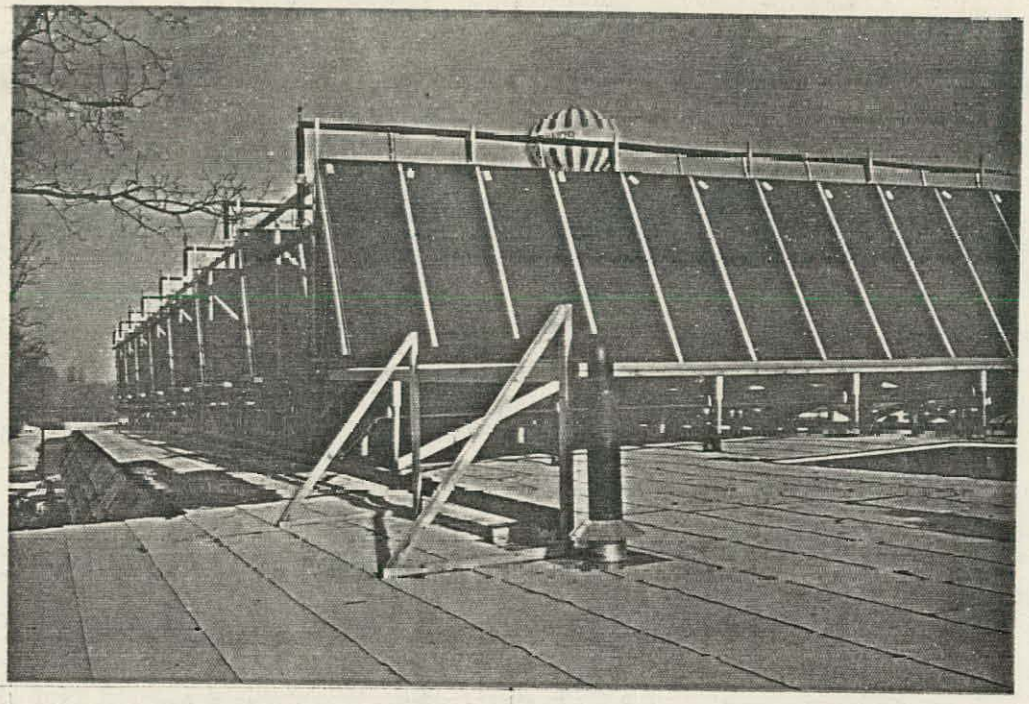
Wilson D. McQueen, P.E.

WDMQ:bk

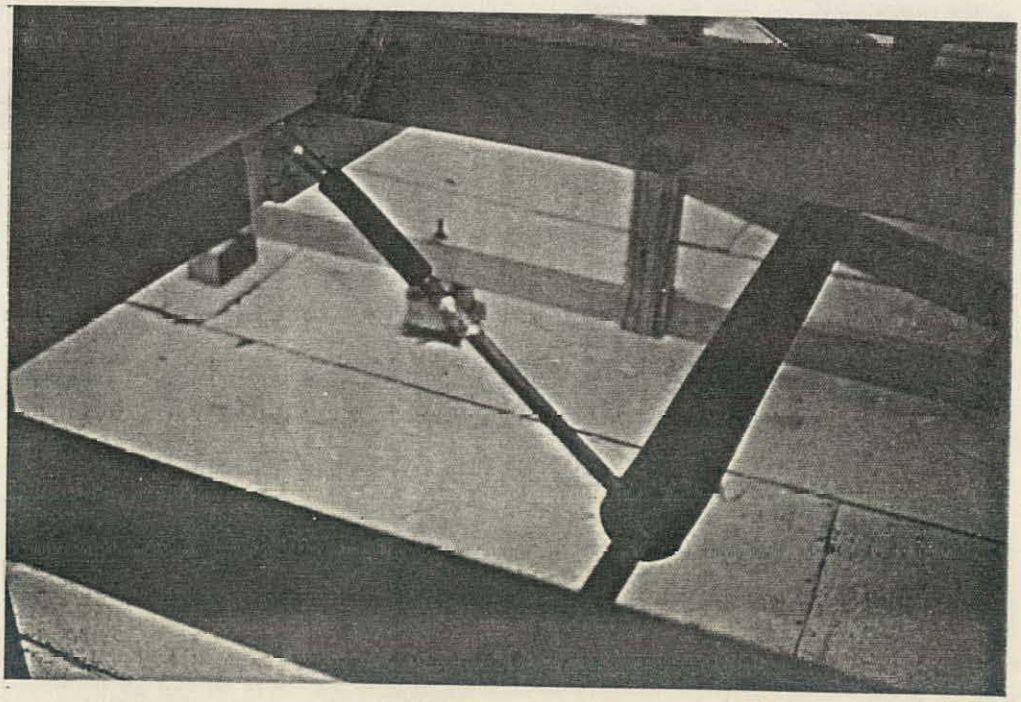
PICTURES OF
INSTALLATION

APPENDIX C

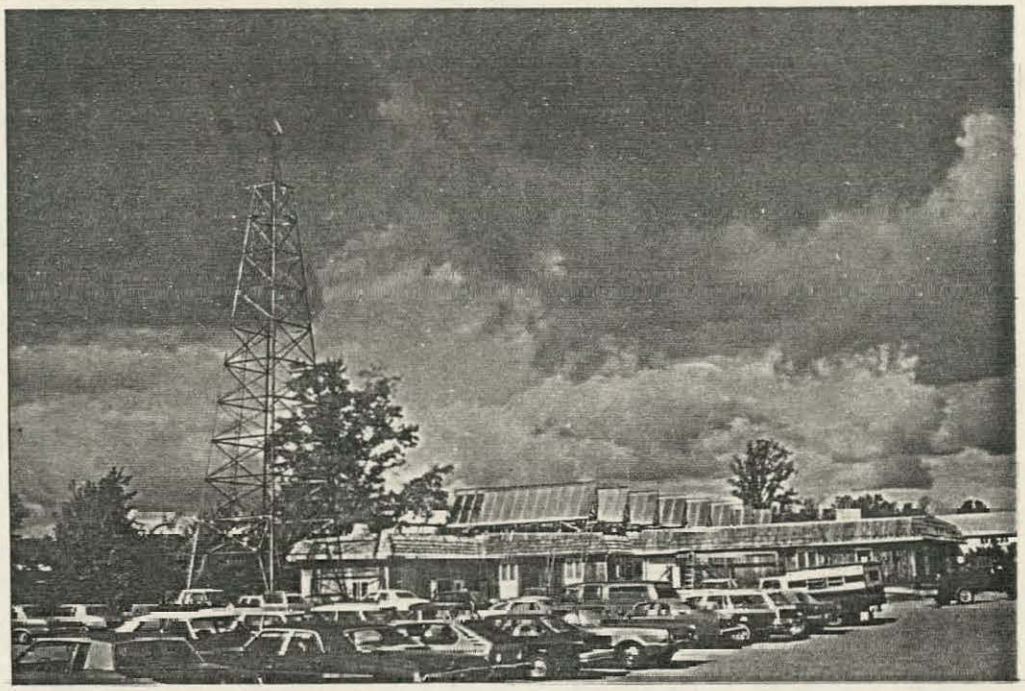
PICTURES OF THE INSTALLATION



VIEW OF COLLECTORS AND PIPING FROM ROOF

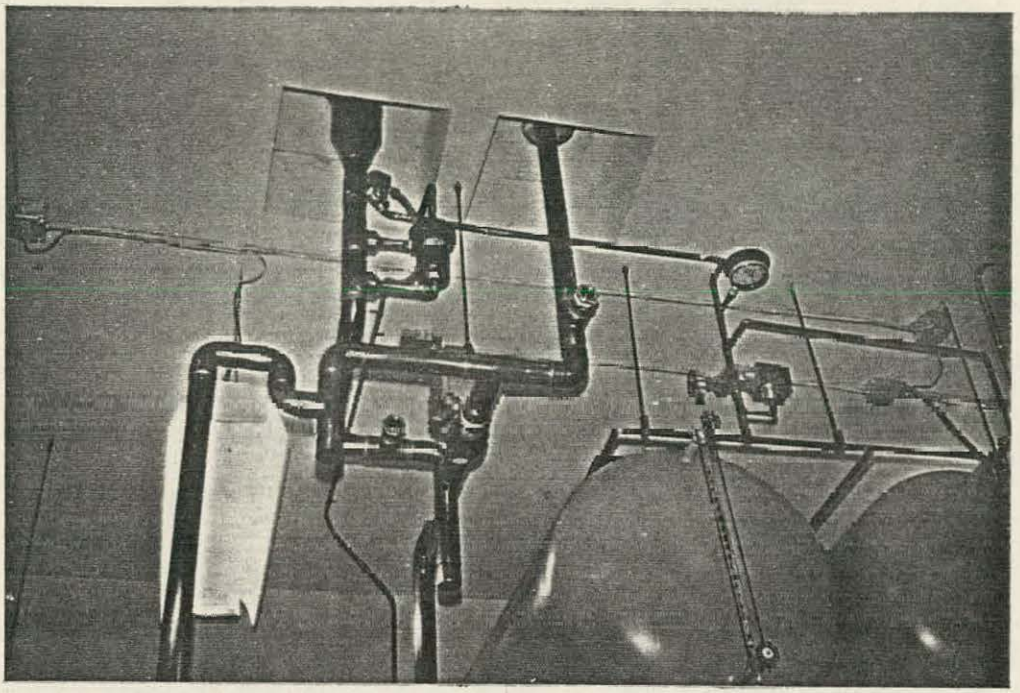


TYPICAL FLEXIBLE CONNECTOR

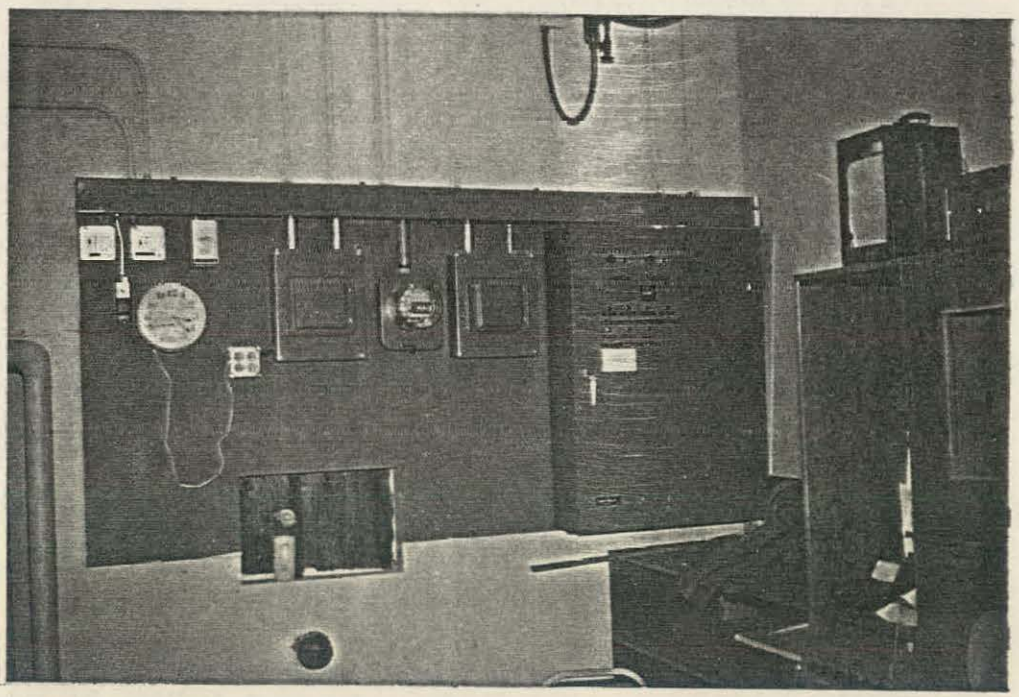


VIEW OF COLLECTORS FROM THE GROUND

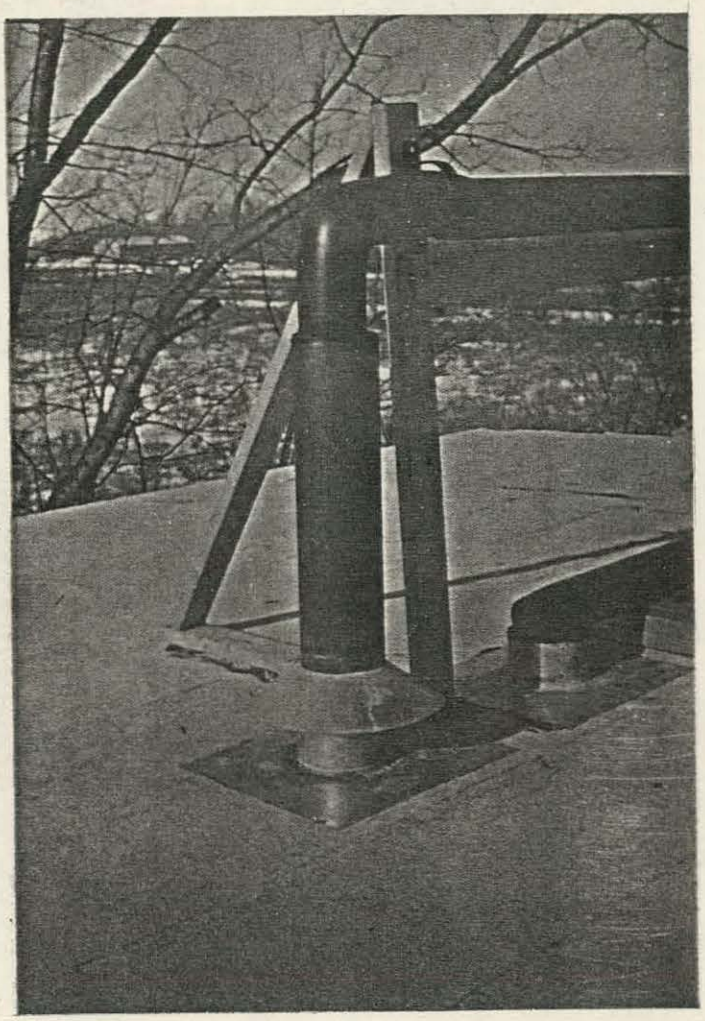
VIEW OF COLLECTORS FROM ADJACENT BUILDING



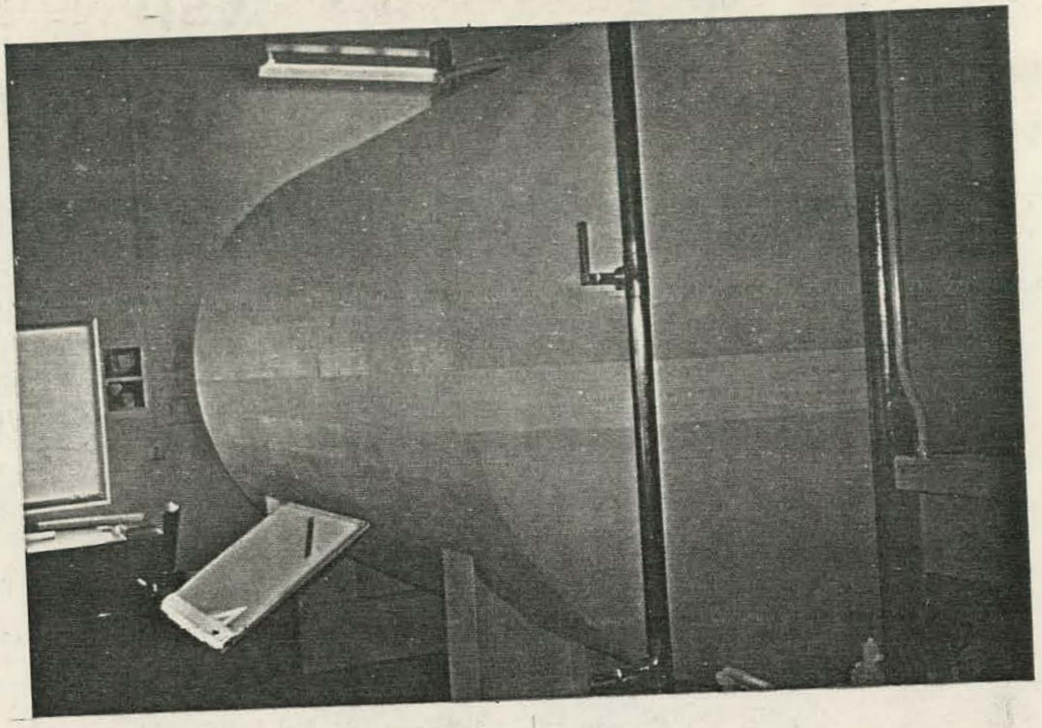
EXPANSION TANKS, PIPING AND ROOF PENETRATION



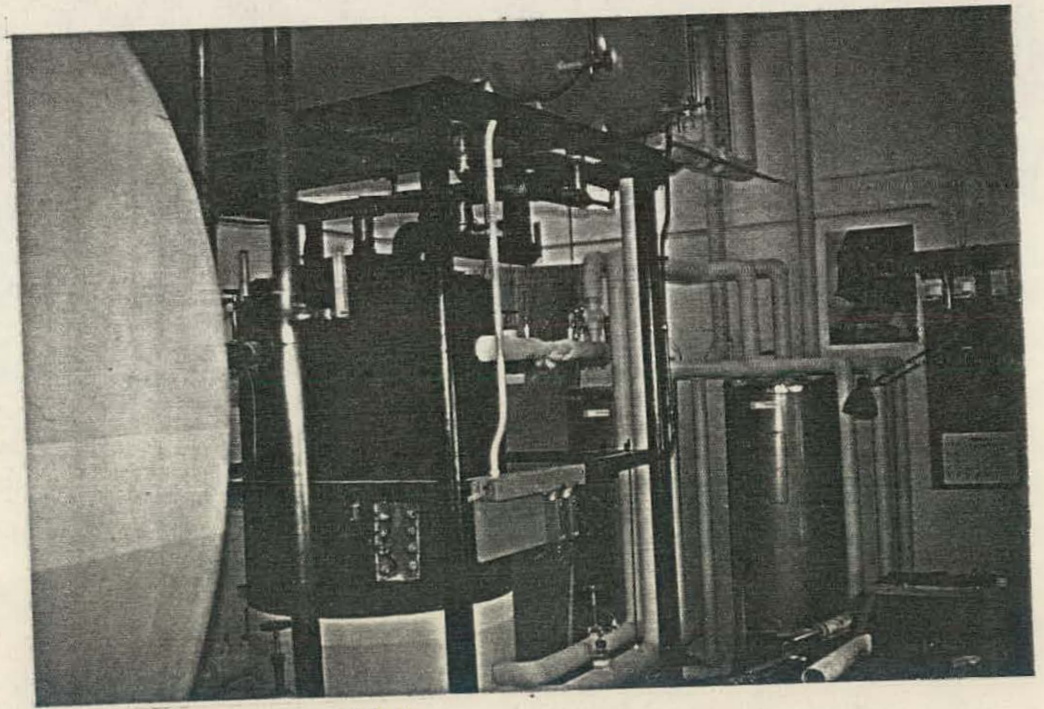
CONTROL PANEL



CONDENSATE TRAP



5,000 GALLON STORAGE TANK



300 GALLON DAY TANK

OPERATING
INSTRUCTIONS

APPENDIX D

OPERATING INSTRUCTIONS

JORDAN COLLEGE
MADISON HALL
OPERATING INSTRUCTIONS

INDEX

JORDAN COLLEGE
MADISON HALL
OPERATING INSTRUCTIONS

I. SOLAR SYSTEM GENERAL DESCRIPTION

The Solar System is a pressurized drain down type. Minimum system pressure is 14 PSIG. Maximum system pressure is 30 PSIG, as established by the boiler pressure relief valve.

Flat plate collectors absorb solar energy for heating demand use in hydronic baseboard fin tube radiation and domestic water preheat.

During periods when solar energy is not being collected, the solar collectors are drained of water. The drained volume of water is stored in the two (2) expansion tanks. Tank levels (with the solar pump off) will vary from 1/3 to 3/4 full. An equal volume of nitrogen is displaced and replaces the water in the collectors.

Nitrogen is utilized to inhibit corrosion of the steel tank surfaces.

During periods when solar energy is being collected, water is circulated through the collectors to the day tank. The result is a rise in temperature of the day tank. When the day tank temperature is sufficiently high, the hot water is distributed for use in heating the building and preheating the domestic hot water. Excess energy over and above the heating and domestic water demands is transferred to the storage tank for future utilization.

II. AUXILIARY ENERGY SYSTEM GENERAL DESCRIPTION

The Auxiliary Energy System for building heating is a natural gas fired hot water boiler. The make-up water line to the boiler is to remain closed. The hot water boiler is energized whenever solar energy is not available in either the day tank or the storage tank.

The Auxiliary Energy System for domestic hot water is a natural gas fired hot water heater. The gas fired hot water heater raises the temperature, if required, of the solar preheated domestic hot water to the final use temperature set by the water heater thermostat.

III. HEATING DISTRIBUTION

A circulating pump distributes the heating hot water to the baseboard fintube located throughout the building. The temperature of the hot water is controlled inversely proportional to the temperature outdoors.

Individual zones are controlled by a thermostat cycling a valve which regulates the amount of hot water distributed to that zone.

IV. SOLAR COLLECTORS

The Solar Collectors are manufactured by Pittsburgh Paint Glass Company. The Collectors consist of two (2) layers of heat treated glass, copper absorber plate with a flat black absorber coating, copper internal piping, high temperature fiberglass insulation, and a sheet metal enclosure. The glazing and absorber plate are manufactured as an integral unit.

The collectors are mounted on a wood truss system and raised a minimum of three feet above the roof surface. The collectors are raised to prevent accumulation of snow on the collector face.

There are eight (8) rows of 13 collectors for a total of 104 collectors. Each collector has a net absorber surface of 20 sq. ft., for a total of 2080 sq. ft. of net absorber surface.

The supply and return piping headers and branch headers are pitched for drainage back to the Solar Equipment Room. All piping is insulated with 1" of Armaflex expanded closed cell insulation.

Each collector bank is piped reverse return. The banks of collectors are piped in parallel.

V. STORAGE TANKS

A. 5,000 Gallon Storage Tank

The 5,000 Gallon Storage Tank is a horizontal steel tank manufactured to ASME Codes. Approximate tank dimensions are 8' diameter x 15' OAL. The tank consists of a manhole, a dip tube for temperature sensing and an internal baffle plate. The tank is mounted on two saddles which are supported by reinforced concrete piers.

The tank is insulated with 3" of fiberglass insulation.

B. Day Tank

The Day Tank is a 300 gallon vertical steel tank manufactured to ASME Codes. Approximate tank dimensions are 36" diameter x 7' OAL. The tank is constructed with 10 threaded taps for sensor locations, a dip tube and miscellaneous taps for pipe connections.

The Day Tank is insulated with 3" of fiberglass insulation.

V. STORAGE TANKS (CONT'D)

C. Expansion Tanks

The two (2) Expansion Tanks are each 270 gallon steel tanks manufactured to ASME Codes. Approximate tank dimensions are 30" diameter x 8' OAL. The Expansion Tanks are sized to accommodate thermal expansion of all the water in the entire system as well as the drain down volume from the collectors.

The Expansion Tanks are not insulated.

VI. CIRCULATING PUMPS

A. Pump P-1 - Main hot water circulating pump. Runs continuously when the outdoor temperature is below 60°F.

B. Pump P-2 - Transfers solar energy from the day tank to the domestic hot water preheat tanks.

C. Pump P-3 - Main solar circulating pump. Transfers solar energy from the collectors to the day tank.

D. Pump P-4 - Transfers excess energy from the day tank to the storage tank for future use.

E. Pump P-5 - Transfers auxiliary energy from the gas fired boiler to the hot water circulating system. P-5 operates with the boiler burner.

F. Pump P-6 - Transfers solar energy from the day tank to the hot water circulating system.

G. Pump P-7 - Transfers energy from the storage tank to the day tank.

VII. CONDENSATE TRAP

The Condensate Trap is a passive device to minimize vapor migration to the collectors during the drain down mode when the outdoor temperature is below freezing. The trap consists of an expanded copper pipe in the collector return line which is cooled by conduction of the cold outside temperature. The cooled surface condenses any vapors before they can travel to the collectors.

Thermal traps are used in conjunction with the condensate trap to minimize the driving force of the vapor migration.

VIII. UNIT HEATER

A Unit Heater provides heat in the Solar Equipment Room. The Unit Heater is supplied with hot water from the hot water circulating system. A room thermostat cycles the unit fan to maintain the desired space temperature. A strap-on thermostat de-energizes the Unit Heater when hot water is no longer supplied to the Unit Heater.

IX. EXHAUST FAN

An Exhaust Fan provides summer cooling and ventilation in the Solar Equipment Room. A room thermostat or manual control cycles the fan on a rise in space temperature.

X. START-UP SEQUENCE

With all switches on the control panel in the "AUTO" position, the Start-Up Sequence is completely automatic.

The sequence of automatic start-up is as follows:

> When the surface of the solar collector is 20°F higher than the day tank temperature, Pump P-3 is energized. Water is then drawn from the expansion tanks to fill the collectors and transfers solar energy to the day tank. When P-3 is energized, it will remain energized for an adjustable minimum time period of up to 15 minutes. Suggested minimum run time is 10 - 12 minutes.

Manual start-up can be accomplished by turning the switch for P-3 to "MANUAL". P-3 will then remain energized continuously.

XI. SHUT-DOWN SEQUENCE

With all switches on the control panel in the "AUTO" position, the Shut-Down Sequence is completely automatic.

The sequence of automatic shut-down is as follows:

> When the temperature of the collector return water to the day tank is less than 2°F different than the collector supply water from the day tank, P-3 is de-energized. When P-3 is de-energized, the water in the collector system drains down into the expansion tanks. P-3 will remain de-energized for an adjustable minimum time period of up to 15 minutes before it can be restarted. Suggested minimum "off" period is 10 - 12 minutes.

Manual shut-down can be accomplished by turning the switch for P-3 to "OFF". P-3 will then remain de-energized.

XII. OPERATING SEQUENCE

With all switches on the control panel in the "AUTO" position, the Operating Sequence is completely automatic.

When the outdoor temperature is below 60°F, main hot water circulating Pump P-1 runs continuously.

A dual bulb controller reset from the outdoor air temperature maintains the hot water supply temperature in an inverse ratio. If the day tank temperature is above the hot water supply temperature, Pump P-6 is energized to transfer solar energy into the hot water supply to satisfy the building heating demand. If the day tank temperature is less than the hot water supply temperature, the auxiliary boiler and Pump P-5 are energized to transfer auxiliary energy into the hot water supply to satisfy the building heating demand.

When the outdoor temperature is below 20°F and when the day tank temperature exceeds the hot water supply temperature by 20°F and when the solar collectors are operating, Pump P-4 is energized to transfer solar energy from the day tank to the storage tank for future use. When the outdoor temperature is above 20°F, the day tank maximum temperature is limited to 150°F, at which point Pump P-4 is energized to transfer solar energy from the day tank to the storage tank.

When the storage tank temperature is above the day tank temperature and when the solar collectors are not operating, Pump P-7 is energized to transfer solar energy from the storage tank to the day tank.

When the day tank temperature is greater than the domestic water preheat storage tank temperature, Pump P-2 is energized to transfer solar energy from the day tank to the domestic water preheat tanks.

A seven day program clock located in the control panel indexes the heating system to the "night" cycle. The night thermostat located in the corridor of the Dormitory Area over-rides the controls to maintain the desired night setback temperature.

Automatic alarms and limits are as follows:

A. A high limit thermostat de-energizes the solar collection system when the day tank temperature exceeds 220°F.

B. A high water alarm turns "on" an audible alarm as well as a visual rotating beacon located above the collectors whenever the expansion tanks are completely flooded. The audible alarm can be silenced, but the visual alarm will remain "on" until the problem is rectified.

XII. OPERATING SEQUENCE (CONT'D)

C. A low pressure alarm causes the same alarm functions to activate as the high water alarm, when system pressure drops below the minimum level.

D. A high limit thermostat de-energizes Pump P-2 when the domestic hot water preheat tanks exceed 180°F.

E. A low water cutoff located on the Boiler prevents the burner from operating upon a loss of water in the Boiler.

All control functions can be manually operated at the control panel by placing selected pump switches in the "on" position.

In a "heating emergency", place Pumps P-1 and P-5 in the "on" position. This will energize the auxiliary boiler and circulate hot water to the building. If the boiler fails to operate, check the pilot, gas supply valve, fuses, limits, etc. If the boiler still fails to operate, contact a heating contractor.

APPENDIX

SOLAR SYSTEM OPERATION - DAILY LOG

JORDAN COLLEGE
MADISON HALL SOLAR SYSTEM
CEDAR SPRINGS, MICHIGAN

$$*\%Eff. = \frac{GPM \times 500 \times DT}{I \times Ft^2} \times 100 = \frac{48 \times 500 \times DT}{I \times 2080} \times 100 = 1153.8 \times \frac{DT}{I}$$

Prepared by: Fairbrother & Gunther, Inc.
Grand Rapids, Michigan

Day	Date	Time	Solar Pump P-3 On/Off	Solar Pump P-3 Run Time	Total Hours	Water Level	System Press.	Storage Tank Temp. °F	T OA °F	DT Collector T In °F	DT Collector T Out °F	Insolation I	* System % Eff.	Remarks

JORDAN COLLEGE
MADISON HALL SOLAR SYSTEM
CEDAR SPRINGS, MICHIGAN

Prepared by: Fairbrother & Gunther, Inc.
Grand Rapids, Michigan

FOSIL FUEL CONSUMPTION

(Log Data on first day of each Month)

Day	Date	Time	Storage Tank Temp °F	Solar Pump P-3		Purchased Energy to Operate Solar System		Purchased Energy to Operate Auxiliary System			
				Run Time	Total Hours	Elec Meter	Consumed KWH	Gas Meter #1	Gas Meter #2	Diff.	Consumed FT^3

SYSTEM EVALUATION

JORDAN COLLEGE
MADISON HALL SOLAR SYSTEM
CEDAR SPRINGS, MICHIGAN

Prepared by: Fairbrother & Gunther, Inc.
Grand Rapids, Michigan

		JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
Estimated Domestic Hot Water Energy Req'd. (BTU x 10^6)	1	7.5	7.5	7.5	7.5	7.5	3.9	3.9	3.9	7.5	7.5	7.5	7.5
Estimated Heating Energy Req'd (BTU x 10^6)	2	89.4	78.2	68.2	38.3	18.6	3.0	--	--	7.9	28.2	54.4	80.4
Total Estimated Energy Req'd. (BTU x 10^6) 1 + 2	3	96.9	85.7	75.7	45.8	26.1	6.9	3.9	3.9	15.4	35.7	61.9	87.9
Average Degree Days	4	1296	1134	989	555	270	44	0	0	114	409	789	1166
Estimated Solar Contribution (BTU x 10^6)	5	10.6	15.9	20.4	20.1	19.3	21.4	25.4	29.0	27.7	24.1	10.5	6.5
Estimated % Solar $\frac{5}{3}$ x 100	6	11	19	17	44	74	100	100	100	100	68	17	07
Actual Degree Days	7												
Adjusted Heating Energy Req'd. (BTU x 10^6) $\frac{7}{4} \times 2$	8												
Actual Heating & Domestic H.W. Energy Used (BTU x 10^6) $FT^3 \times \frac{1000}{10^6}$	9												
Energy Saved (BTU x 10^6) 1 + 8 − 9	10												
Actual % Solar $\frac{10}{1+8}$ x 100	11												

MAINTENANCE INSTRUCTIONS

APPENDIX E

MAINTENANCE INSTRUCTIONS

JORDAN COLLEGE
MADISON HALL
MAINTENANCE INSTRUCTIONS

INDEX

JORDAN COLLEGE
MADISON HALL
MAINTENANCE INSTRUCTIONS

I. INTRODUCTION

Good maintenance is a specific science dependent on the quality of personnel involved. Millions of dollars are wasted, equipment life varies from 40% of "equipment life" at "no maintenance" to 100% of "equipment life" at "regular maintenance".

The following pages are suggested as a practical guide to good maintenance. All situations could not be covered and each Owner must determine what is economical for his particular situation and personnel capabilities.

If special equipment and material is involved or should questions arise concerning recommended procedures or materials; refer to the "Operating and Maintenance Manual" for specific equipment (supplied under separate cover).

II. IMPORTANT FACTORS FOR EFFICIENT, SAFE AND TROUBLE FREE SYSTEMS

A. Scheduled Routine Check of Safety Devices.

B. Clean Heating Surfaces (Inside and Out).

C. Elimination of All Leaks.

D. Water Treatment.

E. Keep All Hot Pipes Insulated.

F. Programmed Lubrication.

G. Accurate Record Keeping, Reporting and Analysis.

III. CIRCULATING PUMPS

A. QUARTERLY

Pump bearing assembly should be oiled with 20W non-detergent oil, such as Shell Turbo #33 or equal.

B. SEMI-ANNUALLY

Lubricate motor with 5 to 6 drops Shell Turbo #33, 20W non-detergent oil.

C. ANNUALLY

1. Check motor to pump coupling for alignment, wear, tightness to shafts.
2. Measure and record pump discharge and suction pressures. "See Hydronic Report for Original Set Pressures". Note differences.
3. Check mechanical seals for leaks. Replace as necessary.
4. Check motor and pump mountings. Tighten.
5. Inspect and open and close all shut-off valves to assure free operation. Reset to balanced position. Check valve "memory" setting for tightness.
6. Clean motor blower with a vacuum.
7. Clean, remove rust and paint as needed.

IV. UNIT HEATERS

A. SEMI-ANNUALLY

Lubricate motors with 2 - 3 drops of Shell #33 20W non-detergent oil.

IV. UNIT HEATERS (CONT'D)

B. ANNUALLY

1. Inspect and clean housing and fan.
2. With a soft brush and vacuum cleaner, clean inlet air surface of coil.
3. Check and make sure all air vents are operational and all air is bled from system at start of each heating system.
4. Open and close shut-off valves to assure free movement. (Make sure balancing valves are reset to balanced position).

V. ISOLATION AND CONTROL VALVES

ANNUAL HEATING SEASON START-UP

1. All valves should be opened and shut to assure operation in emergencies. Lubricate all rising stem valves.
2. All control valve operation should be checked and proper maintenance followed.
3. Check for leaks, signs of electrolysis and pipe corrosion around valves. Repair before emergencies develop.

NOTE: Above items will assure operation in emergencies and personnel will learn where valves are in case of emergencies.

4. Make sure all balancing valves are reset to balance position.

VI. ELECTRIC MOTORS

A. SEMI-ANNUALLY

1. For Oil Cups - Oil with 5 - 6 drops Shell Turbo #33, 20W non-detergent oil.
2. Measure ampere draw, which should not exceed (FLAmps) full load ampere rating on motor plate.

B. ANNUALLY

1. For Oil Cups - Oil to 5 - 6 drops Shell Turbo #33, 20W non-detergent oil.

   NOTE: Over lubrication of motors will cause motor failure as much as inadequate lubrication.
2. For grease fittings - remove relief plug, add Shell Alvania #2 grease, while motor is warm, with low pressure grease gun until new grease emerges from relief plug. Run motor briefly. Clean off excess grease. Replace plug.
3. Check motor mounting and tighten, if necessary.
4. Check wiring and conduit.
5. Check for excessive heat or noise. Measure amperes of each leg and compare with nameplate FLA rating.
6. Clean and vacuum air passages and windows.
7. Check starter and disconnect for wear or burned contacts and any loose connections.

VII. CONTROLS

SEMI-ANNUALLY

1. Check operating "set point" of all thermostats.
2. Test control action of all thermostats.
3. Test "ON" and "OFF" differential of each differential temperature controller.
4. Test time delay relays for proper timed cycles.
5. Visually inspect relays for pitted and burned contacts.
6. Test high water alarm.
7. Test low pressure alarm.
8. Test audible alarm.
9. Test alarm beacon.
10. Test low water boiler cut-off.

VIII. COLLECTORS

SEMI-ANNUALLY (SPRING AND FALL)

1. Visually inspect each collector.
2. Wash all collectors (Fall only).
3. Inspect caulking around perimeter of collectors. Recaulk as required.

IX. COLLECTOR SUPPORTS

ANNUALLY (SPRING)

1. Inspect all wooden support trusses.
2. Replace and paint any defective members.
3. Repaint weathered areas, as required.

X. PIPING AND PIPE INSULATION

A. SEMI-ANNUALLY (SPRING AND FALL)

1. Inspect piping runs for low points.

2. Inspect piping for leaks.

B. ANNUALLY (SPRING)

1. Check insulation. Loose joints and connections should be re-glued. Missing sections should be replaced and painted.

2. Check insulation paint. Repaint weathered areas, as required.

XI. LOW WATER CUT-OFF

ANNUALLY (FALL)

1. Blow down low water cut-off.

2. Test for proper operation.

XII. MAKE-UP WATER

A loss in system water, which can be observed on the gauge glass of the expansion tanks, should be replaced through the make-up water line. Locate and repair any leaks before adding water and before placing the system back in operation.

Procedure for adding water:

1. Turn off Solar Pump P-3.

2. Open Make-Up Water line and fill system until expansion tanks are 1/3 full.

XII. MAKE-UP WATER (CONT'D)

3. Close Make-Up Water line. (Keep closed at all times)

4. Place Solar Pump P-3 in "AUTO" position.

XIII. NITROGEN CHARGE

Replace nitrogen bottle when empty.

In the event that the system is opened to atmosphere, or the nitrogen charge is lost, take the following steps to recharge the system.

NOTE: If the nitrogen charge is lost, it is a good indication of a system leak. Locate, repair and pressure test the system before recharging with nitrogen. A small air compresser can be used to perform the pressure testing.

PROCEDURE FOR RECHARGING WITH NITROGEN

1. Turn "off" Solar Pump P-3.
2. Partially open valves to the nitrogen tank and allow nitrogen to enter the system.
3. Hold open each relief valve on the collector banks for several minutes.
4. Further open valves to the nitrogen tank and allow system to reach the minimum operating pressure of 14 PSIG.
5. Close valves to the nitrogen tank.
6. Place Solar Pump P-3 in the "AUTO" position.

XIII. NITROGEN CHARGE (CONT'D)

PROCEDURE FOR RECHARGING WITH NITROGEN (CONT'D)

NOTE: If a small loss in system pressure is observed with no loss in system water, the system may be recharged following the above steps, except omit Step 3.

XIV. WATER TREATMENT

SEMI-ANNUALLY

Test and record concentration of corrosion inhibitor, using test apparatus supplied and test procedure attached. Consult with water treatment specialists regarding any changes in concentration and/or water treatment problems.

Mitco Inc.
WATER MANAGEMENT CHEMICALS AND SYSTEMS
1601 STEELE AVE., S. W. / GRAND RAPIDS, MICHIGAN 49507 / 616-241-4684

TEST PROCEDURE FOR:

CW-21
CW-21L

Apparatus:

1 - Test Tube, calibrated at 10 ml.
1 - Bottle, with 1/2 ml. dropper.
1 - Bottle, Plax, with plastic insert and cap.

Reagents:

Standard Potassium Permanganate ($KMnO_4$), 0.13N
Sulfuric Acid 1:1

Procedure:

Fill test tube to the 10 ml. mark with water under test. Add 1 ml. of sulfuric acid 1:1. Immediately follow with the standard potassium permanganate in dropwise fashion until the solution develops a faint pink color which persists for 15 seconds.

For greater accuracy perform the test a second time adding the potassium permanganate first (a total of one drop less than that required in first titration). Add the sulfuric acid and complete the titration as indicated above.

Calculation:

Number of drops $KMnO_4$ X 50 = ppm. CW-21 or CW-21L

April 1, 1974

CW-21 and CW-21L CLOSED SYSTEM TREATMENTS FOR CORROSION

DESCRIPTION

Mitco CW-21 contains sodium nitrite, sodium borate, and a copper corrosion inhibitor. It is a very effective corrosion inhibitor for air conditioning chilled water systems, and hot water heating boilers. It is available as a powder (CW-21) and as a liquid (CW-21L).

PRODUCT DATA

Physical State: Powder (CW-21) or Liquid (CW-21L)
Density: 10.1 Lbs./Gal. (CW-21L)

DOSAGE

8.3 Lbs. CW-21 per 1,000 Gal. in system.
4 Gal. CW-21L per 1,000 Gal. in system.

FEEDING

CW-21 and CW-21L are usually added to closed systems by utilizing pot feeders.

HANDLING

Avoid contact with skin, eyes, and clothing. In case of contact, flush with water.

PACKAGING

Mitco CW-21 is shipped in 100, 200 and 400 pound fibre non-returnable containers.

Mitco CW-21L is shipped in 15, 30 and 55 gallon steel non-returnable drums.

Mitco Inc.
1601 Steele Ave., S.W., Grand Rapids, Mich. 49507 • 616/241-4684

#1

BILL OF MATERIALS

Solar Collector Panel, Type I, Models A and B
Narrow Edge, External Headers Required

Model A Series Model B Series	☒ 34 3/16" x 76 3/16" x 1 1/4" ☒ 31 1/2" x 95 1/2" x 1 1/4"
External Connections	Copper: 5/8" O.D. Type M Top right and bottom left
Internal Pipe	Copper: 1/2" O.D., Type L
Cover Plates	Transparent heat treated glass, 3.0 mm. thick, double glazed. Covers are not replaceable.
Glass Types	☒ Soda-Lime, Transmittance = 85 ± 1%/cover ☐ Low-Iron, Transmittance = 88 ± 1%/cover ☐ Water White, Transmittance = 91 ± 1%/cover
Absorber Plate	All copper, tube soldered to .021 sheet
Absorber Coating	☒ Flat Black: α=95%, ϵ=88% ☐ Selective Black Chrome: α=95%, ϵ=10%
Insulation	Sides: None Back: ☐ None ☒ 3" High temperature fiberglass, R-13.7 Edge dimension 1 3/8" with steel container
Container Construction	☐ No container ☒ 24 gauge, primed and painted steel
Weight	5.9 lbs./sq. ft., dry 7.8 lbs./sq. ft. with insulation and cover, dry
Fluid Capacity Model A Model B	 .61 gallons .67 gallons

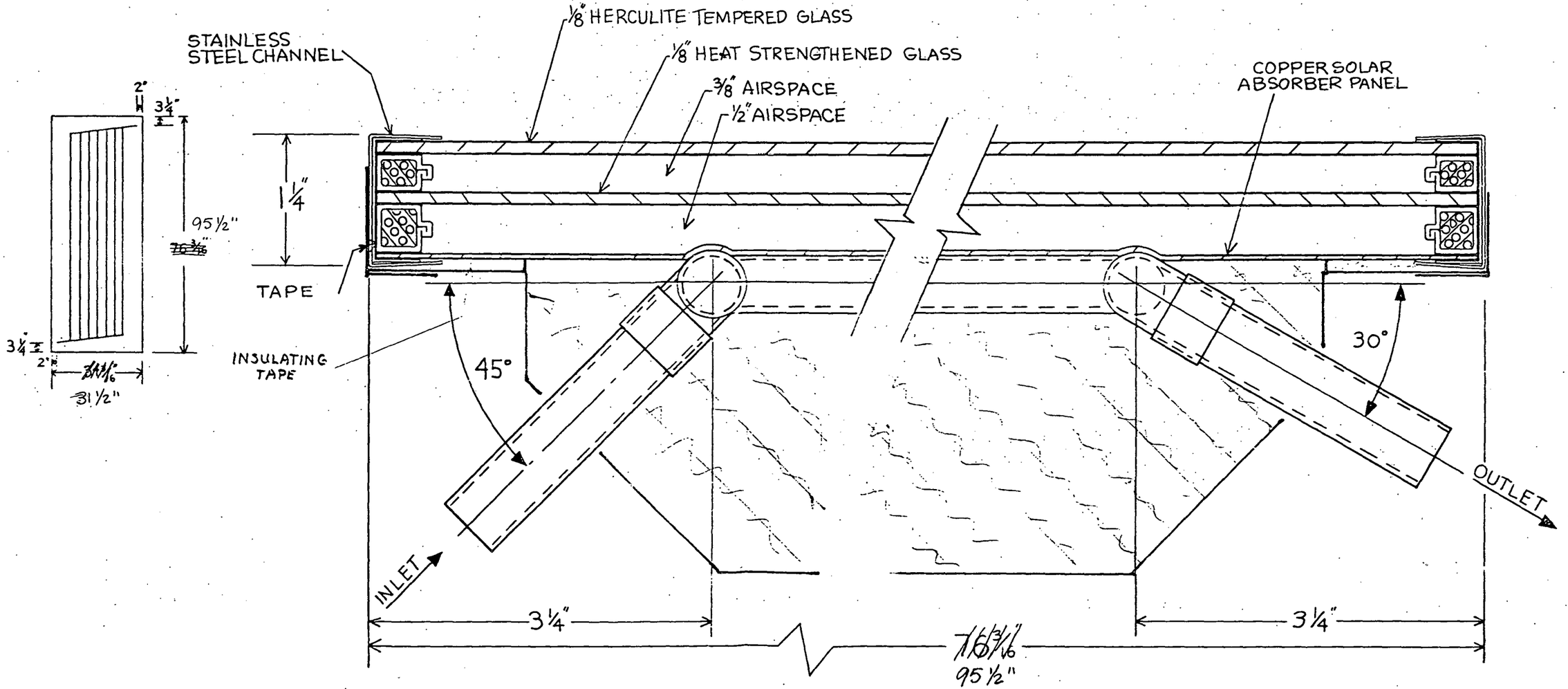
Areas	Gross Collector	Net Absorber	Ratio
Model A	18.01 sq. ft.	17.15 sq. ft.	.95
Model B	20.89 sq. ft.	20.00 sq. ft.	.96

REVIEWED WITH EXCEPTIONS NOTED ✓
RESUBMITTAL REQUIRED _____
SHOP DRAWINGS ARE REVIEWED FOR GENERAL CONFORMANCE WITH THE DESIGN CONCEPT OF THE PROJECT. ALL EQUIPMENT SUBJECT TO DETAILED REQUIREMENTS OF CONTRACT DOCUMENTS.
FAIRBROTHER & GUNTHER, INC.
DATE 6-16-77
BY MW

JORDAN COLLEGE , MADISON HALL

TYPE I , MODEL ~~A-412~~ B

PPG COPPER SOLAR COLLECTOR
(FULL SIZE)



SOLAR SYSTEMS SALES
PPG INDUSTRIES
ONE GATEWAY CENTER
PITTSBURGH, PA. 15222 11/75

TRANE AIR CONDITIONING

FILE:
TRANE HEATING PRODUCTS
UNIT HEATERS
Steam - Hot Water
Installation - Maintenance

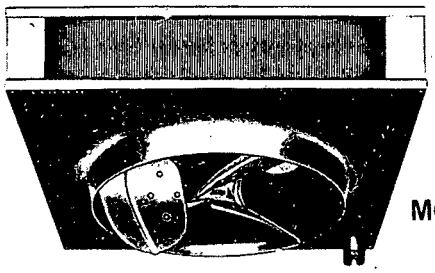
LITERATURE FILE NO.

UH-IM-2

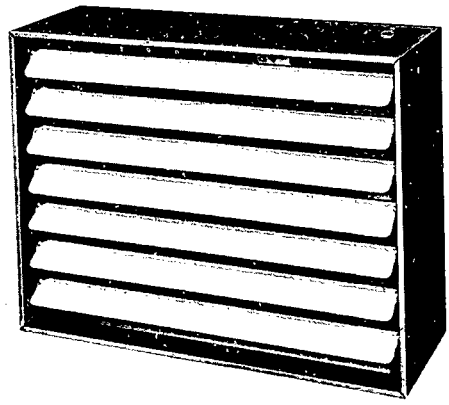
INST.-MAIN.

THE TRANE COMPANY — LA CROSSE, WISCONSIN 54601

APRIL, 1976
SUPERSEDES UH-IM-1
DATED MAY, 1973



MODEL P



MODEL S

PROPELLER UNIT HEATERS

MODELS S AND P

TABLE OF CONTENTS

MODEL NUMBER DESCRIPTION

MODEL "P" UNIT HEATERS

UHPA-042P-4A-BAB

UNIT HEATER
MODEL P

DEVELOPMENT SEQUENCE

UNIT SIZE

BTU		BTU	
042 -	41,300	252 -	249,800
064 -	65,500	280 -	283,800
080 -	80,600	336 -	333,400
102 -	101,800	384 -	386,000
122 -	124,400	500 -	496,000
146 -	152,000	600 -	585,000
166 -	173,000	720 -	705,000
202 -	201,200		

COIL TYPE
P - STEAM OR HOT WATER **

FIN SERIES
4 - 144**
9 - SPECIAL

DESIGN SEQUENCE

MOTOR

	H.P.	TYPE*	RPM	VOLTAGE
B	1/25	ENCL	1550	115/60/1 **
C	1/20	ENCL	1550	115/60/1 **
D	1/8	ENCL	1070	115/60/1 **
F	1/6	ENCL	1100	115/60/1 **
G	1/6	EXPL	1140	115/60/1 **
H	1/6	ENCL	1140	230-460/60/3
J	1/4	ENCL	1100	115/60/1 (202 ONLY)**
K	1/4	ENCL	1100	115/60/1 (252 ONLY)**
L	1/4	EXPL	1100	115/60/1
M	1/4	ENCL	1100	230-460/60/3
P	1/2	ENCL	1100	115/60/1**
R	1/2	EXPL	1100	115/60/1
S	1/2	ENCL	1100	230-460/60/3
T	3/4	ENCL	1100	230-460/60/3**
U	1-1/2	ENCL	1100	230-460/60/3
W	3	ENCL	1100	230-460/60/3
X	SPECIAL			

FIN MATERIAL
A - ALUMINUM **
S - SPECIAL

TUBE MATERIAL
B - .025 COPPER **
C - .049 RED BRASS
E - .049 CUPRO-NICKEL
F - .049 STEEL

* ENCL - Totally Enclosed Motor
EXPL - Explosion Proof Motor

** STANDARD EQUIPMENT

MODEL "S" UNIT HEATERS

UHSA-018S-8A-AAA

UNIT HEATER
MODEL S

DEVELOPMENT SEQUENCE

UNIT SIZE

FULL COIL BTU		MODIFIED COIL BTU	
018 -	17,400	019 -	19,300
020 -	20,000	031 -	30,400
038 -	38,700	045 -	45,800
042 -	41,600	053 -	53,300
060 -	60,500	069 -	69,400
070 -	68,200	077 -	76,600
090 -	87,600	091 -	91,000
100 -	96,000	127 -	125,800
126 -	125,700	137 -	135,800
168 -	172,000	181 -	180,700
186 -	185,200	207 -	206,900
230 -	229,700	243 -	238,700
260 -	256,300	273 -	272,200
320 -	324,000		
354 -	355,500		

COIL TYPE
S - STEAM**
W - HOT WATER - WITH FIN SERIES 132 ONLY **

MOTOR

	H.P.	RPM	VOLTAGE	TYPE*
A	1/25	1050	115/60/1**	ENCL
C	1/20	1550	115/60/1**	ENCL
E	1/8	1550	115/60/1**	ENCL
F	1/6	1100	115/60/1**	ENCL
G	1/6	1140	115/60/1**	EXPL
H	1/6	1140	230-460/60/3	ENCL
J	1/4	1100	115/60/1**	ENCL
L	1/4	1100	115/60/1	EXPL
M	1/4	1100	230-460/60/3	ENCL
N	1/2	1100	115/60/1**	ENCL
R	1/2	1100	115/60/1	EXPL
S	1/2	1100	230-460/60/3	ENCL
X	SPECIAL			

FIN MATERIAL
A - ALUMINUM**
S - SPECIAL

TUBE MATERIAL
A - .031 COPPER**
C - .049 RED BRASS
D - .031 CUPRO-NICKEL
F - .049 STEEL

DESIGN SEQUENCE

FIN SERIES
2 - 132-WITH COIL TYPE "W" ONLY **
8 - 108**
9 - SPECIAL

* ENCL - Totally enclosed motor
EXPL - Explosion proof motor

** STANDARD EQUIPMENT

All Trane Model P and S Unit Heaters are shipped fully assembled and may be used for steam or hot water applications. Coils are factory tested at 300 psig air under water, fans are balanced and motors are prelubricated.

Each unit is packaged individually and marked for proper identification. Use normal care in handling and during installation to prevent damage to the coil fins, fan and casing. Do not set the Model P Unit on the floor with the weight of the unit resting against the fan blades. In this position, the blades may be forced out of balance.

Figures 1, 2 and 3 and Tables 1, 2 and 3 give unit dimensions. Unit weights are listed in Table 6.

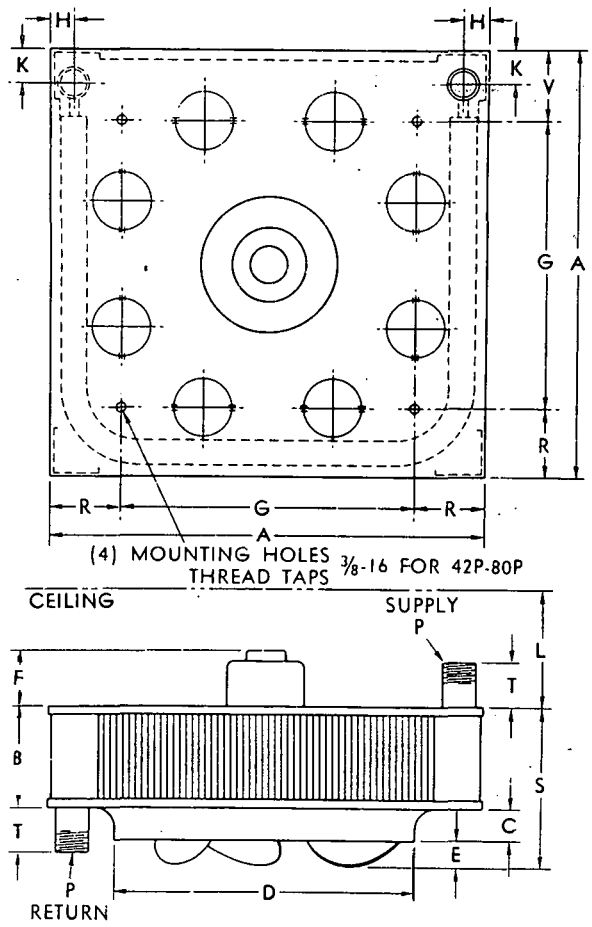


FIGURE 1 - Dimensions, Model P Unit Heater, Sizes 42-80

TABLE 1 - Model P Unit Heater Dimensions (Figure 1)

MODEL P	Fan Dia.	A	B	C	D	E	F	G	H	K	L (Min)	P (NPT)	R	S	T	U	V
42P	11-1/4	18-1/4	4-5/8	1-1/4	11-3/4	3/4	1-1/4	11	1-3/8	1-7/8	6	1-1/2	3-5/8	6-5/8	2-3/4	11	3-5/8
64P	13-1/2	21-1/4	4-5/8	1-5/8	14	1	2-1/2	14	1-3/8	1-7/8	6	1-1/2	3-5/8	7-1/8	2-3/4	14	3-5/8
80P	13-1/2	21-1/4	6-1/8	1-5/8	14	1	3/4	14	1-3/8	1-7/8	6	1-1/2	3-5/8	8-5/8	2-3/4	14	3-5/8

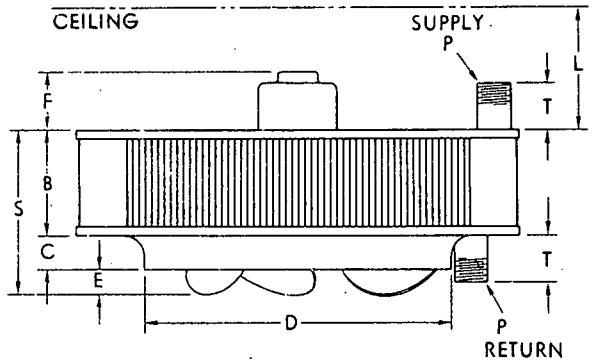


FIGURE 2 - Dimensions, Model P Unit Heater, Sizes 102-720

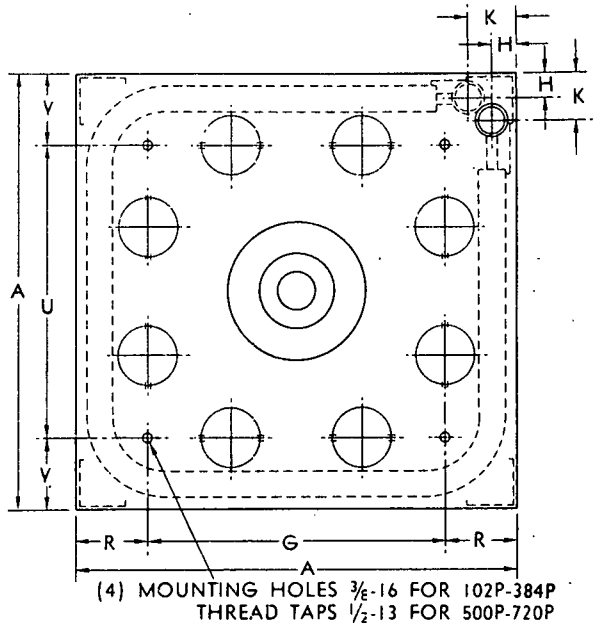
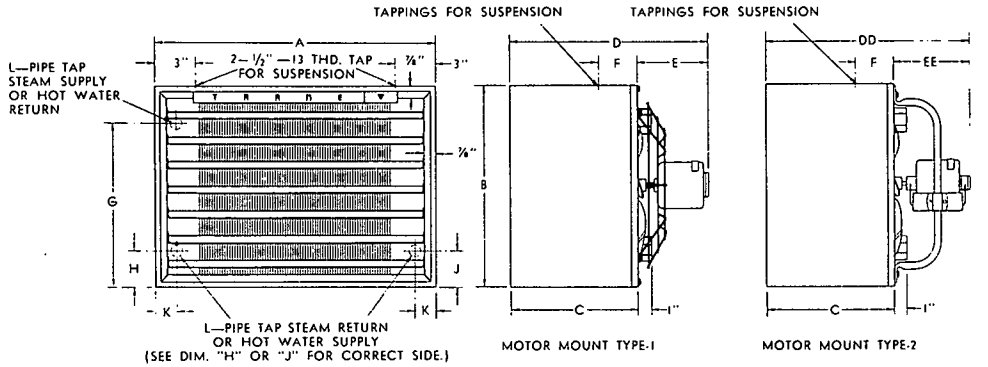


TABLE 2 - Model P Unit Heater Dimensions (Figure 2)

MODEL P	FAN DIA.	A	B	C	D	E	F	G	H	K	L(MIN)	P(NPT)	R	S	T	U	V
102 P	16-3/4	25-1/4	6-1/8	2	17-1/2	1-1/8	1	17	1-3/8	2-3/4	6	1-1/2	4-1/8	9-1/8	2-3/4	17	4-1/8
122 P	16-3/4	25-1/4	6-1/8	2	17-1/2	1-3/4	3-1/2	17	1-3/8	2-3/4	6	1-1/2	4-1/8	9-3/4	2-3/4	17	4-1/8
146 P	19-3/4	29-1/2	6-1/8	2-3/8	20-5/8	1-1/4	3-1/2	20-1/2	1-3/4	3-1/2	6	2	4-1/2	9-5/8	2-3/4	20-1/2	4-1/2
166 P	19-3/4	29-1/2	6-1/8	2-3/8	20-5/8	1-3/4	3-1/2	20-1/2	1-3/4	3-1/2	6	2	4-1/2	10-1/8	2-3/4	20-1/2	4-1/2
202 P	19-3/4	29-1/2	7-5/8	2-3/8	20-5/8	2	3-1/2	20-1/2	1-3/4	3-1/2	6	2	4-1/2	12	2-3/4	20-1/2	4-1/2
252 P	25-1/4	37-1/2	7-5/8	3	26-3/8	1	1-3/4	28	1-3/4	3-1/2	6	2	4-3/4	11-5/8	2-3/4	18	9-3/4
280 P	25-1/4	37-1/2	7-5/8	3	26-3/8	1-1/4	3	28	1-3/4	3-1/2	6	2	4-3/4	11-3/4	2-3/4	18	9-3/4
336 P	25-1/4	37-1/2	7-5/8	3	26-3/8	2-1/8	4-1/4	28	1-3/4	3-1/2	6	2	4-3/4	12-3/4	2-3/4	18	9-3/4
384 P	25-1/4	37-1/2	9-1/8	3	26-3/8	2	2-1/2	28	1-3/4	3-1/2	6	2	4-3/4	14-1/8	2-3/4	18	9-3/4
500 P	30	42	9-1/8	3-1/2	31-1/4	1-5/8	3-3/4	30	2-1/4	4-1/4	7	2-1/2	6	14-1/4	3	30	6
600 P	30	42	12-1/8	3-1/2	31-1/4	2-1/8	2-1/2	30	2-1/4	4-1/4	7	2-1/2	6	17-3/4	3	30	6
720 P	30	42	13-5/8	3-1/2	31-1/4	3	6-1/4	30	2-1/4	4-1/4	7	2-1/2	6	20-1/4	3	30	6



NOTE: MOTOR MOUNT TYPE-1 IS USED ON ALL STANDARD SINGLE PHASE MOTORS. MOTOR MOUNT TYPE-2 IS USED ON THREE PHASE, EXPLOSION PROOF 1 OR 3 PHASE, AND OTHER SPECIAL MOTORS.

FIGURE 3 - Dimensions, Model S Unit Heater

TABLE 3 - Model S Unit Heater Dimensions (Figure 3)

Model S	Fan Dia.	A	B	C	D	DD	E	EE	F	G	H	J	K	L	No. of Horizontal Louvers Std.	No. of Louver Fin Diffusers
18, 19 & 20S	11-1/4	20-7/8	14-1/4	9-3/8	15-3/8	20-5/8	6	11-1/4	3-1/8	8-5/8	2-5/8	-	1-3/4	1		
31S	11-1/4	20-7/8	14-1/4	9-3/8	16-1/8	20-5/8	6-3/4	11-1/4	3-1/8	8-5/8	-	2-5/8	1-3/4	1		
38 & 42S	11-1/4	20-7/8	14-1/4	9-3/8	16-1/8	20-5/8	6-3/4	11-1/4	3-1/8	11-5/8	2-5/8	-	1-3/4	1	4	3
45S	13-1/2	23-7/8	17-1/4	10	17	21-1/4	7	11-1/4	3-1/2	11-5/8	2-5/8	-	2	1-1/4		
60S	13-1/2	23-7/8	17-1/4	10	17	21-1/4	7	11-1/4	3-1/2	14-5/8	-	2-5/8	2	1-1/4		
53S	13-1/2	23-7/8	17-1/4	10	17-1/4	21-1/4	7-1/4	11-1/4	3-1/2	11-5/8	2-5/8	-	2	1-1/4		
70S	13-1/2	23-7/8	17-1/4	10	17-1/4	21-1/4	7-1/4	11-1/4	3-1/2	14-5/8	-	2-5/8	2	1-1/4	5	4
69S	13-1/2	26-3/4	20-1/4	11-1/4	18-1/2	22-1/2	7-1/4	11-1/4	4-1/8	14-5/8	-	2-5/8	2	1-1/4		
90S	13-1/2	26-3/4	20-1/4	11-1/4	18-1/2	22-1/2	7-1/4	11-1/4	4-1/8	17-5/8	2-5/8	-	2	1-1/4	6	5
77S	16-3/4	26-3/4	20-1/4	11-1/4	18-3/4	22-1/2	7-1/2	11-1/4	4-1/8	14-5/8	-	2-5/8	2	1-1/4		
100S	16-3/4	26-3/4	20-1/4	11-1/4	18-3/4	22-1/2	7-1/2	11-1/4	4-1/8	17-5/8	2-5/8	-	2	1-1/4	6	5
91S	16-3/4	31-1/8	23-1/4	11-1/4	21	22-1/2	9-3/4	11-1/4	4-1/8	14-5/8	-	2-5/8	2-1/2	1-1/2		
126S	16-3/4	31-1/8	23-1/4	11-1/4	21	22-1/2	9-3/4	11-1/4	4-1/8	20-5/8	-	2-5/8	2-1/2	1-1/2	7	6
168S	19-3/4	33-3/4	26-1/4	12-3/8	22-1/8	23-5/8	9-3/4	11-1/4	4-5/8	23-5/8	2-5/8	-	2-1/2	1-1/2		
186S	19-3/4	33-3/4	26-1/4	12-3/8	22-1/8	24-5/8	9-3/4	12-1/4	4-5/8	23-5/8	2-5/8	-	2-1/2	1-1/2		
127S	19-3/4	33-3/4	26-1/4	12-3/8	22-1/8	23-5/8	9-3/4	11-1/4	4-5/8	17-5/8	2-5/8	-	2-1/2	1-1/2		
137S	19-3/4	33-3/4	26 1/4	12-3/8	22-1/8	24-5/8	9-3/4	12-1/4	4-5/8	17-5/8	2-5/8	-	2-1/2	1-1/2	8	7
181S	19-3/4	39-3/8	32-1/4	13-1/4	23	25-1/2	9-3/4	12-1/4	5-1/8	23-5/8	2-5/8	-	2-1/2	1-1/2		
230S	19-3/4	39-3/8	32-1/4	13-1/4	23	25-1/2	9-3/4	12-1/4	5-1/8	22-1/8	-	2-5/8	2-1/2	1-1/2	10	9
207S	25-1/4	39-3/8	32-1/4	13-1/4	24-1/2	26	11-1/4	12-3/4	5-1/8	23-5/8	2-5/8	-	2-1/2	1-1/2		
260S	25-1/4	39-3/8	32-1/4	13-1/4	24-1/2	26	11-1/4	12-3/4	5-1/8	22-1/8	-	2-5/8	2-1/2	1-1/2	10	9
320 & 354S	25-1/4	52-1/8	32-1/4	13-3/4	25	26-1/2	11-1/4	12-3/4	5-3/8	22-1/8	-	2-5/8	2-1/2	1-1/2		
243 &273S	25-1/4	52-1/8	32-1/4	13-3/4	25	26-1/2	11-1/4	12-3/4	5-3/8	23-5/8	2-5/8	-	2-1/2	1-1/2	10	9

INSTALLATION

Place the units at points of greatest heat loss. Blanket outside doorway and provide ample coverage of window areas. Keep units away from obstructions that will impede the full and natural air delivery of the units.

To insure delivery of the heated air to the desired area, follow the maximum distance of throw and mounting heights given in Tables 4 and 5.

Mounting heights is to be measured from the floor to the bottom of the unit.

The discharge air temperature on Model P Units may be adjusted after installation. The top of all Model P Units contain a pattern of easily removed air port openings. To lower the discharge air temperature, it is only necessary to open the desired number of air ports.

TABLE 4 - Maximum Distance Of Throw And Mounting Height In Feet For Model S Unit Heaters

Unit	Outlet Velocity	CFM	Final Temp (F)	Mounting Height	Maximum Throw	
					Without Diffuser	With Louver Fin Set For Maximum Throw
18-S	162	280	117	8	12	15
20-S2	186	318	118	8	15	18
38-S	319	544	126	9	18	22
42-S	347	590	125	9	20	25
60-S	343	815	129	9	22	27
70-S	454	1100	117	10	28	35
90-S	382	1214	127	11	28	35
100-S	476	1535	118	12	28	35
126-S	411	1760	126	13	32	40
168-S	452	2380	127	14	40	50
186-S	528	2808	121	14	45	56
230-S	431	3300	124	15	40	50
260-S	529	4100	118	15	50	62
320-S	442	4480	127	15	50	62
354-S	550	5660	118	15	60	75
19-S2	220	390	106	8	18	22
31-S	359	635	104	8	20	25
45-S	363	897	107	9	25	31
53-S	439	1090	105	10	28	35
69-S	407	1337	108	12	30	37
77-S	458	1510	107	13	32	40
91-S	394	1740	108	14	32	40
127-S	448	2440	108	15	40	50
137-S	495	2700	107	15	45	56
181-S	430	3392	109	15	42	52
207-S	514	4059	107	15	48	60
243-S	439	4607	108	15	55	68
273-S	536	5644	105	15	60	75

NOTE: The Above is based on 2 psig Steam Pressure, 60 F Entering Air.
TO MEET OSHA REQUIREMENTS, MODEL "S" UNIT HEATERS MUST BE MOUNTED NO LOWER THAN 7.5 FEET FROM THE FLOOR.

TABLE 5 - Maximum Mounting Height In Feet For Model P Unit Heaters

Unit Size	Steam Pressure (PSI)					
	2	5	10	50	100	150
42-P	10.5 12.5	10.0 12.0	10.0 12.0	9.0 11.0	7.5 9.5	7.5 8.5
42-P LS*	7.5 9.0	7.5 8.5	7.5 8.5	7.5 7.5	7.5 7.5	7.5 7.5
42-P-L**	12.5 14.5	12.0 14.0	12.0 13.5	10.5 12.0	9.0 11.0	8.5 10.0
42-P-L LS	9.0 10.5	8.5 10.0	8.5 10.0	7.5 9.0	7.5 8.0	7.5 7.5
64-P	12.0 14.5	11.5 14.0	11.5 14.0	10.0 12.0	9.0 11.0	8.0 10.5
64-P LS	9.5 11.5	9.0 11.0	9.0 11.0	8.0 9.5	7.5 8.5	7.5 8.0
64-P-L	15.0 19.0	14.5 18.5	14.5 18.5	12.5 16.5	11.0 16.0	10.0 14.0
64-P-L LS	11.5 14.0	11.0 13.5	11.0 13.5	9.5 12.0	8.5 11.0	8.0 10.0
80-P	15.0 18.5	14.5 18.0	14.0 17.5	12.0 15.5	11.0 14.0	10.0 13.0
80-P LS	11.0 13.5	10.5 13.0	10.5 13.0	9.0 11.5	8.5 11.0	8.0 10.0
80-P-L	18.0 22.0	17.5 21.0	17.5 21.0	15.0 19.0	13.5 17.0	12.0 16.0
80-P-L LS	13.0 17.0	12.5 16.5	12.0 16.0	11.0 14.0	10.0 13.0	9.0 12.0
102-P	14.0 17.0	13.5 16.5	13.0 16.0	11.5 14.0	11.0 13.0	10.0 12.0
102-P LS	11.0 13.5	10.5 13.0	10.5 13.0	9.5 12.0	8.5 11.0	8.0 10.0
102-P-L	17.5 21.5	17.0 21.0	16.5 20.5	15.0 18.5	14.0 16.5	13.0 16.0
102-P-L LS	15.0 18.5	14.5 18.0	14.5 18.0	13.0 16.0	12.0 14.5	11.0 13.5
122-P	16.0 19.5	15.5 19.0	15.5 18.5	14.0 17.0	13.0 15.5	12.0 14.0
122-P-L	21.0 26.0	20.5 25.5	20.0 25.0	17.5 22.5	17.0 20.5	16.0 19.0
146-P	15.5 19.0	15.0 18.5	14.5 18.0	13.0 16.0	11.5 15.0	11.0 14.0

Unit Size	Steam Pressure (PSI)					
	2	5	10	50	100	150
146-P-L	18.0 22.5	17.5 22.0	17.5 21.5	15.0 18.5	13.5 17.5	12.5 16.0
166-P	18.0 22.5	17.5 22.0	17.0 21.5	14.5 19.0	13.5 17.5	13.0 16.0
166-P-L	22.0 27.5	21.5 27.0	21.0 26.5	18.5 23.5	16.5 21.5	15.5 20.0
202-P	22.0 27.5	21.5 27.0	21.0 26.5	18.5 24.0	16.5 22.0	16.0 20.0
202-P-L	25.5 31.5	25.0 31.0	24.5 30.5	22.0 27.0	20.0 25.0	18.0 23.0
252-P	20.0 25.0	19.5 24.0	19.0 23.5	17.0 20.5	15.5 18.5	14.0 17.5
252-P-L	24.0 29.5	23.5 28.5	23.0 28.0	20.0 24.5	18.0 22.5	17.0 21.0
280-P	21.0 26.0	20.5 25.5	20.0 25.0	17.5 22.0	16.0 20.0	15.0 18.0
280-P-L	25.0 32.0	25.0 31.0	24.5 30.0	21.0 26.0	19.0 24.0	18.0 23.0
336-P	24.0 30.0	23.0 29.0	22.0 28.0	20.0 25.0	18.5 23.5	17.0 22.0
336-P-L	29.0 36.0	28.5 35.0	28.0 34.0	25.0 30.0	23.0 28.0	21.0 26.0
384-P	28.5 35.5	28.0 35.0	27.5 34.0	24.0 30.0	22.0 28.0	20.0 26.0
384-P-L	32.5 41.0	31.5 40.0	30.5 39.0	27.5 35.0	25.5 32.0	24.0 30.0
500-P	29.5 36.5	29.0 36.0	28.5 35.5	25.0 32.0	23.0 29.0	21.0 26.0
500-P-L	35.0 43.5	34.0 42.5	33.0 41.5	29.0 35.0	27.0 33.0	25.0 31.0
600-P	34.0 42.5	33.0 41.5	32.0 40.5	28.0 36.0	26.0 33.0	24.0 30.0
600-P-L	37.0 46.5	36.0 45.5	35.0 44.5	31.0 39.0	29.0 35.0	27.0 33.0
720-P	38.5 48.0	37.5 47.0	36.5 46.0	32.0 40.0	29.0 38.0	27.0 35.0
720-P-L	42.5 53.0	41.5 52.0	40.5 51.0	35.0 44.0	32.0 40.0	30.0 37.0

NOTES: *LS = Low Speed

**PL = Model P Low Final Temperature Model With All Air Ports Open.

Figures in Shaded areas give maximum mounting height with louver cone diffuser blades set vertically.

The above Table is based on 60 F entering air temperature. In providing for the use of diffusers, it must be remembered that adjustment of a LCD to deflect air toward horizontal immediately lowers the mounting height.

TO MEET OSHA REQUIREMENTS, MODEL "P" UNIT HEATERS MUST BE MOUNTED NO LOWER THAN 7.5 FEET FROM THE FLOOR.

DUCTWORK

Propeller unit heaters are designed primarily for free air delivery and, basically, the propeller fan is not efficient when used with extensive ductwork. However, short runs of duct may be used by observing the following restrictions:

1. Do not use hot water units when entering outside air may be below the freezing point. Use full sized coil with at least 5 psig steam or a modified coil with 10 psig steam for freezing conditions. Steam must be at full pressure during low temperatures.

2. Under no conditions should air filters be used.

3. All ductwork should be kept straight and as simple as possible.

4. The next size larger motor should be used.

The use of ductwork will present a reduction in air volume and unit capacity. Contact the local Trane representative for performance data and ducting recommendations.

UNIT MOUNTING

To meet Occupational Safety and Health Act (OSHA) requirements Model P Unit Heaters must be mounted no lower than 7.5 feet from the floor.

Weld nuts are provided at the top of all units for suspension purposes. See Figures 1, 2 and 3. Figure 4 shows the 2 weld nuts and steel channels provided on Model S Units. Support rods should support the total unit weight to assure that no strain is placed on supply and return piping. Provisions for removal of the unit from the suspension rods may be desirable for servicing purposes.

Units must hang level vertically and horizontally.

Provide sufficient clearance around units for maintenance purposes. This includes at least 7 inches above all Model P Unit Heaters even though the motor is removable through the bottom.

Isolators are not required but may be desirable for some applications. For these special cases, contact the local Trane representative. Refer to Table 6 for Unit Weights.

PIPING

Threaded pipe headers are provided on all Model P Units for piping connections. See Figure 5. Connections are given in Figures 1 and 2 and Tables 1 and 2.

Model S Units have female type threaded couplings with pipe grip faces which permit the coupling to be held securely while pipe connections are being made. See Figure 6. Connection sizes are given in Figure 3 and Table 3.

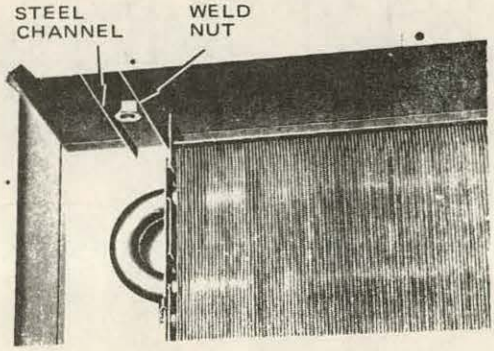


FIGURE 4 - Model S Unit Mounting Channel and Weld Nut

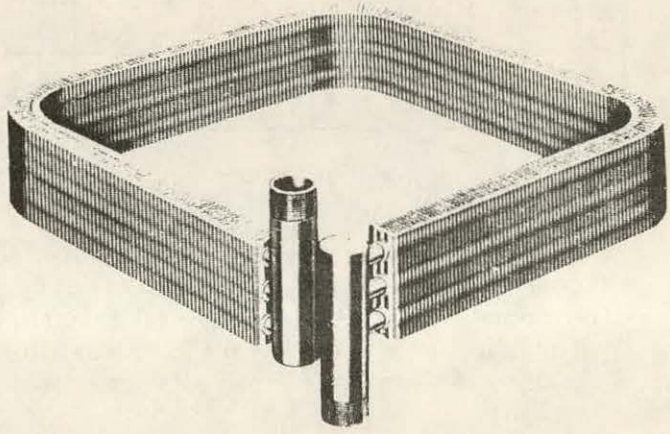


FIGURE 5 - Model P Unit Heater Coil and Headers

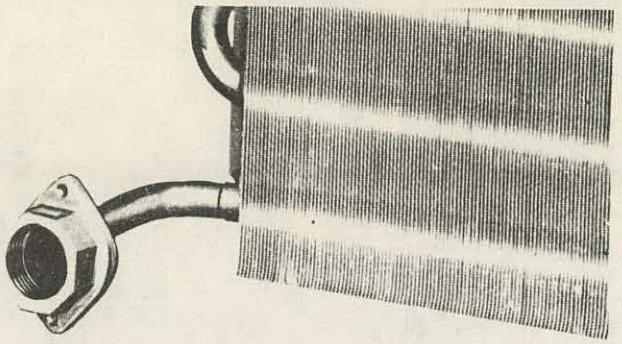


FIGURE 6 - Model S Unit Heater Coil and Piping Coupling

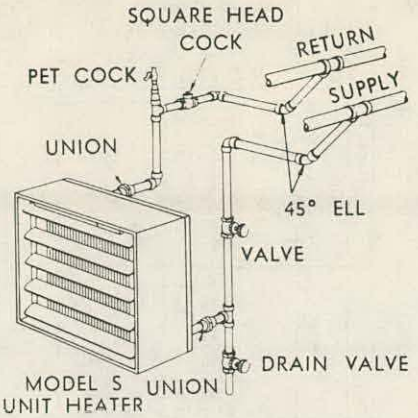


FIGURE 7 - Hot Water System With Overhead Supply and Return Lines. An Automatic Air Vent may be substituted for the Pet Cock if desired.

Follow standard practices and codes when installing the piping. Provide swing joints for expansion purposes, unions and shut-off valves for servicing purposes and, as illustrated in Figures 7 through 11, valves and traps for control purposes. Use 45 degree angle run-offs from all supply and return mains.

Dirt pockets should be the same pipe size as the return tapping of the unit heater. Also, pipe size in the branch-off should be the same size as the tapping in the traps. Beyond the trap, the return lateral pipe should be increased one size up to the return main.

Tables 7 and 8 list recommended steam trap selections.

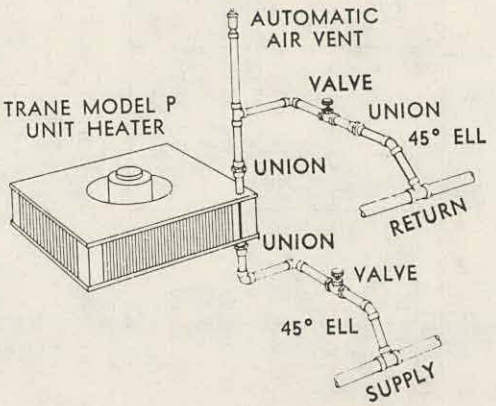


FIGURE 8 - Hot Water System with Lower Supply and Return Lines on a Model P Unit. Pet Cock may replace Automatic Air Vent.

TABLE 6 - Unit Weights - Lbs.

Model P*		Model S			
Unit	Weight lbs.	Unit	Weight lbs.	Unit	Weight lbs.
42 P	30	18S	40	19S2	40
64 P	35	20S2	40	31S	40
80 P	40	38S	40	45S	55
102 P	55	42S	40	53S	55
122 P	55	60S	55	69S	70
146 P	80	70S	60	77S	80
166 P	80	90S	75	91S	95
202 P	85	100S	85	127S	135
252 P	135	126S	100	137S	135
280 P	135	168S	145	181S	180
336 P	135	186S	145	207S	185
384 P	175	230S	190	243S	230
500 P	250	260S	195	273S	235
600 P	260	320S	245		
720 P	325	354S	250		

*P and PL Units

TABLE 7 - Steam Trap Selection - Model P Unit Heaters

Model P Size	2 PSIG	5 PSIG		10 PSIG		15 PSIG		30 PSIG		50 PSIG		100 PSIG	
	F-T Trap	F-T Trap	Bucket Trap	F-T Trap	Bucket Trap	F-T Trap	Bucket Trap	F-T Trap	Bucket Trap	F-T Trap	Bucket Trap	F-T Trap	Bucket Trap
42-166	3/4" 55AL	3/4" 55AL	No. 62	3/4" 55AL	No. 62	3/4" 55AL	No. 62	3/4" 55AM	No. 62	3/4" 55AM	No. 62	3/4" 55AH	No. 62
202-252	1" 55AL	1" 55AL	No. 62	1" 55AL	No. 62	1" 55AL	No. 62	3/4" 55AM	No. 62	3/4" 55AM	No. 62	3/4" 55AH	No. 121
280	1" 55AL	1" 55AL	No. 62	1" 55AL	No. 62	1" 55AL	No. 62	3/4" 55AM	No. 62	3/4" 55AM	No. 62	3/4" 55AH	No. 191
336	1" 55AL	1" 55AL	No. 62	1" 55AL	No. 62	1" 55AL	No. 62	3/4" 55AM	NO. 121	3/4" 55AM	No. 121	1-1/4" 66CH	No. 191
384	1" 55AL	1" 55AL	No. 121	1" 55AL	No. 62	1" 55AL	No. 62	3/4" 55AM	No. 121	3/4" 55AM	No. 121	1-1/4" 66CH	No. 191
500	1-1/4" 66CL	1-1/4" 66CL	No. 191	1-1/4" 66CL	No. 121	1-1/4" 66CL	No. 62	1-1/4" 66CM	No. 191	1-1/4" 66CM	No. 191	1-1/4" 66CH	No. 351
600	1-1/4" 66CL	1-1/4" 66CL	No. 191	1-1/4" 66CL	No. 121	1-1/4" 66CL	No. 121	1-1/4" 66CM	No. 191	1-1/4" 66CM	No. 191	1-1/4" 66CH	No. 351
720	1-1/4" 66CL	1-1/4" 66CL	No. 191	1-1/4" 66CL	No. 191	1-1/4" 66CL	No. 121	1-1/4" 66CM	No. 191	1-1/4" 66CM	No. 191	1-1/2" 77HH	No. 351

NOTE: Above selections of Trane Company Traps are based on cataloged unit capacities. A load factor of 2 has been used.

TABLE 8 - Steam Trap Selection - Model S Unit Heaters

Model S Size	2 PSIG	5 PSIG		10 PSIG		15 PSIG		30 PSIG		50 PSIG		100 PSIG	
	F-T Trap	F-T Trap	Bucket Trap	F-T Trap	Bucket Trap	F-T Trap	Bucket Trap	F-T Trap	Bucket Trap	F-T Trap	Bucket Trap	F-T Trap	Bucket Trap
18-137	3/4" 55AL	3/4" 55AL	No. 62	3/4" 55AL	No. 62	3/4" 55AL	No. 62	3/4" 55AM	No. 62	3/4" 55AM	No. 62	3/4" 55AH	No. 62
160-186	3/4" 55AL	3/4" 55AL	No. 62	3/4" 55AL	No. 62	3/4" 55AL	No. 62	3/4" 55AM	No. 62	3/4" 55AM	No. 62	3/4" 55AH	No. 121
207-243	1" 55AL	1" 55AL	No. 62	1" 55AL	No. 62	1" 55AL	No. 62	3/4" 55AM	No. 62	3/4" 55AM	No. 62	3/4" 55AH	No. 191
260-273	1" 55AL	1" 55AL	No. 62	1" 55AL	No. 62	1" 55AL	No. 62	3/4" 55AM	No. 62	3/4" 55AM	No. 62	3/4" 55AH	No. 191
320	1" 55A1	1" 55AL	No. 62	1" 55AL	No. 62	1" 55AL	No. 62	3/4" 55AM	No. 121	3/4" 55AM	No. 121	1-1/4" 66CH	No. 191
354	1" 55AL	1" 55AL	No. 121	1" 55AL	No. 62	1" 55AL	No. 62	3/4" 55AM	No. 121	3/4" 55AM	No. 121	1-1/4" 66CH	No. 191

NOTE: Above selections of Trane Company Traps are based on cataloged unit capacities. A load factor of 2 has been used.

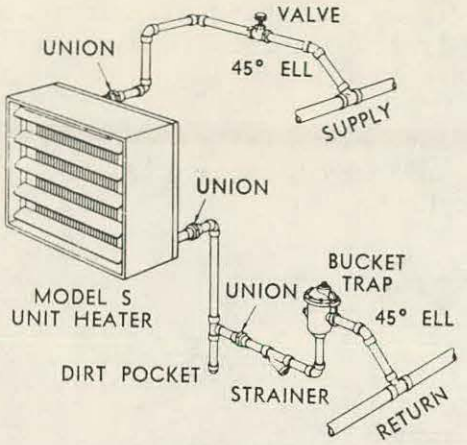


FIGURE 9 - High Pressure Steam System. Top of Bucket Trap must be located below Return Outlet of Coil to assure complete drainage of condensate

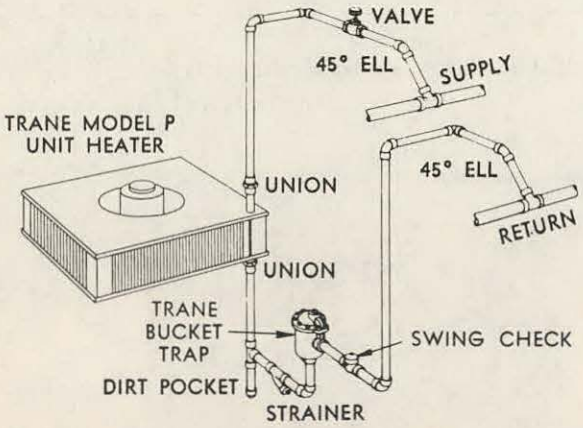


FIGURE 10 - High Pressure Steam System with Overhead Supply and Return Mains. Place Bucket Trap below Coil Return Outlet for proper Condensate Drainage.

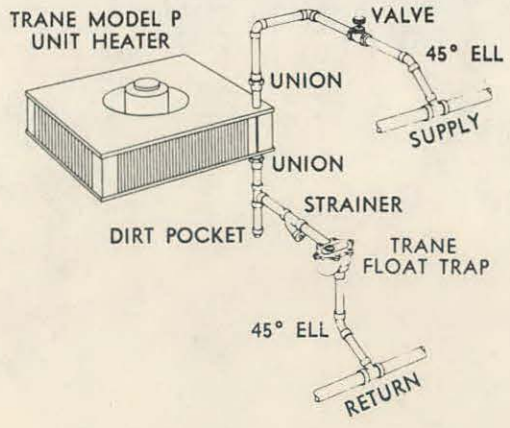


Figure 11 - Vapor or Vacuum System With Lower Supply and Return Mains

WIRING

The installer shall furnish all wiring to the fan motor. Connections are shown in Figures 12 and 13. See "Operating Information - Motors" for a discussion of the standard motors used with model S and P unit heaters.

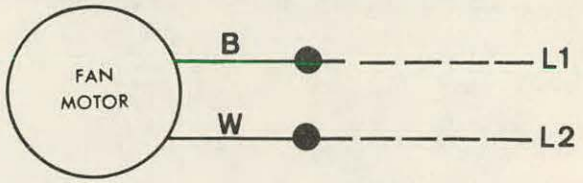


FIGURE 12 - Fan Motor Connections, 115/60/1, Constant Speed, Two Lead (G.E., Marathon, Universal)

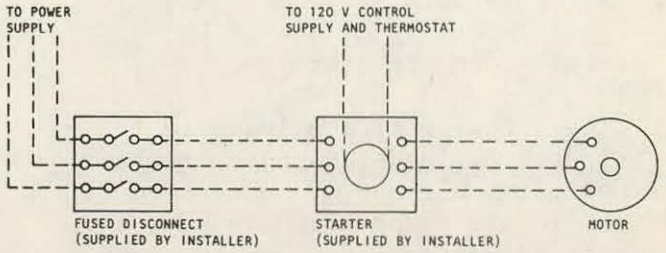


FIGURE 13 - Fan Motor Connections 3 Phase Wiring

MOTORS

The standard 115/60/1 motors provided on S and P Unit Heaters are totally enclosed, Class "B" insulated and have built-in thermal overload protection.

NOTE: Motors rated 1/2 H.P. and smaller are interchangeable between S and P models. This assures simplified and economical maintenance.

Models 53S through 100S - use permanent split capacitor motors with sleeve bearings.

Model S Units, 18 through 60 and model P Units, 42 through 80, use sleeve type bearings.

Models 91S through 354S and model P units, 122 through 280, use permanent split capacitor motors with ball bearings.

All sleeve bearing motors have oil

holes to allow lubrication. Ball bearing motors are permanently lubricated although some three phase or special motors have removable plugs which will allow field installation of grease fittings.

The standard 42P through 102P and 18S through 100S motors can be converted to variable speed operation with the addition of the solid state speed control.

See Figures 12 and 13 for typical wiring diagrams.

VARIABLE SPEED CONTROL

The solid state speed controller may be installed at any convenient location and is suitable for surface or flush type mounting. A standard electrical single or double gang wall box is recommended as in Figure 14.

Installation procedure:

1. Attach the control's leads to the electrical leads in the control box using wire nuts. The speed control is to be wired in series with the motor. See wiring diagram in Figure 14.
2. Make certain wire nuts are tight with no copper wire being exposed.
3. Place wires and wire nuts back into box allowing room for the control to fit in box also.
4. Mount speed control to box using Number 6 flathead screws provided.

Setting speed control:

1. Turn the control shaft fully clockwise. If the motor is not running at the desired low speed, adjust the trim on the face of the control for low speed setting using a small screwdriver.
2. Rotate the control shaft counter clockwise. The speed will increase smoothly from minimum to maximum and then switch off.
3. Mount face plate with screws provided and attach control knob. See Figure 15.

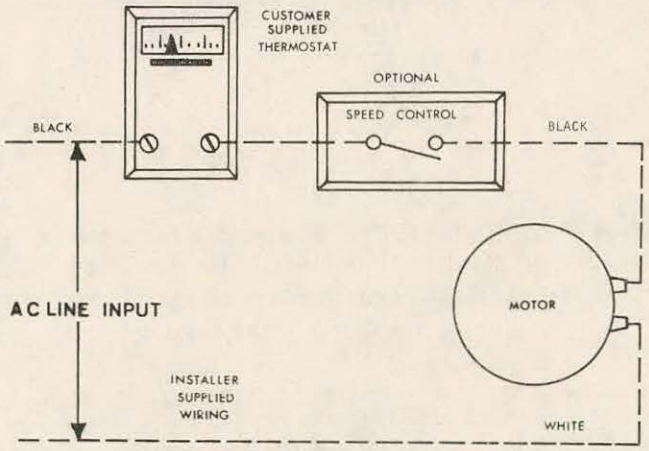


FIGURE 14 - Wiring Diagram of Speed Control Installation

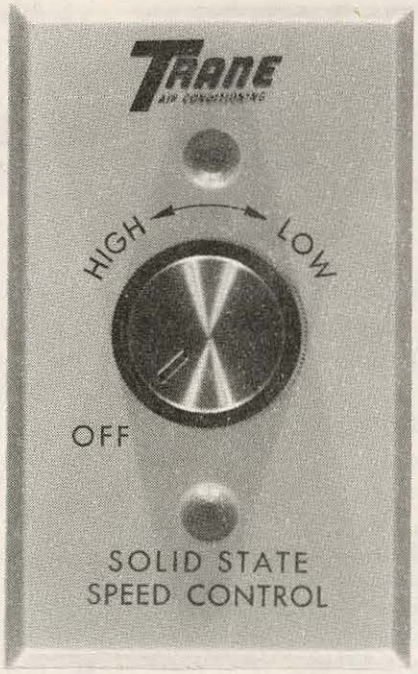


FIGURE 15 - Solid State Speed Control

DIFFUSERS (Optional Equipment)

MODEL P LOUVER CONE DIFFUSER

Rubber mounts and mounting nuts and bolts are provided with each louver cone diffuser. Attach the diffuser to the bottom of the unit heater as shown in Figure 16. Mounting holes are provided in the unit base plate.

Adjust the diffuser to provide the desired air pattern.

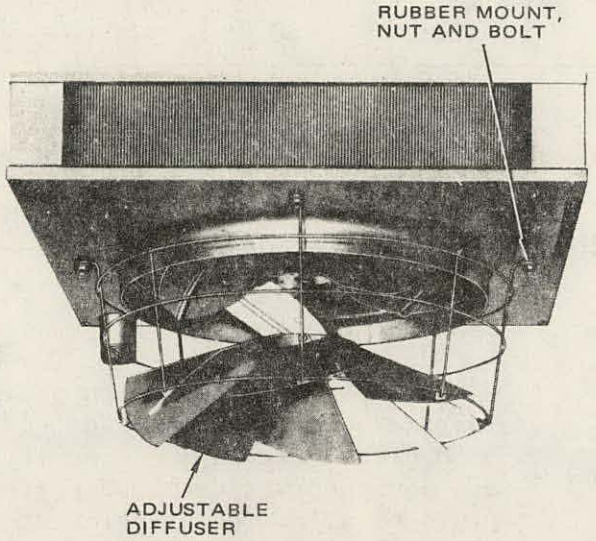


FIGURE 16 - Louver Cone Diffuser Attached to Model P Unit Heater

MODEL S LOUVER FIN DIFFUSER

Turn all horizontal louvers on the unit heater, except the top louver, downward to allow installation of the diffuser.

Starting with the second horizontal louver from the top, position a diffuser between the louvers with the collar of the diffuser over the rear edge of the louver. The diffuser fins should be extended upward between the first and second horizontal louvers. Press the diffuser collar down over the louver. The dimples on the collar will hold the row of diffusers firmly in place. See figures 17, 18 and 19.

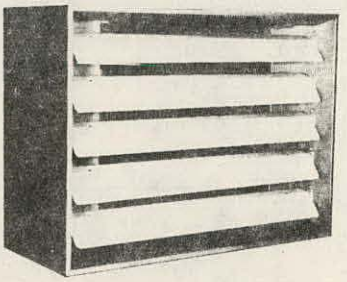


FIGURE 17 - Horizontal Louvers

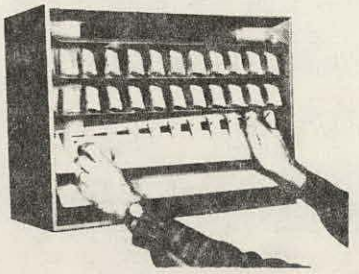


FIGURE 18 - Installing Fin Diffusers

FIGURE 19 - Installing Collar

OPERATING INFORMATION

COILS

Standard Model S Unit Heater coils have 1" O.D. x .031" wall copper tubing and standard Model P Unit Heater coils use 5/8" O.D. x 0.25" wall copper tubing. Maximum recommended steam pressure for standard units is 75 psig at 325 F temperature. For hot water applications, the maximum recommended pressure is 200 psig for Model S and 225 psig for Model P Units with 325 F water temperature for both units.

For higher operating temperatures and pressures, special coils are required. Table 9 outlines the limitations for various coil tube materials.

TABLE 9 - Coil Tube Limitations (Pressure/Temperature)

Tube Material	Tube		Steam		Hot Water	
Model S	O.D.	Wall	Pres. PSIG	Deg. F	Pres. PSIG	Deg. F
Copper (Std.)	1"	.031	75	325	200	325
Red Brass	1"	.049	200	400	260	390
90-10 Cupronickel	1"	.031	300	450	400	450
Steel	1"	.049	600	450	600	450
Model P						
Copper (Std.)	5/8"	.025	75	325	225	325
Red Brass	5/8"	.049	200	425	300	425
90-10 Cupronickel	5/8"	.049	400	450	600	450
Steel	5/8"	.049	600	450	600	450

MAINTENANCE

MOTOR LUBRICATION

SLEEVE BEARINGS

Motors with oilers or oil holes are lubricated before shipment with a good grade of electric motor oil. Refill when necessary with the motor at a stand-still until oil reaches the proper level.

Use SAE 20W oil for motors operating in ambient temperatures of 32 F to 100 F. Above 100 F, use an SAE 30 to SAE 50 oil. Below 32 F, a SAE 10W oil will be required.

The frequency of oiling will depend upon operating conditions and length of running time. Inspect the oilers or oil holes when cleaning the unit. If the unit has a fractional horsepower motor, lubricate at least once a year. Under high ambient conditions or constant fan operation, fractional horsepower motors should be lubricated every 90 days.

On those motors without oilers or oil holes, follow the instructions given on the motor nameplate.

BALL BEARINGS

Ball bearing motors are prelubricated and normally not equipped with grease fittings. However, motors are equipped with removable grease plugs to allow installation of grease fittings if desired by the owner.

Motor manufacturers do not recommend or require on the job lubrication of ball bearing motors. If on the job lubrication is required by the owner, use the following procedure:

With the motor at a stand-still, remove the vent and grease plugs. Install grease fitting and add grease sparingly. Remove the old grease from the vent relief chamber. Operate the motor a few minutes before reinstalling the vent plug to allow excess grease to escape. If there is evidence of grease working out around the motor shaft, less grease should be added and the greasing periods lengthened. If grease continues to appear, take the motor to the motor manufacturer's authorized service station for repair.

NOTE: Consult local motor manufacturer's service facility for information on type of grease and oil to be used.

FAN AND MOTOR ASSEMBLY

For cleaning or maintenance purposes, the fan and motor assembly may be removed easily from the Unit Heater. The motor is attached to the fan guard which is, in turn, mounted to the top or back panel of the unit as shown in Figures 20 and 21.

On Model P Units, reach up through the fan and remove the fan guard mounting screws. Lower the motor, fan and fan guard assembly down through the fan outlet. If desired, the top and bottom panels may be removed from the coil by taking out the four panel mounting bolts. See Figure 20.

On Model S Units, loosen the fan guard mounting screws and lift the motor, fan and fan guard assembly away from the unit. The one-piece back panel may also be removed and slid back over the connecting piping for greater access. See Figure 20.

CLEANING THE UNIT

The unit casing, fan, diffuser and coil should be cleaned thoroughly once a year.

Coil heat transfer efficiency depends on cleanliness. The following recommended procedures may be performed when lubricating the motor and cleaning the coil.

1. Wipe all excess lubricant from the motor, fan and casing. Clean the motor thoroughly. A dirty motor will run hot and eventually cause internal damage.

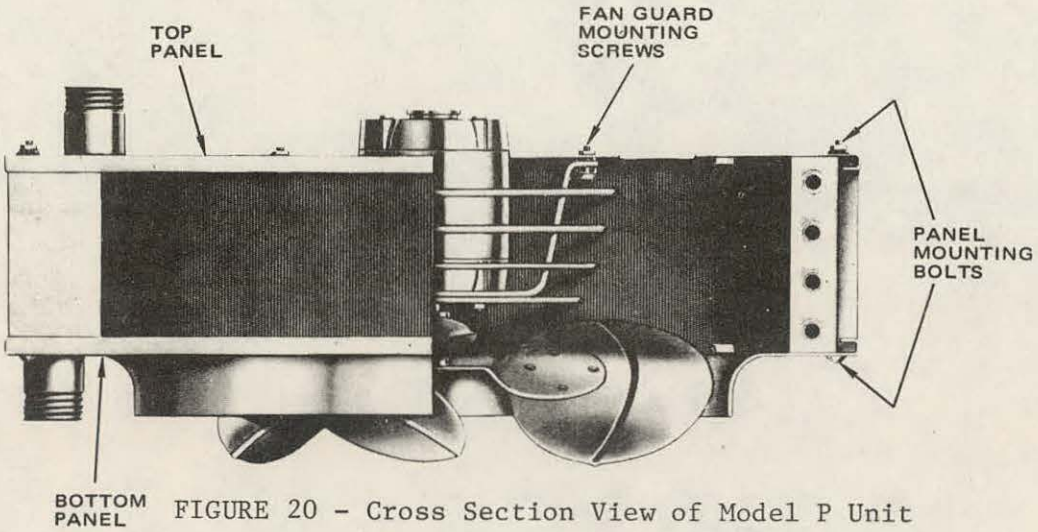


FIGURE 20 - Cross Section View of Model P Unit

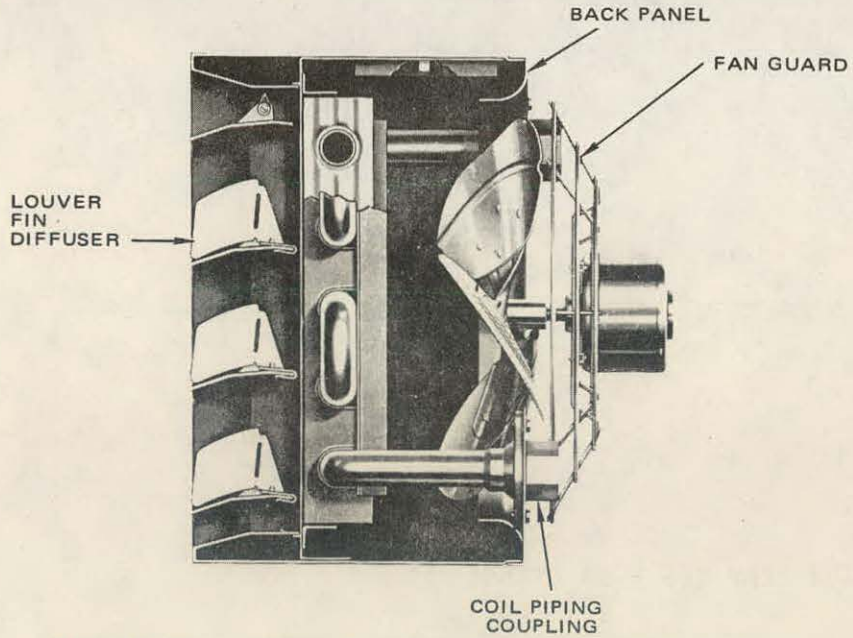


FIGURE 21 - Cross Section View of Model S Unit

2. Clean the coil:

   a. Loosen the dirt with a brush on the fan side of the coil. Operate the motor allowing the fan to blow the loosened dirt through the unit.

   b. Use high pressure air or steam on the side of the coil away from the fan.

      NOTE: A piece of cheesecloth or burlap bag may be used to collect the large particles during the cleaning process.

3. Clean the casing, fan blades, fan guard and diffuser using a damp cloth. Any rust spots on the casing should be cleaned and re-painted.

4. Tighten the fan guard, motor frame and fan bolts. Check the fan for clearance in the panel orifice and free rotation.

REPLACEMENT PARTS

Should service or replacement of parts be required, give complete name-plate identification including the unit serial number. Motors and motor controls supplied with these units are not manufactured by The Trane Company. Service instructions issued by the manufacturers of these items supersede the previous instructions and should be followed in maintaining the units.

PRINTED BY PRODUCTION SERVICES - LA CROSSE S.O.S.

LIMITED WARRANTY

FORD PRODUCTS CORPORATION

VALLEY COTTAGE, N. Y.

PRODUCT: AQUA COIL/SOLAR WATER HEATER

FORD PRODUCTS CORPORATION warrants to the OWNER of this product that FORD will furnish a replacement storage tank assembly in the event of TANK LEAKAGE OR FAILURE OF THE HEAT EXCHANGER, and will furnish a replacement for any other part which has failed in normal use and service because of any defect in material or workmanship.

PARTS WARRANTED:

1. STORAGE TANK ASSEMBLY—The storage tank assembly consists of the storage tank, internal heat exchanger, insulation and outer jacket.
2. OTHER PARTS—Other parts consist of the operating parts, controls, fittings, valves and accessories not directly related to the storage tank.

DURATION OF WARRANTY:

1. STORAGE TANK ASSEMBLY
   a. Domestic service in dwelling having no more than two apartments. — 5 years
   b. Commercial service—all other use. — 3 years
2. OTHER PARTS— — 1 year

NOTE THAT ANY WARRANTY REPLACED ITEM CARRIES ONLY THE UNEXPIRED PORTION OF THE ORIGINAL WARRANTY.

OWNER RESPONSIBILITIES

THE OWNER MUST:

1. Have the storage tank assembly installed with a pressure and temperature relief valve and in accordance with local codes and ordinances.
2. Operate the storage tank assembly at pressures below that shown on the rating plate.
3. Keep the storage tank free of damaging scale deposits.
4. Use a heat transfer fluid that is not toxic and not corrosive.
5. Make provision so that in the event that the unit or one of its fittings were to leak, the resulting flow of water will not cause damage to its surroundings.

HOW TO MAKE A CLAIM

Any claim under this warranty should be made to the contractor or dealer from whom the tank assembly was purchased. If this cannot be done, the factory should be contacted directly.

Any item to be replaced MUST BE made available for inspection in exchange for a replacement.

ITEMS NOT COVERED BY THIS WARRANTY:

FORD PRODUCTS CORP. WILL NOT BE RESPONSIBLE FOR:

1. Any damage resulting from water leaks or accidental discharge from fittings or valves.
2. Any claims resulting from loss of use of the unit, inconveni loss or damage to personal property or consequential damage.
3. Any illness or injury resulting from use of toxic heat transfer fluid.
4. Any shipping costs, either of the replacement unit or part to the owner, or of defective unit or part to the Ford factory.
5. Any labor charges for service, removal or reinstallation.
6. Failure resulting from:
   a. Installation of unit without a properly installed pressure and temperature relief valve.
   b. Coil failure resulting from corrosive action of collector cell liquid agent.
   c. Use of a toxic heat transfer fluid.
   d. Exposure to freezing temperatures.

MISCELLANEOUS

No one is authorized to make any other warranty on Ford Products Corporation's behalf.

Any implied warranty, including merchantability or fitness for a particular purpose shall not extend beyond the warranty period from the date of original installation. Some states do not allow limitation on how long an implied warranty lasts and/or do not allow the exclusion or limitation of incidental or consequental damages, so the above limitations or exclusion may not apply to you.

In the absence of suitable proof of installation the effective date of this warranty will be based upon the month of manufacture plus three (3) months.

This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

OWNERS RECORD—RETAIN IN YOUR FILE

Name of Dealer	Model No.
Address of Dealer	Serial No.

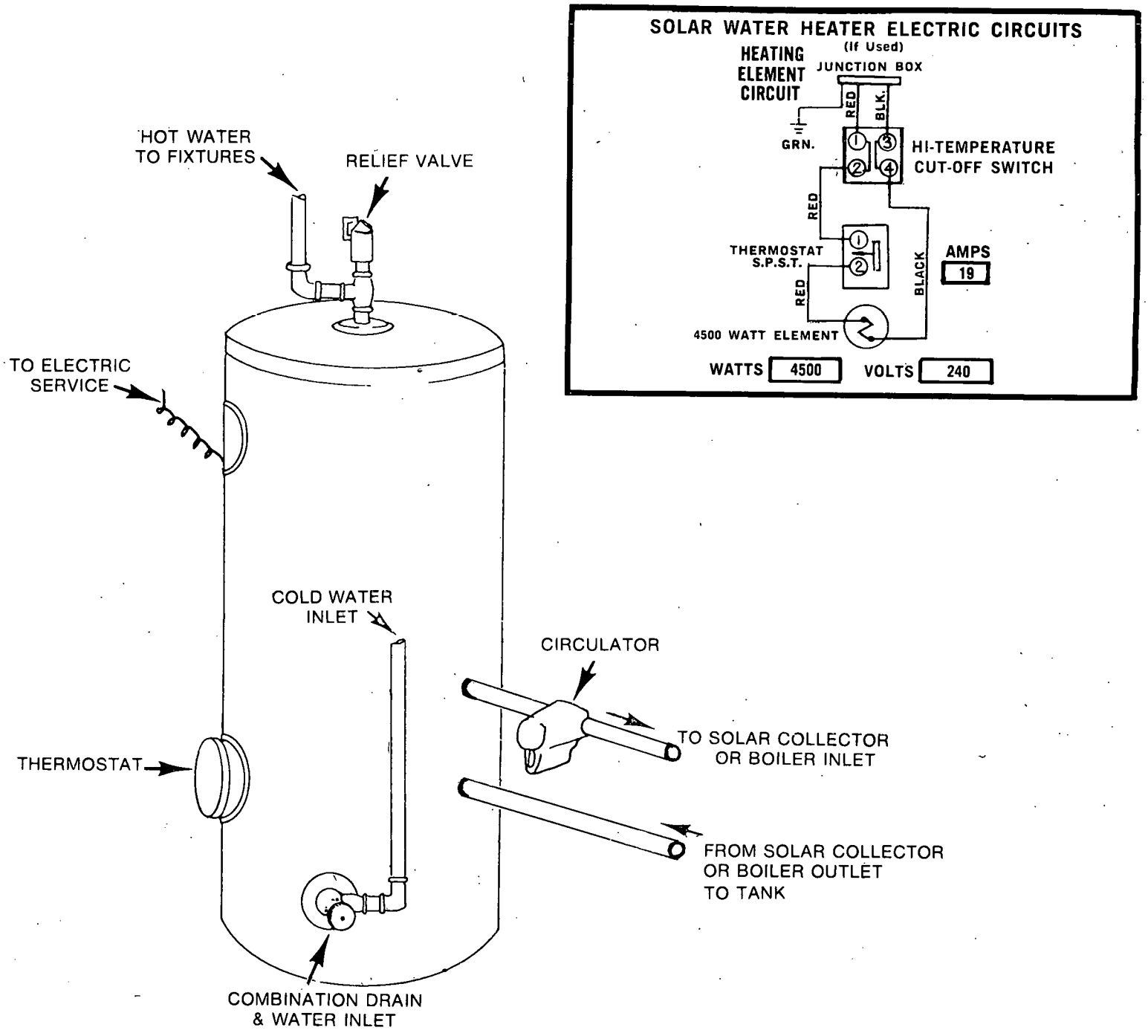
Date of Installation

FORD PRODUCTS CORPORATION
FORD PRODUCTS ROAD
VALLEY COTTAGE, NEW YORK 10989

Form No. A/S 5M-9-77

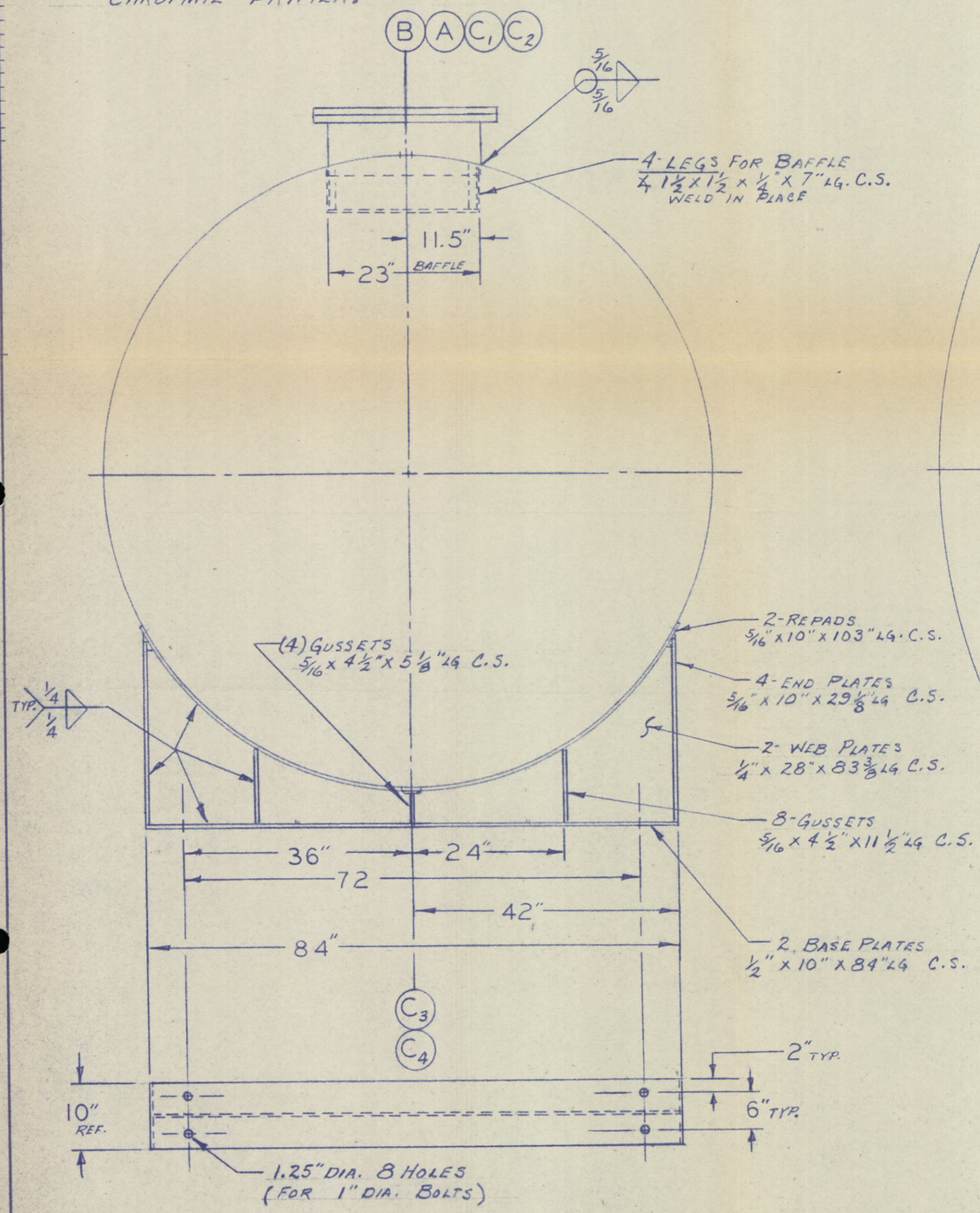
Solar Water Heater

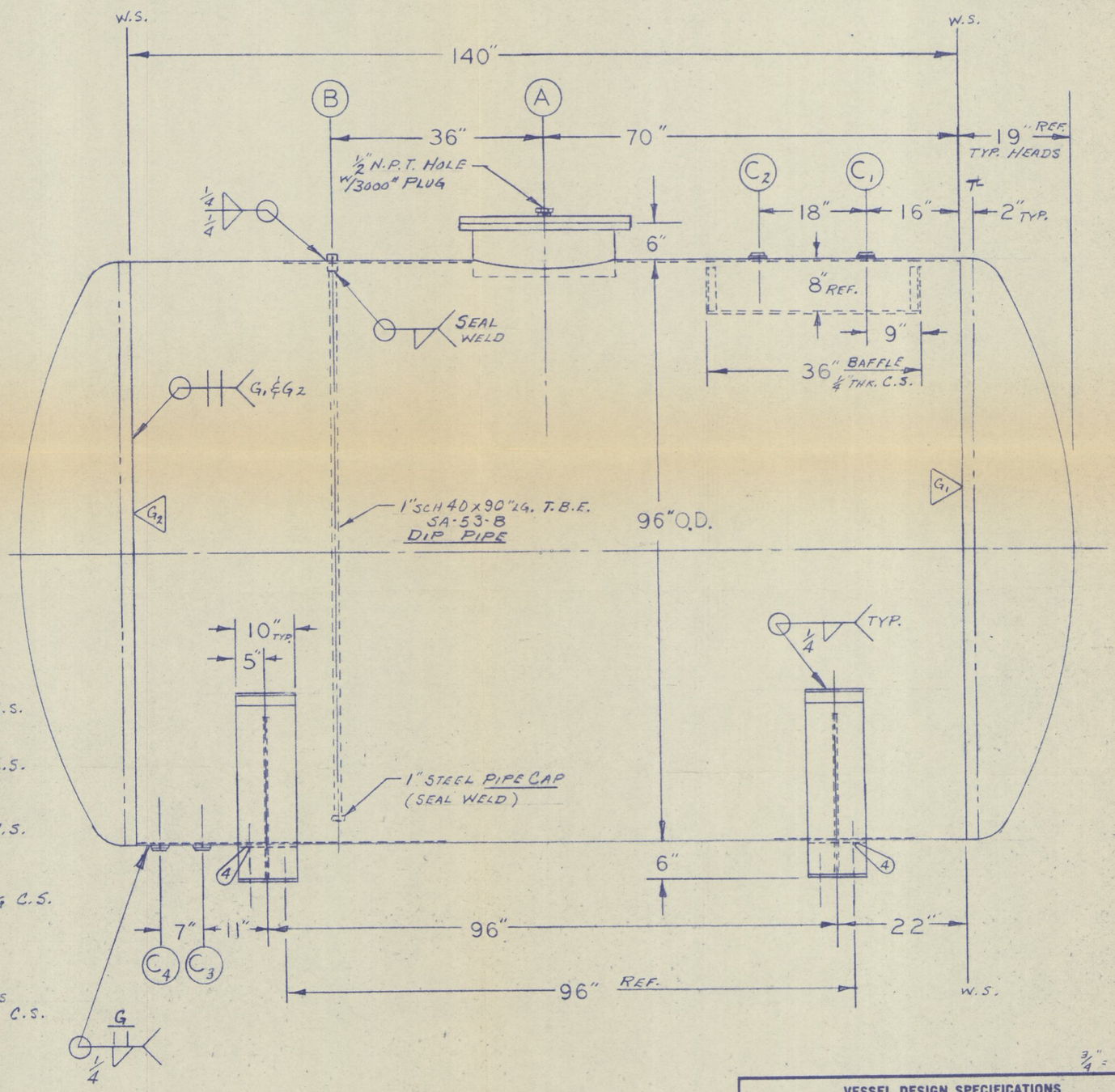
Installation Diagram



NOTES

1. CROWN OF WELD NOT TO EXCEED 1/16.
2. BOLT HOLES TO STRADDLE NATURAL CENTER LINES.
3. REMOVE ALL FOREIGN MATTER FROM INTERIOR.
4. 1/4" N.P.T. HOLE IN REPAD ONLY.
5. EXERIOR PREP: REMOVE ALL FOREIGN MATTER & LOOSE MILL SCALE AND APPLY ONE SHOP COAT OF ZINC CHROMATE PRIMER.





3/4" = 12"

WEIGHT EMPTY 6320# APPROX.
WEIGHT FULL H_2O
PURCHASE ORDER NO. #1397
PROJECT NUMBER
PRESSURE VESSEL NO.
EQUIPMENT NO.

VESSEL DESIGN SPECIFICATIONS U

VESSEL CONSTRUCTED TO CODE ASME SEC VIII STAMPED YES
SHELL MAT'L SA-455 THICKNESS 5/16 (.313)
HEAD MAT'L SA-515-70 THK. 5/16 (.313) TYPE ASME F&P 30" I.D. R II" DA
DESIGN PRESSURE 50 PSI AT TEMP. -20 TO 650 °F
TEST PRESSURE AIR 63 PSI
STRESS RELIEVE NONE JOINT EFFICIENCY GIRTH 70% LONG 70%
CORR. ALLOW. NONE RADIOGRAPHY NONE

MK.	SIZE	FLANGE TYPE	FLANGE RATING	FLANGE MATERIAL	NECK SCH.	NECK MATERIAL	QTY.	SERVICE	REMARKS
C	2"	W. F.	150	SA-105	—	—	4	INLETS & OUTLETS	
B	1"	THD. FULL CPLG	3000	SA-105	—	—	1	THERMAL WELL	W/ DIP PIPE & CAP
A	24"	FAB.	50	SA-515-70	1/4"	SA-455	1	MANWAY	#25-008-20

NOZZLE SCHEDULE

LET.	REVISION	DATE	BY

SIMILAR TO

TOLERANCE UNLESS OTHERWISE SPECIFIED - SEE SPEC. NO.

NILES STEEL TANK
713 WAYNE STREET
NILES, MICHIGAN 49120

TITLE STORAGE TANK 5000 GAL. APPROX.
BUILDING FACILITIES CORPORATION

DRAWN BY	CHECKED BY	APPROVED BY
SNOW 7-26-77	LGK 26 JUL 77	

S.O. NUMBER		DRAWING NUMBER	REV.
7646 C	DO NOT SCALE DRAWING	C-02-233	

SHT. 1 OF 1

DWG. REF.

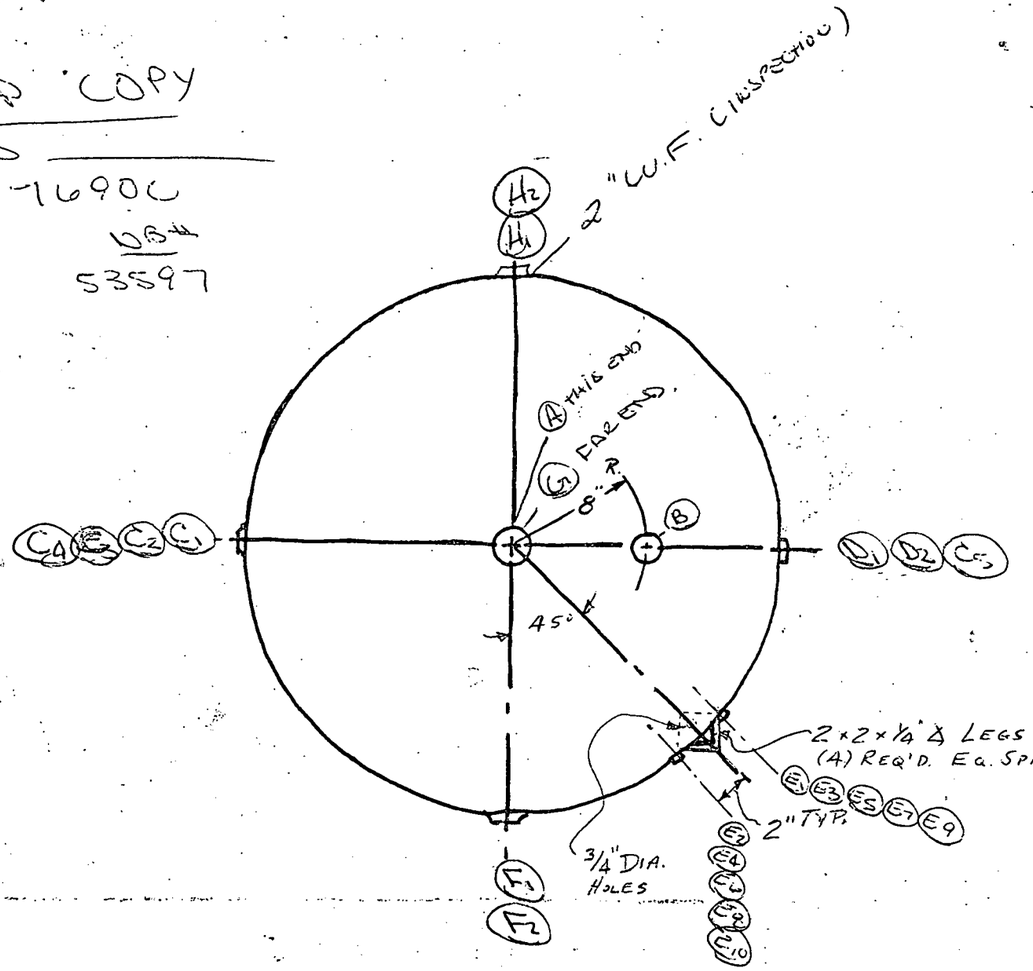
G. LENGEMANN CO. N25481A

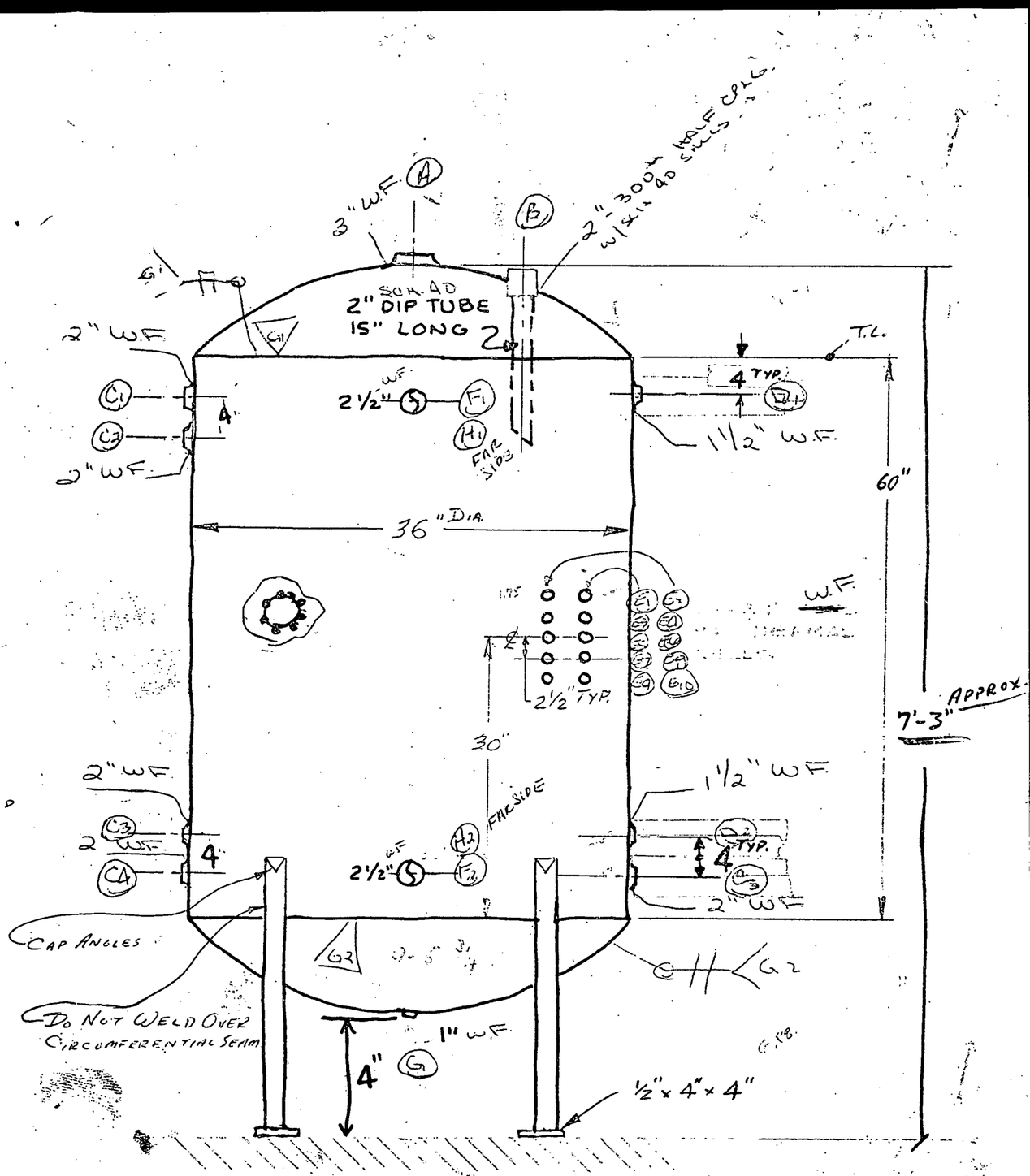
SHOP COPY

REQ'D

S.O.# 7690C

SH#	DB#
75577	53597





VESSEL DESIGN SPECIFICATIONS

VESSEL CONSTRUCTED TO CODE Sec 8

SHELL MAT'L SA-455 THICKNESS .188

HEAD MAT'L SA-455 THK .188 TYPE 2:1 ELIP ~~SPH~~ OF

DESIGN PRESSURE 50 AT TEMP. 650

HYDRO TEST PRESSURE 75

STRESS RELIEVE No JOINT EFFICIENCY 70%

CORR. ALLOW. No RADIOGRAPHY NONE

PAINT EXT: ZINC CHROMATE PRIMER

INT. SOLVIS # 916

FAIRBROTHER & GUNTHER, INC.

THE ENVIRONMENTAL ENGINEERS

325 FULLER N.E. GRAND RAPIDS, MICHIGAN 49503

DR.	
APPR.	
DATE	
ENG. No.	

SHEET No.

FORM U-1A MANUFACTURERS' DATA REPORT FOR PRESSURE VESSELS
(Alternate Form for Single Chamber, Completely Shop-Fabricated Vessels Only)
As Required by the Provisions of the ASME Code Rules, Section VIII, Division 1

1. Manufactured by NILES STEEL TANK COMPANY, NILES, MICHIGAN 7690C
2. Manufactured for Building Facilities Corp., Grand Rapids, Michigan 1400
3. Location of Installation
4. Type Vert. (Horiz. or vert. tank) 75577 (Mfgr's Serial No.) (CRN) (Drawing No.) 53597 (Nat'l Brd. No.) (Year Built) 1977

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 1974 (Year) and Addenda to W-1976 (Date) and Code Case Nos.

Special Service per UG-120(d)

Manufacturers' Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report:

6. Shell Matl. SA-455 (Spec. No., Grade) Nom. Thk. .188 in. Corr. Allow. 0 in. Diam. 3 ft. 0 in. Length 5 ft. 0 in.

7. Seams: Long DBW (Welded, Dbl., Sngl., Lap, Butt) R.T. none (Spot or Full) Efficiency 70 % H.T. Temp. F Time hr.

Girth SBW/BU (Welded, Dbl., Sngl., Lap, Butt) R.T. none (Spot, Partial, or Full) No. of Courses 1

8. Heads: (a) Material SA515-70 (Spec. No., Grade) (b) Material Same (Spec. No., Grade)

Location (Top, Bottom, Ends)	Min. Thk.	Corr. Allow.	Crown Radius	Knuckle Radius	Ellipse Ratio	Conical Apex Angle	Hemisph. Radius	Flat Diam.	Side to Pressure (Convex or Concave)
top	.169				2:1				concave
bottom	.169				2:1				concave

If removable, bolts used (describe other fastenings) (Material, Spec. No., Gr., Size, No.)

9. Constructed for max. allowable working pressure 50 psi. at max. temp. 650 F. Min. temp. (when less than -20 F) F. Hydrostatic test pressure 75 psi.

10. Safety Valve Outlets: Number Size Location in piping

11. Nozzles and Inspection Openings:

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Matl.	Nom. Thk.	Reinforcement Matl.	How Attached	Location
Inspection:	two	2"	thd'd fittings	SA 181 Gr 1			welded	in shell
Inlets & outlets:	one	3"	thd'd fitting	SA 181 Gr 1			weld mat'l	welded
Inlets & outlets:	one	2"-300#	half cplg.	SA 181 Gr 1	w/.154	SA53B	weld mat'l	welded
Inlets & outlets:	five	2", two 1½", one 1"	thd'd fittings	SA 181 Gr 1			weld mat'l	welde
Inlets & outlets:	ten	3/4"	thd'd fittings	SA 181 Gr 1			weld mat'l	welded
Inlets & outlets:	two	2½"	thd'd fittings	SA 181 Gr 1			weld mat'l	welded

12 Supports: Skirt no (Yes or No) Lugs none (No.) Legs 4 (No.) Other none (Describe) Attached welded to bottom head (Where and how)

13. Remarks: Water Storage Tank

CERTIFICATE OF COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME Code for Pressure Vessels, Section VIII, Division 1.

Date SEP 16 1977 Signed NILES STEEL TANK COMPANY (Manufacturer) by James L. Gregg, Inspector

"U" Certificate of Authorization No. 1413 expires March 31, 1980

CERTIFICATE OF SHOP INSPECTION

Vessel made by NILES STEEL TANK COMPANY at Niles, Michigan

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and the State or Province of Ohio and employed by H.S.B.I.&I. Co. have inspected the pressure vessel described in this Manufacturers' Data Report on SEP 16 1977 19____, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied concerning the pressure vessel described in the FManufacturers' Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or loss of any kind arising from or connected with this inspection.

Signed Date SEP 16 1977 Commissions Nat'l Bd. Comm. #2574 Ohio Comm. #1141

FORM U-1A MANUFACTURERS' DATA REPORT FOR PRESSURE VESSELS
(Alternate Form for Single Chamber, Completely Shop-Fabricated Vessels Only)
As Required by the Provisions of the ASME Code Rules, Section VIII, Division 1

1. Manufactured by NILES STEEL TANK COMPANY, NILES, MICHIGAN 7646C
2. Manufactured for Building Facilities Corporation, Grand Rapids, Michigan 1397
3. Location of Installation
4. Type Horiz. (Horiz. or vert. tank) 75560 (Mfgr's Serial No.) (CRN) C-02-233 (Drawing No.) 53580 (Nat'l Brd. No.) (Year Built) 1977
5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 1974 (Year) and Addenda to W-1976 (Date) and Code Case Nos.

Special Service per UG-120(d)

Manufacturers' Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report:

6. Shell Matl. SA-455 (Spec. No., Grade) Nom. Thk. .313 in. Corr. Allow. 0 in. Diam. 8 ft. 0 in. Length 11 ft. 8 in.
7. Seams: Long. DBW (Welded, Dbl., Sngl., Lap, Butt) R.T. none (Spot or Full) Efficiency 70 % H.T. Temp. F Time hr.

Girth DBW (Welded, Dbl., Sngl., Lap, Butt) R.T. none (Spot, Partial, or Full) No. of Courses 2

8. Heads: (a) Material SA515-70 (Spec. No., Grade) (b) Material Same (Spec. No., Grade)

Location (Top, Bottom, Ends)	Min. Thk.	Corr. Allow.	Crown Radius	Knuckle Radius	Ellipse Ratio	Conical Apex Angle	Hemisph. Radius	Flat Diam.	Side to Pressure (Convex or Concave)
ends	.282		90	6.72					concave

If removable, bolts used (describe other fastenings) (Material, Spec. No., Gr., Size, No.)

9. Constructed for max. allowable working pressure 50 psi. at max. temp. 650 F. Min. temp. (when less than -20 F) F ~~hydrostatic~~, pneumatic, ~~or combination~~ test pressure 63 psi.
10. Safety Valve Outlets: Number Size Location in piping
11. Nozzles and Inspection Openings:

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Matl.	Nom. Thk.	Reinforcement Matl.	How Attached	Location
Inspection:	one	24"-50#	manway	SA515-70	w/.250	SA-455	neck welded	in she
Inlets & outlets:	one	3"-3000#	full cplg.	SA-105	w/.133	SA53B	weld mat'l	welded
Inlets & outlets:	four	2" thd'd	fittings	SA-105			weld mat'l	welded

12 Supports: Skirt no (Yes or No) Lugs none (No.) Legs none (No.) Other 2 saddles (Describe) Attached welded to shell (Where and how)

13. Remarks: Water Storage Tank

CERTIFICATE OF COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME Code for Pressure Vessels, Section VIII, Division 1.

Date SEP 2 2 1977 Signed NILES STEEL TANK COMPANY (Manufacturer) by J. L. Gregg James L. Gregg, Inspector

"U" Certificate of Authorization No. 1413 expires March 31, 1980

CERTIFICATE OF SHOP INSPECTION

Vessel made by NILES STEEL TANK COMPANY at Niles, Michigan

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and the State or Province of Ohio and employed by H.S.B.I.&I. Co. have inspected the pressure vessel described in this Manufacturers' Data Report on SEP 2 2 1977 19____, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied concerning the pressure vessel described in the FManufacturers' Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or loss of any kind arising from or connected with this inspection.

Signed Harold A. Lee Date SEP 2 2 1977 Commissions Nat'l Bd. Comm. #2574 Ohio Comm. #1141

JOB: Jordan College
Solar System
Cedar Springs, Michigan

ENGINEER:
Fairbrother & Gunther, Inc.
Grand Rapids, Michigan

CONTRACTOR:
Earl Phelps Mechanical
Cedar Springs, Michigan

#3

TABLE OF CONTENTS

P2 1 -- B100 Bell & Gossett All BRonze Booster Pump, Cap. 12 GPM @ 7' Hd., 1/12 HP, 115/60/1, 1750 RPM. ODP. (with 1½" flanges).

P3 1 -- #60-2A B & G Bronze-fitted Inline Pump, Cap. 48 GPM @ 32' Hd., 1 HP, 115/230/60/1, 1750 RPM. ODP.

P4 1 -- 2" B & G Bronze-fitted Booster Pump, Cap. 40 GPM @ 8' Hd., 1/6 HP, 115/60/1, 1750 RPM. ODP.

P5 1 -- 2" B & G Bronze-fitted Booster Pump, Cap. 20 GPM @ 10' Hd., 1/6 HP, 115/60/1, 1750 RPM. ODP.

P6 1 -- 2" B & G Bronze-fitted Booster Pump, Cap. 20 GPM @ 10' Hd., 1/6 HP, 115/60/1, 1750 RPM. ODP.

P7 1 -- 2" B & G Bronze-fitted Booster Pump, Cap. 40 GPM @ 8' Hd., 1/6 HP, 115/60/1, 1750 RPM. ODP.

2 -- 270 Gallon B & G ASME Compression Tanks, 125# WP with label. 30" dia. x 96" OAL. Complete with Gauge Glass Sets and Special Openings.

1 -- #480-30 B & G ASME Pressure Relief Valve.

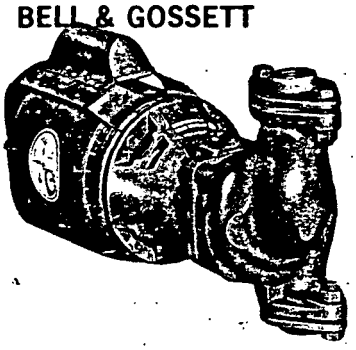
REVIEWED WITHOUT EXCEPTION ✓
REVIEWED WITH EXCEPTIONS NOTED
RESUBMITTAL REQUIRED
SHOP DRAWINGS ARE REVIEWED FOR GENERAL CONFORMANCE WITH THE DESIGN CONCEPT OF THE PROJECT. ALL EQUIPMENT SUBJECT TO DETAILED REQUIREMENTS OF CONTRACT DOCUMENTS.
FAIRBROTHER & GUNTHER, INC.
BY J. VanDam DATE 9.6.77

(1-1)

R.L. DEPPMANN COMPANY
333 Fuller Avenue NE
Grand Rapids, Michigan 49503

August 31, 1977

BELL & GOSSETT



Iron & Bronze* Booster Pump

SUBMITTAL

A-120
REVISION 10

JOB Jordan College Solar System
UNIT TAG NO. _____
B & G REPRESENTATIVE R.L. Deppmann Company
ORDER NO. (BF) 1408 DATE 8/30/77
ENGINEER Fairbrother & Gunther, Inc. SUBMITTED BY _____ DATE _____
CONTRACTOR Earl Phelps Mechanical APPROVED BY _____ DATE _____

*Where Service Water Is Pumped, Use A Bronze Booster Pump.

OPERATING DATA

Maximum Working Pressure.....125 PSI
Maximum Operating Temperature
Standard Seal: 225°F. continuous • 250°F. intermittent on closed systems using modulated temperature control, proper pump location and system pressurization.
Special Seals: 250°F. continuous consult your local wholesaler, B&G representative or the factory).
Maximum Motor RPM.....1750

CONSTRUCTION MATERIALS

Booster Body..Cast Iron or Bronze
Impeller:

Pump Model No.	Iron Body	Bronze Body
Series 100	— Polypropylene or Brass —	
SC-75	—	Brass
Series HV & 2"	Phenolic	Phenolic
Series PR, 2½", LD3, HD3, PD35 & PD37	Steel, Cadmium Plated	Brass
PD38 & PD40	Cast Iron	Brass

Shaft.....Carbon Steel
Seal.....Mechanical, Carbon on Ceramic
Pump Bearings..Bronze, Sleeve, Oil Lubricated
Coupler...All Booster Pumps except PD38 and PD40 Flexible, Spring-loaded type PD38 and PD40...Flexible
Motor....Vibrationless oil lubricated sleeve bearing motor approved by CSA and recognized under the Component Program of Underwriters' Laboratories, Inc.
Motor Bearings..Bronze, Sleeve, Oil Lubricated

SCHEDULE

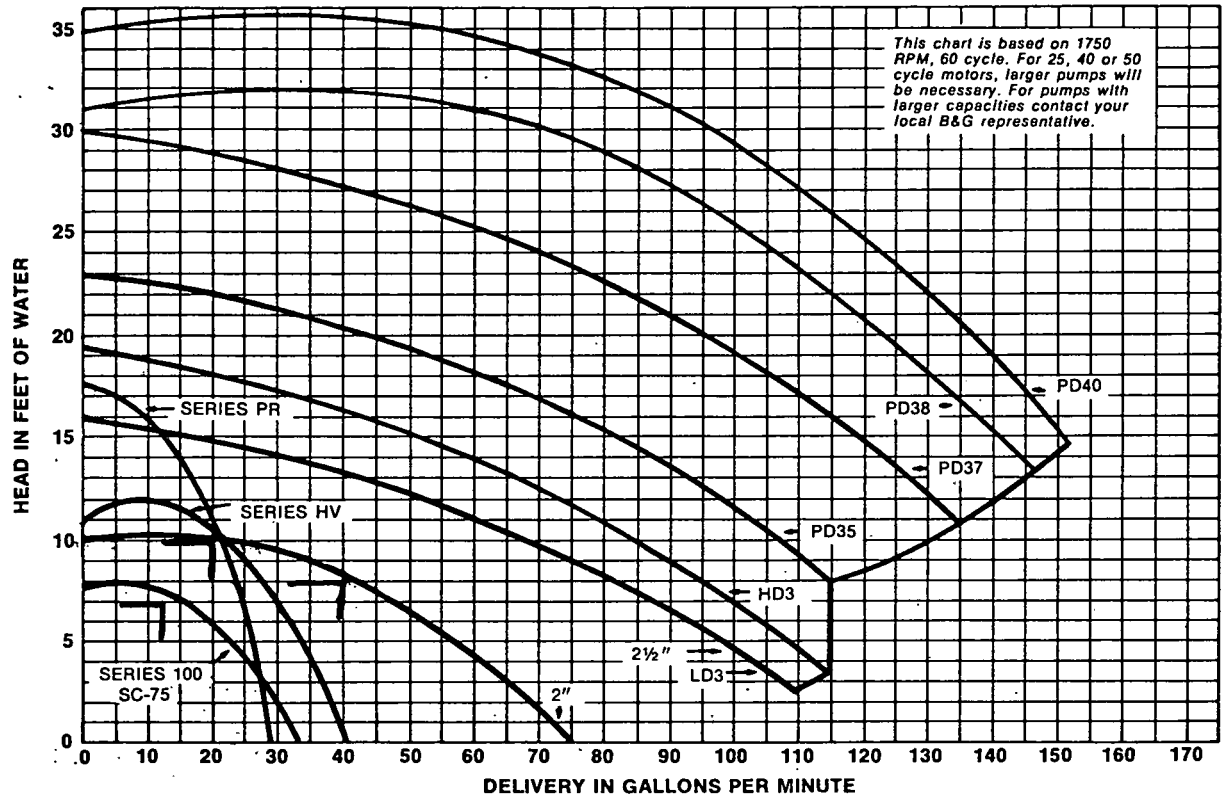
MODEL NO.	FLANGE SIZE—NPT INCHES (specify size)	**STANDARD 60 CYCLE MOTOR CHARACTERISTICS (special motors available on request) HP	ø	VOLTAGE	TAGGING INFORMATION	QUANTITY
SERIES 100	¾, 1, 1¼ & 1½	1/12	1	115—WITH BUILT-IN OVERLOAD PROTECTION	P2	1
SC-75	SWEAT					
SERIES PR	¾, 1, 1¼ & 1½	1/6				
SERIES HV	1, 1¼ & 1½					
2	2				P4, P5, P6, P7	4
2½	2½	1/4				
LD3	3					
HD3		1/3				
PD35-S		1/2		115/230		
PD35-T***			3	208-230/460		
PD37-S		3/4	1	115/230		
PD37-T***			3	208-230/460		
PD38-S		1	1	115/230		
PD38-T***			3	208 or 230/460		
PD40-S		1½	1	115/230		
PD40-T***			3	208 or 230/460		

**Motors with special electrical characteristics are available on request at additional cost. Refer to motor data sheet HS-615 or contact your local Bell & Gossett Representative for details.
***External overload must be provided.

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

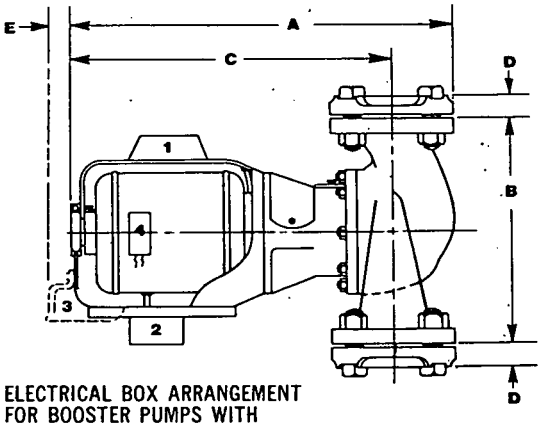
IRON AND BRONZE BOOSTER PUMP

*Performance characteristics are based on using 1¼" or 1½" flanges. When using ¾" or 1" flanges performance will be slightly reduced.



DIMENSIONS & WEIGHTS

MODEL NO.	FLANGE SIZE NPT INCHES (specify size)	DIMENSIONS IN INCHES (open drip-proof) A	B	C	D	E	APPROX. SHPG. WT. LBS. IRON BODY	BRONZE
SERIES 100	¾	15	6⅜	12⅞	9/16	—	21	21
	1 & 1¼				¾	—		
	1½				15/16	—		
SC-75	SWEAT		7⅜		—	—	—	20
SERIES PR	¾	16¼	8½	13⅜	9/16	—	35	37
	1 & 1¼				¾	—		
	1½				15/16	—		
SERIES HV	1	16⅛		13¾	⅝	—	28	30
	1¼ & 1½				¾	—		
2	2	17⅜		14¾	13/16	—	40	42
2½	2½		10	14⅛	1 1/16	—	58	62
LD3	3					—	55	60
HD3		18⅜		15⅛		—	60	65
PD35-S		20¾	12	17⅜		1⅛	78	83
PD35-T		20¼		16⅞			75	80
PD37-S		21¼		17⅞			85	90
PD37-T		20¾		17⅜			82	87
PD38-S		24	14½	19½	1¼	—	128	138
PD38-T		24¼		19¾		—	125	135
PD40-S		24⅝		20⅛		—	130	140
PD40-T		25⅛		20⅝		—	127	137



ELECTRICAL BOX ARRANGEMENT FOR BOOSTER PUMPS WITH BELL & GOSSETT MANUFACTURED MOTORS

Model Number	#1	#2	#3	#4
Series 100 and SC-75	All Standard	Other-1Ø	3Ø	—
Series HV and 2"	115 Volt 1Ø Only			
Series PR 2½", LD3 and HD3	—	1Ø		
PD35 and PD37		—	All	
PD38 and PD40			—	All

TYPICAL SPECIFICATION

The Contractor shall furnish and install In-The-Line Pumps as illustrated on the plans and in accordance with the following specifications:

1. The pumps shall be of the horizontal, oil-lubricated type, specifically designed and guaranteed for quiet operation. Suitable for 125# working pressure.

2. The pumps shall have a ground and polished steel shaft with integral thrust collar. The shaft shall be supported by two horizontal sleeve bearings designed to circulate oil. The pumps are to be equipped with a water-tight seal to prevent leakage. Mechanical seal faces to be carbon on ceramic. The motor shall be non-overloading at any point on pump curve.

3. The motor shall be of the open, drip-proof, sleeve-bearing, quiet-operating, rubber-mounted construction. Motors shall have built-in thermal overload protectors. (Exception—PD models with 3-phase motors, see paragraph 4.)

4. For PD models with 3-phase motors, add the following: The Contractor shall furnish and install a magnetic starter for each booster pump, with at least two thermal overload protectors. The starter shall be equipped with manual reset buttons.

The pump shall be Bell & Gossett Model No. _____, or approved equal with a capacity of _____ GPM at _____ Ft. head when directly driven through a self-aligning flexible coupling by an oil-lubricated motor, _____ volts _____ cycle _____ phase(Ø).

PRINTED IN U.S.A. 3-77

BELL & GOSSETT
8200 N AUSTIN AVE • MORTON GROVE, ILL 60053
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

BELL & GOSSETT PRODUCTS

CENTRIFUGAL PUMPS
SUBMITTAL B-131.4
REVISION 7

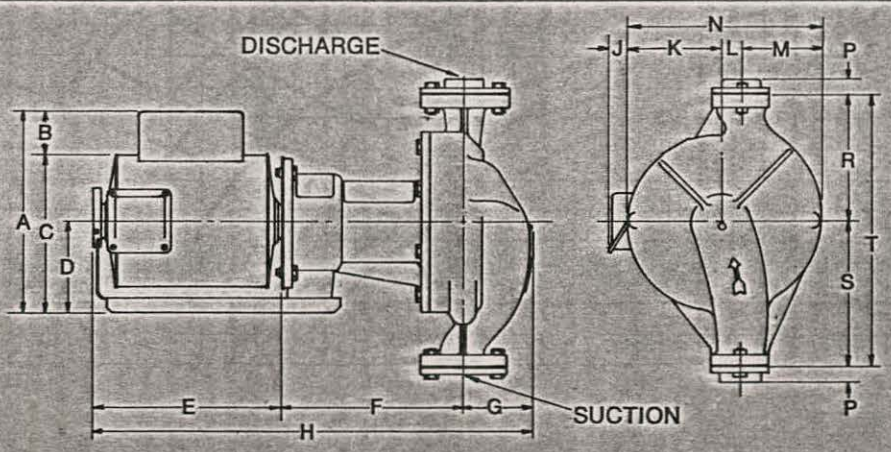
2A

In-Line Mounted Centrifugal Pumps

SERIES "60"

JOB Jordan College
Solar System
UNIT TAG NO. P3
ENGINEER Fairbrother & Gunther, Inc.
CONTRACTOR Earl Phelps Mechanical
B & G REPRESENTATIVE R.L. Deppmann Company
ORDER NO. (BF)1408 DATE 8/30/77
SUBMITTED BY _____ DATE _____
APPROVED BY _____ DATE _____

DIMENSIONS



PUMP SIZE	SUCTION AND DISCHARGE SIZE—INCHES NPT	PUMP DIMENSIONS—INCHES									
		F	G	K	L	M	N	P	R	S	T
2A	2	9¾	3½	4¾	1	4⅛	9⅞	1⅜	6½	7½	14

Companion Flanges furnished for Suction and Discharge

ALL MOTORS 1750 RPM

MOTOR SIZE		MOTOR DIMENSIONS—INCHES						
H.P.	PHASE	A	B	C	D	E	H	J
½	1	9½	2⅛	7⅜	4⅜	11½	24¾	—
½	3	7⅜	—	7⅜	4⅜	11	24¼	—
¾	1	9½	2⅛	7⅜	4⅜	12	25¼	—
¾	3	7⅜	—	7⅜	4⅜	11½	24¾	—
1	1	10⅝	2⅛	8⅛	4¾	9¾	23	¾
1	3	8⅛	—	8⅛	4¾	10	23¼	¾
1½	1	10⅝	2⅛	8⅛	4¾	10⅜	23⅝	¾
1½	3	8⅛	—	8⅛	4¾	10⅞	24⅛	¾
2	3	8⅛	—	8⅛	4¾	11⅛	24⅛	¾

SPECIAL INFORMATION REQUIRED

48 GPM 32 FT.

MATERIALS OF CONSTRUCTION:

☒ BRONZE FITTED ☐ ALL IRON ☐ ALL BRONZE

ELECTRICAL DATA: 1 HP

115/230 VOLTS 60 CY. 1 PH.

MOTOR ENCL. ODP

SPEC. CONSTR. _____

APPROXIMATE WEIGHT _____ LBS.

MAXIMUM WORKING PRESSURE 175 PSI

SEE PERFORMANCE CURVE ON REVERSE SIDE

BELL & GOSSETT MORTON GROVE, ILL. 60053
Fluid Handling Division, International Telephone and Telegraph Corporation ITT

PRINTED IN U.S.A. 12-73

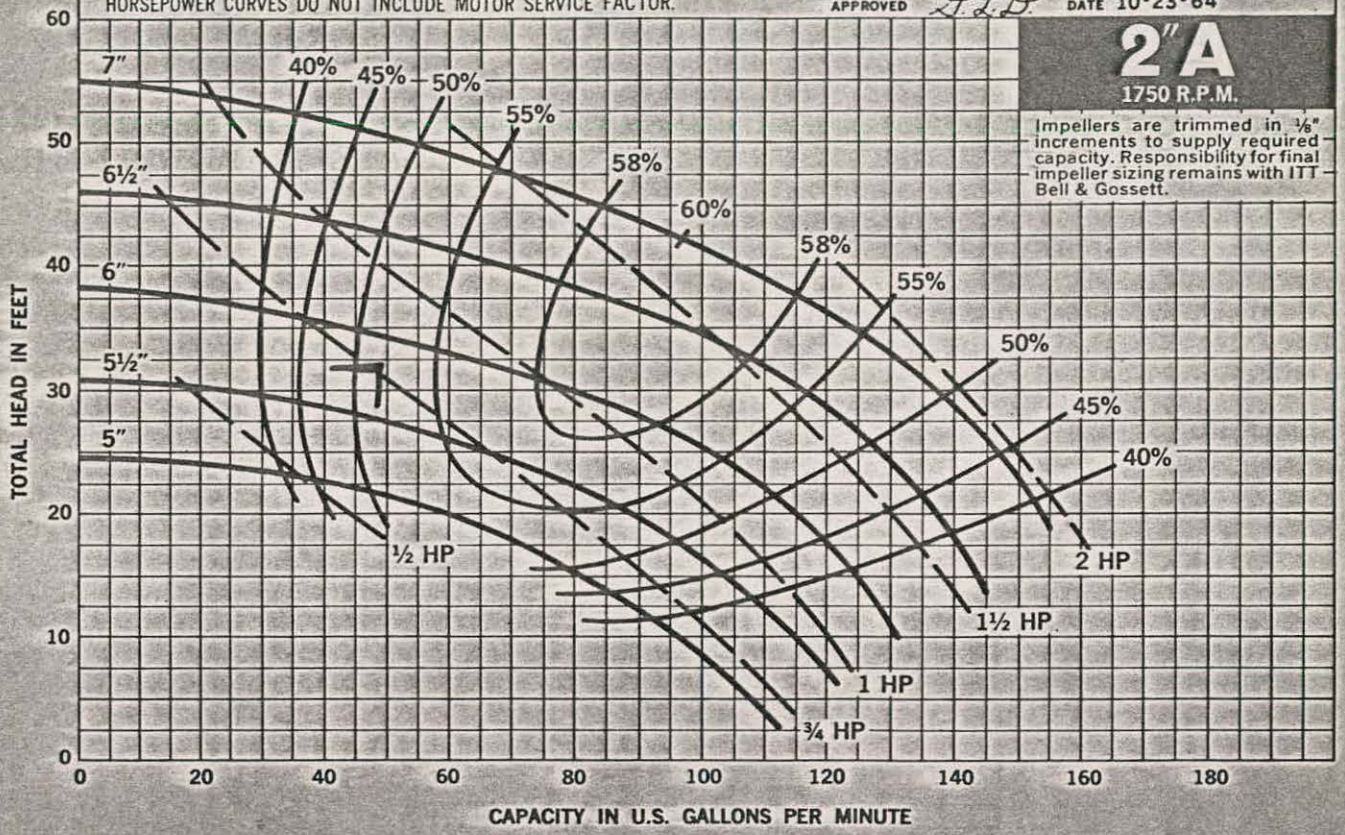
SERIES "60" PERFORMANCE CURVES

PERFORMANCE CHARACTERISTIC CURVE

FOR 2"A CENTRIFUGAL PUMP FIG. NO. SERIES 60 SPEED 1750 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY. HORSEPOWER CURVES DO NOT INCLUDE MOTOR SERVICE FACTOR.

APPROVED L.L.D. DATE 10-23-64



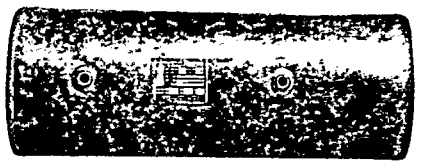
BELL & GOSSETT MORTON GROVE, ILL. 60053 ITT

Fluid Handling Division, International Telephone and Telegraph Corporation

BELL & GOSSETT

SUBMITTAL

A-332
REVISION 6



ASME Compression Tanks

Air Control

JOB Jordan College Solar System
UNIT TAG NO. _____
B & G REPRESENTATIVE R.L. Deppmann Company
ORDER NO. 1408 DATE 8/30/77
ENGINEER Fairbrother & Gunther, Inc SUBMITTED BY _____ DATE _____
CONTRACTOR Earl Phelps Mechanical APPROVED BY _____ DATE _____

DESCRIPTION

The Compression Tank absorbs the expansion forces of the system water and provides proper pressurization under varying operating conditions. Used with *Airtrol Fittings* it provides positive air control, by accepting and confining all free air in the system.

CONSTRUCTION

Carbon steel with two ½" gauge glass tappings and four 3/16" diameter telltale holes (approved by the A.S.M.E. Pressure Vessel Code) on the shells. Constructed in accordance with ASME and so stamped.

PERFORMANCE LIMITATIONS

Maximum Working Pressure 125 PSIG
Maximum Operating Temperature 375°F

SCHEDULE

MODEL NO. AND GALLON CAPACITY	TAGGING INFORMATION	QUANTITY
15		
24		
30		
40		
60		
80		
100		
120		
144		
163		
202		
238		
270		2
306		
337		
388		

TYPICAL SPECIFICATION

Furnish and install as shown on the plans a _____ gallon, _____" X _____" compression tank with 1/2" gauge glass tappings. The unit must be constructed in accordance with A.S.M.E. boiler and pressure vessel code and stamped 125 PSIG working pressure.

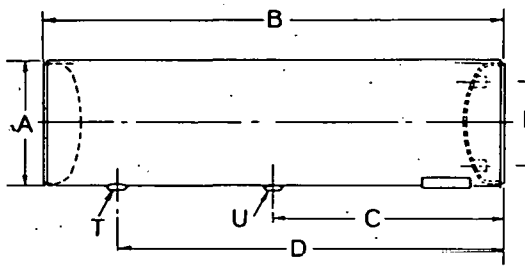
A Manufacturers' Data Report for Pressure Vessels, Form U-1 as required by the provisions of the A.S.M.E. boiler and pressure code shall be furnished with each unit.

Each compression tank shall be ITT Bell & Gossett Model No. _____ or equal.

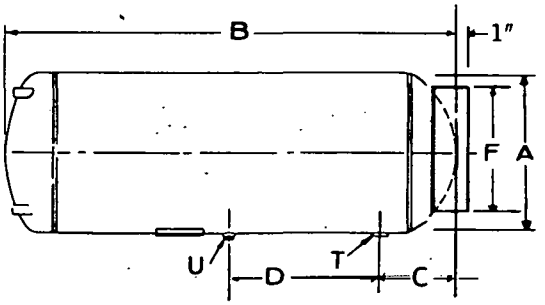
(see reverse side for Airtrol product and system guarantee)

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

ASME COMPRESSION TANKS (Air Control)



Nos. 15 thru 144



Nos. 163 thru 388

DIMENSIONS & WEIGHTS

MODEL NUMBER	DIMENSIONS IN INCHES						TAPPINGS NPT			APPROX. SHIP. WGT.—LBS.
	A	B	C	D	E	F	T	U	W	
15	13	34½	17¼	24¾	7½		½	½	½	63
24	13	51	25½	38	7½		½	½	½	86
30	13	61½	30¾	46¼	7½		½	½	½	99
40	16¼	53	26½	39¼	10		½	½	½	119
60	16¼	76½	38¼	58	10		½	½	½	157
80	20¼	68	34	50¾	14		½	1	½	205
100	20¼	82	41	61¾	14		½	1	½	236
120	24¼	71½	35¾	53¼	18		½	1	½	267
144	24¼	83½	41¾	62¾	18		½	1	½	298
163	30	60	13⅛	16⅞	24	27	½	1	½	396
202	30	72	13⅛	22⅞	24	27	½	1	½	456
238	30	84	13⅛	28⅞	24	27	½	1	½	515
270	30	96	13⅛	34⅞	24	27	½	1	½	574
306	30	108	13⅛	40⅞	24	27	½	1	½	633
337	36	84	14¾	27 5/16	30	30½	½	1	½	599
388	36	96	14¾	33 5/16	30	30½	½	1	½	669

AIRTROL SYSTEM PERFORMANCE GUARANTEE

The B&G Airtrol System consists of a B&G Compression Tank(s), Airtrol Tank Fittings(s), Airtrol Boiler Fitting, In-Line Airtrol or Rolairtrol Air Separator.

The Airtrol System is guaranteed to prevent the accumulation of air in heating and cooling units and prevent noises caused by entrained air in piping. In case of failure of any B&G Airtrol System (within the USA) to operate correctly, when installed and operated in accordance with our published instructions on an air tight system, we will provide, free of charge, the services of a factory trained engineer who will supervise steps necessary to provide satisfactory results.

AIRTROL PRODUCT GUARANTEE

B&G Compression Tanks, Airtrol Tank Fittings, Airtrol Boiler Fittings, In-Line Airtrol and Rolairtrol Air Separators are guaranteed to last the entire life of the heating or cooling system in which they are installed. Labor charges for replacement are not allowed.

PRINTED IN U.S.A. 6-75

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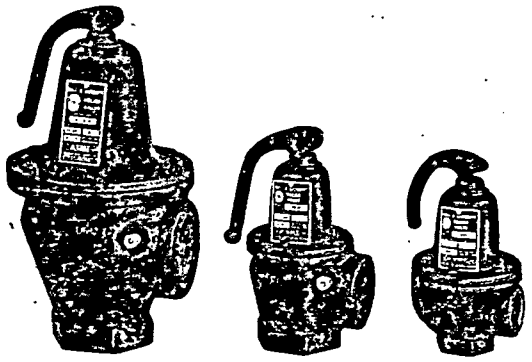
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

BELL & GOSSETT

SUBMITTAL

A-434
REVISION 2



RELIEF VALVES—ASME

Valves and Fittings

JOB Jordan College
Solar System

UNIT TAG NO. _____

ENGINEER Fairbrother & Gunther, Inc.

CONTRACTOR Earl Phelps Mechanical

B & G REPRESENTATIVE R.L. Deppmann Company

ORDER NO. (BF) 1408 DATE 8/30/77

SUBMITTED BY _____ DATE _____

APPROVED BY _____ DATE _____

DESCRIPTION

B&G Relief Valves are designed to protect the heating system against high pressure conditions. During an emergency, a B&G diaphragm-operated valve has exceptionally strong opening power. These valves are built to A.S.M.E. requirements—tested by National Board and labeled with A.S.M.E. symbol. They are offered in a wide range of capacities to permit close matching of Relief Valve capacity to the boiler load.

CONSTRUCTION

All internal working parts in B&G Relief Valves are made of brass or specially compounded rubber. Body is iron.

SCHEDULE

MODEL NUMBER	SIZE TAPPINGS	VALVE SETTING	TAGGING INFORMATION	QUANTITY ORDERED
480-15	¾ x 1	15		
480-30		30		1
480-36		36		
480-45		45		
480-50		50		
480-75		75		
480-100		100		
480-125		125		
750-15	1 x 1¼	15		
750-30		30		
750-36		36		
750-45		45		
750-50		50		
750-75		75		
750-100		100		
750-125		125		
1050-15	1¼ x 1¼	15		

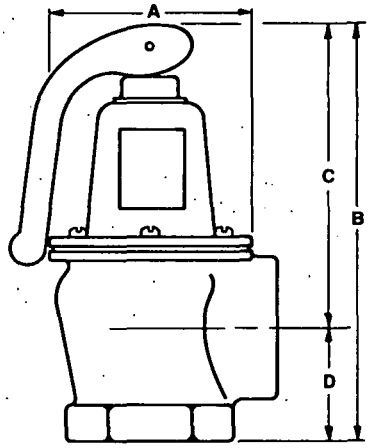
MODEL NUMBER	SIZE TAPPINGS	VALVE SETTING	TAGGING INFORMATION	QUANTITY ORDERED
1050-30	1¼ x 1¼	30		
1050-36		36		
1050-45		45		
1050-50		50		
1050-75		75		
1050-100		100		
1050-125		125		
3300-15	1½ x 2	15		
3300-30		30		
3300-36		36		
3300-45		45		
3300-50		50		
4100-15	2 x 2	15		
4100-30		30		
4100-36		36		
4100-45		45		
4100-50		50		

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

PERFORMANCE CHARACTERISTICS

MAX. WORKING PRESSURE—125 P.S.I.G. MAX. OPERATING TEMPERATURE—250°F.

VALVE SETTING	RELIEF VALVE MODEL NUMBER AND CAPACITY IN BTU PER HOUR				
15 Lbs.	No. 480-15 300,000	No. 750-15 500,000	No. 1050-15 650,000	No. 3300-15 2,000,000	No. 4100-15 2,500,000
30 Lbs. Standard Setting	No. 480 480,000	No. 750 750,000	No. 1050 1,050,000	No. 3300 3,300,000	No. 4100 4,100,000
36 Lbs.	No. 480-36 540,000	No. 750-36 830,000	No. 1050-36 1,200,000	No. 3300-36 3,800,000	No. 4100-36 4,600,000
45 Lbs.	No. 480-45 640,000	No. 750-45 1,000,000	No. 1050-45 1,350,000	No. 3300-45 4,500,000	No. 4100-45 5,550,000
50 Lbs.	No. 480-50 700,000	No. 750-50 1,100,000	No. 1050-50 1,440,000	No. 3300-50 4,900,000	No. 4100-50 6,050,000
75 Lbs.	No. 480-75 980,000	No. 750-75 1,500,000	No. 1050-75 2,020,000		
100 Lbs.	No. 480-100 1,250,000	No. 750-100 1,900,000	No. 1050-100 2,565,000		
125 Lbs.	No. 480-125 1,540,000	No. 750-125 2,300,000	No. 1050-125 3,015,000		



DIMENSIONS & WEIGHTS

MODEL NUMBER	DIMENSIONS—INCHES				VALVE TAPPINGS		APPROX. SHIPPING WEIGHT—LBS.
	A	B	C	D	INLET	OUTLET	EACH
480	3½	6⅜	4⅞	1½	¾	1	4
750		7⅜	5⅜	2	1	1¼	5
1050					1¼		
3300	6	11	7	3¼	1½	2	18
4100					2		

TYPICAL SPECIFICATION

Furnish and install as shown on plans a diaphragm operated Relief Valve, ASME labeled for relieving pressure of_____psig with a rating of_____Btu/hr. The fluid should not discharge into the spring chamber. The valve should have a low blow-down differential. The valve seat and all moving parts exposed to the fluid to be of non-ferrous material.

Manufacturer ITT Bell & Gossett No._____.

ASME Relief Valve set at_____psig, rated at_____Btu/hr.

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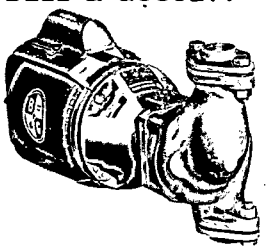
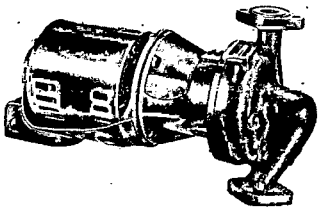
BELL & GOSSETT





INSTRUCTION SHEET

S16946
REVISION 4
Also replaces
Instruction Manual S17630

BOOSTER AND SERIES "60" IN-LINE CENTRIFUGAL PUMPS

INSTALLATION, OPERATION AND SERVICE INSTRUCTIONS

INSTALLATION INSTRUCTIONS

LOCATION

If the pump is not installed on a closed system it should be placed as near as possible to the source of supply, and located to permit installation with the fewest possible number of bends or elbows in the suction pipe.

ALIGNMENT

The compact construction of this pump makes it very unlikely that any misalignment of parts will occur, but a check should be made before putting the pump in service by turning the shaft by hand to determine that there is no binding.

PIPING

It is important that air be kept out of the system. On an open system always place the end of the suction pipe at least 3 feet below the surface of the water in the suction well to prevent air from being drawn into the pump. Avoid air pockets in the suction line and make sure that each section of the suction pipe is absolutely air tight.

Install a square head valve and a check valve in the discharge pipe close to the pump. The check valve should be between the square head valve and the pump discharge nozzle. The square head valve can be used to control the capacity of the pump or to shut off the discharge line while repairs are being made. The function of the check is to protect the pump casing from breakage that might occur due to the action of water hammer.

A 10-32 NF eye bolt has been included with the larger pump packages, use of which is optional, to enable supporting the bearing bracket from above the pump when the piping is not able to provide the necessary support.

Do not support under motor, misalignment will occur.

SYSTEM PREPARATION

Prior to pump start up, the system should be cleaned with a trisodium phosphate solution, flushed and drained. Then refilled with clean liquid. The PH should be maintained between 7 and 8.

PRIMING

DO NOT RUN PUMP DRY. Before starting, these pumps must be filled with water. After the pump has been filled, turn the shaft a few times by hand to allow all air to escape and if necessary add more water. The square head valve in the discharge should be kept closed until the pump is running at full speed and then gradually opened.

LUBRICATION

All new Bell & Gossett Boosters and Series "60" In-line centrifugal pumps are test run at the factory, but must be lubricated before being placed in operation.

Lubricate as follows:

1. Pump Bearings—Fill the bearing frame per oiling instruction tag with SAE #20 oil until oil flows from the overflow hole on the side of the bearing bracket. PD38, PD40 and Series 60 "A" size pumps are to be lubricated until oil level is up to the side hole. Relubricate as necessary to maintain this level.

2. Sleeve Bearing Motor—Lubricate thru the two motor oil cups per motor lubrication tag once every four months. Use ten to fifteen drops in each oil cup if required.

3. Ball Bearing Motor—Relubricate every six months to two years depending on operating conditions with a good soda-soap or lithium base grease.

NOTE: Over-oiling can cause deterioration of the motor mounts which in turn causes excessive coupler wear from misalignment.

OPERATING INSTRUCTIONS

1. Be sure to operate the pump in the proper direction. All PD and Series 60 run clockwise when looking at the pump from the motor end. All boosters run counterclockwise when looking at the pump from the motor end. All pumps are provided with arrows showing direction of rotation.

2. Keep pump and motor bearings lubricated.

3. Do not disassemble pump unless absolutely necessary as impeller has been accurately adjusted and tested before leaving factory.

4. Pump shaft should always turn freely by hand.

5. Ask for information or help if trouble is experienced that cannot be rectified since this pump is guaranteed to operate as recommended.

6. If pumps are to be idle for a very long period of time the interior of the volute should be cleaned and oiled. This prevents parts from rusting together and assures a longer period of satisfactory operation.

7. The motor should be protected against overload and under-voltage. Control devices for this purpose can be obtained at a very low cost. They are inexpensive insurance.

(OVER)

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

SERVICE INSTRUCTIONS

An exclusive feature of the B & G Booster & Series "60" pumps is the availability of complete bearing bracket assemblies as replacements.

In those cases where it may be necessary only to replace the seal assembly the following instructions apply:

1. Turn off current to motor.
2. Close valves on both sides of pump (If no valves have been installed, it may be necessary to drain the system).
3. Detach bearing-frame assembly from pump volute by removing eight cap-screws from center body-flange.
4. Remove impeller from pump-shaft (First turning impeller-nut counter clockwise).
5. Lift off seal-spring — then place screwdriver point under top compression ring of seal and pry off. Seal can then be removed by pulling upward.
6. Be sure that the shaft is thoroughly cleaned then lubricate with a thin film of oil or water and push the replacement seal on as far as possible by hand. Next, using a screwdriver press down firmly all around the outer edge of the top compression ring until the seal is tight against the face of the remite insert. If end play is present push the seal on tighter.
7. Replace impeller on shaft making certain that impeller-nut is firmly tightened. The pump and bracket can then be reassembled into pump volute and placed in service.

HOW TO REPLACE THE COUPLER ASSEMBLY

A — Turn off current to motor.

B — Remove bearing bracket cover.

C — Loosen coupler half from pump shaft by turning Allen set screw counter-clockwise.

D — Remove four cap screws that connect motor bracket to pump bracket and slide motor away from bracket. If coupler sticks on pump, insert screwdriver between rear bearing and coupler half; exerting pressure outward. Loosen set screw on motor coupling half and remove coupling.

E — Install new coupler, slipping one coupling half on motor shaft first and tighten set screw. Slip other coupling half on pump shaft, tighten set screw and bolt motor bracket to pump bracket. Replace bearing bracket cover.

CAUTION:
Do not attempt to replace individual coupler springs. If coupler arms are worn or springs are broken, always replace entire coupler assembly.

HOW TO REPLACE THE RING MOTOR MOUNTINGS

A— Turn off current to motor.

B— Disconnect motor leads.

C— Remove coupler from motor shaft.

D— Loosen rear clamp on motor using screwdriver to pry off clamp motor can then be lifted out of bracket.

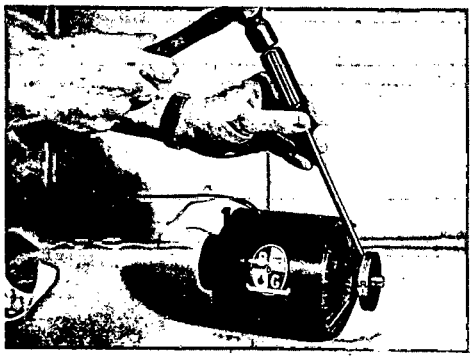
E— Place screwdriver between front mounting and end-bell of motor and strike firmly with a hammer on handle of screwdriver, forcing inner ring of motor mounting off the boss of end-bell. (Figure 1)

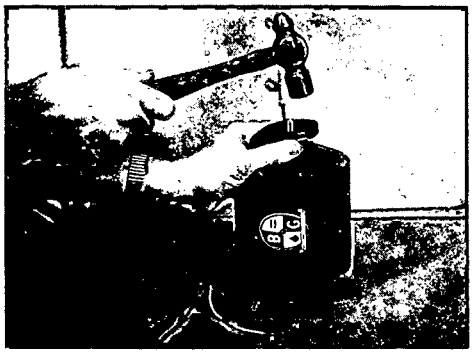
F— To install motor mounts, hold mounting firmly against boss of end-bell and tap inner ring lightly until mounting has started. Continue to tap around the inner ring (compression ring) until mounting is flush with end of boss. (Figure 2) Repeat procedure with rear mount, however, do not rest motor on end of shaft when applying this unit.

G— Replace motor in bracket with oil well spouts up and tighten clamp.

H— Reconnect coupler and turn shaft by hand to make sure it is free.

I— Reconnect motor leads and turn current back on.





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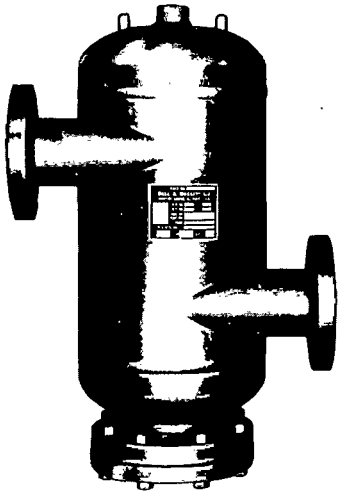
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
ITT

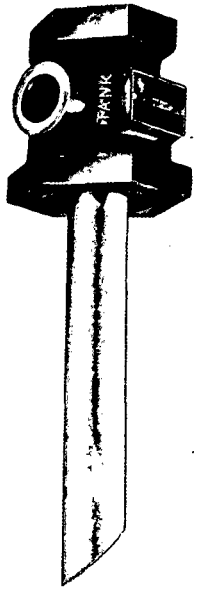
BELL & GOSSETT

INSTRUCTION MANUAL

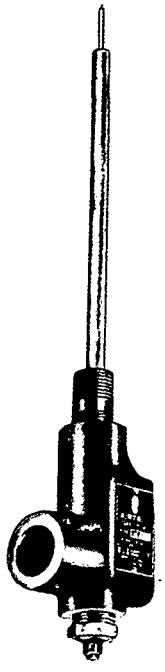
S10300
REVISION 2



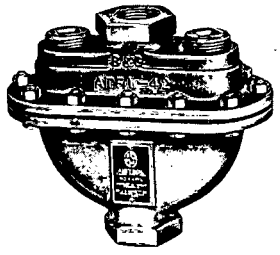
ROLAIRTROL®
Air Separator



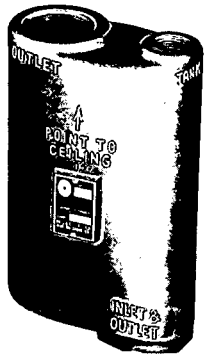
ABF
Airtrol
Boiler Fitting



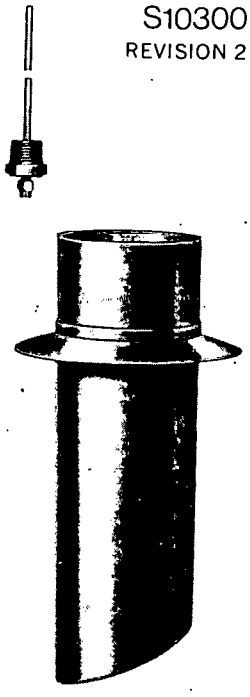
ATF
Airtrol
Tank Fitting



ATFL
Airtrol Tank Fitting



IAF
In-Line Airtrol
Air Separator



AFBF
Airtrol
Boiler
Fitting

Airtrol® System

Installation and Operating Instructions

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

HOW TO INSTALL THE

INSTALLATION ON TOP OUTLET BOILERS

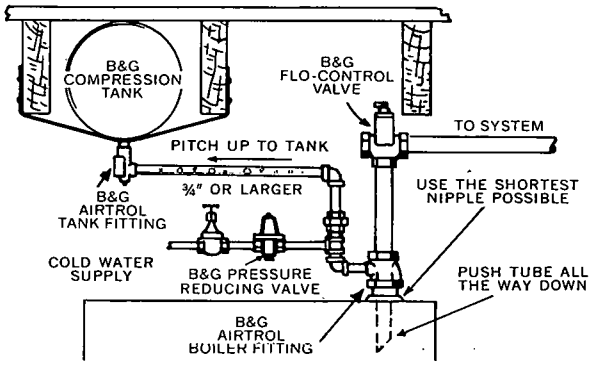


FIG. 1. Horizontal piping between boiler and compression tank must be full size of tapping in the Airtrol Tank Fitting. If horizontal pipe length is more than 7 feet, increase to next larger size pipe—two sizes larger if horizontal pipe is more than 20 feet. *Do not use a valve of any kind between the compression tank and boiler!* It is unnecessary and prevents free passage of air into the tank. If a valve must be used, install a gate valve in the vertical pipe line.

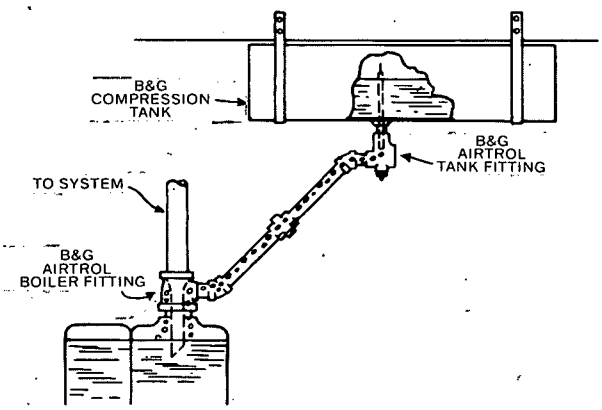


FIG. 2. This is an ideal method of running the pipe between the boiler and compression tank, as it permits an unrestricted flow of air bubbles to the tank. When this type of connection is not practical, horizontal piping with sufficient pitch-up to the tank (see Fig. 1) is adequate. A minimum of 1" pitch-up in five feet should be used.

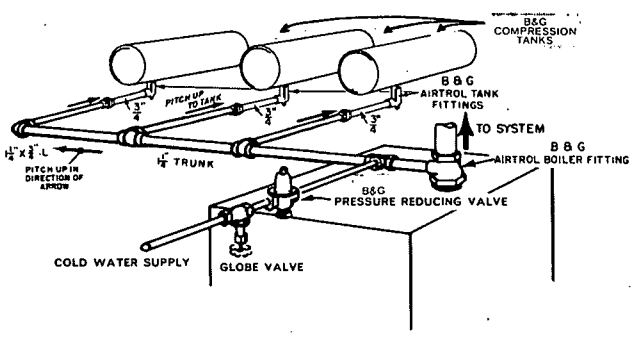


FIG. 3. Where there is not sufficient space between the boiler and the ceiling for a single compression tank of adequate capacity, several smaller tanks may be used. When two tanks are used, increase the horizontal header to one size larger than the tapping in the Airtrol Tank Fitting. For three or more tanks in parallel, increase the header two sizes. In installations where ceiling height will not permit unions in vertical piping they may be used horizontally. Airline piping must pitch-up to tanks.

INSTALLATION OF ATFL-1" TANK FITTING

The ATFL Airtrol Tank Fitting is made especially for compression tanks with capacities of 100 gallons and larger. This fitting may be used with all suitably sized ABF, and AFBF Airtrol Boiler Fittings, Rolairtrol and In-Line Airtrol Air Separators. Figs 14 and 15 show typical recommended methods of installation.

The horizontal pipe between the ATFL Fitting and the boiler must always pitch-up. For example, if the horizontal pipe is from 3 to 4 feet, use a nipple in the vertical pipe (see Fig.14) approximately ½" shorter than would be required to make the line horizontal. Then pull the horizontal line down to catch the union.

For horizontal run-outs more than 7 feet long, use 1¼" pipe size. For lengths of 20 feet or more, use 1½" pipe.

The Manual Vent tubing which is furnished with each ATFL fitting, is installed into a separate tapping in the tank. When uncoiled, the tube is long enough to be used in a 48" diameter tank. To use with any other size diameter tank, tube must be cut to right length with a hack saw as shown in the table below.

Diameter of Tank	*Length of Tube*
48"	28"
42"	24"
30"	20"
24"	16"

Fig. 14
ATFL Tank Fitting connected to top outlet ABF Boiler Fitting.

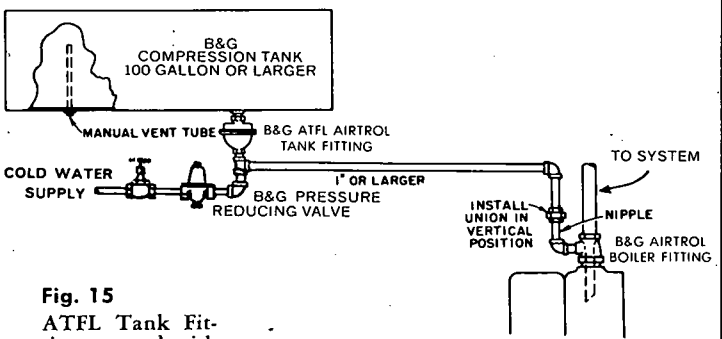
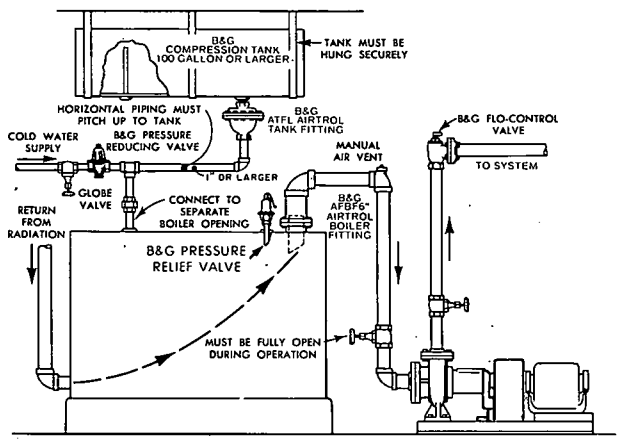


Fig. 15
ATFL Tank Fitting as used with a 6" or 8" Airtrol Boiler Fitting.



B&G AIRTROL SYSTEM

TYPICAL INSTALLATIONS—INLINE AIRTROL FITTING

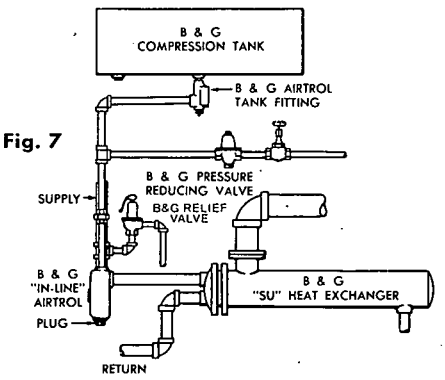


Fig. 7

CONVERTOR

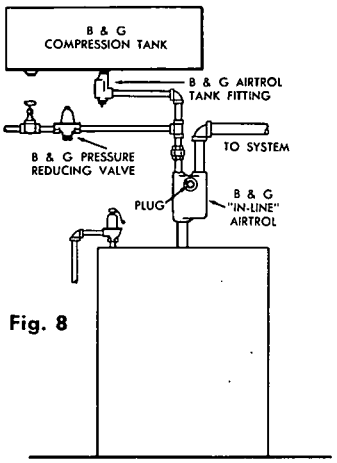


Fig. 8

TOP OUTLET BOILER

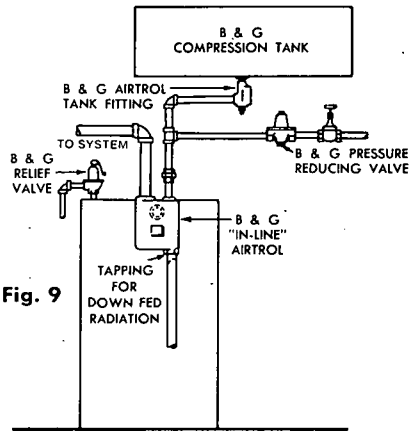
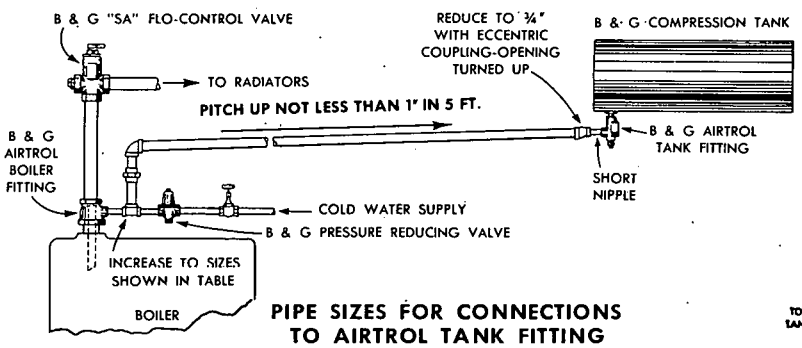


Fig. 9

SIDE OUTLET BOILER

OTHER INSTALLATION DETAILS

Fig. 10



PIPE SIZES FOR CONNECTIONS TO AIRTROL TANK FITTING

Total length of horizontal connections from boiler to most distant compression tank		
Less than 7 ft.	Over 7 ft. and not more than 20 ft.	Over 20 ft. and not more than 40 ft.
¾"	1"	1¼"

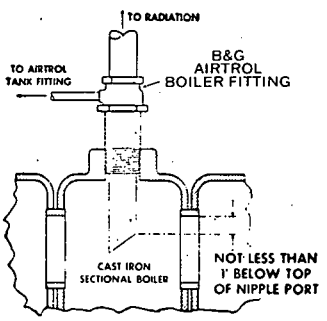


Fig 11. Airtrol Boiler Fitting installation in a cast iron boiler, showing correct depth of tube.

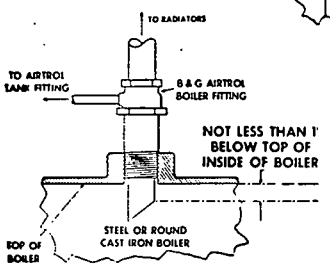


Fig. 12. Airtrol Boiler Fitting installation in steel or round cast iron boiler, showing correct depth of tube.

INSTALLATION OF 6" AND 8" BOILER FITTING

Follow these steps when installing a 6" and 8" Airtrol Boiler Fitting—

1. Make up the lower flange* and nipple* in the boiler opening.
2. Lay one flange gasket on the face of the lower flange.*
3. Place the stainless steel collar on the gasket with the large opening of collar down.
4. Slip the Neoprene holding band around the dip tube and position it to hold the tube as indicated in Figure 13 at right. The Neoprene holding band will keep dip tube from slipping down too far during installation.
5. Insert the dip tube into the stainless steel collar. Be sure the angle cut of the tube is in the "down" position.
6. Lay the second gasket on top of the stainless steel collar. Place companion flange* on top of gasket. Install nuts and bolts* and make up evenly around the entire circle.
7. Using an ATFL Airtrol Tank Fitting, pipe the tank fitting to the compression tank and to the tapping provided in the top of the boiler. Be sure the piping between the boiler and the compression tank pitches up to the tank.

*Not furnished with AFBF Airtrol Boiler Fittings.

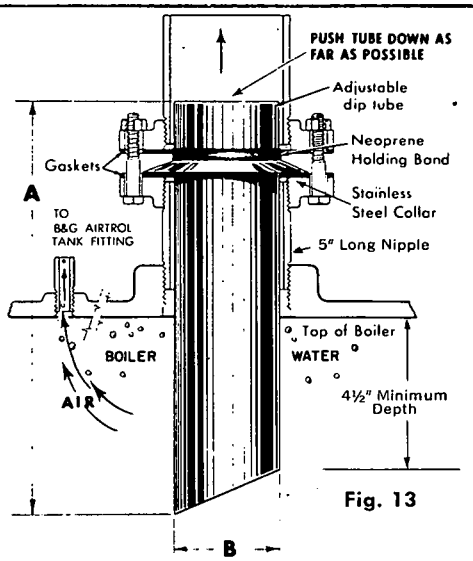


Fig. 13

AVOID THESE ERRORS IN INSTALLING THE B & G AIRTROL SYSTEM

Air in the radiation, gurgling in the piping and frequent operation of the relief valve because of a waterlogged compression tank are the results of improper Airtrol System installation.

1. Tank hung insecurely. Nails too small and loosened when water entered tank, causing—
2. Pitch of air line in wrong direction. Using pipe strap which has been folded will also cause tank to sag with added weight.
3. Square head cock in line. Never install a valve in the horizontal part of air line. If a valve must be used, install a gate valve in the vertical pipe line.
4. Union should be in the *vertical* instead of horizontal section of pipe line.
5. Bushings in both Airtrol Tank and Boiler Fitting. Pipe is too small to allow free passage of air in opposite directions.
6. Relief valve installed in air line. This can result in loss of air from the tank if relief valve operates.
7. Nipple between Airtrol Boiler Fitting and the boiler too long—it must be short as possible. Tube must be submerged in boiler water or there is no effective air trap. After Boiler Fitting is made up, push adjustable tube down as far as possible.
8. Frequent venting of Airtrol Tank Fitting will result in a water-logged tank. This vent should be opened to release air trapped in the tank *only* when the system is first filled and placed in operation.
9. Do not use the tapping in the Flo-Control Valve for the connection to the compression tank. Use the tapping on the Airtrol Boiler Fitting.

OPERATING INSTRUCTIONS FOR THE B & G AIRTROL SYSTEM

WHEN THE SYSTEM IS FULLY CONNECTED AND READY FOR FILLING:

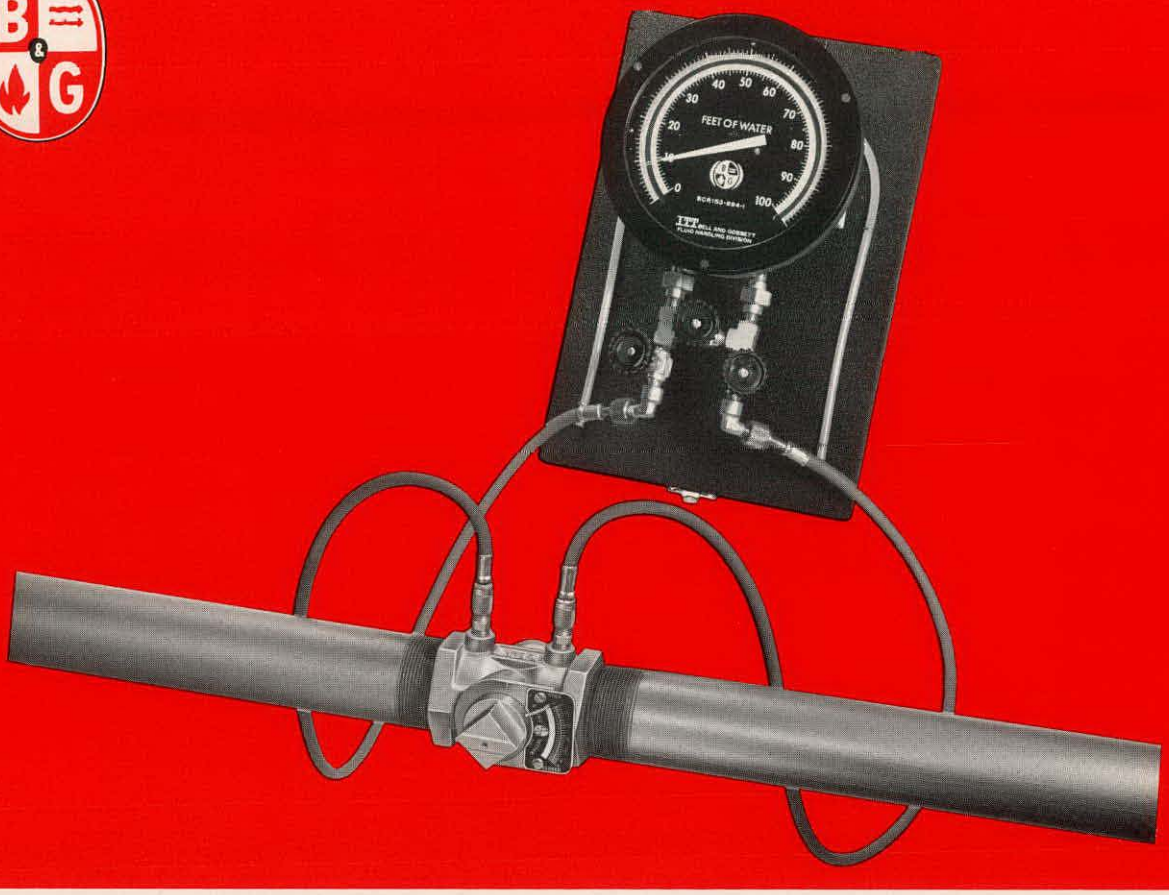
1. **Close all air vents, except the vent at the bottom of the Airtrol Tank Fitting and begin filling system. Leave the ATF vent open until water runs freely from it, then close tightly. DO NOT OPEN THIS VENT AGAIN UNLESS SYSTEM HAS TO BE DRAINED.**
2. **Vent radiation units and high points of the system.**
3. **Adjust the B & G Pressure Reducing Valve to provide pressure to the highest point of the system.**
4. **After system has been completely filled, start pump and allow it to circulate cold water for a short time. This will dislodge entrained air bubbles in the system and return them to the air separator.**
5. **Stop pump and start boiler burner. Allow boiler temperature to reach 220°, then stop firing. Wait at least one minute, then start pump. (If any of the radiation is of the panel type, which may be damaged by extremely hot water, allow boiler to cool to 140° before starting pump.)**
6. **Stop pump, vent radiation and high points of system. Normal operation may now be started at any time.**

IF THE ABOVE PROCEDURE HAS BEEN FOLLOWED CAREFULLY, THERE SHOULD BE NO REASON FOR FURTHER VENTING. HOWEVER, IF THERE ARE LEAKS IN THE SYSTEM THROUGH WHICH AIR MAY BE LOST, THE COMPRESSION TANK CAN LOSE ITS AIR AND BECOME WATERLOGGED. TO DRAIN THE TANK, OPEN THE BOILER DRAIN AND AIRTOL TANK FITTING VENT SCREW. THE TANK CAN BE DRAINED QUICKLY IN THIS MANNER.

PRINTED IN U.S.A. 8-77

BELL & GOSSETT
8200 N. AUSTIN AVE · MORTON GROVE, ILL 60053
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

Bulletin A-507
Revision 1



CIRCUIT SETTER®

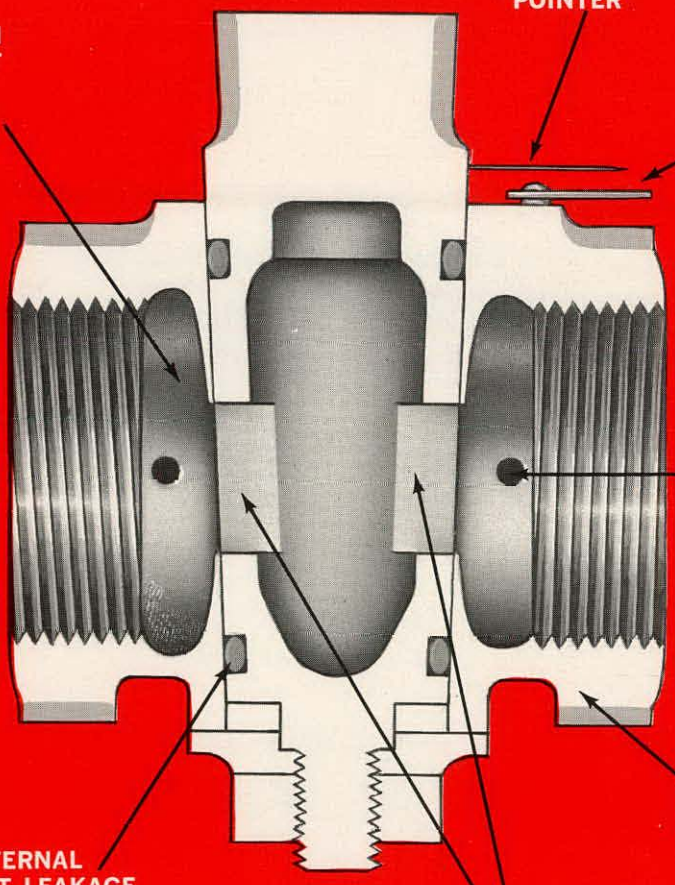
BALANCE VALVE

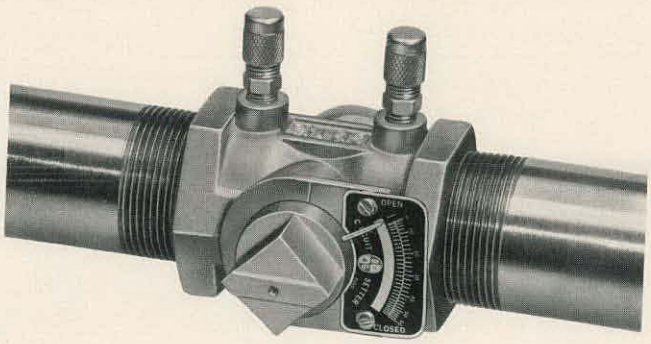
ACCURATE FLUID FLOW CONTROL AT YOUR FINGERTIPS
PRESETS, BALANCES AND METERS SYSTEM FLOW
AVAILABLE WITH NPT. FLANGED AND SOLDER CONNECTIONS

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

THE B&G CIRCUIT SETTER BALANCE VALVE

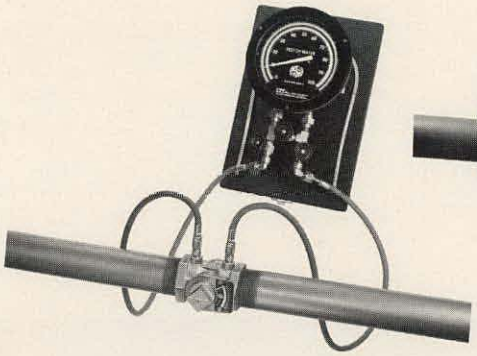
This precisely calibrated balance valve is used to preset, balance and meter the flow rate of a circuit, terminal unit, or zone. The pressure drop of the valve is measured by a portable differential meter. The pressure drop and the setting of the valve will determine actual system flow rate. The valve may be adjusted to match the flow rate with the design requirements. Circuit Setter Balance Valves are of all bronze or cast iron with bronze disc (depending on model selected) construction, and are available in ½" through 4" sizes. All Circuit Setter Balance Valves are furnished with preformed flexible polyurethane insulation suitable for use on both heating and cooling systems.



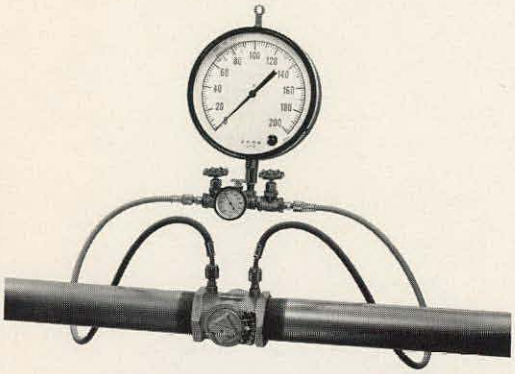


HOW TO INSTALL YOUR B&G CIRCUIT SETTER BALANCE VALVE

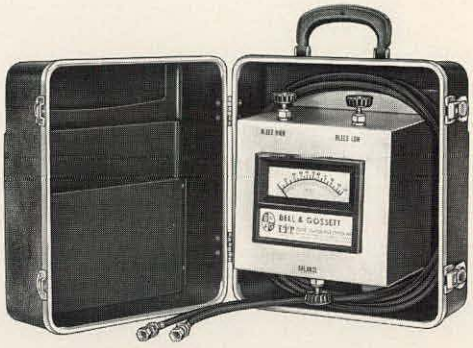
Install B&G Circuit Setter Balance Valve in position. Allow enough space to use wrench when Circuit Setter Balance Valve is being adjusted.



DIFFERENTIAL METER MODEL # RO-2

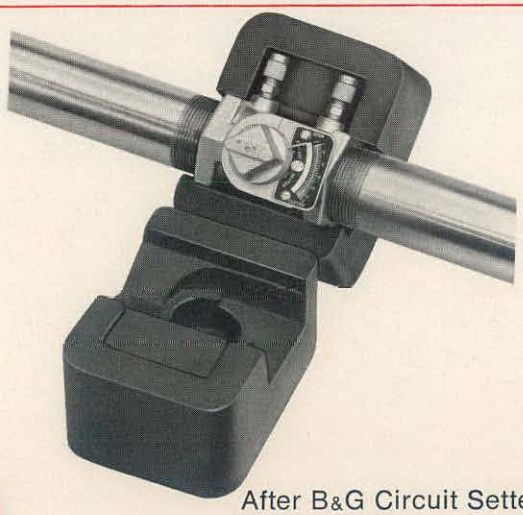


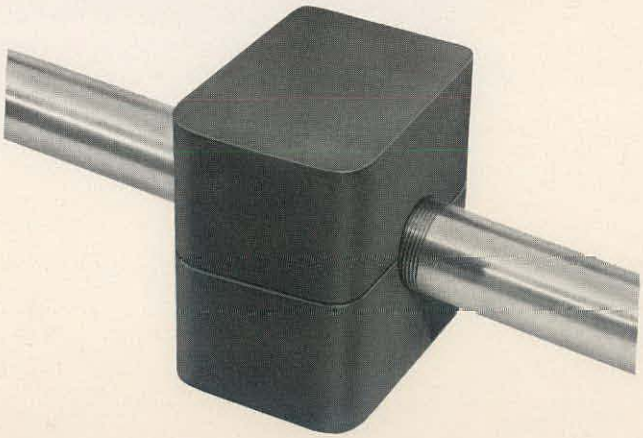
DIFFERENTIAL METER MODEL # RO-1



DIFFERENTIAL METER MODEL # RO-3 OR 4

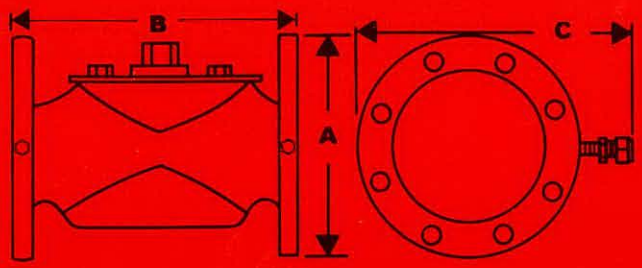
Connect differential meter leads finger tight to the pressure gauge connections on the B&G Circuit Setter Balance Valve. Meters will register differential pressure drop of the valve. This reading is transposed to the calculator to determine flow rate. The valve may be adjusted manually. A pointer will indicate the setting of valve opening.





After B&G Circuit Setter Balance Valve has been adjusted to precise design requirements, disconnect differential meter and replace thread protectors on check valves.

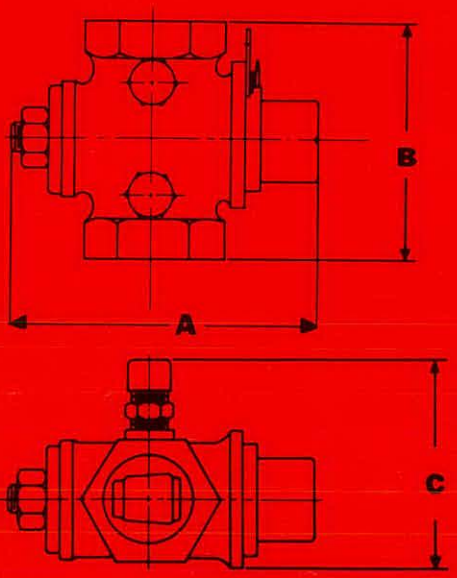
Polyurethane packing can be reused for insulation around the Circuit Setter Balance Valve on heating and cooling systems. Polyurethane block around the valve is held in place by tape.



CB-4

DIMENSIONS AND WEIGHTS

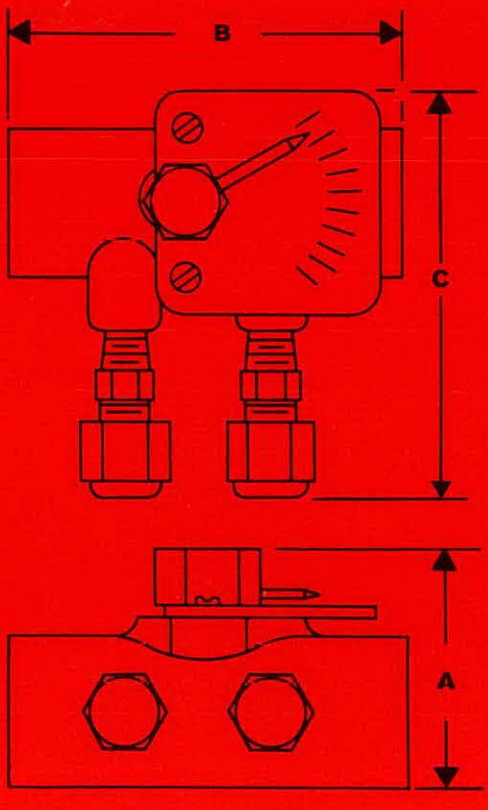
Model No.	Size		DIMENSIONS IN INCHES A Normal	A Insul	B Normal	B Insul	C Normal	C Insul	Weight in Lbs.
CB-½	½	NPT	2¾	4¼	2⅛	4¼	2½	4¼	¾
CB-¾	¾		2⅞		2¼		2⅝		1
CB-1	1		3½	5½	2⅝	3⅜	2⅞	4¾	1½
CB-1¼	1¼		3⅞		3		3⅛		2
CB-1½	1½		4⅜	6¼	3⅜	4¼	3⅜	6	3½
CB-2	2		5⅛		4⅛		3⅞		5½
CB-2½	2½		7⅝	9	5⅞	7	4¾	7	16
CB-3	3		8		6⅝		5⅜		20
CB-4	4	FLG	9	9⅞	8	8	10⅛	10⅛	52



CB-½ THRU CB-3

DIMENSIONS AND WEIGHTS

Model No.	Size	A Normal	A Insul	B Normal	B Insul	C Normal	C Insul	Weight in Lbs.
CB-½S	½	1⅝	4¼	2¼	4¼	2¾	4¼	¾
CB-¾S	¾			2⅝		2⅞		1



CB-½S and CB-¾S

TYPICAL SPECIFICATIONS

Furnish and install a calibrated (bronze/cast iron with bronze disc) balance valve with provisions for connecting a portable differential pressure meter as shown on plans. Meter connections to have built-in check valves. An integral pointer shall register degree of valve opening. Each balance valve to be constructed with internal seals to prevent leakage around rotating element.

Each balance valve shall be constructed for 125 psig. working pressure at a maximum temperature of 250°F. and supplied with preformed polyurethane insulation suitable for use on heating and cooling systems. Each unit to be ITT Bell & Gossett No. CB-_____ Circuit Setter Balance Valve.

NOTE 1. B&G Circuit Setter Balance Valves are designed in such a manner as to facilitate their use as service valves to restrict flow, but not as a drop tight shut-off valve.

2. B&G Circuit Setter Balance Valves are not recommended for use with meter connections pointing downward.

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BELL & GOSSETT ITT
8200 N. AUSTIN AVE. • MORTON GROVE, ILL. 60053
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

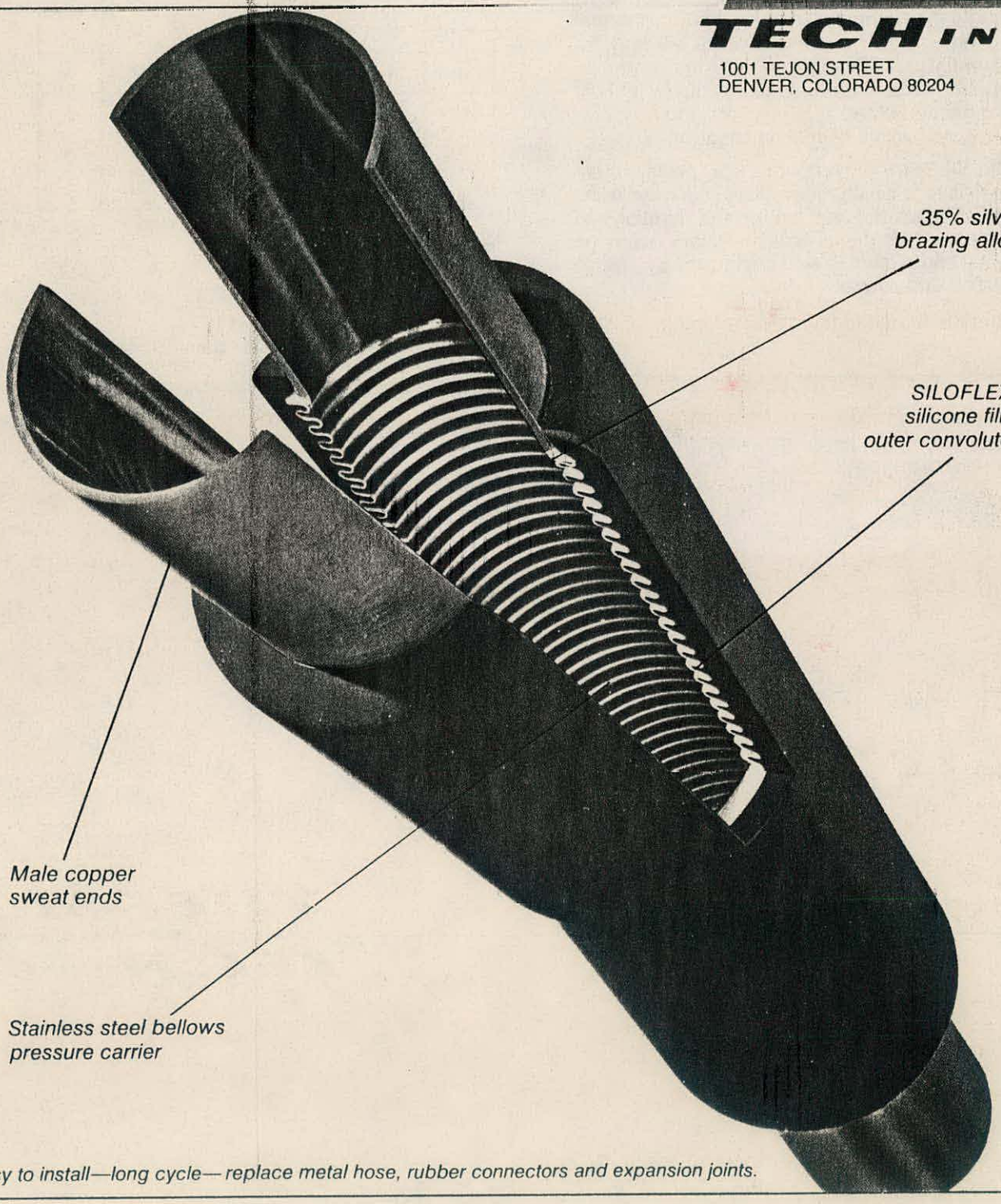
HOT DOGS™

All purpose flexible connector: pump connector—equipment connector—compressor connector—vibration eliminator—sound attenuator—expansion compensator—Steam—Hot water—Cold water—Air—Gas—Low vacuum—Minus 60°F to 400°F—150# design—Max. Test Pressure 225 PSIG. Sizes 1/2" through 1½"

FLEX/FLO™

THERMO TECH INC.

1001 TEJON STREET
DENVER, COLORADO 80204



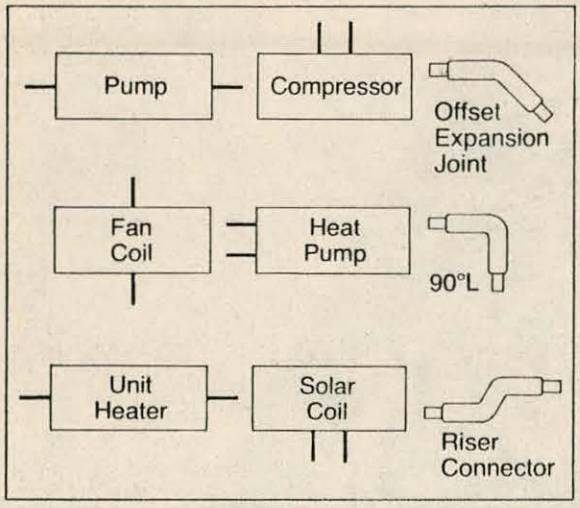
Easy to install—long cycle—replace metal hose, rubber connectors and expansion joints.

HOT DOGS™

The HOT DOG™ is another innovative product by THERMO TECH. It will take motion in contraction, extension, offset or bend to 90°. It will handle misalignment, shock, vibration, thermal motion and sound attentuation. It will work for essentially all piping and equipment motion requirements where it is compatible with fluid and gaseous medias, pressures and temperatures, and within its motion capabilities.

The SILOFLEX® compound is a specially blended silicone which will produce a long cycle life. SILOFLEX® dampens sound and vibration and replaces the metal braid normally used on metal connectors. It also permits the bellows to extend and contract.

For pipe threads attach pipe adapters.



PART NO.	NOM. I.D. IN.	TUBE O.D. IN.	PART O.D. MAX.	O/A LENGTH IN.	ELAST. LENGTH IN.	OFF-SET ± O IN.
1514-1	½	⅝	1.0	8	4.8	¾
1514-2	¾	⅞	1.4	10	6.7	¾
1514-3	1	1⅛	1.6	10	6.7	¾
1514-4	1¼			12½	8.7	¾
1514-5	1½				8.7	¾

NOTES
1. Wc
2. A
3. Oper ,00°F
4. Misalignme allel - lateral offset from center to de
5. Angular Deflectio ±15° center to one side
6. Max. Test Pressure 225 PSIG

THERMO TECH INC.

G/TT - 500
12/76
Printed in U.S.A.
Patent Pending

DeZURIK
DeZURIK CORP., SARTELL, MINNESOTA 56377
DeZURIK OF CANADA, LTD., GALT, ONTARIO

INSTALLATION, OPERATION AND MAINTENANCE OF 1/2" – 3" ECCENTRIC VALVES WITH MANUAL ACTUATORS.

GENERAL INFORMATION

A. DESCRIPTION

This is a DeZurik Eccentric Valve requiring 90° rotation for operation.

B. ENDS

Standard valves are furnished as follows:

1. Flanges are to 125# or 150# American National Standard, except the ½" thru 1½" valves have ½–13NC tapped holes and the 2" thru 3" bronze, acid resisting bronze, stainless steel and other alloys have 5/8–11NC tapped holes.
2. Screwed ends have U.S.A. Standard pipe thread.
3. Bell ends are to A.W.W.A. Standard C100–55, Class D.
4. Mechanical ends are A.W.W.A. Standard C111–53.
5. Victaulic ends are sized to use Victaulic Co. Style #77 Standard Couplings.

C. SPARE PARTS LIST

Plug (if rubber faced)	- 1
Stem Seal (standard)	
U-Cup Seal	- 1
U-Cup Filler	- 1
Stem Seal (compression)	
O-ring	- 1
Washer	- 1
Gasket	- 1

INSTALLATION

A. FLOW

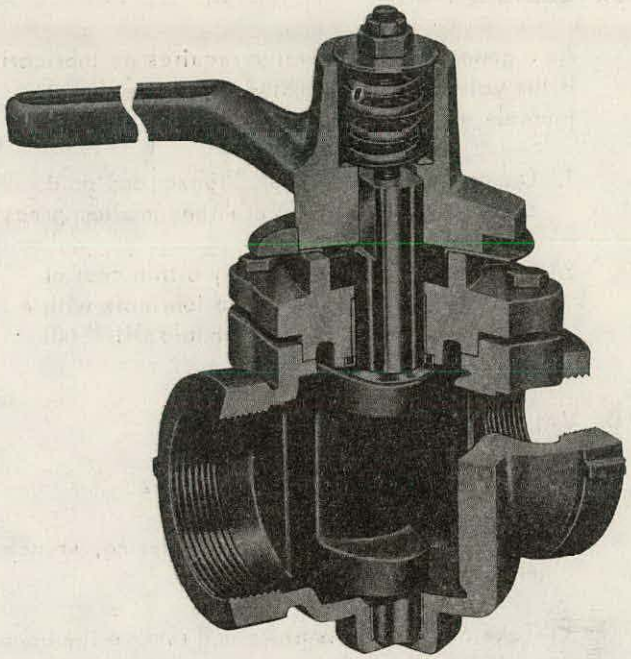
The word "seat" is cast on the valve body and the seat end of valve is indicated on the assembly drawing.

1. Valves with all metal or rubber faced plugs.

   a. STANDARD SERVICE (liquids or gases)

   Install with seat on downstream side.

   b. SUSPENDED SOLIDS (paper stock - 2% or greater, raw sewage sludge, mining slurries, wet cement, etc)



CAUTION

THIS VALVE IS A PRESSURE VESSEL. PRESSURE MUST BE COMPLETELY RELEASED BEFORE DISASSEMBLY. USE EXTREME CAUTION WHEN REMOVING THE BONNET. THE BONNET WILL BLOW OFF IF THE BOLTS ARE REMOVED WITH PRESSURE IN THE VALVE.

   Install with seat on upstream side. If possible, install the valve with the main axis of the plug horizontal.

2. Valves with Teflon Faced Plugs

   a. 2" and smaller, install with seat on upstream side.

   b. 2 1/2" and 3", install same as valve with all metal or rubber faced plug.

B. MOUNTING

1. Fig. 145 floorstand has six 5/8" diameter mounting holes equally spaced on a 12 3/4" diameter bolt circle. They are located as shown on assembly drawing.
2. Fig. 147 extension handle has a bearing plate with four 9/16" diameter mounting holes equally spaced on a 6 3/4" diameter bolt circle as shown on assembly drawing. The flange is 3/4" thick.

MAINTENANCE AND REPAIR

A. LUBRICATION

As a general rule this valve requires no lubrication. If the valve is disassembled, lubricate the plug journals as follows:

1. On semi-steel, ni-resist, bronze, and acid bronze use Keystone Vetostane medium grease.
2. On all other materials apply a thin coat of Alpha-Molykote Type G and lubricate with a mixture of graphite and Standard Oil # 140 gear lube.

B. VALVE DISASSEMBLY

1. Relieve the valve of line pressure.
2. Remove the lock nut, washer, spring, wrench and stop ring.
3. Take out the four screws and remove the bonnet and plug.

C. VALVE REASSEMBLY

1. Install plug.
2. Install stem seal in bonnet.
3. Replace the gasket and bolt on the bonnet.

   If bolts are 1/4" do not tighten in excess of 100 inch pounds.
4. Install the stop ring, wrench, washer, and lock nut.
5. Make stem seal and valve closing adjustments.

ADJUSTMENTS

A. STEM SEAL

Keep spring compressed 1/16 inch.

B. VALVE CLOSING

1. Loosen the screw that holds the stop ring.
2. Close the valve with the torque given in the chart below and tighten down the stop ring after rotating it to contact the wrench.

TROUBLE SHOOTING

STEM LEAKAGE

Check stem seal adjustment and replace stem seal if worn.

VALVE SEAT LEAKAGE

Check to see if valve is installed with seat in proper direction. Check valve closing adjustment and replace plug if worn.

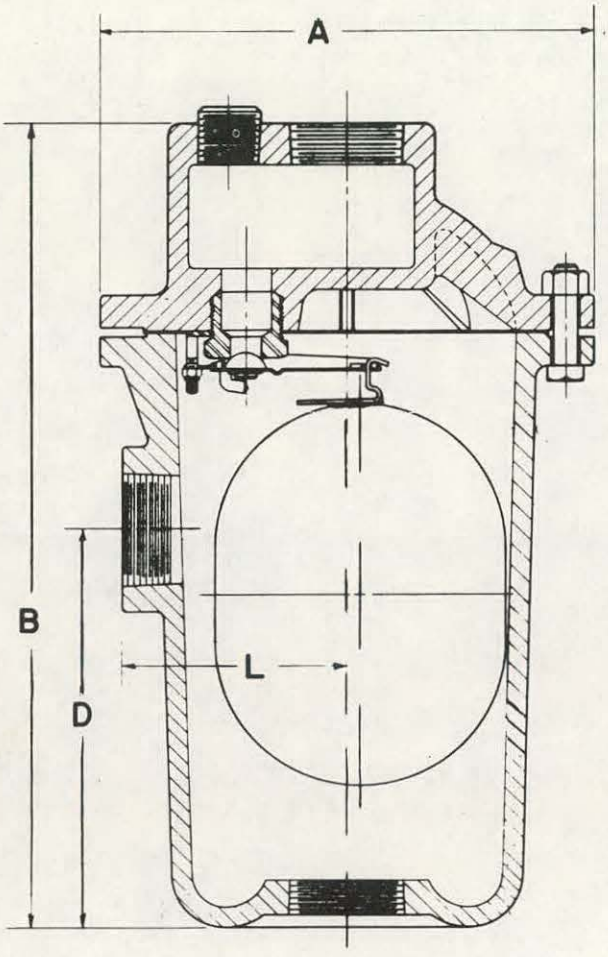
VALVE SIZE	SEATING TORQUE FOOT POUNDS
1/2 – 1	9
1 1/4 – 1 1/2	16
2	24
2 1/2	34
3	52

Dimensions & Data certified correct for:

Customer _____ Order _____

Job _____ ARMSTRONG MACHINE WORKS

By Frank G Carlson



	Cast Iron (ASTM 278, Class 30)		
Model Number	2-AV	3-AV	6-AV
Pipe Connections, Inches	½" or ¾"	¾" or 1"	1½" or 2"
Dimension, "A"	5¼"	6⅜"	10³⁄₁₆"
"B"	8"	10⅝"	17"
"D"	4⅜"	6³⁄₃₂"	8⅜"
"E"	—	—	—
"K"	—	—	—
"L"	2⁷⁄₁₆"	2⅞"	4⅝"
Weight, Lbs.	13	22	80
Vessel Design Limitations, psig	250 @ 450°F	250 @ 450°F	250 @ 450°F

List of Materials:

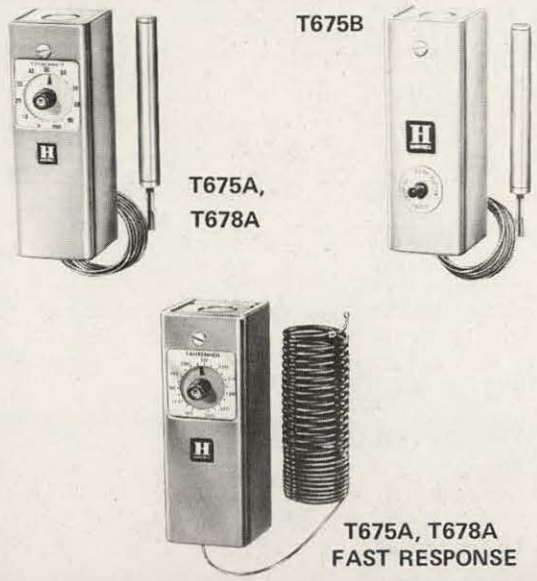
Body & Cap: Cast Iron ASTM A-278 Class 30
Valve & Seat: Hardened Chrome Steel
Leverage System: Stainless Steel
Float: Stainless Steel
Gasket: Compressed Asbestos

ARMSTRONG MACHINE WORKS	
No. 2-AV, 3-AV and 6-AV Air Vents	SM-316 12/6/68

TEMPERATURE CONTROLLERS

THE T675 AND T678 TEMPERATURE CONTROLLERS REGULATE THE TEMPERATURE OF AIR OR LIQUIDS IN DUCTS, PIPES, AND TANKS. TYPICAL USES INCLUDE CONTROL OF DAMPERS AND VALVES IN HEATING, COOLING, OR HEATING-COOLING SYSTEMS.

- ☐ T675A High Limit Controller makes a circuit on a rise in temperature.
- ☐ T675B Low Limit Controller makes a circuit on a decrease in temperature.
- ☐ T678A Low Limit Controller makes two independent circuits in sequence on a decrease in temperature.
- ☐ Fast response models with adjustable differential available.
- ☐ Ambient temperature compensated.
- ☐ Setting knob on front.
- ☐ Sensing element may be mounted up to 20 feet from controller case.



T675A,B
T678A

Honeywell

E.S.
REV. 11-75

FORM 60-2200 —1
RESIDENTIAL DIV.

SPECIFICATIONS

MODELS (also refer to Table I):

T675A Temperature Controller — spdt switching to make or break a circuit on a temperature change; fast response models operate approximately seven times faster than standard models.

T675B Low Limit Temperature Controller — breaks a circuit on a temperature fall; must be manually reset.

T678A Temperature Controller—two spdt switches operate two independent circuits in sequence; fast response models operate approximately seven times faster than standard models.

TABLE I

MODEL NO.	RANGE	MAX. TEMP.	SWITCHING
T675A	0 to 100 F[a]/-15 to 35 C	125 F	spdt
	55 to 175 F[a]/ 15 to 75 C	200 F	
	80 to 180 F / 30 to 80 C	200 F	
	160 to 260 F / 75 to 125 C	280 F	
T675B[b]	30 to 50 F	125 F	spst
T678A	0 to 100 F[a]/-15 to 35 C	125 F	two spdt
	55 to 175 F[a]/ 15 to 75 C	200 F	
	80 to 180 F / 30 to 80 C	200 F	
	160 to 260 F / 75 to 125 C	280 F	

[a]Available with fast response sensing element.
[b]T675B scale is marked 30, 40, 50; set point is factory set and locked at 37 F.

SWITCH DIFFERENTIALS:

T675A—fixed differential models—1 F (.6 C); adjustable models—3 to 10 F (1.7 to 5.6 C); fast response models—3.6 to 12 F (2 to 6.6 C).

T675B—fixed 10 F (5.6 C).

T678A—fixed 3 F per switch with adjustable interstage 3 to 10 F (1.7 to 5.6 C); models with 55 to 175 F scale—fixed 3.6 F (2 C) per switch with adjustable interstage 3.6 to 12 F (2 to 6.6 C).

ELECTRICAL RATINGS:

T675A adjustable models and T678A:

	120 v ac	240v ac
Full Load	8.0	5.1
Locked Rotor	48.0	30.6

T675A nonadjustable models, 125 va at 120/208/240v ac.

T675B 125 va at 240v ac pilot duty.

MAXIMUM AMBIENT OPERATING TEMPERATURE: 125 F.

NOTE: The maximum recommended ambient for the T675B, when used for freeze-up protection, is 100 F. An ambient of 125 F lowers the switch break point about 1.5 F.

BULB SIZE: 1/2 x 4-3/16 inches for 0 to 100 F models; 1/2 x 3-9/16 inches for other scale ranges.

MAXIMUM BULB PRESSURE: 50 psig direct immersion.

CAPILLARY LENGTH AND MATERIAL:

T675A, T678A standard response models—5 or 20 foot copper, or 20 foot Monel or stainless steel.

T675A, T678A fast response models—5 foot copper with the sensing portion of element 1-1/2 inch dia. x 5 inches long (coiled 1/8 inch tubing). The coil may be stretched to approximately 10 inches.

T675B—10 foot copper.

CAPILLARY HOLDER: Honeywell part 131524A included with all fast response models.

(continued on page 3)

ORDERING INFORMATION

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

SPECIFY—
1. MODEL NUMBER.
2. SCALE RANGE.
3. STANDARD OR FAST RESPONSE MODEL.
4. CAPILLARY LENGTH AND MATERIAL.
5. FIXED OR ADJUSTABLE DIFFERENTIAL ON T675A.
6. ACCESSORIES, IF DESIRED.

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)

DIMENSIONS: See Fig. 1.

LISTING BODIES: Listed by Underwriters' Laboratories, Inc.

ACCESSORIES:

1. Separable immersion wells; short necked, 1/2 inch NPT, copper—order 112622AA. For additional information on immersion wells see Honeywell Tradeline Catalog.

2. Pressure fitting rated at 50 psi water or 15 psi air—order 7617ABY. For additional information on pressure fittings see Honeywell Tradeline Catalog.

3. Duct bulb holder 311266; also refer to Honeywell Tradeline Catalog.

4. T-strap 105900 for strapping the bulb to a pipe.

5. Bag assembly 7617ABZ with bracket for mounting the controller to fan coil units.

6. Calibration wrench 801534.

7. Bag assembly 7640HY with standoff bracket for mounting the controller to an insulated duct.

8. Q615A weatherproof enclosure.

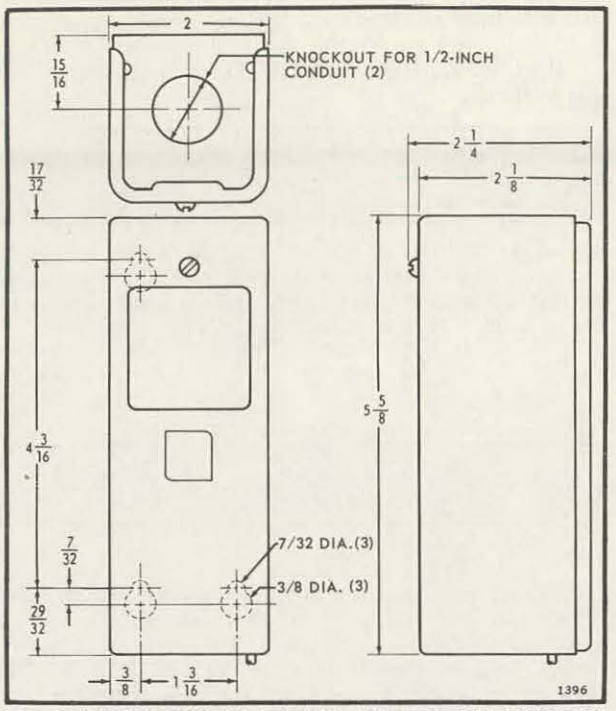


FIG. 1—DIMENSIONS (IN INCHES) OF T675 AND T678 CONTROLLERS.

INSTALLATION

CAUTION

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

LOCATION AND MOUNTING

The controller may be installed in any convenient position. Be sure to consider the length of the capillary before mounting controller.

Install the sensing element where it is exposed to the average temperature of the controlled medium. T675A fast response models must use the capillary holder furnished with the device. The sensing bulb of standard models should be held in place with a bulb holder, immersion well, or pressure fittings. (See Figs. 2-4.) Sharp bends or kinks in the capillary tubing affect the efficiency of the controller and must be avoided. Excess capillary should be carefully coiled and left directly beneath the controller.

NOTE: When pressure fittings are used in areas of vibration such as pipe lines, the bulb must be adequately supported.

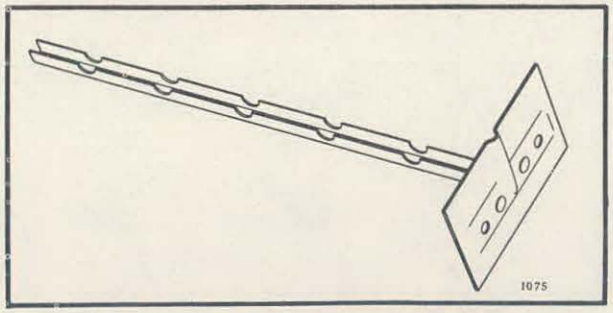


FIG. 2—BULB HOLDER FOR MOUNTING SENSING ELEMENT.

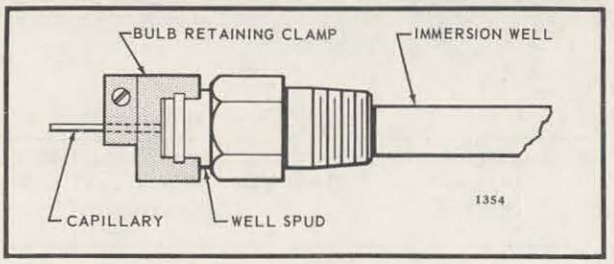


FIG. 3—IMMERSION WELL ASSEMBLY FOR MOUNTING SENSING BULB.

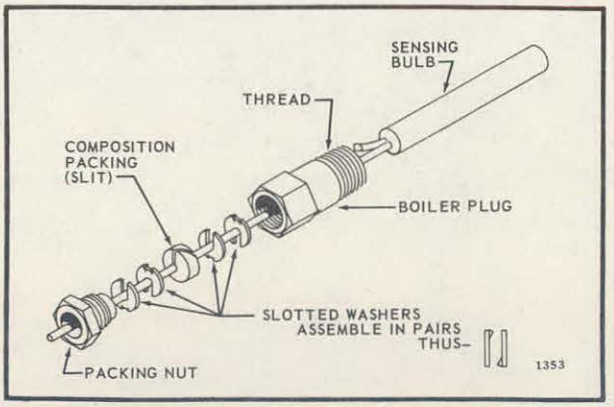


FIG. 4—COMPRESSION FITTING FOR PRESSURE TIGHT MOUNTING OF SENSING ELEMENT.

WIRING

All wiring must comply with local electrical codes and ordinances.

CAUTION
Disconnect the power supply before proceeding with wiring.

Two knockouts for 1/2 inch conduit are provided, one at top and one at bottom of case. Follow the wiring instructions furnished with the heating or cooling system. Fig. 5 shows the switching action.

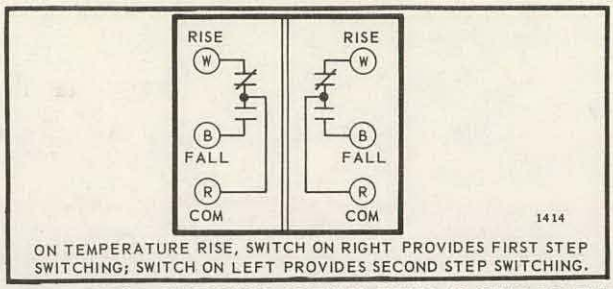


FIG. 5–T678A SWITCHING ACTION. T675A IS SIMILAR BUT HAS ONLY ONE SPDT SWITCH. T675B HAS ONE SPST SWITCH.

OPERATION

T675A

As the temperature of the controlled medium falls below the set point, less differential, the T675A switches to make terminals R to B and energize a normally closed solenoid valve to provide heat. In cooling applications, the T675A makes terminal R to W as the temperature rises above the set point and energizes cooling equipment. Fig. 7 shows the operation of the T675A.

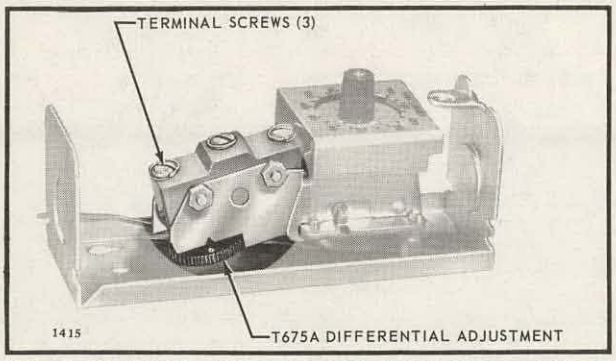


FIG. 6–INTERNAL VIEW OF T675A SHOWING THE SWITCH DIFFERENTIAL ADJUSTMENT WHEEL (APPLICABLE MODELS).

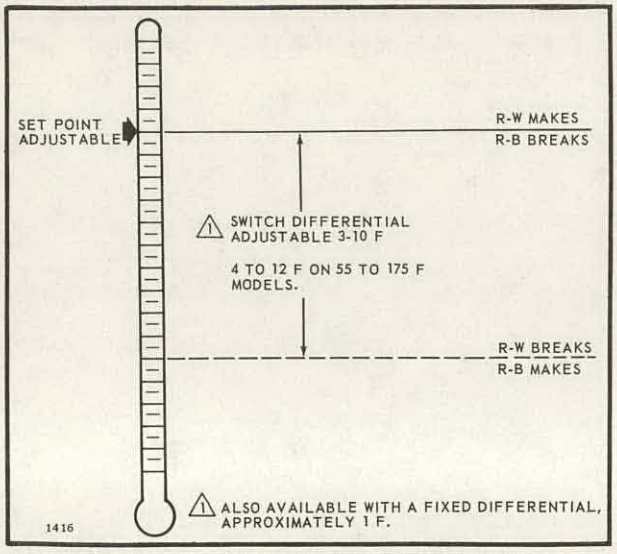


FIG. 7–DIFFERENTIAL ADJUSTMENT RANGE OF T675A.

FREEZE-UP PROTECTION

When using the T675A (auto-recycling) for freeze-up protection, the recommended set point is 38 F plus the switch differential.

example: SET POINT 38 F, plus 1 F (fixed differential model) equals an actual set point of 39 F.

example: SET POINT 38 F, plus 3 F (adjustable differential model) equals an actual set point of 41 F.

This ensures adequate safety factor for freeze-up protection.

NOTE: The T675B is a manual reset device and is specifically designed for freeze-up protection.

T675B

Used as a low limit controller, the T675B interrupts the operation of equipment if the temperature of the controlled medium falls below a predetermined limit. The device is reset manually after a rise in temperature of approximately 10 F. The operation of T675B is shown graphically in Fig. 8.

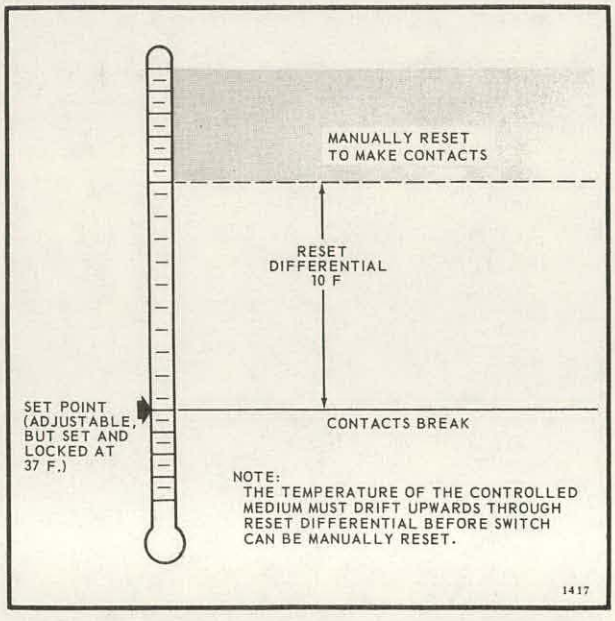


FIG. 8–DIFFERENTIAL ADJUSTMENT RANGE OF T675B.

T678A

When the temperature at the sensing bulb rises above the setting of the controller, the switch on the right completes a circuit between the R-W terminals of that switch. Should the temperature continue to rise through the preselected interstage differential of the controller, the switch on the left will complete its R-W circuit.

Conversely, on a temperature fall the switch on the left provides first step switching. If the temperature continues to fall, the switch on the right completes its R-B circuit to provide sequencing of equipment.

Each T678 has a between-switch differential adjustment. Make this adjustment by inserting a narrow screwdriver into the rectangular hole in the chassis (See Fig. 9) and pushing the star wheel. At its maximum position, interstage differential is 10 F. At minimum position differential is 3 F. Adjust until satisfactory operation is achieved.

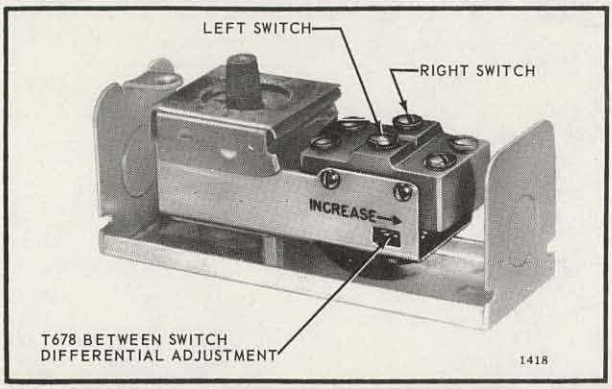


FIG. 9—INTERNAL VIEW OF T678A SHOWING THE BETWEEN SWITCH DIFFERENTIAL ADJUSTMENT.

The T678A Temperature Controller may be adjusted to give an interstage differential of three to ten degrees above the set point. The set point adjustment dial determines the temperature at which the right switch operates. The operation of the left switch is adjustable from three to ten degrees above that point of operation. An illustration depicting the operation of the T678A is shown in Fig. 10.

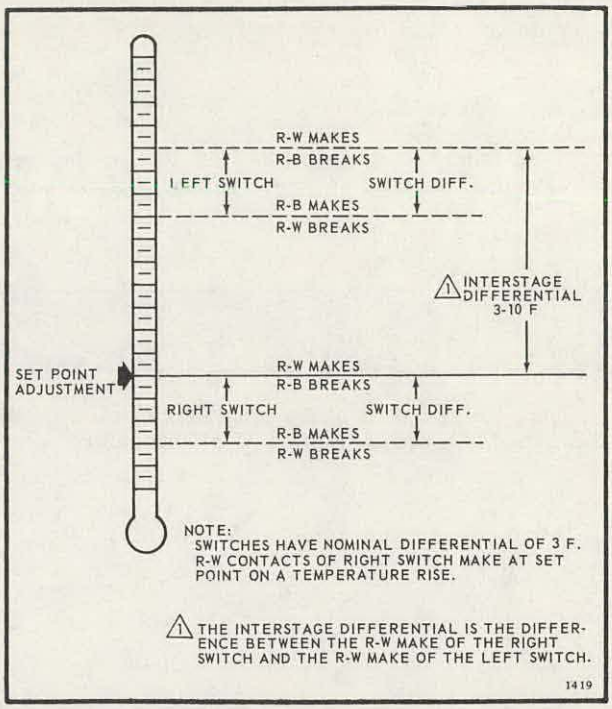


FIG. 10—DIFFERENTIAL ADJUSTMENT RANGE OF T678A.

CALIBRATION

All controllers are carefully tested and calibrated at the factory under controlled conditions. If the controller is not operating at a temperature corresponding to the scale setting and differential setting, check to see that the bulb senses the average temperature of the medium controlled. If the temperature of the controlled medium is changing rapidly the differential will appear wider than its setting.

For calibration, an accurate temperature reading of the controlled medium must be taken. Place an accurate thermometer near the bulb of the controller, or refer to a thermometer that has been installed as part of the system. If the bulb of the controller is installed in an inaccessible area, or if the controlled medium is unstable, it should be removed and placed in a controlled bath for accurate calibration.

T675A

These controllers are calibrated so that the dial setting is the point at which the R-W switch contacts make on a temperature rise. Measure the temperature at the bulb. Rotate the dial counterclockwise from the top of the scale, simulating a temperature rise, until the R-W switch contacts make. Note the dial reading. If it differs from the set point, calibrate the dial as follows:

1. Determine the number of degrees difference between the set point and the point at which the contacts make.

2. Remove the dial knob and slip the fingers of the calibration wrench into the slots of the dial. Rotate the dial until the fingers of the wrench drop into the slots of the calibration nut under the dial. Note the dial indication at this point. Turn the dial and the calibration nut up or down scale the number of degrees that the set point differs from the point at which the contacts make (determined in step 1). For example, move dial from 45 to 65 degrees for a 20 degree change in calibration.

3. Check the calibration adjustment by moving the dial up and down the scale while watching the contacts make and break. If dial is still out of calibration, repeat calibration procedure.

T675B

These controllers are calibrated so that the dial setting is the point at which the switch contacts break on a temperature fall. Measure the temperature at the bulb. Rotate the dial clockwise ↷ from the bottom of the scale to simulate a temperature fall until the switch contacts break. Note the dial reading.

If it differs from the set point, follow the calibration procedure outlined for the T675A.

T678A

These controllers are calibrated so that the nonadjustable (right hand) switch makes on a temperature rise and the adjustable (left hand) switch makes 3 to 10 F higher. The point at which the nonadjustable switch makes represents the dial setting. Rotate the dial reading. Continue rotating the dial until the left hand switch makes. The difference between the two readings is the interstage differential. The left hand switch must make at a lower reading than the right hand switch. Adjust the differential if necessary. Changing the differential may change the calibration.

Measure the temperature at the bulb. Rotate the dial counterclockwise ↶ from the top of the scale to simulate a temperature rise until the contacts of the left hand switch make. Note the reading.

If it differs from the set point, follow the procedure outlined for the T675A.

CHECKOUT

Check the operation of the controller by raising and lowering the set point through the temperature range of the air or liquid being controlled. Make sure that controlled equipment operates as intended.

DUAL BULB TWO STAGE TEMPERATURE CONTROLLER

T678B

The T678B Temperature Controller is a dual-bulb, dual-switch device for two-stage temperature control in heating ducts, tanks, boilers, etc. Its dual bulbs or sensors provide automatic control-point adjustment of system temperature in reference to changes sensed in outdoor temperature. As the outdoor temperature falls below 70 F, the indoor control point maintained by the T678 rises.

The indoor bulb (in one model, an averaging element) mounts in the area under control, such as a hot deck. The outdoor bulb is mounted on the outside of the building where it will sense average air temperature.

Two enclosed-type spdt MICRO SWITCH switches provide line voltage switching. Each switch has a fixed differential of 6 degrees F (factory-set). The between-switch differential is adjustable (except averaging model).

Available with reset ratios of 1 to 1, 1 to 1-1/2, and 1-1/2 to 1.

- ☐ Ambient compensated lever mechanism provides increased stability in varied ambient temperatures.
- ☐ A sturdy steel case houses and protects the power head assembly, lever mechanism, and diaphragm.
- ☐ Control case and elements mount in any position convenient to the installation.
- ☐ Reset ratio provides an automatic shift in control point for economical heating equipment operation.

HONEYWELL SPECIFICATION 71-92207 8-69 R.C.

SPECIFICATIONS

MODEL: T678B Dual Bulb Temperature Controller.

SWITCHING ACTION: 2 spdt (see Fig. 2).

ELECTRICAL RATING (amperes each switch):

	120v ac	240v ac
Full Load[a]	8.0	5.1
Locked Rotor	48.0	30.6
Pilot Duty	125 va at 120 to 240 ac 0.25 amp at 1/4 to 12v dc	

[a]At full motor loads the differential of each switch may increase 1 or 2 F. Maximum connected load 2000 va.

BULB SIZES AND RESET RATIOS:

Reset Ratios	Indoor Bulb (in.)		Outdoor Bulb (in.)	
	Diameter	Length	Diameter	Length
1:1	1/2	4-3/16	1/2	4-3/16
1:1[a]	1/8	12 feet	1/2	4-3/16
1:1-1/2	1/2	4-3/16	1/2	6-5/32
1-1/2:1	1/2	4-3/16	1/2	2-27/32

[a]Averaging element.

CAPILLARY LENGTHS AND DIAMETER[a]:

	Standard-bulb Models	Averaging-element Model
Indoor Length	10 ft	6 ft plus 12 ft element
Outdoor Length	30 ft	20 ft

[a]Diameter (all models): 5/64 in. O.D.

BULB PRESSURE (Max.): 50 psi with direct-immersion fittings. See ACCESSORIES. For well ratings see Form 90-0559.

RESET RATIO AND TEMPERATURE LIMITS:

RESET RATIOS[a]	MAX. OPERATING AMBIENT DEG. F	MAX. STORAGE TEMPERATURE (F)	MAXIMUM BULB TEMPERATURE
1:1[b]	125	132	Indoor-bulb temperature plus outdoor-bulb temperature must not exceed 265 F.
1:1/2	125	125	Indoor-bulb temperature plus 1.5 times the outdoor-bulb temperature must not exceed 312 F.
1 1/2:1	125	145	Indoor-bulb temperature plus 2/3 times the outdoor-bulb temperature must not exceed 242 F.

[a]First figure is change in outdoor temperature; second figure is change in control point.
[b]Available with either a standard 4-3/16 inch long indoor bulb or a 12 ft. averaging element.

SETTING RANGE: 70 to 140 F.

DIFFERENTIAL:
Each Switch—Fixed at 6 F (all models).
Between Switches—Adjustable 3 to approx. 10 F, except Averaging Model which is factory-set at 3 F.

ACCESSORIES:
1. Direct-immersion fittings (See Form 90-0559). 1/2 NPT—7617ABY.
2. Wells—see Form 90-0559.
3. Averaging-element Mounting Kit, 7640HX (See Form 95-7023).
4. Calibration Wrench (Part No. 801534).
5. Warm Air Bulb Holder (Part No. 107324A).
6. Outdoor Bulb Shield, 34886A.
7. Weatherproofing Kit—Q615A1004.

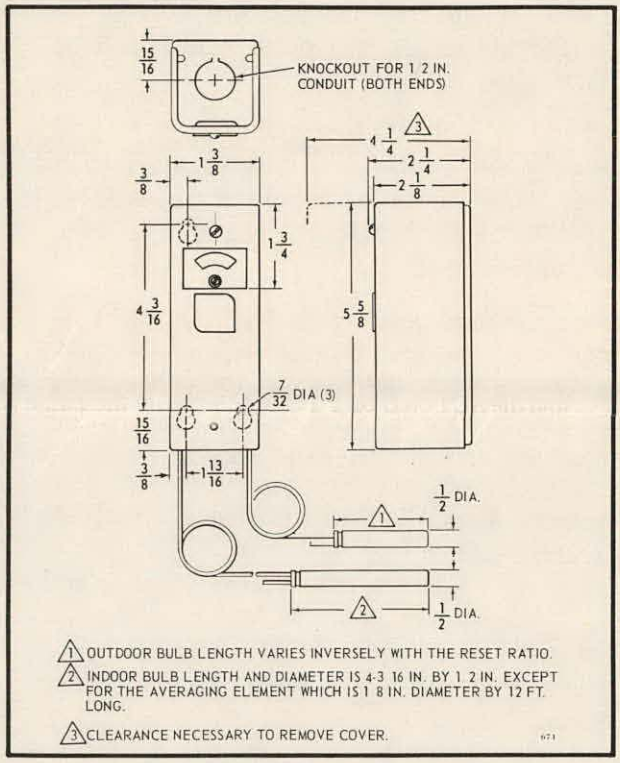


FIG. 1—APPROXIMATE INSTALLATION DIMENSIONS IN INCHES.

ORDERING INFORMATION

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

SPECIFY—
1. MODEL NUMBER, (AVERAGING – ELEMENT MODEL, IF DESIRED).
2. RESET RATIO REQUIRED
3. ACCESSORIES, IF NEEDED.

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)

INSTALLATION

LOCATION

Choose a suitable location for mounting the instrument case. Consider the length of capillary tubing for runs to the sensing locations before mounting the case. See CAPILLARY LENGTHS AND DIAMETER under SPECIFICATIONS. Maximum ambient temperature for the case should not exceed 125 F.

MOUNTING

CASE—Remove the cover and fasten the case securely to any convenient surface, such as a wall, joist, beam, or mounting board. The case can be mounted in any position. See Fig. 1 for mounting dimensions.

INDOOR BULB—Always follow the instructions and recommendations of the furnace or boiler manufacturer if these are available. In warm-air applications, be sure to mount the bulb in a location that allows free air circulation around it. The bulb should be far enough from the combustion chamber to prevent direct radiation from affecting it.

On averaging-element model, expose the entire element to the air flow under control to assure good, average sensing. Do not bend tubing sharply. Kinks will affect the averaging operation and sensitivity of the device.

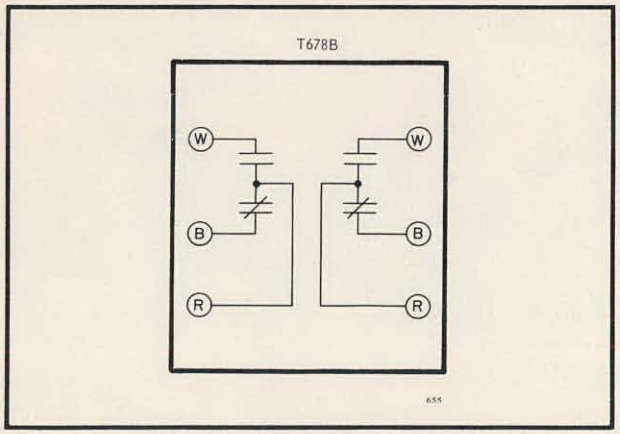


FIG. 2—SWITCH CIRCUIT OF T678B.

OUTDOOR BULB—Choose a location for the bulb where it can sense average outdoor air temperature. This location will normally be on the north side of the building. Avoid abnormal conditions, such as direct or indirect radiation from the sun or other heat-radiating sources, also from accumulation of ice and from direct wind. Use of a suitable shield is recommended. Shield Assembly 34886A is available for this purpose.

WIRING

Wiring must conform to all applicable codes, ordinances, and regulations regarding wire size, type of insulation, and conductor enclosure. Case has knockouts for 1/2 inch conduit.

Caution: Disconnect power before wiring.

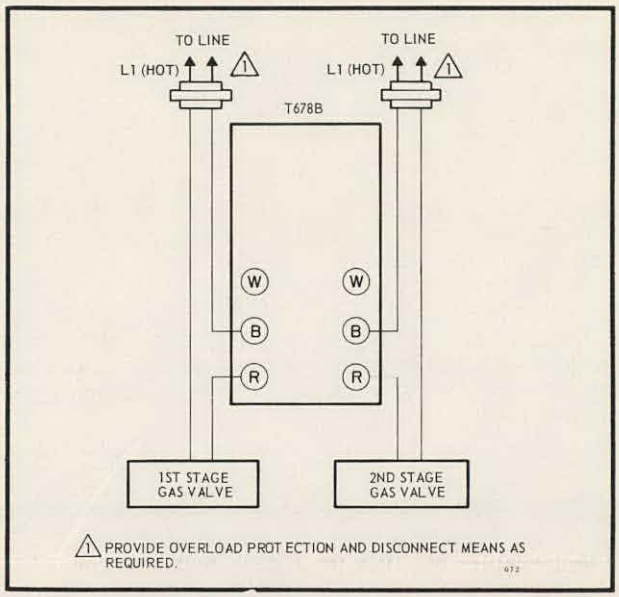


FIG. 3—TYPICAL SWITCHING OF THE T678B (HEATING APPLICATIONS).

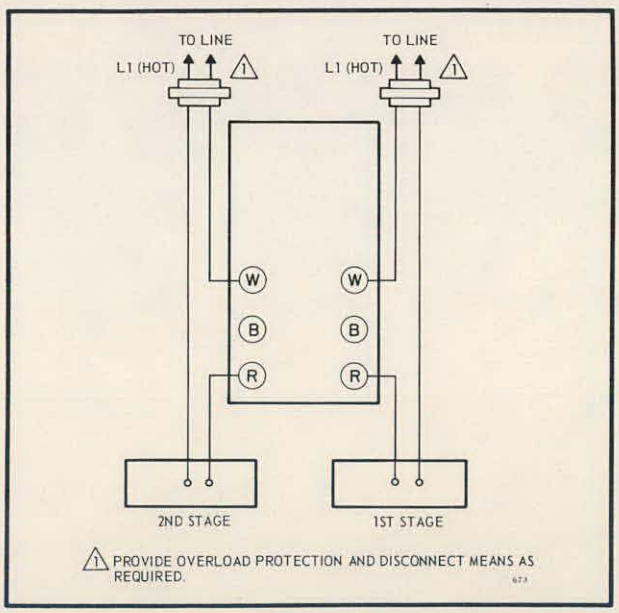


FIG. 4—TYPICAL SWITCHING OF THE T678B (COOLING APPLICATIONS).

OPERATION

The demands for heat made on a furnace vary considerably with the season and with load conditions, such as occupancy and use of the space under control. To provide both the necessary capacity and also economy of operation, stages of heating are often used.

The T678B can switch two gas valves or two electric-strip heaters in sequence and is adjustable from 3 to approximately 10 F. Switching is cycled in response to boiler-water or duct temperature sensed by the indoor bulb. The control point of the indoor bulb is reset according to the temperature of outdoor air, as sensed by the outdoor bulb. The amount of shift in control point depends on the temperature of the outdoor air and on the reset ratio of the T678B used.

RESET ACTION

The range of the T678B is 70 to 140 F. The device is calibrated at the factory with the case and both bulbs at 70 F. When the outdoor bulb is at 70 F, the indoor bulb controls at the setpoint temperature indicated on the scale on the front of the case. At all other outdoor temperatures above and below 70 F the control point (the temperature at which the device actually controls) shifts from the setpoint. The amount of shift is a function of the reset ratio and the difference between the outdoor-air temperature and the calibration temperature (70 F).

A T678B with a reset ratio of 1 to 1 will shift, or "reset", the control point 1 degree upward for each 1 degree the outdoor temperature is below the calibration point of 70 F. For example, if the outdoor bulb senses an air temperature of -10 F the indoor bulb will control at a temperature (control point) higher than the setpoint setting on the scale. Since the outdoor temperature is 80 below calibration (outdoor bulb has fallen from +70 to -10 F), the control point will be raised 80 deg. above the set point. If the set point temperature were 115 F, the water temperature would be reset to 195 when outdoor-air temperature is 10 below zero.

> Note that reset action does not cause a change in the set point setting on the scale of the device, but rather causes a change in the control point—the temperature at which the device actually controls.

Other reset ratios effect similar changes in control point. A ratio of 1-1/2 to 1 resets the control point 1 deg. for each 1-1/2 degrees of change in outdoor-air temperature; a ratio of 1 to 1-1/2 changes the control point 1-1/2 deg. for each 1 deg. change in outdoor air temperature.

SWITCHING ADJUSTABLE DIFFERENTIAL MODEL

Figs. 5 and 6 show the sequence of operation and differentials of the models of the T678B having an adjustable between-switch differential. These models are factory-calibrated at the point where the RIGHT-HAND switch breaks R to B with the outdoor bulb held at 70 F, the indoor bulb just approaching 70 F, and the between-switch differential set at the minimum position.

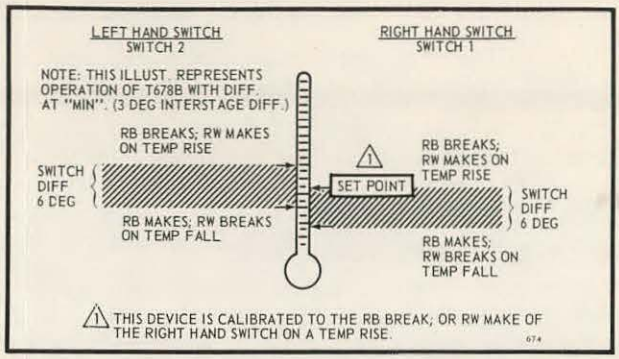


FIG. 5—SWITCHING SEQUENCE, MODELS WITH ADJUSTABLE DIFFERENTIAL BETWEEN SWITCHES – ADJUSTED TO 3 DEGREES OF MINIMUM.

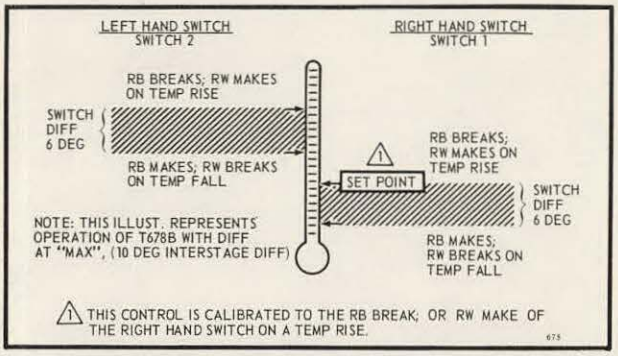


FIG. 6—SWITCHING SEQUENCE, MODELS WITH ADJUSTABLE DIFFERENTIAL BETWEEN SWITCHES – ADJUSTED TO 10 DEGREES OR MAXIMUM.

SWITCHING (FIXED DIFFERENTIAL MODEL)

Figure 7 shows the sequence of operation and differential of the averaging element model of the T678B. The between-switch differential is fixed at 3 F. Calibration is made during manufacture at the point where the LEFT-HAND switch makes R to B with the outdoor bulb held at 70 F and the indoor bulb just approaching 70 F.

SETTING— Adjust the scale to a suitable set point temperature (from 70 to 140 F). Usually a set point of 90 is satisfactory for most heating systems. See OPERATION.

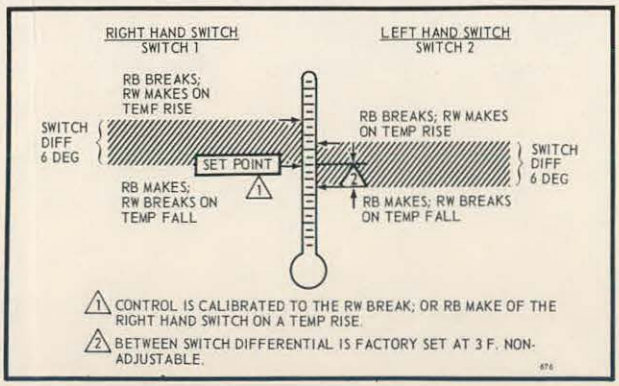


FIG. 7—SWITCHING SEQUENCE OF MODELS WITH FIXED BETWEEN-SWITCH DIFFERENTIAL.

CALIBRATION AND CHECKOUT

The T678B is carefully calibrated at the time of manufacture and will maintain adjustment for years of normal service. Poor control can be the result of many factors, and field recalibration is not recommended. If reason exists for verifying calibration, this can be performed with reasonable accuracy with a good thermometer.

TO CHECK CALIBRATION

1. Determine the outdoor air temperature as accurately as possible at the location of the outdoor bulb. Subtract this temperature from 70 F (the calibration reference point of the T678B) to find the DIFFERENCE TEMPERATURE.

2. Multiply the DIFFERENCE TEMPERATURE by the RESET FACTOR (see table below) to find the amount of shift, or "reset", in the control point.

Reset Ratio	Reset-Ratio Factor
1 to 1	1.0
1 to 1-1/2	1.5
1-1/2 to 1	0.667

3. Determine the temperature of the heating-medium at the indoor bulb and subtract the amount of the control-point reset (Step 2) to find the THEORETICAL SET POINT.

4. Adjust the actual set point (on the scale of the T678B) to the THEORETICAL SET POINT. If the T678B is in calibration, the THEORETICAL SET POINT and the ACTUAL SET POINT should be the same value. If not proceed to Step 5 for calibration.

On models of the T678B having an adjustable differential between stages, the right hand switch will break R to B as the temperature rises to the THEORETICAL SET POINT (cooling application). On a temperature fall, the SET POINT shifts (see Figs. 5 and 6). Models of the T678B, with a fixed interstage differential, break R to W (make R to B) of the left hand switch on a temperature fall to the THEORETICAL SET POINT.

NOTE—Check the outdoor air and heating medium temperatures to make certain that they have not changed from the readings used to make the above computations. Calibration check must be carried out with reasonable speed.

5. TO CALIBRATE:

a. Find the difference between the actual operating point and the THEORETICAL SET POINT by turning the dial of the controller with a screwdriver while observing the controlled equipment. For example, assume that the THEORETICAL SET POINT is 70 degrees, but while moving the dial the controlled equipment comes on at 50 degrees — this means the control is off calibration by 20 degrees. You must increase the calibration by 20 degrees.

b. Slip the fingers of the calibration wrench (part number 801534) into the slots of the dial. Rotate the dial until the fingers of the wrench drop into the slots of the calibration nut under the dial. Note this point by observing the temperature indication on the dial. Assume this point is 45 degrees. You want to raise the calibration by 20 degrees; turn both the dial and the calibration nut, with the wrench, to a dial indication of 65 degrees. This will raise the calibration by 20 degrees.

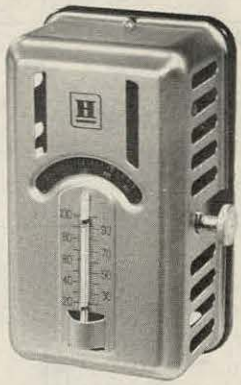
c. Repeat step a. to check your adjustment. If you find the THEORETICAL SET POINT and the actual set point still off, repeat step b.

CHECKOUT

Careful installation of the T678B will assure that full advantage is taken of the close calibration given each controller at the time of manufacture.

Verify switching by lowering the set point on the scale. The first stage of heating should come on at set point plus reset determined by the outdoor temperature. Three degrees (approximately) below this point the second stage of heating should come on.

MULTISTAGE THERMOSTATS



STANDARD CASE
(METAL)

CONTEMPORARY
CASE

T42 Thermostats control line or low voltage heating, cooling, and heating-cooling systems. Multistage models control two or three circuits in sequence.

- ☐ Removable setting knob locks setting lever at desired temperature set point.
- ☐ Protective thermostat case available in standard or contemporary design.
- ☐ Bellows element operates silent, dust-free mercury switches.
- ☐ Thermometer and temperature setting scales located on thermostat cover.

T42A,B,G,H, J,K,L,M,N,P

Residential Div. Form Number 60-2229 7-71 J.A.

60-2229—7/71

SPECIFICATIONS

MODELS:

MODEL NUMBER	SWITCH ACTION	DIFFERENTIAL		SCALE RANGES			
		PER STAGE (non-adj.)	BETWEEN STAGES	40-80 F	5-25 C	60-100 F	15-35 C
T42A	Closes circuit on temperature fall	2 to 3 F midscale	—	x	x	x	—
T42B	Closes circuit on temperature rise	2 to 5 F midscale	—	x	—	x	—
T42G	Closes three circuits in sequence on temperature rise	3 F	2 F non-adj.	x	—	x	—
T42H[a]	Closes two circuits in sequence on temperature fall	1 F	1 to 5 F	x	x	x	x
T42J	Closes two circuits in sequence on temperature rise	3 F	1 to 5 F	x	—	x	x
T42K	Opens one circuit and closes other circuit on temperature rise	1 F heating 3 F cooling	1 to 5 F	x	x	x	x
T42L	Closes one circuit and opens other circuit in sequence on temperature rise	1 F high stage 3 F low stage	1 to 5 F	x	—	—	—
T42M	Closes three circuits in sequence on temperature fall	2 F	2 F non-adj.	x	—	x	—
T42N	Closes two circuits in sequence on temperature fall and one circuit on temperature rise	2 F	2 F non-adj.	—	—	x	x
T42P	Closes one circuit on temperature fall and two circuits in sequence on temperature rise	2 F	2 F between cooling stages 4 F between heating stage and low cooling stage	—	—	x	—

[a]Standard or heavy duty models, see electrical ratings.

ELECTRICAL RATINGS (amps):

MODEL NUMBER	FULL LOAD		RESISTANCE LOAD	
	120V AC 120V DC	240V AC 240V DC	120V AC 120V DC	240V AC 240V DC
T42B	2	1	—	—
T42G, H, J, K L, M, N, P	1	0.5	2	1
T42H1065 (ac only)				
Stage 1	7.4	5.1	10.0	5.0
Stage 2	2.2	1.1	5.0	2.5

T42A	FULL LOAD	LOCKED ROTOR
120v ac	7.4	44.4
240v ac	3.7	22.2
120v dc	2.4	24.0
240v dc	1.2	12.0

FINISH: Silver bronze.

ACCESSORIES:

1. Thermostat guards—133722A (clear plastic cover) or 133723A (beige plastic cover).
2. Back assembly 127246A (two adapter plates and screws) for mounting T42 on a horizontal outlet box.

(continued on page 3)

ORDERING INFORMATION

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

SPECIFY—
1. MODEL NUMBER.
2. SCALE RANGE.
3. COVER STYLE.
4. ACCESSORIES, IF DESIRED.

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)
   INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

DIMENSIONS:

Standard cover (T42A, B, H, J): See Fig. 1.

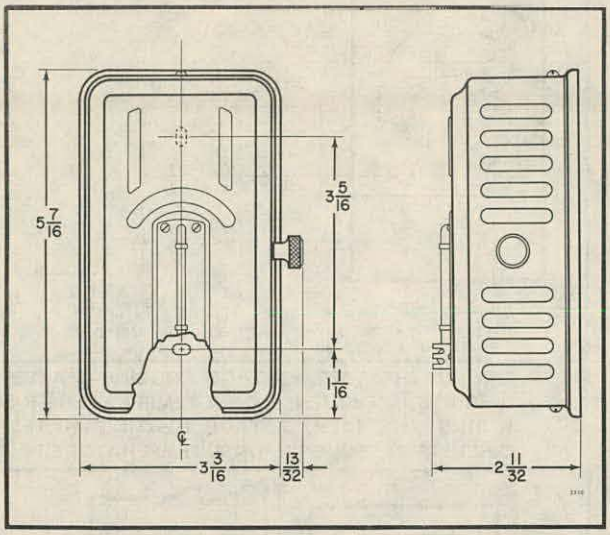


FIG. 1–APPROXIMATE DIMENSIONS (INCHES) OF STANDARD COVER.

Contemporary cover (T42A, G, H, J, K, L, M, N, P): See Fig. 2.

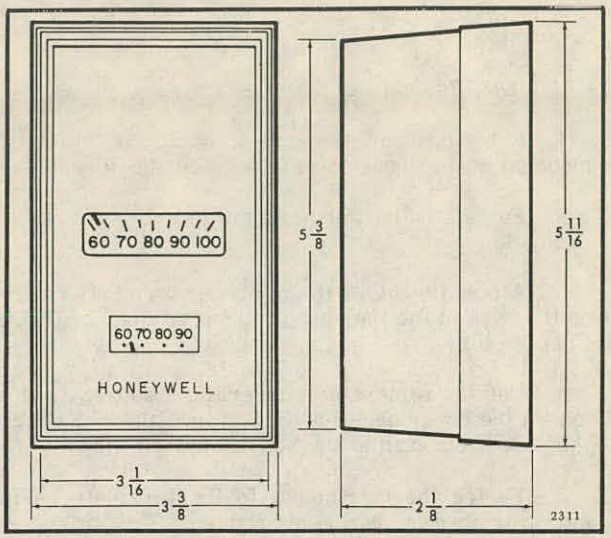


FIG. 2–APPROXIMATE DIMENSIONS (INCHES) OF CONTEMPORARY COVER.

INSTALLATION

LOCATION

Mount the thermostat about five feet above the floor on a wall where there is good air circulation at average temperatures. It should not be mounted on an outside wall or in a location where it may be affected by drafts, hot or cold air from water pipes or ducts, radiant heat from the sun, a fireplace, or appliances.

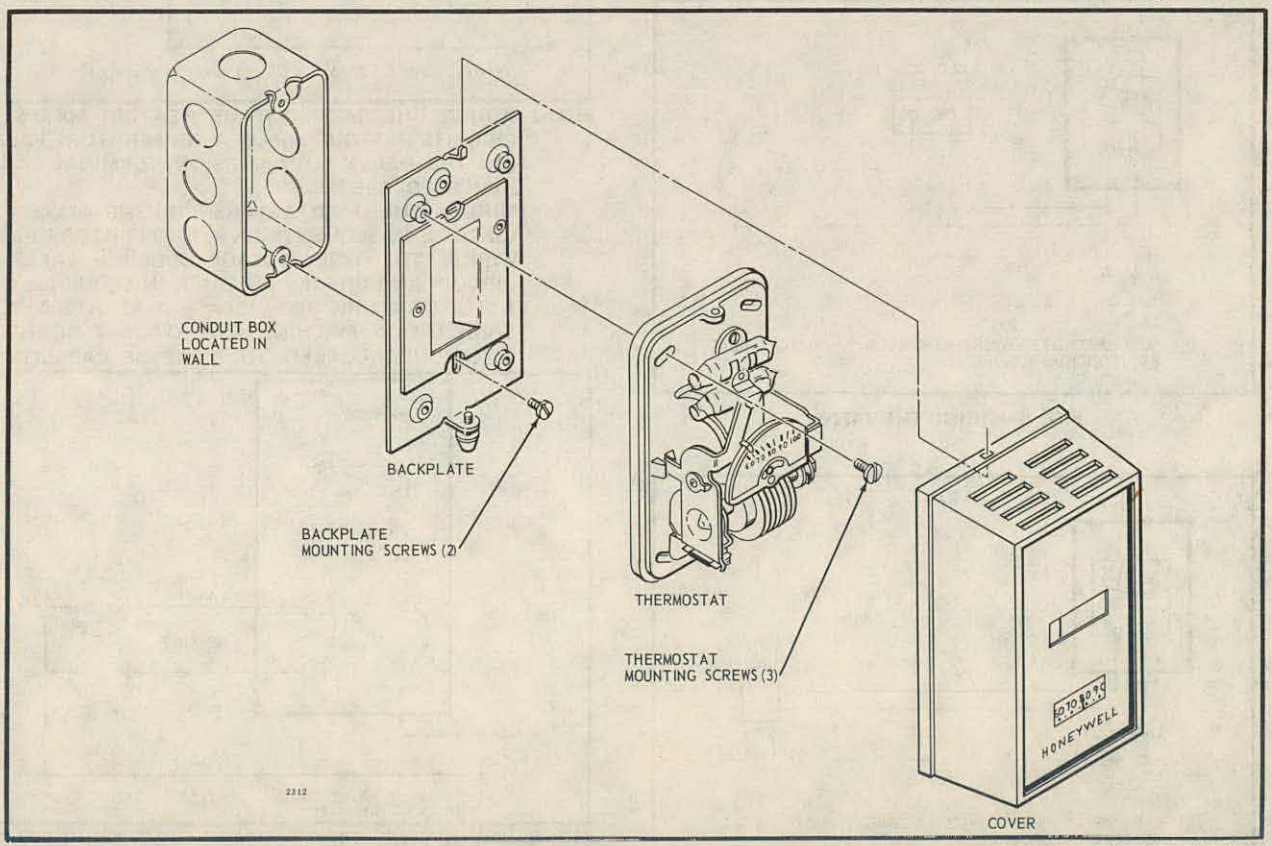


FIG. 3–MOUNTING THE T42 ON VERTICAL OUTLET BOX. FOLLOW INSTRUCTION SHEET PACKED WITH BAG ASSEMBLY WHEN MOUNTING THE T42 ON A HORIZONTAL OUTLET BOX.

MOUNTING AND WIRING

All wiring must agree with local codes and ordinances.

CAUTION: Disconnect power supply.

1. Run approved wire to a standard outlet box mounted at the location selected for the thermostat.

2. Fasten the backplate on the switch box as shown in Fig. 3.

3. Attach the wires to the proper terminal screws on the back of the thermostat; note wiring diagrams, Figs. 4-10.

4. Use the removable temperature setting knob to loosen the cover screw at the bottom of the thermostat. Pull cover outward at the bottom and lift off.

5. Fasten the thermostat to the backplate, using mounting screws, but do not tighten.

6. Level the thermostat. This is necessary to maintain calibration for proper operation.

7. Tighten the three mounting screws to hold the thermostat securely.

IMPORTANT

When the T42 is calibrated at the factory, a backplate mounted at true level is used. Inaccurate leveling can cause thermostat control deviation.

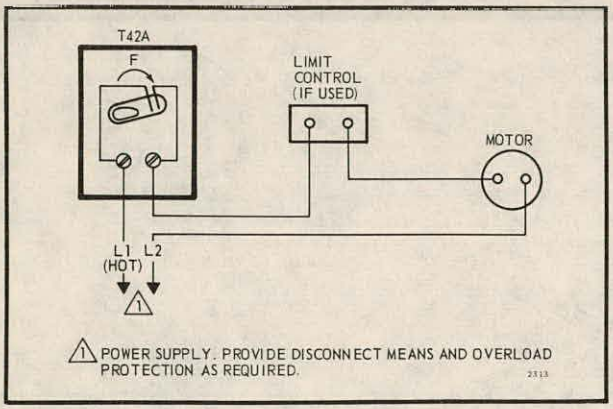


FIG. 4–WIRING THE T42A.

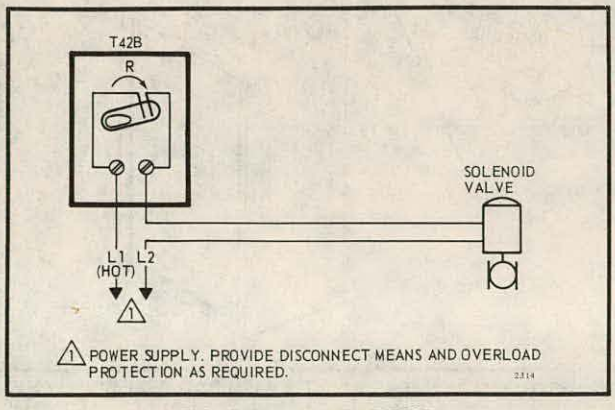


FIG. 5–WIRING THE T42B.

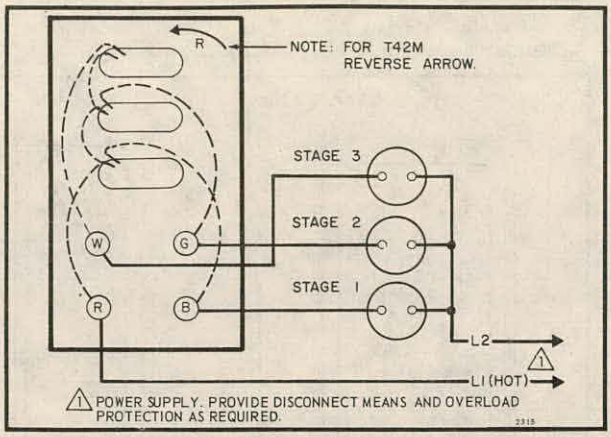


FIG. 6–WIRING THE T42G: 3-STAGE COOLING–MAKES 3 CIRCUITS IN SEQUENCE ON A TEMPERATURE RISE. WIRING THE T42M: 2-STAGE HEATING–MAKES 3 CIRCUITS IN SEQUENCE ON A TEMPERATURE FALL.

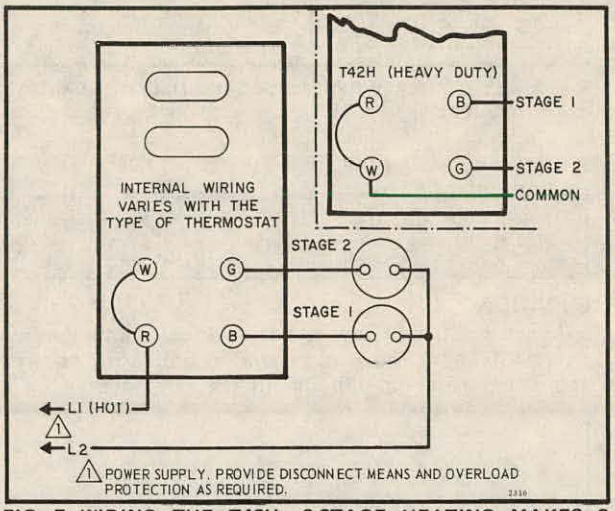


FIG. 7–WIRING THE T42H: 2-STAGE HEATING–MAKES 2 CIRCUITS IN SEQUENCE ON A TEMPERATURE FALL. (ON THE HEAVY-DUTY VERSION, TERMINALS ARE REVERSED–SEE INSET.)
WIRING THE T42J: 2-STAGE COOLING–MAKES 2 CIRCUITS IN SEQUENCE ON A TEMPERATURE RISE. WIRING THE T42L: 2-STAGE COOLING–MAKES 1 CIRCUIT AND BREAKS ANOTHER IN SEQUENCE ON A TEMPERATURE RISE. (STAGE 1 STARTS A REFRIGERATION MACHINE AND STAGE 2 DE-ENERGIZES UNDERLOADER TO INCREASE CAPACITY.)

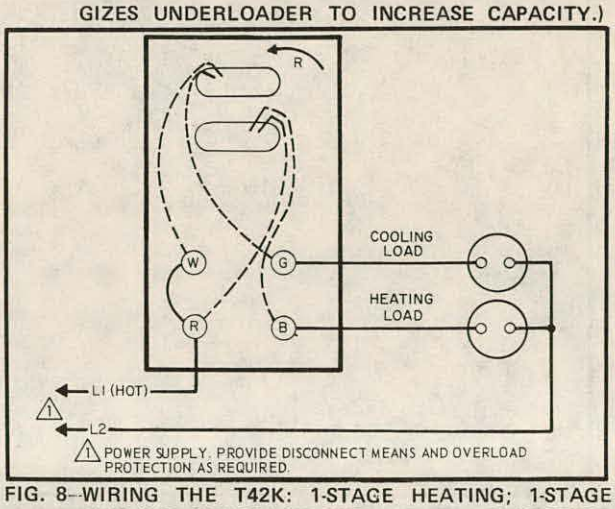


FIG. 8–WIRING THE T42K: 1-STAGE HEATING; 1-STAGE COOLING–MAKES 1 CIRCUIT AND BREAKS ANOTHER ON A TEMPERATURE RISE.

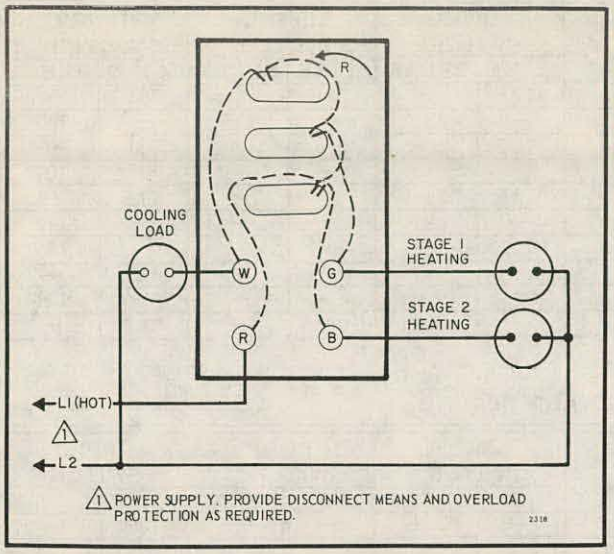


FIG. 9–WIRING THE T42N: 2-STAGE HEATING; 1-STAGE COOLING–BREAKS 2 CIRCUITS AND MAKES 1 CIRCUIT IN SEQUENCE ON A TEMPERATURE RISE.

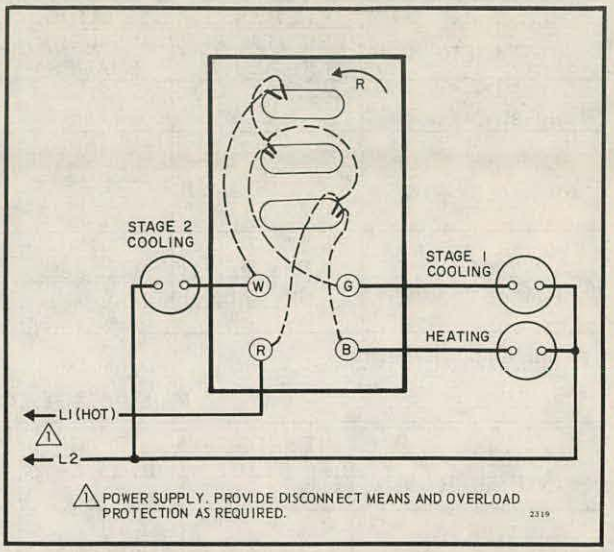


FIG. 10–WIRING THE T42P: 2-STAGE COOLING; 1-STAGE HEATING–BREAKS 1 CIRCUIT AND MAKES 2 CIRCUITS IN SEQUENCE ON A TEMPERATURE RISE.

OPERATION

With cover removed, it is possible to observe the making and breaking action of the mercury switches while manually moving the temperature setting lever along the setting scale.

The following tables on page 6 illustrate the operating characteristics of multistage models of the T42. The temperature values shown are based on the inherent differentials of the thermostats, assuming room temperature changes not exceeding 5 or 6 F per hour. With faster temperature changes, the actual operating differentials (both between stages and within each stage) will be larger than the manual differentials indicated.

In the tables a temperature set point of 72 F has been chosen for each example. A small "a" indicates the assumed setting, and the column in which the small "a" appears indicates the switch that is calibrated to set at the assumed setting.

For each model having an adjustable differential, two sets of figures are given: the first for the minimum between-stage differential setting of 1 degree, and the second for the maximum setting of 5 degrees.

The differential settings for the T42H, J, K, and L are adjustable from 1 to 5 degrees F. If the factory setting of 1 F is not satisfactory, the differential may be increased by means of the eccentric adjustment screw (see Fig. 11).

T42H—Increase differential between stages by turning the screw clockwise slightly.

T42J, K, L—Increase differential between stages by turning the screw counterclockwise slightly.

TO CHECK THE ADJUSTMENT

1. Move the temperature pointer slowly up and down scale by turning the temperature setting knob.

2. On the scale, note the number of degrees between the make or break of one switch and the make or break of the other.

NOTE: These directions apply only to the differential between stages. In all T42 Thermostats, the differential per stage is non-adjustable. Between-stage differentials for the T42G, M, N, and P are factory set and are non-adjustable.

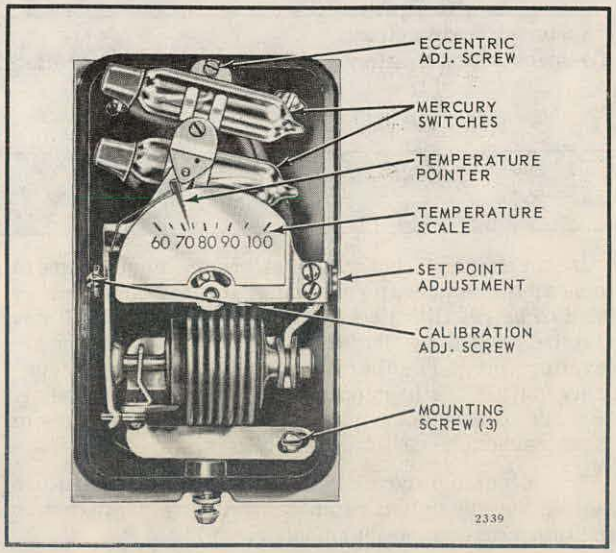


FIG. 11 INTERNAL VIEW OF T42H.

MULTI-STAGE COOLING

MODEL NUMBER	DIFFERENTIAL SETTING PER STAGE (NON-ADJ.)	DIFFERENTIAL SETTING BETWEEN STAGES	TEMP. CHANGE	LOWER SWITCH MAKE	LOWER SWITCH BREAK	MIDDLE SWITCH MAKE	MIDDLE SWITCH BREAK	UPPER SWITCH MAKE	UPPER SWITCH BREAK
T42G Three-stage cooling	3F	2F non-adj.	Rise	[a]72F	—	74F	—	76F	—
			Fall	—	69F	—	71F	—	73F
T42J Two-stage cooling	3F	1F min. set.	Rise	[a]72F	—	—	—	73F	—
			Fall	—	69F	—	—	—	70F
		5F max. set.	Rise	[a]72F	—	—	—	77F	—
			Fall	—	69F	—	—	—	74F
T42L Two-stage cooling	3F (low stage) 1F (high stage)	1F max. set.	Rise	[a]72F	—	—	—	—	73F
			Fall	—	69F	—	—	72F	—
		5F max. set.	Rise	[a]72F	—	—	—	—	77F
			Fall	—	69F	—	—	76F	—

[a]Assumed scale setting.

MULTI-STAGE COOLING AND HEATING

MODEL NUMBER	DIFFERENTIAL SETTING PER STAGE (NON-ADJ.)	DIFFERENTIAL SETTING BETWEEN STAGES	TEMP. CHANGE	LOWER SWITCH MAKE	LOWER SWITCH BREAK	MIDDLE SWITCH MAKE	MIDDLE SWITCH BREAK	UPPER SWITCH MAKE	UPPER SWITCH BREAK
T42K One-stage heating One-stage cooling	1F (heating) 3F (cooling)	1F min. set.	Rise	—	[a]72F	—	—	73F	—
			Fall	71F	—	—	—	—	70F
		5F max. set.	Rise	—	[a]72F	—	—	77F	—
			Fall	71F	—	—	—	—	74F
T42N Two-stage heating One-stage cooling	2F	2F non-adj.	Rise	—	72F	—	74F	76F	—
			Fall	70F	—	[a]72F	—	—	74F
T42P One-stage heating Two-stage cooling (Red pointer indicates heating setting, green pointer indicates low cooling stage setting.	2F	2 F between cooling stage 4 F between heating stage and low cooling stage	Rise	—	74F	78F	—	80F	—
			Fall	[a]72F	—	—	76F	—	78F

[a]Assumed scale setting.

MULTI-STAGE HEATING

MODEL NUMBER	DIFFERENTIAL SETTING PER STAGE (NON-ADJ.)	DIFFERENTIAL SETTING BETWEEN STAGES	TEMP. CHANGE	LOWER SWITCH MAKE	LOWER SWITCH BREAK	MIDDLE SWITCH MAKE	MIDDLE SWITCH BREAK	UPPER SWITCH MAKE	UPPER SWITCH BREAK
T42H Two-stage heating	1F	1F min. set.	Rise	—	73F	—	—	—	72F
			Fall	[a]72F	—	—	—	71F	—
		5F max. set.	Rise	—	73F	—	—	—	68F
			Fall	[a]72F	—	—	—	67F	—
T42H (Heavy Duty) Two-stage heating	3F	3F non-adj.	Rise	—	72F	—	—	—	75F
			Fall	69F	—	—	—	[a]72F	—
T42M Three-stage heating	2F	2F non-adj.	Rise	—	74F	—	72F	—	70F
			Fall	[a]72F	—	70F	—	68F	—

[a]Assumed scale setting.

To check which heating or cooling stage is controlled by any given switch, refer to the wiring diagrams.

CALIBRATION AND CHECKOUT

If thermostat fails to maintain room temperature at or near the temperature setting, the thermostat may need to be recalibrated. However, faulty control may also be caused by drafts, poor location, inaccurate leveling, etc. The thermostat may not control accurately until it has been operating for an hour or more. If thermostat inaccuracy cannot be traced to any of these causes, recalibrate as follows:

1. Determine the difference between temperature setting and the actual room temperature indicated by the thermometer on thermostat cover.

2. Remove the thermostat cover.

3. Turn the calibration adjustment screw (see Fig. 11) one quarter turn for each degree of control error—clockwise ↷ if the thermostat is maintaining too low a temperature; counterclockwise ↶ if too high a temperature is maintained.

4. Check each adjustment by allowing the thermostat to operate automatically for at least one hour.

CHECKOUT

After all adjustments have been made, operate the system to make sure that thermostat controls equipment as intended. Remove setting knob from thermostat case to lock temperature set point.

Honeywell

DIFFERENTIAL TEMPERATURE CONTROLLER

R7412A-F

THE R7412 DIFFERENTIAL TEMPERATURE CONTROLLER PROVIDES AUTOMATIC CONTROL OF CIRCULATING PUMPS, VALVES, DAMPERS, MOTORS, AND OTHER ACCESSORIES USED IN SOLAR ENERGY SYSTEMS.

- All models contain a solid state differential temperature controller.
- R7412B,C include freeze protection.
- R7412D,E include overtemperature protection.
- R7412F includes freeze and overtemperature protection (field adjustable), and an auxiliary relay driver.
- Plug-in resistors permit changing on and off temperature differential and adapting R7412 for single function temperature control.
- R7412B-E overtemperature and freeze protection set points are selectable for factory setting, but are not field adjustable.
- Uses one or two C773 Temperature Sensors.
- Separate sensors are not required for freeze and/or overtemperature protection.

R.L.
REV. 2-78 (.09)

Form Number 60-2305—2

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.

TRADELINE MODELS

TRADELINE MODELS are selected and packaged for ease of stocking, ease of handling, and maximum replacement value. TRADELINE specifications are the same as those of standard models except as noted below.

TRADELINE MODEL AVAILABLE:

R7412F Differential Temperature Controller.

TRADELINE FEATURES:

- Includes freeze and overtemperature protection and an auxiliary relay driver.
- TRADELINE Pack with cross reference label.

STANDARD MODELS

MODEL	DIFF. TEMP. CONTROL	FREEZE PROTECTION	OVERTEMPERATURE PROTECTION	AUXILIARY RELAY DRIVER
R7412A	Yes[a]			
R7412B	Yes[a]	Yes[ad]		
R7412C	Yes[a]	Yes[cd]		Yes[c]
R7412D	Yes[a]		Yes[bd]	
R7412E	Yes[a]		Yes[cd]	Yes[c]
R7412F	Yes[a]	Yes[acd]	Yes[bcd]	Yes[c]

[a]Internal relay energizes. [b]Internal relay de-energizes. [c]Auxiliary relay energizes. [d]Protection setpoint is factory fixed.

TEMPERATURE SETTING RANGES:

Control Range–0 to plus 210 F [minus 18 to plus 99 C] as defined by temperature of low temperature sensor.

Differential Temperature Controller–Adjustable ON and OFF differentials from minus 10 to plus 40 F [minus 5.6 to plus 22.2 C]. Factory-set at 18 F [10 C] temperature difference ON and 3 F [1.7 C] temperature difference OFF. Plug-in resistors vary settings (see Table 1, page 7).

Freeze Protection–

R7412B,C set point may be specified at 37, 42, or 47 F [3, 6, or 8 C], but it is factory fixed.

R7412F has field adjustable settings at 37, 42, or 47 F [3, 6, or 8 C].

Freeze differential–3 F [1.7 C].

Overtemperature Protection–

R7412D,E set point may be specified at 5 F [3.2 C] increments from 140 to 190 F [60 to 88 C], but it is factory fixed.

R7412F has field adjustable settings in 5 F [3.2 C] increments from 140 to 190 F [60 to 88 C].

Overtemperature differential–10 F [5.5 C].

(continued on page 3)

ORDERING INFORMATION

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

1. **Differential Temperature Controller order number.**
2. **Temperature Sensor order number (two required).**
3. **Freeze protection (R7412B,C) or overtemperature protection (R7412D,E) set point desired.**
4. **Immersion well order number.**
5. **Accessories, if desired.**
6. **Optional specifications, if desired.**

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.

ELECTRICAL RATINGS:

Input Voltage–120V ac, 60 Hz.

Load Relay Contacts–

1 N.O. Pole–10 AFL/60 ALR at 120V ac.

1 N.C. Pole–125 VA at 120V ac.

Auxiliary Relay Drive–5 VA maximum at 24V ac, 60 Hz.

Power Consumption–7 watts maximum.

AMBIENT TEMPERATURE RANGE:

Controller–plus 20 to 115 F [minus 7 to plus 46 C].

Temperature Sensor–Minus 50 to plus 450 F [minus 46 to plus 232 C].

MOUNTING:

Controller–two screw holes in opposite corners of case. Mounting screws not included.

Electronic Temperature Sensor–Sensor is available for mounting with clip or has a flattened end with a mounting hole. Tank sensor mounts in an immersion well. See ACCESSORIES.

WIRING CONNECTIONS: 9 screw terminals. Also, 2 leadwires on R7412C,E,F.

DIMENSIONS: See Fig. 2.

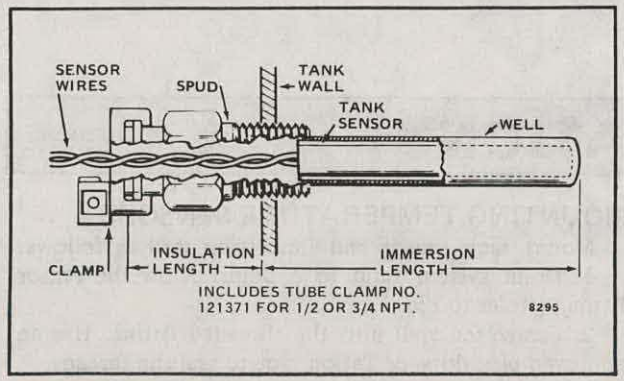


FIG. 1–TANK SENSOR INSERTED IN IMMERSION WELL.

AUXILIARY RELAYS:

R856A Fan Centers–

Line voltage spst and spdt switching.

Low voltage terminal strip for wiring thermostat and high side panel.

R8225A Fan Relay–spdt switching, one double throw contact.

R8225B Fan Relay–spst switching; normally open contacts.

R8225C Fan Relay–dpst switching; one normally open and one normally closed contact.

R8225D Fan Relay–dpst switching; one normally open main and one normally open auxiliary pole.

OPTIONAL SPECIFICATIONS:

Indicator Light–indicates when pump or fan are operating.

Auto-Off-On Switch–manual override switch which permits automatic operation of the controller or allows the controller to be switched directly ON and OFF. Switch does not affect the operation of the auxiliary relay in R7412C,E, and F.

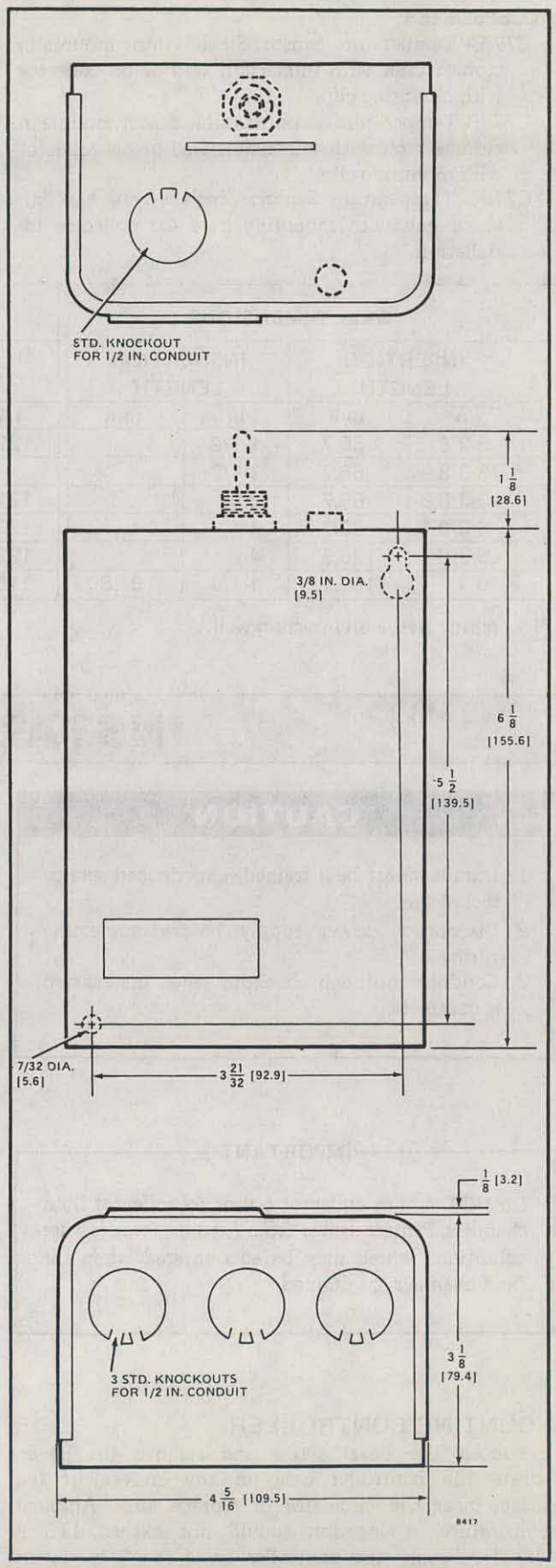


FIG. 2–R7412 MOUNTING DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

ACCESSORIES:

C773A Temperature Sensor. Single sensor mounts in storage tank with immersion well or on collector with mounting clip.

C773B Temperature Sensor. Double sensor mounts in storage tank with immersion well or on collector with mounting clip.

C773C Temperature Sensor. Single sensor has flattened end with mounting hole for collector installation.

C773D Temperature Sensor. Double sensor has flattened end with mounting hole for collector installation.

Immersion Well–for mounting sensor in storage tank. See immersion well table and Fig. 1.

Remote Sensor Wiring Compartment–mounts to immersion well. Part No. 111892F.

WELL DIMENSIONS				SELECT WELL MATERIAL AND ORDER NUMBER BELOW			
INSERTION LENGTH		INSULATION LENGTH		COPPER		STAINLESS STEEL	
in	mm	in	mm	1/2 NPT	3/4 NPT	1/2 NPT	3/4 NPT
3-3/8	85.7	1-1/2		121371A	121371B	121371E	121371F
3-3/8	85.7	1-1/2		–	121371K[a]	–	–
3-3/8	85.7	3		121371L	121371M	–	–
5-3/8	85.7	4		122554B[a]	122555B[a]	–	–
3-3/8	136.5	4		122554A[a]	122555A[a]	–	–
6	152.4	1-1/4	31.8	112620BB	–	–	–

[a]Has plastic sleeve on insertion well.

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.

IMPORTANT

Do NOT mount collector sensor to collector fluid channels. Protect sensor from extreme temperature conditions which may be encountered when the fluid channels are drained.

MOUNTING CONTROLLER

Loosen the cover screw and remove the cover. Locate the controller case on any convenient flat surface near the circulator or storage tank. Ambient temperature at location should not exceed 115 F [46 C]. Secure the controller using the 2 mounting holes located in opposite corners of the case and 2 mounting screws (not included).

MOUNTING TEMPERATURE SENSORS

Mount tank sensor and immersion well as follows:

1. Drain system fluid to a point below the sensor fitting. (Refer to Fig. 1.)
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 over groove on well spud. Fit wires in clamp groove and lightly tighten screw. Do not over tighten.

Mount collector sensor according to the collector manufacturers recommendations. Fasten the sensor to the panel with a No. 8 or 10 screw (Fig. 3). *Do NOT mount collector sensor to collector fluid channels.* Do not exceed ambient temperature ratings.

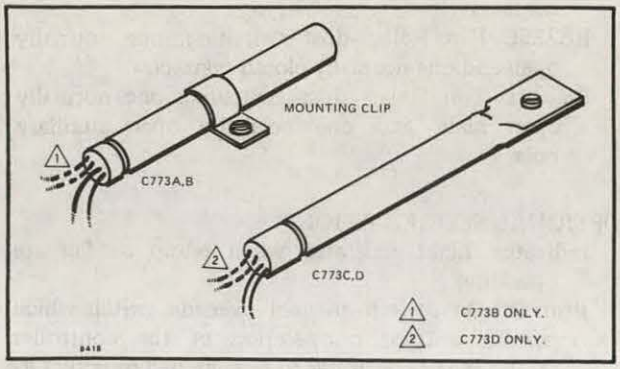


FIG. 3–MOUNTING THE C773 TEMPERATURE SENSOR.

WIRING

All wiring must comply with applicable codes and ordinances. The R7412 can be used for numerous applications in solar energy systems. Refer to Figs. 4 through 7 for typical examples of R7412 hookups. Also, the OPTIONAL APPLICATIONS section depicts the R7412 using only one temperature sensor.

The temperature sensors are wired to the controller through the 1/2 inch knockout for conduit in the top of the controller case. Wire the power supply, relay contacts, and auxiliary relay driver using the three knockouts for 1/2 inch conduit in the bottom of the controller case (Fig. 1).

If the amount of sensor cable used exceeds 100 feet [30.5 m], use No. 14 wire and grounded metallic conduit or two conductor shielded cable. Connect the shield to ground at the controller. Grounded metallic conduit and shielded cable (such as Belden 8762 or equivalent) minimizes possible radio frequency signal interference.

111892F Remote Sensor Wiring Compartment is available for tank sensor wiring (see ACCESSORIES).

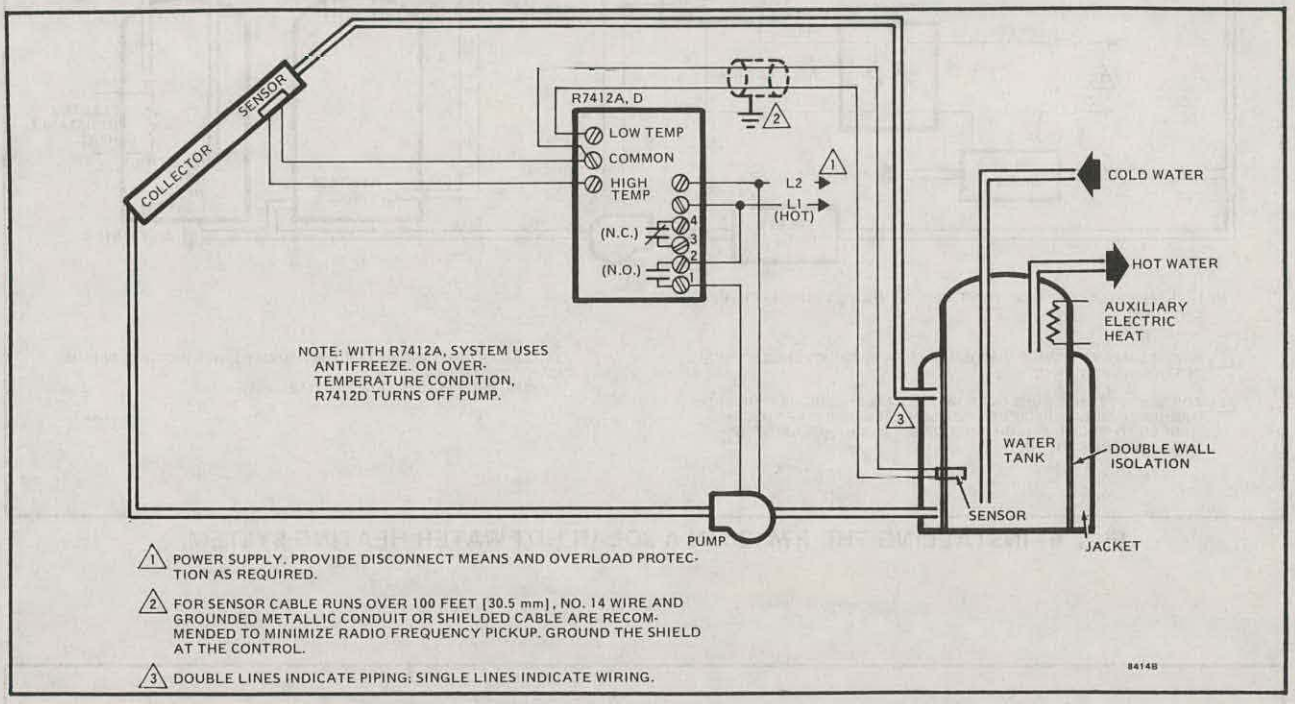


FIG. 4—USING THE R7412A,D WITH A SOLAR WATER HEATER.

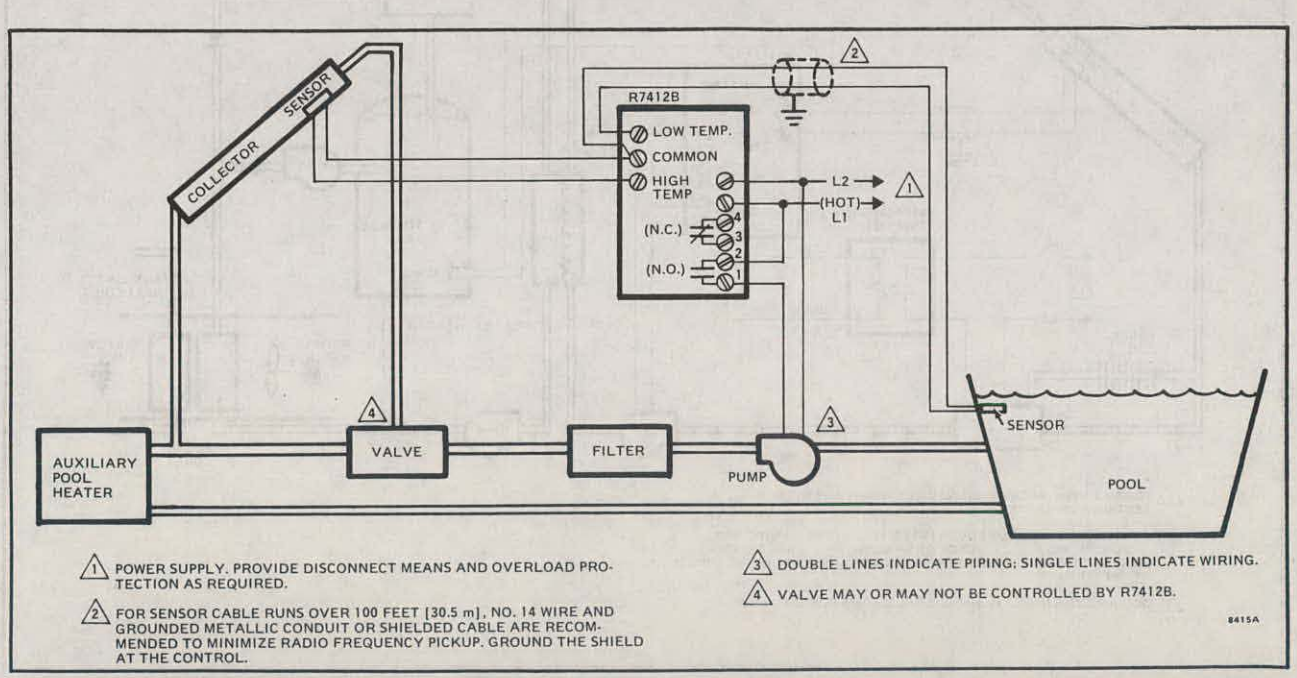


FIG. 5—USING THE R7412B WITH A SOLAR POOL HEATER. CONTROLLER ENERGIZES PUMP DURING FREEZE CONDITION.

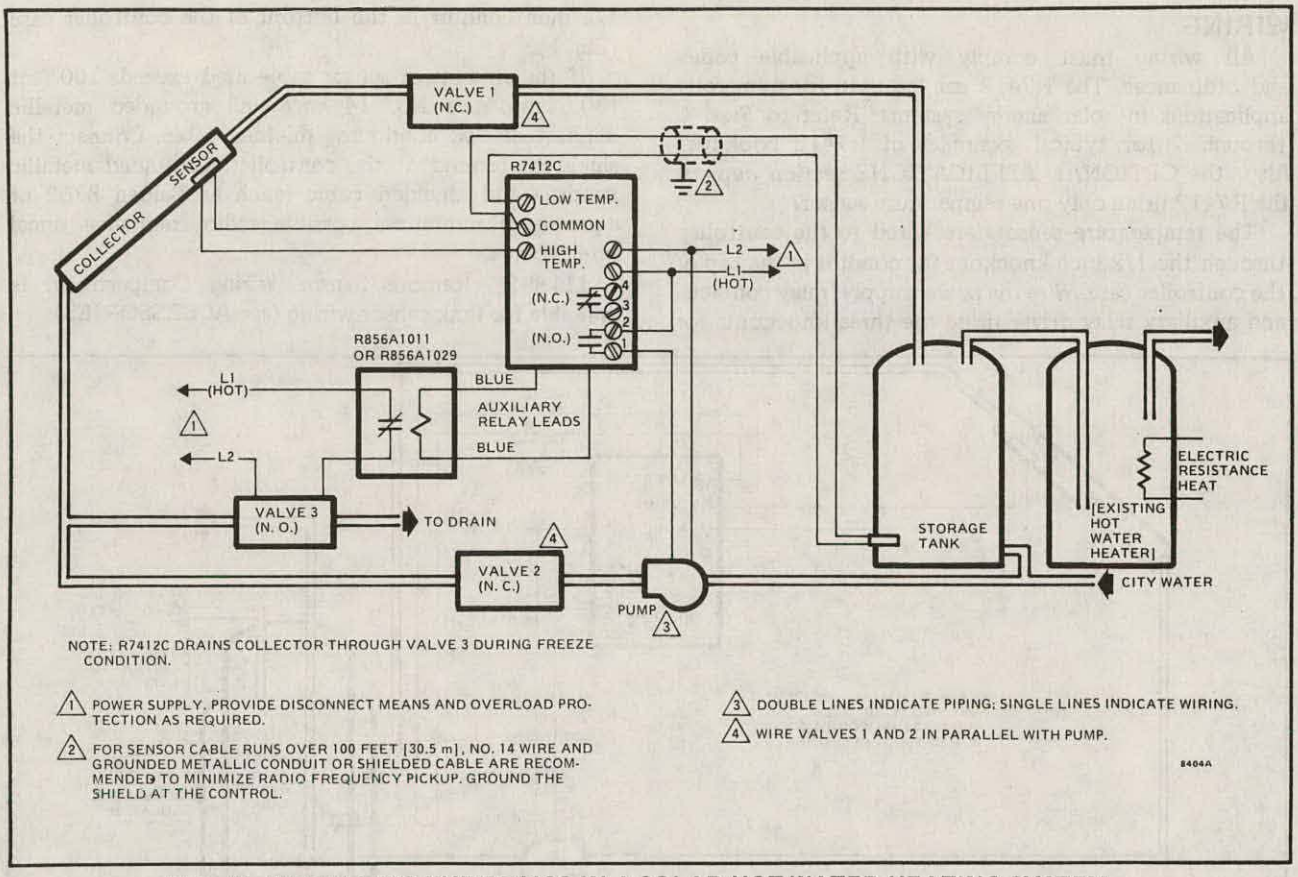


FIG. 6–INSTALLING THE R7412C IN A SOLAR HOT WATER HEATING SYSTEM.

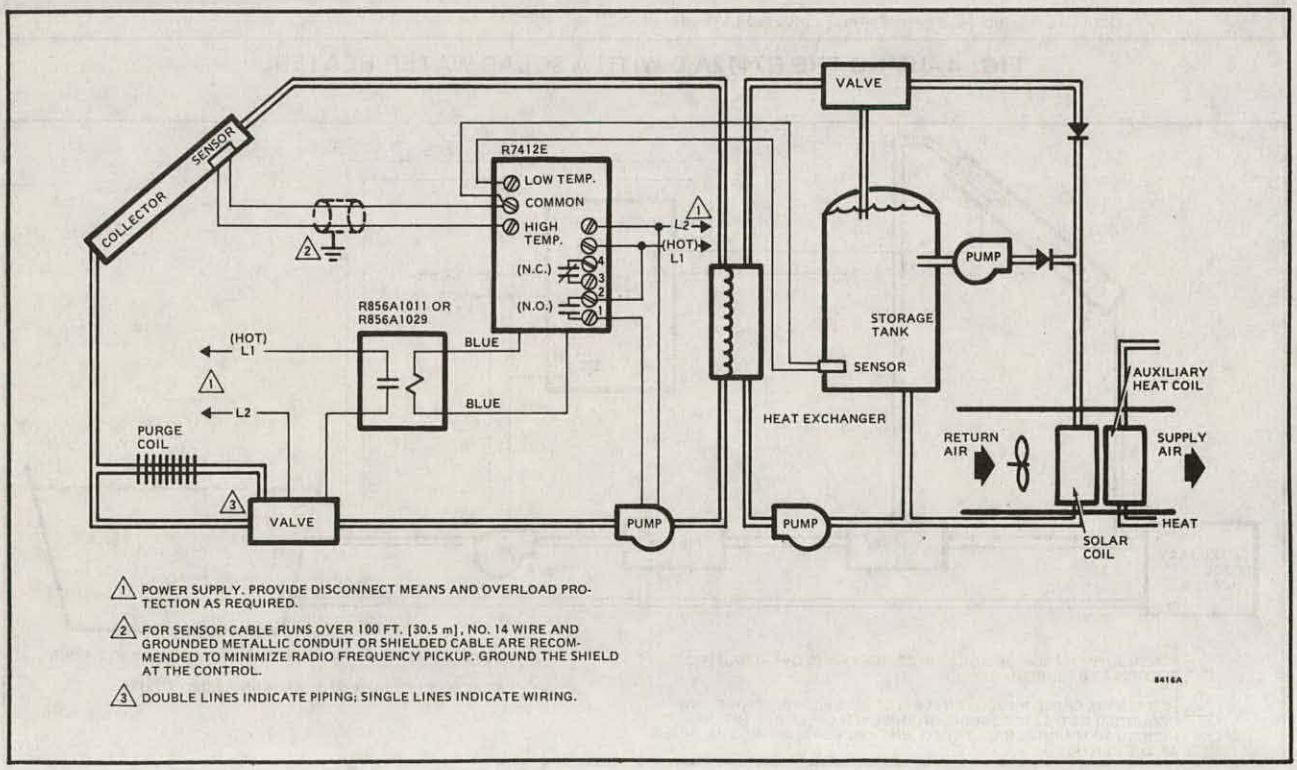


FIG. 7–TYPICAL INSTALLATION OF THE R7412E IN A SOLAR HOT WATER TO WARM AIR HEATING SYSTEM.

ADJUSTMENTS AND CHECKOUT

DIFFERENTIAL TEMPERATURE SELECTION

The control settings may be adjusted by changing the ON and OFF plug-in resistors (see Fig. 8). The R7412 is factory-set for pull-in at 18 F [10 C] temperature difference with a 4750 ohm ON resistor. Dropout is set for 3 F [1.7 C] temperature difference with a 9760 ohm OFF resistor.

To change either setting, refer to Table 1 to select the resistor(s) needed. See Fig. 9 to prepare resistor for installation. Remove the old resistor and plug in the replacement. Be sure the correct resistor is inserted in the proper position. Use 1/8 watt, 1 percent resistors, available locally.

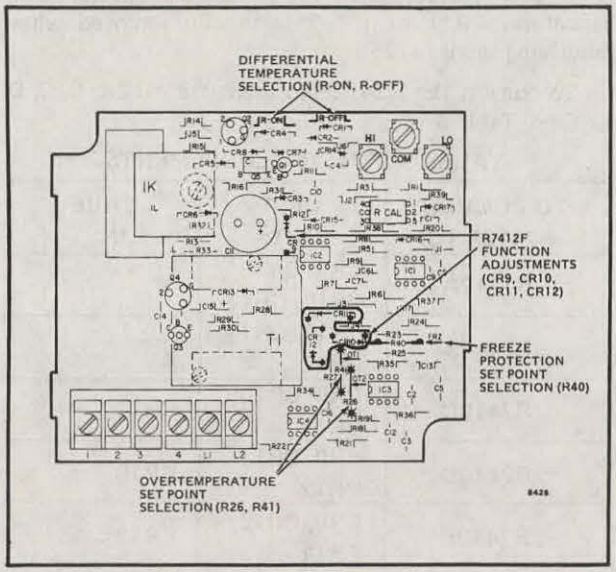


FIG. 8–ADJUSTMENT COMPONENTS OF THE R7412.

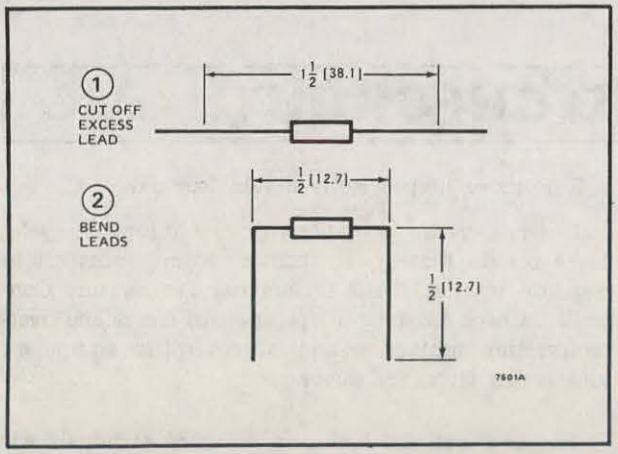


FIG. 9–PLUG-IN RESISTOR PREPARATION. DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

TABLE 1–ON, OFF DIFFERENTIAL TEMPERATURE CONTROL

FOR TEMPERATURE DIFFERENCE OF:		USE RESISTANCES BELOW FOR ON OR OFF RESISTORS (IN OHMS)
F	C	
-10	- 6.0	27500
- 5	- 3.0	15400
0	0	11500
1	0.6	11000
2	1.0	10500
3	1.7	9760
4	2.2	9310
5	3.0	8870
6	3.3	8250
7	4.0	7870
8	4.4	7500
9	5.0	7150
10	6.0	6810
12	7.0	6340
14	8.0	5620
16	9.0	5230
18	10.0	4750
20[a]	11.0[a]	4220[a]
25	14.0	3320
30	17.0	2430
35	19.0	1750
40	22.0	1210

[a]Maximum OFF setting must not exceed 20 F [11 C]; resistor value must be greater than 4220 ohms.

R7412F FREEZE PROTECTION TEMPERATURE SELECTION

Freeze protection setting is adjusted by changing the freeze protection plug-in resistor, R40 (see Fig. 8). The R7412 freeze protection is factory-set at 37 F [3 C].

To change the setting to 37 F [3 C], simply remove the freeze protection resistor and leave it open circuited. For a setting of 42 F [6 C], install a 110 kilohm resistor using the resistor preparation indicated in Fig. 9. Use a 48.7 kilohm resistor to change the freeze protection setting to 47 F [8 C].

R7412F OVERTEMPERATURE SETTING SELECTION

Overtemperature protection setting may be adjusted by changing the overtemperature protection resistors, OT1 (R41) and OT2 (R26) (see Fig. 8). The R7412 overtemperature limit is factory-set at 140 F [66 C].

To change the setting, refer to Table 2 to select the resistors needed. See Fig. 9 to prepare resistor for installation. Remove the old overtemperature resistors and insert the correct resistor in the proper position. Use 1/8 watt, 1 percent resistors, available locally.

TABLE 2–OVERTEMPERATURE CONTROL

FOR OVER-TEMPERATURE LIMIT OF:		CHANGE RESISTOR OT1 (R41) TO: (OHMS)	CHANGE RESISTOR OT2 (R26) TO: (OHMS)
F	C		
140	60	11,800	174,000
145	63	16,900	113,000
150	66	19,100	61,900
155	68	22,100	44,200
160	71	25,500	33,200
165	74	30,900	27,400
170	77	38,300	23,200
175	79	52,300	20,000
180	82	78,700	17,800
185	85	154,000	15,800
190	88	Open	14,300

ADJUSTING FUNCTIONS OF THE R7412F

Refer to Fig. 8 for the location of the components which can be removed to change the function of the R7412F.

The R7412F can be modified to provide freeze protection through the internal relay, the auxiliary relay, both the internal and the auxiliary relay, or neither. Diodes CR9 and CR11 control these types of freeze protection. If both CR9 and CR11 remain in the controller, the internal relay will be energized as well as the auxiliary relay. Removing CR9 disables the internal relay; clipping out CR11 disables the auxiliary relay. When both CR9 and CR11 are taken out, the freeze protection feature of the R7412F is completely disabled.

Usually, CR9 or CR11 is removed to provide freeze protection which is operated by either the internal relay or the auxiliary relay, but not both.

Also, the R7412F may be adjusted to give overtemperature protection through the internal relay, the auxiliary relay, both the internal and the auxiliary relay, or neither. Diodes CR10 and CR12 control these types of overtemperature protection. If both CR10 and CR12 remain in the controller, the internal relay will be de-energized and the auxiliary relay will be energized. Removing CR10 prevents the internal relay from locking out the pump during overtemperature; clipping out CR12 disables the auxiliary relay. If both CR10 and CR12 are clipped out, the overtemperature protection capabilities of the R7412F are completely disabled.

Normally, CR10 or CR12 is clipped out to give overtemperature protection through the internal relay or auxiliary relay, but not through both.

In most cases the auxiliary relay is used for freeze protection or overtemperature protection, but not both. Therefore, CR11 or CR12 is usually removed when modifying the R7412F.

To convert the R7412F to models R7412A, B, C, D, or E use Table 3.

TABLE 3–R7412F ADJUSTMENTS

TO CONVERT R7412F TO:	CLIP OUT:	LEAVE IN:
R7412A	CR9, CR10, CR11, CR12	
R7412B	CR10, CR11, CR12	CR9
R7412C	CR9, CR10, CR12	CR11
R7412D	CR9, CR11, CR12	CR10
R7412E	CR9, CR10, CR11	CR12

OPERATION AND CHECKOUT

OPERATION

The controller relay contacts make when the differential temperature is greater than the ON setting and breaks when the temperature difference is less than the OFF setting.

CHECKOUT

Check control for proper operation as follows:

1. Disconnect low temperature terminal, jumper low temperature and common terminal. Relay should pull in.
2. Remove jumper. Relay should drop out.

Observe system operation for one automatic cycle. Make certain that system comes on and turns off in response to the R7412 Differential Temperature Controller. Check for proper operation of freeze and overtemperature protection and of controlled equipment such as circulators and valves.

Shorting out the high and common terminals will simulate a freeze condition.

Shorting out the common and low terminals will simulate an overtemperature condition.

OPTIONAL APPLICATIONS

In addition to the differential temperature control, the R7412A can serve as a single function temperature controller such as a high temperature limit or an Aquastat. The R7412A is adapted to these functions by changing the ON and OFF resistors and the sensor connections. When changing functions, use 1/8 watt, 1 percent resistors, available locally.

Use the following procedures to change the factory-set differential temperature controller to a single function temperature controller as indicated in Figs. 10 and 11.

1. Remove cover. Remove the OFF resistor and replace with an 11,500 ohm resistor according to resistor preparation shown in Fig. 9.
2. To adjust the temperature differential, remove the ON resistor and select a resistor value according to Table 1. Install the selected resistor.
3. To adjust the temperature setpoint, select a resistor value according to the graph in Fig. 12. Connect the selected setpoint resistor to the low temperature and common terminals for make on temperature rise control (Fig. 10). Connect to high and common terminals for make on temperature fall.
4. Wire the sensor to the high temperature and common terminals for make on temperature rise; wire the sensor to the low temperature and common terminals on temperature fall.
5. Check the resistors for proper location and value. Replace the cover.

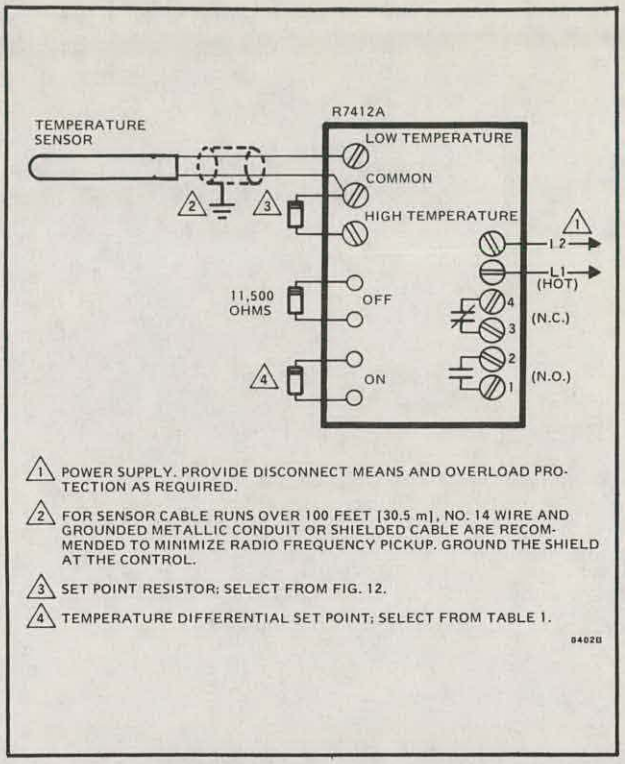


FIG. 11—SINGLE FUNCTION SET POINT CONTROL. CONTROL MAKES ON TEMPERATURE FALL TO SET POINT MINUS DIFFERENTIAL, BREAKS ON TEMPERATURE RISE TO SET POINT.

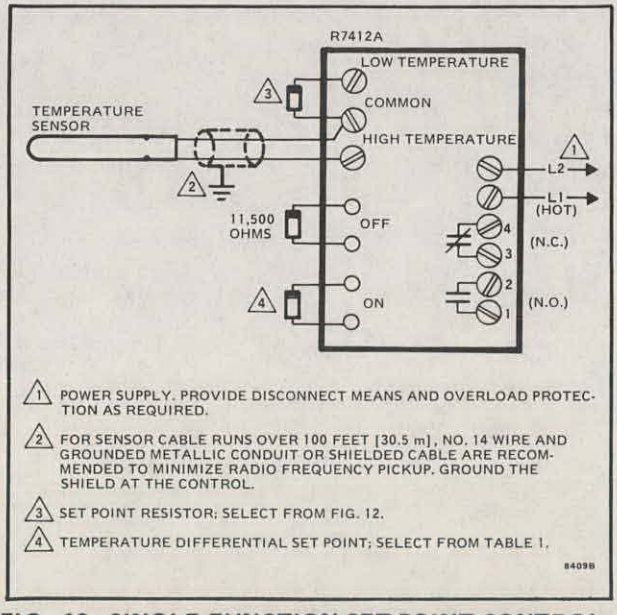


FIG. 10—SINGLE FUNCTION SET POINT CONTROL. CONTROL MAKES ON TEMPERATURE RISE TO SET POINT PLUS DIFFERENTIAL, BREAKS ON TEMPERATURE FALL TO SET POINT.

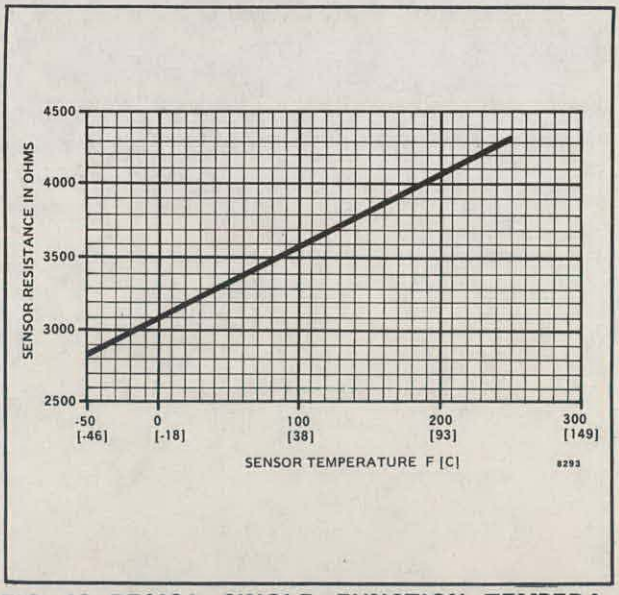


FIG. 12—R7412A SINGLE FUNCTION TEMPERATURE SET POINT. CHOOSE A RESISTANCE ACCORDING TO THE DESIRED SET POINT.

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Honeywell

SINGLE SEATED VALVES

V5011A-C

THE V5011 IS A SINGLE SEATED VALVE FOR CONTROL OF STEAM AND WATER IN HEATING OR AIR CONDITIONING APPLICATIONS. THESE VALVES ARE USED IN TWO POSITION AND MODULATING CONTROL SYSTEMS. A LINKAGE AND MOTOR ARE REQUIRED FOR VALVE OPERATION; ORDER SEPARATELY.

THESE VALVES ARE NOT SUITABLE FOR COMBUSTIBLE GAS SERVICE.

- Sizes range from 1/2 to 6 inches.
- Available with screw or flanged pipe connections.
- Direct- or reverse-acting models.
- Valve designs provide equal percentage characteristic of flow for close control of water, and linear characteristic of flow for close control of steam.
- Spring-loaded, self-adjusting Teflon cone packing.
- Stainless steel stem prevents corrosion which would be injurious to the packing.
- V5011C models available with metal-to-metal seating for high pressure applications.

N.J.
9-75 (.046)

Residential Div. Form Number 60-2126

SPECIFICATIONS

TRADELINE MODELS

Tradeline models are selected and packaged for ease of handling, ease of stocking, and maximum replacement value. Tradeline model specifications are the same as those of standard models except as noted below:

TRADELINE MODELS AVAILABLE:

V5011A Valve—single seated valve for water or 2-position steam. Throttling plug provides equal percentage characteristic of flow. NOT RECOMMENDED FOR MODULATING STEAM. Push valve stem down to close valve.

SERVICE TEMPERATURE RANGE: 115 F to 275 F.

PIPE CONNECTIONS: Screw connections.

VALVE DISC: Composition disc with removable throttling plugs.

VALVE SIZES AND FLOW CAPACITIES:

MODEL NUMBER	PIPE SIZE (INCHES)	FLOW CAPACITY (CV)
V5011A	1/2	2.5
		4.0
	3/4	6.3
	1	10.0
	1-1/4	16.0
	1-1/2	25.0
	2	40.0
	2-1/2	63.0
	3	100.0

ADDITIONAL FEATURES:

- Tradeline pack with cross reference label and special instruction sheet.

STANDARD MODELS

MODELS:

V5011A Valve—single seated valve for water or 2-position steam. Throttling plug provides equal percentage characteristic of flow. NOT RECOMMENDED FOR MODULATING STEAM. Push valve stem down to close valve. Screw or flanged pipe connections. Refer to Table I.

V5011B Valve—single seated valve for water or 2-position steam. Throttling plug provides equal percentage characteristic of flow. NOT RECOMMENDED FOR MODULATING STEAM. Push valve stem down to open valve (reverse acting). Flanged pipe connections. Refer to Table I.

V5011C Valve—single seated valve for modulating steam; also suitable for 2-position steam. Throttling plug provides linear characteristic of flow. Push valve stem down to close valve. Screw pipe connections. Refer to Table I.

PIPE CONNECTIONS: 1/2 to 3 inch valves have screw connections; 2-1/2 to 6 inch valves have flanged connections.

VALVE SEAT: Brass, removable, on screw end models; bronze, removable, on flanged end models.

VALVE STEM: Stainless steel.

VALVE DISC: Composition discs with removable throttling plugs; some models of the V5011C have a metal-to-metal valve disc for high pressure applications.

VALVE STROKE: 1/2 to 3 inch valves—3/4 inches; 4 to 6 inch valves—1-1/2 inches.

VALVE PATTERN: Straight-through.

VALVE BODY MATERIAL: Screw end connection models—bronze; flanged end connection models—cast iron.

VALVE BODY RATINGS:

Nominal ambient temperature (maximum)—
—screw end connection models, 366 F.
—flanged end connection models, 353 F.

Pressure (maximum)—
—screw end connection models, 150 psi.
—flanged end connection models, 125 psi.

(continued on page 3)

ORDERING INFORMATION

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

SPECIFY—
1. MODEL NUMBER AND VALVE SIZE.
2. FLOW CAPACITY.
3. SERVICE TEMPERATURE RANGE, FOR MODELS WITH COMPOSITION DISC.
4. TYPE OF PIPE CONNECTIONS (SCREW OR FLANGED) FOR V5011A 2-1/2 AND 3 INCH VALVES.

ORDER FROM—
1. YOUR USUAL SOURCE, OR
2. HONEYWELL
1885 DOUGLAS DRIVE NORTH
MINNEAPOLIS, MINNESOTA 55422
(IN CANADA—HONEYWELL CONTROLS LIMITED
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PAGES 3 to 4

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TABLE II—Dimensions for Figures 2 through 5.

BODY STYLE AND FIGURE REFERENCE	SIZE (IN.)	DIMENSIONS (IN INCHES)									
		A[a]	B	C	D	E	F	G	H	I (TRAVEL)	J (DIAM)
V5011A, C Screwed, Direct body (Fig. 2)	1/2	3-1/2	1-13/32	1-3/4	1-1/2	1-7/8	1-13/16	1-23/32	3	3/4	1-3/8
	3/4	3-1/2	1-13/32	1-3/4	1-1/2	2	1-13/16	1-23/32	3	3/4	1-3/8
	1	3-1/2	1- 3/8	1-5/8	2-1/8	2-1/4	1-31/32	1- 3/4	3	3/4	1-3/8
	1-1/4	3-1/2	1- 9/16	1-1/2	2-1/2	2-1/2	2- 9/16	1-15/16	3- 1/16	3/4	1-3/8
	1-1/2	3-1/2	1-11/16	1-3/8	2-7/8	2-7/8	3- 9/32	2- 1/16	3- 1/16	3/4	1-3/8
	2	3-1/2	1-15/16	2	2-7/8	2-7/8	3- 9/32	2- 5/16	3-15/16	3/4	1-3/8
	2-1/2	3-1/2	2- 3/16	2-3/8	3-3/4	3-3/4	4- 3/16	3- 1/32	4- 9/16	3/4	1-3/8
	3	3-1/2	2- 5/8	2-3/8	4-7/16	4-7/16	4-15/16	3- 5/8	5	3/4	1-3/8
V5011A Flanged, Direct body (Fig. 3)	2-1/2	3-1/2	4-13/16	4	9-1/2	7	2- 1/2	3/4	5- 1/2	3/4	1-3/8
	3	3-1/2	5- 3/8	4-5/8	11	7-1/2	3	3/4	6	3/4	1-3/8
V5011A Flanged, Direct body (Fig. 4)	4	5-1/4	7- 9/16	5-3/16	13	9	4	3/4	7- 1/2	1-1/2	1-7/8
	5	5-1/4	7	6-1/8	15	10	5	7/8	8- 1/2	1-1/2	1-7/8
	6	5-1/4	8	7-1/16	16-1/2	11	6	7/8	9- 1/2	1-1/2	1-7/8
V5011B Flanged, Reverse body (Fig. 5)	4	6-3/4	4-11/16	8-1/16	13	9	4	3/4	7- 1/2	1-1/2	1-7/8
	5	6-3/4	5- 5/8	7-1/2	15	10	5	7/8	8- 1/2	1-1/2	1-7/8
	6	6-3/4	6- 9/16	8-1/2	16-1/2	11	6	7/8	9- 1/2	1-1/2	1-7/8

[a]Dimension A is with the valve closed (stem down for the V5011A and C, stem up for the V5011B).

INSTALLATION

CAUTION

1. Installer must be a trained, experienced serviceman.
2. Mount valve with fluid flow in direction of arrow cast on valve body.
3. Perform all required checkout tests after installation is complete.

LOCATION

Select a location where the valve, linkage, and motor to be used will be within their ambient pressure and temperature ratings.

Leave approximately a 20 inch clearance above the valve for installation of the linkage and motor and to provide room for servicing the valve body. (The valve body should be completely installed in the pipe line before the motor and linkage are installed.)

When selecting a location for the valve, remember that most Modutrol motors must be mounted with the motor shaft horizontal.

MOUNTING

The preferred mounting position of the valve is with the stem vertical. Avoid mounting the valve with the stem below the horizontal. Scale and foreign material might collect and tend to score the stem and cause packing leakage. Protect the stem from damage due to bending or scratching.

SCREW VALVE BODIES

Screwed body threads conform to American Standard Taper Pipe Threads (NPT).

Line up the pipes squarely with the valve at each end connection. If the pipes are forced into the valve, the body may become twisted and improper seating will result. Apply pipe dope sparingly. Take care to prevent pipe chips, scale, etc., from entering the piping since this material may lodge in the seat and prevent proper closing.

Refer to Fig. 6 for a table of pipe sizes and length of threads on the valve. The figure also shows 2 effective means of holding the valve and pipe when attaching. The valve will not function properly if it is twisted or squeezed during installation.

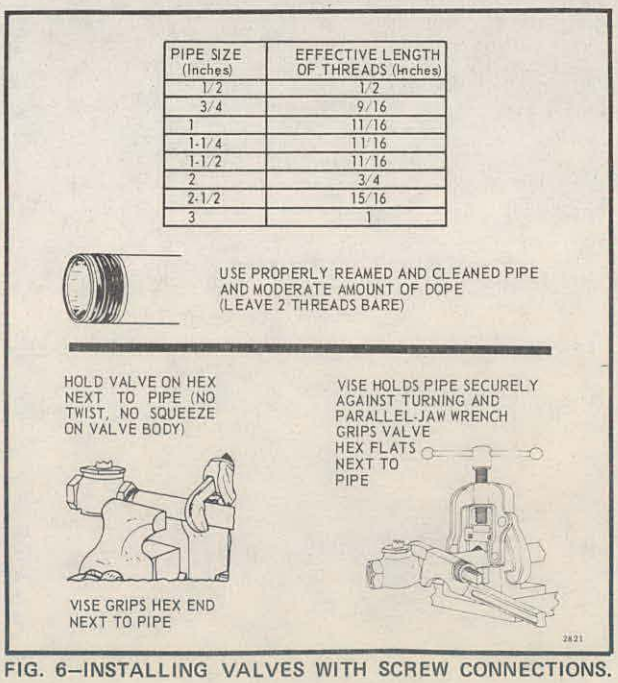

FIG. 6—INSTALLING VALVES WITH SCREW CONNECTIONS.

FLANGED VALVE BODIES

Flanged valve bodies conform to the American Standard for Cast-iron Pipe Flanges and Flanged Fittings. The valve flanges are flat faced with a smooth finish. Companion flanges must be of the same specifications.

Mounting bolts must be of sufficient length to allow nuts to utilize full length of the nut threads. The bolts should be 1/8 in. smaller than the diameter of the bolt hole to allow clearance for installing.

To prevent leakage, use a gasket material recommended for the medium to be handled. See Fig. 7.

Refer to installation information furnished with the linkage and motor when installing these controls.

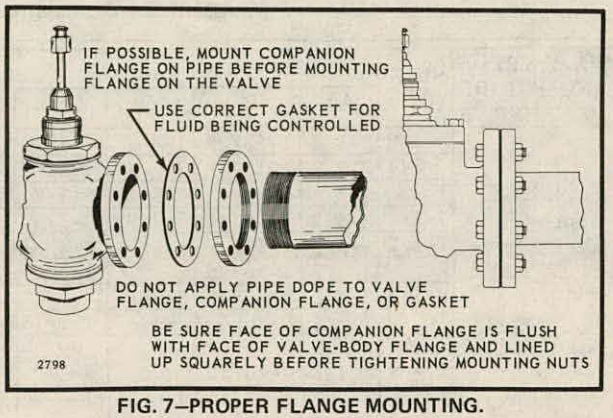

FIG. 7—PROPER FLANGE MOUNTING.

CHECKOUT

Before installing linkage and motor, make sure that valve stem operates freely. Impaired stem operation may indicate that the body was twisted by faulty piping or that the stem was bent by rough handling. Either of these conditions may require replacement of valve.

Check valve body and connections for leaks. After installing linkage and motor, check their operation according to installation information furnished with these controls. Operate the system through 1 complete cycle to make certain that valve controls properly.

HONEYWELL MINNEAPOLIS, MINN. 55408 INTERNATIONAL Sales Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

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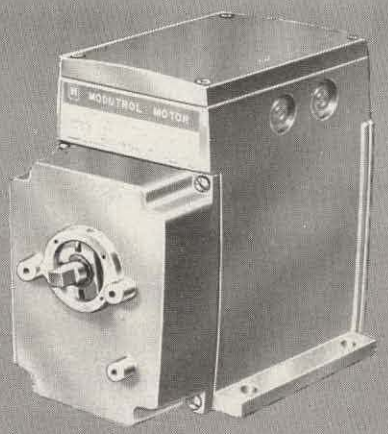
Honeywell

MODUTROL MOTORS

THE M445 AND M845 ARE 2 POSITION, SPRING RETURN MODUTROL MOTORS. THEY ARE USED TO OPERATE DAMPERS OR VALVES IN APPLICATIONS WHERE IT IS NECESSARY OR DESIRABLE TO HAVE THE CONTROLLED ELEMENT RETURN TO THE STARTING POSITION IN THE EVENT OF POWER FAILURE OR INTERRUPTION.

- ☐ The M445 operates on line voltage; the M845 operates on 24V ac.
- ☐ The M445C and M845B are equipped with internal, thermostatically controlled heaters for use in cold weather applications.
- ☐ The M445B and M845E are designed for normally open valves; all other motors are normally closed.
- ☐ All models have a one minute, 160 degree stroke.
- ☐ Sturdy, lightweight, die-cast aluminum case.
- ☐ Integral spring returns motor to normal position when power fails or is interrupted.
- ☐ Built-in spdt adjustable switch is available on some models for the control of auxiliary equipment.
- ☐ Oil immersed gear train assures long life and quiet operation.
- ☐ Full line of accessories includes weatherproofing kit and explosion-proof housing as well as auxiliary switches and a number of linkages.
- ☐ Tradeline M845A includes multitap transformer for 120/208/240V ac control circuits.



M445 A,B,C,D
M845 A,B,C,E

S.K.
REV. 7-75 (.025)

Residential Div. Form Number 60-2037-2

SPECIFICATIONS

TRADELINE MODELS

Tradeline models of this device are selected and packaged to provide ease of stocking, ease of handling, and maximum replacement value. Tradeline model specifications are the same as those of standard models except as noted below:

TRADELINE MODELS AVAILABLE: M845A Modutrol Motor–2 position, spring return motor for use with dampers and normally closed valves. An internal spdt switch is provided for actuating auxiliary equipment. Motor operates from 24V ac and includes a cover mounted transformer for 120/208/240V ac control circuits.

ELECTRICAL RATINGS: Voltage and frequency–motor requires 24V ac, 60 Hz. Cover mounted transformer has 120/208/240V ac multitap primary and 24V ac secondary.

ADDITIONAL FEATURES:

–Multitap transformer for 120/208/240V ac control circuits.

–Tradeline pack with cross reference label and special instruction sheet.

STANDARD MODELS

MODELS:

The M445 and M845 are 2 position, spring return Modutrol motors with 1 internal auxiliary spdt switch. They are for use with dampers and normally closed valves (except M445B and M845E are for normally open valves).

M445A–Modutrol motor as described above for line voltage operation.

M445B–Modutrol motor as described above for line voltage operation with normally open valves.

M445C–Modutrol motor as described above for line voltage operation. Includes internal thermostatically controlled heater.

M445D–Modutrol motor as described above for line voltage operation; without auxiliary switch.

M845A–Modutrol motor as described above for 24 volt operation. Available with 120/208/240V ac multitap cover mounted transformer (see Tradeline specifications).

M845B–Modutrol motor as described above for 24 volt operation. Includes internal thermostatically controlled heater. Available with 120V ac cover mounted transformer.

M845C–Modutrol motor as described above for 24 volt operation; without auxiliary switch.

M845E–Modutrol motor as described above for 24 volt operation with normally open valves. With 120V ac cover mounted transformer.

ELECTRICAL RATINGS:

MODEL	WATTS	VA	VOLTAGE, AC 50/60 HZ
M445A	17	21	120,208,220[a], 240
M445B	17	21	120
M445C	47[b]	53	120
M445D	17	21	120
M845A[c]	18	21	24
M845B[c]	49[b]	51	
M845C	18	21	
M845E[d]	18	21	

[a]50 Hz only.

[b]Including 30 watts for internal heater.

[c]Available with cover mounted transformer.

[d]Includes cover mounted transformer.

AUXILIARY SWITCH RATING[a] (in amperes):

	120V AC	240V AC
Full Load	7.2	3.6
Locked Rotor	43.2	21.6

[a]Switch rating is for one contact only; if both are used, second contact is rated 40 VA.

(continued on page 3)

ORDERING INFORMATION

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

SPECIFY–

1. MODEL NUMBER, SPECIFY TRADELINE IF DESIRED.
2. VOLTAGE AND FREQUENCY, ON MODELS WITH COVER MOUNTED TRANSFORMER AVAILABLE, SPECIFY WHEN ORDERING.
3. ACCESSORIES, IF REQUIRED.

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)

INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

INTERNAL HEATER THERMOSTAT (M445C, M845B ONLY): Automatically makes at 20 F on temperature fall, breaks at 50 F on temperature rise.

CRANK SHAFT: Double ended shaft, 3/8 inch square.

STROKE: 160 degrees.

DUTY CYCLE: Unlimited.

MAXIMUM OPERATING TORQUE: 50 pound-inches (may be divided between the 2 ends of motor if no more than 25 pound-inches is applied to auxiliary end).

DEAD WEIGHT LOAD ON SHAFT:

Power end–200 pounds.

Auxiliary end–10 pounds.

AMBIENT TEMPERATURE RATING:

Maximum–125 F.

Minimum–15 F (minus 40 F with internal heater).

UNDERWRITERS' LABORATORIES, INC. LISTED: M445A,B,D and M845A,B,E–File No. E4436, Guide No. XAPX. (NOTE: Only motors with line voltage or auxiliary switches require listing.) require listing.)

DIMENSIONS: See Fig. 1.

ACCESSORIES:

Q607 Auxiliary Switch–controls auxiliary equipment as a function of motor position.

Q605 Damper Linkage–connects motor to damper. INCLUDES MOTOR CRANK ARM.

Cover-transformer–die-cast aluminum cover with built-in transformer. Part No. 130810A has 120V ac primary and 24V ac secondary; Part No. 130810B has multitap primary for 120/208/240V ac and 24V ac secondary.

Q601 Linkage–connects Modutrol motor to water or steam valve.

Q100 Linkage–connects Modutrol motor to butterfly valve.

Q618 Linkage–connects Modutrol motor to water or steam valve.

7640JT Weatherproofing Kits–weatherproofs the M445 and M845 Modutrol Motors.

7616BR Motor Crank Arm–included with Q605 but not with motor.

DHE 94 Explosion-proof Housing–encloses Modutrol motor for use in explosive atmospheres. Not for use with Q601 and Q445 Linkages. Order from Crouse Hinds Co. Requires Honeywell 7617DM Coupling.

W859A,B Economizer Controls–provide changeover, mixed air, and minimum position controls. Mounts on top of motor.

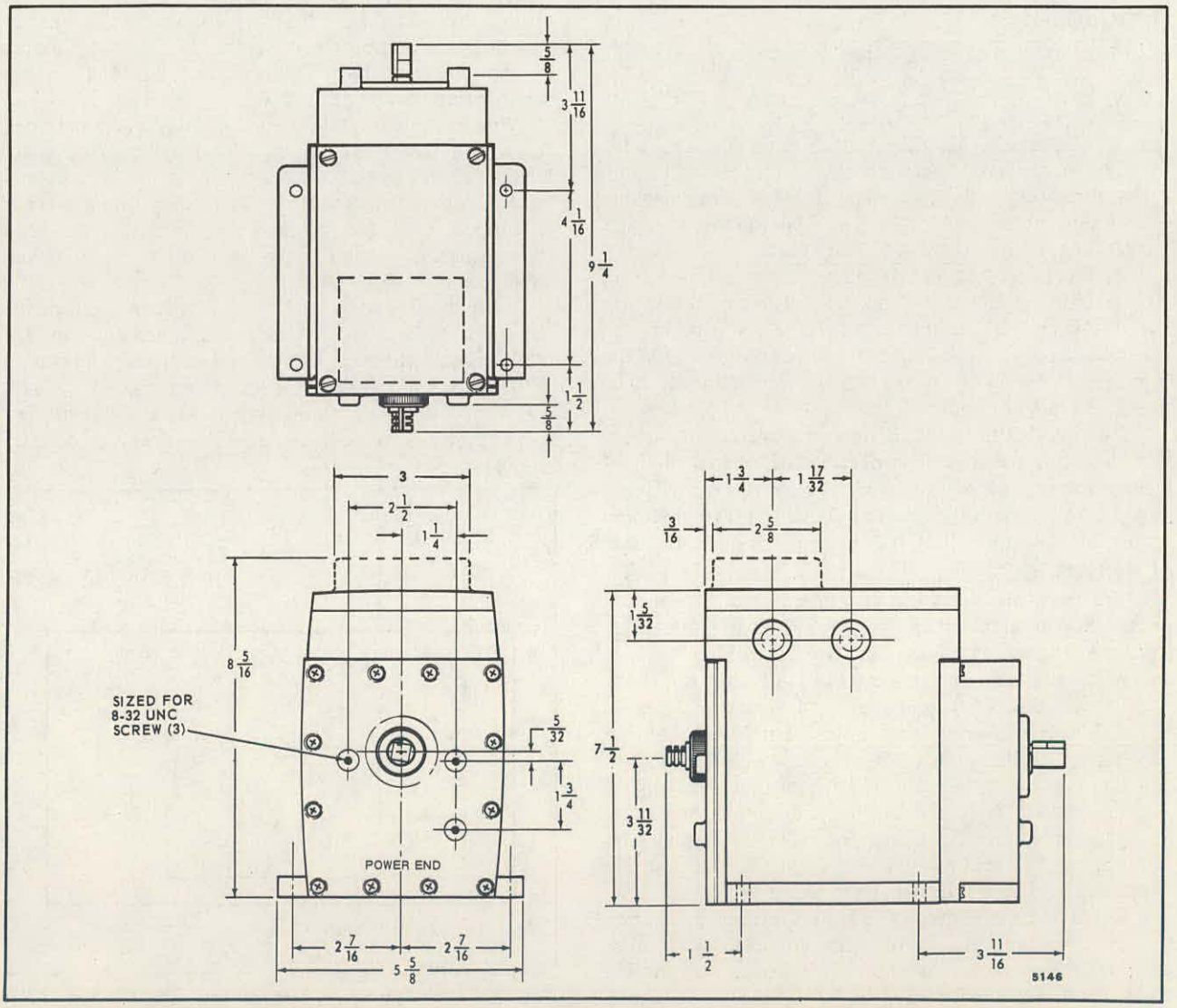


FIG. 1–DIMENSIONS OF M445 AND M845 MOTORS (IN INCHES). BROKEN LINES SHOW ADDITION OF COVER MOUNTED TRANSFORMER.

INSTALLATION

CAUTION

1. Installer must be a trained, experienced serviceman.
2. Disconnect power supply before installation to prevent electrical shock and equipment damage.
3. All wiring must comply with applicable codes and ordinances.
4. Do not exceed the ratings given in the SPECIFICATIONS section.
5. Always conduct a thorough checkout when installation is complete.

LOCATION

Install the Modutrol motor in any location except where acid fumes or other deteriorating vapors might attack the exposed metal parts of the motor or in atmospheres of escaping gases or other explosive mixtures. When choosing a location, allow enough clearance for mounting auxiliary equipment and servicing the motor.

MOUNTING

CAUTION

Do not turn the motor shaft manually or with a wrench as damage to the gear train will result.

The motor has a flange on the bottom for mounting. The mounting holes are sized for 1/4 inch machine screws or bolts. The motor may be mounted in any position as long as the shaft is horizontal.

The M445A,C,D and M845A,B,C are shipped from the factory in the closed position. The closed position is the limit of counterclockwise ↶ rotation, as viewed from the power end of the motor, with the groove in the shaft on top and the flat of the shaft 10 degrees from horizontal.

The M445B and M845E are shipped from the factory in the open position. The open position is the limit of clockwise ↷ rotation as viewed from the power end of the motor, with the groove in bottom of the shaft and the flat of the shaft 10 degrees from horizontal.

LINKAGES

The motor comes without a crank arm. The motor crank arm is included in the Q605 Damper Linkage or may be ordered separately (Part No. 7616BR).

When planning for and installing a motor and linkage, check for the following points of operation.

1. When energized, the motor shaft must be free to travel to the end of its stroke while opening or closing a valve or damper. The motor must be stopped at the end of its stroke by the limit switch and must not be stalled by the damper or valve. This holds true even if the full energized stroke is not required to drive the valve or damper through its required stroke.

2. When de-energized, the spring returns the motor to its starting position. In some applications, it may be desirable to use a shortened stroke to provide additional force with the motor in the de-energized position, as, for example, when holding a damper closed.

In these cases, the linkage may be adjusted so that the damper closes before the motor reaches its internal mechanical limit in the de-energized mode. (Note that this applies to the de-energized mode only; the motor must always be free to travel to end of its stroke when energized.

CAUTION

When shortening the motor stroke in the de-energized position as described above, use extreme care in adjusting the linkage as damage to the linkage or damper may result.

3. Do not exceed load or torque ratings in any application.

WIRING

CAUTION

Disconnect power supply before making wiring connections to prevent electrical shock and equipment damage.

All wiring must comply with applicable codes and ordinances. Make sure that the voltage and frequency stamped on the motor correspond to the characteristics of the power supply. Do not exceed switch ratings when wiring auxiliary switches.

Wiring terminals and conduit knockouts are provided for wiring the motor. When wiring, remove top cover by removing 4 screws, replace when wiring is complete. Models with cover mounted transformer have a bracket to support the cover on motor when wiring. Multitap transformers have color-coded leads for wiring the power supply; refer to Fig. 15.

Internal schematics and typical wiring hookups are shown in Figs. 2 to 14. Note that these diagrams for M845 motors show an external transformer. On motors with a cover mounted transformer, the secondary leads are wired to the motor terminals. (If the transformer is not required, remove leads and wire 24V ac directly to the motor.)

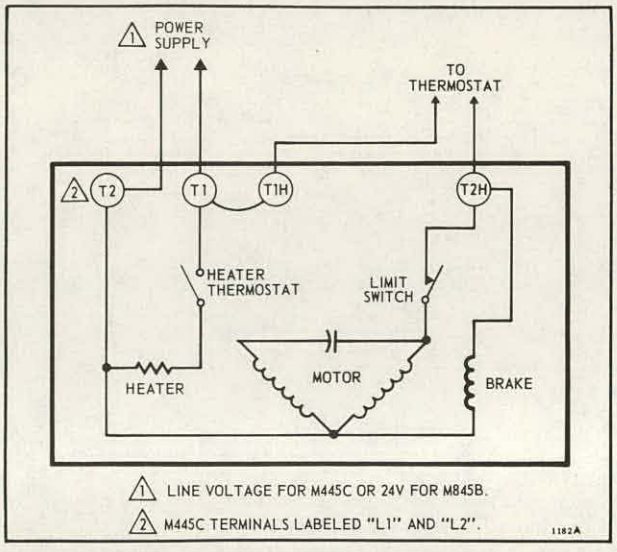


FIG. 2–INTERNAL SCHEMATIC DIAGRAM FOR THE M445C AND M845B WITH INTERNAL HEATER.

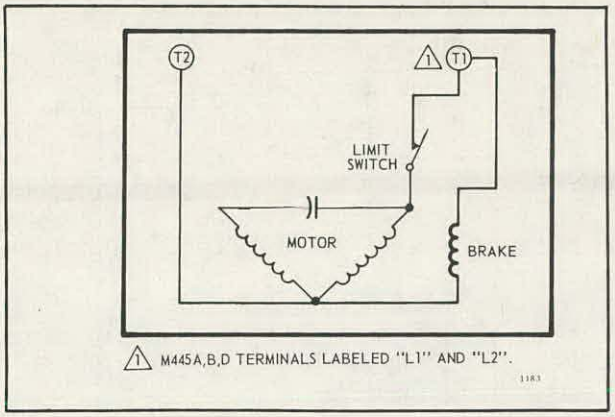


FIG. 3–INTERNAL SCHEMATIC DIAGRAM FOR M445A,B,D AND M845A,C,E.

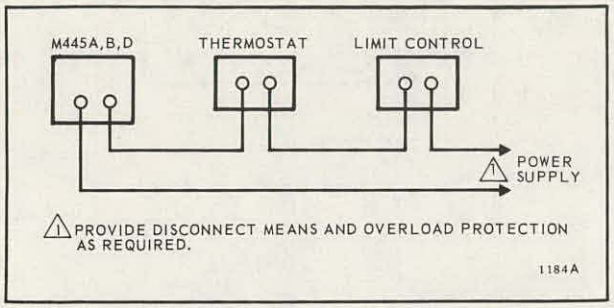


FIG. 4–CONNECTION DIAGRAM FOR M445A,B,D MODUTROL MOTORS.

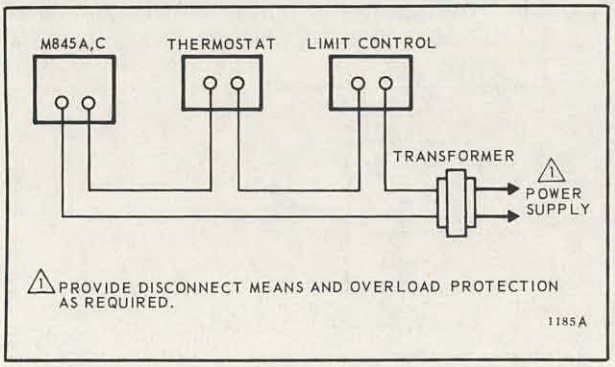


FIG. 5–CONNECTION DIAGRAM FOR M845A,C,E MODUTROL MOTORS.

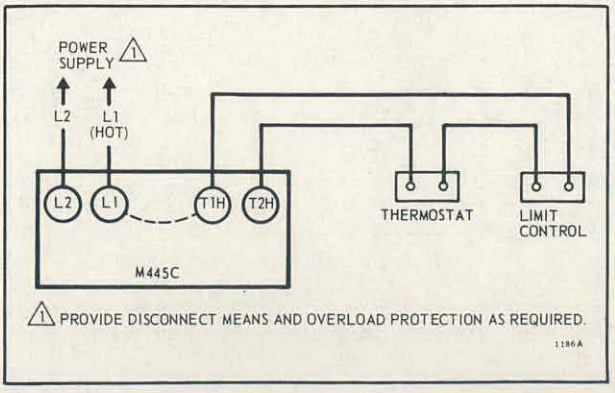


FIG. 6–EXTERNAL CIRCUIT CONNECTIONS FOR THE M445C (WITH INTERNAL HEATER).

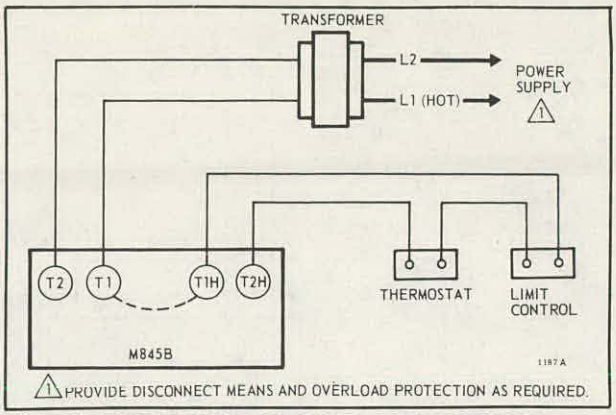


FIG. 7–EXTERNAL CIRCUIT CONNECTIONS FOR THE M845B (WITH INTERNAL HEATER).

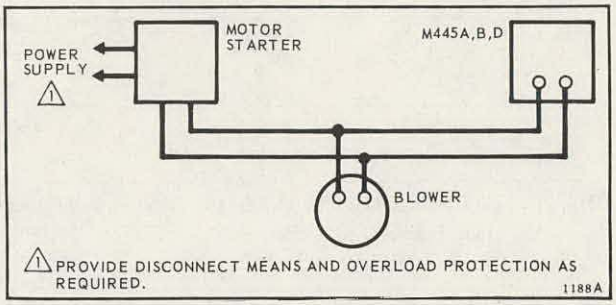


FIG. 8–POWER CONNECTION FOR M445A,B,D MODUTROL MOTORS USED TO CONTROL AIR DAMPERS.

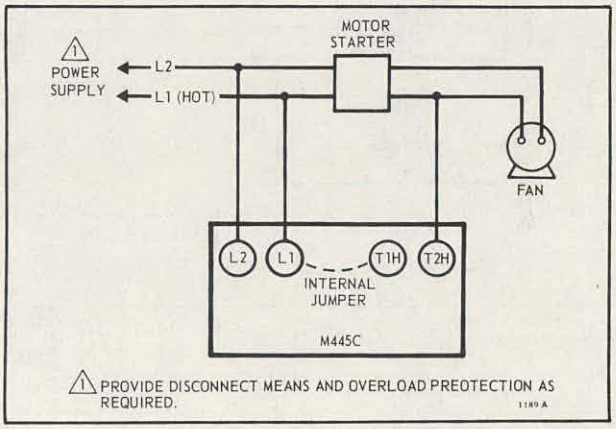


FIG. 9–M445C MODUTROL MOTOR CONNECTIONS WHEN USED TO OPEN A DAMPER ON FAN START. DAMPER CLOSES WHEN FAN STOPS.

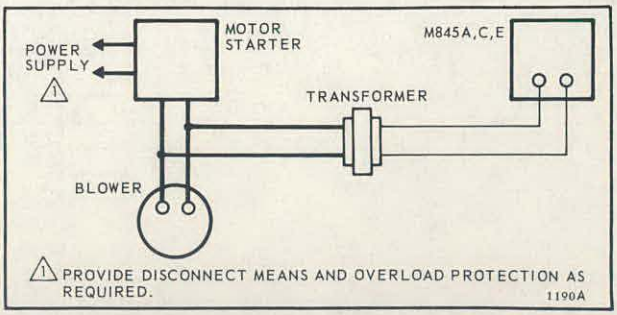


FIG. 10–POWER CONNECTION FOR THE M845A,C,E MODUTROL MOTORS USED TO CONTROL AIR DAMPERS. DAMPERS CLOSE WHEN FAN STOPS.

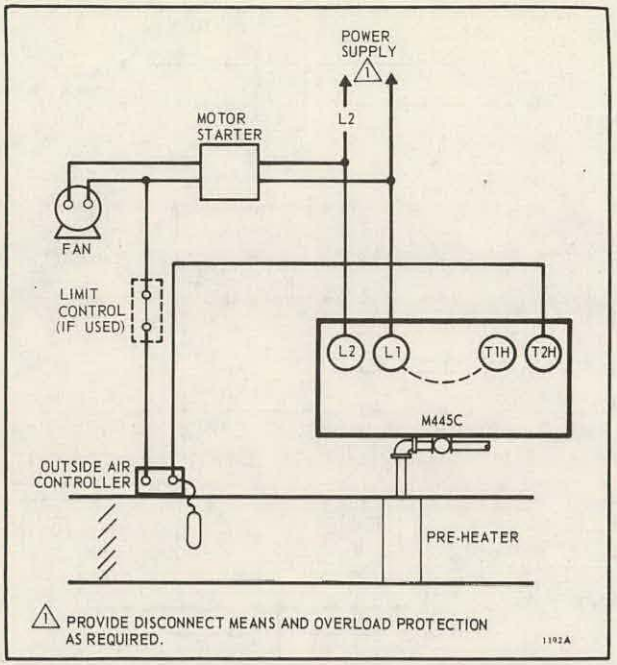


FIG. 11–WIRING DIAGRAM FOR AN M445C MODUTROL MOTOR USED TO CONTROL A PRE-HEATER COIL VALVE.

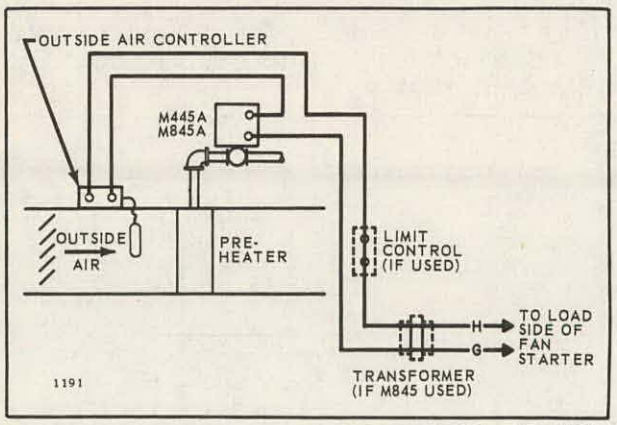


FIG. 12–WIRING DIAGRAM FOR M445 OR M845 WITHOUT INTERNAL HEATER CONTROLLING A PRE-HEATER COIL VALVE.

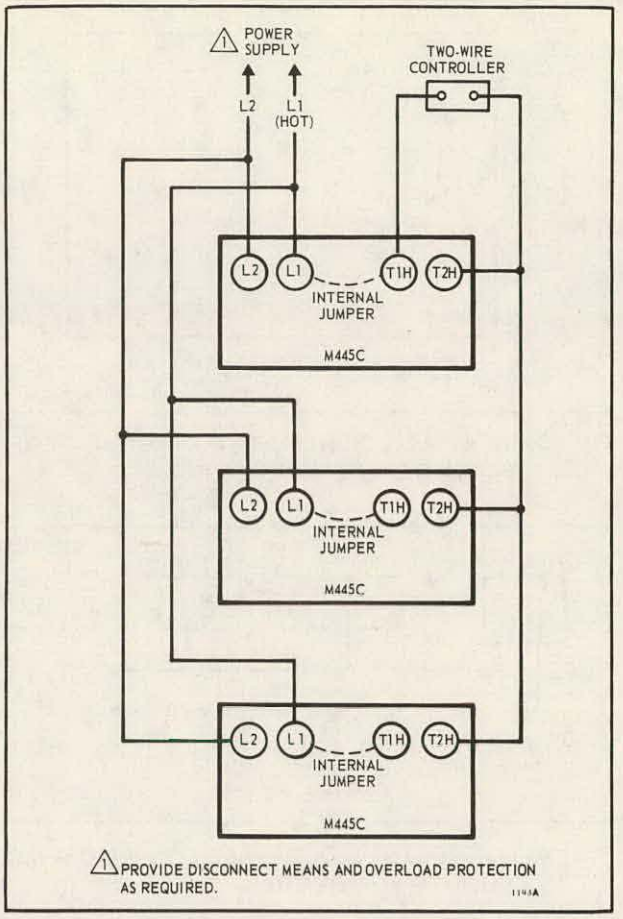


FIG. 13–THREE M445C MODUTROL MOTORS UNDER THE COMMAND OF ONE CONTROLLER.

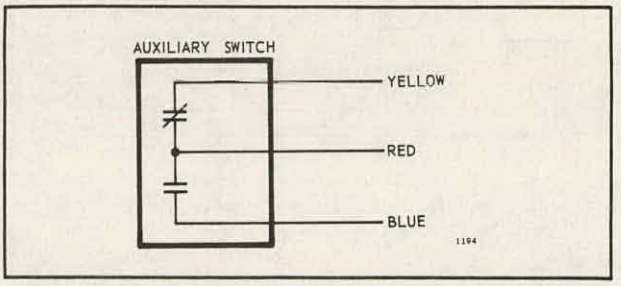


FIG. 14–AUXILIARY SWITCHES USED IN THE M445 AND M845 HAVE COLOR-CODED LEADWIRES.

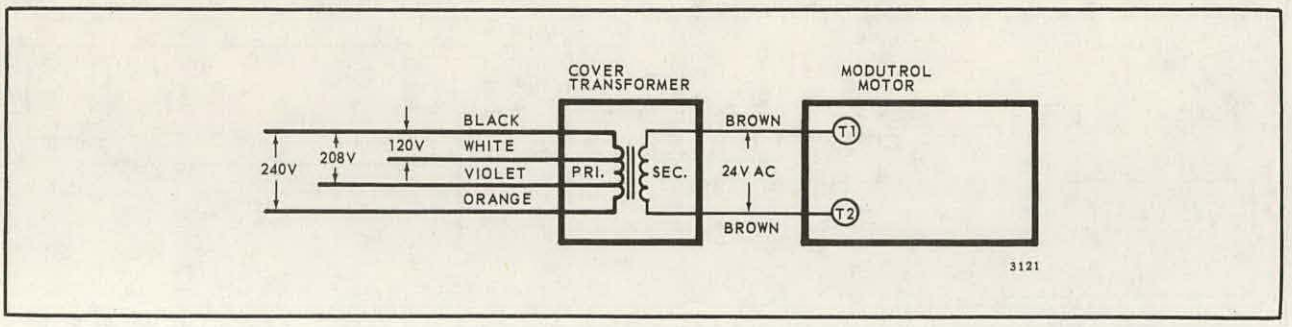


FIG. 15–WIRING DIAGRAM SHOWING COLOR-CODED LEADS FOR POWER SUPPLY CONNECTIONS.

ADJUSTMENTS

AUXILIARY SWITCHES

The M445 and M845 Modutrol Motors have an auxiliary switch that can be adjusted to operate at any point in the stroke of the motor. See Fig. 16. This switch may be adjusted approximately without running the motor by using the following procedure:

1. Remove the "C" clip holding the drive bracket against the spring hub. Take off the drive bracket. Refer to Fig. 18.

2. Remove the 4 screws from the corners of the return spring housing and pull the housing and spring straight out.

CAUTION

Do not attempt to adjust or loosen the locking screw on the differential cam.

3. With the motor in the normal position, loosen the adjustment screw for the operational cam. See Fig. 17. Using the 10-degree marks on the cam and a fixed point such as the cam roller for a guide, rotate the cams clockwise ↷ (counterclockwise ↶ for normally open motors) through an arc equal to the number of degrees the motor should travel before switch operates. Tighten the operational cam adjustment screw.

4. Replace the spring and return spring housing using the 4 screws removed earlier.

5. Replace the drive bracket and "C" clip.

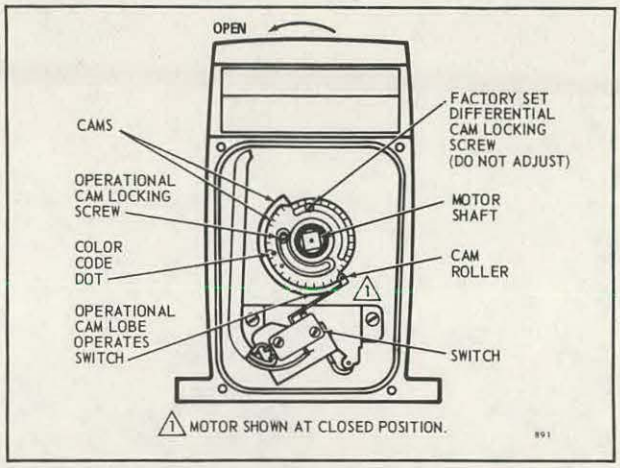


FIG. 16–LOCATION OF AUXILIARY SWITCH IN THE M445 OR M845 MODUTROL MOTOR.

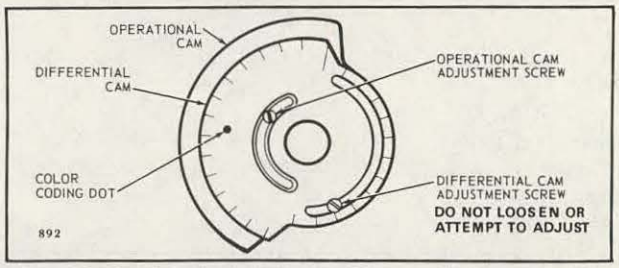


FIG. 17–SWITCH CAM MAY BE ADJUSTED TO OPERATE THE SWITCH DURING ANY PART OF THE STROKE.

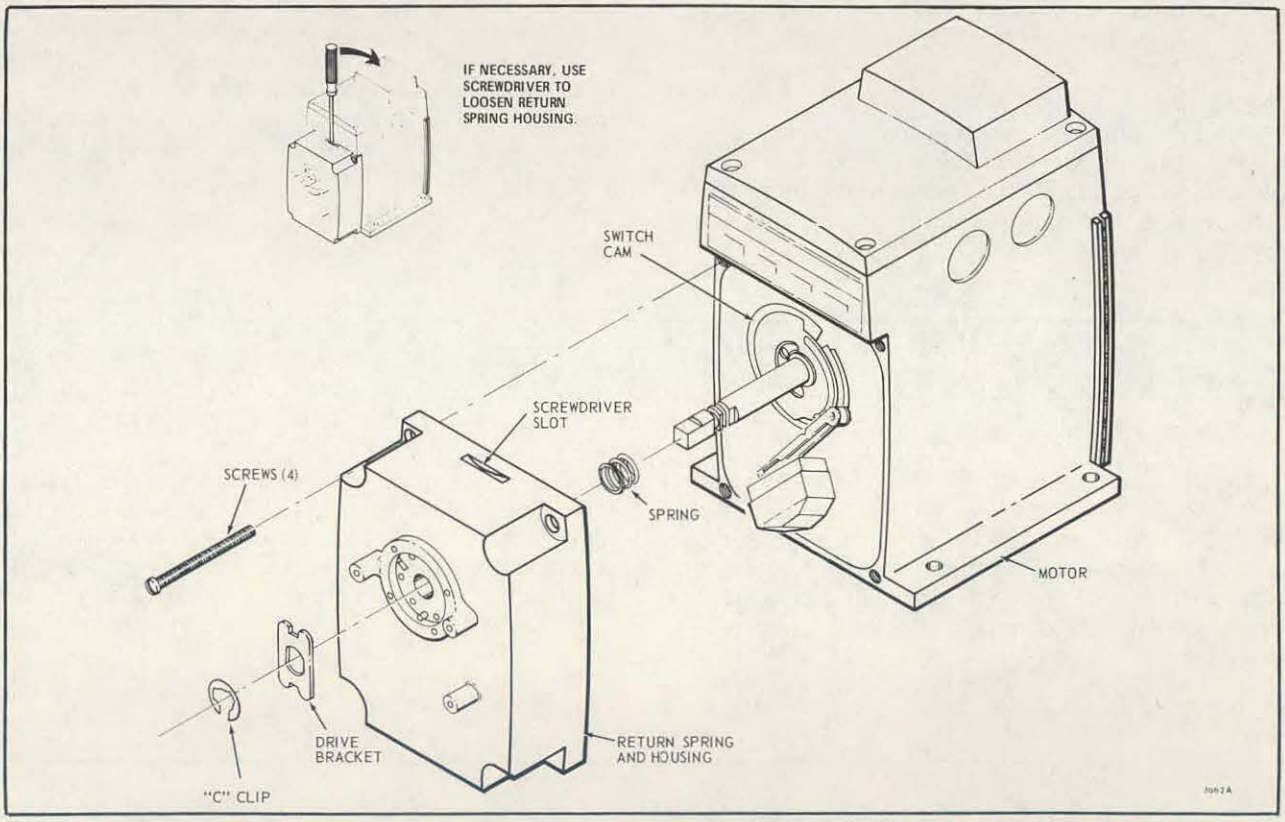


FIG. 18–REMOVING THE RETURN SPRING HOUSING TO ADJUST AUXILIARY SWITCH.

CHECKOUT

After the installation is complete, check the entire system for the following points of operation:

1. Motor operates the load properly.
2. Motor responds properly to the controller.
3. Motor returns to the starting position when power is interrupted.

DAMPER OPERATION

STEP 1

Check the entire motor-damper linkage to see that the mechanical connections are secure and properly made. Make sure the ball joint on the damper crank arm is properly placed to give the required amount of travel.

STEP 2

Energize the motor and run it to the full open position. Check the damper linkage while the motor is running to see that there are no loose or binding connections.

If the motor does not begin to run, check the control circuit for an "open" or "short," the presence of power, and the amount of power available at the motor. (The voltage at the motor must be at least 85 percent of the rated voltage on the nameplate.) Make sure that the maximum net load of the motor is not exceeded.

STEP 3

Interrupt the power to de-energize the motor and allow the spring to return the motor to the starting position. If the motor does not return, check to see that power is actually interrupted and that the return load is not exceeding the rated motor load.

VALVE OPERATION

STEP 1

Check the entire motorized valve assembly to see that the mechanical connections between the motor, linkage, and valve are proper and secure. Make sure that the linkage is adjusted according to the linkage instructions. Leave the cover off the linkage until the checkout is completed.

STEP 2

Make sure that the load does not exceed the motor rating. When using a Q601 Linkage with the motor, lubricate the bearing surfaces to prevent excessive loading. The valve packing must not be too tight. The motor actuating arm must be installed against the shoulder of the motor shaft to prevent binding at the connecting linkage bearings.

STEP 3

Energize the motor by setting the controller so that its contacts close. The motor should start and run smoothly, and the valve stem should move to the opposite end of its stroke. If this is not the case, make sure that there is power to the motor. If there is no power, check the controller circuit for open or short circuits. If the trouble still cannot be found, measure the voltage at the source supply. Line voltage must be at least 85 percent of the rated voltage stamped on the nameplate of the motor.

STEP 4

De-energize the motor by resetting the controller so its contacts open, or remove one of the wires from a controller terminal. Spring power should return the valve to its normal position. If this does not happen, check the linkage for binding or in the case of normally closed valves, check for fluid pressure in excess of the close-off rating.

STEP 5

Replace the linkage cover.

OPERATION

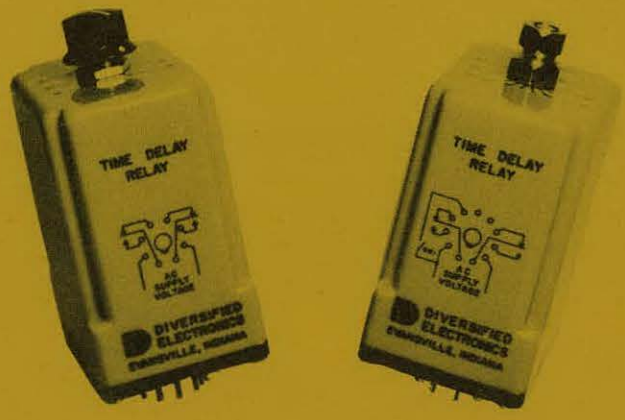
In an operational circuit, a single-pole, single-throw controller (line voltage for M445 or low voltage for M845) is wired in series with the motor circuit. When the controller switch closes, the motor is energized and runs to the end of its stroke. At this point, the limit switch is opened and the motor is de-energized. The brake solenoid is energized, however, and remains so as long as the controller is closed. The brake holds the motor in the open position until the controller opens. At this point the brake is released and the spring on the motor returns it to the starting position.

HONEYWELL MINNEAPOLIS, MINN. 55408 INTERNATIONAL Sales Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

PRINTED IN U.S.A.

TIME DELAY RELAYS

- INTERVAL ON OPERATE
- DELAY ON OPERATE
- DELAY ON RELEASE
- SINGLE SHOT
- REPEAT CYCLE



APPLICATIONS

- PROCESS CONTROL
- CONVEYOR CONTROL
- DISPENSING MACHINES
- WELDING CONTROL
- PACKAGING MACHINERY
- PLASTIC MOLDING
- ALARM CIRCUITS
- MOTOR CONTROL
- SAFETY MONITORS
- METERING-FLOW

TIME DELAY SOLID STATE

MADE IN USA

DIVERSIFIED ELECTRONICS, INC.
119 N. Morton Avenue
Evansville, Indiana 47711
(812) 426-2806

TD 1176

Manufacturing Division: 320 E. Main Street; Leesburg, Florida 32748
(904) 787-7259

TD SERIES

Diversified Electronics offers a wide variety of solid-state Time Delay Relays designed to meet the severe environment and timing applications encountered in industry. The Time Delay Relay combines a solid-state timing circuit and a heavy-duty 10 amp DPDT relay in a single package. Timing is accomplished by charging a capacitor through a resistor. When the voltage across the capacitor reaches a triggering point a solid state trigger circuit turns on the logic circuit, which controls the internal relay.

TIMER TERMINOLOGY

AUTOMATIC RESET: The timer returns to the ready state automatically after the completion of the timing cycle.
VOLTAGE TRANSIENT: A spurious signal which appears on the input voltage.
REVERSE POLARITY PROTECTION: Internal protection from polarity reversal on D.C. timers.
FALSE TRANSFER: Removal of the input voltage before the timer has timed out causes the internal relay to momentarily pick up and drop out.
TOLERANCE: The variations in the maximum setting of the time delay at nominal voltage and room temperature.
RESET TIME

BEFORE TIME OUT: The minimum time the voltage must be interrupted in order for the timer to revert to a state that would allow the timer to perform another timing cycle and to insure a timing loss no greater than 10% plus 1 cycle.

AFTER TIME OUT: The minimum time the voltage must be interrupted after the timer has pulled in for the "Recycle Time" to insure a time loss no greater than 5% plus 1 cycle.
CONTINUOUS DUTY CYCLE: The nominal voltage may be continuously applied without causing damage.
RECYCLE: The minimum time the voltage must remain on the timer after timing out before the voltage is removed and the timer reset. It is the minimum time the relay must be energized before removing the voltage and resetting the timer.
REPEATABILITY: The maximum variation in timing between successive timing cycles beginning with the second timing cycle. It is determined at fixed operating conditions of temperature, dial setting, reset time and input voltage.
ACCURACY: The maximum variation from a time setting under any combination of rated voltage and temperature.

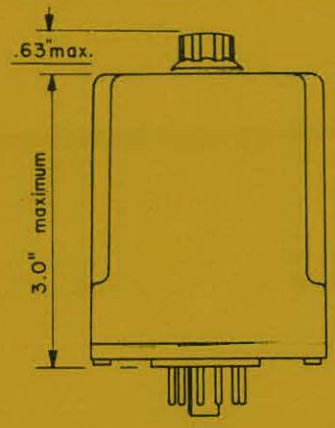
SPECIFICATIONS COMMON TO ALL SERIES

Voltage Ranges:	24 VDC, 24 VAC, 120 VAC 50 or 60 Hz
Temperature	
Operating:	0°C to +55°C
Storage:	-45°C to +85°C
Rated Output:	DPDT Relay-10A @ 24 VDC or 120 VAC resistive
Accuracy:	±10%
Tolerance	
Adjustable Time Delays	Min. time is +0 to -20% Max. time is ±10%
Fixed Time Delays:	±5%
Repeatability:	±1%
Reset Time	
Before Time Out:	100 m sec.
After Time Out:	50 m sec.
Recycle:	40 m sec.
False Transfer:	No
Reverse Polarity Protection:	Yes
Power Consumption:	3 watts
Duty Cycle:	Continuous
Life Expectancy	
Mechanical:	10 million operations (Min.)
Electrical	100,000 operations @ rated load
Enclosure Style:	"A"

ORDER INFORMATION

T D X - X X X - X X X - X X X

- Time Delay
- Series
- Nominal Voltage
- Type of Voltage
  - A-AC
  - D-DC
- Type of Operation
  - K-Knob Adjustable
  - L-Locking Pot. Adj.
- Enclosure Style "A"
- Time Delay (in seconds)
  - 010 = 10 sec. 030 = 30 sec.
  - 060 = 60 sec. 100 = 100 sec.
  - 200 = 200 sec. 300 = 300 sec.
  - 600 = 600 sec. 900 = 900 sec.



LEXAN DUST COVER

PLUG - IN SOCKET

MIN. DELAY	MAX. DELAY
.1	10
.3	30
.6	60
1.0	100
2.0	200
3.0	300
6.0	600
9.0	900

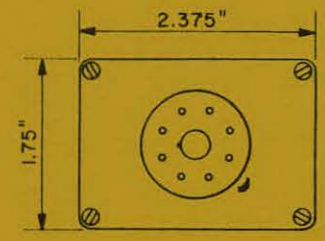


Fig 1

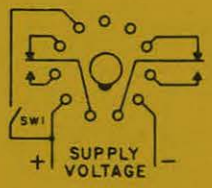


Fig 2

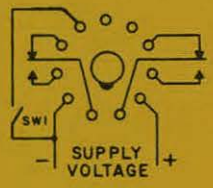
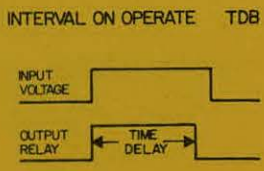


Fig 3

(DC polarity shown)

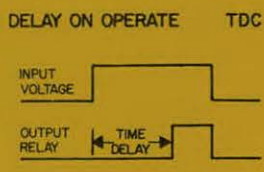
TDB series

The TDB Series are interval on operate timers. Contacts of the internal relay close for an interval of time after input voltage has been applied. If input voltage is removed before the timer has timed out, the relay will de-energize and the time delay will reset.
Fig. 1



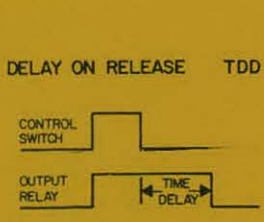
TDC series

The TDC Series are delay on operate timers that will not false transfer when power is removed before completion of the timing cycle. When input voltage is applied, the delay period begins. On completion of the time delay period, the internal relay contacts close. When voltage is removed, the relay returns to normal. A fast recycle allows accurate high speed continuous operations. Delay on operate timers are used where it is required to delay the start of an event.
Fig. 1



TDD series

The TDD Series are delay on release timers. Voltage is applied to the input at all times. Upon closure of the control switch, the internal relay energizes and the contacts immediately transfer. The relay remains energized if no further action is taken. Immediately upon opening the switch, the time delay period begins. If the switch is not reclosed before the end of the delay period, the relay will de-energize. Closure of the switch before time out will reset the timer. Time delay on release is used where it is necessary to delay the end of an event for a period of time.
Fig. 2



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119 N. Morton Avenue
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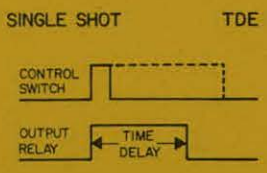
(812) 426-2806

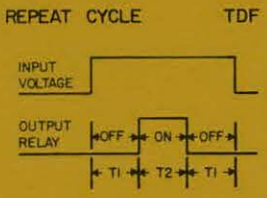
TDE series

The TDE Series are single shot timers. Voltage is applied to the input at all times. Upon closure of the control switch (momentarily or maintained), the internal relay energizes. At the end of the delay period,the relay will de-energize. Single shot timers remove any dependence of an operator from the process during the timing period. After closure of the control switch, timing continues until completion, regardless of the control switch position.
Fig. 3



TDF series

The TDF Series are repeat cycle timers. When voltage is applied, T1 time period begins. During T1 time period the internal relay is de-energized. When T1 times out, the internal relay energizes and T2 time period begins. When T2 times out, the internal relay de-energized and T1 time period starts again and the cycle is repeated. If the input voltage is removed during the cycle,the unit will return to its original state (internal relay de-energized), and when voltage is applied again T1 time period will begin.
Fig. 1



RELAY SOCKETS

RATING: 10 Amps 250 Volts

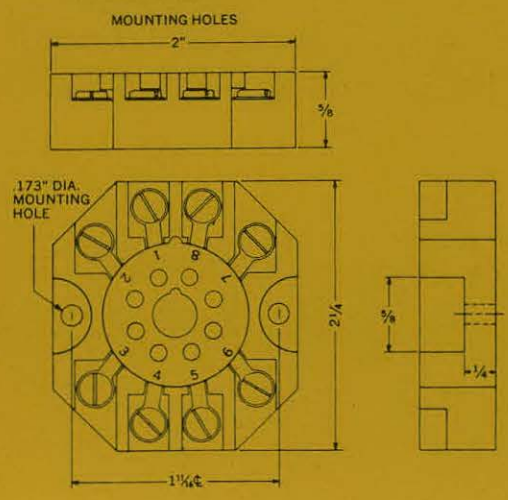
TERMINALS: 6/32 screw 5/16 long Nickel plated

WIRE: Up to one No. 12 AWG. Lugs recommended on wire larger than No. 16 AWG.

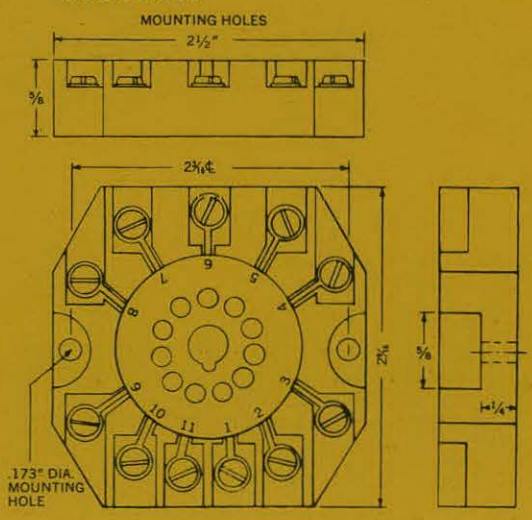
MATERIAL:

MOLDING G.E. Noryl
HARDWARE Brass, Nickel plated
INSERTS Brass
SCREWS Steel Nickel plated.

Model RB08



Model RB11



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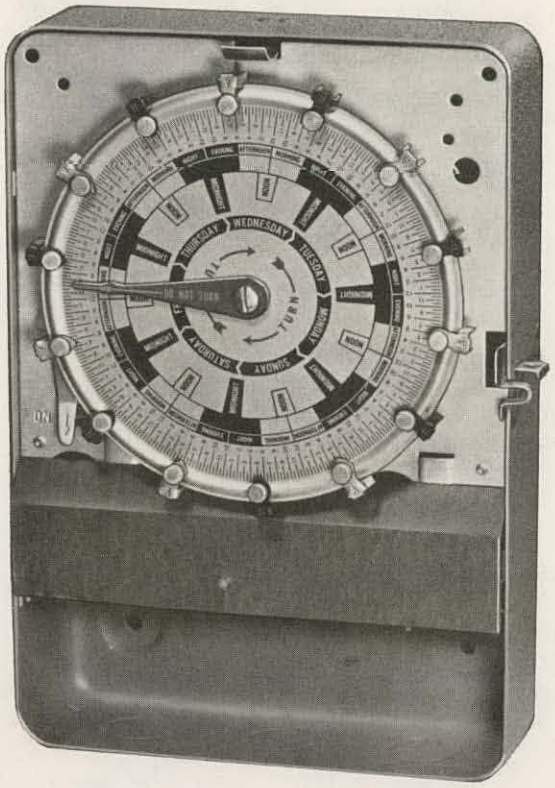
AMF | PARAGON

7000 Series 7-Day Time Controls

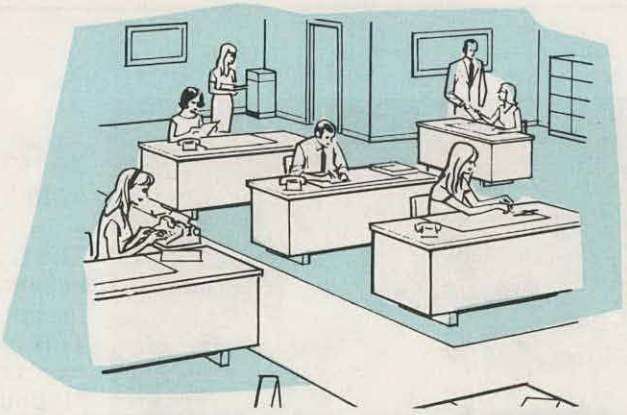
Bulletin No. 3276; 7-76

Supercedes Bulletin No. 276; 8-72



FOR WEEKLY PROGRAMMING OF HEATING, LIGHTING, AIR-CONDITIONING, AND OTHER OPERATIONS IN COMMERCIAL BUILDINGS.

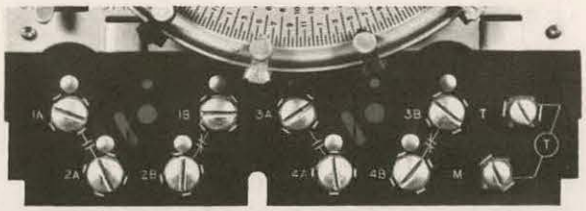
- Full independent 4-pole design - S.P.S.T., D.P.S.T., S.P.D.T., D.P.D.T. and EXCLUSIVE 4PST switching capability
- 7-day dial permits different ON-OFF schedules for different days of the week.
- High load capacity — 40 Amps. per pole.
- Positive switching with EXCLUSIVE slider-bar action.
- Independent motor circuit isolates contacts from motor supply.
- Easy installation provided by king-size terminal screws and large wiring gutters.



AMF

Paragon

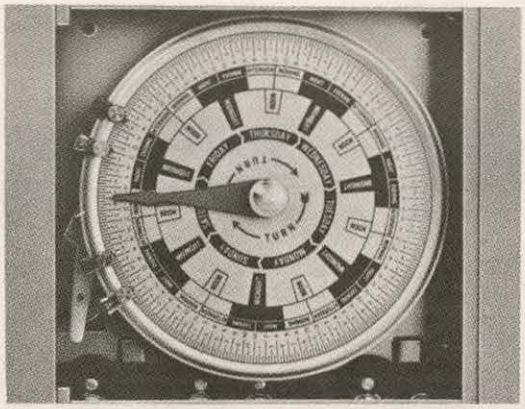
7000 Series 7-Day Time Controls



Isolated Contacts
The 7000 series 4-pole switch has all switching contacts isolated including the timing motor terminals.

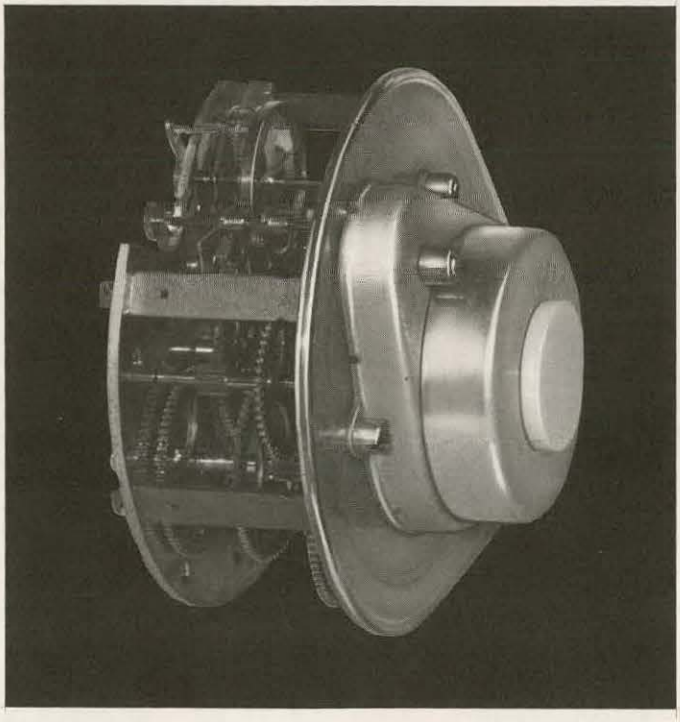
King Size Terminal Screws
Large terminal screws resist stripping and vibration; attach wires securely to terminal board. Accommodate up to AWG #8 wire. Large wiring gutters provided.

Manual Skip-Trip
The 7000 series design includes a manual hand trip which can transfer the switch operation at any time (except one hour after each tripping time) without disturbing the following daily or weekly tripping schedules.



Easy To Read Dial
The 7-day dial is graduated into the 7 days of the week and each day is subdivided into day and night divisions and 30 minute increments.

Easy To Set Dial
The 7000 series provides a dial which can be set to the time of the day by merely turning the dial in a clockwise direction: no dial nuts to remove and no dial slippage problems.



10 HOUR POWER FAILURE PROTECTION
With Spring Wound Carry-Over

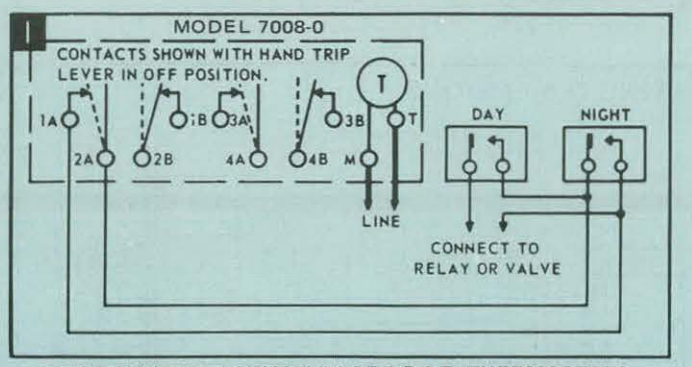
The Carry-Over takes over during a power failure, keeping the control running on time until power resumes; the Carry-Over then rewinds automatically. This feature eliminates expensive field service calls to reset time controls after each outage. It has a 10 hour reserve, and only 2 hours are required to rewind for each hour of power outage. The Carry-Over can take care of several successive short power failures as well as any unusual extended outage.

The PARAGON Carry-Over has an EXCLUSIVE auxiliary movement which operates continuously, thus eliminating failure due to oil clogging or rust from long periods of inactivity.

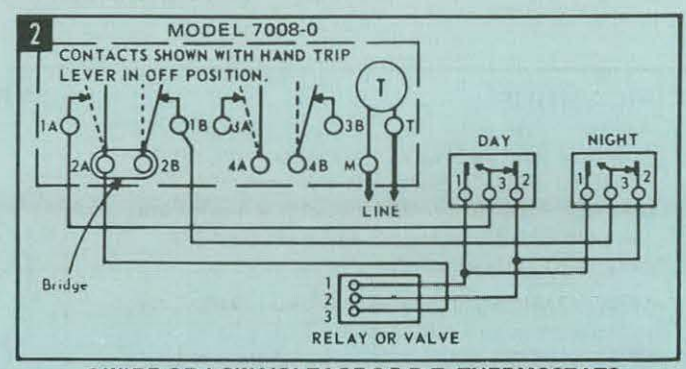
The Spring Wound Carry-Over is made in Switzerland to PARAGON'S exacting specifications, and is available on all 7000 series models in indoor-outdoor enclosures.

SUGGESTED WIRING DIAGRAMS FOR VARIOUS CONTROL SYSTEMS

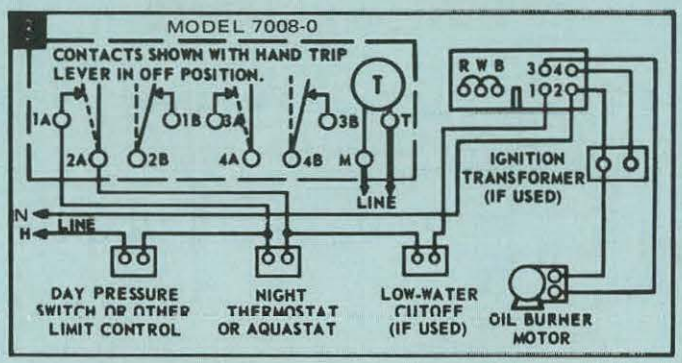
These are only suggested methods of wiring time controls. External wiring must be connected in accordance with national and local electrical codes. All auxiliary devices are to be furnished by others.

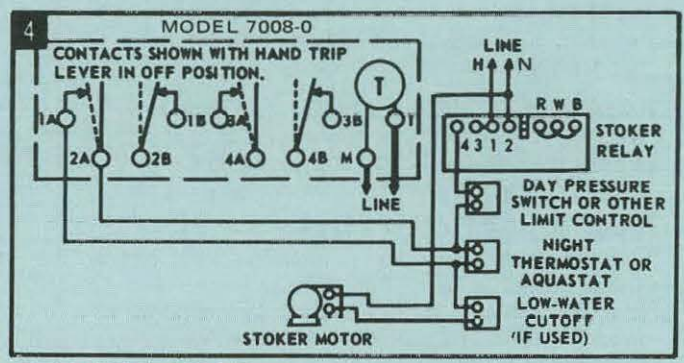


2 WIRE LINE OR LOW VOLTAGE S.P.S.T. THERMOSTATS

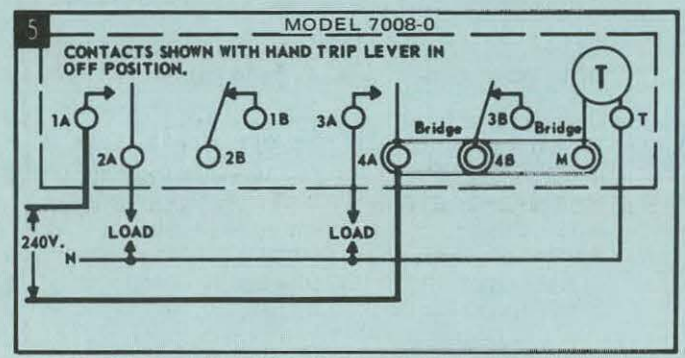


3 WIRE OR LOW VOLTAGE S.P.D.T. THERMOSTATS

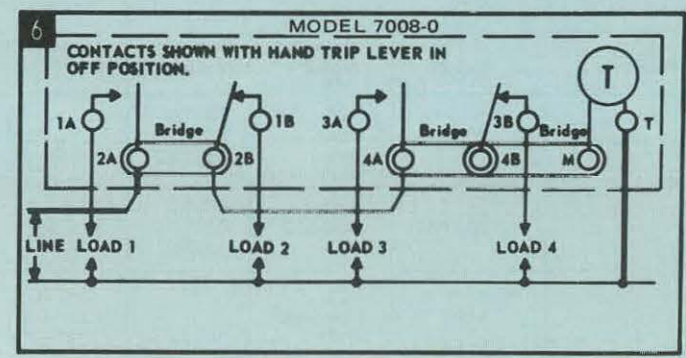




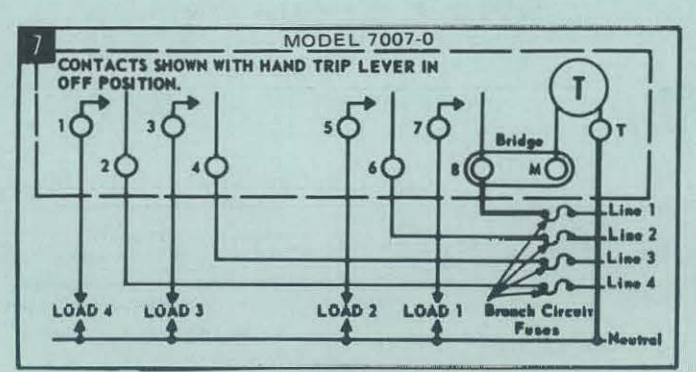
2 WIRE LINE VOLTAGE S.P.S.T. THERMOSTATS



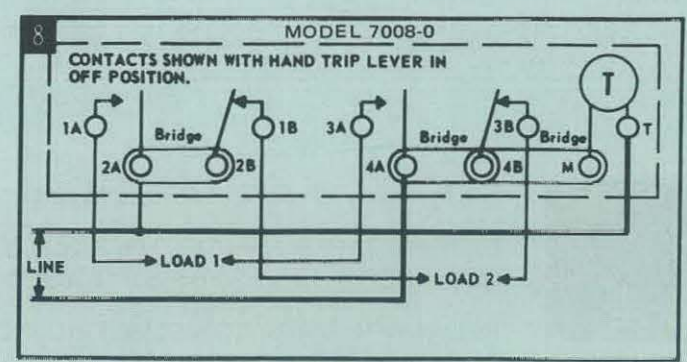
DOUBLE POLE SINGLE THROW 3-WIRE USING 120 VOLT MOTOR.



DOUBLE POLE DOUBLE THROW, ONE SIDE OF LINE COMMON TO SWITCHES AND MOTOR.



FOUR POLE SINGLE THROW WITH COMMON NEUTRAL & MOTOR CONNECTED TO ONE CIRCUIT.



TWO DOUBLE BREAK LOADS, ONE "OFF" WHEN OTHER IS "ON" COMMON MOTOR VOLTAGE.

AMF | PARAGON 7000 Series 7-Day Time Controls

SPECIFICATIONS

SWITCH RATING: 7007 Series 40 Amp, 40 Amp Tungsten, 690 VA pilot duty per pole, 120-277 volt AC. 7008 Series 40 Amp; 690 VA pilot duty per pole 120-277 volts AC and 1 HP (one pole only) 120-240 volts AC.

SWITCH MECHANISM: 7007 Series - 4PST; 4NO isolated contacts. 7008 Series - 2NO 2NC; SPDT or DPDT possible by using extra jumpers furnished.

OPERATION: Up to 28 ON-OFF operations per week, or 4 ON-OFF operations per day. Minimum 3 hours between each operation. One set of trippers mounted on dial, 6 extra sets included as standard with each control. Manual trip lever standard.

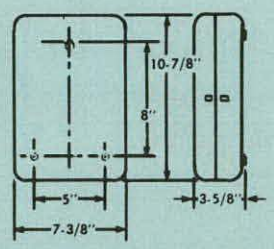
MOTOR: 120, 208-240, and 277 volts 60 Hz AC. 50 Hz available on special order. Lubricated-for-life mechanism suitable for low temperature (-40F.) operation.

CASE: Standard models furnished with grey wrinkle finish. Carry-Over models furnished with Indoor-Outdoor Nema Type 3 case. Flush mounted Nema Type 1B case with lock and key available. All units available on bracket for sub-panel mounting.

SHIPPING WEIGHT: 6½ pounds.

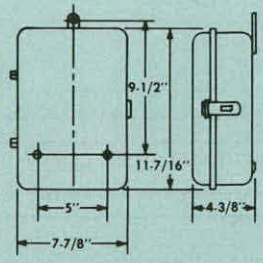
MOUNTING DIMENSIONS

7000 Series
Indoor



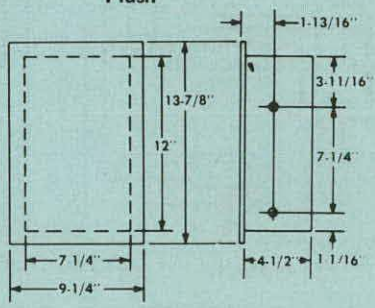
Nema Type 1

7210 Series
Indoor-Outdoor



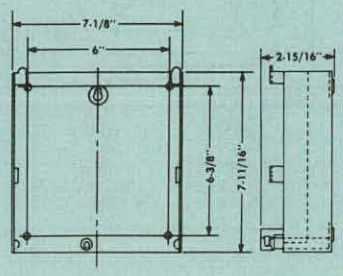
Nema Type 3

7030-7230 Series
Flush



Nema Type 1B

Mounting Bracket



MODEL SELECTION

Enclosure	Switch	Volts A.C. 60 Hz	Standard Models	Models with Carry-Over
NEMA 1	4PST	120 208-240 277	7007-0 7007-20 7007-27	
	2N0-2NC	120 208-240 277	7008-0 7008-20 7008-27	
NEMA 3	4PST	120 208-240 277		7217-0 7217-20 7217-27
	2N0-2NC	120 208-240 277		7218-0 7218-20 7218-27
NEMA 1B	2N0-2NC	120 208-240 277	7038-0 7038-20 7038-27	7238-0 7238-20 7238-27

NOTE: For bracket mounting, add suffix "B" to Model No.; e. g. 7007-0B
For movement only, add suffix "M" to Model No.; e. g. 7007-0M.

HOW TO SPECIFY: Paragon 7000 Series

Installer shall furnish and install model PARAGON 7-Day Calendar Dial Time Control, 4PST (or 2N0 2NC) contacts rated 40 Amps per pole up to 277 volts AC. Synchronous motor shall be independent of load switches. 7-Day dial to provide up to 4 ON-OFF operations per day, 3 hour minimum between operations.

FOR CARRY-OVER ADD: SPRING WOUND CARRY-OVER shall keep pre-set schedules on time for 10 hour minimum; shall rewind automatically after each power outage; during normal power conditions Carry-Over shall be exercised continuously under no mechanical load.

AMF Paragon

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Division of AMF CANADA LIMITED

Bulletin No. 3276; 7-76

Litho in U.S.A.

P.O. 1410 JORDAN SOLAR SYSTEM

MERCOID SERIES AP MERCOID PRESSURE CONTROLS

INSTALLATION INSTRUCTIONS

APPLICATION—OPERATION

AP-153, AP-2, AP-3, AP-26 and AP-36 AP-88 and AP-89.

For mediums not injurious to steel, silver solder or Fairprene diaphragm. A variation in control pressure causes the diaphragm to actuate the hermetically sealed mercury switch to open or close the electrical contact.

AP-41-153, AP-41-2, AP-41-3, AP-41-26 and AP-41-36.
AP-41-88 and AP-41-89.

For mediums not injurious to 316SS and Teflon. A variation in control pressure causes the diaphragm to actuate the hermetically sealed mercury switch to open or close the electrical contact.

MOUNTING

Install control firmly in a LEVEL POSITION on a panel or smooth wall surface by means of the two mounting ears. Where pipe mounting is desired, control may be connected by means of the ¼" I.P.S. connection. Do not mount control by twisting the case, use a wrench on the square part of the ¼" bottom pipe connection.

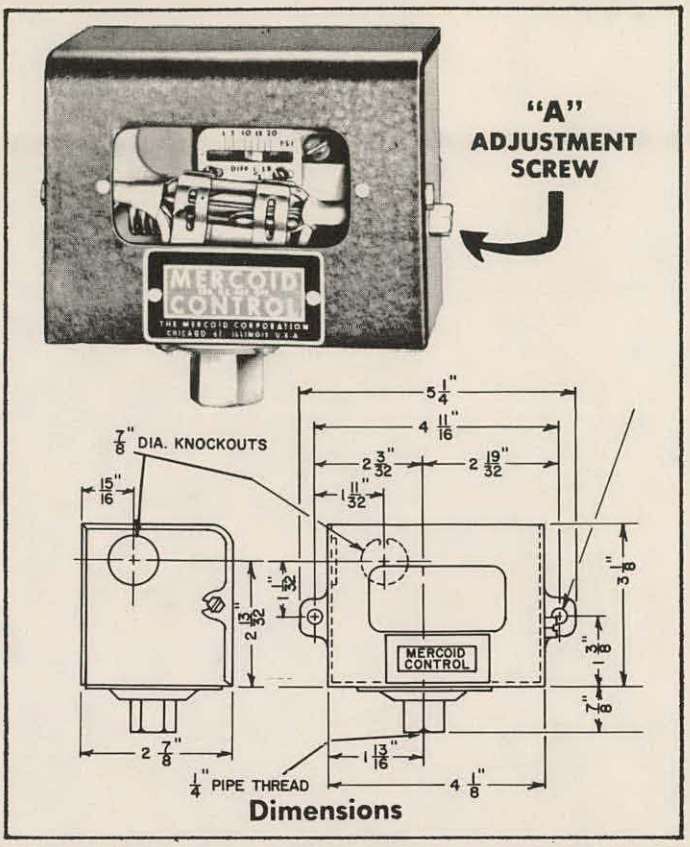
To level, sight across the two cover screws or check the lower end of the glass opening in cover to see that instrument is lined up horizontally.

WIRING

Wire in accordance with local electrical codes or equipment manufacturer's instructions. See nameplate attached to inside of control case for terminals markings and electrical rating.

HOW TO SET OPERATING POINT

Turn adjustment screw "A" (illustration No. 1) until pointer on dial indicates desired operating pressure.



Dimensions

Do not overload—see electrical rating on nameplate located inside of control case. Do not oil any parts.

RANGES—DIFFERENTIALS—ELECTRICAL RATINGS *Differential non-adjustable—(factory set).*

ADJUSTABLE OPERATING RANGE PSIG	SWITCH DIFFERENTIAL WITH PIONEER SET AT LOW OR HI END OF SCALE		SWITCH ACTION ON PRESSURE RISE	ELEC. RATING SEE CODE	FOR MEDIA NOT INJURIOUS TO STEEL SILVER SOLDER OR NYLON & BUNA N	FOR MEDIA NOT INJURIOUS TO 316 SS & TEFLON
	LOW	HIGH				
10" Vac. 50" wc MAX. SURGE LIMITS 15 PSIG RANGE NO. R33	4" wc	5" wc	SP-DT	A	AP-153	AP-41-153
	5" wc	7" wc	SP-ST Opens	B*	AP-2	AP-41-2
	5" wc	7" wc	SP-ST Closes	B*	AP-3	AP-41-3
	1.5" wc	1.5" wc	SP-ST Closes	D	AP-88	AP-41-88
	2" wc	2" wc	SP-ST Opens	D	AP-89	AP-41-89
1-20 PSIG MAX. SURGE LIMITS 30 PSIG RANGE NO. R36	0.3 psig	0.5 psig	SP-DT	A	AP-153	AP-41-153
	0.5 psig	1.0 psig	SP-ST Opens	B*	AP-2	AP-41-2
	0.5 psig	1.0 psig	SP-ST Closes	B*	AP-3	AP-41-3
	0.75 psig	1.25 psig	SP-ST Opens	B&C	AP-36	
	0.75 psig	1.25 psig	SP-ST Closes	B&C	AP-26	
	2" wc	4" wc	SP-ST Closes	D	AP-88	AP-41-88
	3" wc	6" wc	SP-ST Opens	D	AP-89	AP-41-89
1-30 PSIG MAX. SURGE LIMITS 40 PSIG RANGE NO. R37	0.4 psig	0.75 psig	SP-DT	A	AP-153	AP-41-153
	0.5 psig	1.5 psig	SP-ST Opens	B*	AP-2	AP-41-2
	1.0 psig	1.5 psig	SP-ST Closes	B*	AP-3	AP-41-3
	1.25 psig	1.25 psig	SP-ST Opens	B&C	AP-36	
	1.25 psig	1.25 psig	SP-ST Closes	B&C	AP-26	
	3" wc	6" wc	SP-ST Closes	D	AP-88	AP-41-88
	4" wc	8" wc	SP-ST Opens	D	AP-89	AP-41-89
10-100 PSIG MAX. SURGE LIMITS 150 PSIG RANGE NO. R39	2 psig	6 psig	SP-DT	A	AP-153	AP-41-153
	3 psig	8 psig	SP-ST Opens	B*	AP-2	AP-41-2
	4 psig	8.5 psig	SP-ST Closes	B*	AP-3	AP-41-3
	4 psig	10 psig	SP-ST Opens	B&C	AP-36	
	4 psig	10 psig	SP-ST Closes	B&C	AP-26	
	.75 psig	1.5 psig	SP-ST Closes	D	AP-88	AP-41-88
	.75 psig	1.5 psig	SP-ST Opens	D	AP-89	AP-41-89

*INCHES OF WATER

ELECTRICAL RATING—

CODE
"A" ——— 4A. 115V., 2A. 230V. ac or dc (single phase A.C. ⅛ H.P.)
"B" ——— 10A. 115V., 5A. 230V. ac or dc (single phase A.C. ¾ H.P.—D.C. ⅓ H.P.) for 440V., (3A.)
"C" ——— Non-Inductive A.C. heater loads only: 120V., 17A; 240V., 17A; 277V., 17A.
"D" ——— (24V. A.C. 1.0A., D.C. 0.5A.)—(115V., A.C. 1.0A., D.C. 0.5A.)—(230V., A.C. 0.5A., D.C. 0.25A.)

MERCOID CONTROL ®

THE MERCOID CORPORATION 4207 BELMONT AVE. CHICAGO, ILLINOIS, 60641

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JORDAN SOLAR SYSTEM

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INSTRUCTION MANUAL AND PARTS LIST FOR FLANGED FLOAT CAGE MODEL LIQUID LEVEL CONTROLS

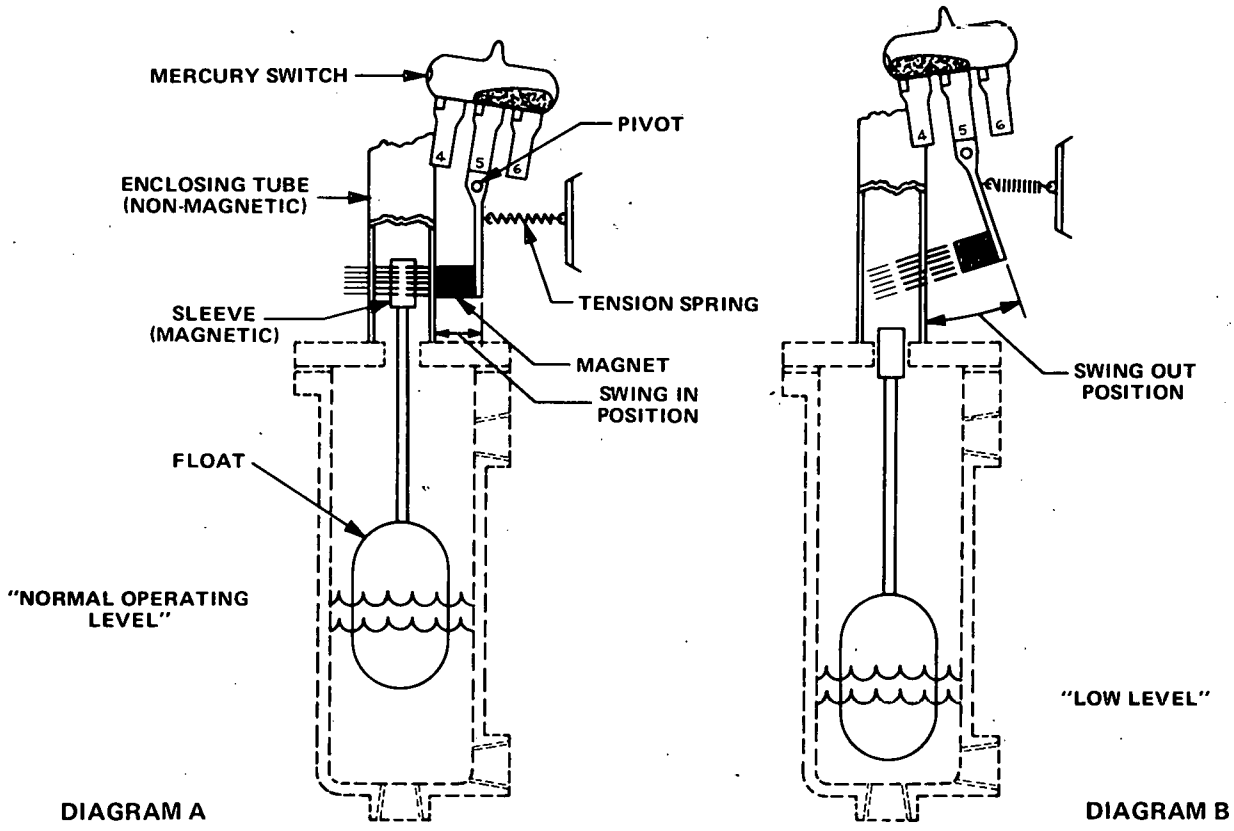


FIG. 1

DESCRIPTION

The flanged float cage series level controls are completely self-contained units designed for side mounting to a vessel or boiler with threaded or flanged pipe connections. Thirteen basic models are included in this series, each with a wide range of optional features. Special models include units constructed entirely of stainless steel (not covered in this manual) and tandem type units with two switch mechanisms, each operated by a separate float in a special length float chamber.

OPERATING PRINCIPLE

Diagrams A and B illustrate the simple and foolproof Magnetrol® operating principle. Switching action is obtained through the use of a magnetic attracting sleeve, actuated by a float, and a switching mechanism. These two basic component assemblies are separated by a non-magnetic, pressure tight enclosing tube. A switch and magnet are assembled to a swinging arm which operates on precision stainless steel pivot sockets.

OPERATING CYCLE

At "Normal Operating Level" of liquid in the chamber (diagram "A"), the float moves the magnetic attracting sleeve upward in the enclosing tube and into the field of the switch mechanism magnet. As a result, the magnet is drawn in tightly to the enclosing tube causing the switch to tilt, "making" or "breaking" an electrical circuit. As liquid level recedes, the float pulls the magnetic attracting sleeve downward until, at a pre-determined "Low Level" (diagram "B"), the switch magnet releases and is drawn outward away from the enclosing tube by a tension spring. This in turn tilts the switch in an opposite direction, thus reversing switch action.

When liquid level returns to normal, the float once again moves the magnetic attracting sleeve up the enclosing tube, causing the switch to assume its original position.

INSTALLATION

TYPICAL PIPING ARRANGEMENT

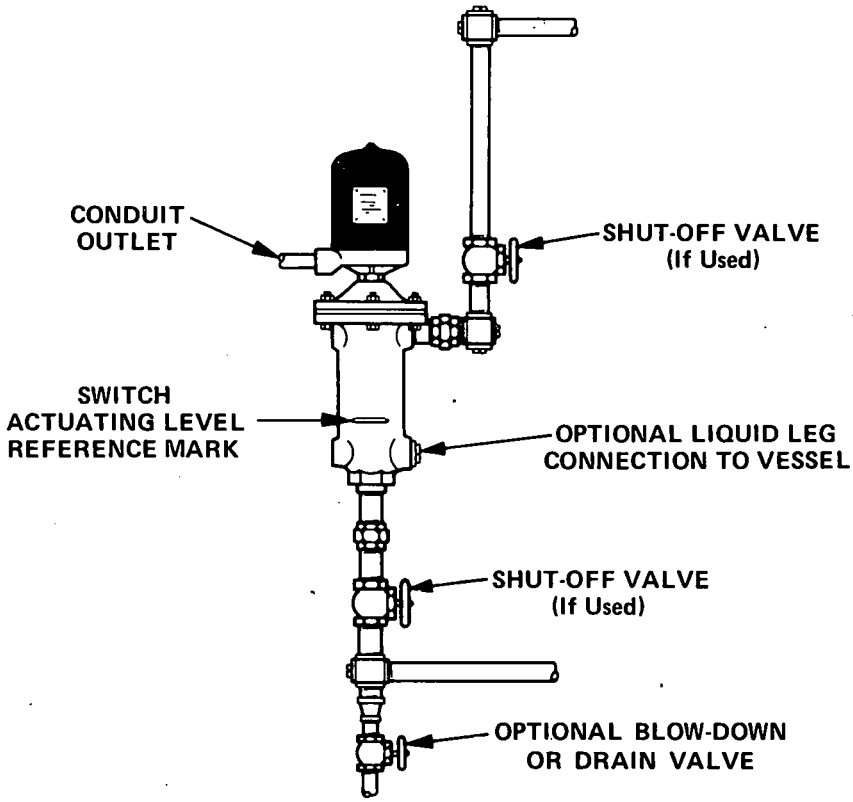


FIG. 2

PIPING

Figure 2 shows a typical piping installation of a Magnetrol flanged float cage control to a vessel or boiler. Reference mark on float chamber should be aligned to correspond with liquid level in vessel or boiler at which switch control is desired (refer to dimensional drawing, if furnished). On boiler installations, line indicated would be the low water cut-off level.

NOTE: Refer to boiler manufacturer's specifications regarding control levels for piping alignment requirements.

Use pipe of sufficient strength to support the control. If necessary, provide a stand or hanger to help support its weight. All piping should be straight and free of "low spots" or "pockets" so that lower liquid line will drain towards the vessel or boiler and upper vapor line will drain toward the control. Shut-off valves are recommended for installation between vessel or boiler and the float chamber of the control. If the control is to be used with a low temperature liquid (one which will "boil" in the float chamber if outside heat is absorbed), the chamber and piping should be insulated. Such boiling in the chamber will cause false level indications. Do NOT insulate chamber if control is to be used with a high temperature liquid. Switch housing should never be insulated on any application.

If the liquid to be controlled has a tendency to leave deposits in the piping, right angle turns should be made with cross type fittings equipped with plugs in unused openings. Removal of plugs will permit pipe line to be "rodded" clean. Blow-down connection on boiler installations should be piped in such a manner that the operator will not scald himself when blowing down control.

RECOMMENDED INSTALLATION

The lowest visible part of the water-gage glass should be at least 2.00 inches above the lowest permissible water level, which level should be that at which there will be no danger of overheating any part of the boiler when in operation at that level.

Boilers of the horizontal fire-tube type should be so set that when the water is at the lowest reading in the water-gage glass there should be at least 3.00 inches of water over the highest point of the tubes, flues, or crown sheet.

— continued

INSTALLATION – continued

SHUT-OFF VALVES (IF USED)

When shut-offs are used in the pipe connections between a boiler and a water column or between a boiler and the shut-off valves required for the gage glass they should be either outside-screw-and-yoke or level-lifting type gate valves or stopcocks with levers permanently fastened thereto and marked in line with their passage, or of such other through-flow construction as to prevent stoppage by deposits of sediment, and to indicate by the position of the operating mechanism whether they are in open or closed position; and such valves or cocks should be locked or sealed open. Where stop-cocks are used they should be of a type with the plug held in place by a guard or gland.

NOTE: On controls equipped with pneumatic switching assemblies, consult installation bulletin on mechanism furnished for air (or gas) piping instructions.

MOUNTING

Controls used on boiler applications should be mounted as close to the boiler as possible. This will result in a more responsive and accurate level change in the control. Water in a long line will be cooler and more dense than the boiler water causing lower level indication in the control than actual level in the boiler.

Adjust piping as required to bring control to a vertical position. Magnetrol controls must be mounted within three (3°) degrees of vertical. A three degree slant is noticeable by eye, but installation should be checked with a spirit level on top or sides of float chamber.

WIRING

Most all Magnetrol control switch housings are designed to allow 360° positioning of the conduit outlet by loosening the set screw(s) located under the housing base. Diagrams of the control's internal electrical circuits (switching action between terminals) will be found in the switch mechanism instruction bulletin provided (see listing that follows).

On high temperature applications (above 250°F. in float chamber), asbestos covered wire should be used between control and first junction box located in a cooler area. On non-hazardous applications, flexible conduit may be used between control and first junction box. Conduit should have sufficient slack to permit removal of control top flange for cleaning and inspection.

1. To gain access to switch mechanism(s), remove switch housing cover.
2. Pull in supply wires (conductors), wrap them around enclosing tube under the baffle plate and connect to proper terminals. Be certain that excess wire does not interfere with "tilt" of switch and that adequate clearance exists for replacement of switch housing cover.

NOTE: See one of the following bulletins furnished with your control for proper connections.

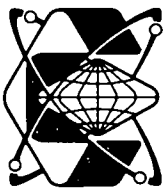
SWITCH MECHANISM (Model Suffix Number)	BULLETIN	Ref. Type
S-1 & DPS-1 Mercury Switches	42-608	S-1
J-1 Bleed Type Pneumatic Valve	42-617	J-1
J-2 Non-Bleed Type Pneumatic Valve	42-621	J-2
S-1M & DPS-1M Dry Contact Switches	42-657	S-1
M-1 & M-4 Anti-Vibration Dry Contact Switches	42-670	M-1
SPS-1 & SPDPS-1 Anti-Vibration Mercury Switches	42-675	S-1
S-1 & DPS-1 High Temperature Mercury Switches	42-676	S-1
SPS-1 & SPDPS-1 Hi-Temp, Anti-Vibration Mercury	42-677	S-1
S-1M & DPS-1M Hi-Temp, Dry Contact Switches	42-678	S-1

3. Connect power supply to control and test switch action by varying liquid level in float chamber. If switch mechanism fails to function, check vertical alignment of control and consult instruction bulletin on mechanism furnished.
4. Replace switch housing cover and place control into service.

NOTE: If control has been furnished with an explosion proof (cast) or moisture proof (gasketed) switch housing, check the following:

– After wiring connections have been completed, housings must be sealed at the conduit outlet with a suitable compound or "dope" to prevent entrance of air.

– Check cover to base fit to be certain gasketed joint is tight. A positive seal is necessary to prevent infiltration of moisture laden air or corrosive gases into switch housing.



— PREVENTIVE MAINTENANCE —

Periodic inspections are a necessary means to keep your Magnetrol level control in good working order. This control is, in reality, a safety device to protect the valuable equipment it serves. Should the control fail, the resultant damage to equipment dependent upon its performance could very well cost far in excess of the control itself. Therefore, a systematic program of "Preventive Maintenance" should be implemented when control is placed into service. If the following sections on "What to Do" and "What to Avoid" are observed, your control will provide reliable protection of your capital equipment.

WHAT TO DO

1. KEEP CONTROL CLEAN

— NEVER leave switch housing cover off the control. This cover is designed to keep dust and dirt from interfering with switch mechanism operation. In addition, it protects against damaging moisture and acts as a safety feature by keeping bare wires and terminals from being exposed. Should the housing cover become damaged or misplaced, order a replacement immediately.

2. INSPECT SWITCH MECHANISMS, TERMINALS AND CONNECTIONS MONTHLY

— Mercury switches may be visually inspected for short circuit damage. Check for small cracks in the glass tube containing the mercury. Such cracks can allow entrance of air into the tube causing the mercury to "oxidize". This is noticeable as the mercury will appear dirty and have a tendency to "string out" like water, instead of breaking into clean round pools. If these conditions exist, replace the mercury switch immediately.

— Dry contact switches should be inspected for excessive wear on actuating lever or misalignment of adjustment screw at point of contact between screw and lever. Such conditions can cause false switch actuating levels. Adjust switch mechanism to compensate (if possible) or replace switch.

DO NOT operate your control with defective or maladjusted switch mechanisms (refer to bulletin on switch mechanism furnished for service instructions).

— Magnetrol controls may sometimes be exposed to excessive heat or moisture. Under such conditions, insulation on electrical wires may become brittle, eventually breaking or peeling away. The resulting "bare" wires can cause short circuits. Check wiring carefully and replace at first sign of brittle insulation.

— Vibration may sometimes cause terminal screws to work loose. Check all terminal connections to be certain that screws are tight. Air (or gas) operating medium lines, subjected to vibration, may eventually crack or become loose at connections causing leakage. Check lines and connections carefully and repair or replace, if necessary.

WHAT TO AVOID

1. **NEVER** leave switch housing cover off the control longer than necessary to make routine inspections.
2. **NEVER** use lubricants on pivots of switch mechanisms. A sufficient amount of lubricant has been applied at the factory to insure a lifetime of service. Further oiling is unnecessary and will only tend to attract dust and dirt which can interfere with mechanism's operation.
3. **NEVER** place a jumper wire across terminals to "cut-out" the control. If a "jumper" is necessary for test purposes, be certain it is removed before placing control into service.
4. **NEVER** attempt to make adjustments or replace switches without reading instructions carefully. Certain adjustments provided for in Magnetrol controls should not be attempted in the field. When in doubt, consult the factory or your local Magnetrol representative.

— TROUBLE SHOOTING —

Usually the first indication of improper operation is failure of the controlled equipment to function — pump will not start (or stop), signal lamps fail to light, etc. When these symptoms occur, whether at time of installation or during routine service thereafter, check the following potential external causes first.

- Fuses may be blown.
- Reset button(s) may need resetting.
- Power switch may be open.
- Controlled equipment may be faulty.
- Wiring (or medium lines) leading to control may be defective.

If a thorough inspection of these possible conditions fails to locate the trouble, proceed next to a check of the control's switch mechanism(s).

1. Pull disconnect switch or otherwise assure that electrical circuit(s) through the control is deactivated.
2. Remove switch housing cover.
3. Swing magnet assembly in and out by hand, checking carefully for any sign of binding. Assembly should require no force, however slight, to move it through its full swing.

TROUBLE SHOOTING – continued

4. If binding exists, magnet may be rubbing enclosing tube or pivot sockets may be overly tight. Readjust pivot sockets as required until a slight amount of side play is evident. If magnet is rubbing, loosen magnet clamp screw and shift magnet position.

5. If switch magnet assembly swings freely and mechanism still fails to actuate, check installation of control to be certain it is within the specified three (3°) degrees of vertical (use spirit level on side of enclosing tube in two places, 90° apart).

6. If mechanism is equipped with a mercury switch, examine glass tube closely, as previously described in Preventive Maintenance section. If switch is damaged, replace it immediately.

NOTE: As a matter of good practice, spare switches should be kept on hand at all times.

If switch mechanism(s) is operating satisfactorily, a test of the complete control's performance is the next likely step.

1. Reconnect power supply and carefully actuate switch mechanism(s) manually (using a non-conductive tool on electrical switch mechanisms) to determine whether controlled equipment will operate.

CAUTION: With electrical power "on", care should be taken to avoid contact with switch leads and connections at terminal block.

2. If controlled equipment responds to manual actuation test, trouble may be located in level sensing portion of the control [float(s), stem(s) and magnetic attraction sleeve(s)].

NOTE: Check first to be certain liquid is entering float chamber. A valve may be closed or pipe line plugged.

3. With liquid in float chamber, proceed to check level sensing action by removing switch housing assembly.

CAUTION: Be certain to pull disconnect switch or otherwise assure that electrical circuit(s) through control is deactivated. Close operating medium supply valve on controls equipped with pneumatic switch mechanisms.

A. Disconnect wiring from supply side of switch mechanism(s) and remove electrical conduit or operating medium line connections to switch housing.

B. Perform system shut-down as required to relieve pressure from float chamber of control and allow unit to cool.

- Close shut-off valves (if so equipped) to isolate control from vessel. Drain off liquid in chamber, if required.
- On boiler applications or installations without shut-off valves, relieve pressure from vessel or boiler and drain off liquid "head" above control mounting level.

NOTE: Control chamber, connections and pipe lines need not be removed from vessel or boiler.

C. Remove switch housing assembly by loosening hex nut located immediately below housing base.

4. With switch housing assembly removed, inspect attraction sleeve(s) and inside of enclosing tube for excessive corrosion or solids build-up which could restrict movement, preventing sleeve(s) from reaching field of switch magnet(s).

5. If the differential adjustment has been changed in the field by repositioning the lower jam nuts on the float stem, check for tightness and position of the jam nuts.

NOTE: Differential adjustment affects a change in the amount of level travel between "switch on" and "switch off" actuations. Do NOT attempt adjustment without first consulting factory for assistance in computing level differential change for your control.

6. Check float(s) to be certain it is bouyant in the liquid (float chamber or vessel must have adequate liquid level). If float is determined to be filled with liquid or collapsed, it must be replaced immediately. Do NOT attempt to repair a float. (See float replacement instructions on page 7.)

If all the components in the control are in operating condition, the trouble must be (and should be) located external to the control. Repeat inspection of external conditions previously described.

NOTE: When in doubt about the condition or performance of a Magnetrol control, return it to the factory. See "Our Service Policy" on back page.

The instructions contained in this bulletin are general and can be applied to most any Magnetrol flanged float cage level control. If difficulties are encountered which can not be identified, consult with the factory or your local representative for assistance. A complete description of the trouble should be provided along with information concerning your piping and mounting arrangement, and a description of your operation sequence. Sketches or photographs showing the installation are also beneficial.

When communicating about your control, be certain always to specify the complete Model and Serial numbers.

STANDARD® DIFFERENTIAL ADJUSTMENT

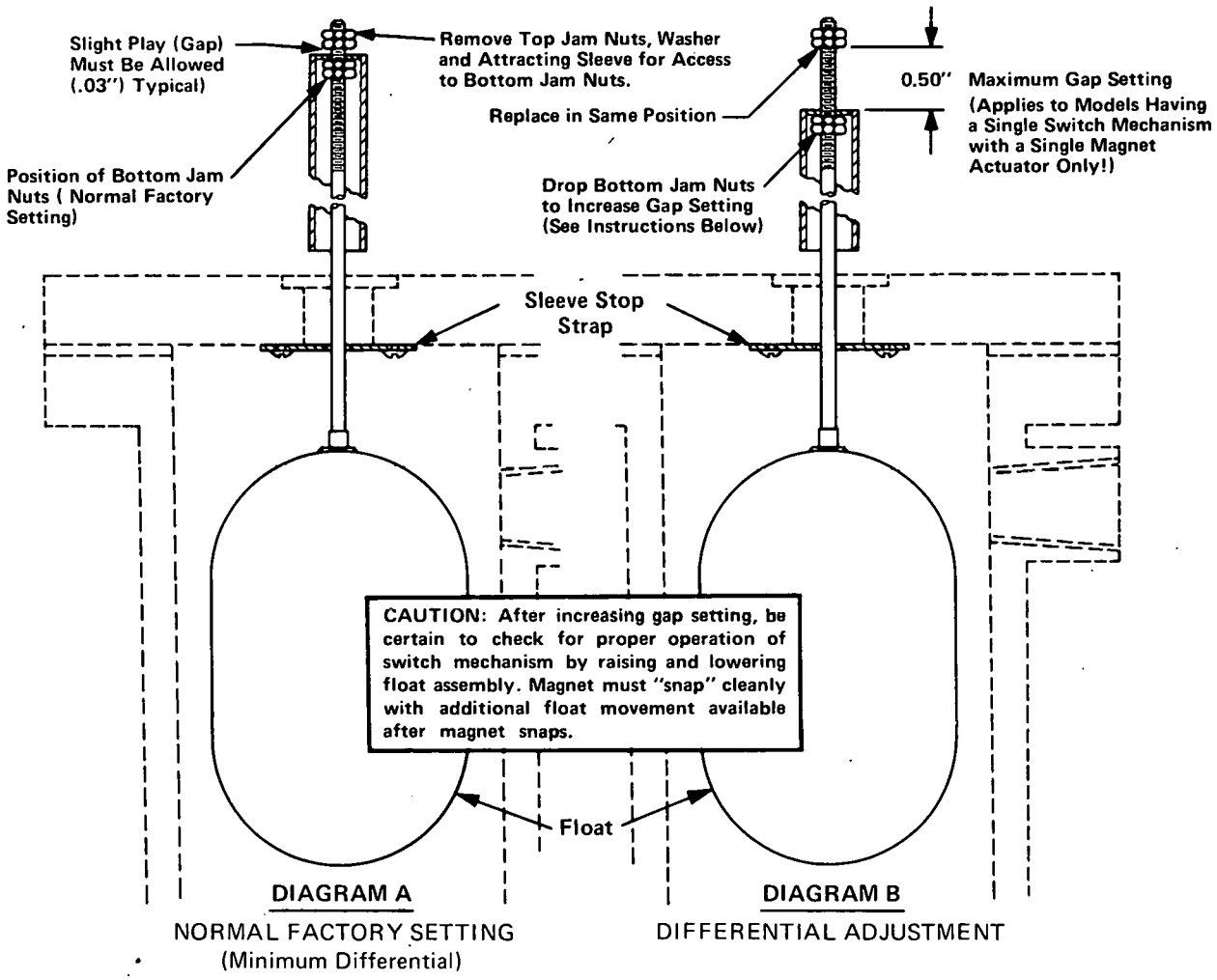


FIG. 3

The amount of level travel between "switch-on" and "switch-off" actuations (differential) may be field adjusted by repositioning the lower jam nuts on the float stem. The standard factory setting is for a minimum amount of play (gap) between the top jam nuts and the attraction sleeve, as shown in diagram "A" above. This setting may be increased to a maximum of 0.50" as shown in diagram "B".

NOTE: For assistance in computing level differential change for a specific control, consult the factory giving Model and Serial number of the control.

With level change specifications determined, proceed as follows:

CAUTION: Before attempting any work on the control, be certain to pull disconnect switch or otherwise assure that electrical circuit(s) through control is deactivated. Close operating medium supply valve on controls equipped with pneumatic switch mechanisms.

1. Disconnect wiring from supply side of switch mechanism(s) and electrical conduit or operating medium line connections to switch housing.
2. Perform system shut-down as required to relieve pressure from float chamber of control and allow unit to cool.

NOTE: Control chamber, connections or pipe lines need not be removed from vessel or boiler.

3. Remove switch housing assembly by loosening hex nut located immediately below housing base (see figure 5).
4. With switch housing removed, jam nuts and attraction sleeve are accessible. Measure position of upper jam nuts from stem end, then loosen and remove upper jam nuts, guidewasher and attraction sleeve.
5. Loosen and adjust lower jam nuts to desired position. Make certain jam nuts are retightened securely.
6. Reassemble control in reverse of steps 1 thru 4 making certain upper jam nuts are locked in original position.

NOTE: Use new gasket in assembly of switch housing to chamber.

7. Test switch actuation by varying liquid level in float chamber.

⊛ **Instructions given are for standard Magnetrol controls only — not for models specifically tailored to special customer specifications.**

REPLACEMENT OF STANDARD® FLOAT AND STEM ASSEMBLY

(FOR REF. TYPE S-1 AND J-1 MODELS ONLY)

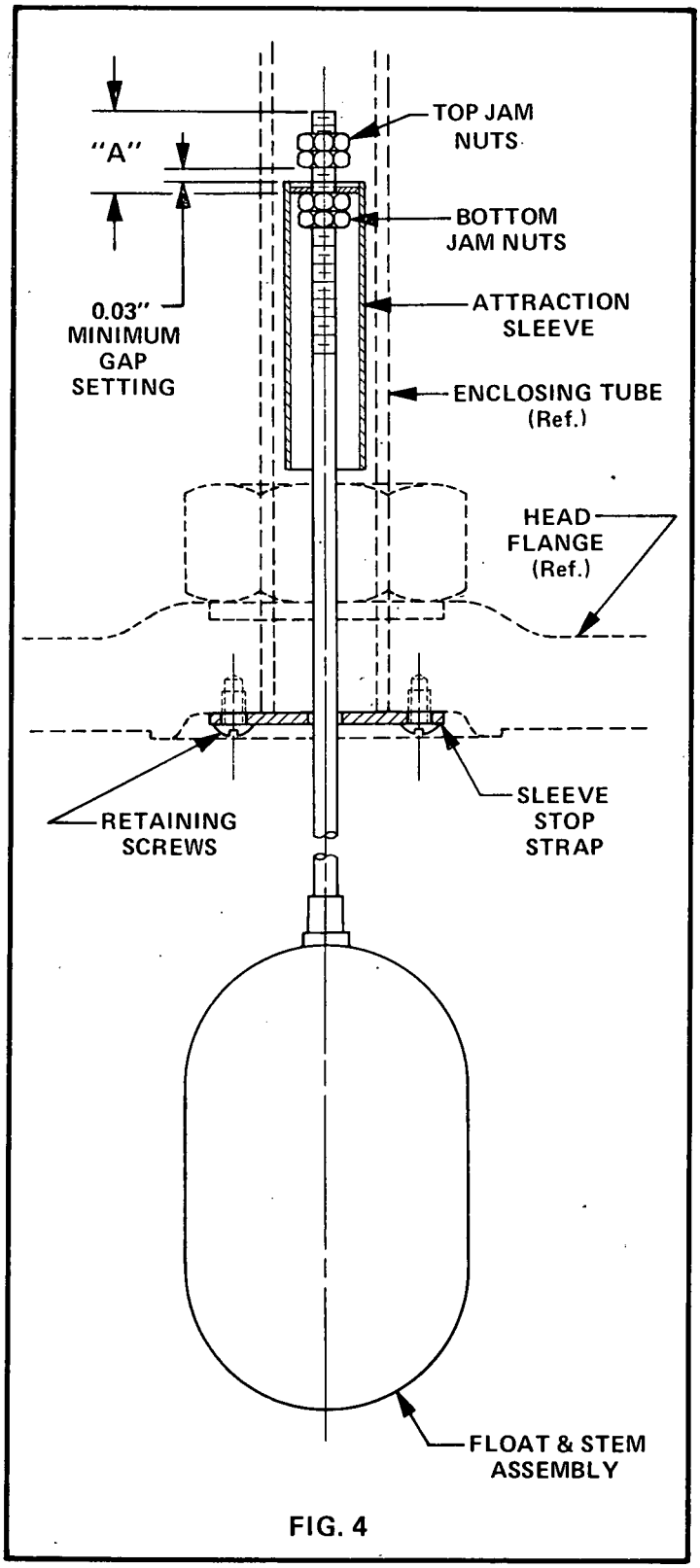


FIG. 4

1. Disconnect wiring or medium lines from control and perform system shut-down as described previously in trouble shooting and differential adjustment instructions.
2. Remove switch housing assembly from float chamber at head flange (not at enclosing tube hex nut as noted in the previous instructions).
3. Remove sleeve stop strap from the underside of the head flange and slide the float stem assembly out of the enclosing tube.

NOTE: New float and stem assembly is supplied with attraction sleeve components factory assembled and adjusted for your particular control model.

4. Check new float and stem assembly to be certain it is the correct replacement unit:
   A. Float should be of same physical size and shape.
   B. Stem length should match closely.
   C. Measure dimension "A" and compare on reference chart below.

NOTE: If differential adjustment has been altered in the field, disregard dimension "A" and re-adjust new assembly to the previously determined level differential setting per instructions on page 6.

5. Replace new float and stem assembly into head flange and install new stop strap with screws included.
6. Remount head flange on float chamber using new gasket provided. Tighten flange nuts evenly, using an alternating pattern, typical of standard industry practice.

NOTE: Care must be taken during installation to be certain float stem does not get bent.

7. With control assembled in place, test switch actuation by varying liquid level in float chamber.

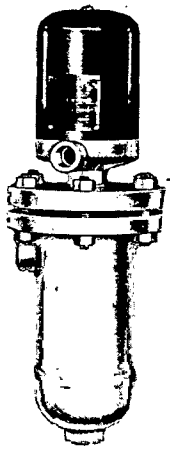
STANDARD LOWER JAM NUT SETTINGS	
MODEL	DIMENSION "A"
249	.38"
251	.48"
291	.50"
D-301	.48"
303	.50"
601	.38"
W-251	.56"
W-254	.62"
W-291	.56"
W-601	.48"

⊙ **Instructions given are for standard Magnetrol controls only — not for models specifically tailored to special customer specifications.**

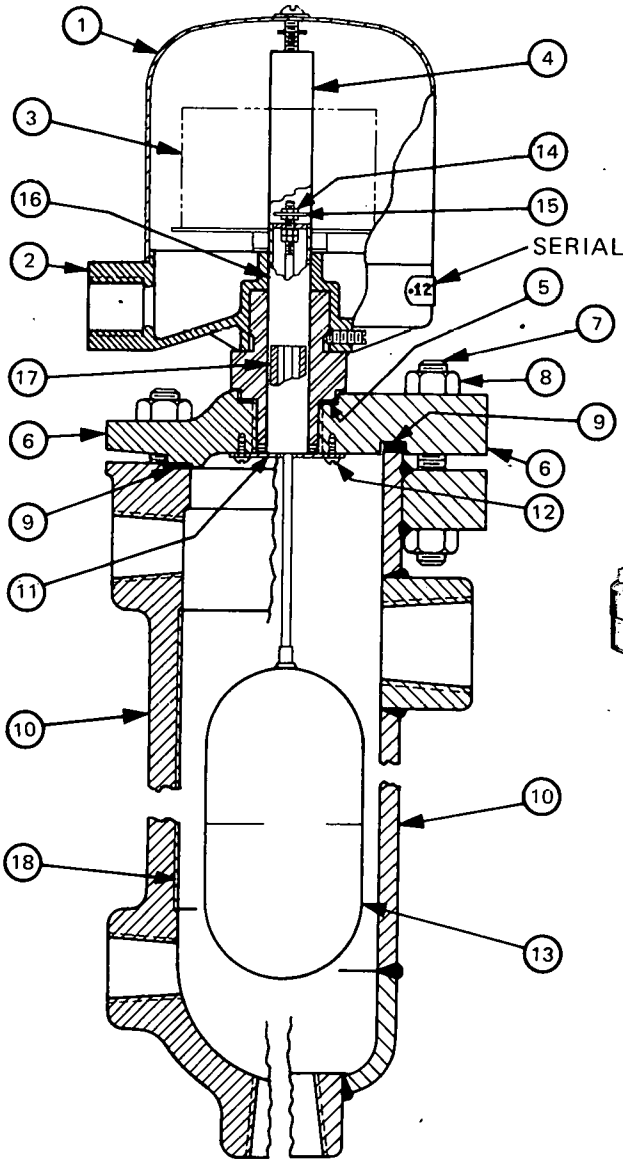
REPLACEMENT PARTS

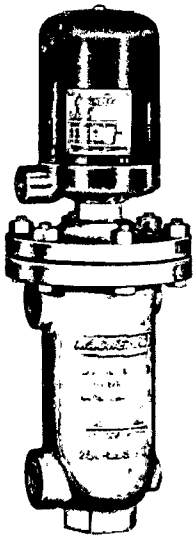
IMPORTANT: Many control models are specially tailored to meet specific customer specifications and therefore may contain special parts. When ordering replacement parts, always give Serial Number of Control.

TYPICAL MODEL 249

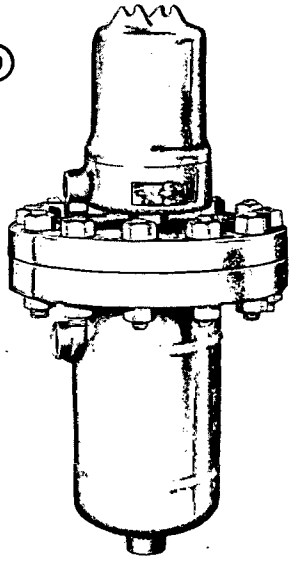


TYPICAL MODEL 291 & D-301





TYPICAL MODEL 251



TYPICAL MODEL 303 & 601

TYPICAL MODEL W-251 & W-254

NOTE: Models W-291 & W-601 (not shown) are typical of models W-251 & W-254 except for fabricated float cage construction.

CAST IRON FLOAT CAGE MODELS

FABRICATED STEEL FLOAT CAGE MODELS

FIG. 5

REPLACEMENT PARTS – continued

ITEM	DESCRIPTION		STANDARD REPLACEMENT ASSEMBLY KITS ①												
			MODEL												
			249 ②	251 ②	291	D-301 ③	J-303	L-303	M-303	B-601	C-601	W-251 ②	W-254 ②	W-291	W-601
1	Housing Cover	Housing Kits	SEE BULLETIN 42-680 FOR REF. TYPE S-1 SWITCH HOUSING REPLACEMENT ASSEMBLIES. CONSULT LOCAL REPRESENTATIVE ON TYPE J-1, J-2 & M-1 HOUSINGS.												
2	Housing Base														
3	Switch Mechanism	–	SEE BULLETIN ON SWITCH MECHANISM FURNISHED (Listed on page 3)												
4	Enclosing Tube	Enclosing Tube Kits	89-5908-001	89-5909-001		89-5915-001	89-5909-001			89-5933-004		89-5909-001			89-5933-004
5	E-Tube Gasket														
5	E-Tube Gasket	Head Flange Kits	89-4201-001	89-4202-001	89-4203-001	89-4204-001	89-4205-001			89-4206-001		89-4207-001		89-4203 001	89-4206-001
6	Head Flange														
7	Studs / Bolts														
8	Hex Nuts														
9	Flange Gasket														
7	Studs / Bolts	Float Chamber Kits	89-4601-001	89-4602-001	89-4603-001	89-4604-001	89-4605-001			89-4606-001		89-4607-001	89-4608-001	89-4609-001	89-4610-001
8	Hex Nuts														
9	Flange Gasket														
10	Float Chamber														
9	Flange Gasket	Float & Stem Kits	89-3201-001	89-3202-001	89-3203-001	89-3204-001	89-3205-001	89-3206-001	89-3207-001	89-3208-001	89-3209-001	89-3210-001		89-3212-001	89-3213-001
11	Stop Strap														
12	Screws														
13	Float & Stem Ass'y.														
14	Jam Nuts														
15	Guide Washer														
16	Attraction Sleeve														
17	Stop Tube (if used)			– NOT REQUIRED –											
9	Flange Gasket		89-4401-001	89-4402-001	– NOT REQUIRED –							89-4403-001	89-4404-001	NOT REQUIRED	
18	Chamber Liner ②														
5	E-Tube Gasket	Gasket Kits	89-3601-001		89-3602-001	89-3603-001	89-3604-001			89-3605-001		89-3601-001		89-3602-001	89-3605-001
9	Flange Gasket														

NOTE:

① All replacement assemblies listed are furnished in kit form for standard base models which use ref. type S-1 switch mechanisms only. Consult local representative for ordering assistance on all special model replacement parts or accessories not included in above listing.

② Cast float cage models used on boiler service require brass chamber liner. See bulletin 43-618 for replacement instructions.

③ Model D-301 is unit specially designed for Dowtherm "A" service only.

④ See page 10 & 11 for standard tandem model replacement parts.

IMPORTANT:

When ordering, please specify:

A. Model and Serial number of control.

B. Replacement assembly (kit) part number.

TANDEM FLOAT MODELS

DESCRIPTION

Models with tandem style floats are used on applications where widely spaced high and low switching functions can be accomplished with a single control. The units incorporate two floats which operate independently and are arranged so that the lower float actuates the upper switch mechanism and the upper float actuates the lower switch mechanism. The upper float is attached to the lower attraction sleeve by means of a hollow stem. The lower float attaches to the upper attraction sleeve with a solid stem which extends upward through the upper float and stem assembly.

INSTALLATION, PREVENTIVE MAINTENANCE AND TROUBLE SHOOTING

Installation and Maintenance of tandem float models is accomplished in much the same manner as previously described for standard models. Some additional consideration must be given to the piping arrangement to allow for alignment of the two switch actuating level marks on the float chamber with the desired levels in the vessel or boiler. When trouble-shooting the level sensing portion of the control, additional checks may be made of the following:

1. Inspect for binding of solid (lower) float stem within hollow (upper) float stem due to corrosion or possible damage incurred during shipment or previous maintenance.
2. Make certain that retaining "snap" rings, used to locate lower attraction sleeve, are locked in place. An extreme shock or hammer, such as during blow-down on a water column boiler control, may have damaged a ring causing it to snap out of its retaining groove in the hollow (upper) float stem.

DIFFERENTIAL ADJUSTMENT

CAUTION: No differential adjustment should be made on tandem float models in the field. Switch actuation levels have been set at the factory to meet specific customer specifications. Variations in actual conditions from design conditions usually requires special control modifications. Consult with the factory or local representative for assistance.

REPLACEMENT OF FLOAT AND STEM ASSEMBLIES

Should replacement of either upper or lower float and stem assembly be required, instructions previously given for standard units (page 7) may be followed with additional considerations as follows:

1. New float and stem assemblies are available in separate replacement kits, as listed on following page, with attraction sleeve parts furnished loose to allow for field assembly with existing serviceable components.
2. Dimension "A", referred to in standard instructions, must be arrived at by direct measurement from old assembly.

NOTE: Disregard dimension "A" figures shown in chart on page 7. If in doubt or unable to get an accurate measurement from old assembly, consult with factory or local representative for assistance.

3. Lower attraction sleeve locks in place on hollow (upper) float stem with external type snap rings. Care must be taken to be certain rings are properly installed. Use correct type external snap ring pliers, if available.

TYPICAL TANDEM FLOAT MODEL

NOTE: Fabricated steel float cage model shown. W-251 and W-254 models have cast iron float cage.

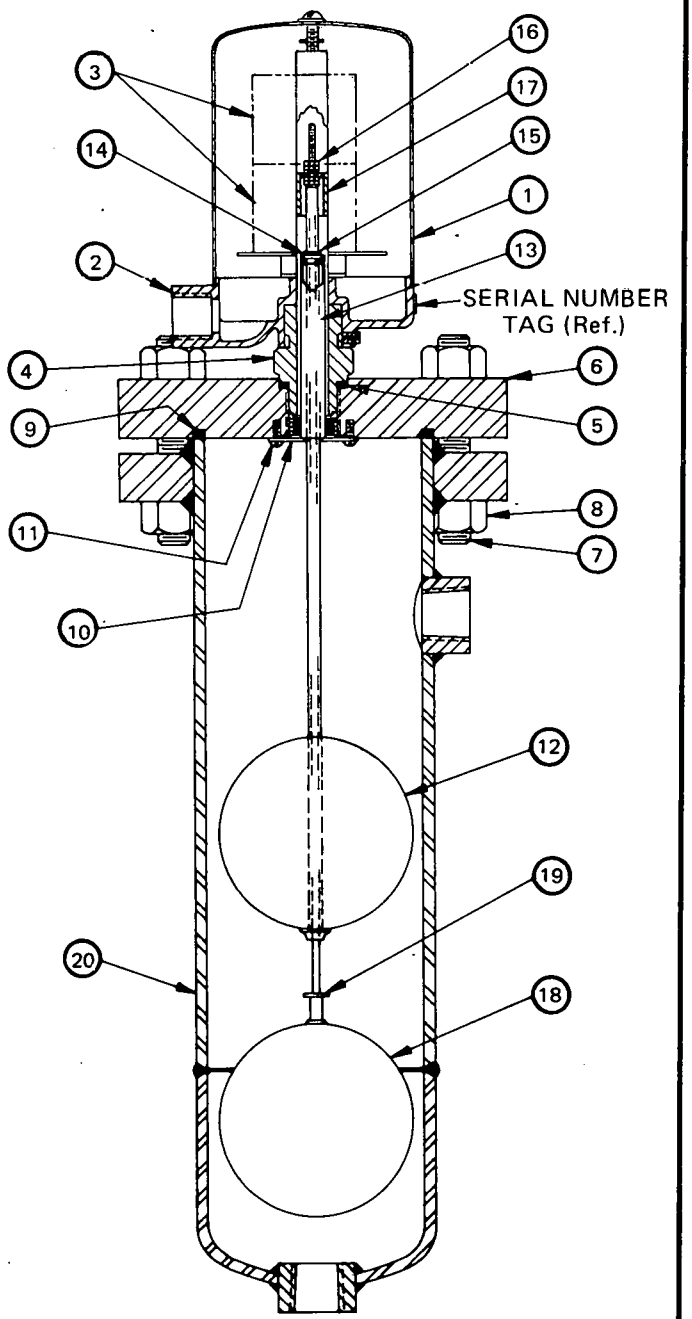


FIG. 6

NOTE:

① All replacement assemblies listed are furnished in kit form for standard tandem models which use ref. type S-1 switch mechanisms only. Consult local representative for ordering assistance on all special model replacement parts or accessories not listed above.

TANDEM FLOAT MODELS — continued

REPLACEMENT PARTS

ITEM	DESCRIPTION		STANDARD REPLACEMENT ASSEMBLY KITS ① MODEL									
			291-TDM	D-301-TDM ②	J-303-TDM	L-303-TDM	M-303-TDM	B-601-TDM	C-601-TDM	W-251-TDM ③	W-254-TDM ③	W-291-TDM	W-601-TDM
1	Housing Cover (Tall)	Housing Kits	SEE BULLETIN 42-680 FOR REF. TYPE S-1 SWITCH HOUSING REPLACEMENT ASSEMBLIES. CONSULT LOCAL REPRESENTATIVE ON TYPES J-1, J-2 & M-1 HOUSINGS.										
2	Housing Base												
3	Switch Mechanisms	—	SEE BULLETIN ON SWITCH MECHANISMS FURNISHED (Listed on page 3)										
4	Enclosing Tube	Enclosing Tube Kits	89-5909-001					89-5933-004		89-5909-001			89-5933-004
5	E-Tube Gasket												
5	E-Tube Gasket	Head Flange Kits	89-4203-001	89-4204-001	89-4205-001			89-4206-001		89-4202-001		89-4203-001	89-4206-001
6	Head Flange												
7	Studs / Bolts												
8	Hex Nuts												
9	Flange Gasket												
9	Flange Gasket	Upper Float & Stem Kits	89-3217-001	89-3218-001	89-3219-001	89-3220-001	89-3221-001	89-3222-001	89-3223-001	89-3224-001	89-3225-001	89-3217-001	⊙ Special Order Item. See Order Note Below.
10	Stop Strap												
11	Screws												
2	Upper Float & Stem Ass'y.												
3	Lower Attraction Sleeve												
14	Spacer Washer												
15	Retaining Ring												
9	Flange Gasket	Lower Float & Stem Kits	⊙ LOWER FLOAT AND STEM ASSEMBLY IS SPECIAL ORDER ITEM. SEE IMPORTANT ORDERING NOTE BELOW.							89-3214-001		89-3216 001	
16	Jam Nuts												
17	Upper Attraction Sleeve												
18	Lower Float & Stem Ass'y.												
19	Safety Stop Washer												
7	Studs / Bolts	Float Chamber Kits	⊙ FLOAT CHAMBER ASSEMBLY IS SPECIAL ORDER ITEM. SEE IMPORTANT ORDERING NOTE BELOW.							89-4607-001	89-4608-001	89-4609-001	
8	Hex Nuts												
9	Flange Gasket												
20	Float Chamber												
9	Flange Gasket	Chamber Liner Kits	— NOT REQUIRED —							89-4403-001	89-4404-001	NOT REQUIRED	
21	Chamber Liner ③ (Not Shown)												
5	E-Tube Gasket	Gasket Kits	89-3602-001	89-3603-001	89-3604-001			89-3605-001		89-3601-001		89-3602-001	89-3605-001
9	Flange Gasket												

② Model D-301-TDM is unit specially designed for Dowtherm "A" service only.

③ Cast float cage models used on boiler service require brass chamber liner. See bulletin 43-618 for replacement instructions.

⊙ **IMPORTANT:**

When ordering, please specify:

A. Model and Serial number of control.

B. Replacement assembly (kit) part number.

Guarantee

We guarantee to repair or to replace, at our option, any MAGNETROL Level or Flow Control which, within one year from date of shipment, exhibits any defect in material or workmanship, provided that: (1) the unit has been properly installed; and (2) it has been operated with the liquid and within the pressure, temperature, specific gravity and electric current or pneumatic supply limitations specified on the original purchase order or as stamped on the MAGNETROL instrument nameplate.

Important

OUR SERVICE POLICY

Owners of Magnetrol controls may request to return a control or any part of a control for complete rebuilding or replacement. They will be rebuilt or replaced promptly. If, once returned, the underlying cause of the trouble is found to be defective material or workmanship (within the guarantee period), the item will be either rebuilt, or replaced completely, without charge on an F.O.B. factory basis. If the trouble is the result of conditions beyond our control or is not covered by the guarantee, there will be a charge for labor and a charge for parts required to rebuild or replace the item.

In some cases it may be expedient to ship new parts or in extreme cases, a complete new control to replace the original before it is returned. If this is desired, inform us as to what parts are needed, the model number and the serial number of the control and repair part number. Credit for materials returned in such cases will be determined on the basis of the applicability of our guarantee.

No claims for labor or consequential damage will be allowed.

RETURN MATERIAL PROCEDURE

So that we may efficiently process any materials that are returned, it is essential that a "Return Material Authorization" tag be obtained from the factory for attachment to the goods. This is available through Magnetrol's local representative or by writing directly to the factory supplying the following information:

1. Installation Name
2. Description of Material
3. Production Number
4. Serial Number
5. Reason for Return
6. Desired Action

All shipments returned to the factory must be by Prepaid transportation.

All replacements will be shipped F.O.B. factory.

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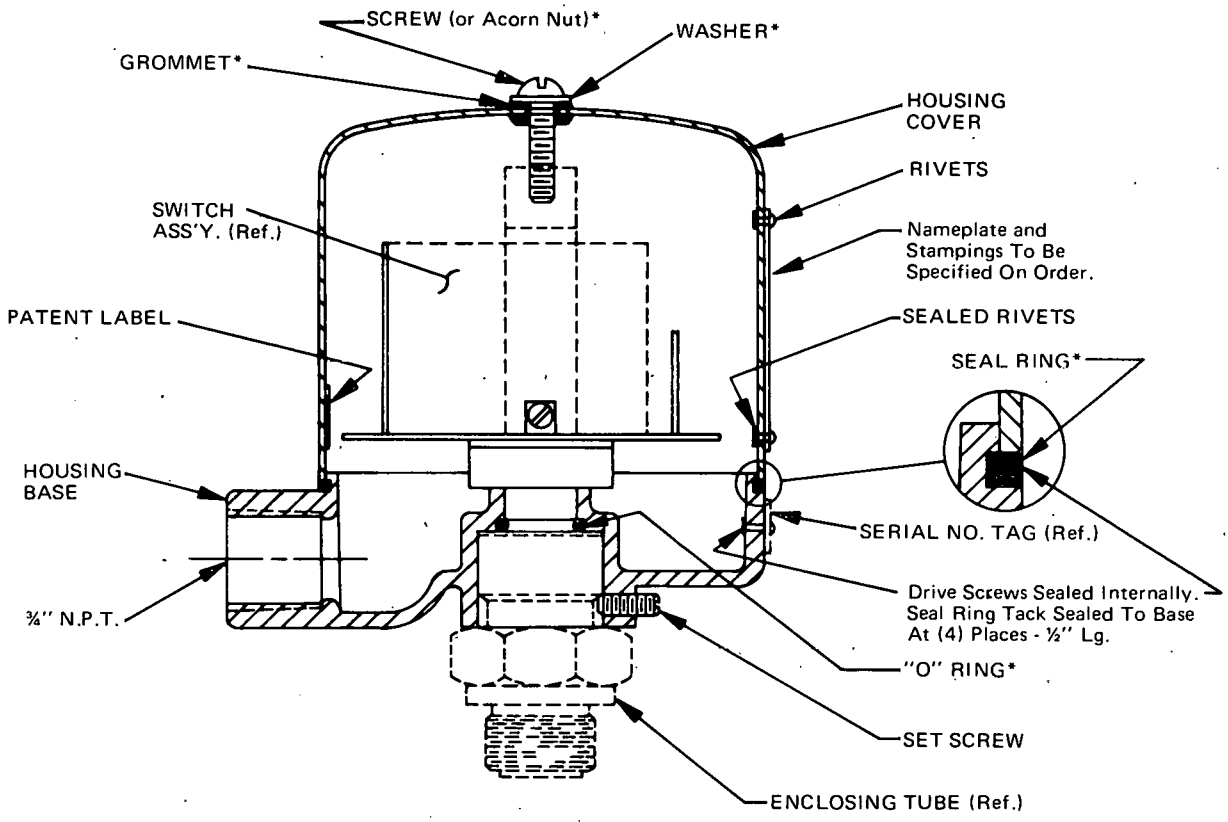
MAGNETROL
INTERNATIONAL, INCORPORATED

BULLETIN: 42-680.4
EFFECTIVE: October 1977
SUPERSEDES: November 1975

MAGNETROL TYPE S-1 SWITCH HOUSING REPLACEMENT ASSEMBLIES



TYPICAL STANDARD HOUSING ASSEMBLY

DESCRIPTION

Standard housing replacement assemblies are designed for applications ranging from general purpose indoor use to non-hazardous installations requiring a dust, water, lint, fiber and oil tight enclosure.

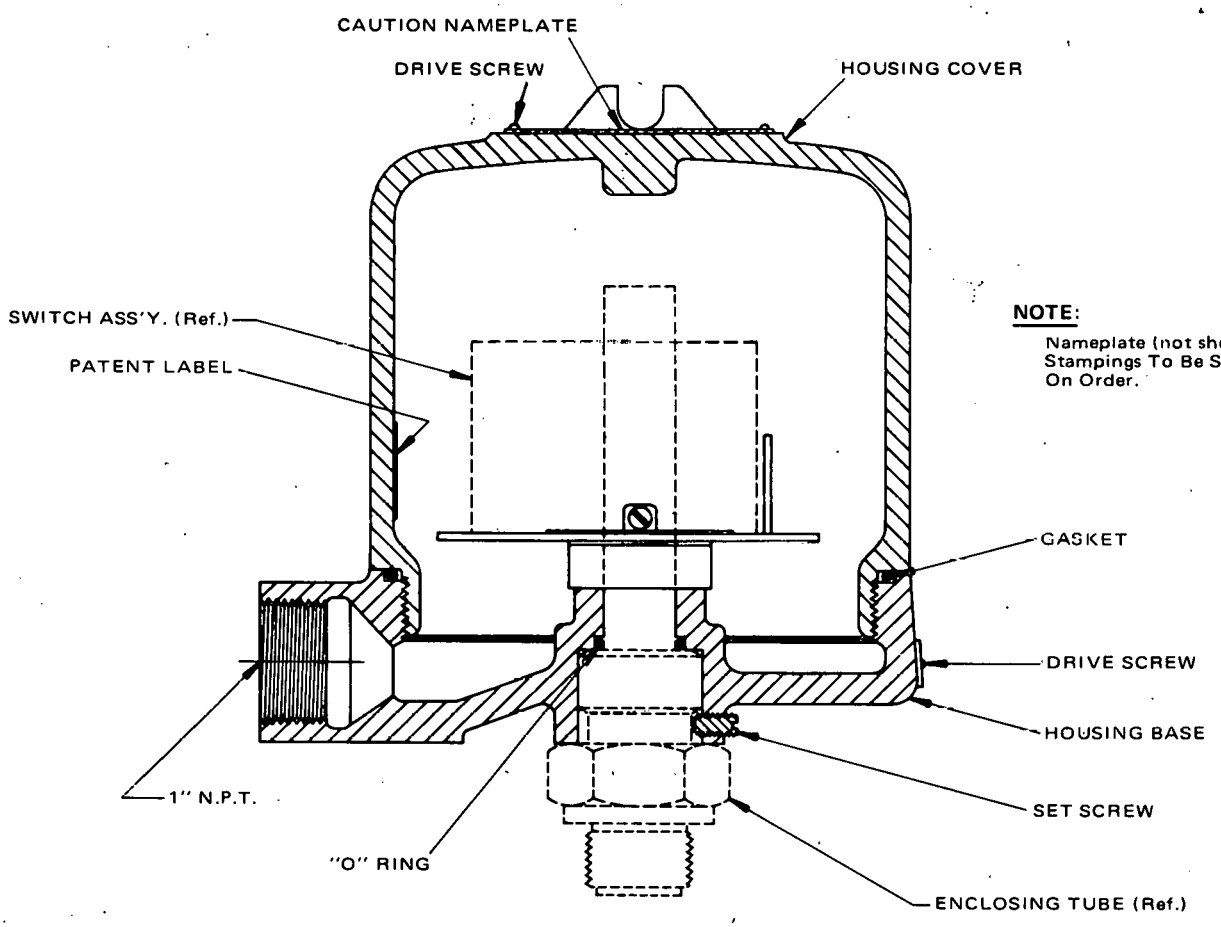
The manual reset (M.R.) assemblies utilize the same basic components as the standard units, but are limited to general purpose indoor applications where unit is not exposed to unusual conditions.

NOTE: Manual reset mechanism requires a hole in the side of the cover to accommodate the reset actuating plunger.

DESCRIPTION		NEMA ① TYPE	REPLACEMENT PART KIT NO.
Standard Housing Cover	Short (4")	NEMA 1 thru 5 & 12	89-6509-001 ②
	Tall (6")		89-6510-001 ②
Manual Reset Housing Cover	Short (4")	NEMA 1 (only)	89-6511-001 ②
	Tall (6")		89-6512-001 ②
Transparent "Lexan" Housing Cover Tall (6") Only		NEMA 1 thru 5 & 12	89-6522-001 ②
Housing Base (Std. & M.R.)		NEMA 1 thru 5 & 12	89-6505-001 ③
Cover Assembly Hardware *		NEMA 1 thru 5 & 12	89-6508-001

① National Electrical Manufacturers Association.
② Includes assembly hardware kit (89-6508-001).
③ Includes base assembly hardware.

(continued)



TYPICAL EXPLOSION PROOF (E.P.) HOUSING ASSEMBLY

DESCRIPTION

Explosion proof housing replacement assemblies are designed for applications in hazardous atmospheric locations, as classified under types NEMA 7 and 9 of the National Electrical Code.

Housings equipped with submersible base are suitable for submersion under water, as classified under NEMA type 6 of the code.

IMPORTANT:

When ordering, please specify:

1. Model and Serial number of control.
2. Name and Number of replacement kit.

NOTE:

Consult your local representative on applications to meet NEMA and other codes not covered in this bulletin.

DESCRIPTION	NEMA ① TYPE	REPLACEMENT KIT PART NO.
Explosion Proof Housing Cover (4")	NEMA 6, 7 & 9	89-6513-001 ②
Explosion Proof Housing Cover (6")	NEMA 6, 7 & 9	89-6514-001 ②
Standard Explosion Proof Housing Base	NEMA, 7 & 9	89-6515-001 ③
Explosion Proof Housing Base W/Drain	NEMA 7 & 9	89-6516-001 ③
Submersible Explosion Proof Housing Base	NEMA 6, 7 & 9	89-6517-001 ③

① National Electrical Manufacturers Association
② Includes cover assembly hardware.
③ Includes base assembly hardware.

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THIS IS A MAGNETROL®
SERIAL NUMBER TAG

SERIAL NUMBERS — YOUR GUIDE TO PROMPT, ACCURATE SERVICE

Should an electrical short circuit damage or physical damage make parts replacement necessary, be sure your purchase order includes the SERIAL NUMBER of your Magnetrol control. This will insure prompt delivery of the proper parts.

WHY SERIAL NUMBER?

The serial number of each Magnetrol control is recorded and cross-indexed with the production records. These records are then kept on micro film to provide a quick access "key" to the complete engineering of any given control. This file contains full information on the mechanism furnished, exact control action, the liquid or material for which the control was intended, its specific gravity, dielectric constant, pressure and temperature, etc. In addition, all drawings and specifications are included for any special parts used in the construction of non-standard model controls.

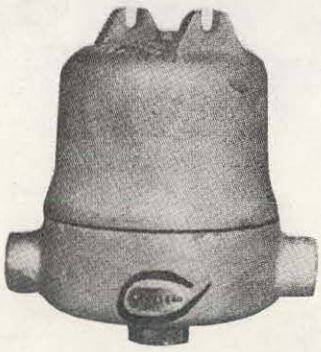
On the Type S-1 Moisture Proof Housings . . .

The Serial Number will be located at a point 180° from the conduit opening. This housing is distinguished by the black sheet-steel cover. Whether the cover is the standard "short" (illustrated), standard "tall" or "extended", the Type S-1 standard cover serial number will be in this location.

On the Type S-5 Splash-Proof Housings . . .

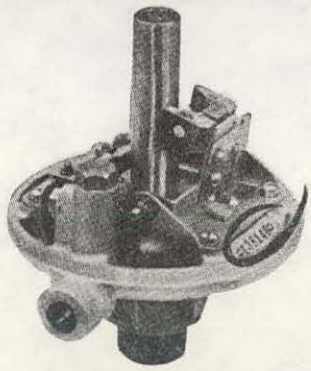
The Serial Number is also located at a point 180° from the conduit opening.

RECORD THE SERIAL NUMBER OF YOUR CONTROL



On the Type S-1 Double-tap Explosion- or Vapor-Proof Housing . . .

The Serial Number will be located at a point 90° from either of the conduit openings (one will be "plugged"). Whether the cover is the EP or VP short, tall or "extended", the Serial Number tag will be in this position.



On the Type J-1 Pneumatic Pilot Mechanism . . .

The Serial Number is located *inside* the housing. After the housing is removed, the Serial Number will be found riveted to the housing base.

On the Type S-1 or S-5 Explosion- or Vapor-Proof Housing . . .

The Serial Number will be located at a point 90° from the conduit opening, or 90° from the nameplate.

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November 1977

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BULLETIN: 42-608.8
EFFECTIVE: January 1978
SUPERSEDES: November 1976

GENERAL INSTRUCTIONS FOR TYPE "S-1" and TYPE "DPS-1" SWITCH MECHANISMS

DESCRIPTION

TYPE S-1 SWITCH MECHANISM
The type S-1 switch mechanism is standard in most Magnetrol® level controls and flow switches. It is completely self contained with numbered terminal strip and removable mercury switch. SPDT and SPST mercury switches are available for up to 13 AMP service. See bulletin 42-110 for further details and rating information.

TYPE DPS-1 SWITCH MECHANISM
The type DPS-1 mechanism uses two mercury switches, actuated by the same magnet, to obtain double pole operation. DPDT and DPST switches are available and a high temperature porcelain terminal block is featured as standard. See bulletin 42-110 for complete specifications.

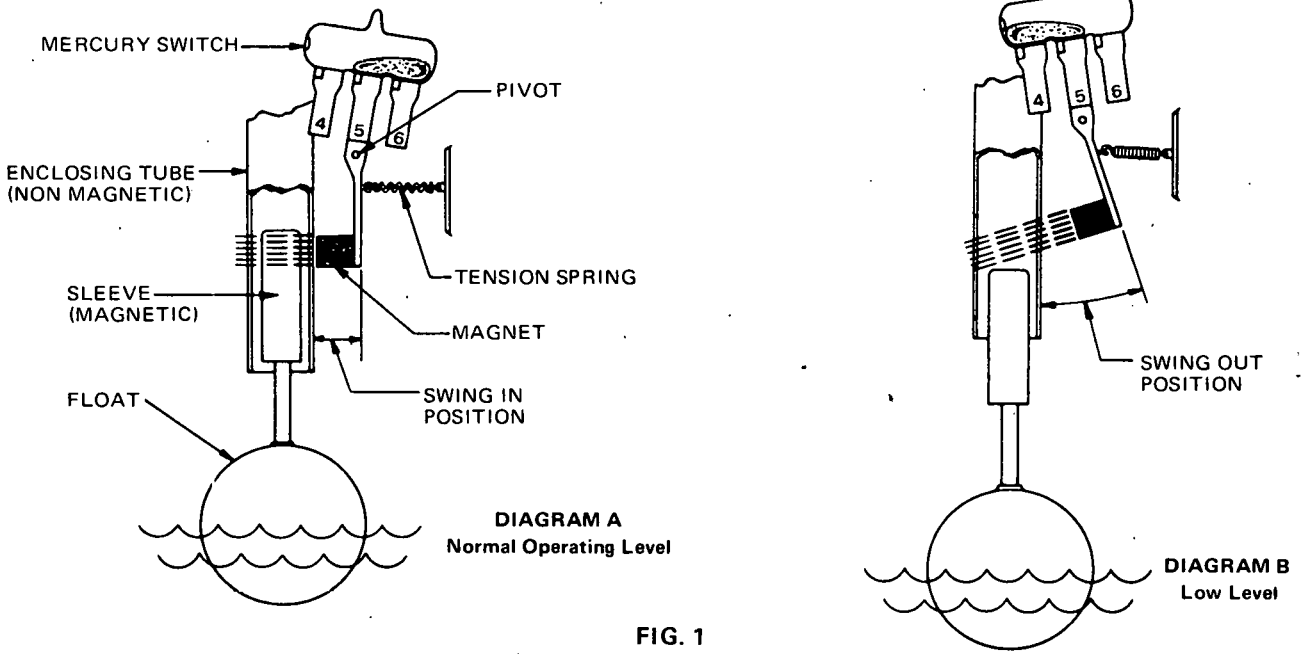

FIG. 1

OPERATING PRINCIPLE

Diagrams A and B illustrate the simple and foolproof Magnetrol operating principle. Switching action is obtained through the use of a magnetic sleeve actuated by a float (or flow sensing device) and a switching mechanism. These two basic component assemblies are separated by a non-magnetic, pressure tight enclosing tube. The mercury switch and magnet are assembled to a swinging arm which operates on precision stainless steel pivot sockets.

OPERATING CYCLE

At "Normal Operating Level" of liquid in a storage vessel (diagram "A"), the float moves the magnetic sleeve up within the field of a switch magnet, drawing it in tightly to the enclosing tube. This causes the mercury switch to tilt, "making" or "breaking" an electrical circuit. As liquid level recedes, the float pulls the magnetic sleeve downward until, at a pre-determined "Low Level", the switch magnet releases and swings outward away from the enclosing tube. This in turn tilts the mercury switch in an opposite direction, thus reversing the switch action.

When liquid level returns to normal, the float once again moves the magnetic sleeve up the enclosing tube, causing the mercury switch to assume its original position.

Switch mechanisms can be used singly or in multiples depending on operational requirements and switching action desired.

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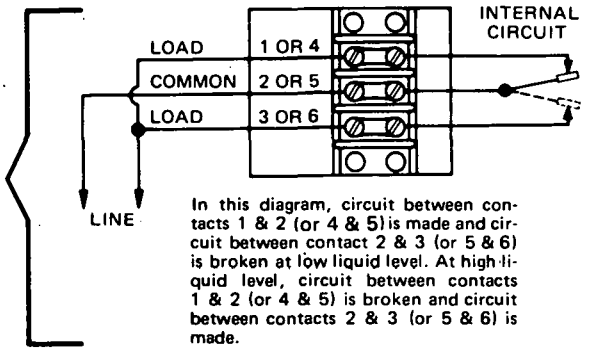
WIRING INSTRUCTIONS

S-1 SWITCH MECHANISMS

TERMINAL CONNECTIONS FOR SPDT SWITCHES

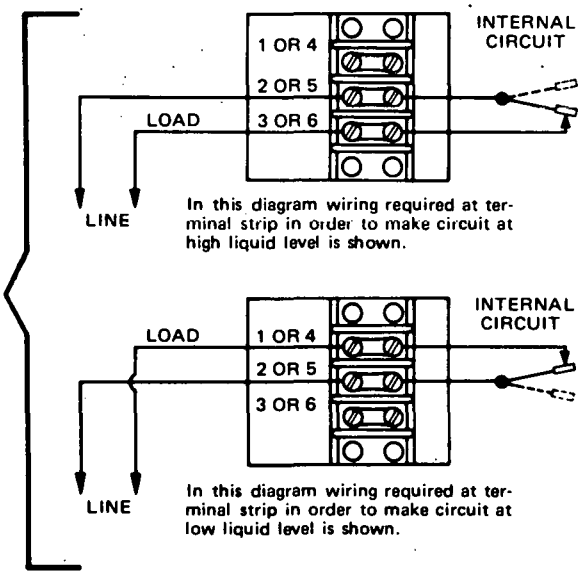
An SPDT (single pole, double throw) switch handles two electrical circuits. Tilting the switch "makes" one circuit and simultaneously "breaks" the second circuit.



In this diagram, circuit between contacts 1 & 2 (or 4 & 5) is made and circuit between contact 2 & 3 (or 5 & 6) is broken at low liquid level. At high liquid level, circuit between contacts 1 & 2 (or 4 & 5) is broken and circuit between contacts 2 & 3 (or 5 & 6) is made.

TERMINAL CONNECTIONS FOR SPST SWITCHES

An SPST (single pole, single throw) switch involves one electrical circuit only. Tilting the switch in one direction will "make" the circuit. Tilting in opposite direction "breaks" the circuit.

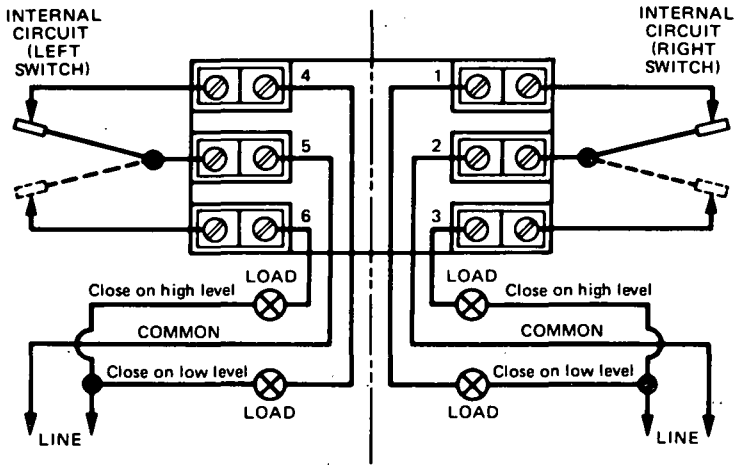


In this diagram wiring required at terminal strip in order to make circuit at high liquid level is shown.

In this diagram wiring required at terminal strip in order to make circuit at low liquid level is shown.

FIG. 2

DPS-1 SWITCH MECHANISMS



NOTES: – Double pole action is obtained by simultaneous operation of the right and left side single pole switches.

– Above switching actions apply to S.P.D.T. switches. When S.P.S.T. switches are furnished, disregard the unused terminals.

– Wiring diagram is reversed (close on high becomes close on low, etc.) when this switch mechanism is used on side-mounted float-in-tank switches employing a reversing pivot.

FIG. 3

REMOVING THE SWITCH MECHANISM

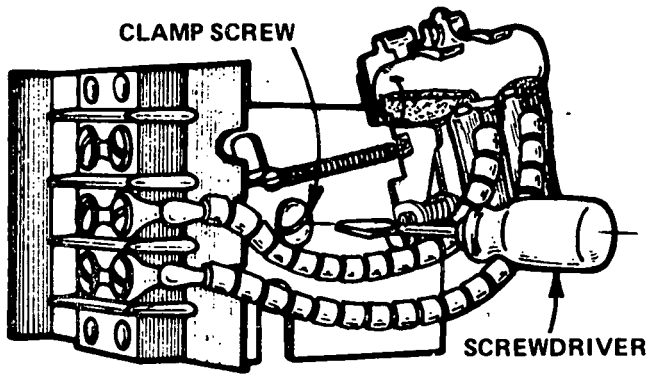


FIG. 4

All type S-1 and DPS-1 switch mechanisms can be easily removed from a Magnetrol control without disturbing piping connections or the rest of the control. Switch mechanisms are secured in the controls by means of a split clamp screw.

CAUTION: Before attempting to remove a switch mechanism, be certain to pull disconnect switch or otherwise assure that electrical circuit through control is de-energized.

1. Disconnect wiring from supply side of terminal block on switch mechanism(s). Note and record lead wire terminal locations.

NOTE: Measure location of switch mechanism(s) on enclosing tube and record for reference use during reassembly. Measure from top of enclosing tube to top of split mounting clamp on switch mechanism.

2. Loosen screw in split mounting clamp until mechanism slides freely on enclosing tube.
3. Remove small round head screw securing lower switch mechanism to baffle plate.
4. Carefully lift off switch mechanism(s) and place on clean surface, free of metal particles which may be attracted to switch magnet(s).
5. Replace switch mechanism(s) in reverse of steps 1 thru 4 above. Be certain, in the case of S-1 mechanisms, that assemblies are stacked in proper order on controls with multiple mechanisms.
   - "B" mechanism must be replaced first and attached to baffle plate, then followed by an "A" mechanism.
   - On controls with three or more mechanisms, an "A" mechanism must be positioned between two "B" mechanisms.

NOTE: All S-1 mechanisms have "A" or "B" identification markings placed next to terminal blocks.

REPLACING THE MERCURY SWITCH

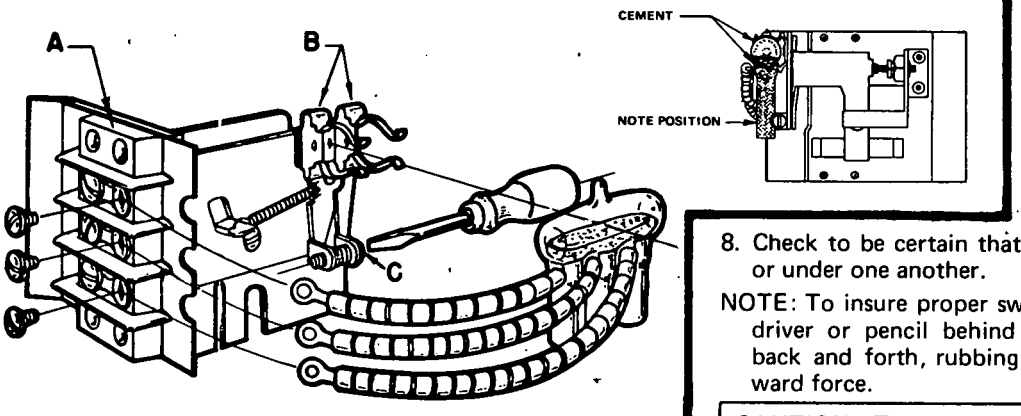


FIG. 5

Mercury switches used in Magnetrol S-1 and DPS-1 switch mechanisms are easily removed and replaced when damaged or broken.

1. Disconnect Magnetrol control from power supply.
2. Disconnect switch leads from terminal block "A", noting terminal post numbers marked on switch mechanism.

NOTE: Before removing existing mercury switch, loosen cement holding switch by gentle prying between switch clips and glass tube.

3. Remove mercury switch from clips "B".
4. Replace new mercury switch into clips "B" making certain that switch legs are positioned close to tilt adjustment screw "C" in a vertical plane (see inset illustration) to help prevent fouling of leads.
5. Glue switch to clips "B" using a cement such as DuPont Duco, Goodyear Pliobond, Shellac, or equivalent.
6. Connect switch leads to terminal block "A" on identical post positions as those in the original assembly.

NOTE: Replacement mercury switch will be tagged with terminal numbers matching post numbers on switch mechanism.

7. Switch lead projecting from the "leg" between switch clips "B" always connects to the center terminal screw; the shorter length lead will connect to the top terminal and a longer lead to the bottom terminal.
8. Check to be certain that switch leads do NOT cross over or under one another.

NOTE: To insure proper switch lead drape, insert a screwdriver or pencil behind switch leads and swing switch back and forth, rubbing porcelain beads with light outward force.

CAUTION: The glass tube on a replacement mercury switch may vary in size and shape from the original switch. This variation may, in some cases, affect the switch's ability to "make" or "break" a circuit (tilt of switch).

9. Check switch tilt carefully and adjust as follows:
   A. With mercury switch properly mounted and connected, turn adjusting screw "C" counter-clockwise four complete turns.
   B. Hold magnet firmly against enclosing tube and turn adjusting screw "C" clockwise until mercury in glass tube just "makes" or breaks" a circuit.
   C. When this occurs, give adjusting screw "C" two more full turns clockwise to provide "over-travel".

NOTE: A properly adjusted mercury switch will have equal over-travel tilt in both directions after switch actuation.

10. DPS-1 mechanisms have "left hand" and "right hand" switches (as viewed facing terminal block of mechanism). Follow all steps for switch replacement and adjustment described above except that each switch will have its own adjustment screw.
11. Re-connect power supply and test switch action by varying liquid level in the vessel or by "blowing down" float chamber.

REPLACEMENT PARTS

PART NUMBERS FOR TYPE S-1 SWITCH MECHANISMS (W/MERCURY SWITCH)

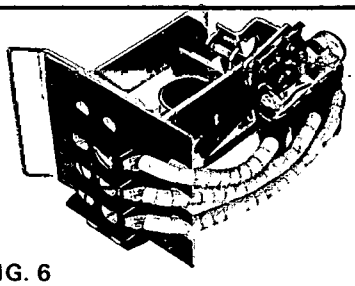


FIG. 6

DESCRIPTION	MAXIMUM LIQUID TEMPERATURE – 750°F.			
	RED DOT MAGNET		YELLOW DOT MAGNET	
	"A" mechanism	"B" mechanism	"A" mechanism	"B" mechanism
SPST, make on low level ①	89-7401-003	89-7401-006	89-7401-009	89-7401-012
SPST, make on high level ①				
SPDT				
Baffle Plate Assembly	36-5303-001 (RP-1011)			

PART NUMBERS FOR TYPE DPS-1 SWITCH MECHANISMS (W/MERCURY SWITCH)

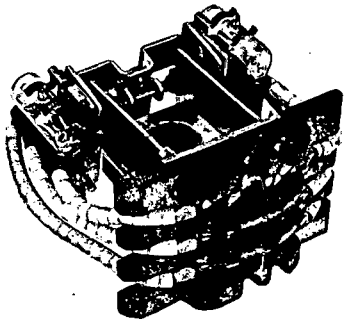
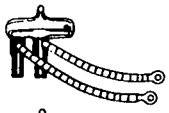
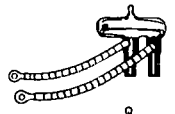
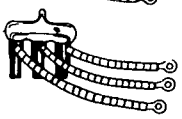
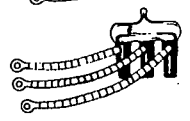


FIG. 7

DESCRIPTION	MAXIMUM LIQUID TEMPERATURE		
	450°F		750°F
	Red Dot Magnet	Yellow Dot Magnet	Yellow Dot Magnet
DPST, make on low level ①	89-7401-018	89-7401-021	89-7401-055
DPST, make on high level ①			
DPST, 1 SPST, make on low 1 SPST, make on high			
DPDT			
Baffle Plate Assembly	36-5305-001 (RP-6206)		

CAUTION: **When ordering replacement switch mechanisms, be certain to determine color dot on magnet. NEVER replace a mechanism having a red dot magnet with one having a yellow dot magnet, and vice versa.**

PART NUMBERS FOR MERCURY SWITCHES ONLY

LEFT HAND ②	L.H. switches for DPS-1 mech. only	PART NO. 450°F	PART NO. 750°F	PART NO. 450°F	PART NO. 750°F	R.H. switches for S-1 and DPS-1 mech.	RIGHT HAND ②
	SPST Make on low level ①	89-7101-034 (RP-6380-2)	89-7101-014 (RP-6380-3)	89-7101-012 (RP-1015-2)	89-7101-013 (RP-1015-3)	SPST Make on low level ①	
	SPST Make on high level ①					SPST Make on high level ①	
	SPDT					SPDT	

NOTE:
1. For direct acting float switches only. Actuation is reversed on side mounting controls, such as Model TF-63 or TF-62.
2. "LEFT HAND" or "RIGHT HAND" switch determined by viewing switch mechanism facing terminal block.

IMPORTANT:
When ordering, please specify:
1. Model and Serial number of control.
2. Name and Number of part.

MAGNETROL
INTERNATIONAL, INCORPORATED

Printed in U.S.A.

INSTALLATION AND MAINTENANCE INSTRUCTIONS

2-WAY INTERNAL PILOT OPERATED SOLENOID VALVES DIAPHRAGM TYPE - 3/8, 1/2, and 3/4 N.P.T. NORMALLY OPEN AND NORMALLY CLOSED

BULLETIN
8210 8211
ASCO®
Form No. V-5427

DESCRIPTION

Bulletin 8210 valves are 2-way internal pilot operated solenoid valves (diaphragm type). Standard valves have a General Purpose, Nema Type 1 Solenoid Enclosure.

Bulletin 8211's are the same as Bulletin 8210's except the solenoids are equipped with an enclosure which is designed to meet Nema Type 4-Watertight, Nema Type 7 (C or D) Hazardous Locations – Class I Group C or D, and Nema Type 9 (E, F or G) Hazardous Locations – Class II Group E, F or G are shown on separate sheets of Installation and Maintenance Instructions Form Nos. V-5380, V-5391 and V-5414.

MANUAL OPERATOR (OPTIONAL)

Valves with suffix "MO" in catalog number are provided with a manual operator which allows manual operation when desired, or during an interruption of electrical power.

OPERATION

Normally Closed: Valve is closed when the solenoid is de-energized and open when solenoid is energized.

Normally Open: Valve is open when the solenoid is de-energized and closed when solenoid is energized.

NOTE: Some Bulletin 8210 valves require a minimum operating pressure differential while others (hung diaphragm type) require no minimum operating pressure differential.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage and service.

POSITIONING

Valve may be mounted in any position.

PIPING

Connect piping to valve according to markings on valve body. Apply pipe compound sparingly to male pipe threads only; if applied to valve threads, it may enter valve and cause operational difficulty. Pipe strain should be avoided by proper support and alignment of piping. When tightening pipe, do not use valve as a lever.

IMPORTANT: For protection of the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Periodic cleaning is required depending on the service conditions. See Bulletin 8600, 8601 and 8602 for strainers.

WIRING

Wiring must comply with Local and National Electrical Codes. For valves equipped with an explosion-proof, watertight solenoid enclosure, the electrical fittings must be approved for use in the approved hazardous locations. Housings for all solenoids are made with connections for ½ inch conduit. The general purpose enclosure may be rotated to facilitate wiring by removing the retaining cap.

NOTE: Alternating Current (A-C) and Direct Current (D-C) solenoids are built differently. To convert from one to the other, it is necessary to change the complete solenoid including the core assembly.

SOLENOID TEMPERATURE

Standard catalog valves are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched with the bare hand for only an instant. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

MAINTENANCE

WARNING: Turn off electrical power and line pressure to valve before making repairs. It is not necessary to remove valve from pipe line for repairs.

CLEANING

A periodic cleaning of all solenoid valves is desirable. The time between cleanings will vary, depending on the media and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation or excessive leakage will indicate that cleaning is required.

IMPROPER OPERATION

1. Faulty Control Circuit: Check the electrical system by energizing the solenoid. A metallic click signifies solenoid is operating. Absence of the click indicates loss of power supply. Check for loose or blown-out fuses, open-circuited or grounded coil, broken lead wires or splice.
2. Burned-Out Coil: Check for open-circuited coil. Replace coil, if necessary.
3. Low Voltage: Check voltage across the coil leads. Voltage must be at least 85% of nameplate rating.
4. Incorrect Pressure: Check valve pressure. Pressure to valve must be within range specified on nameplate.
5. Excessive Leakage: Disassemble valve and clean all parts. Replace parts that are worn or damaged with a complete "Spare Parts Kit" for best results.

COIL REPLACEMENT

Turn off electrical power supply, disconnect coil lead wires and proceed as follows:

Coil Replacement For Figures 1, 4 and 5

1. Remove retaining cap, (and spacer on Normally Open Constr.) nameplate and cover.
2. Slip yoke containing coil, sleeves and insulating washers off the solenoid base sub-assembly. Insulating washers are omitted when molded coil is used. In some D-C Constructions, a single flux plate over the coil replaces yoke, sleeves and insulating washers.
3. Reassemble in reverse order of disassembly.

Coil Replacement For Figures 2, 3 and 6

1. Remove retaining cap, nameplate and housing.
2. Remove wave spring washer and insulating washers. Insulating washers are omitted when molded coil is used.
3. Reassemble in reverse order of disassembly.

VALVE DISASSEMBLY AND REASSEMBLY

(REFER TO EXPLODED VIEWS)
Depressurize valve and turn off electrical power supply.

1. Remove retaining cap and slip entire solenoid off solenoid base sub-assembly.
2. Remove solenoid base sub-assembly (and plugnut/adapter assembly) Normally Open Constr.) unscrew bonnet.
3. All internal parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete "Spare Parts Kit" for best results.
4. Reassemble in reverse order of disassembly paying careful attention to exploded views provided.

SPARE PARTS KITS

Spare Parts Kits and Coils are available for ASCO valves. Parts marked with an asterisk (*) are supplied in Spare Parts Kits.

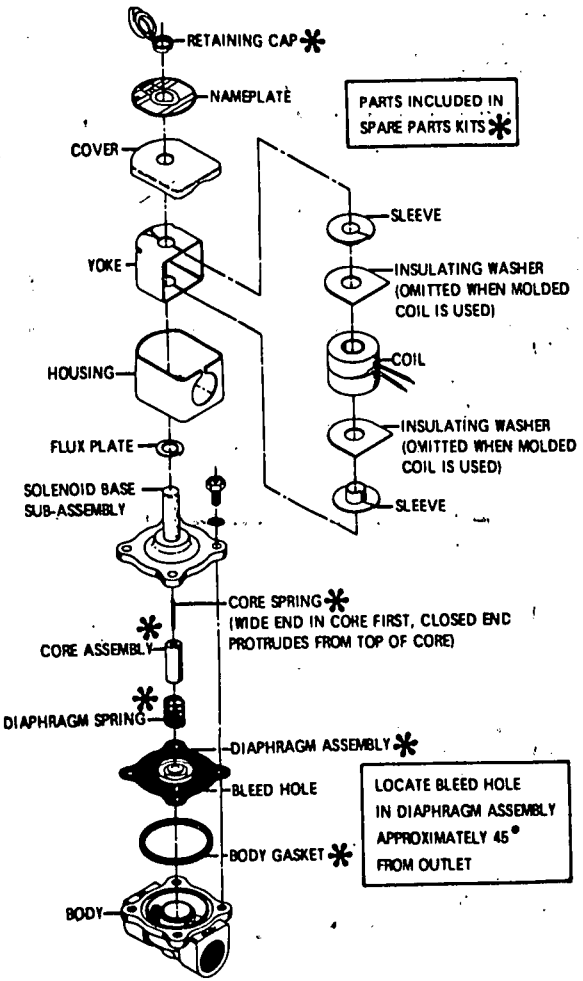
ORDERING INFORMATION FOR SPARE PARTS KITS

When Ordering Spare Parts Kits or Coils Specify Valve Catalog Number, Serial Number and Voltage.

FORM NO. V-5427 PRINTED IN USA 1970

ASCO Valves
Automatic Switch Co. FLORHAM PARK, NEW JERSEY 07932

ASCO®
ASCO Valves
Automatic Switch Co. FLORHAM PARK, NEW JERSEY 07932 FORM NO. V-5427 PRINTED IN USA 1970



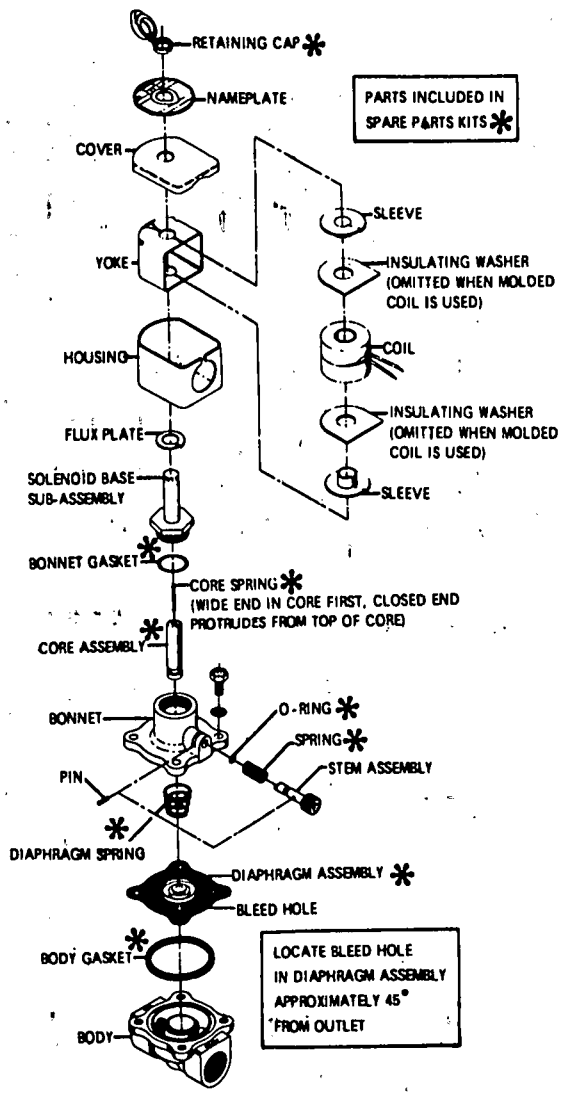


Figure 1. Normally Closed, A-C Construction, 3/8, 1/2, and 3/4 N.P.T. (General Purpose Solenoid Enclosure shown. For Explosion-Proof, Watertight Enclosure, see Form No. V-5391)

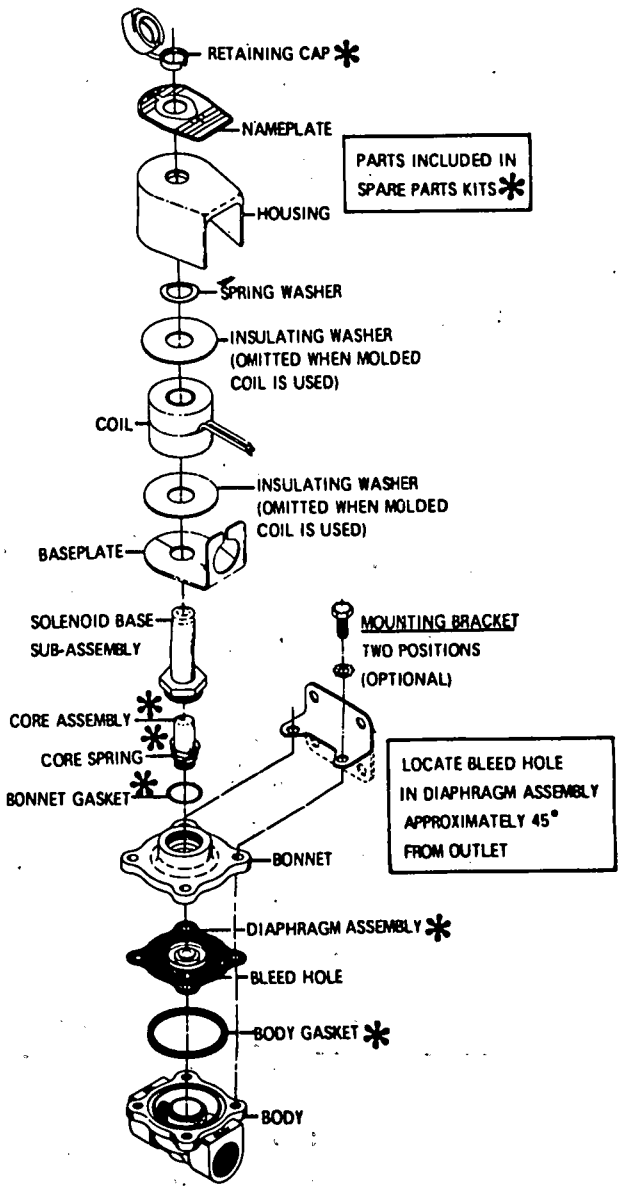


Figure 2. Normally Closed, A-C and D-C Construction, 3/8, 1/2 and 3/4 N.P.T. For Manual Operator, refer to Fig. 1. (General Purpose Solenoid Enclosure shown. For Explosion-Proof, Watertight Enclosure, see Form No. V-5380)

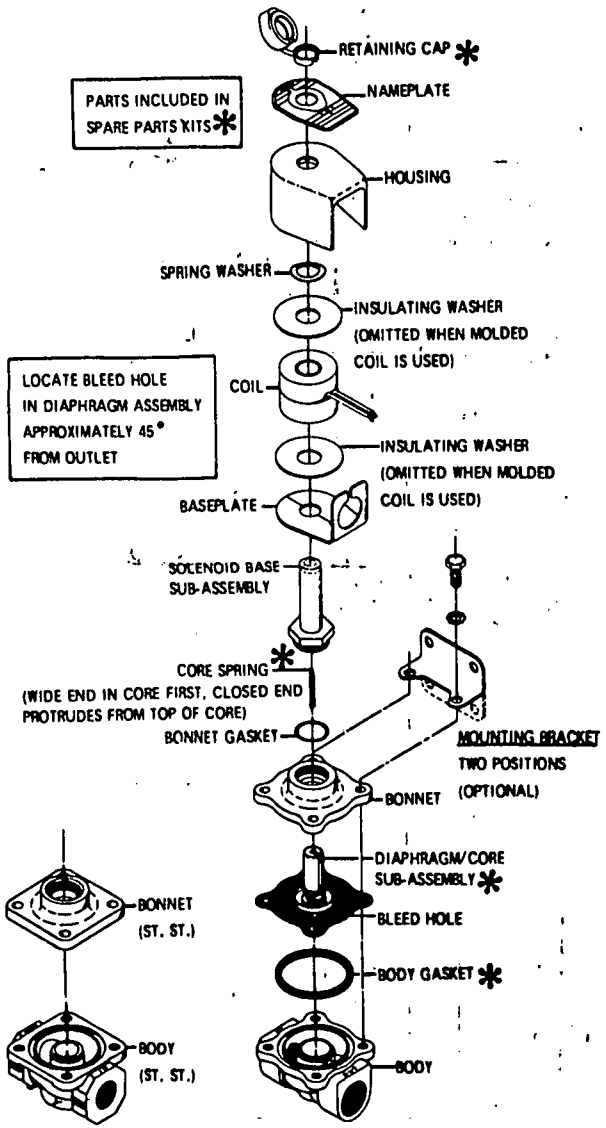


Figure 3. Normally Closed, (Hung Diaphragm) A-C and D-C Construction 3/8, 1/2 and 3/4 N.P.T. For Manual Operator, refer to Fig. 1. For St. St. Fig. 7. (General Purpose Solenoid Enclosure shown. For Explosion-Proof, Watertight Enclosure, see Form No. V-5380)

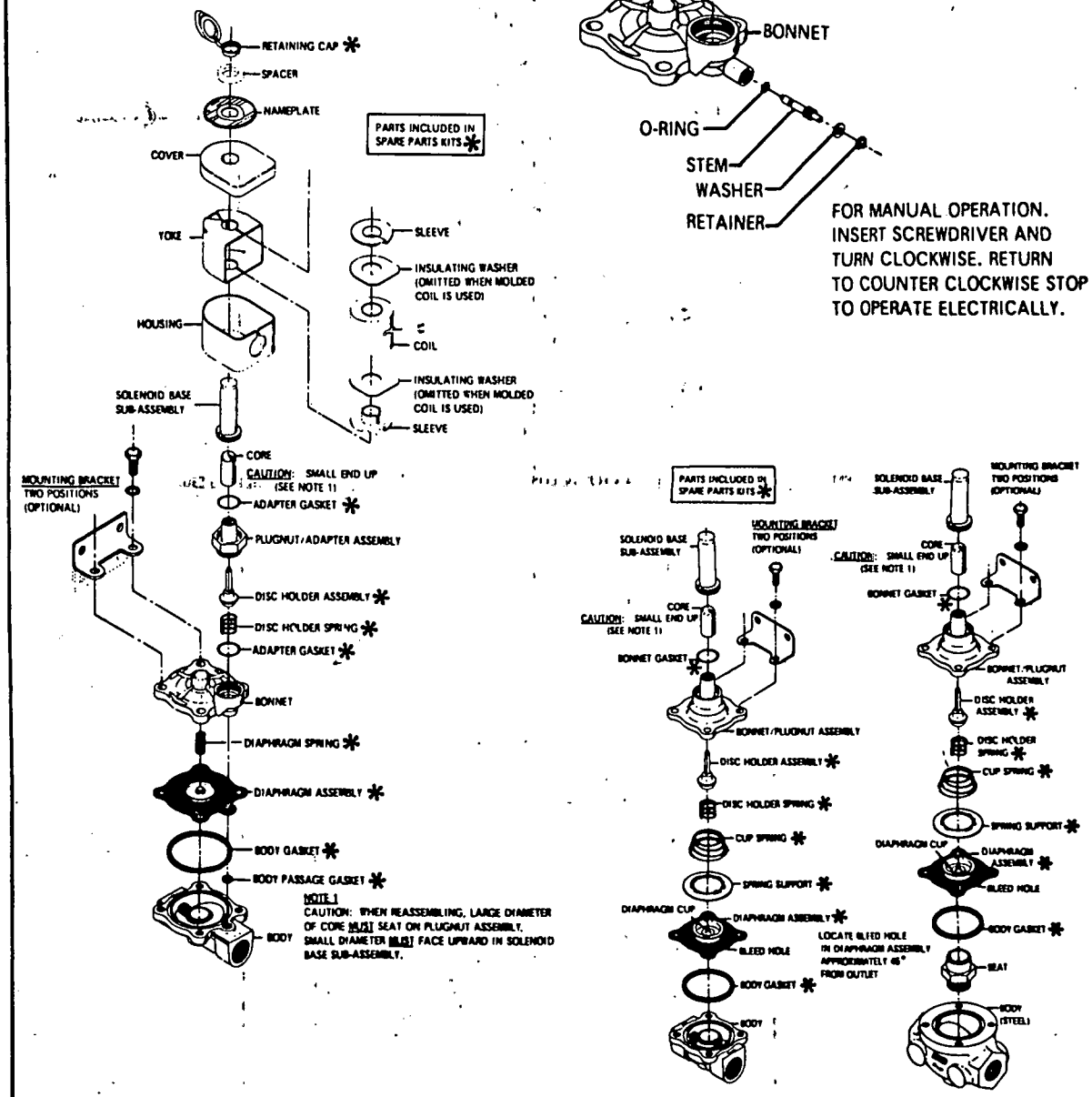


Figure 4. Normally Open, A-C and D-C Construction, 3/8, 1/2 and 3/4 N.P.T. (General Purpose Solenoid Enclosure shown. For Explosion-Proof, Watertight Enclosure, see Form No. V-5414)

ASCO Valves
Automatic Switch Co. FLORHAM PARK, NEW JERSEY 07932 FORM NO. V5427 PRINTED IN U.S.A. 1970

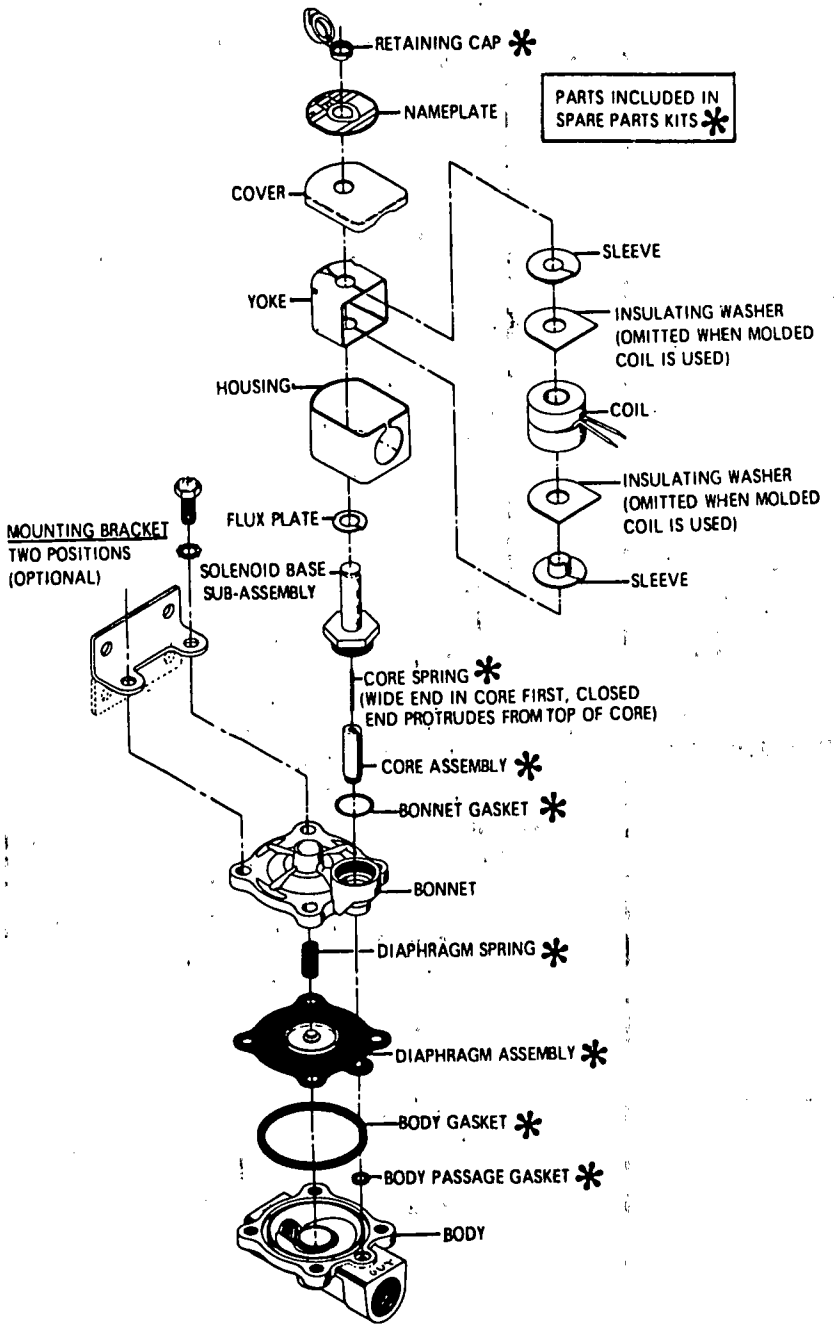


Figure 5. Normally Closed, A-C Construction, 3/4 N.P.T. For Manual Operator, refer to Fig. 7 (General Purpose Solenoid Enclosure shown. For Explosion-Proof, Watertight Enclosure, see Form No. V-5391)

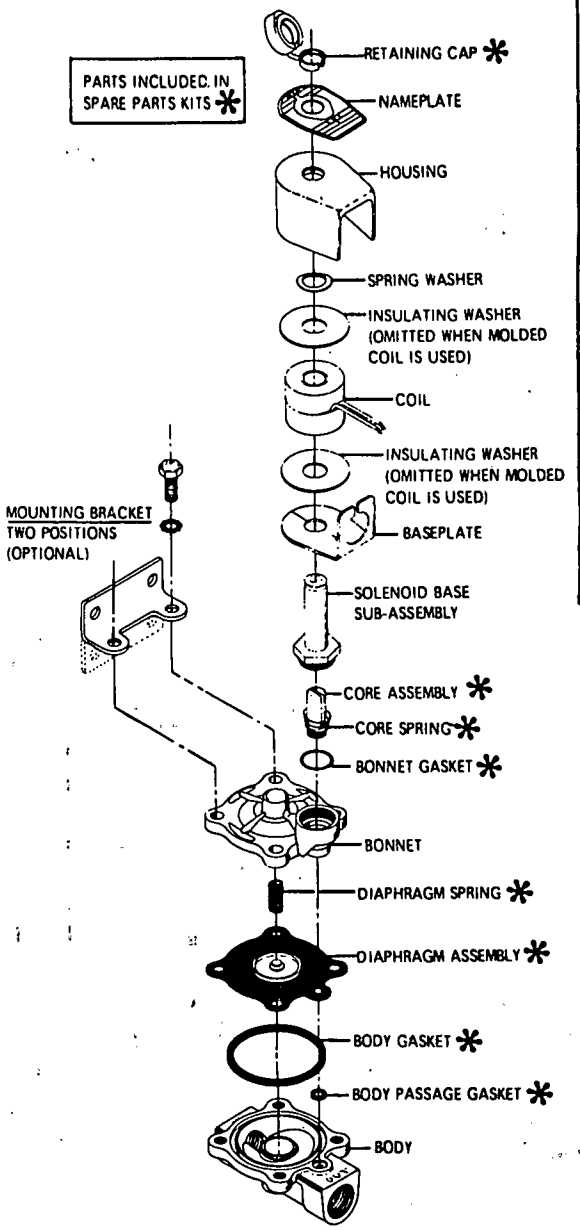


Figure 6. Normally Closed, D-C Construction, 3/4 N.P.T. For Manual Operator, refer to Fig. 7. (General Purpose Solenoid Enclosure shown. For Explosion-Proof, Watertight Enclosure, see Form No. V-5380).

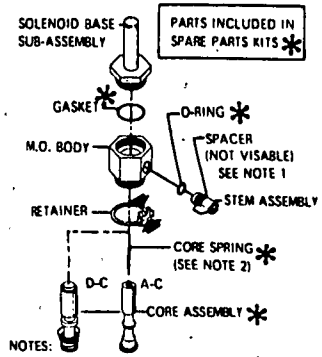
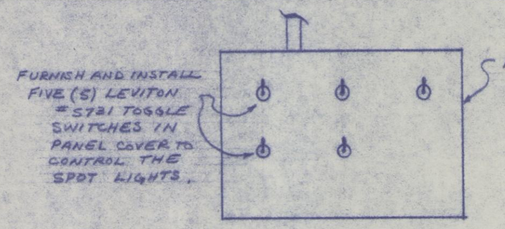


Figure 7 Manual Operator

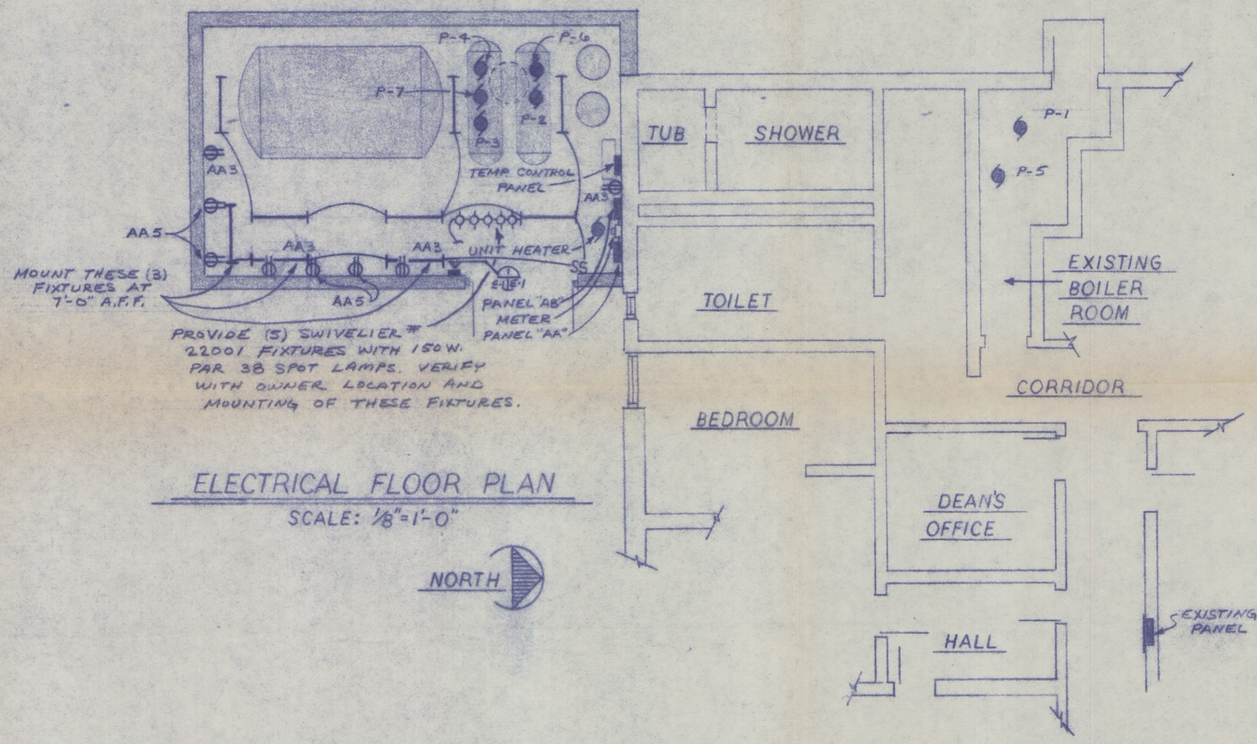
APPENDIX F

AS BUILT DRAWINGS

AS BUILT
DRAWINGS

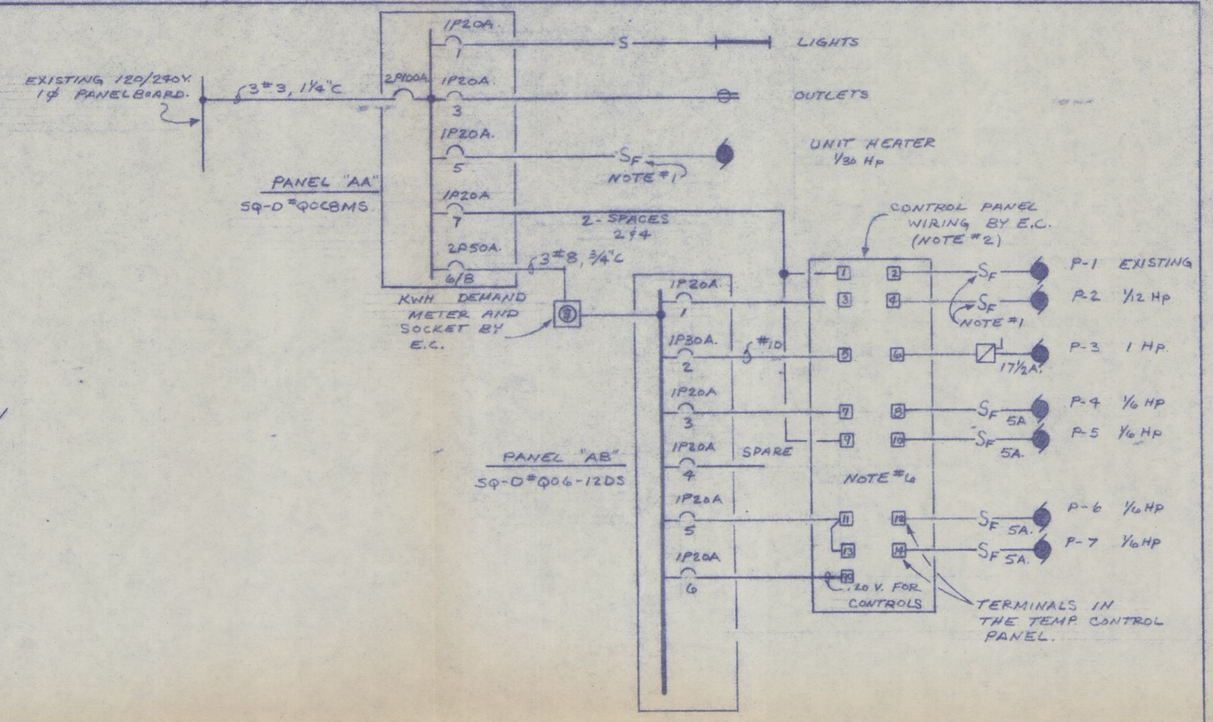


DETAIL 1 E-1 | E-1



ELECTRICAL FLOOR PLAN

SCALE: 1/8"=1'-0"



ONE-LINE DIAGRAM 120/240 V. 1Ø 3W

NOTES:

1. FUSIBLE SWITCHES NOT LABELED WITH FUSE SIZE SHALL BE FUSED TO 125% OR LESS NAMEPLATE RATING OF MOTOR.
2. SEE SHEET # 5 FOR CONTROL PANEL WIRING.
3. ALL WIRING TO BE #12 UNLESS NOTED OTHERWISE.
4. MOUNT CONTROL PANEL, POWER PANELS, & METER ON ½" X 4'X6' PLYWOOD. PAINT PLYWOOD GRAY.
5. ALL WIRING TO BE IN CONDUIT.
6. CONTROL WIRING TO BE #14.

ELECTRICAL SPECIFICATIONS

1. ALL MATERIALS SHALL BE NEW AND CONFORM WITH THE STANDARDS OF UNDERWRITERS LABORATORIES.
2. THE INSTALLATION SHALL COMPLY WITH ALL LAWS IN EFFECT, APPLYING TO ELECTRICAL INSTALLATIONS AND WITH THE N.E.C., OSHA AND ALL LOCAL CODES.
3. ALL WORK SHALL BE DONE BY LICENSED ELECTRICIANS.
4. THE ELECTRICIAN SHALL OBTAIN ALL PERMITS AND PAY ALL NECESSARY FEES.
5. ALL WIRING SHALL BE #12 AWG MINIMUM, TYPE THW OR THWN. FOR RUNS OVER 100 FEET, USE #10 AWG IN LIEU OF #12.
6. RIGID GALVANIZED CONDUIT SHALL BE USED UNDER FLOOR, IN POURED CONCRETE, AND WHERE SUBJECT TO MECHANICAL DAMAGE.
7. PROVIDE TYPEWRITTEN DIRECTORIES FOR ALL PANELS. ALL PANELS AND OTHER ELECTRICAL EQUIPMENT SHALL BE LABELED, INCLUDING VOLTAGE, WITH BLACK LAMACOID PLASTIC.
8. THE ELECTRICAL CONTRACTOR SHALL LEAVE THE ENTIRE ELECTRICAL SYSTEM IN PROPER WORKING ORDER. HE SHALL ALSO EXTEND TO THE OWNER ANY GUARANTEE EXTENDED BY THE MANUFACTURER OF EQUIPMENT AND DEVICES INSTALLED AND FURNISHED BY HIM. THE GUARANTEE PERIOD SHALL BE EXTENDED AS OF THE DATE OF SUBSTANTIAL COMPLETION OF HIS WORK.
9. TERMINATE ALL CONDUIT RUNS TO VIBRATING EQUIPMENT (I.E., PUMPS, ETC.) VIA A LENGTH OF LIQUID TIGHT FLEXIBLE METAL CONDUIT.
10. ALL MOTOR FRAMES TO BE GROUNDED.

SYMBOL LEGEND

SYMBOL	DESCRIPTION	MANUFACTURER & CAT. NO.	REMARKS
S	SINGLE POLE SWITCH	LEVITON #1221-B W/S.S.P.	MT. AT 48" A.F.F.
S_F	FUSED SWITCH	BUSSMANN #SSU	MT. NEAR UNIT
	FUSIBLE DISCONNECT	SQ-D #D111N	MT. NEAR UNIT
	DUPLEX RECEPTACLE	LEVITON #5262-B W/S.S.P.	MT. AT 48" A.F.F.
	4'-0" FLUORESCENT FIXTURE	MILLER #1C-2111-04	CHAIN HANG AT 12'-0" A.F.F.
	SINGLE PHASE MOTOR		

AS BUILT DRWG. 4-18-78

REVISED: 12-5-77

ELECTRICAL PLAN FOR A SOLAR SYSTEM

MADISON HALL — JORDAN COLLEGE

CEDAR SPRINGS MICHIGAN

FAIRBROTHER & GUNTHER, INC.
THE ENVIRONMENTAL ENGINEERS
325 FULLER N.E. GRAND RAPIDS, MICHIGAN 49503

DR.	D.B.B.
APPR.	D.B.B.
DATE	9-20-77
ENG. No.	7678

SHEET No. E-1 1 OF 1

128'-6"

EXISTING VENT. THRU ROOF

EXISTING BOILER & H.W. HEATER FLUE

ANCHORS

RETURN

SUPPLY

2 1/2" ℄ 2 1/2" ℄ 2" ℄ 2" ℄ 2" PITCH 1/8" FT. ℄ 2" ℄ 2" ℄ 1 1/2" ℄ 1 1/4"

2 1/2" ℄ 2 1/2" ℄ 2" ℄ 2" ℄ 2" PITCH 1/8" FT. ℄ 2" ℄ 1 1/2" ℄ 1 1/4"

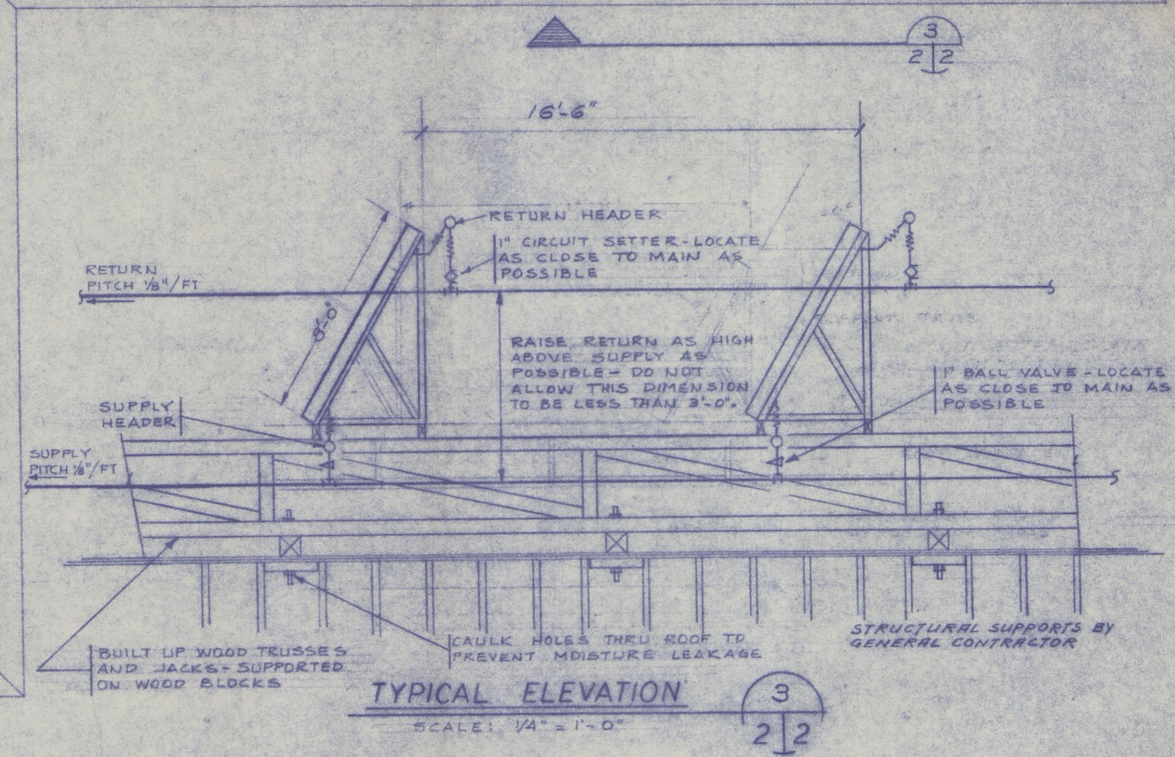
45'-0"

NEW SOLAR EQUIPMENT RM. MATCH EXISTING ROOF LINE

2'-8"

4'-6" 4'-0" 16'-6"

8 ROWS - 13 COLLECTORS EACH



TYPICAL ELEVATION 3/2 2

SCALE: 1/4" = 1'-0"

ROOF PLAN

SCALE: 1/8" = 1'-0"

NORTH

AS BUILT DRWG. 4-18-78

SOLAR SYSTEM - MADISON HALL

JORDAN COLLEGE

CEDAR SPRINGS MICHIGAN

FAIRBROTHER & GUNTHER, INC.

THE ENVIRONMENTAL ENGINEERS

325 FULLER N.E. GRAND RAPIDS, MICHIGAN 49503

DR.

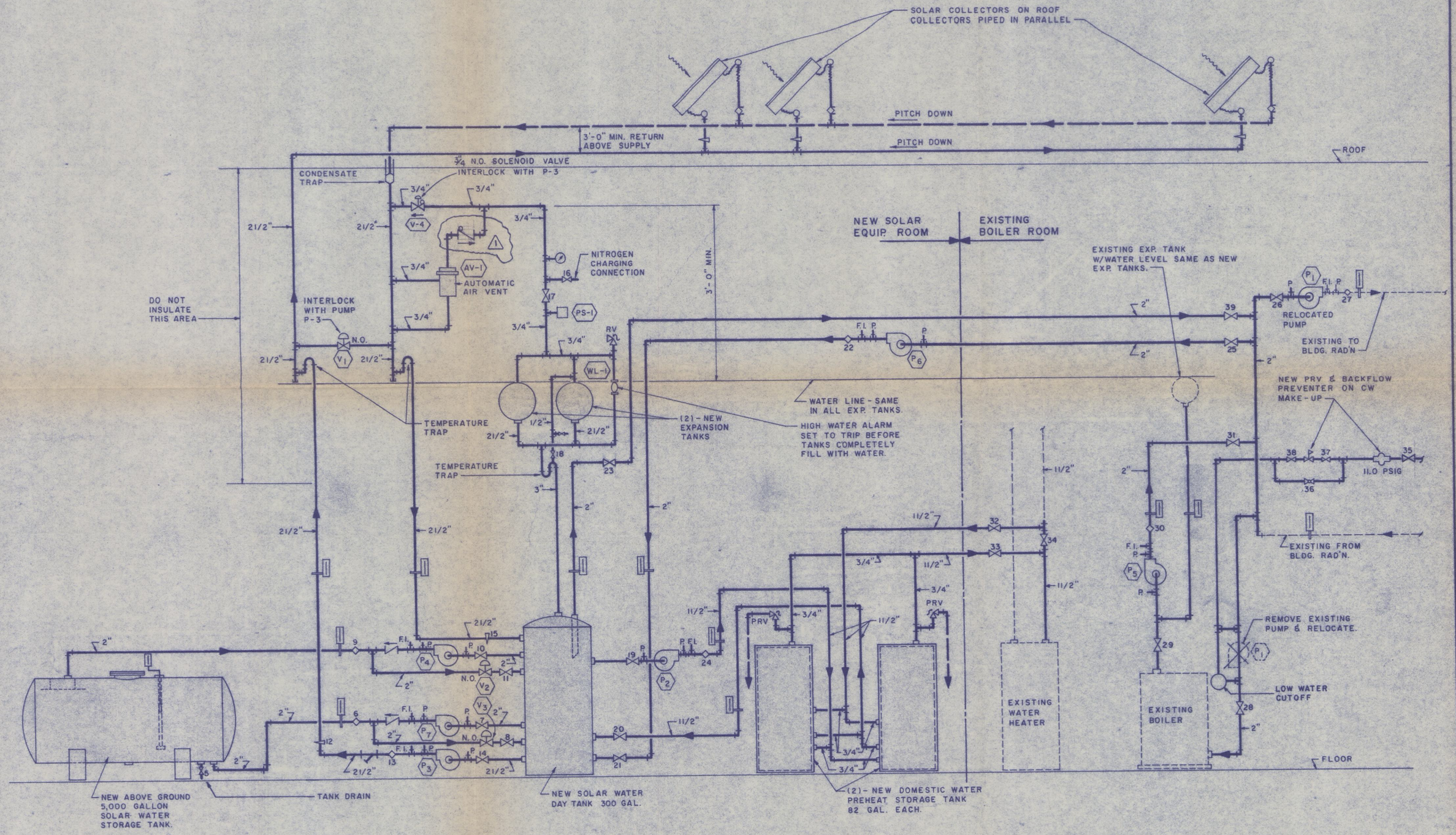
APPR. K.E.G

DATE 8-12-77

ENG. No. 7678

SHEET No. 2

2 OF 7



SCHEMATIC PIPING DIAGRAM

NOT TO SCALE

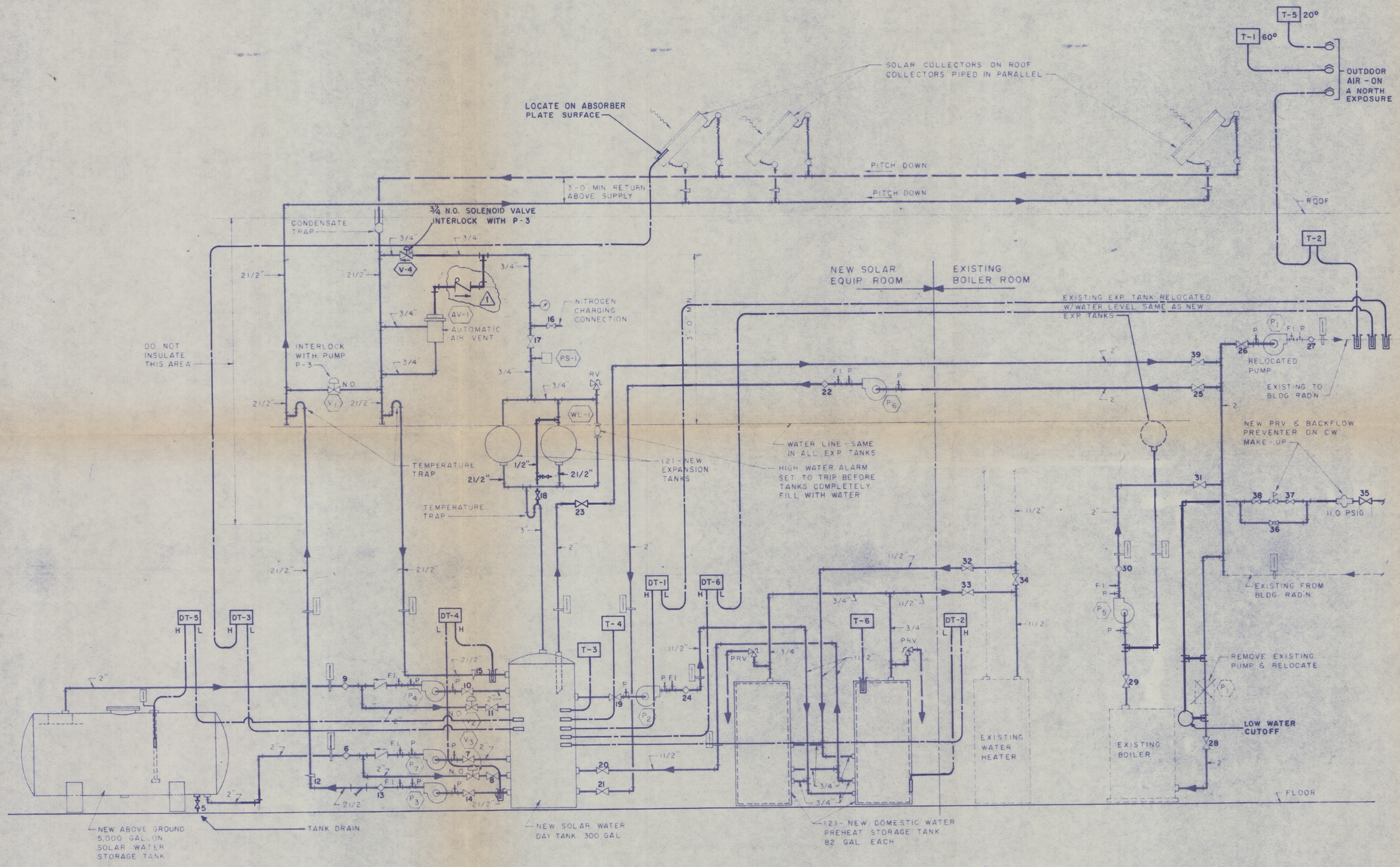
AS BUILT DRWG. 4-18-78
⚠1 REVISED 1-26-79

SOLAR SYSTEM MADISON HALL
JORDAN COLLEGE
CEDAR SPRINGS MICHIGAN

FAIRBROTHER & GUNTHER, INC.
THE ENVIRONMENTAL ENGINEERS
325 FULLER N.E. GRAND RAPIDS, MICHIGAN 49503

DR.
APPR.
DATE 5/12/77
ENG. No. 7678

SHEET No. 3
3 OF 7



SCHEMATIC CONTROL DIAGRAM

NOT TO SCALE

1 AS BUILT DRWG. 4-18-78
REVISED 1-26-79

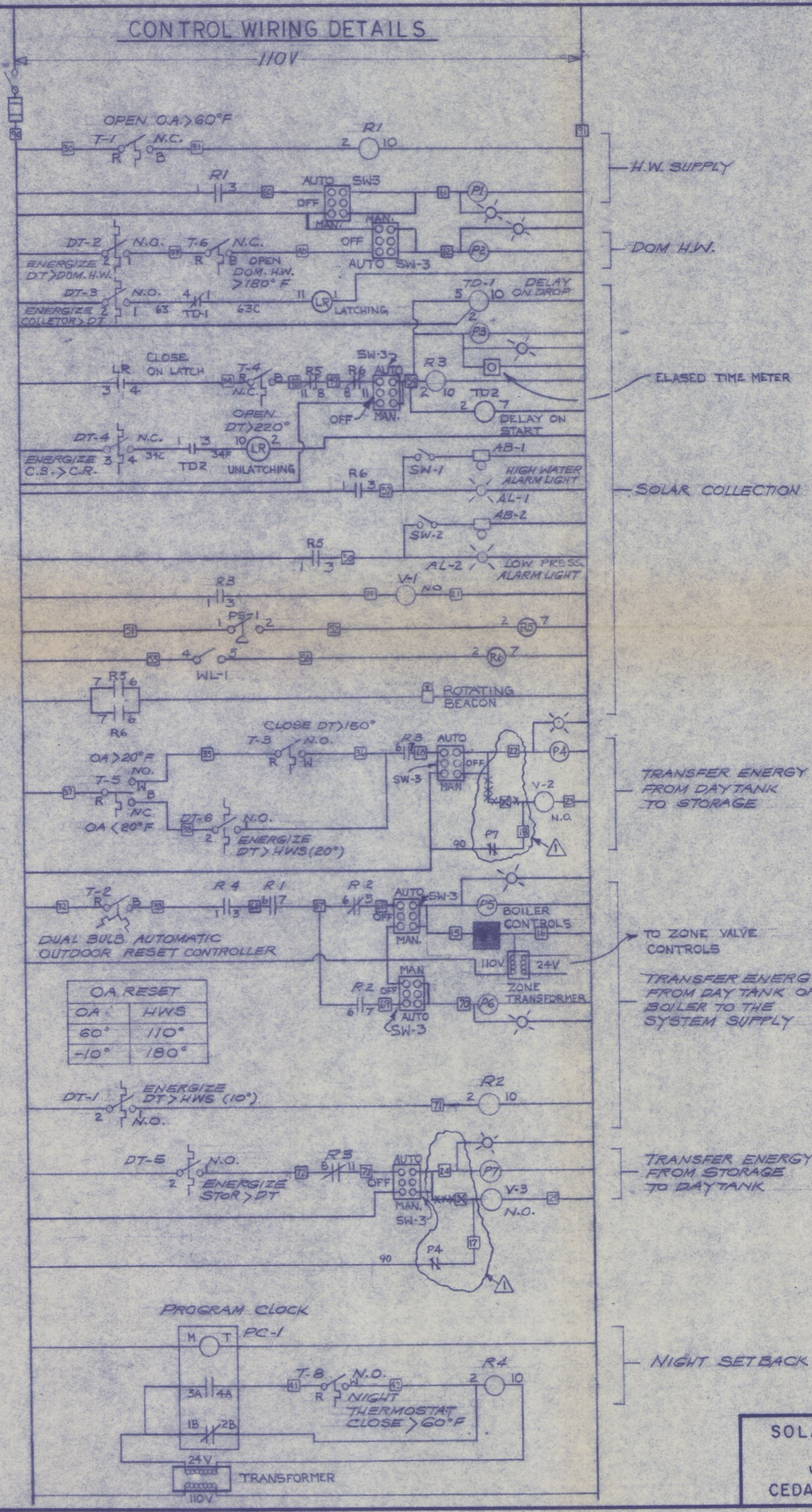
SOLAR SYSTEM MADISON HALL
JORDAN COLLEGE
CEDAR SPRINGS MICHIGAN

FAIRBROTHER & GUNTHER, INC.
THE ENVIRONMENTAL ENGINEERS
325 FULLER N.E. GRAND RAPIDS, MICHIGAN 49503

DR.
APPR.
DATE 8/12/77
ENG No. 7678

SHEET No. 4
4 OF 7

CONTROL WIRING DETAILS



OA RESET	
OA	HWS
60°	110°
-10°	180°

CONTROL LOGIC

HOT WATER SUPPLY

WHEN THE OUTDOOR AIR TEMPERATURE IS ABOVE 60°F, OUTDOOR THERMOSTAT T-1 DE-ENERGIZES PUMPS P-1, P-5, P-6. WHEN THE OUTDOOR AIR TEMPERATURE IS BELOW 60°F, T-1 ENERGIZES PUMP P-1 AND T-2 CYCLES P-5 OR P-6.

TRANSFER ENERGY FROM DAY TANK OR BOILER TO THE HOT WATER SYSTEM SUPPLY

DUAL BULB CONTROLLER T-2 RESET FROM THE OUTDOOR AIR TEMPERATURE MAINTAINS THE SCHEDULED HOT WATER SUPPLY TEMPERATURE. DIFFERENTIAL CONTROLLER DT-1 ALLOWS T-2 TO CYCLE P-5 AND THE BOILER BURNERS WHEN THE DAY TANK TEMPERATURE IS LESS THAN THE HOT WATER SUPPLY TEMPERATURE. DT-1 ALLOWS T-2 TO CYCLE P-6 WHEN THE DAY TANK TEMPERATURE IS GREATER THAN THE HOT WATER SUPPLY TEMPERATURE.

SOLAR COLLECTION

DIFFERENTIAL CONTROLLER DT-3 CLOSES VALVE V-1, AND ENERGIZES PUMP P-3 WHEN THE SOLAR COLLECTOR TEMPERATURE EXCEEDS THE DAY TANK TEMPERATURE BY 20°F. TIME DELAY RELAY TD-1 IS ENERGIZED TO PREVENT SHORT CYCLING.

DIFFERENTIAL CONTROLLER DT-4 OPENS V-1 AND DE-ENERGIZES P-3 WHEN THE TEMPERATURE DIFFERENCE BETWEEN THE SOLAR HEATED WATER SUPPLIED TO THE DAY TANK AND THE RETURN WATER FROM THE DAY TANK TO THE COLLECTORS IS NEGLIGABLE. HIGH LIMIT THERMOSTAT T-4 DE-ENERGIZES THE COLLECTOR SYSTEMS WHEN THE DAY TANK EXCEEDS 220°F. HIGH WATER LEVEL SENSOR WL-1 DE-ENERGIZES THE COLLECTOR SYSTEM AND SOUNDS AN ALARM WHEN THE WATER LEVEL IN THE EXPANSION TANKS COVERS THE AIR OPENINGS. LOW PRESSURE SENSOR PS-1 DE-ENERGIZES THE COLLECTOR SYSTEM AND SOUNDS AN ALARM WHEN THE SYSTEM PRESSURE IS TOO LOW.

TRANSFER ENERGY FROM DAY TANK TO STORAGE

WHEN THE DAY TANK TEMPERATURE EXCEEDS THE HOT WATER SUPPLY TEMPERATURE BY 20°, DURING SOLAR COLLECTION, DIFFERENTIAL CONTROLLER DT-6 ENERGIZES PUMP P-4 TO TRANSFER ENERGY FROM THE DAY TANK TO THE STORAGE TANK. WHEN THE OUTDOOR AIR TEMPERATURE IS ABOVE 20°F, THERMOSTAT T-5 OVERRIDES DT-6 TO LET T-3 CYCLE P-4 TO MAINTAIN THE DAY TANK AT 150°.

TRANSFER ENERGY FROM STORAGE TANK TO DAY TANK

WHEN THE STORAGE TANK IS ABOVE THE DAY TANK TEMPERATURE, AND THE SOLAR COLLECTION SYSTEM IS DE-ENERGIZED, DIFFERENTIAL CONTROLLER DT-5 ENERGIZES P-7 TO TRANSFER ENERGY FROM THE STORAGE TANK TO THE DAY TANK.

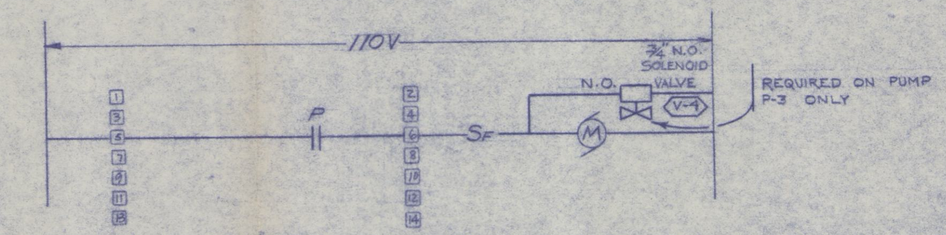
DOMESTIC HOT WATER

WHEN THE DAY TANK TEMPERATURE EXCEEDS THE DOMESTIC WATER PREHEAT STORAGE TANK TEMPERATURE, CONTROLLER DT-2 ENERGIZES PUMP P-2. HIGH LIMIT THERMOSTAT T-6 DE-ENERGIZES P-2 WHEN THE DOMESTIC HOT WATER PREHEAT TANKS EXCEED 180°F.

NIGHT SETBACK

PROGRAM CLOCK PC-1 ENERGIZES THE NIGHT THERMOSTAT T-8 ACCORDING TO A PRESET PROGRAM. T-8 OVERRIDES THE DUAL BULB AUTOMATIC OUTDOOR RESET CONTROLLER T-2 TO MAINTAIN THE DESIRED NIGHT SETBACK TEMPERATURE.

TYPICAL PUMP WIRING DETAIL



□-CONTROL PANEL TERMINAL

AS BUILT DRWG. 4-18-78
⚠1-REVISED 1-22-79

SOLAR SYSTEM MADISON HALL
JORDAN COLLEGE
CEDAR SPRINGS MICHIGAN

FAIRBROTHER & GUNTHER, INC.
THE ENVIRONMENTAL ENGINEERS
325 FULLER N.E. GRAND RAPIDS, MICHIGAN 49503

DR.	
APPR.	
DATE	8/12/77
ENG. No.	7678

SHEET No. 5
5 OF 7

TEMPERATURE CONTROL BILL OF MATERIAL

ITEM	QTY.	MFGR.	MODEL	DESCRIPTION	CONTROL OPERATION
T-1	1	HONEYWELL	T675A1565 (N.C.)	OUTDOOR AIR - REMOTE BULB TEMP. CONTROL, SPDT 20 FT. CAPILLARY LENGTH - 0 - 100° RANGE	SET DIFFERENTIAL AT 3°F SET TO OPEN AT 60°F OUTDOOR AIR TEMP.
T-2	1	HONEYWELL	T678B1006	DUAL BULB AUTOMATIC OUTDOOR RESET CONTROLLER 2 SPDT, CAPILLARY - 10 FT/30 FT.	RESET RATIO - 1.0 TO 1.0 - OA 60°, -10° HWS 110° 180°
T-3	1	HONEYWELL	T675A1540 (N.O.)	DAY TANK - 150° LIMIT CONTROL - SPDT 5 FT. CAPILLARY LENGTH, 55 - 175° RANGE	SET DIFFERENTIAL AT MIN. SET TO CLOSE AT 150° DAY TANK TEMP.
T-4	1	HONEYWELL	T675A1532 (N.C.)	DAY TANK - 220° HIGH LIMIT CONTROL - SPDT 5 FT. CAPILLARY LENGTH, 160 - 260° RANGE	SET DIFFERENTIAL AT MIN. SET TO OPEN AT 220° DAY TANK TEMP.
T-5	1	HONEYWELL	T675A1565 (N.O.)	OUTDOOR AIR - REMOTE BULB TEMP. CONTROL - SPDT 20 FT. CAPILLARY - 0 - 100° RANGE	SET DIFFERENTIAL AT 3°F SET TO CLOSE AT 20°F OUTDOOR AIR TEMP.
T-6	1	HONEYWELL	T675A1532 (N.C.)	DOM. H.W. - 180° HIGH LIMIT CONTROL - SPDT 5 FT. CAPILLARY LENGTH, 160° - 260° RANGE	SET DIFFERENTIAL AT MIN. SET TO OPEN AT 180°SUPPLY MAIN TEMP.
T-8	1	HONEYWELL	T42A1003	NIGHT THERMOSTAT - LINE VOLTAGE - 1 STAGE HEATING	SET TO CLOSE AT 60° SPACE TEMP.
	3 4	HONEYWELL HONEYWELL	34886A 112630AA	OUTDOOR BULB SHIELD 3/4" NPT IMMERSION WELL	
DT-1	1	HONEYWELL	R7412 A 1004 (N.O.)	DIFFERENTIAL CONTROLLER - DAY TANK/HWS	ON TD = 10°F (6810 OHMS RESISTOR) OFF TD = 2°F (10,500 OHMS RESISTOR)
DT-2	1	HONEYWELL	R7412 A 1004 (N.O.)	DIFFERENTIAL CONTROLLER - DAY TANK/DOM. H.W.	ON TD = 10°F (4750 OHMS RESISTOR) OFF TD = 3°F (9760 OHMS RESISTOR)
DT-3	1	HONEYWELL	R7412 A 1004 (N.O.)	DIFFERENTIAL CONTROLLER - COLLECTOR/DAY TANK	ON TD = 20°F (4220 OHMS RESISTOR) OFF TD = 2°F (10,500 OHMS RESISTOR)
DT-4	1	HONEYWELL	R7412 A 1004 (N.O.)	DIFFERENTIAL CONTROLLER - COLLECTOR SUPPLY/RETURN COLLECTOR	ON TD = 5°F (8250 OHMS RESISTOR) OFF TD = 2°F (10,500 OHMS RESISTOR)
DT-5	1	HONEYWELL	R7412 A 1004 (N.O.)	DIFFERENTIAL CONTROLLER - STORAGE/DAY TANK	ON TD = 5°F (8250 OHMS RESISTOR) OFF TD = 2°F (10,500 OHMS RESISTOR)
DT-6	1	HONEYWELL	R7412 A 1004 (N.O.)	DIFFERENTIAL CONTROLLER - DAY TANK/H.W.S.	ON TD = 20°F (4220 OHMS RESISTOR) OFF TD = 4°F (9310 OHMS RESISTOR)
	12	HONEYWELL	C773A 1006	BULB TYPE TEMPERATURE SENSOR	WELL OR SURFACE MOUNTING
	10	HONEYWELL	121371M	IMMERSION WELL 3/4" NPT	
TD-1	1	DIVERSIFIED ELECTRONICS	TDD-120-AKA-900	TIME DELAY RELAY, DELAY ON DROP OUT	120V, 1-15MIN., 10 AMP
TD-2	1		TDC-120-AKA-900	TIME DELAY RELAY, DELAY ON OPERATE	
	1	DIVERSIFIED ELECTRONICS	RB 11	OCTAL STYLE SOCKET 11-PIN	
R-1, 2, 3, 4 5, 6	4	POTTER & BRUMFIELD	KAP14AG	RELAY, 3 PDT, 120V, 10 AMP.	NEWARK STOCK #24F2580
P-1, 2, 3, 4, 5, 6, 7	7	POTTER & BRUMFIELD	PRD11AGO	RELAY, DPDT, 120V, 30 AMP. 1 HP 120/240 V	NEWARK STOCK #33F1536
	4	POTTER & BRUMFIELD	27E123	OCTAL STYLE SOCKETS 11-PIN	NEWARK STOCK # 57 F 3432
SW-1,2	2	CUTLER-HAMMER	7580K4	SPST SWITCH (ON-OFF) 6 AMP. 120V	NEWARK STOCK #23F341
SW-3	7	CUTLER-HAMMER	7591K4	DPDT SWITCH (ON-OFF-ON) 6 AMP. 120V	NEWARK STOCK #23F349
PC-1	1	PARAGON	7008-20	7 DAY TIME CONTROL, 120V	
PS-1	1	MERCOID	AP-153 RANGE NO. R-37	PRESSURE SWITCH - SPDT	SET TO SWITCH AT MIN. TANK PRESSURE OF 9 PSIG
AB-1,2	2	MALLORY	SC110H	SONALERT SOLID STATE SIGNAL - 120V	NEWARK STOCK NO. 64F316
WL-1	1	MAGNETROL	249-C	LIQUID LEVEL CONTROL TYPE S-1 SPDT SWITCH CAST IRON BODY STAINLESS FLOAT	ONE CIRCUIT CLOSES AS OTHER CIRCUIT OPENS
AL-1,2	2	DIALIGHT	95-1308-09-341	INDICATOR LIGHT, SCREW TERM. 120V	NEWARK STOCK NO. 57F3727
	2	DIALIGHT	95-0931	RED LENS	NEWARK STOCK NO. 25F466
	2	CHICAGO MINIATURE LAMPS	NE 51 (BIA)	NEON LAMP	NEWARK STOCK NO. 27E256
LR	1	POTTER & BRUMFIELD	KBP11AG	DPDT LATCHING RELAY 120V, 10AMP	
V-1	1	HONEYWELL	V5011A 6444	2 1/2" N.O. SCREWED VALVE BODY	
V-2	1	HONEYWELL	V5011A 6436	2" N.O. SCREWED VALVE BODY	
V-3	1	HONEYWELL	V5011A 6436	2" N.O. SCREWED VALVE BODY	
	3	HONEYWELL	M845E 1007	TWO POSITION SPRING RETURN MOTOR	WITH TRANSFORMER
	3	HONEYWELL	Q618A 1032	VALVE LINKAGE	
V-4	1	ASCO	821D835	3/4" N.O. SOLENOID VALVE	INTERLOCK WITH PUMP P-3

AS BUILT DRWG. 4-18-78

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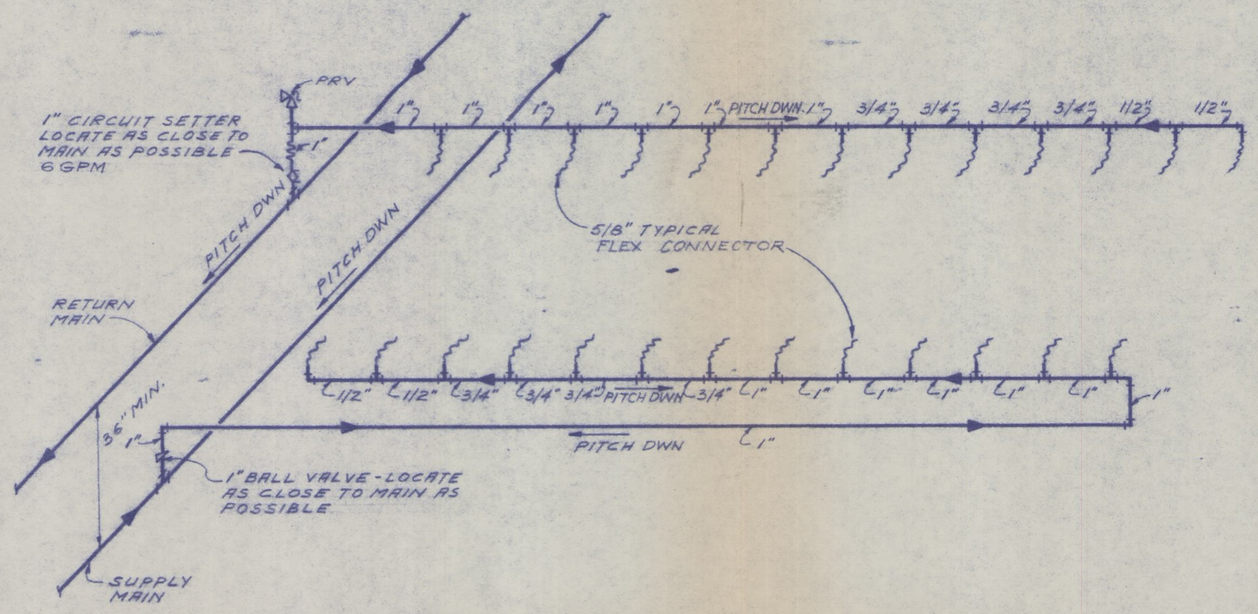
325 FULLER N.E.
GRAND RAPIDS, MICHIGAN 49503

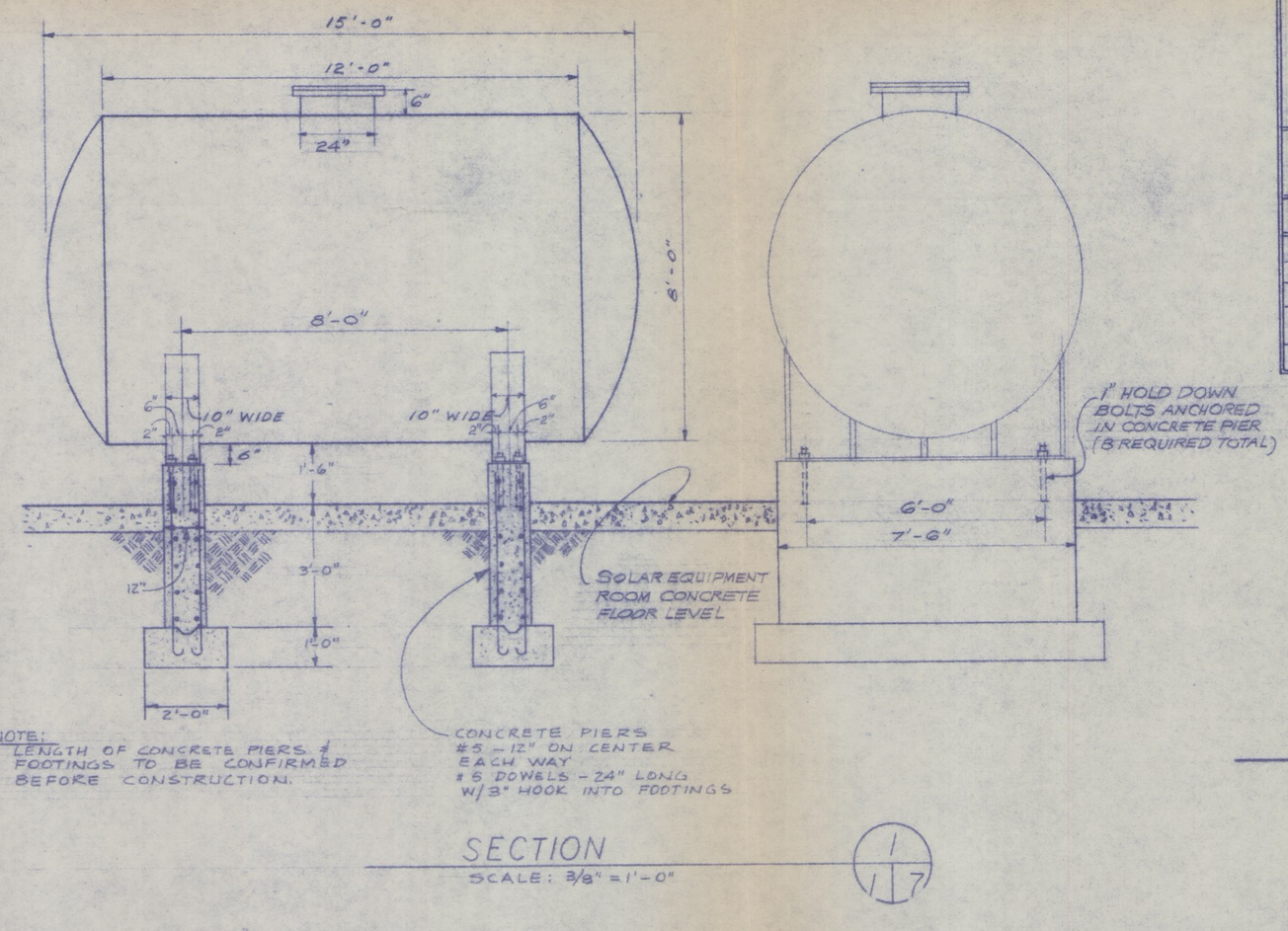
DR.
APPR.
DATE 8/2/77
ENG. No. 7673

SHEET No. 6
6 OF 7



HEADER PIPING DETAIL

NOT TO SCALE



NOTE:
LENGTH OF CONCRETE PIERS & FOOTINGS TO BE CONFIRMED BEFORE CONSTRUCTION.

SECTION

SCALE: 3/8" = 1'-0"

1/17

PUMP SCHEDULE

TAG NO.	GPM	HEAD FT.	MOTOR H.P.	MOTOR ELECT.	RPM	MODEL	TYPE	REMARKS
P-1	RELOCATED EXIST.							HOT WATER SYSTEM SUPPLY
P-2	12	7'	1/12	115	1750	B100 (1 1/2")	B & G	DOMESTIC HOT WATER PREHEAT CIRCUIT
P-3	48	32'	1	115/230	1750	SERIES 60	B & G	COLLECTOR CIRCUIT
P-4	40	8'	1/6	115	1750	2"	B & G	TRANSFER ENERGY FROM DAY TANK TO STORAGE
P-5	20	10'	1/6	115	1750	2"	B & G	BOILER SUPPLY CIRCUIT
P-6	20	10'	1/6	115	1750	2"	B & G	SOLAR SUPPLY CIRCUIT
P-7	40	8'	1/6	115	1750	2"	B & G	TRANSFER ENERGY FROM STORAGE TO DAY TANK

EQUIPMENT SCHEDULE

COLLECTORS

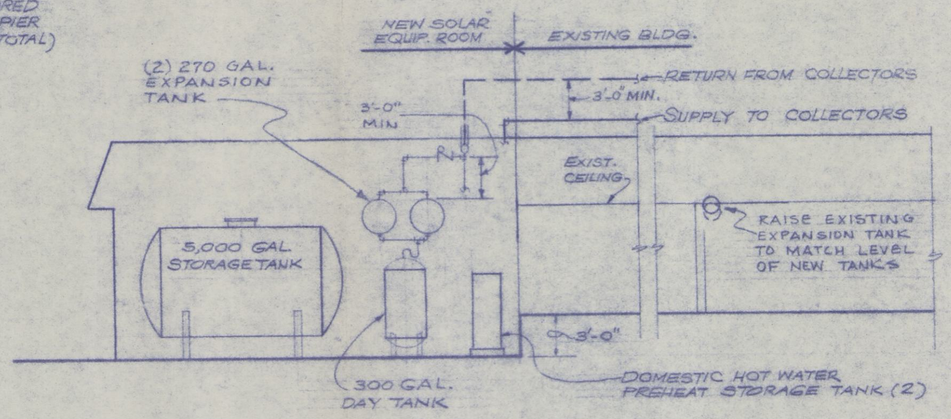
QTY.	TYPE	MODEL	SIZE	ABSORBER PLATE	GLAZING	INSULATION
104	PPG	B	31 1/2" x 95 1/2" x 1 1/4"	COPPER	DOUBLE	3" HIGH TEMP. FIBERGLASS

TANKS

SIZE	QTY	FUNCTION	DIMENSIONS	INSULATION & COVERING
5000 GAL.	1	STORAGE TANK - ASME	8' DIA x 15' LOA	3 1/2" FIBER GLASS & FABRIC
300 GAL.	1	DAY TANK - ASME	36" DIA x 7' LOA	1 1/2" FIBER, GLASS & FABRIC
270 GAL.	2	B & G ASME EXPANSION TANK	30" DIA x 8' LOA	NONE
80 GAL.	2	DOMESTIC HOT WATER PREHEAT	24" DIA x 70"	FACTORY INSTALLED

MISC. PIPING COMPONENTS

SYMBOL	QTY	DESCRIPTION	MISC.
AV-1	1	ARMSTRONG AIR VENT #2-AV	5/16" ORIFICE, 7 1/2 OZ. FLOAT, 3/4" CONN.
	8	B & G SERIES "CB"	CIRCUIT SETTERS
FI	7	ELLISON ANNUBAR TYPE 730	FLOW MEASURING STATION
	7	DEZURIK SERIES 100	COMBINATION BALANCING & SHUT OFF VALVES WITH BALANCE POINT MEMORY DEVICE
P	14	1/4" NEEDLE VALVE	



SECTION

2/17

AS BUILT DRWG. 4-18-78

SOLAR SYSTEM MADISON HALL
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CEDAR SPRINGS MICHIGAN

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SHEET No. 7
7 OF 7

5,000 GAL. ABOVE GROUND STORAGE TANK.

(2) - EXPANSION TANKS

(2) - NEW 80 GAL. DOMESTIC HOT WATER PREHEAT STORAGE TANK

WEEP HOLE

300 GAL. DAY TANK

EXISTING DOMESTIC WATER HEATER

EXIST'G BOILER

EXISTING EXPANSION TANK - RAISED TO MATCH LEVEL OF NEW TANKS

CONNECT TO HWS HEADER

TUB

SHOWERS

3/4"

EXISTING BOILER ROOM

STUDENT ROOMS

1/17

2/17

TOILET

CONCRETE SLAB - SLOPE TO DRAIN THROUGH WEEP HOLES

CORRIDOR

BEDROOM

UNIT HEATER

TRANE - MODEL S - UNIT SIZE 38-S
9.4 MBH, 1.95 GPM, 543 CFM
1650 RPM, 1/30 H.P., 180° EWT, 15° ΔT

DEAN'S OFFICE

THERMOSTAT

HONEYWELL T42A1003
1-STAGE HEATING THERMOSTAT,
SET - 60° F, MOUNT ON UNITHEATER

GUEST

STUDENT ROOMS

LIVING ROOM

HALL

GARAGE

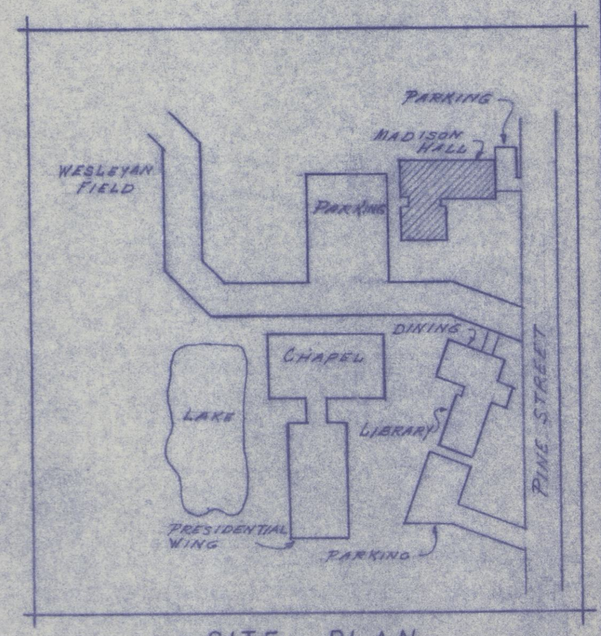
MEN

WOMEN

LINCOLN LOUNGE

FLOOR PLAN
SCALE 1/8" = 1'-0"

NORTH



SITE PLAN
NOT TO SCALE

NORTH

AS BUILT DRWG. 4-18-78

SOLAR SYSTEM - MADISON HALL JORDAN COLLEGE CEDAR SPRINGS MICHIGAN	FAIRBROTHER & GUNTHER, INC. THE ENVIRONMENTAL ENGINEERS 325 FULLER N.E. GRAND RAPIDS, MICHIGAN 49503	DR. APPR. R.F.G. DATE 8/12/77 ENG. No. 7678	SHEET No. 1 1 OF 7