DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-161830

SOLAR HEATING AND HOT WATER SYSTEM INSTALLED AT JAMES HURST ELEMENTARY SCHOOL, PORTSMOUTH, VIRGINIA

Prepared from documents furnished by.

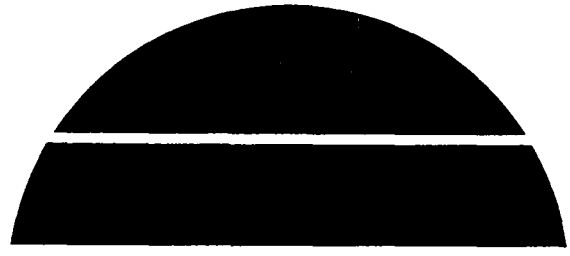
Portsmouth Public Schools
P. O. Box 998
Portsmouth, VA 23705

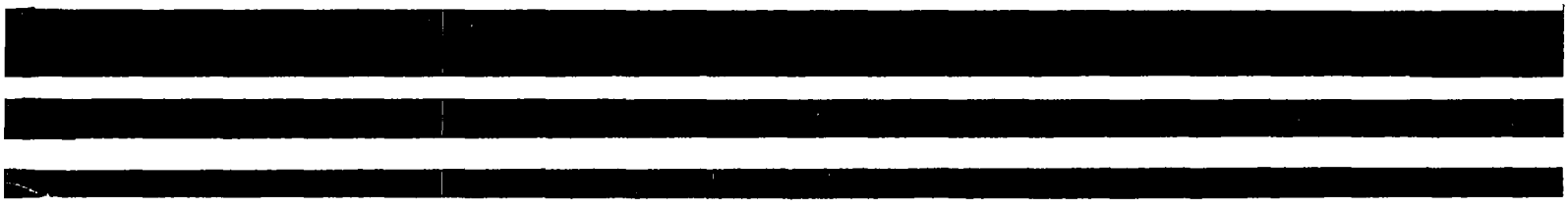
Under Contract DOE EM-78-F01-5205

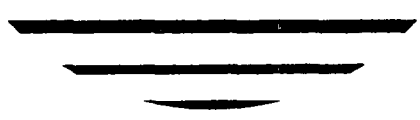
Monitored by:

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

For the U. S. Department of Energy







U.S. Department of Energy

Solar Energy

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SOLAR HEATING AND HOT WATER SYSTEM
JAMES HURST ELEMENTARY SCHOOL
SCHOOL BOARD, CITY OF PORTSMOUTH
PORTSMOUTH, VIRGINIA

ABSTRACT

Application	Space and water heating
System Type	Active
Collector Type	Flat plate liquid
Collector Manufacturer	InterTechnology/Solar Corp.
Collector Area	3,630 sq. ft. (gross)
Storage Capacity	6,000 gal.
Building Load	636.37 x 10^6 BTU/Yr.
BTU's Produced	367.48 x 10^6 BTU/Yr.
Building Owner	Portsmouth Public Schools
Architect	Williams and Tazewell & Assoc., Inc. (a) InterTechnology/Solar Corp. (Solar Consultants) (b) Vansant & Gusler (Consulting Engineers)
Contractor	Pittman Mechanical Contractors

INTRODUCTION

James Hurst is a 63,525 sq. ft. facility housing 842 kindergarten through fourth grade students. The lower floor was designed as an open configuration with six large teaching pods, administration, cafeteria and other support services; while the second floor has thirteen self-contained classrooms.

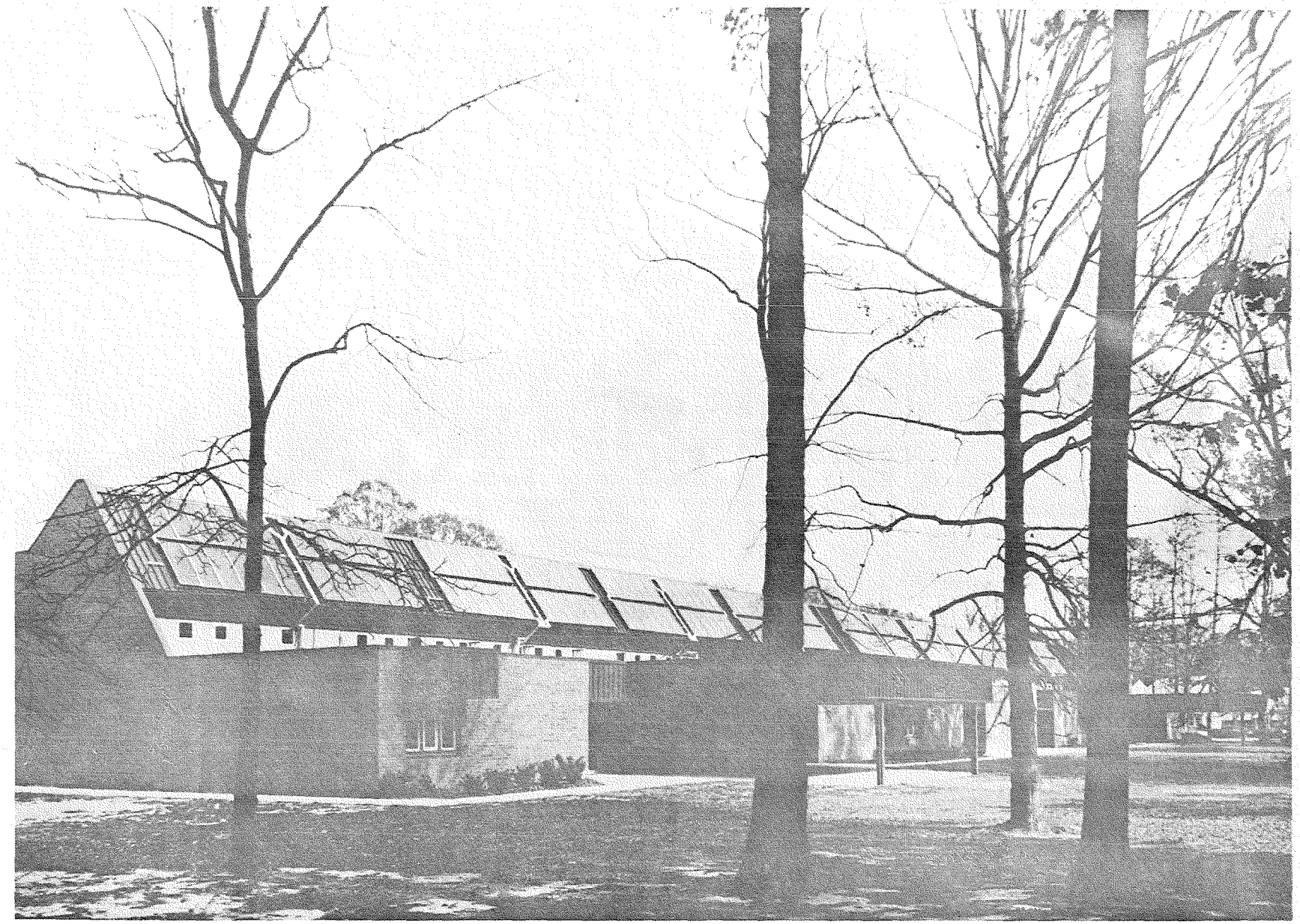
The building has a steel structure with concrete slab floors. The exterior walls are 6" metal studs with face brick or foam core, composite metal wall panels. The roof is steel deck with rigid insulation and built-up roofing membrane. The building construction complies with ASHRAE standard 90-75. The U_o value for walls is 0.143 Btu/hr-ft^2°F whereas the ASHRAE standard requires a maximum U_o of 0.30 Btu/hr-ft^2°F. The U_o value for the roof construction is 0.090 Btu/hr-ft^2°F whereas the ASHRAE standard requires a maximum U_o value of 0.096 Btu/hr-ft^2°F.

The building was originally designed in 1976 to accommodate solar collectors on a south facing portion of the roof sloped at 53°. The building was completed in 1978 and the solar collection system was installed in 1979. Figure 1 is a photograph from the southwest showing the collector array.

DESIGN PHILOSOPHY

The building is zoned into 4 heating/cooling areas. Each area has an air-handling unit that is monitored and controlled by a Honeywell DELTA 1000 Central Control and Monitoring System. The ground floor has a perimeter zone, an internal zone and a zone for only the cafeteria/multi-purpose area. The second floor is a single zone. Back-up heating is provided by an oil fired boiler.

Figure 1



Completed Installation
View from Southwest

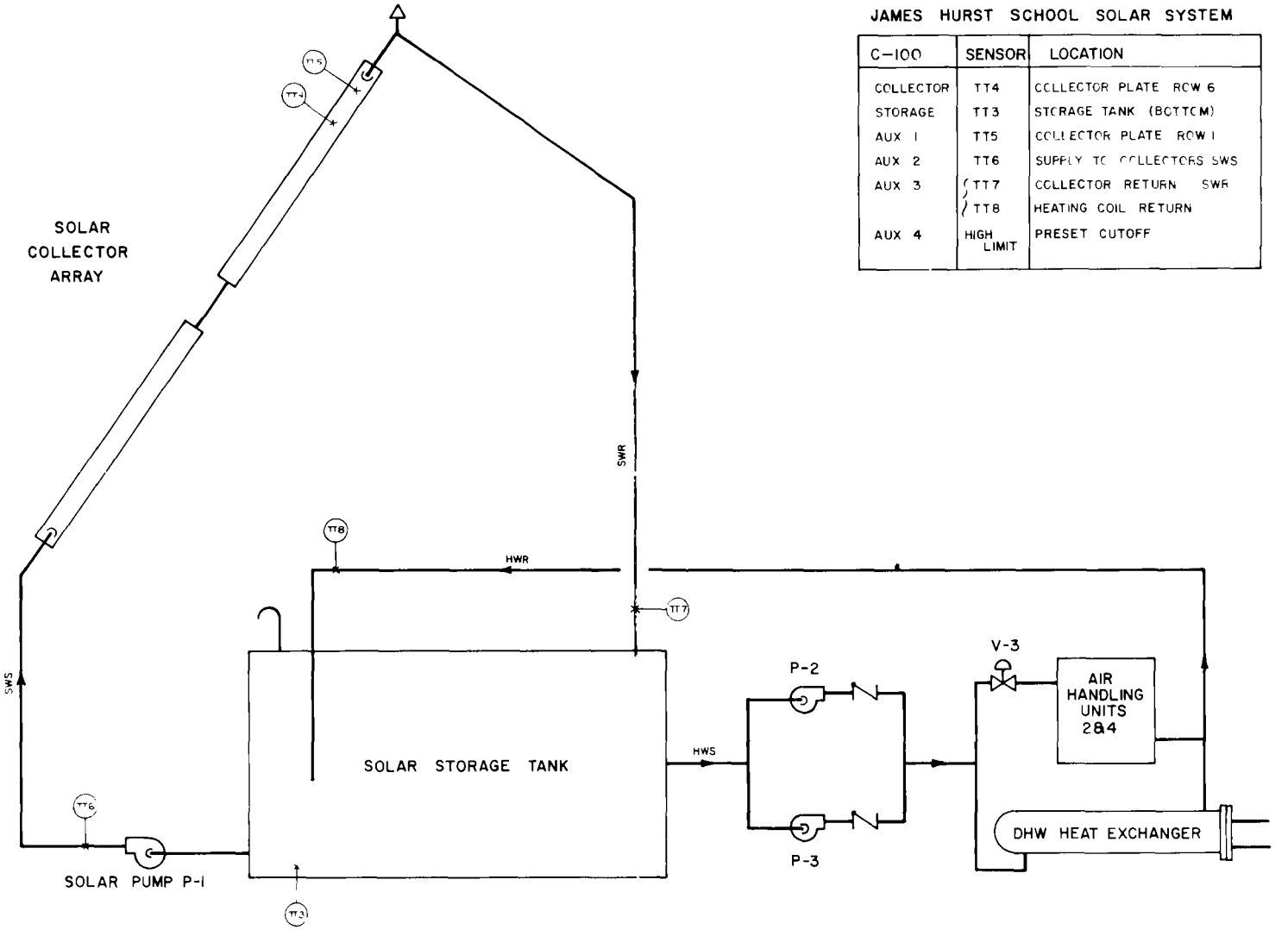
The solar system is a draindown water type that provides space heating and hot water. Thermal storage is provided by an insulated steel tank in a storage shed attached to the school. For space heating, the solar heated water is pumped from the storage tank to heating coils in three of the air handling units (the cafeteria zone does not have solar heating coils). Solar water is pumped to a shell and tube type heat exchanger for domestic hot water preheating.

Figure 2 shows a schematic of the final system design. Freeze protection is provided by the deactivation of pump P-1 which allows the water in the collectors to drain down to the storage tank when the exterior temperature is less than 50^{o} and the collector plate temperature is less than 20^{o} greater than the storage tank water.

The collector area and storage capacity were originally sized at 4,400 sq. ft. and 7,100 gal. respectively. These were optimization figures based on an assumed "should cost" figure of $10/sq. ft. for collectors and $0.70/gal. for storage. To meet budget constraints, this was reduced to 3,600 sq. ft. of collector and 6,000 gal. storage capacity.

PROJECT STATUS

The system installation was virtually completed in December and became operational in January of 1981. No major problems have been encountered during the first few months of operation.



JAMES HURST SCHOOL SOLAR SYSTEM

C-100	SENSOR	LOCATION
COLLECTOR	TT4	COLLECTOR PLATE ROW 6
STORAGE	TT3	STORAGE TANK (BOTTOM)
AUX 1	TT5	COLLECTOR PLATE ROW 1
AUX 2	TT6	SUPPLY TO COLLECTORS SWS
AUX 3	TT7	COLLECTOR RETURN SWR
	TT8	HEATING COIL RETURN
AUX 4	HIGH LIMIT	PRESET CUTOFF

L.D. DIAGRAM

9 DEC 1980

PROJECT MILESTONES

January 1978:	Proposal submitted to DOE by Portsmouth Public Schools.
June 1978:	Proposal selected as solar demonstration project.
September 1978:	Cooperative agreement executed.
October 1978:	Engineering and design began.
December 1978:	Solar collectors (only) bid.
March 1979:	Final Design Review (system and installation).
August 1979:	System installation bid and all bids rejected.
December 1979:	System installation rebid, all bids rejected.
December 1979:	System rebid.
January 1980:	Contract awarded.
May 1980:	Construction began.
December 1980:	System installed, operational testing began.
December 1980:	Acceptance test.

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APPENDIX A: ACCEPTANCE TEST

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ACCEPTANCE TEST PLAN

PROJECT NAME: James Hurst Elementary School

PROJECT LOCATION: Portsmouth, VA.

DATE OF TEST: December 8, 1980

INSPECTOR: F. Hawkins-Portsmouth City Schools
J. Hankins-Marshall Space Flight Center
N. Brittle-Inter Technology Solar Corporation

1. SYSTEM INSTALLATION

A. Verify that collectors are installed per plans and specifications.

COMMENTS: 192, Inter Technology/Solar brand, Mark V collectors in 16 arrays of 12 collectors each.

B. Verify that horizontal runs of solar water supply and return pipes are sloped for drain down.

COMMENTS: O.K.

C. Verify that collectors were pressure tested after installation at 1½ times anticipated operating pressure.

COMMENTS: O.K.; Max. anticipated operating pressure is 20 psi. Collectors tested at 50 psi.

D. Verify that piping and heating coils have been pressure tested at 100 psi.

COMMENTS: O.K.

E. Verify that DHW heat exchanger is installed per plans and and specifications.

COMMENTS: O.K.; Adamson Company model HE-503-T

F. Verify that solar storage tank is sized and installed per plans and specifications. Verify that tank carries an ASME seal.

COMMENTS: Adamson 6,000 gallon

2. SYSTEM OPERATION

A. Set collector sensor temperature to 10°-15° above storage tank temperature. Slowly bring collector temperature up to 20° above tank temperature. Pump P-1 should start.

COMMENTS: Storage tank temperature=119°F.
Collector sensor temperature=127°F.
Collector sensor artificially elevated to 140°F.
Pump P-1 started. O.K.

B. Note collector sensor temperature; bring solar tank temperature up to within 3° of collector temperature, pump P-1 should stop.

COMMENTS: Collector sensor temperature=144°F.
Tank sensor temperature=138°F.
Tank sensor artificially elevated to 140°F.
Pump P-1 should shut off
O.K.

C. With pump P-1 operating and collector sensor temperature artificially set above 200°; bring tank sensor up to 180°. Pump P-1 should stop.

COMMENTS: O.K.

D. Establish true tank temperature. Bring collector sensor temperature down to 3° above tank temperature. Pump P-1 should stop.

COMMENTS: Tank temperature = 122°F.
Collector temperature artificially lowered to 127°F.
Pump P-1 should shut off. O.K.

E. Set control on outdoor thermostat at 5°-10° above ambient temperature. Set control on storage tank thermostat to within 50° of out door thermostat setting. Pump P-2 should activate after a 15 minute delay.

COMMENTS: O.K.

F. Ensure pump P-2 is not activated. Pump P-3 should start when storage tank temperature is raised 30° above heat exchanger temperature. (Temporary thermometer may be used to check heat exchanger temperature.)

COMMENTS: Heat exchanger temperature =90°
Artificially decrease and then elevate storage tank temperature to 124°.
Pump P-3 activates. O.K.

G. De-energize Pump P-3 and time drain down from collectors.

COMMENTS: O.K. actual drain down = 12 min.
design drain down = 15 min.

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APPENDIX B: EQUIPMENT, OPERATION AND MAINTENANCE DATA

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STORAGE TANKS

AND

HEAT EXCHANGERS

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ADAMSON COMPANY, INC.
Belle Isle
Richmond, Virginia 23219

Customer PITTMAN MECHANICAL CONTRACTORS

P. O. No. JAMES HURST 101

Mfg. Job No. HE-503-T

Installation - Operation - Maintenance

LAYOUT AND INSTALLATION

Clearances: Sufficient space must be provided for maintenance. Space approximately equal to the length of the unit should be provided at the fixed tube sheet end of removable bundle exchangers. With non-removable bundles, this space can be at either end for tube replacement and the operation of cleaning tools.

Adequate space should be provided around channels for aligning parts and handling tools.

Cleanliness: Before installing, inspect all openings for foreign matter.

Setting and Alignment: The exchanger should be installed in the position shown on the assembly drawing. Generally, horizontal units should be level and vertical units should be plumb. Foundation bolts in one support should be slightly backed off. Oversized bolt holes allow movement to compensate for thermal expansion.

Piping: Pipe size should be selected after consideration of the entire system. Exchanger connections are sized on entrance considerations and are not necessarily suitable or required for the rest of the system.

Connections should be made according to the assembly drawing. Piping should be properly aligned and supported and adequate provision made for thermal expansion. This is particularly important for single pass internal floating heads, outside packed heads and fixed tube sheets with shell expansion joints. In these designs, if proper precautions are not taken, pipe thrust is absorbed directly at the tube joints and can cause serious damage.

Condensate piping from condensers and steam heated units should be run and pitched to assure complete drainage of the vapor space.

Vents and Drains: Proper venting is essential for the operation of any exchanger and adequate drainage can be important for corrosion control. Both are preferably run to atmosphere if the fluids involved permit. Otherwise, they should be run to areas of lower pressure with no pockets or obstructions to restrict flow.

Always drain a unit completely when it is to be shut down under freezing conditions

Appurtenances: Relief valves should be installed to protect the exchanger from over-pressure due to thermal expansion, failure of internal parts or external controls. They should be installed directly on the exchanger or in the piping immediately adjacent. There should be no intervening valves and the discharge should be conducted to a safe place.

Thermometers and pressure gages should be installed at inlet and outlet so that operating conditions can be checked and performance and fouling evaluated.

Appurtenances (Continued):

Control valves should be carefully selected to be sure required pressures and temperatures are maintained in the exchanger.

Water gage glasses should be provided on condensers and steam heated units to indicate failure in the condensate drainage system.

Traps on condensing units should be carefully selected and installed according to manufacturer's recommendations. Take into account the operation of control valves when specifying the operating conditions for traps. Install a trap for each exchanger. Do not manifold several exchangers into one trap.

OPERATION

Before starting up, the system should be checked for correct piping and proper control and safety devices.

The following procedure is generally applicable to all heat exchangers:

(1) Start the moderate temperature fluid and operate vents to remove trapped air.

(2) Gradually start the extreme temperature fluid, allowing the exchanger to adjust its temperature slowly. Operate the vents.

(3) When shutting down, stop the extreme temperature fluid first, then the moderate temperature fluid. Operate the drains.

(4) Avoid thermal shock due to rapidly altering the flow of either stream, unless the unit is specifically designed to withstand this type of service.

(5) Be sure all condensate is drained from steam units before admitting steam to avoid water hammer.

(6) When the exchanger has reached operating conditions, check all bolted connections for tightness.

(7) Record operating pressures and temperatures for future reference. Loss of capacity and increase of pressure drop will indicate the progress of fouling.

(8) Internal leaks will be indicated by contamination of the low pressure stream. External leaks can usually be seen or heard. To locate leaks, follow procedure for testing a repaired exchanger.

REPAIRS

Cleaning: The method of cleaning will be dictated by the composition of the dirt or scale, its location and the type of exchanger. Each cleaning job must be considered individually with the help of cleaning tool manufacturers and chemical cleaning contractors.

Generally, the tube side of exchangers can be cleaned mechanically, except for U-tubes where the small radius inside bends are usually not cleanable.

REPAIRS (Continued):

Removable bundles with tubes on square pitch can be cleaned mechanically on the shell side. Removable bundles with triangular pitch can sometimes be cleaned by jetting but generally these and non-removable bundles must be cleaned chemically on the shell side.

Mechanical cleaning tools must be applied carefully to avoid cutting or otherwise damaging the tubes. Sharp, hard cleaning tools should be avoided.

Chemical cleaning solutions must be used with care and completely flushed out to avoid corrosion damage. Never use cleaning solutions containing hydrochloric acid on galvanized exchangers.

Tube Bundle Removal: - Caution - Before attempting to dismantle a heat exchanger, be sure internal pressure is relieved. Remote valves should be locked closed.

Remove channels and floating head cover. On double packed units, remove the retaining ring. On outside packed units, back off on the packing gland.

Small bundles can usually be pulled manually after starting with jackscrews or a pry. When using a pry, be careful not to damage gasket faces. Large bundles may be pulled with a chain fall.

On floating tube sheet units a jack can be used at the floating end to start the bundle. Use a soft wood filler to protect the floating tube sheet and apply the jack to a bearing plate against the wood filler. When the bundle is started, make the chain fall fast to strong-backs set behind the fixed tube sheet. The strong-backs distribute the pull over the tube sheet and help prevent cocking of the bundle. The chain fall can also be made fast to rods run through the tubes and attached to the bearing plate at the floating tube sheet.

On single tube sheet exchangers, the bundle must be pried out until a strong-back can be bolted to the face of the tube sheet. The strong-back must include enough tube sheet bolt holes to prevent bending of the tube sheet.

In all cases the bundle must be pulled straight out and supported as it is removed to prevent damage to tubes and baffles, or scoring of packed tube sheets.

Use wide slings or cradles when handling the bundle to prevent damage to individual tubes.

Tube Replacement: Where a small portion of the bundle is concerned, it may prove more practical to plug defective tubes than to replace them. Plugs can be supplied by the Company or purchased locally.

The following procedure is generally acceptable for average exchangers of ordinary materials. For large units and stronger materials, better tooling will probably be justified and may be necessary. In these cases follow the recommendations of the tool manufacturer.

(1) Face off the tube ends flush with the tube sheet with a cut-off tool.

(2) Loosen one end of the tube with a knock-out tool, then drive the tube out from the other end. Some judgment is required here and several tries may be necessary before the tube can be driven out. If an inner tube of a U-tube bundle is to be removed it will be necessary to remove some outer tubes to gain access to the faulty one.

Tube Replacement (Continued):

(3) Clean the tube hole of all tube material and dirt.

(4) Insert the new tube so that it projects 1/16" beyond the face of the tube sheet and roll. Tube rolling is a skilled job and must be done carefully. Lubricate the roller well and keep it clean. Do not over-expand the tubes. If the maintenance department is not experienced in tube rolling, it will probably be more satisfactory to return the bundle to the manufacturer for repairs.

Reassembly and Testing: Clean all gasket faces and use new gaskets of the same material, thickness and dimensions as originally supplied. Pull up bolts only enough to produce a tight seal, alternating between diametrically opposed bolts to keep flange faces parallel. Do not over-stress bolts or flanges. When replacing bolts be sure to use the same alloy and grade as originally supplied.

Heat exchangers are usually tested for tightness with water. Do not pressurize an exchanger with gas until it has been tested up to the gas pressure with a liquid. Do not exceed the test pressure stamped on the nameplate of the exchanger.

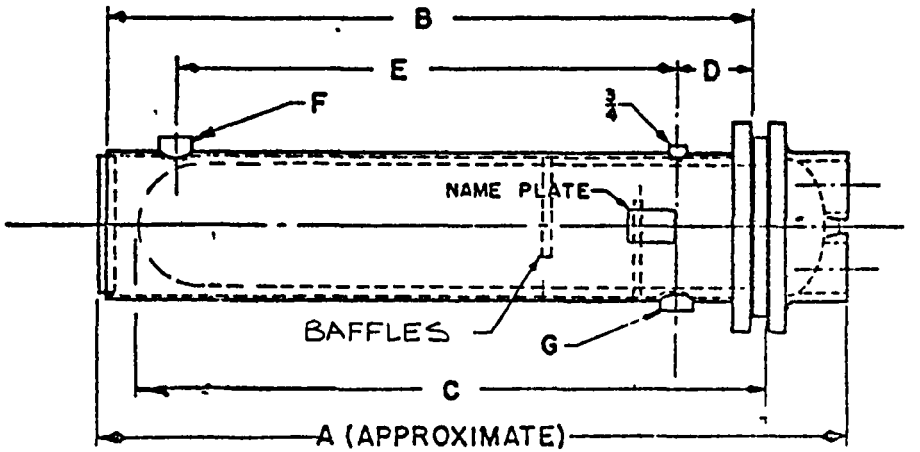
To test tube joints, fill and pressurize the shell side with the channels removed to expose the tube ends. Have the shell side packing ring and retaining ring in place on double packed units. A special test fixture is required for internal floating heads. Leaking tube joints can be rolled lightly. Do not over-roll.

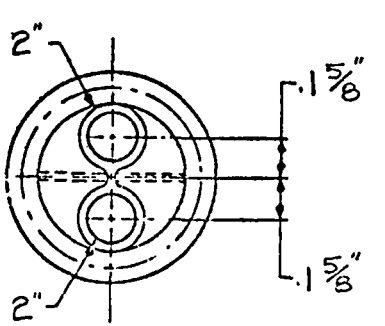
Replace the channels and pressurize both shell and tube sides to test flange joints.

Be careful to protect instruments and fixtures which are not designed for the test pressure.

Tools: Cut-off and knock-out tools and tube expanders can be supplied by the manufacturer.

Routine Inspection: Exchangers should be painted and inspected periodically for corrosion. Check for corrosion, particularly around connections and under insulation.





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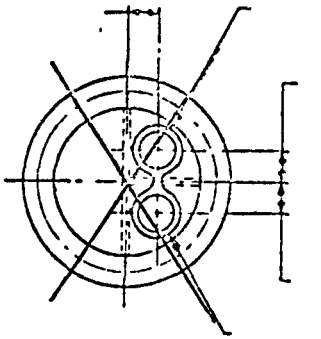

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THIS SUBMITTAL ISSUED TO DESCRIBE ADAMSON NO. 2WW05-125 | REV. 1 | REV 2 | REV 3

( ) REQD. SELECTION	UNIT SIZE WW5	A	B	C	D	E	F	G	HEATING SURFACE 2 PASS	4 PASS
	125	132	128	125½	4	120	1½	1½	28.6	—

SPECIFICATIONS:

1. UNIT BUILT IN ACCORDANCE WITH LATEST EDITION OF THE A S M E. CODE, SECT VIII FOR UNFIRED PRESSURE VESSELS AND SO STAMPED.
2. SHELL SIDE CONNECTIONS 3" AND UNDER SHALL BE EXTRA HEAVY FORGED STEEL COUPLINGS. CONNECTIONS OVER 3" SHALL BE 150 lb. FLANGED NOZZLES. ALL TUBE SIDE CONNECTIONS SHALL BE SCREWED.
3. MATERIALS.
   A SHELL - CARBON STEEL
   B TUBE SHEET - CARBON STEEL
   C ELEMENT HEAD - CAST IRON
   D TUBES - SEAMLESS COPPER ¾" O D x 20 GA.
   E SPACER PLATES AND TIE RODS - CARBON STEEL
4. PAINT ONE SHOP COAT ON ALL EXTERNAL SURFACES
5. DESIGN

	TUBE SIDE	SHELL SIDE
A. DESIGN PRESSURE	150 PSI	150 PSI
B DESIGN TEMPERATURE	400 °F	400 °F
C. TEST PRESSURE	[illegible] PSI	PSI

   D. CORROSION ALLOWANCE - NONE REQUIRED
6. HEATING DATA
   THIS UNIT WILL HEAT 8.3 G P M OF WATER IN THE SHELL IN AT 50° F OUT AT 110° F. WITH 25 CPM OF WATER IN AT 140° F OUT AT 120° F IN THE TUBES

CUSTOMER: PITTMAN MECHANICAL CONTR.
NORFOLK, VA.
P O NO:
PROJECT: JAMES HURST J.H.M. SCHOOL
PORTSMOUTH, VA.
ARCHITECT:
ENGINEER:
AGENT: R.L. BROWN

ADAMSON

ADAMSON CO.

DRAWN BY [illegible] | DATE [illegible] | JOB NO HE- [illegible]

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TACO

INSTRUCTION SHEET NUMBER

IS-200-1-1

HEAT EXCHANGERS

Effective March 15, 1965
Supersedes NEW

INSTALLATION

1. Allow sufficient clearance for removal of tube bundle
2. After initial start and run at operating temperatures and pressures, shut down and tighten head bolts.
3. Make certain that tubing is full of water before introducing steam or hot water into shell, otherwise flashing or noise may occur

CLEANING

Shell and tube bundle should be flushed out periodically. If cleaning is necessary, remove head and bundle to clean inside of shell and outside of tubes. Replace gaskets if necessary.

If unit is installed in a hard water area, inside of tubing can be cleaned as follows. -

1. - Break water connections and plug bottom opening
2. - Fill the tubes with a solution of 1 part muriatic acid to 10 parts of water and allow to stand for 2 hours
   CAUTION A longer period may cause damage to the copper tubing.
3. - Drain off and flush thoroughly with clean water
4. - Re-Assemble unit

NOTE

Commercially available cleaners may also be used

REPLACEMENT PARTS

When ordering Replacement Parts specify complete model number from nameplate.

Normally, the only Replacement Parts required would be

1 - Tube Bundle
1 - Set of Gaskets

Replacement Heads are also available if required

Taco Heaters of Canada, Ltd.
3090 Lenworth Drive
Cooksville, Ontario

TACO, INC. 1160 Cranston Street, Cranston, Rhode Island 02920

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PUMPS

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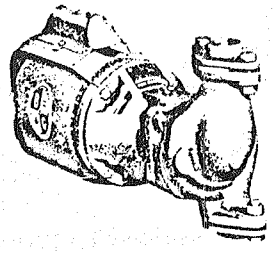
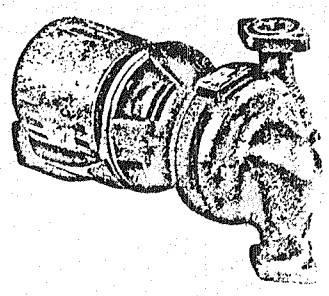
BELL & GOSSETT





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.

INSTALLATION

B & G Booster and Series 60 In-Line Pumps can be installed to discharge up, down, left or right, but the motor and bearing assembly must always be installed in a horizontal position with the oiling ports in the 12 o'clock position.

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.

NOTE: 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 four or 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.

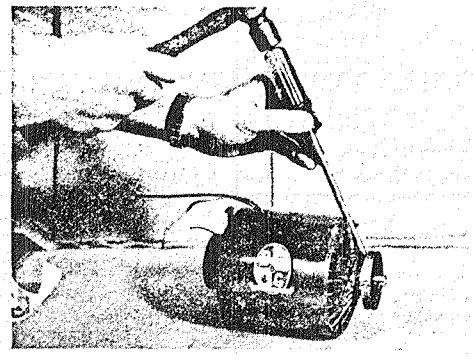


FIGURE 1

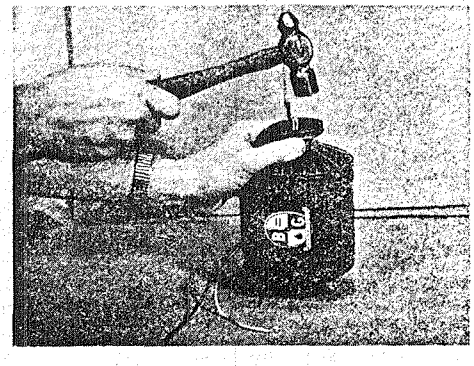


FIGURE 2

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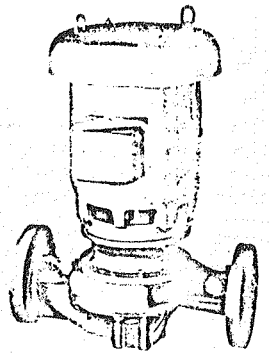
BELL & GOSSETT

INSTRUCTION SHEET

P01620
REVISION 3



Series "80" In-Line Mounted Centrifugal Pumps

Installation, Operation & Service 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.

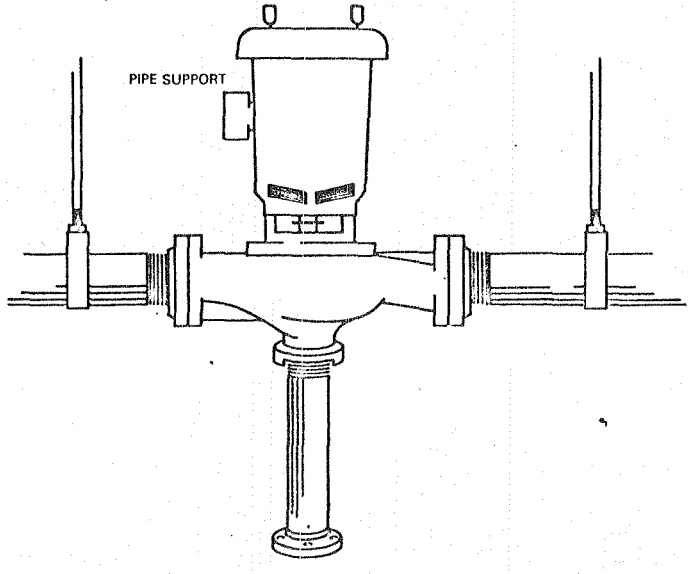
ALIGNMENT

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 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.



Be sure to eliminate any pipe strain on the pump. Support the suction and discharge lines by using pipe hangers or ground supports close to the pump. A support can be bolted to the underside of the pump body but it must be so constructed as to allow freedom of movement with the normal expansion of the piping.

If the pump is to be mounted in vertical piping with the motor in the horizontal position provide adequate support to prevent strain on pump parts and piping. It is not recommended that pump be mounted with the motor vertically downward. Do not use motor lift rings as a means of suspending the pump.

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 INSTRUCTIONS

All new Bell & Gossett Series "80" In-line Mounted Centrifugal pumps are lubricated and test run at the factory, future lubrication should be in accordance with the motor manufacturers instructions.

ROTATION

Rotation is clockwise when viewed from back of the motor. An arrow cast into the pump body shows the direction of rotation.

SERVICE INSTRUCTIONS

80-PF
Stuffing Box (Packing With Flushing Tubing)

To replace packing remove flushing tube from stuffing box and disconnect motor power leads if insufficient length will not allow removal of motor from mounting position. Next, remove the pump assembly from the pump body and remove impeller. The volute coverplate with packing intact can now be pulled from the motor shaft. The packing gland and packing can then be removed from the stuffing box. Check the condition of shaft sleeve, replace if scored or otherwise damaged.

To assemble, insert two packing rings into the stuffing box followed by the lantern ring and remaining two pieces of packing. Make certain that the packing joints are staggered 90 degrees. Install but do not tighten the packing gland. Apply grease to the assembled packing and install over the motor shaft. Tighten packing gland to compress packing. Install impeller and position pump assembly in pump body.

Caution: When returning the pump to service follow instructions on start-up tag carefully.

At initial start-up, back off packing gland nuts or screws until glands are loose. Re-tighten with fingers until glands are just snug against the first packing ring. AFTER PUMP IS RUNNING AT FIRST START, WATER MAY RUN FREELY

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FLUID HANDLING DIVISION

FROM PACKING This is normal, and should be allowed to continue for a period of time before further tightening the glands Take up the gland bolts uniformly one flat at a time

For fluid temperatures in the range of 32°F to 190°F average leakage rates of 60 to 80 drops per minute are recommended However, each individual pump and installation will have unique operating conditions that will result in broadly variable leakage rate requirements

An adequate leakage rate is NOT ONE SINGLE VALUE FOR ALL pumps and installations, but is the amount required to provide adequate cooling and lubrication The required leakage will be largely influenced by operating pressures, fluid temperature, shaft speed, etc

At fluid operating temperatures near the upper limit of 190°F, the maximum temperature rise of the leakage is particularly important A packed pump should never operate with steam forming at the gland This necessarily limits the temperature rise to a maximum of about 20°F If the formation of steam persists at higher leakage rates, cooling water must be provided by means of an external supply or a heat exchanger used to cool the by-pass flush

80-S
Stuffing Box (With Special Single Mechanical Seal)

To replace the single mechanical seal remove pump assembly from the body by following instructions as outlined for model 80-PF After the pump has been removed the next step is to remove the impeller Removing the seal cap bolts then allows the coverplate to be removed exposing the seal

Important Note position of seal assembly on pump shaft When installing replacement seal it must locate at positioning undercut in the shaft sleeve

To assemble, place seal carbon in seal cap and carefully put in position over the motor shaft Lubricate the seal "O" ring and position and lock to shaft Place coverplate in position and carefully bolt the seal cap with carbon insert in position against rotating seal member Install impeller and position pump assembly in pump body

80-D
Stuffing Box (With Special Double Mechanical Seal)

To replace double mechanical seal remove pump assembly from the body by following instructions as outlined for model 80-PF After the pump has been removed the next step is to remove the impeller Then release the coverplate and pull entire assembly from the motor shaft The seal cap and seal can now be removed from the stuffing box

To assemble, place the seal cap and one seal carbon with the "O" ring toward the cap in position on the motor shaft Lubricate the "O" rings of the rotating seal member and position on the shaft against the carbon Install the second seal carbon in the bottom of the stuffing box with the "O" ring down and carefully position against the motor bracket Move the first seal carbon in position against the rotating seal member and bolt in place Install impeller and position pump assembly in pump body

80
(With Standard Mechanical Seal)

To replace the standard mechanical seal remove pump assembly from the body by following instructions as outlined for model 80-PF After the pump has been removed the next step is to remove the impeller exposing the seal assembly To remove the rotating portion of the seal use a screwdriver to break loose the rubber ring from the shaft and pull it forward The seal insert and insert gasket can then be removed from its position in the volute coverplate

To assemble pump, reverse the above procedure Care should be taken to avoid getting grease or oil on the seal faces

If trouble occurs that cannot be rectified, contact your local B&G representative We will need the following information in order to give you our best help

1 Complete nameplate data of pump and motor
2 Suction and discharge gauge readings
3 Ampere draw of the motor
4 A sketch of the pump hook-up and piping

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CONTROL

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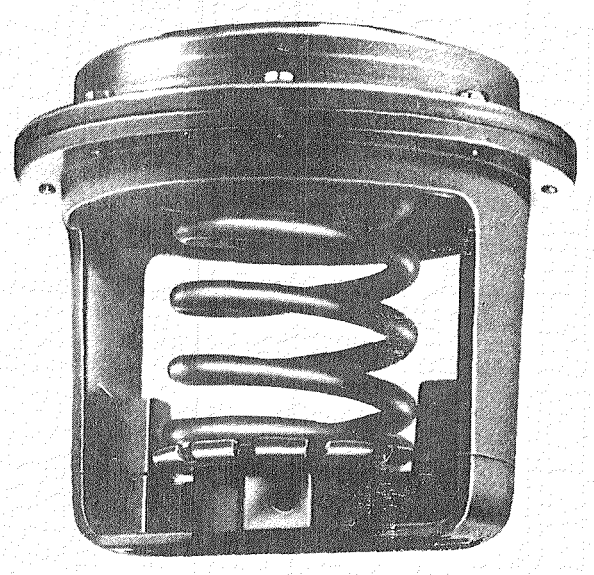
Honeywell

Comfort Control Systems

MP 953A-D
PNEUMATIC VALVE ACTUATOR

Service Data



GENERAL

The MP/MO953 pneumatic valve actuators operate the V5011 and V5013 valve assemblies and with adapters, control older steam and water valves.

The MP953A, available in three sizes and three stem travel lengths, has a positive positioning relay with an adjustable spring range start point of 3 to 10 psi (21 to 69 kPa).

The MP953B, also with a positive positioning relay and adjustable spring range start point, is 7-1/8 in. (181 mm) in diameter and has stem travel lengths of 1/2 in. (13 mm) and 3/4 in. (19 mm).

The MP953C with no positioning relay is available in three nonadjustable spring ranges, three sizes and three stem travel lengths.

The D model with no positioner is available with two nonadjustable spring ranges, is 7-1/3 in. (181 mm) in diameter, and has 1/2 in. (13 mm) and 3/4 in. (19 mm) stem travel lengths.

For further identification, refer to Table 1.

SPECIFICATIONS

MODELS:

MP953A - Direct-Acting, with Positioner
MP953B - Reverse-Acting, with Positioner
MP953C - Direct-Acting, without Positioner
MP953D - Reverse-Acting, without Positioner

Rev. 8-78
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Form Number 75-5500
Commercial Div.

MLF TAB: II. C. 7.

Table 1. MO953 and MP953 Model Identification.

Device	Active	Inactive (1978)				Size - Inches (mm)				Travel - Inches (mm)			Max. Temp.*		Spring Range - psi (kPa)				Corrosion Resistant
		MP953			MO953	5 (127)	7-1/8 (181)	8 (203)	13 (330)	1/2 (13)	3/4 (19)	1-1/2 (38)	160 F (71 C)	250 F (121 C)	2 to 7 (14 to 48)	4 to 11 (28 to 76)	8 to 12 (55 to 83)	8 to 13 (55 to 90)	
MP/MO 953A	1210	1087	1004		A1														No
	1228	1095	1012		A2														
		1103	1046		A6														
	1111	1079			A9														No
					A5														
	1244	1145	1020		A3														
	1152	1038			A4														
		1178	1053		A7														
	1269	1202	1186	1061	A8														No
MP/MO 953B	1069	1002	1036		B6														No
	1044	1010	1044		B7														
		1028	1051		B8														
MP/MO 953C	1000				C1XH														No
	1018				C1XK														
	1026				C1XL														
		1034			C2XH														
		1042			C2XK														
		1059			C2XL														
	1067				C3XH														
	1075				C3XK														
	1083				C3XL														
	1091				C4XH														
	1109				C4XK														
	1117				C4XL														
		1141			C9XH														
		1158			C9XK														
		1166			C9XL														
		1174			C5XH														
		1182			C5XK														
		1190			C5XL														
		1208			C6XH														
		1216			C6XK														
		1224			C6XL														
		1232			C7XH														
		1240			C7XK														
		1257			C7XL														
		1414																	
	1471	1125			C8XH														No
	1489	1133			C8XL														
MP/MO 953D	1107	1008			D1														No
		1115	1016		D2														
		1123	1024		D3														
	1131	1073																	No
		1081	1149																
		1099	1156																
	1172														3 to 7				No
	1198		Sales Special																
	1214														3 to 7				
	1222																		No

*Diaphragm color varies with maximum temperature; Black (Neoprene) = 160 F, White (Silicone) = 250 F, Black with White Dot (Ethylene Propylene) = 250 F.

N Maximum Safe Air Pressure (all models): 25 psi (172 kPa).

Honeywell

SUBJECT TITLE

MP953A-D PNEUMATIC VALVE ACTUATOR

Correction [X]

Addition [ ]

Errata No. [1]

ERRATA DATA

Literature Type Service Data

For more information contact:

Bill Hoipkemier Phone HVN 661-5634 Location Arlington Heights

Page 1, "General" section, fifth paragraph:

The MP953D device diameter is 7-1/8"; not 7-1/3".

Page 10, Figure 8:

The part numbers for the high temperature diaphragm and sleeve are reversed. The correct part numbers are:

Diaphragm, 250°F	14002040-001
Sleeve, 250°F	14002039-001

Page 13, Figure 10:

The part numbers for the high temperature diaphragm and sleeve are reversed. The correct part numbers are:

Diaphragm, 250°F	14002040-001
Sleeve, 250°F	14002039-001

ERRATA DATA Page 1 of 1

M.L.F. Index Code II.C.7

Date 2/15/80

File with Form Number 75-5500 dtd. 8/7

Commercial Div.

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APPLICATION

These pneumatically powered actuators operate V5011, V5013, or certain older coil or line valve assemblies which proportionally control steam or hot or cold liquids in HVAC systems.

OPERATION

MP953A & B (With Grad-U-Trol*)

The force balance of the valve unit lever pivot and ball check arrangements establishes a true proportional relationship between the diaphragm cup position and the pilot air pressure which is independent of the shaft load The operating (control air) pressure range is directly proportional to the feedback spring rate and the cup travel. (Decreasing pilot diaphragm area increases the operating range) The clinching forces are available at all positions of the diaphragm cup, equal to the main supply air pressure force acting on the operator diaphragm cup less the operating spring load at the corresponding cup position

MP953C & D (Without Grad-U-Trol)

The actuator has a rolling diaphragm operated piston-like cup to build thrust as the actuator inlet pressure increases The spring loaded cup returns as the actuator inlet pressure decreases

MAINTENANCE

Periodically make a visual check for leaks loose fittings, etc Clean the actuator with a commercial cleaning solvent or degreaser Keep solvent away from the diaphragm as it causes deterioration

> **CAUTION**
>
> Careless handling of solvents can result in permanent damage to the respiratory system or to the skin Avoid prolonged inhalation or contact with the skin.

OPERATIONAL CHECK

Vary the branch line pressure through the operational range of the actuator in both directions The valve should open and close smoothly

ADJUSTMENTS

NOTE Adjustments are necessary only for the Grad-U-Trol relay used with the MP953A and B actuators (see Fig. 1)

TO SET OPERATING RANGE

Select the proper range and adjust as follows

1. Using wrench (Part No 301572A), loosen the cover locking screw.
2. Unscrew the start point adjustment knob and remove cover
   a. For three psi (21 kPa) range, back all screws off to friction stop.
   b. For five psi (34 kPa) range, back only the black screws to stop and tighten the outer plated screws.
   c. For ten psi (69 kPa) range, tighten all the screws

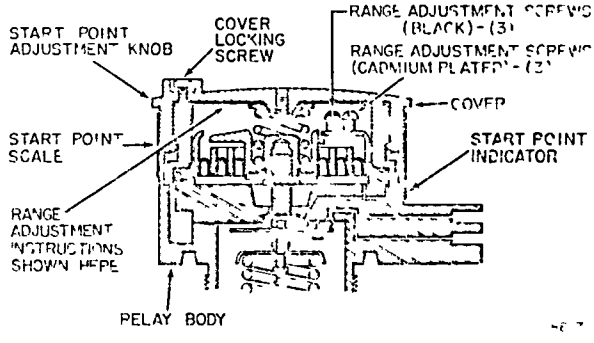

Fig 1 Adjustment Points of Gradutrol Relay

TO SET START POINT

1 Tighten the cover by turning it until it bottoms on the relay body

2 Back off (one turn maximum) until the start point of the correct scale range lines up with the start point indicator near "B" marking

3 Tighten the cover locking screw until it engages the relay body Do not overtighten

*Trademark

ADJUSTMENT CHECK

1. Install gages in the main and pilot air lines

2 Verify main air pressure. It must be at least 13 psi (90 kPa) if top of sequencing range exceeds 13 psi (90 kPa)

3 Slowly apply pilot pressure and note the pressure at which the valve stem travel starts This pressure should be within ±3/4 psi (5 kPa) of the start point setting

4 Slowly increase the pilot pressure until the valve stem travel is complete This pressure should be the start point pressure plus the range setting

5 If necessary, make fine adjustments with the start point adjustment knob

CAUTION

Loosen the cover locking screw *before* turning the start point adjustment knob

TROUBLESHOOTING

Symptom	Remedy
MP953A closes too slowly or MP955B opens too slowly	Replace the filters in positioner relay ports Replace restrictor if one exists Add booster relay if controller is too low for the application
MP953A or C Valve won't open or MP953B or D Valve won't close.	Check that actuator is mounted securely and latched to valve stem Check controller action Assure proper bleed off occurs Check for internal valve problems, foreign objects under seat, defective disc or seat, plug unscrewed, etc.

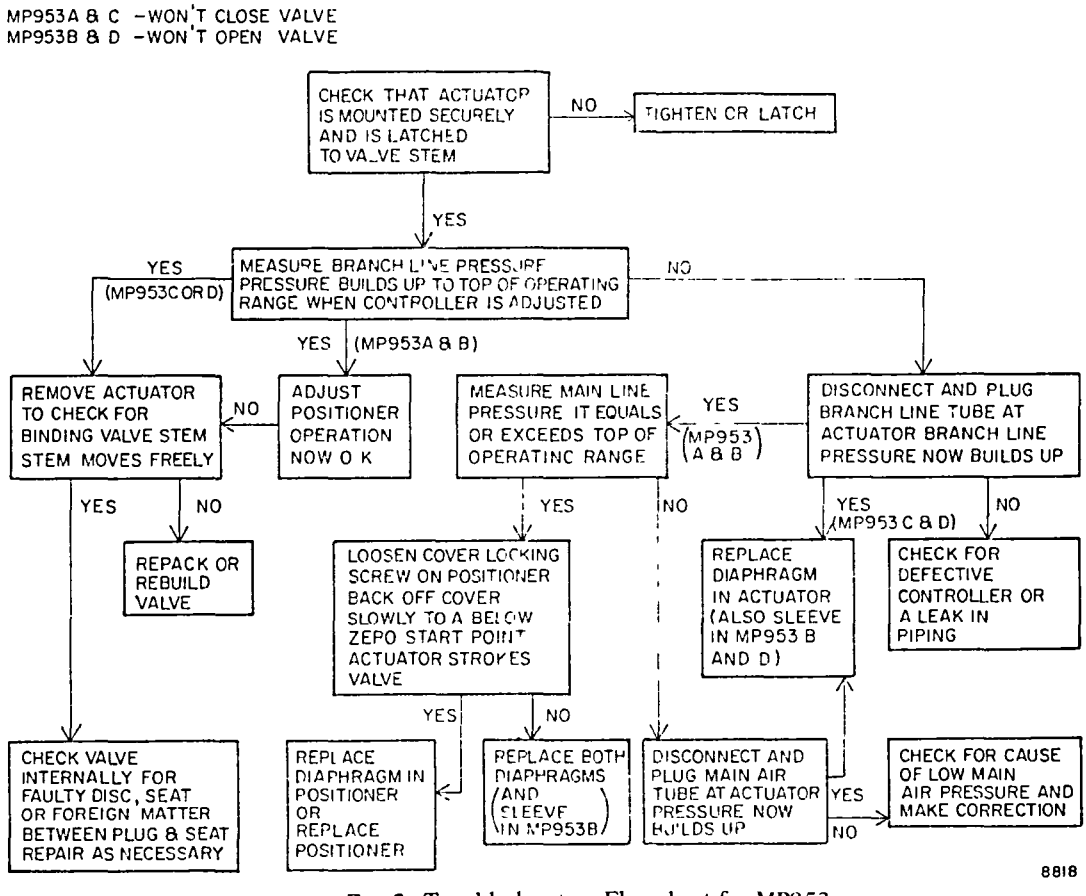

Fig 2 Troubleshooting Flowchart for MP953

Special tools required

Phiobond Glue or equivalent to replace MP953A diaphragm

DIRECT ACTING (MP953A & C)

DIAPHRAGM REPLACEMENT

Before attempting replacement, determine type and material of existing diaphragm Both neoprene and ethylene propylene (EPR) are black but EPR has a white spot. Neoprene and EPR diaphragms are interchangeable but should be applied to suit maximum temperature requirements (EPR used for 250 F [121 C]) Old style flat diaphragms and newer beaded roll types are not interchangeable. Silicone (white) diaphragms are used in 250 F (121 C) applications on MP953A and C models EPR is used on B and D models only

1. Disconnect air line(s)
2. Loosen two base setscrews to partially relieve spring preload
3. Remove cover screws, cover and diaphragm.
4. Install new diaphragm (for positioner models, cement positioner spring cup, 315178, to center of diaphragm).
5 Reassemble positioner spring, cover and screws (Use cap type allen head setscrews to replace socket head setscrews used on older actuators)
6 Tighten base setscrews

FILTER REPLACEMENT

1 Remove tubing
2 Remove Connectors
3. Remove filters with pointed tool such as an awl
4 Install foam filters, taking care not to fold or bunch together
5 Reinstall Connectors and tubing

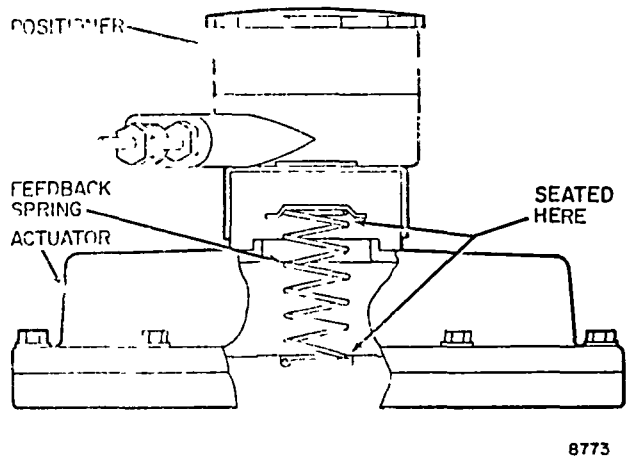

Fig 3 MP953A & C Positioner Replacement

MAIN SPRING REPLACEMENT

Springs with different ranges are interchangeable on the same size actuators Select spring by operating range and stem travel (See Table 2 for MP953C and parts list for MP953A)

5 IN AND 8 IN

1 Remove actuator from valve.
2 Remove two base setscrews
3 Replace spring.
4 Reinstall two base setscrews.
5 Reinstall actuator and latch of valve stem.

13 IN

1 Remove actuator from valve
2 Loosen two base setscrews.
3 Remove cover, diaphragm, cup and stem retainer
4 Replace spring
5 Reinstall stem retainer, cup, diaphragm, cover and screws
6 Tighten two base setscrews
7 Reinstall actuator and latch to valve stem

POSITIONER REPLACEMENT (See Fig 3)

1 Disconnect air lines

2 Unscrew positioner from actuator cover, taking care not to lose feedback spring

3 Screw new positioner in place, being sure new "O" ring is properly seated in positioner groove (Reuse old feedback spring as this is not included in 313695J assembly)

4 Tighten only enough to seat "O" ring

5 Adjust positioner for range and start point

REVERSE ACTING (MP953B & D)

DIAPHRAGM REPLACEMENT

NOTE Replace both diaphragm and sleeve (inner seal) when replacement of either is indicated Use SERVICELINE Kit 14003124-001 for 160 F (71 C) device Select replacement diaphragms by maximum temperature requirements (160 F [71 C]) Standard Applications–neoprene, 250 F [121 C] high temperature applications–EPR)

MP953B

1 Disconnect air lines

2 Remove cover screws, cover, feedback spring, nut 312205, lockwasher 304733, cup and diaphragm

3 Replace diaphragm

4 Reinstall cup, lockwasher and nut

5 Tighten nut only enough to seal diaphragm

6. Reinstall feedback spring, cover and screws

7 Reconnect air lines

MP953D

1 Disconnect air lines

2 Remove cover screws, cover and diaphragm

3 Replace diaphragm

4 Replace cover and screws

5 Reconnect air lines

SLEEVE (Inner Seal) REPLACEMENT

1 Remove diaphragm (follow steps 1 and 2 above)

2 Remove cup 302201, three screws, ring 312180 and sleeve (inner seal)

3 Replace sleeve (inner seal)

4 Reinstall ring, screws, cup and diaphragm

5 Follow steps 4 and 5 for D model (4 through 7 for B models) above to complete repair

MAIN SPRING REPLACEMENT

Select spring by operating range and valve stem travel Springs are interchangeable if operating range and valve stem travel are the same For MP953D, see Table 3 and for MP953B, see parts list

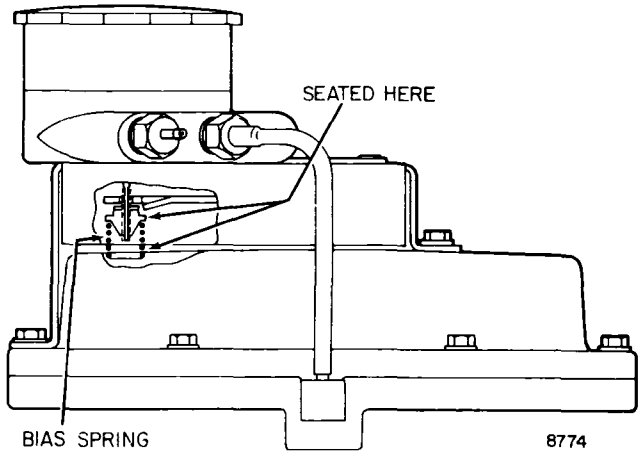

Fig 4 MP953B Bias Spring Position

1 Remove diaphragm and sleeve (inner seal) (see above)

2 Remove two base screws and base

3 Replace main spring

4 Reinstall base, two screws, sleeve and diaphragm

5 Follow steps 4 through 7 for B models and 4 and 5 for D models in DIAPHRAGM REPLACEMENT

POSITIONER REPLACEMENT (See Fig 3 and 4)

1 Remove air lines and two screws from positioner assembly

2 Replace positioner assembly being sure bias and feedback springs are properly seated

3 Adjust positioner for proper range and start point

Figure 7 illustrates parts used in the old MO953 A4 and A8 Series 3 through 7 These parts are not available If repair is necessary, convert the actuator to a new style device by installing the new parts listed in Figure 7

PARTS

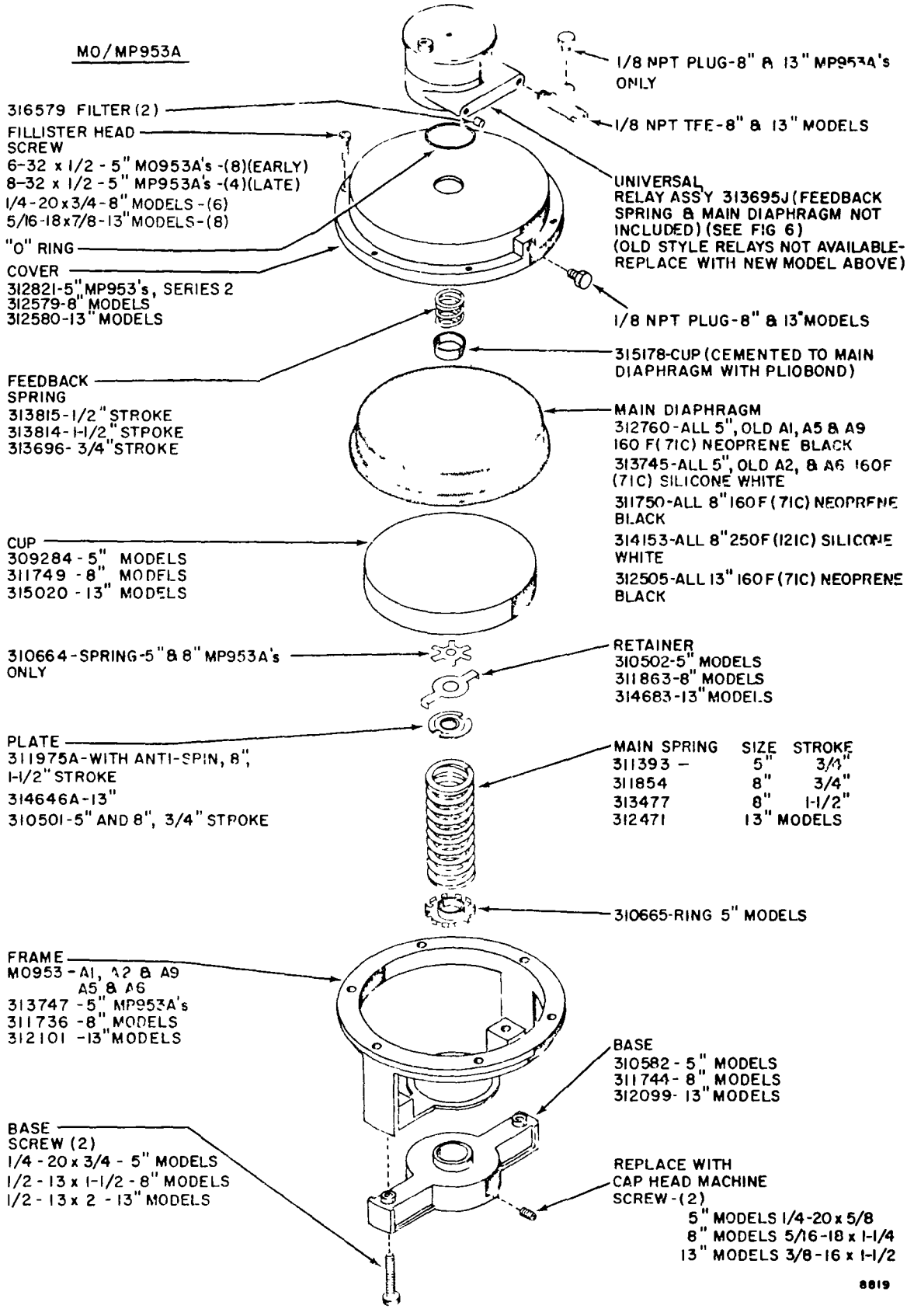

Fig 5 Exploded View

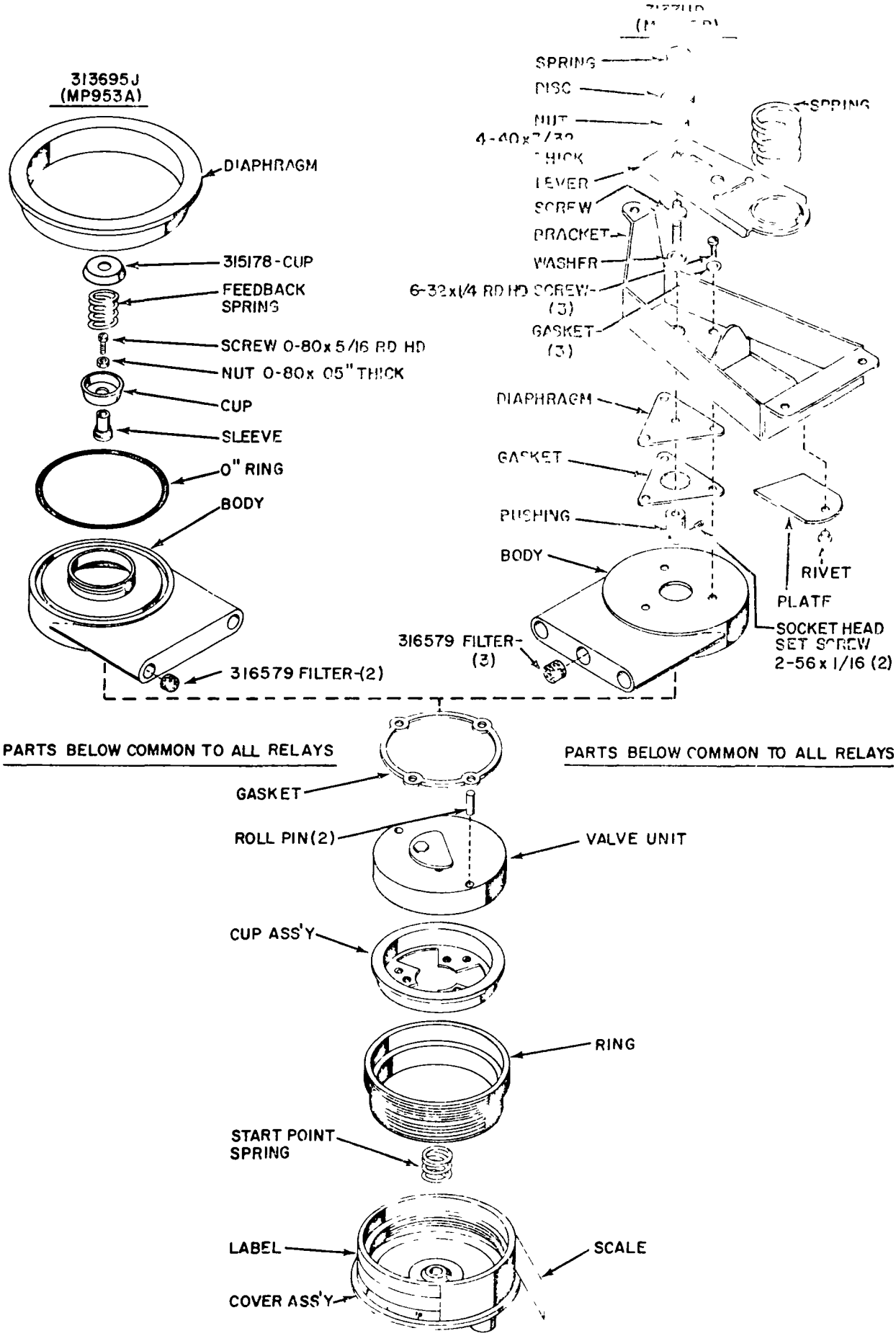

Fig 6 Relay Assemblies - Exploded View

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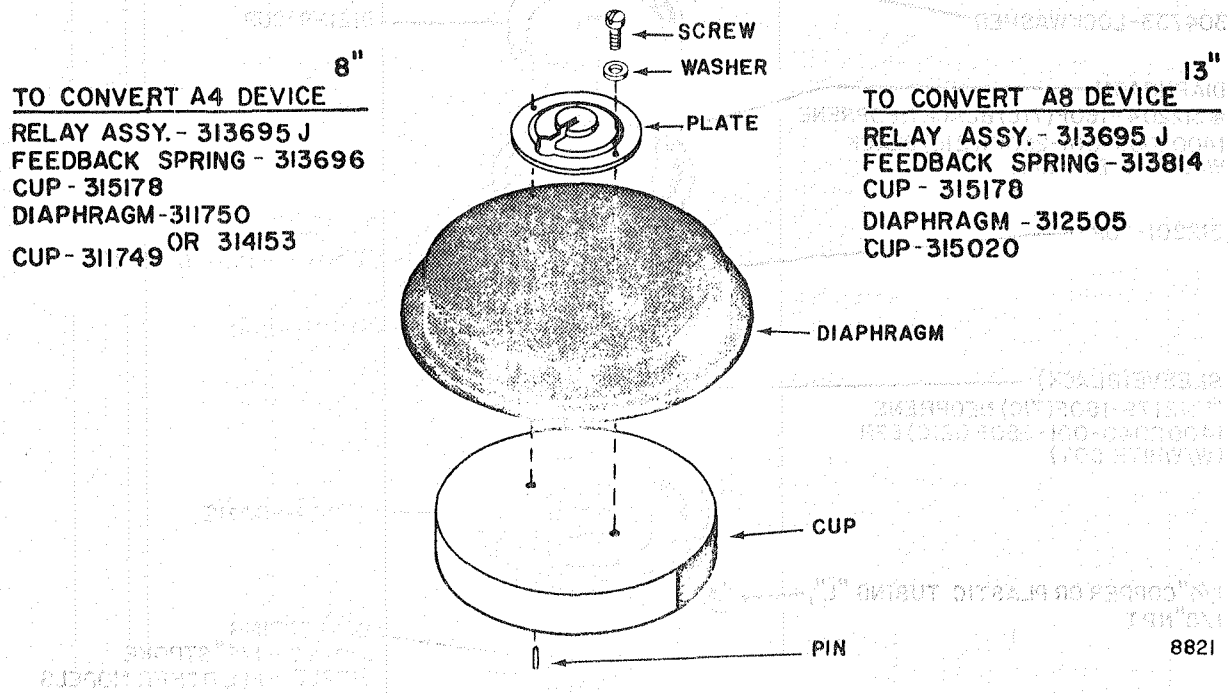


Fig. 7. Old MO953 Conversion.

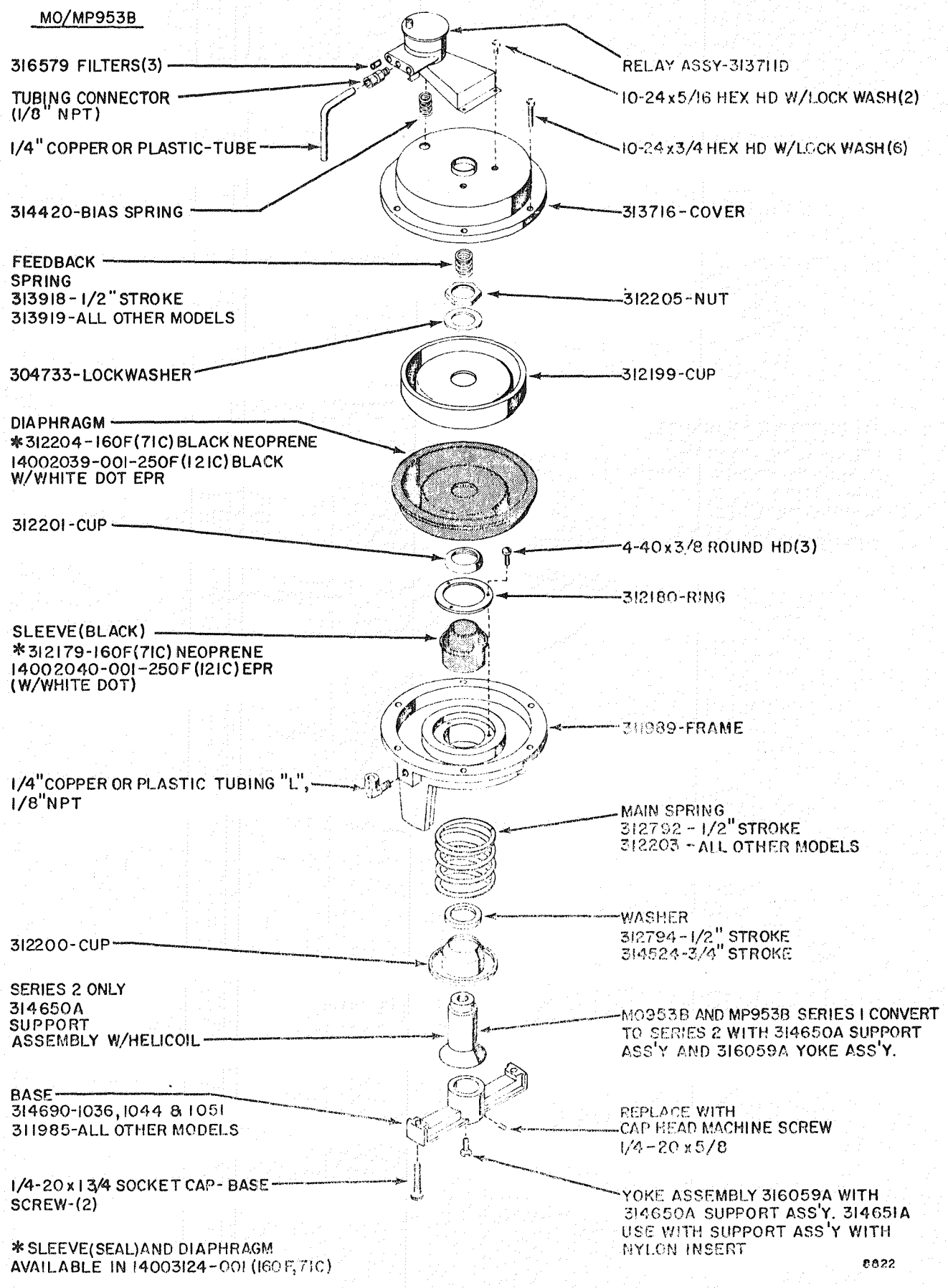


Fig. 8. Exploded View.

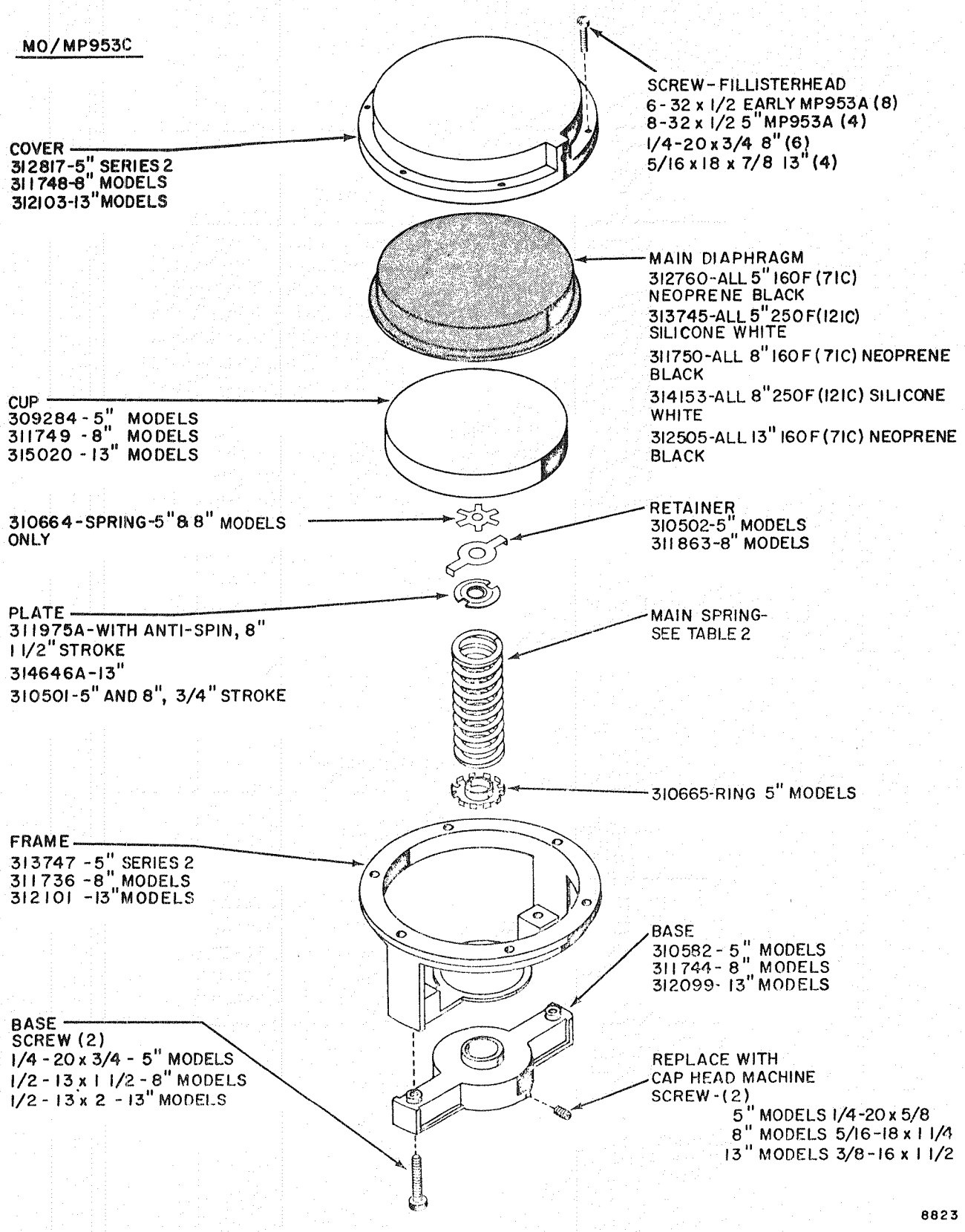


Fig. 9. Exploded View.

Table 2 MP953C Springs

Actuator Diameter (Inches)	Stroke Inches (mm)	Color	Pressure Range psi (kPa)	Part Number
5	1/2 (13)	Brown	2 to 7 (14 to 48)	312788-033
5	1/2 (13)	Gray	8 to 12 (55 to 83)	312790-034
5	1/2 (13)	White	4 to 11 (28 to 76)	312791-0123
5	3/4 (19)	Brown	2 to 7 (14 to 48)	311616-033
5	3/4 (19)	Gray	8 to 12 (55 to 83)	311618-034
5	3/4 (19)	White	4 to 11 (28 to 76)	311393-0123
8	3/4 (19)	Brown	2 to 7 (14 to 48)	311852-033
8	3/4 (19)	Gray	8 to 12 (55 to 83)	311855-034
8	3/4 (19)	White	4 to 11 (28 to 76)	311854-0123
8	1-1/2 (38)	White	4 to 11 (28 to 76)	313477-0123
8	1-1/2 (38)	Green	3 to 15 (21 to 103)	14002934-001
13	1-1/2 (38)	Brown	2 to 7 (14 to 48)	312469-033
13	1-1/2 (38)	White	4 to 11 (28 to 76)	312471-0123

Table 3 MP953D Springs

Stroke Inches (mm)	Color	Pressure Range psi (kPa)	Part Number
1/2 (13)	White	4 to 11 (28 to 76)	314314-0123
1/2 (13)	Black	8 to 13 (55 to 90)	312792-017
3/4 (19)	White	4 to 11 (28 to 76)	314313-0123
3/4 (19)	Black	8 to 13 (55 to 90)	312203-017
3/4 (19)	Silver	3 to 7 (21 to 48)	314963-605

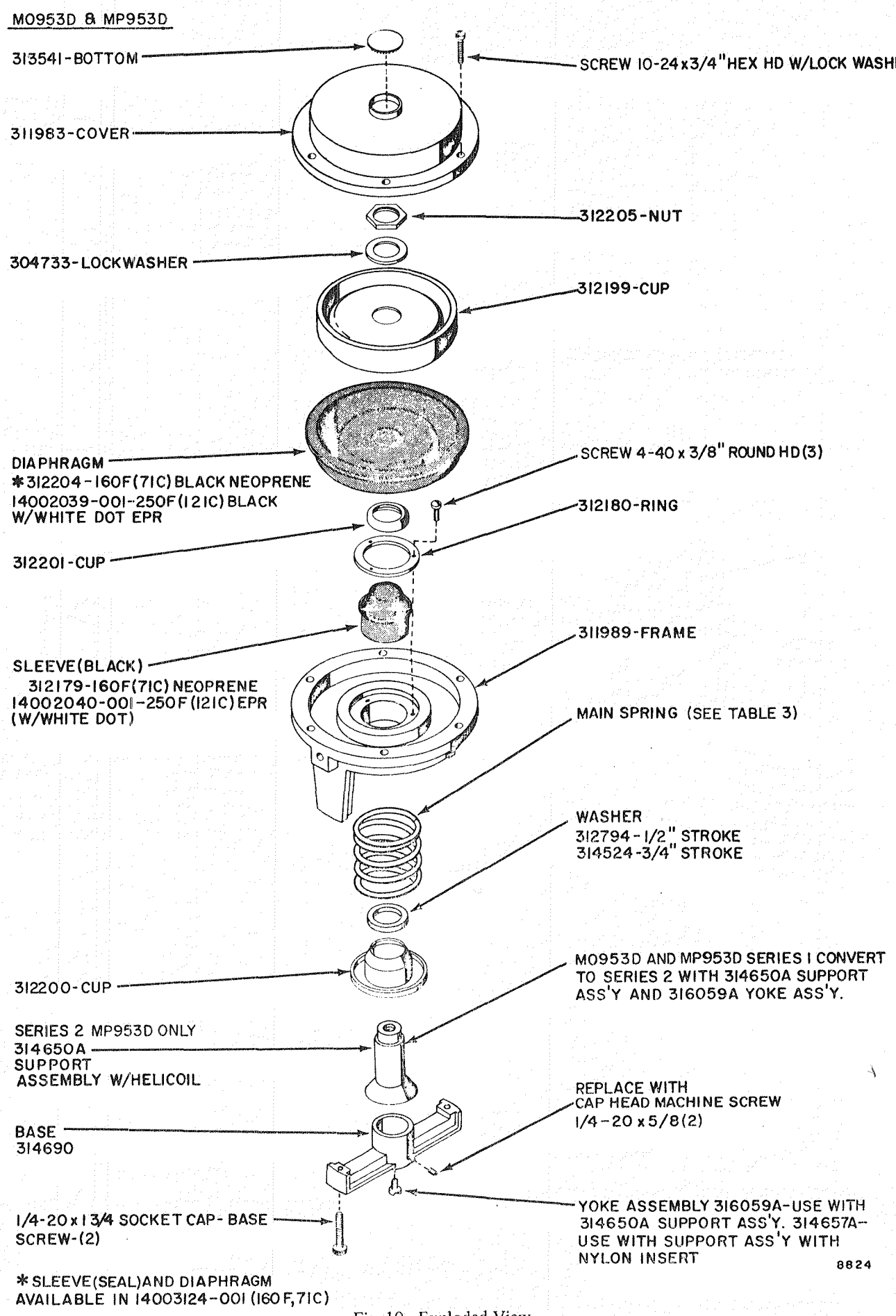
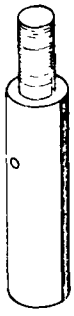
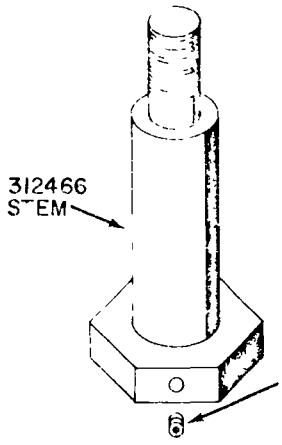


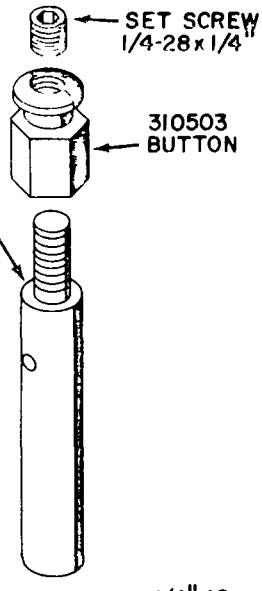
Fig. 10. Exploded View.

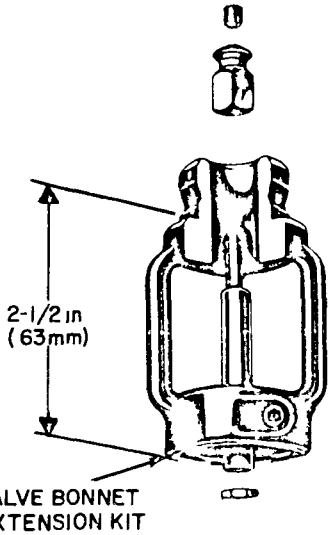


ACTUATOR STEM EXTENSION
311851-8" MODELS

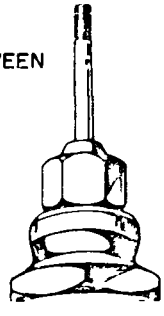


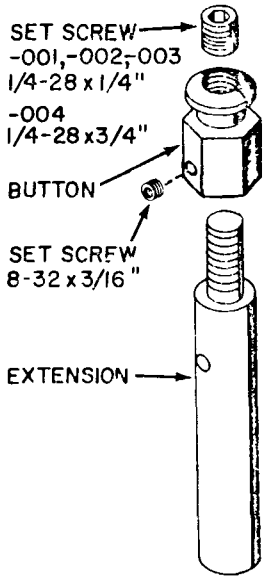
ACTUATOR STEM AND SET SCREW
13" MODELS



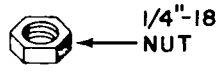


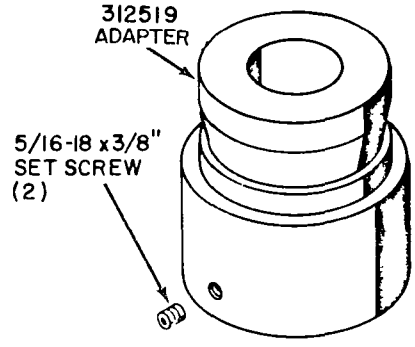
VALVE BONNET
EXTENSION KIT
#14000501-001
(TO INCREASE
DISTANCE BETWEEN
ACTUATOR &
VALVE BODY)





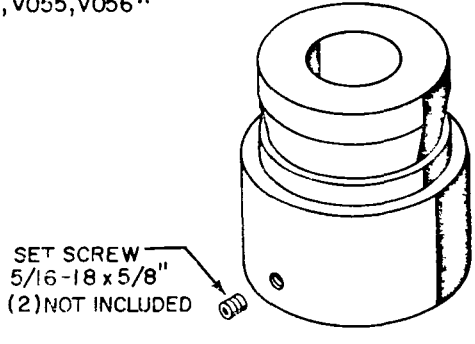
14001165 STEM EXTENSION KITS
ADAPT MP953C TO V053, V055, V056*





MP953 TO V575B, V581B, V597A
AND SMALL SIZE V053, V055 &
V056* ADAPTER BAG ASS'Y

1/2" TRAVEL - 308078AV
3/4" TRAVEL - 308078AW



14001162 ADAPTER
ADAPT MP953C TO V053,
V055 OR V056*

POSITION INDICATOR FOR
5-INCH (127mm) DIA-316028A
7-INCH (178mm) DIA-316035A
8-INCH (203mm) DIA-316037A
13-INCH (330mm) DIA-316036A

CORROSION RESISTANT SPRAY C&S PART NO 3858

*FOR COMPLETE CROSS REFERENCE INFORMATION ON VALVES - SEE FORM NO 95-5579

8825

Fig 11 MP953 Accessories

Honeywell

Comfort Control Systems

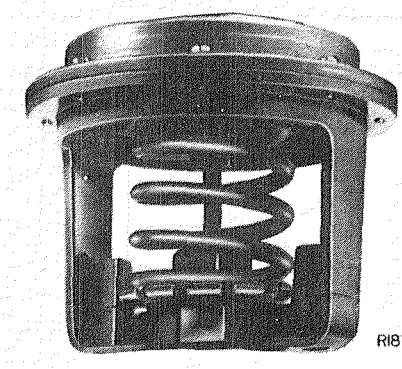
MP953
VALVE OPERATORS

Installation Instructions

BEFORE INSTALLING, NOTE

Be sure that the selected operator is of correct size and that it has the necessary travel to match the valve (see Table 1). A stem extension is included with certain operators for use if needed. See Figures 3 and 4 and Tables 3 and 4.

Do not use a 13-inch (330 mm) operator with V5011 valve smaller than four inches (101 mm).



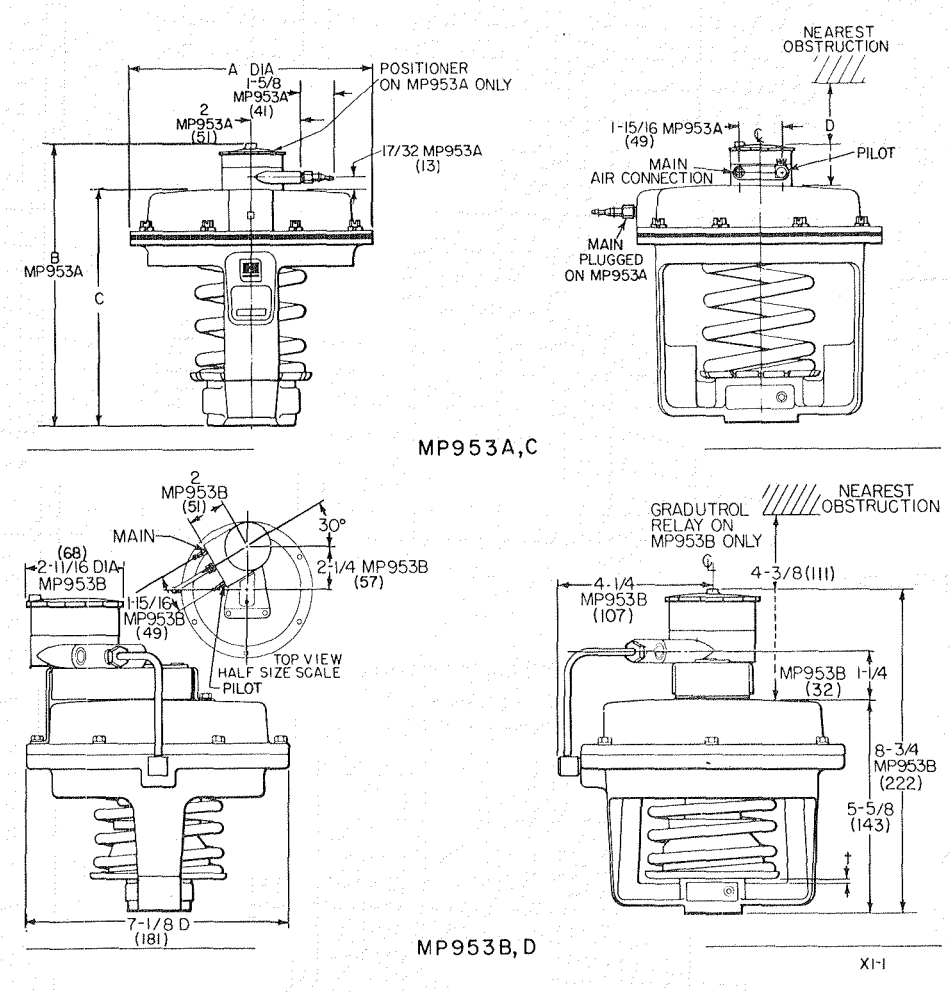


Fig. 1. MP953 Approximate Dimensions in Inches (Millimeters). See Table 2.

Table I–MP953 Model Identification

Characteristics	O S Numbers		Spring Range	Top Diameter	Travel	Diaphragm Material	Corrosion Resistant
	1111			5	1/2	Neoprene	No
MP953A	1087	1210†			3/4		
Direct Acting		1228†				Silicone	
with Attached Relay	1103	1236†					Yes
	1178	1251†		8		Neoprene	
	1145	1244†					No
	1202	1269†		13	1-1/2		
MP953B	1036	1069†		7-1/8	3/4		
Reverse Acting	1051	1077†					Yes
with Attached Relay	1044				1/2		
	1141		2-7	5			No
	1166		4-11				
	1158		8-12				
	1000		2-7		3/4		
	1026		4-11				
	1018		8-12				
MP953C	1208		2-7			Silicone	Yes
	1224		4-11				
Direct Acting	1216		8-12				
	1232		2-7	8		Neoprene	
without Relay	1257		4-11				
	1414		4-11			Silicone	No
	1422		8-12				
	1067		2-7			Neoprene	
	1075		8-12				
	1083		4-11				
	1471		2-7	13	1-1/2		
	1489		4-11				
	1149		4-11	7-1/8	1/2		
MP953D	1115		8-13				
	1107		8-13		3/4		
Reverse Acting	1131		4-11				
	1156		4-11				Yes
without Relay	1123		8-12				
	1122		4-11			Ethylene Propylene	No

†Dual Scale (English – Metric)

Table 2 MP953 Approximate Dimensions in Inches (Millimeters) (See Fig 1)

Operator Size Nominal Dia	A	B	C	D
5 inch	5-1/8 (130)	6-7/8 (175)	4-5/8 (117)	4-3/8 (111)
8 inch	8-1/4 (210)	8-3/4 (222)	6-1/2 (165)	5-3/8 (137)
13 inch	13-1/2 (343)	12-1/2 (311)	10 (254)	7-11/16 (195)

INSTALLATION

PRECAUTIONS

- Do not assemble 13-inch (325 mm) operators to valves smaller than four inches (101 mm)

- Take special care in securing valve stem button to large size MP953 or C Operators with stem extensions

MOUNTING THE MP953A OR C OPERATOR

Refer to Figure 1 and Table 2 for dimensions

1 Loosen the two setscrews at base of operator

2 Pull the valve stem up

3 Position the stem locking slide so that the large hole is in view (Fig 2)

4 Set the operator on the valve bonnet Be sure that the stem button passes through the hole in the stem locking slide and that the operator is down flush on the shoulder of the valve bonnet

5 Rotate the operator on the valve bonnet to the desired position and tighten both operator set-screws

6 Apply air pressure until the diaphragm cup contacts the stem button and secure the stem button with the stem locking slide

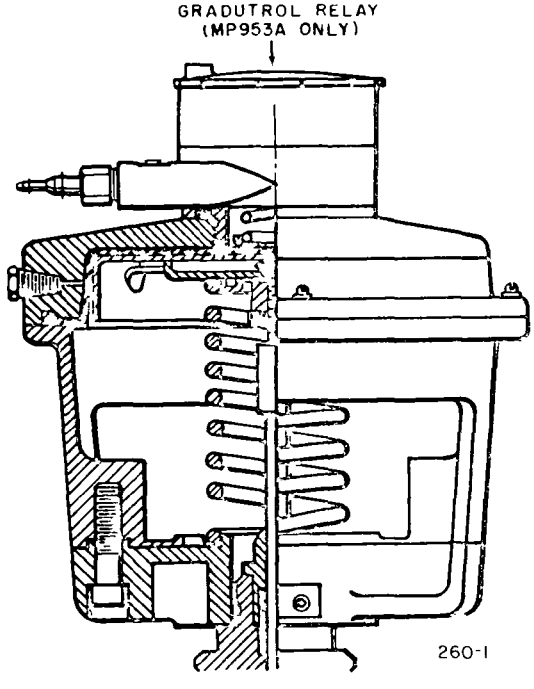


Fig 2 Details of MP953A or MP953C Operator Connected to Valve Stem

ACTUATORS WITH STEM EXTENSIONS

The eight- and thirteen-inch (200 and 325 mm) MP953A and C actuators are usually shipped with stem extensions The stem extensions are required for mounting the eight-inch (200 mm) MP953A and C actuators on 1-1-1/2- through three-inch valves and for mounting thirteen-inch (325 mm) actuators on four- through six-inch valves

The stem extensions extend the valve stem height (see Dimension A, Tables 3 and 4) to accommodate mounting of the larger eight- and thirteen-inch (200 and 325 mm) actuators

MOUNTING EIGHT-INCH (203 mm) MP953 A OR C OPERATOR WITH STEM EXTENSION

1 If converting from a five-inch (127 mm) operator to an eight-inch (200 mm) remove the five-inch (127 mm) operator by following, in reverse, the steps previously outlined in MOUNTING THE MP953A OR C OPERATOR

2 Remove the stem button
NOTE On larger valves, a locking setscrew is located in the side of the stem button This must be loosened before stem button can be removed

3 Screw the stem extension (see Fig 3) on the stem until it bottoms The stem and extension are drilled to accept a 1/16-inch (1 5 mm) drift pin which can be used to assist in holding the stem while turning the extensions

4 Screw the stem button on the extension

CAUTION

It is necessary to have a 5-1/4-inch (133 mm) dimension from the top of the valve bonnet to the top of the stem button when the stem is at the bottom of its travel Break the cement on the set-screw on the top of the stem button and adjust the setscrew and button for this dimension Tighten side locking setscrews

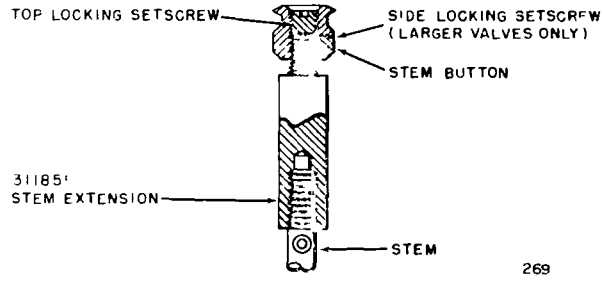


Fig 3 Detail of Stem Extension

5 Cement the top setscrew in place

6 Follow the procedure MOUNTING THE MP953A OR C OPERATOR

MOUNTING 13-INCH (330 mm) MP953A OR C OPERATOR WITH STEM EXTENSION (For 4-, 5- or 6-inch [101, 125 or 152 mm] Valves)

Special care must be taken when latching the 11/16-inch (17 mm) valve stem button to prevent damage to the plate assembly

The plate assembly with locking tabs, as illustrated in Fig 4, is designed to prevent the valve stem from spinning

To prevent spinning, align the flats of the hex stem button and place between the locking tabs If not properly aligned, the points of the hex button will smash the tabs when air is applied *DO NOT apply full air pressure to the actuator until all parts are properly aligned*

TO ATTACH STEM EXTENSION

1 Loosen setscrew in the side of the stem button and remove button from stem.

IMPORTANT

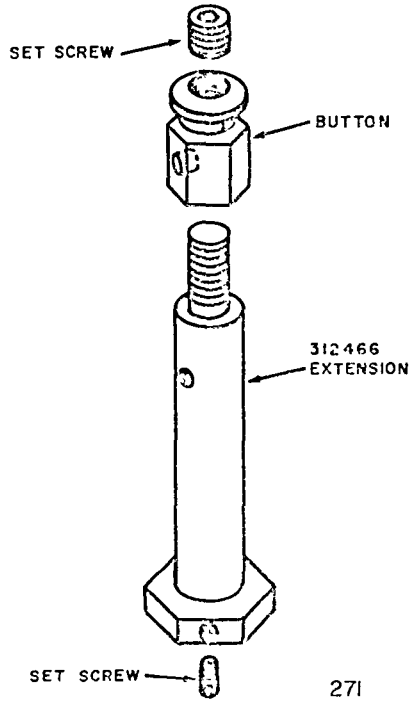
Do not move the setscrew located in the top of the stem button

2 Screw the stem extension onto the valve stem until it bottoms

NOTE The stem and extension are drilled to accept a 1/16-inch (1 5 mm) drift pin which can be used to assist in holding the stem while turning the extension

3 Screw the button onto the extension until the setscrew at the top of the button bottoms

4 Tighten the side setscrews firmly in the side of the button and the side of the stem extension.



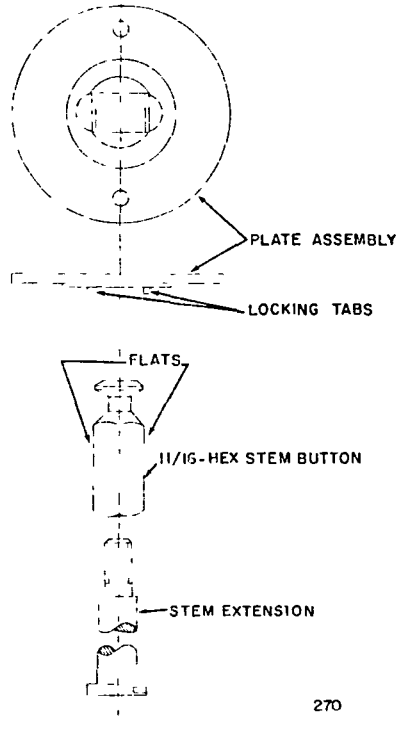


Fig 4 Stem Extension Details

Table 3 V5011A-D/MP953 Operator Selection Matrix

Body Style and Fig Ref	Valve Size In	A* In (mm)	I Travel In (mm)	D In (mm)	⚠1 Pneumatic Operator		
V5011A & C Screwed, Direct Body (Fig 5)	1/2 3/4 1 1-1/4 1-1/2 2 2-1/2 3	3-1/2 (89)	3/4 (19)	1-3/8 (35)	A1, C1 ↕ A1, C1	A2, C2 ↕ A2, C2	B1, D1 ↕ B1, D1
V5011A Flanged, Direct Body (Fig 6)	2-1/2 3	3-1/2 (89)	3/4 (19)	1-3/8 (35)		A2, C2 A2, C2	B1, D1 B1, D1
	4 5 6	5-1/4 (133)	1-1/2 (38)	1-7/8 (48)		A3, C3 A3, C3 A3, C3	
V5011B Flanged, Reverse Body (Fig 7)	4 5 6	6-3/4 (171)	1-1/2 (38)	1-7/8 (48)		A3, C3 A3, C3 A3, C3	
V5011D Flanged, Direct Body (Fig 6)	2-1/2 3	3-1/2 (89)	3/4 (19)	1-3/8 (35)		A2, C2 A2, C2	B1, D1 B1, D1
	4 5 6	5-1/4 (133)	1-1/2 (38)	1-7/8 (48)		A3, C3 A3, C3 A3, C3	
V5011E Flanged Reverse Body (Fig 7)	4 5 6	6-3/4 (171)	1-1/2 (38)	1-7/8 (48)		A3, C3 A3, C3 A3, C3	

*Dimension "A" is with valve closed (stem down for V5011A, C, and D, stem up for V5011B and E)

NOTES

⚠ The MP953A-D are rolling type diaphragm actuators which provide proportional control of V5011 valves

A1 - MP953A D A 5 in (127 mm) dia with positioner
A2 - MP953A D A 8 in (203 mm) dia with positioner
A3 - MP953A D A 13 in (330 mm) dia with positioner

B1 - MP953B R A 7-1/8 in (180 mm) dia with positioner

C1 - MP953C D A 5 in (127 mm) dia without positioner
C2 - MP953C D A 8 in (203 mm) dia without positioner
C3 - MP953C D A 13 in (330 mm) dia without positioner

D1 - MP953D R A 7-1/8 in (180 mm) dia without positioner

Table 4 V5013A-E/MP953 Operator Selection Matrix

Body Style and Fig Ref	Valve Size In	A In (mm)	E In (mm)	F In (mm)	⚠ Pneumatic Operator		
V5013A Three-Way Mixing Valve w/Screwed End Connections (Fig 8)	1/2 3/4 1 1-1/4 1-1/2 2	3-1/2 (89)	1-3/8 (35)	3/4 (19)	A1, C1 ↕ A1, C1	A2, C2 ↕ A2, C2	B1, D1 ↕ B1, D1
V5013B & D Three-Way Mixing Valve, Flanged End Connections (D Model for High Pressure Applications) (Fig 9)	2-1/2 3 4 5 6 8	3-1/2 (89)	1-3/8 (35)	3/4 (19)		A2, C2 A2, C2 A3, C3 A3, C3 A3, C3	B1, D1 B1, D1
		5-1/4 (133)	1-7/8 (48)	1-1/2 (38)			
		5-1/8 (130)	3-1/4 (83)	2 (51)	Industrial Type 01-15 or 01-18S		
V5013C & E Three-Way Diverting Valve, Flanged End Connections (E Model for High Pressure Applications) (Fig 9)	2-1/2 3 4 5 6 8	3-1/2 (89)	1-3/8 (35)	3/4 (19)		A2, C2 A2, C2 A3, C3 A3, C3 A3, C3	B1, D1 B1, D1
		5-1/4 (133)	1-7/8 (48)	1-1/2 (38)			
		5-1/8 (130)	3-1/4 (83)	2 (51)	Industrial Type 01-15 or 01-18S		

NOTES

⚠ The MP953A-D are rolling type diaphragm actuators which provide proportional control of V5013 valves

A1 - MP953A D A 5 in (127 mm) dia with positioner
A2 - MP953A D A 8 in (203 mm) dia with positioner
A3 - MP953A D A 13 in (330 mm) dia with positioner

B1 - MP953B R A 7-1/8 in (180 mm) dia with positioner

C1 - MP953C D A 5 in (127 mm) dia without positioner
C2 - MP953C D A 8 in (203 mm) dia without positioner
C3 - MP953C D A 13 in (330 mm) dia without positioner

D1 - MP953D R A 7-1/8 in (180 mm) dia without positioner

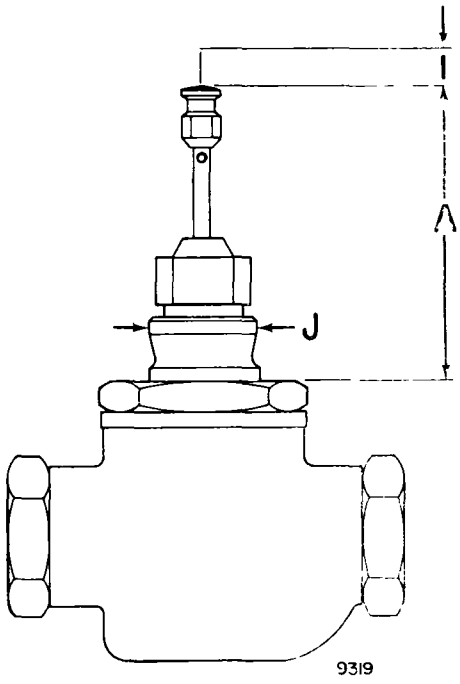


Fig 5 V5011A and C Screwed, Direct Acting Body Dimensions in Inches (Millimeters) Refer to Table 3

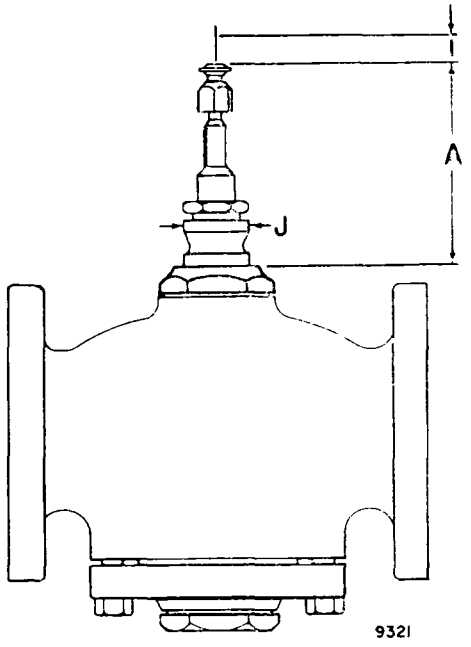


Fig 6 V5011A and D Flanged Body Dimensions in Inches (Millimeters) Refer to Table 3

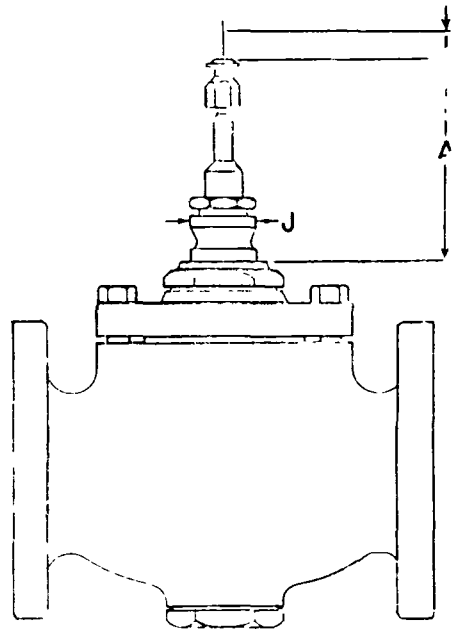


Fig 7 V5011B and E Flanged Body Dimensions in Inches (Millimeters) Refer to Table 3

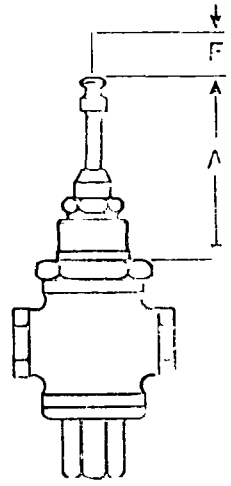


Fig 8 V5013A Screwed Body Dimensions in Inches (Millimeters) Refer to Table 4

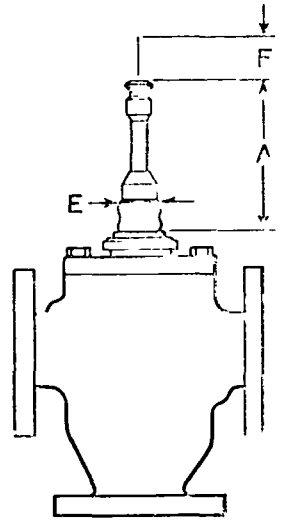


Fig 9 V5013B-E Flanged Body Dimensions in Inches (Millimeters) Refer to Table 4

MOUNT OPERATION

1 Loosen the two setscrews at the base of the actuator

2 Position the stem locking slide so that the large hole is in view (refer to Fig 2 and accompanying step 3) When the actuator is placed on the valve the stem locking slide is not visible This condition necessitates knowing the position of the stem locking slide by "feel"

When the dimpled tab on the vertical ear of the sliding stem lock is next to the spring, the stem lock is in the locked position and the small hole is now in view

3 Position actuator on valve bonnet *DO NOT tighten mounting setscrews in base of actuator*

4 SLOWLY apply air pressure to stroke actuator While applying pressure, rotate the operator until the stem button drops into the parallel locking tabs Secure stem button by pulling locking slide with fingers *Do not try to force with screwdriver or similar tool as damage to the slide will make it impossible to properly lock*

5 Remove air pressure Check actuator to be sure it is properly engaged to valve stem by trying to lift the actuator from the valve

6 If the actuator is properly fastened, return it to its original position on the valve and tighten the actuator to valve with the bonnet setscrews in the base of the actuator to complete the installation

MOUNTING THE MP953B OR D OPERATOR (Refer to Fig 10)

1 Pull the valve stem up

2 Remove the stem button connector from the operator and attach to the stem button

NOTE When properly installed, the horseshoe-shaped locking ring fits over the neck of the stem button and locks the two components together

3 Place the operator on the valve without pushing the stem down If the stem is pushed down, the threaded shank of the connector will not reach the operator

4 Turn the screw slot counterclockwise to backout stem button (It is also possible to hold the screw and spin the operator clockwise) This (on the straight-through valves only) brings the operator into contact with the shoulder of the stem button

5 Push the operator onto the valve bonnet and hold it firmly in place tighten the two setscrews

6 Load the stem by turning the stem button connector clockwise

a On a straight-through valve, turn the screw until a clearance of approximately 1/8-inch (3 mm) exists between spring and operator spider See Clearance "A", Fig 10

b On a three-way valve, a clearance is required at both ends of the stroke to permit proper close off See Clearance "A" and "B", Fig 10 Clearance should be the same on both ends of the spring If there is no air on the operator, adjust the "A" clearance when air is available

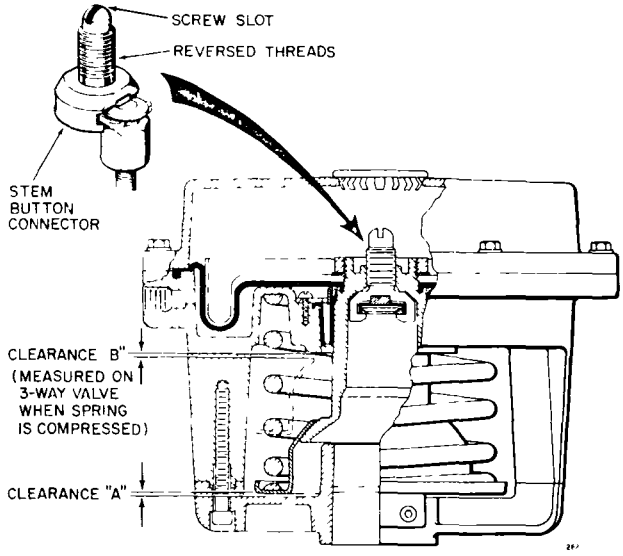


Fig 10 Details of MP953B or MP953D Operator Connected to Valve Stem

7 If the valve will not seat properly after the above adjustments, check for incorrect stem height Adjust the stem button, if necessary, for proper close-off

AIR PIPING

Honeywell recommends the use of 1/4-inch (6 mm) O D polyethylene tube and fittings Install gauge tees where necessary

NOTE Adjustments are necessary only for the Gradutrol* relay used with the MP953A and B actuators

OPERATING RANGE AND START POINT FOR ACTUATORS WITH POSITIVE POSITIONERS (See Fig. 11)

1 Using a wrench (Part No 301572A), loosen the cover locking screw

2 Unscrew the start point adjustment knob and make adjustments according to the directions printed inside the knob as follows

Range adjustment

a Three-pound (21 kPa) range, all screws backed off to friction stop

b Five-pound (34 kPa) range, plated (outer) screws tightened Black (inner) screws backed-off to friction stop

c Ten-pound (69 kPa) range, all screws tightened

Start point adjustment

a Tighten cover until it bottoms

b Back-off (one turn max) until desired start point of correct range scale lines up with indicator near "B" marking

c Tighten the cover locking screw until it engages the relay housing Do not over-tighten

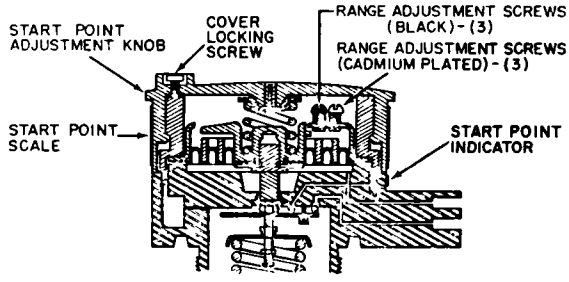


Fig 11 Adjustment Points of Gradutrol Relay

ADJUSTMENT CHECK

1 Install gauges in the main and pilot air lines

2 Slowly apply pilot pressure and note the pressure at which valve stem travel starts This pressure should be within +3/4 lb/in^2 (4 kPa) of the start point setting

3 Slowly increase pilot pressure until valve stem travel is complete This pressure should be within $\pm 3/4$ lb/in^2 (4 kPa) of the start point pressure plus the range setting

4 Make fine adjustments if necessary, with the start point adjustment knob

CAUTION

Loosen the cover locking screw before turning the start point adjustment knob

*Trademark

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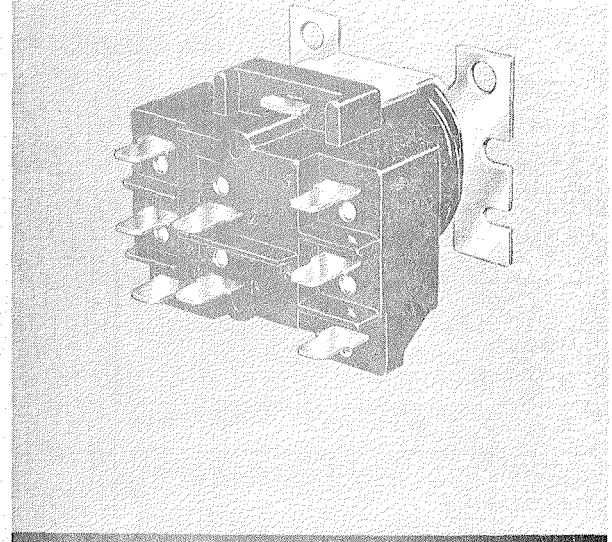
Honeywell

SWITCHING RELAYS



R4222; R8222; R4228; R8228

Form Number 60-2056-2

THE R4222, R8222, R4228 AND R8228 ARE GENERAL PURPOSE RELAYS FOR USE IN REFRIGERATION AND AIR CONDITIONING EQUIPMENT, APPLIANCES, VENDING MACHINES, AND OTHER APPLICATIONS REQUIRING GENERAL PURPOSE SWITCHING.

- R4222 and R8222 contacts are available for Powerpile (millivoltage), pilot duty, and power pole applications.
- R4228 and R8228 have power rated contacts only.
- R4222 and R4228 models have line voltage (120, 208/240, 277, or 480V ac) coils. R8222 and R8228 models have low voltage (24V ac) coils.
- Models available with a variety of switching configurations.
- Laminated magnet construction for high efficiency.
- Contacts rated for voltages up to 600V ac.
- Molded terminal numbers and circuit diagram on top of relay provide easy identification for wiring and checking system operation.
- Relay constructed for high reliability.
- Quick-connect terminals are standard; double quick-connects available on coil terminals.

V.J.
REV. 7-78 (.06)

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 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

R4222B,D,N,V Switching Relay–line voltage
R8222B,D,N,V Switching Relay–low voltage
R4228A,B,D Heavy-duty Relay–line voltage
R8228A,B,D Heavy-duty Relay–low voltage

TERMINALS R4222, R8222, R4228D and R8228D have single quick-connects on poles, double quick-connects on coil terminals R4228A,B and R8228A,B have double quick-connects on poles and double quick-connects on coil terminals.

SWITCHING CONFIGURATIONS R4222 and R8222, see Table II R4228 and R8228, see Table I

ADDITIONAL FEATURES

TRADELINE pack with cross reference label and special instruction sheet

STANDARD MODELS

MODELS

R4222–General purpose relay 120, 208/240, 277, and 480V ac coil.
R8222–General purpose relay 24V ac coil.
R4228–Heavy-duty general purpose relay 120, 208/240, 277, and 480V ac coil
R8228–Heavy-duty general purpose relay 24V ac coil

CONTACT RATINGS

Power Pole (amperes per pole)–

R4222, R8222[c]	120V AC	208V AC	240V AC	277V AC	480V AC
Inductive					
Full Load	12	6	6	6	3
Locked Rotor	60	35	35	35	18
Resistive					
A and C Models[b]	20 8	20 8	20 8	20 8	10
(equivalent resistive power)	(2 5 kW)	(4 3 kW)	(5 0 kW)	(5 7 kW)	(4 8 kW)
All Others[b]	15	15	15	15	10
Combined Ratings for A and C Models[a]					
Resistive	12 5	12 5	12 5	12 5	6 25
(equivalent resistive power)	(1 5 kW)	(2 6 kW)	(3 0 kW)	(3 4 kW)	(3 0 kW)
Inductive	+4 2 AFL, 10 0 ALR				+2 1 AFL 5 0 ALR
Horsepower	3/4 hp	3/4 hp	3/4 hp	3/4 hp	3/4 hp

[a]Combined ratings indicate that both a resistive and inductive load can be operated by each pole

[b]Also rated 5 amp resistive at 600 volts [c]Underwriters Laboratories Inc and CSA approved for 50 cycle applications.

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. **Order number, specify TRADELINE if desired**
2. **Contact ratings**
3. **Coil ratings**
4. **Double quick-connects on coil terminals 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

Pilot Duty Poles for R4222 and R8222 Only
Minimum–3 VA at 24, 120, and 480V ac
Maximum–25 VA at 24V ac, 125 VA at 120, 240, and 480V ac
Resistive–3 amps at 277V ac (0 75 power factor)

Powerpile (millivoltage) for R4222 and R8222 Only:

The normally open pilot duty contacts are rated for Powerpile (millivoltage) applications–0.25 amp at 0 25 to 12V dc.

Power Pole (amperes per pole)–

R4228A,B, R8228A,B	120V AC	208V AC	240V AC	277V AC	480V AC
Inductive					
Full Load	16 | 18	18	18	12	5
Locked Rotor	96 | 72	72	72	72	30
Resistive[a]	25	25	25	25	15
(equivalent resistive power)	(3 0 kW)	(5 2 kW)	(6 0 kW)	(6 9 kW)	(7 2 kW)
Horsepower	1 hp	2 hp	2 hp	2 hp	1.5 hp
R4228C,D, R8228C,D	**120V AC**	**208V AC**	**240V AC**	**277V AC**	**480V AC**
Inductive					
Full Load	5 5	5 5	5 5	5 5	3.0
Locked Rotor	15	15	15	15	8
Resistive[a]	25	25	25	25	12.5
(equivalent resistive power)	(3 0 kW)	(5 2 kW)	(6 0 kW)	(6 9 kW)	(6 0 kW)
Combined Ratings[b]					
Resistive	20 8	20 8	20 8	20 8	10.4
(equivalent resistive power)	(2 5 kW)	(4 3 kW)	(5 0 kW)	(5 6 kW)	(5 0 kW)
Inductive	+4 2 AFL, 10 0 ALR				+2 1 AFL 5.0 ALR

[a]Also rated 10 amps resistive at 600 volts

[b]Combined ratings indicate that both a resistive and an inductive load can be operated by each pole

COIL RATINGS All coils meet Underwriters Laboratories Inc requirements for Class B coils

If coil voltages other than those listed below are desired, contact your local Honeywell representative for additional information

COIL RATINGS		24V	120V	208/240V	277V	480V
DC Resistive		9 5 ohms 9 25 ohms[b]	232 ohms	875 ohms	1385 ohms	3600 ohms
Pickup Voltage (maximum)[a]		18V	96V	176V	220V	384V
Pickup Voltage (nominal)		16 ± 2V	80 ± 10V	150 ± 20V	190 ± 30V	330 ± 40V
Dropout Voltage (nominal)		11 ± 2V	55 ± 10V	100 ± 20V	130 ± 30V	225 ± 40V
Inrush VA (maximum)		20 VA	20 VA	20 VA	20 VA	20 VA
Inrush VA (nominal)		17 0 VA 17 7 VA[b]	17 0 VA	13 5 VA/18 5 VA	17.8 VA	17 VA
Sealed VA (maximum)		10 VA	10 VA	10 VA	10 VA	10 VA
Sealed VA (nominal)		9 VA 9 5 VA[b]	9 VA	6 7 VA/9 2 VA	9 7 VA	9 VA
Sealed Amps (nominal)		375 A 400 A[b]	075 A	032 A/ 038 A	034 A	.019A
Sealed Wattage		5 0 watts 5 3 watts[b]	5 4 watts	3 6 watts/5 watts	5 5 watts	5.5 watts
Admittance	(open)	029 031[b]	0012	0003	0002	.00007
	(sealed)	016 016[b]	0006	00015	00012	00004

[a]Voltages listed are for the relay base mounted vertical With the terminals pointing down, pickup voltage is increased by 12 percent

[b]R8222D,G,J,N,R,T,V only

NOTE Pickup voltage varies with pole form Specific models will have lower tolerance than shown above.

TERMINALS· Quick-connects are provided as shown

MODEL	TERMINALS	NUMBER OF QUICK-CONNECTS	
		SINGLE	DOUBLE
R4222 & R8222	Coil	Std	Opt
	Load	Std	–
R4228 & R8228	Coil	–	Std
R4228A,B & R8228A,B	Load	–	Std
R4228C,D & R8228C,D	Load	Std	–

MOUNTING· Use 2 screws (up to No 10 size) through holes in the metal base Base is designed for easy replacement of competitive relays

MAXIMUM AMBIENT TEMPERATURE 155 F [68 C]

DIMENSIONS See Fig 1

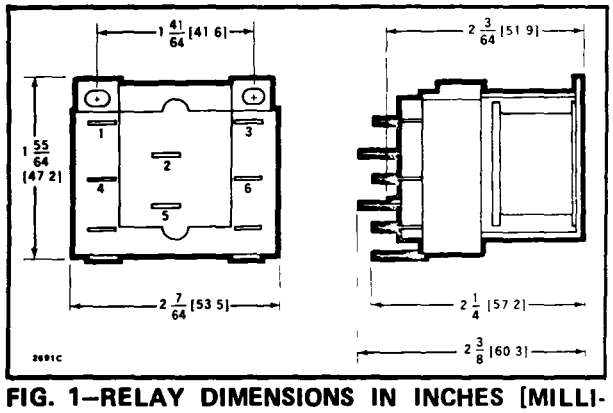


FIG. 1–RELAY DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

SWITCHING CONFIGURATIONS

The following tables give switching configurations, contact ratings, and terminal designations for the switching relays For example, the R4222A is a spst switching relay with normally open power rated contacts The R4222K is a spst relay with normally open contacts rated for pilot duty applications Electrical connections to the A and K models would be made to terminals 1 and 3

TABLE I–R4228, R8228

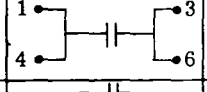
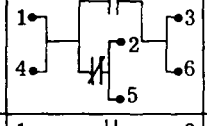
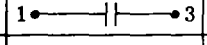
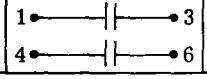
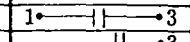
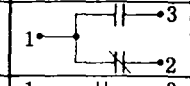
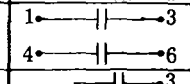
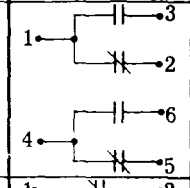
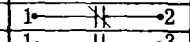
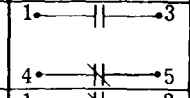
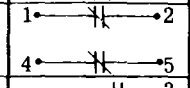
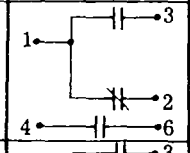
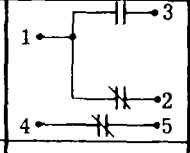
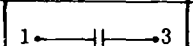
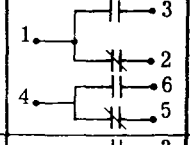
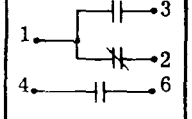
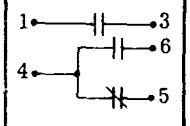
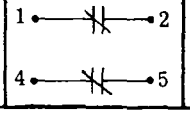
SWITCHING CONFIGURATION	TERMINALS	R4228 OR R8228 MODEL SUFFIX
		POWER RATED ONLY
SPST, N O (DOUBLE QUICK-CONNECTS)		A
SPDT, (DOUBLE QUICK-CONNECTS)		B
SPST, N O		C
DPST, N O		D

TABLE II–R4222, R8222

SWITCHING CONFIGURATION	TERMINALS	R4222 OR R8222 MODEL SUFFIX	
		POWER RATED	PILOT DUTY RATED
SPST, N O		A	K
SPDT		B	L
DPST, N O		C	M
DPDT		D	N
SPST, N C		E	P
DPST, 1-N O AND 1-N C		F	Q
DPST, N C		G	R
SPDT AND SPST, N O		H	S
SPDT AND SPST, N C		J	T
DPST N O (ONE POWER AND ONE PILOT DUTY)		†U	
DPDT (ONE POWER AND ONE PILOT DUTY)		†V	
SPDT AND SPST, N O (ONE POWER AND ONE PILOT DUTY)		†W	
SPDT AND SPST, N O (ONE POWER AND ONE PILOT DUTY)		†Y	
DPST, N C		†Z	

†Models with suffix letters U,V,W,Y, and Z have power rated contacts on silver colored terminals and pilot duty rated contacts on brass colored terminals

ACCESSORIES

1. 129384A Case and Cover Assembly

2. 4074BVJ Receptacle with 8 color-coded plug-in leadwires and retaining bail, for panel mounting applications, see Fig. 2.

3. Q633A1003–4 x 4 plate-mounted relay receptacle with metal relay cover and 8 color-coded plug-in leadwires.

NOTE

a Use the receptacle in applications within the current carrying rating of the wire size and quick-connect terminal being used

b. The receptacle will accept relays with double quick-connect terminals

4. 135959 Receptacle only Leads and quick-connect terminals are not supplied with the receptacle

NOTE Not all standard quick-connect terminals will be adequately retained in this receptacle It is recommended that a quick-connect terminal with 0 016 inch [0 406 mm] maximum material thickness be used (0 012 inch [0 305 mm] preferred). The maximum permissible dimension between the rolls is 0 115 inch [2 92 mm] These requirements are met by AMP, Inc Faston "250" series terminal No. 42100-1 quick-connects or equivalent

5. 135887 Wire Bail only

6 137891A Adapters for converting 1/4 inch [6 4 mm] quick-connects to No. 6 screw terminals (bag of eight)

UNDERWRITERS LABORATORIES INC. COMPONENT RECOGNIZED

R4222 and R8222 models A to H,J,U,V,W,Y,Z; File No E59779, Guide No NLDX2.

R4222 and R8222 models K,L,M,N,P,Q,R,S,T; File No E49809, Guide No NKCR2

R4228 and R8228 models A,B,C,D, File No. E59779, Guide No NLDX2.

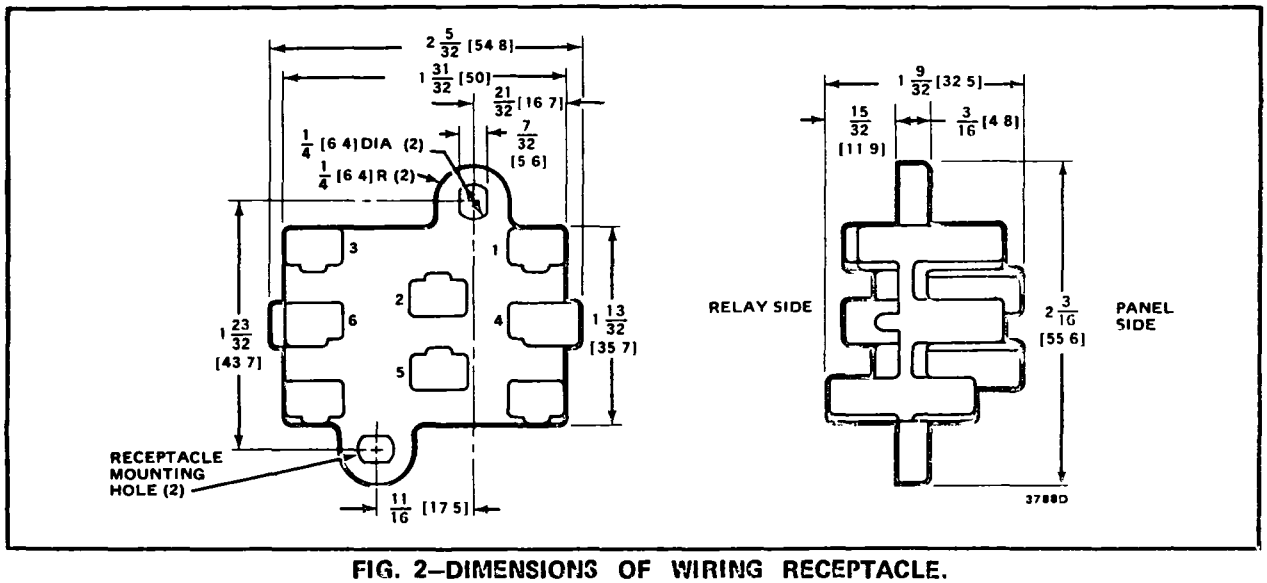


FIG. 2–DIMENSIONS OF WIRING RECEPTACLE.

CAUTION

1. Installer must be a trained, experienced service technician
2. Disconnect power supply before beginning installation to prevent electrical shock and equipment damage.
3. Always perform a thorough checkout when installation is complete
4. All wiring must comply with applicable codes and ordinances

LOCATION

Mount the relay on a flat, solid surface as close as possible to the equipment being controlled *The relay may be mounted in any position except with the terminals pointed down* Secure in place with two screws through holes or slots in the mounting base or as shown in Fig 3 or 4 See Fig 1 for mounting dimensions

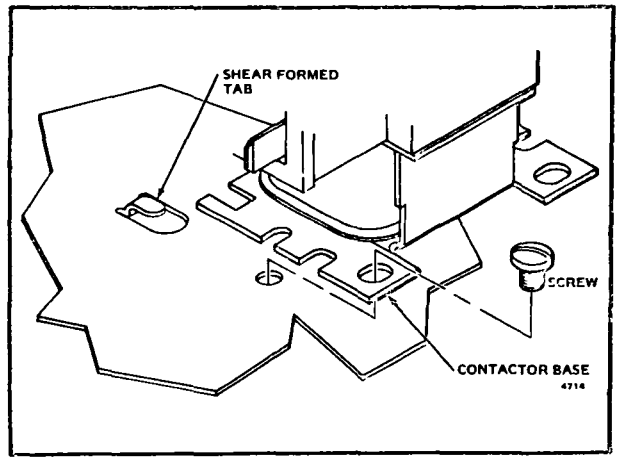


FIG. 3–MOUNTING RELAY ON PANEL WITH SHEAR FORMED TAB AND 1 SCREW.

WIRING

Disconnect power supply before connecting wiring to avoid electrical shock or equipment damage

All wiring must comply with local codes and ordinances Crimp female quick-connects to the system wires and attach to the male quick-connect terminals of the relay The relay has molded terminal numbers and circuit diagram for easy identification when wiring Fig 6 shows the location and circuits of all models

Do not exceed contact and coil ratings when wiring into system

Leadwires are provided with the 135959 Receptacle in 4074BVJ Bag Assembly for additional relay pole positions Insert the required leadwires in the relay receptacle as follows

Determine the leadwire colors required for the relay and application desired Push the leadwire terminal into the receptacle plate from the side stamped with the numbers (Fig 5) When inserting the leadwire, the tang on the quick-connect terminal must align with the small clearance slot in the terminal opening Press the terminal in until it locks in place

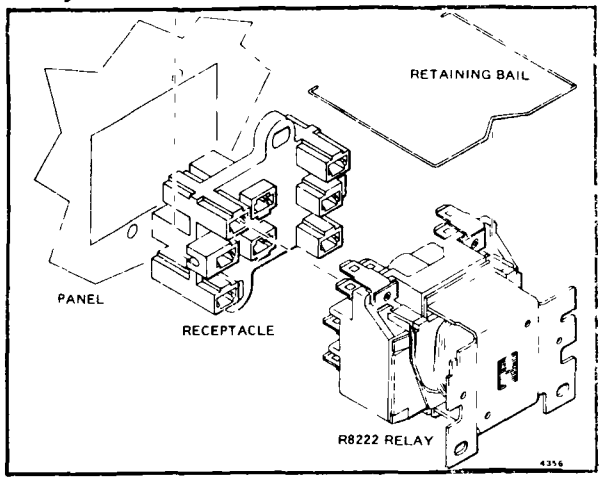


FIG 4–RELAY MOUNTING USING RECEPTACLE AND RETAINING BAIL.

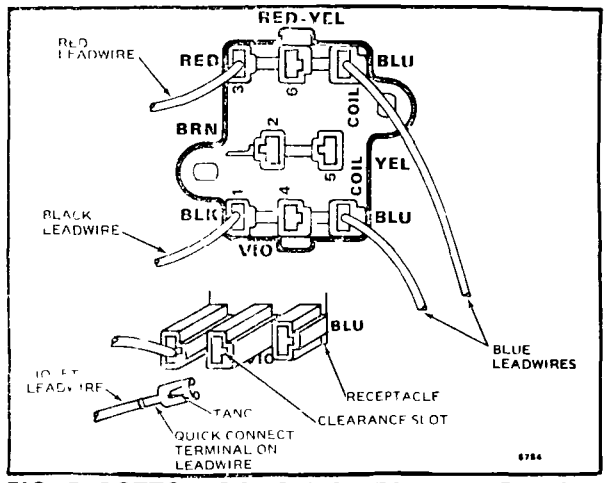


FIG 5–BOTTOM OF 135959 RECEPTACLE SHOWING LEADWIRE INSTALLATION

CHECKOUT

Operate the relay and controlled equipment to make sure that relay pulls in when the coil is energized and that controlled equipment operates as intended

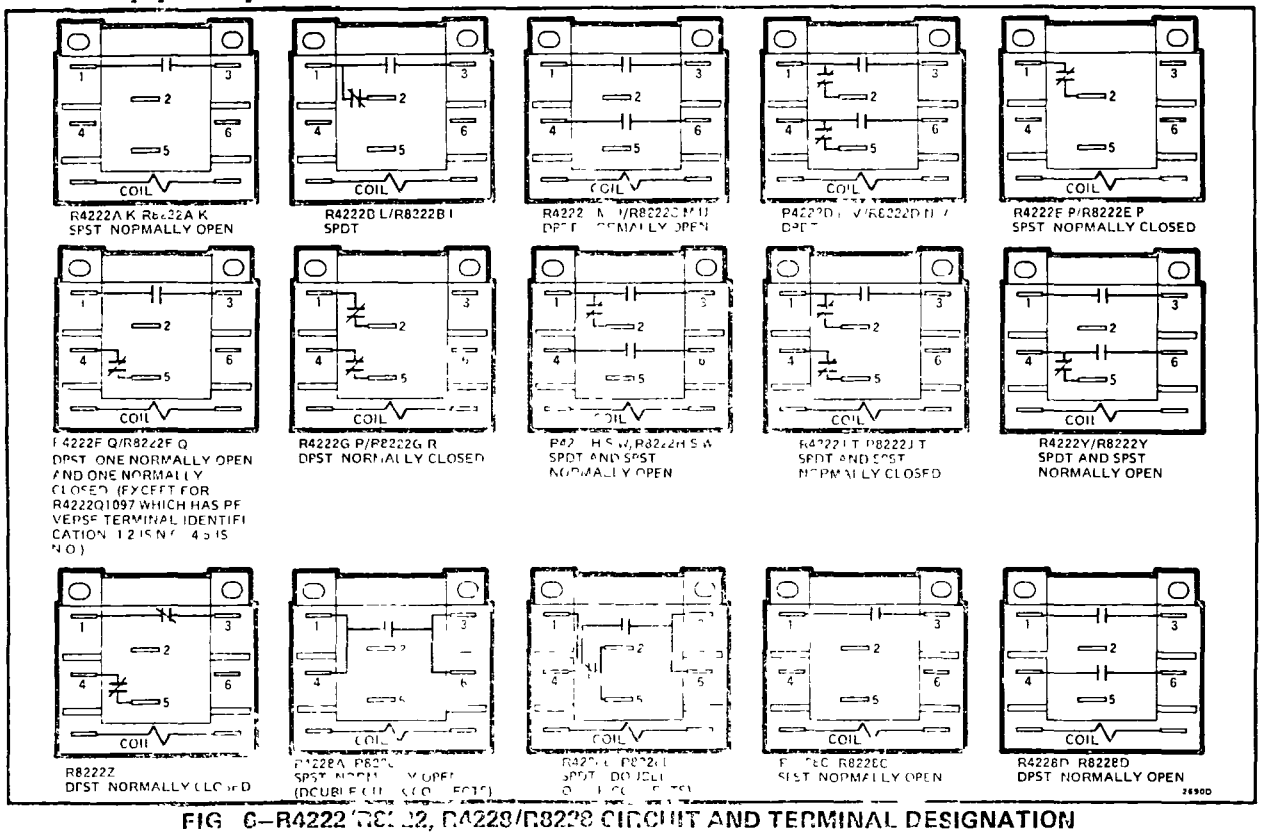


FIG 6–R4222 R8222, R4228/R8228 CIRCUIT AND TERMINAL DESIGNATION

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

Honeywell

Comfort Control Systems

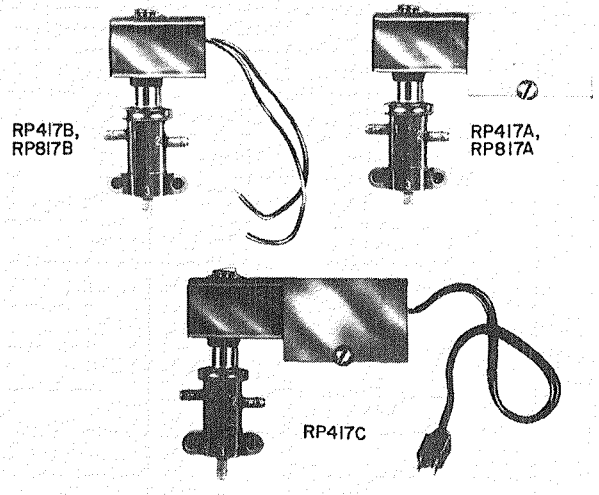
RP417A, B, C; RP817A, B ELECTRIC-PNEUMATIC RELAYS

Service Data

GENERAL

The RP417 and RP817 Electric-Pneumatic Relays are electrically operated pneumatic switches used for interlock between an electrical system and a pneumatic control system. These devices can also be used as stop and bleed relays or as diverting or selector relays.

The RP417 and RP817 Relay valve bodies are designed for either wall mounting or panel mounting. They can be mounted in any position without affecting the operation of the device. An optional mounting kit (14003638-001) is available to facilitate direct mounting to MP516A Operators, VP519C Valves, or PP901B and PP902B Pressure Regulators.



SPECIFICATIONS

AIR CAPACITY: At 20 psi (138 kPa) supply; 1 psi (7 kPa) pressure drop: 0.30 SCFM.

MODELS:

	Line Voltage	Low Voltage	Wall Mount	Panel Mount	Device Mount	Splice Box	Open Coil	Cord & Plug
RP417A	X		X		X	X		
RP417B	X			X			X	
RP417C	X		X		X	X		X
RP817A		X	X		X	X		
RP817B		X		X			X	

AVAILABLE VOLTAGE-CYCLE

Model	Complete O S No.	Voltage-Cycle
RP417A	1009	110/120v AC, 50/60 Hz
	1017	120v AC, 50 Hz
	1025	220/240v AC, 50/60 Hz
	1033	240v AC, 50 Hz
	1041	208v AC, 60 Hz
	1058	208v AC, 50 Hz
	1066	277v AC, 60 Hz
	1074	277v AC, 50 Hz
	1082	440/480v AC, 50/60 Hz
	1090	480v AC, 50 Hz
	1108	100v AC, 50 Hz
	1116	200v AC, 50 Hz
RP417B	1007	110/120v AC, 50/60 Hz
	1015	120v AC, 50 Hz
	1023	220/240v AC, 50/60 Hz
	1031	240v AC, 50 Hz
	1049	208v AC, 60 Hz
	1056	208v AC, 50 Hz
	1064	440/480v AC, 50/60 Hz
	1072	480v AC, 50 Hz
RP417C	1005	110/120v AC, 50/60 Hz
	1013	120v AC, 50 Hz
RP817A	1005	24v AC, 50 Hz
	1013	24v AC, 60 Hz
RP817B	1003	24v AC, 50 Hz
	1011	24v AC, 60 Hz

APPLICATION

The RP417 and RP817 Relay can function as a three way normally open air valve, a three way normally closed air valve, or a three way diverting control, depending upon the piping hookup If applied as shown in Figure 1, when the fan is turned on, the coil is energized, passing supply air to the damper operator With the fan off, the supply port is closed Ports 2 and 3 are connected, bleeding the air from the damper operator to atmosphere

OPERATION

When the coil is de-energized, ports 2 and 3 are connected and port 1 is blocked When the coil is energized, ports 1 and 3 are connected and port 2 is blocked

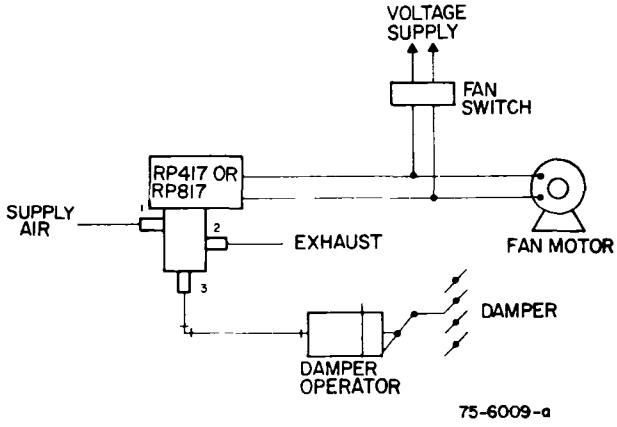


Fig 1 Typical Piping Hookup of the RP417 or RP817 Relays

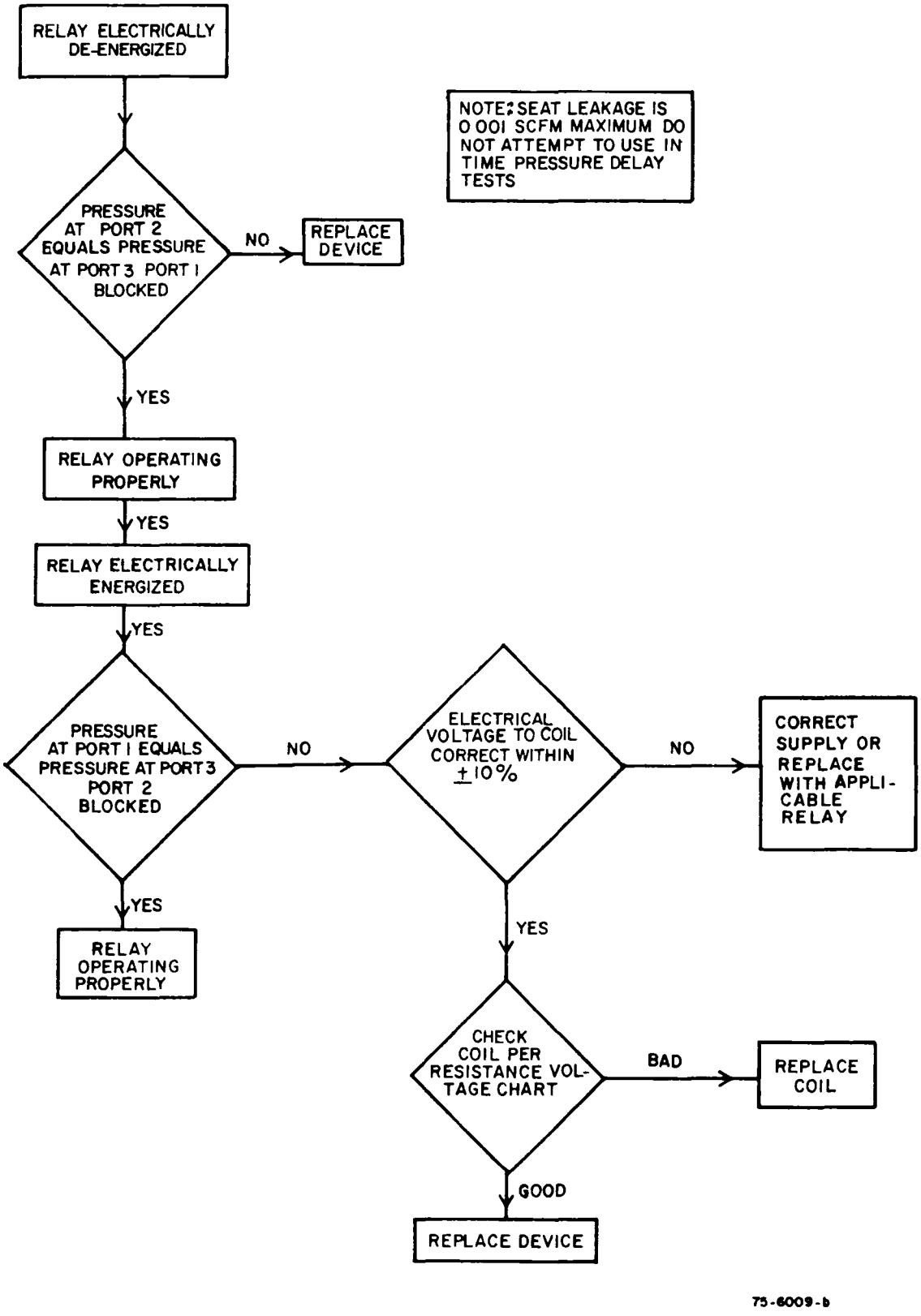
MAINTENANCE

Once the RP417 or RP817 is installed, no maintenance is necessary All movable working parts are internal so the device should never need to be cleaned This relay also requires no lubrication

Coil Resistance–Voltage Chart

Coil Part No 14003535-	Voltage/Hz	Resistance in Ohms ±10% at 68 F (20 C)
001	120/60 110/50	855
002	120/50	1030
003	240/60 220/50	3300
004	240/50	4750
005	208/60	2300
006	208/50	3100
007	277/60	4750
008	277/50	5350
009	480/60 440/50	13200
010	480/50	16000
011	100/50	600
012	200/50	2950
013	24/50	35 5
014	24/60	32
015	575/60	20570
016	110/60	775
017	24V dc	91

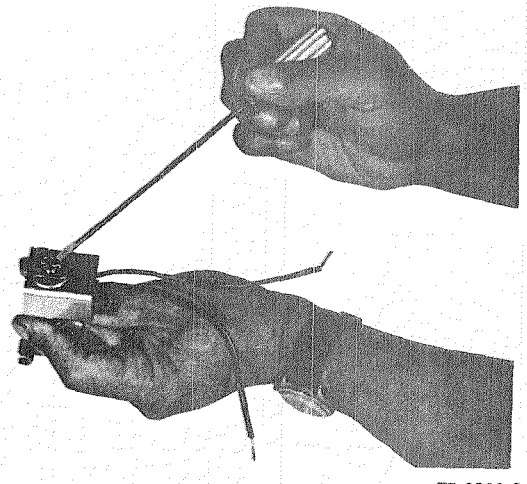
TROUBLESHOOTING CHART



CAUTION

Before attempting any repairs, be sure to disconnect electrical power and shut off the air supply to the relay.

All parts of the RP417-RP817 Relays, with the exception of the splice box cover on splice box models, are held in place by a spring action retaining clip (14003532-001). In order to disassemble the relay for repairs, this clip must first be removed. Using a small screwdriver (see Fig. 2), bend the clip in the direction of its built-in spring action so the clip itself is not damaged. When the clip is removed, the valve body should slide easily free from the rest of the relay, freeing the parts for replacement.

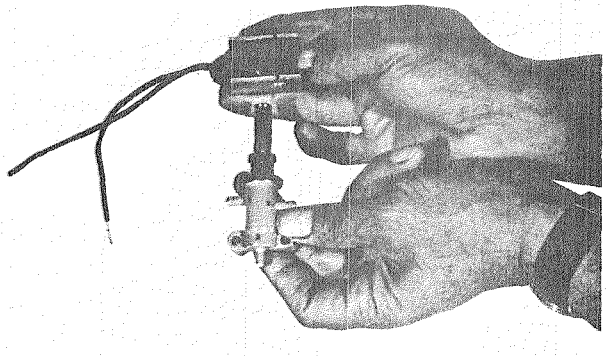


75-6009-2

Fig. 2. Use a Small Screwdriver to Remove the Spring Clip.

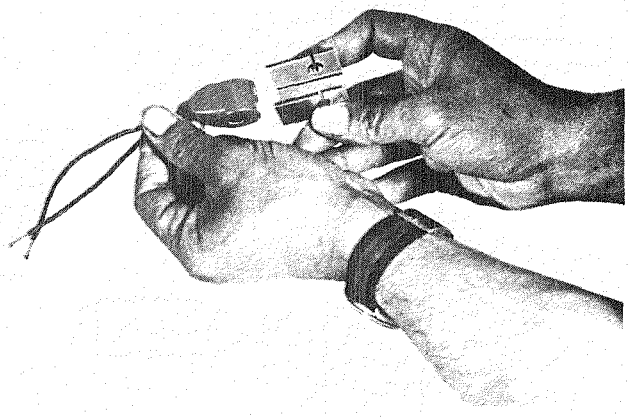
COIL REPLACEMENT PROCEDURE

1. After removing the valve body from the rest of the relay (see Fig. 3), separate the defective coil from the yoke as shown in Figure 4. It should come free from the yoke when pressure is applied to it.



75-6009-3

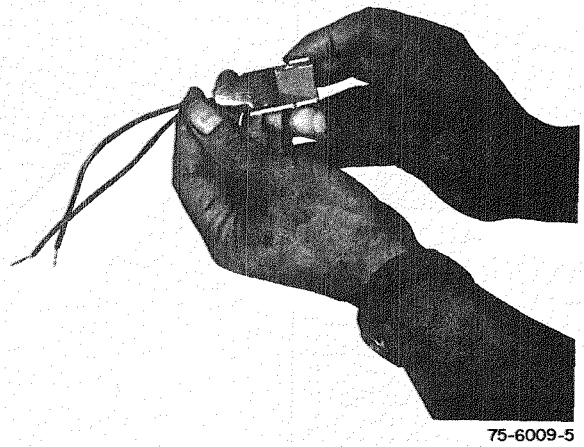
Fig. 3. Remove the Valve Body from the Rest of the Relay.



75-6009-4

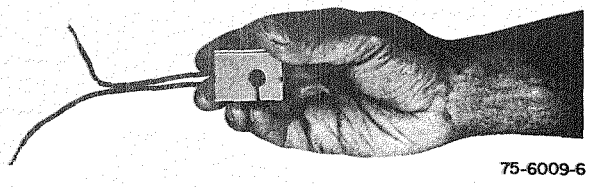
Fig. 4. Push the Defective Coil Out of the Yoke.

2. Push the replacement coil into the yoke and align the holes so the valve body can be slid into place as shown in Figures 5 and 6.



75-6009-5

Fig. 5. Push the Replacement Coil into the Old Yoke.



75-6009-6

Fig. 6. Align the Hole in the Coil with the Holes in the Yoke.

NOTE: On splice box models, the electrical leads will have to be pulled through the grommet in the box when removing the old coil and will have to be pushed back through the grommet when installing the new coil. See Figures 7 and 8.

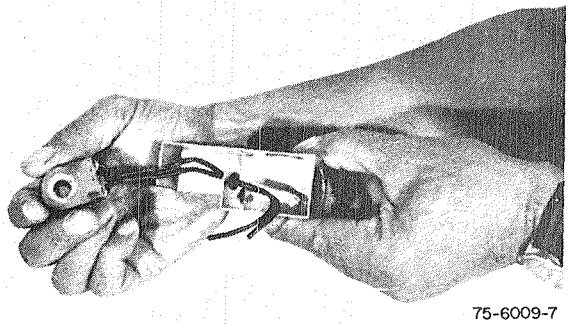


Fig. 7. Pull the Electrical Leads Through the Grommet in the Splice Box.

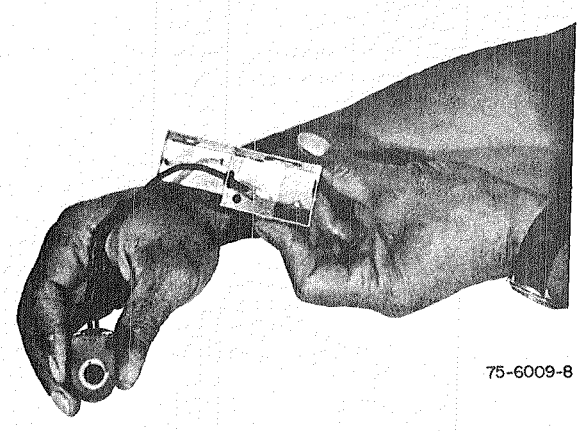


Fig. 8. Insert the Leads of the New Coil Through the Grommet in the Splice Box.

3. After the new coil has been aligned and the valve body replaced, reinstall the clip spacer and retaining clip as shown in Figure 9. Power and air supply can be restored to the device. Then check operation.

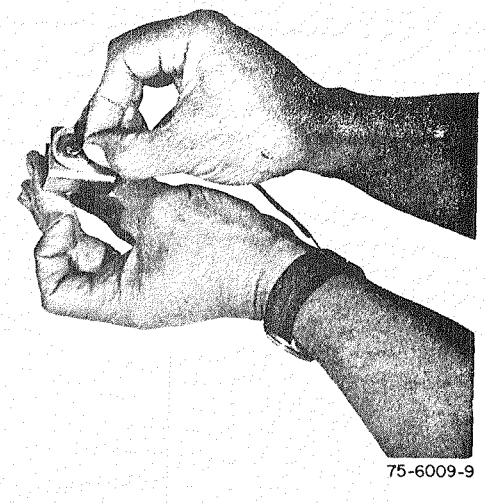


Fig. 9. Push the Spring Clip Back into Place.

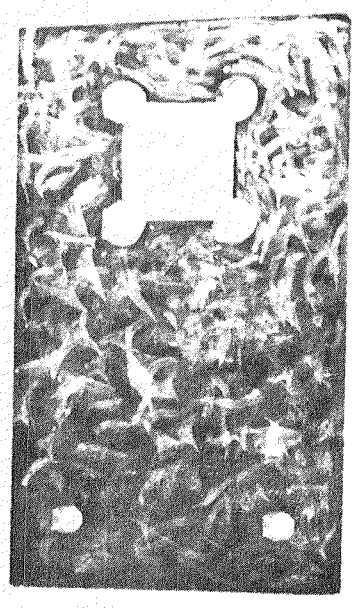


Fig. 10. Optional Mounting Kit 14003638-001 Contains 14003637-001 Mounting Bracket Shown Above. The RP417 and RP817 Relays Can Be Directly Mounted to MP516A Operators, VP519C Valves, or PP901B and PP902B Pressure Regulators by Using This Kit.

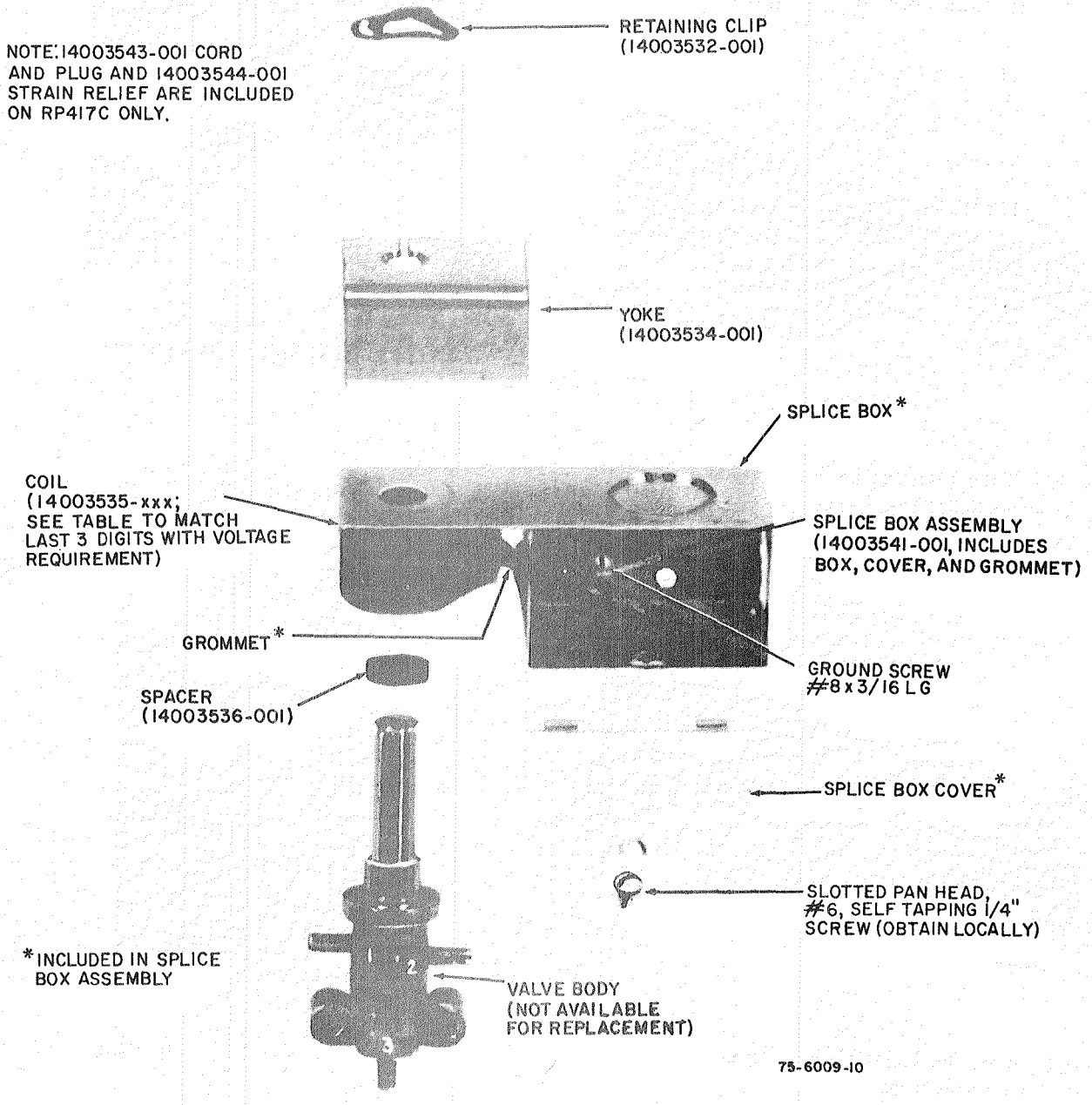


Fig. 11. Exploded View of the RP417A, RP417C, or RP817A.

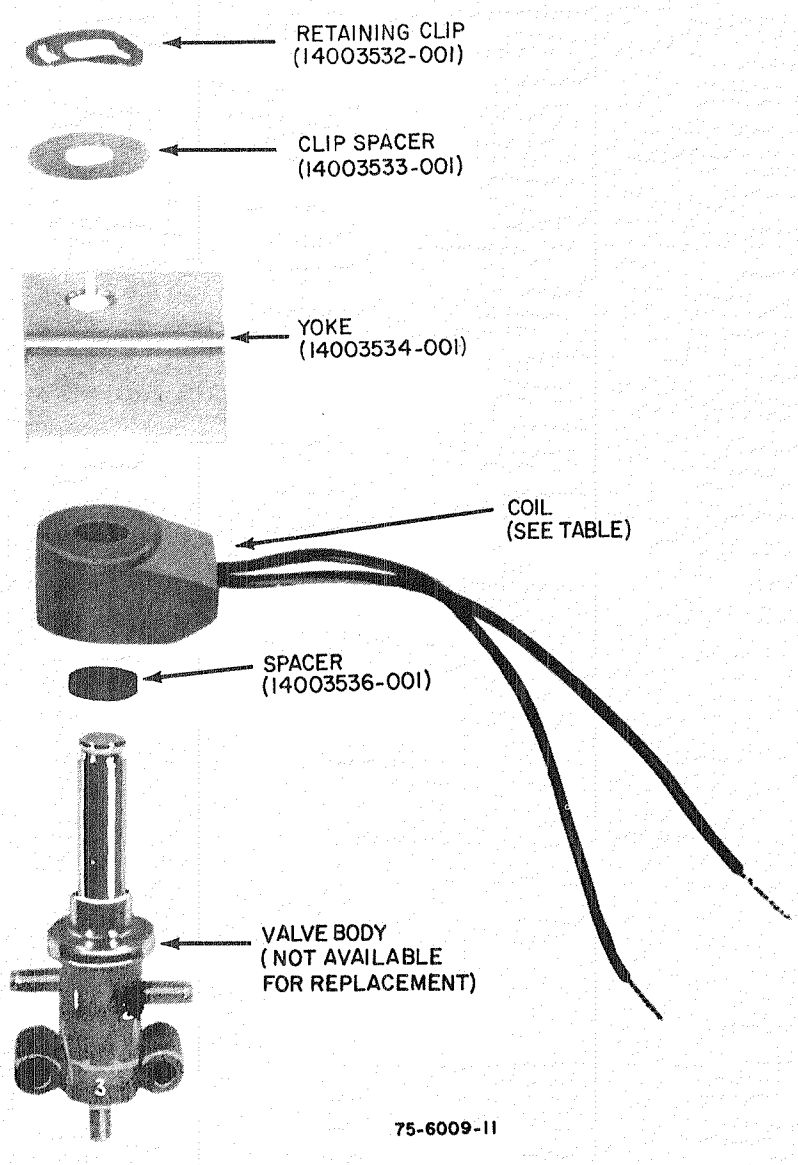


Fig. 12. Exploded View of the RP417B or RP817B.

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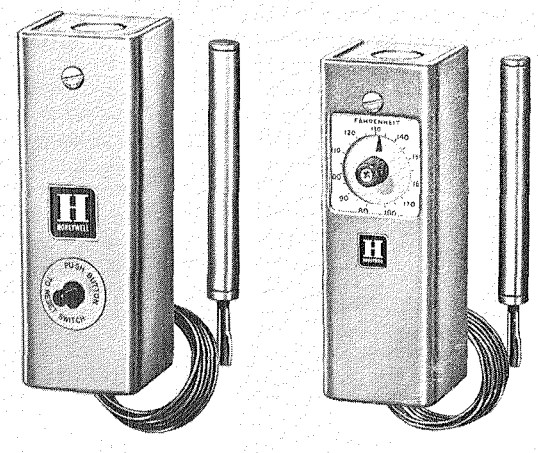
MAINTENANCE AND REPAIR

T675A, B; T678A, B and T478A TEMPERATURE CONTROLLERS

INTRODUCTION

The following instructions are for maintenance, repair and parts replacement of the T675A, T678A, T675B, T678B, and the T478A Temperature Controllers. Standard tools may be used to disassemble and reassemble these controllers. A calibration wrench, Honeywell part number 801534, is required for field calibration. Table 1 of this form lists the recommended cleaning solvent and lubricant. An exploded view drawing and parts list are included to facilitate repair. All parts are designated by part number and description. For ordering information, see note on page 11.

NOTE: Obtain prices form our local branch office. Prices and availability are subject to change without notice.



T675A T675B

MAINTENANCE

PERIODIC MAINTENANCE: Inspection, Cleaning, and Lubrication.

CAUTION: Be sure to disconnect power source from the controller before removing cover to work on internal components.

1. Inspect the controller for external and internal damage.
2. Brush or blow away all dust and dirt. If parts appear damaged, remove controller and disassemble.
3. Clean disassembled parts in the solvent listed in Table 1. Order replacement parts from the parts list on this sheet.
4. When reassembling the controller, coat all screw threads lightly with the lubricant listed in Table 1.

Table 1

TOOL OR MATERIAL	APPLICATION
Inhibited 1, 1, 1-Trichloroethane such as Chlorothene or Vythene.	Obtain locally—Remove caked grease and dirt which cannot be removed easily. Caution: Do not allow any solvent to get into the snap switches.
Lubricant — Multi-Purpose Grease (Honeywell part number 802771—4 oz. Tube).	Obtain from Honeywell branch office—lubricate screw threads to prevent rust and corrosion.
Calibration Wrench—Honeywell part number 801534.	Obtain from Honeywell branch office—calibrate dial setting to bulb temperature — (see CALIBRATION).

CAUTION: Use special care when using solvents. Avoid prolonged inhalation and/or contact with the skin. Careless handling can result in permanent damage to the respiratory system and skin tissue.

OPERATION CHECK:

A quick operational check can be performed by raising or lowering the setpoint through the temperature, including the differential, of the medium controlled. This should cause the controlled equipment to operate.

CALIBRATION

All controllers are carefully tested and calibrated at the factory under conditions that are accurately controlled. If the controller is not operating at a temperature corresponding to the scale setting and differential setting, check to see that the bulb is in a position to sense 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. This can be done by placing an accurate thermometer along side the bulb of the controller, or by referring 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 to be 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 counterclock-

wise from the top of the scale, to simulate a temperature rise, until the R-W switch contacts make. Note the dial reading.

Calibrate the dial as follows.

1. Assume that the setpoint on the dial is 70 degrees, but while moving the dial the controlled equipment comes on at 50 degrees—this means the controller is off calibration by 20 degrees. You must increase the calibration by 20 degrees.
2. 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 the dial and the calibration nut, with the wrench, to a dial indication of 65 degrees. This will raise the calibration by 20 degrees.
3. Repeat step 1 to check your adjustment. If you find the setpoint still off, repeat step 2.

T678A·

These controllers are calibrated so that the adjustable (left hand switch) makes on a temperature rise. This point represents the dial setting. Rotate the dial counterclockwise from the top of the scale, to simulate a temperature rise, until the left hand switch makes. Note the dial reading. Continue rotating dial until the right hand switch makes. The difference between the two readings indicates the switch differential. The adjustable switch must make at a lower reading than the right hand switch. Adjust the differential if necessary, by turning the adjustment screw (visible through the lower left hand corner of the frame). Changing the differential setting 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.

Calibrate the dial as follows

1. Assume that the setpoint on the dial is 70 degrees, but while moving the dial the controlled equipment comes on at 50 degrees—this means the controller is off calibration by 20 degrees. You must increase the calibration by 20 degrees.
2. 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 the dial and the calibration nut, with the wrench, to a dial indication of 65 degrees. This will raise the calibration by 20 degrees.
3. Repeat step 1 to check your adjustment. If you find the setpoint still off, repeat step 2.

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.

Calibrate the dial as follows

1. Assume that the setpoint on the dial is 70 degrees, but while moving the dial the controlled equipment comes on at 50 degrees –this means the controller is off calibration by 20 degrees. You must increase the calibration by 20 degrees.
2. 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 the dial and the calibration nut, with the wrench, to a dial indication of 65 degrees. This will raise the calibration by 20 degrees.
3. To check the calibration, reset the switch by pushing the reset button. Rotate the dial until the switch breaks. Note the reading and compare with the temperature at the bulb. Readjust the dial, if necessary, until the bulb temperature and the dial reading correspond.

T678A·

These controllers are calibrated so that the adjustable (left hand switch) breaks on a temperature fall. This point represents the dial setting. Rotate the dial clockwise from the bottom of the scale, to simulate a temperature fall, until the left hand switch breaks. Note the dial reading. Continue rotating the dial until the right hand switch breaks. The difference between the two readings indicates the switch differential. The adjustable switch must break at a higher reading than the right hand switch.

Adjust the differential, if necessary, by turning the adjustment screw (visible through the rear of the frame). Changing the differential setting may change the calibration.

Measure the temperature at the bulb. Rotate the dial clockwise, from the bottom of the scale, to simulate a temperature fall, until the contacts of the left hand switch break. Note the reading.

Calibrate the dial as follows:

1. Assume that the setpoint on the dial is 70 degrees, but while moving the dial the controlled equipment comes on at 50 degrees—this means the controller is off calibration by 20 degrees. You must increase the calibration by 20 degrees.
2. 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 the dial and the calibration nut, with the wrench, to a dial indication of 65 degrees. This will raise the calibration by 20 degrees.
3. Repeat step 1 to check your adjustment. If you find the setpoint still off, repeat step 2.

T678B

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 re-calibration is not recommended. To verify calibration, compare temperature at bulb with an accurate 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 SETPOINT.

4. Adjust the actual setpoint (on the scale of the T678B) to the THEORETICAL SETPOINT.

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

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 SETPOINT (cooling application) On a temperature fall, the SETPOINT shifts Models of the T678B, with a fixed interstage differential break P to W (make P to B) of the left hand switch on a temperature fall to the THEORETICAL SETPOINT

5. TO CALIBRATE

a. Find the difference between the actual operating point and the THEORETICAL SETPOINT by turning the dial of the controller with a screwdriver while observing the controlled equipment For example, assume that the THEORETICAL SETPOINT 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. To check your adjustment, repeat step a. If you find the THEORETICAL SETPOINT and the actual setpoint still off, repeat step b

PARTS LIST

NOTE Four digit numbers listed in MODELS column indicate complete Ordering Specification Number EXAMPLE T675A1003 Number in parentheses indicates quantity of parts used

PARTS LIST FOR FIG. 1

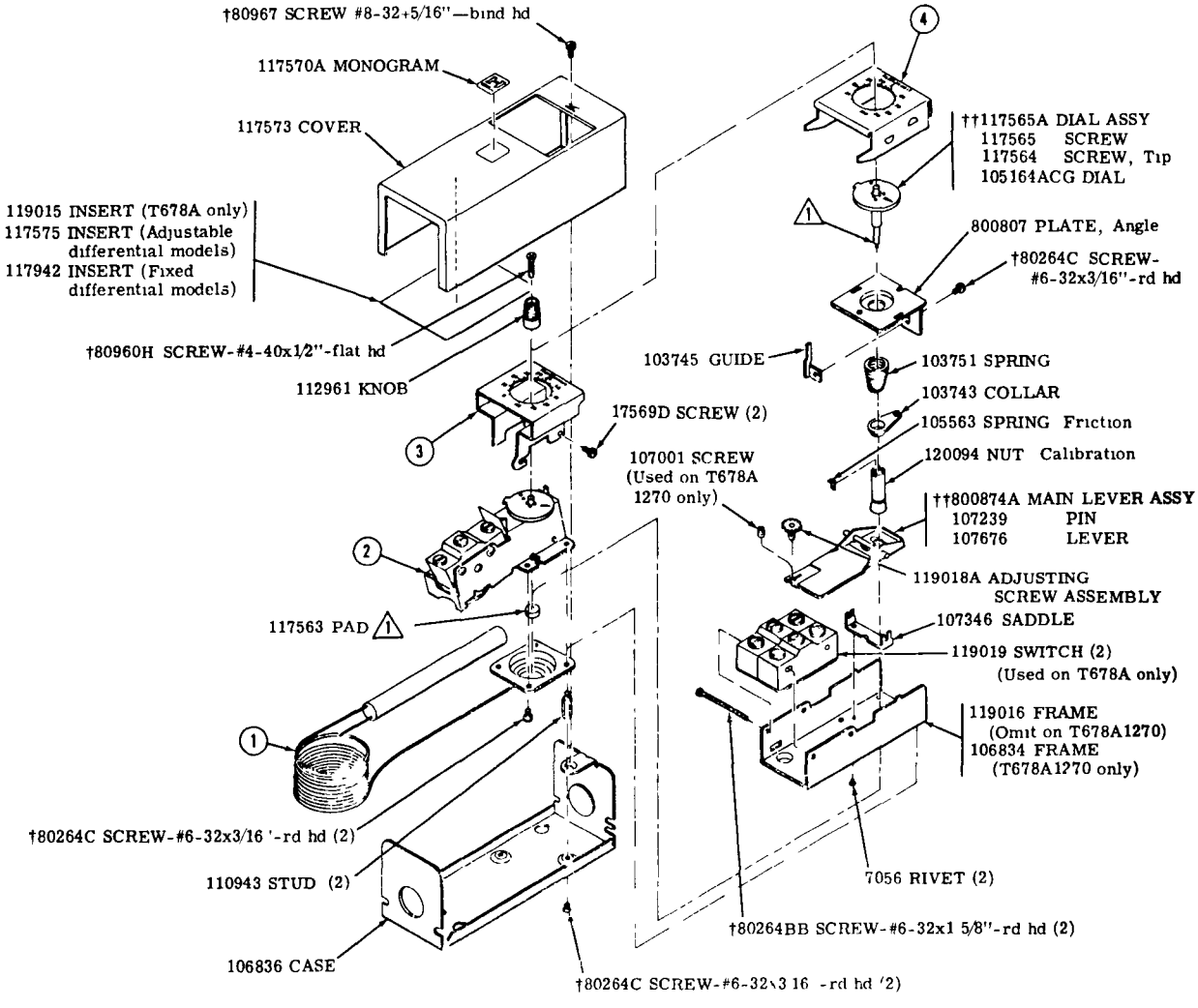
KEY	PART NO.	DESCRIPTION	MODEL	
			T675A	T678A
1	108109AACA	ELEMENT ASSEMBLY (0 to 100°F, -15 to 35°C, 5' copper)	1003 1011 1169 1284 1508 1516	1007 1155 1497
1	108109AACB	ELEMENT ASSEMBLY (80 to 180°F, 30 to 80°C, 5' copper)	1052 1201 1326	1049 1197
1	108109AACC	ELEMENT ASSEMBLY (160 to 260°F, 75 to 125°C, 5' copper)	1094 1243 1334 1532	1080 1229
1	108109AECF	ELEMENT ASSEMBLY (55 to 175°F, 15 to 75°C, 5' copper)	1417 1453 1466 1540	1353 1395 1445
1	108109ACCA	ELEMENT ASSEMBLY (0 to 100°F, -15 to 35°C, 20'copper)	1029 1136 1177 1292	1015 1163
1	108109ACCB	ELEMENT ASSEMBLY (80 to 180°F, 30 to 80°C, 20' copper)	1060 1219	1056 1205
1	108109ACCC	ELEMENT ASSEMBLY (160 to 260°F, 75 to 125°C, 20' copper)	1102 1250	1098 1247

Parts list for Fig 1 continued on page 4

PARTS LIST FOR FIG 1 CONTINUED

KEY	PART NO.	DESCRIPTION	MODEL	
			T675A	T678A
1	108109AGCF	ELEMENT ASSEMBLY (55 to 175°F, 15 to 75°C, 20' copper)	1425 1474 1524	1361 1403
1	108109ACLA	ELEMENT ASSEMBLY (0 to 100°F, -15 to 35°C, 20'stainless steel)	1045 1151 1193 1318	1031 1189
1	108109ACLB	ELEMENT ASSEMBLY (80 to 180°F, 30 to 80°C, 20'stainless steel)	1086 1235	1072 1221
1	108109ACLC	ELEMENT ASSEMBLY (160 to 260°F, 75 to 125°C, 20' stainless steel)	1128 1276	1114 1262

Parts list for Fig 1 continued on page 5



⚠1 Coat the screw to pad and pad to diaphram surfaces with 802771 GREASE, Multipurpose

†Standard parts (screws, washers, electrical components, etc.) should be obtained locally when possible. Component values are subject to change without notice. Always use exact replacement parts when making repairs.

††Because the component parts of this assembly are staked or require a special assembly process, it is recommended that a complete replacement assembly be ordered.

NOTE For information on seperable wells, pressure fittings and bulb holders see Data Sheet 90-0559

75-5193

Fig 1—T675A and T678A Temperature Controllers

PARTS LIST FOR FIG. 1 CONTINUED

KEY	PART NO.	DESCRIPTION	MODEL	
			T675A	T678A
1	108109AGLF	ELEMENT ASSEMBLY (55 to 175°F, 15 to 75°C, 20' stainless steel)	1441 1490	1387 1429
1	108109AALA	ELEMENT ASSEMBLY (0 to 100°F, -15 to 35°C, 5' stainless steel)		1270
1	108109ACMA	ELEMENT ASSEMBLY (0 to 100°F, -15 to 35°C, 20' monel)	1037 1144 1185 1300	1023 1171
1	108109ACMB	ELEMENT ASSEMBLY (80 to 180°F, 30 to 80°C, 20' monel)	1078 1227	1064 1213
1	108109ACMC	ELEMENT ASSEMBLY (160 to 260°F, 75 to 125°C, 20' monel)	1110 1268	1106 1254
1	108109AGMF	ELEMENT ASSEMBLY (55 to 175°F, 15 to 75°C, 20' monel)	1433 1482	1379 1411
2	800806A	††FRAME ASSEMBLY	1011	
	80264AF	†SCREW-#6-32x1"-rd hd (2)	1136	
	117565A	††SCREW ASSEMBLY	1144	
	105563	SPRING, Friction (As needed)	1151	
	117937	NUT	1284	
	801032	SPRING	1292	
	110560	BARRIER	1300	
	111175	SWITCH	1318	
	27544	NUT, Hex (2)	1326	
	800806	FRAME	1334	
	801033	LEVER, Reverse	1458	
	125612	PIN	1516	
	117568	PLATE	1524	
	110556	COLLAR		
2	800806B	††FRAME ASSEMBLY	1003	
	117572	SWITCH	1029	
	117565A	††SCREW ASSEMBLY	1037	
	117937	NUT	1045	
	800806	FRAME	1052	
	80264AF	†SCREW-#6-32x1"rd hd (2)	1060	
	105563	SPRING, Friction (As needed)	1078	
	801032	SPRING	1086	
	110560	BARRIER	1094	
	27544	NUT, Hex (2)	1102	
	801033	LEVER, Reverse	1110	
	125612	PIN	1128	
	117568	PLATE	1508	
	110556	COLLAR	1532	
2	800806C	††FRAME ASSEMBLY	1169	
	801702	SWITCH	1177	
	117565A	††SCREW ASSEMBLY	1185	
	117937	NUT	1193	
	800806	FRAME	1201	
	80264AF	†SCREW-#6-32x1"-rd hd (2)	1219	
	105563	SPRING, Friction (As needed)	1227	
	801032	SPRING	1235	
	110560	BARRIER	1243	
	27544	NUT, Hex (2)	1250	
	801033	LEVER, Reverse	1268	
	125612	PIN	1276	
	117568	PLATE		
	110556	COLLAR		

Parts list for Fig. 1 continued on page 6

PARTS LIST FOR FIG 1 CONTINUED

KEY	PART NO	DESCRIPTION	MODEL T675A	MODEL T678A
2	800806D	††FRAME ASSEMBLY	1417	
	802593	SWITCH	1425	
	117565A	††SCREW ASSEMBLY	1433	
	117937	NUT	1441	
	800806	FRAME	1540	
	80264AF	†SCREW-#6-32x1"-rd hd (2)		
	105563	SPRING, Friction (As needed)		
	801032	SPRING		
	110560	BARRIER		
	27544	NUT, Hex (2)		
	801033	LEVER, Reverse		
	125612	PIN		
	117568	PLATE		
	110556	COLLAR		
2	800806E	††FRAME ASSEMBLY	1466	
	802594	SWITCH	1474	
	117565A	††SCREW ASSEMBLY	1482	
	117937	NUT	1490	
	800806	FRAME		
	80264AF	†SCREW-#6-32x1"-rd hd (2)		
	105563	SPRING, Friction (As needed)		
	801033	LEVER, Reverse		
	125612	PIN		
	117568	PLATE		
	27544(2)	NUT, Hex		
	110556	COLLAR		
	801032	SPRING		
	110560	BARRIER		
3	109070A	SCALEPLATE (0 to 100°F)	1003	
			1011	
			1029	
			1037	
			1045	
			1136	
			1144	
			1151	
			1508	
			1516	
3	109070B	SCALEPLATE (80 to 180°F)	1052	
			1060	
			1078	
			1086	
			1326	
3	109070C	SCALEPLATE (160 to 260°F)	1094	
			1102	
			1110	
			1128	
			1334	
			1532	
3	109070D	SCALEPLATE (15 to 35°C)	1169	
			1177	
			1185	
			1193	
			1284	
			1292	
			1300	
			1318	
3	109070E	SCALEPLATE (30 to 80°C)	1201	
			1219	
			1227	
			1235	

Parts list for Fig 1 continued on page 7

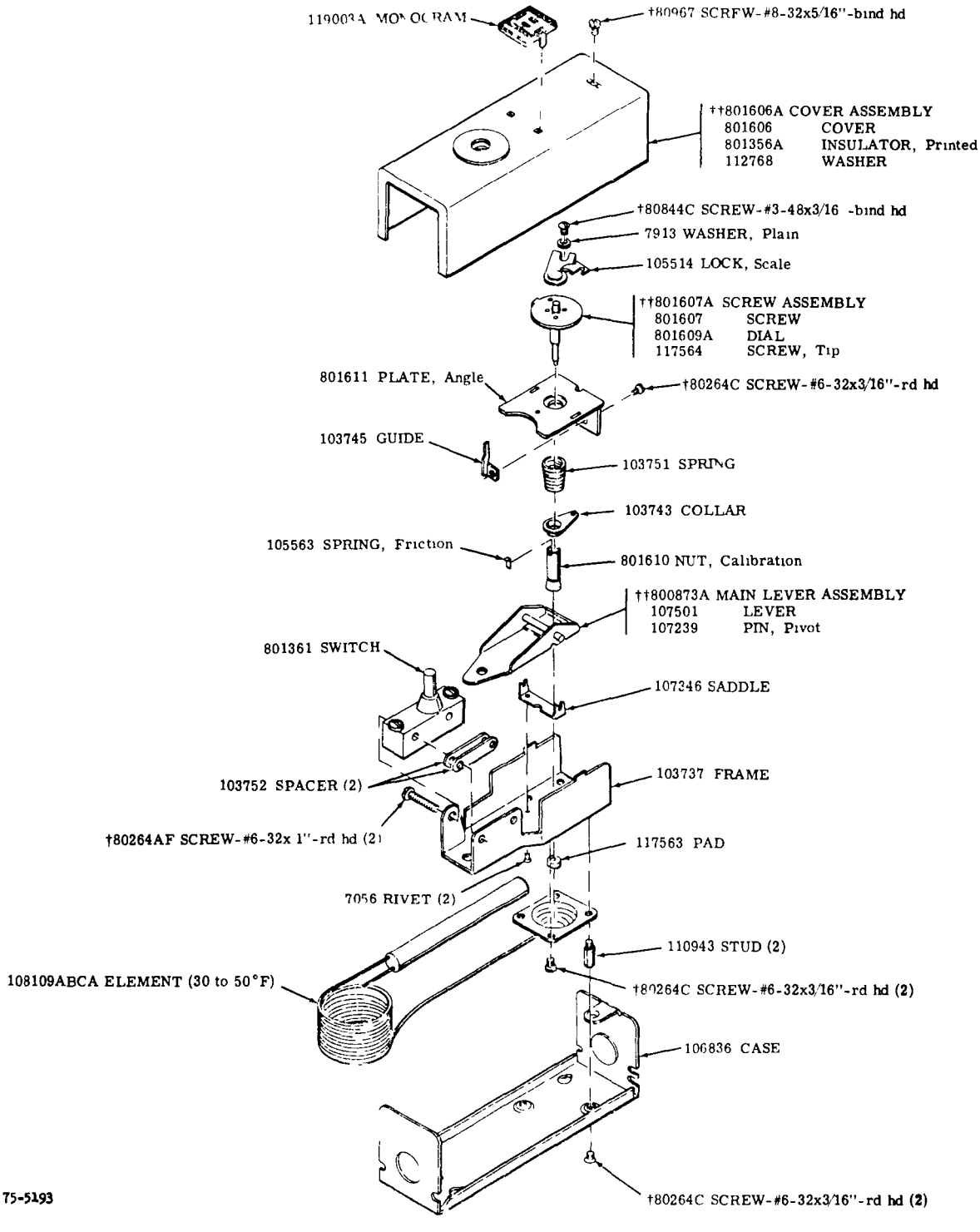
PARTS LIST FOR FIG. 1 CONTINUED

KEY	PART NO.	DESCRIPTION	MODEL T675A	MODEL T678A
3	109070F	SCALEPLATE (-75 to 125°C)	1243 1250 1268 1276	
3	109070H	SCALEPLATE (55 to 175°F)	1417 1425 1433 1441 1458 1540	
3	109070J	SCALEPLATE (15 to 75°C)	1466 1474 1482 1490	
4	109076A	SCALEPLATE (0 to 100°F)		1007 1015 1023 1031 1270 1437
4	109076B	SCALEPLATE (80 to 180°F)		1049 1056 1064 1072
4	109076C	SCALEPLATE (160 to 260°F)	1080 1098 1106 1114	
4	109076D	SCALEPLATE (-15 to 35°C)	1155 1163 1171 1189	
4	109076E	SCALEPLATE (30 to 80°C)	1197 1205 1213 1221	
4	109076F	SCALEPLATE (75 to 125°C)	1239 1247 1254 1262	
4	109076G	SCALEPLATE (55 to 175°F)	1353 1361 1379 1387 1445	
4	109076H	SCALEPLATE (15 to 75°C)	1395 1403 1411 1429	
		ACCESSORIES		
	107324A	BULB HOLDER	1508	
	4074BR	ENVELOPE ASSEMBLY	1532	
	80703	SCREW-Sheet metal	1540	
	105900	CLAMP, 'T' plate		All Models

NOTE For information on separable wells, pressure fittings, and bulb holders see Data Sheet 90-0559.

†Standard parts (screws, washers, electrical components, etc) should be obtained locally when possible. Component values are subject to change without notice Always use exact replacement parts when making repairs.

††Because the component parts of this assembly are staked or require a special assembly process, it is recommended that a complete replacement assembly be ordered

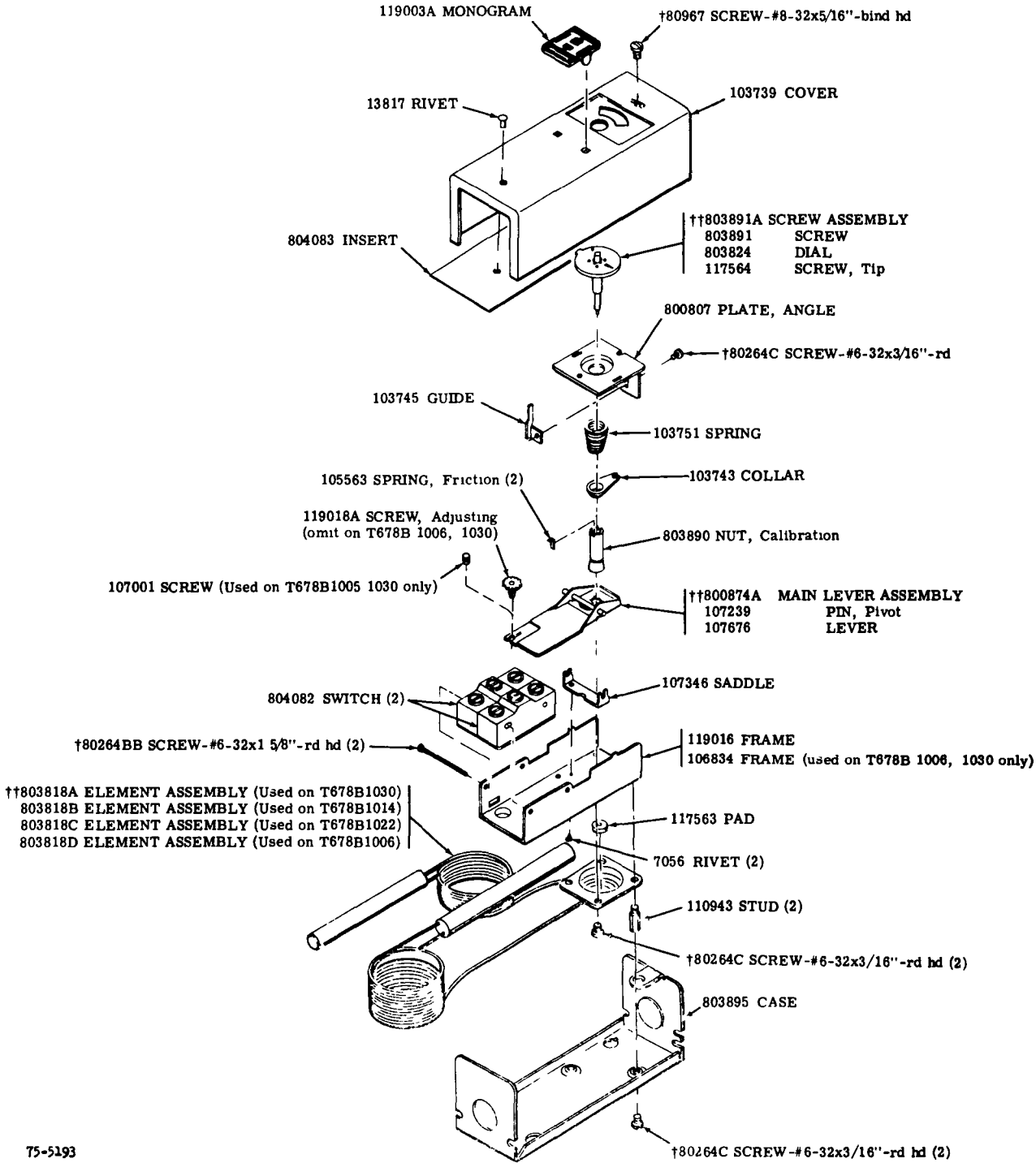


†Standard parts (screws, washers, electrical components etc) should be obtained locally when possible Component values are subject to change without notice Always use exact replacement parts when making repairs

††Because the component parts of this assembly are staked or require a special assembly process, it is recommended that a complete replacement assembly be ordered

NOTE For information on separable wells pressure fittings and bulb holders see Data Sheet 90-0559

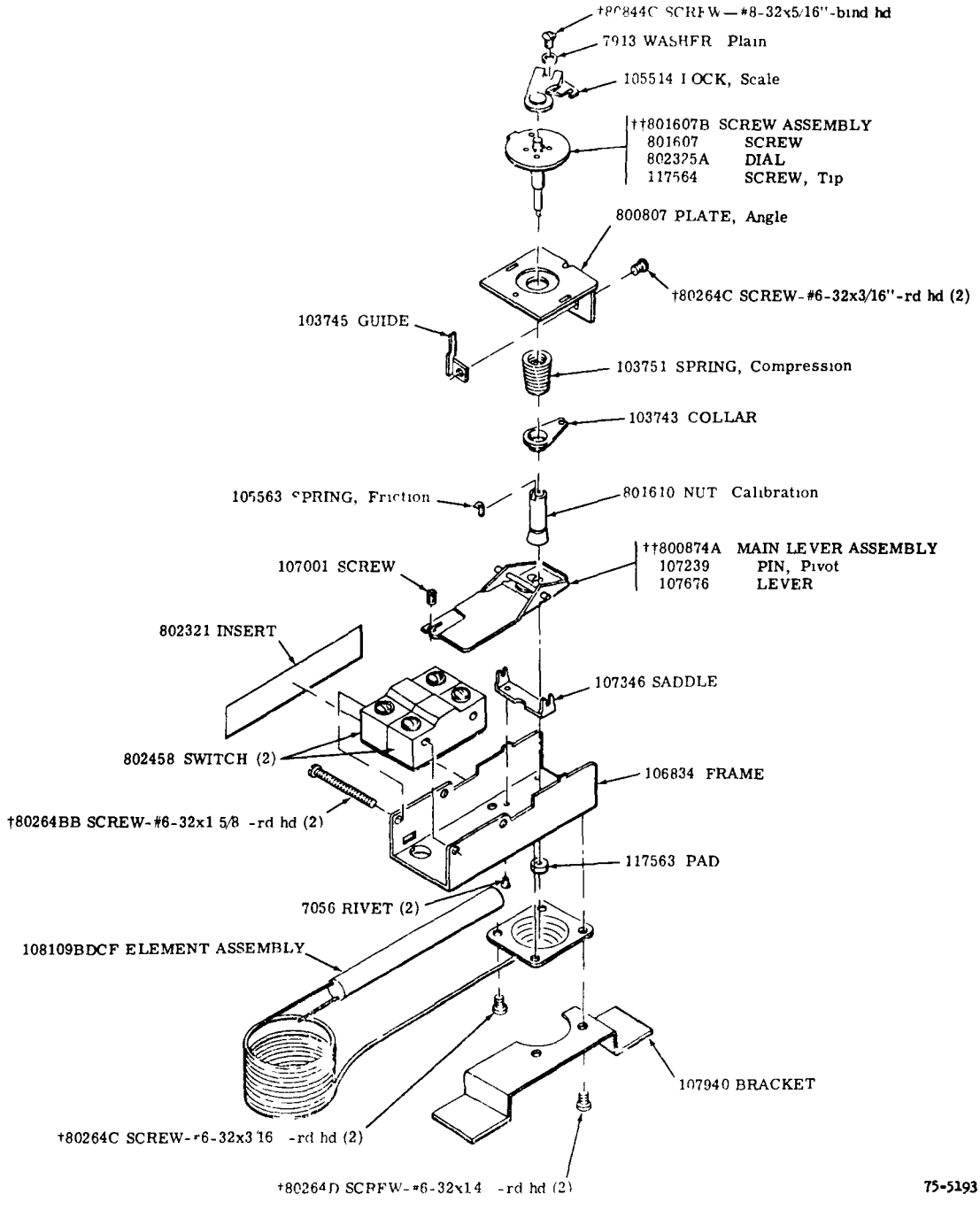
Fig 2—T675B Temperature Controller



†Standard parts (screws, washers, electrical components, etc) should be obtained locally when possible Component values are subject to change without notice Always use exact replacement parts when making repairs
††Because the component parts of this assembly are staked or require a special assembly process, it is recommended that a complete replacement assembly be ordered

NOTE For information on separable wells, pressure fittings and bulb holders see Data Sheet 90-0559

Fig 3—T678B Temperature Controller



†Standard parts (screws, washers, electrical components, etc.) should be obtained locally when possible. Component values are subject to change without notice. Always use exact replacement parts when making repairs.
††Because the component parts of this assembly are staked or require a special assembly process, it is recommended that a complete replacement assembly be ordered.

NOTE: For information on separable wells, pressure fittings and bulb holders see Data Sheet 90-0539.

Fig. 4—T478A Temperature Controller

ORDERING INFORMATION

Please order by Part No and Description Also, give complete Order Specification number of the temperature controller The number is stamped on case. If may be necessary to return the entire device to our factory for complete repair and reconditioning In the U.S., orders should be mailed to Honeywell Inc , 1885 Douglas Drive, Minneapolis, Minnesota 55422 Direct all inquiries on orders to this same address. (In Canada, direct all orders and inquiries to Honeywell Controls Limited, Vanderhoof Avenue, Leaside, Toronto 17, Ontario) For prices or further information, contact your nearest Honeywell Branch Office

Mechanical devices must be serviced periodically if they are expected to give continued satisfactory performance, and controls are not an exception How accurate and how troublefree your control system will be in the years to come depends largely on the maintenance given it. For best results, all devices in your system should be serviced at one time

Time and trouble can be saved by arranging with Honeywell for a maintenance agreement which will guarantee expert, economical care, and insure maximum life and efficiency from your system

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Honeywell

Comfort Control Systems

V5011A-E & V5013A-E VALVE BODIES

Service Data

GENERAL

The V5011A-E is a single seated, two-way, straight through valve that provides proportional control of steam, liquids, air or other noncombustible gases in HVAC systems requiring tight shut-off.

The V5013 valve provides proportional or two-position control of hot or cold water in heating or cooling systems. Use the V5013A, B and D for mixing service to direct flow from one of two inlets to a common outlet. Use the V5013C and E for diverting service to direct flow from a common inlet to one of two outlets.

NOTE: Mixing and diverting valves cannot be interchanged.

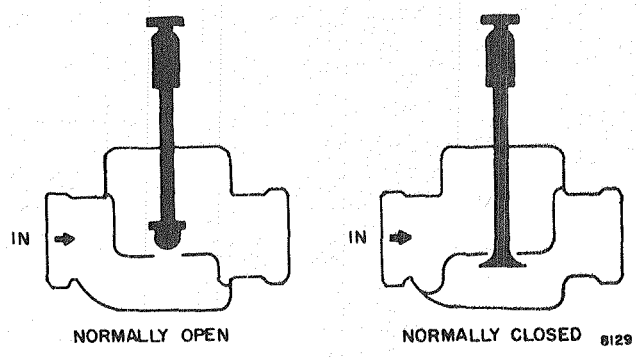
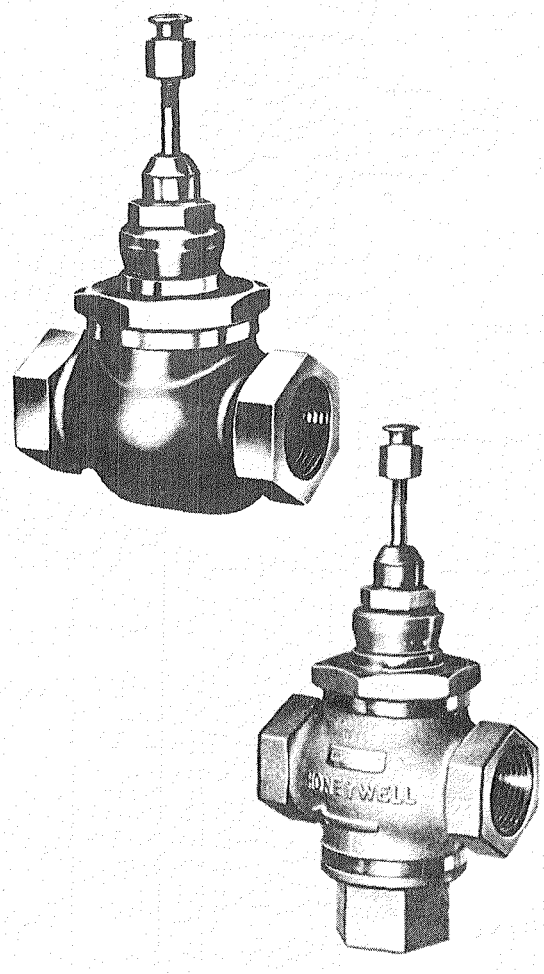


Fig. 1. V5011 Typical Operation.



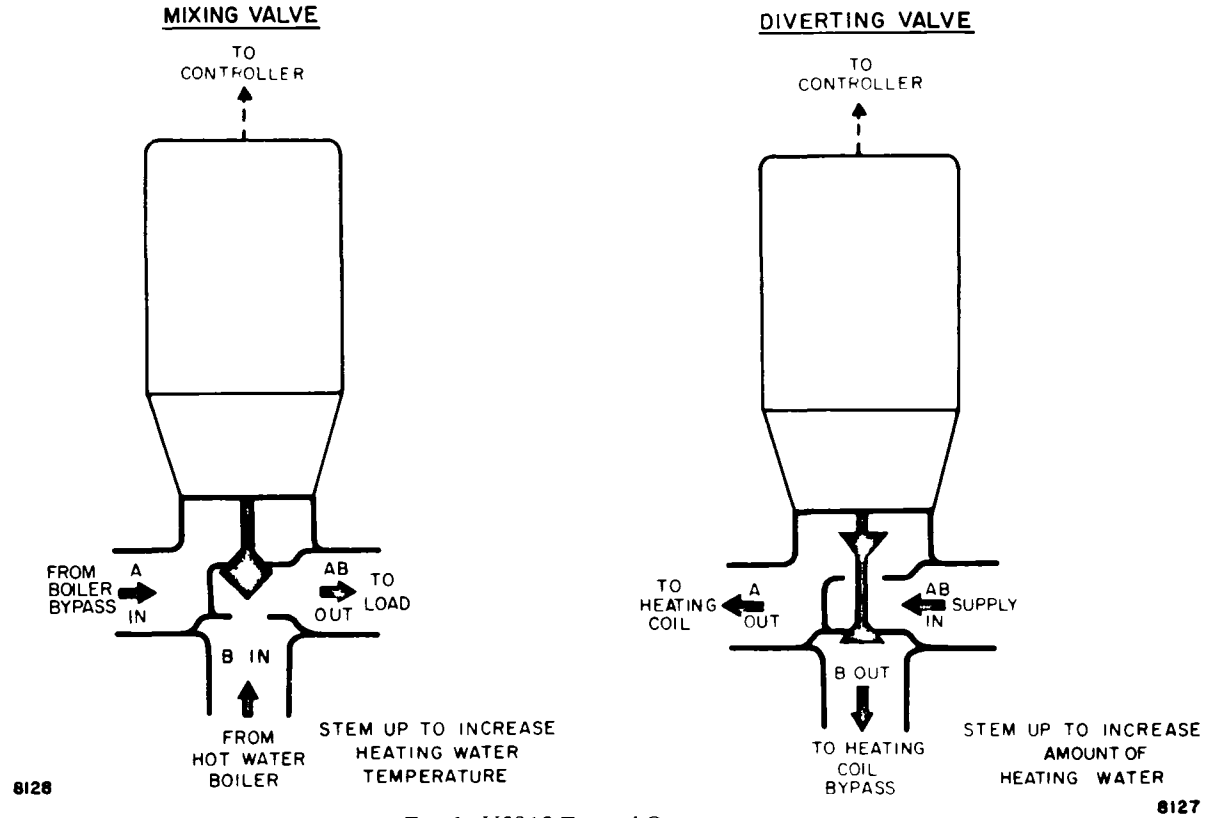


Fig 2 V5013 Typical Operation

Table 1 Valve Identification and Cv Ratings

Valve	Size (In)	End Connection	Cv	Stem Travel (In.)	Stem Dia (In)
V5011A, V5011C	1/2	Screwed	0 4, 0 63, 1 0, 1 6, 2 5, 4.0	3/4	1/4
	3/4		6 3		
	1		10		
	1-1/4		16		
	1-1/2		25		3/8
	2		40		
	2-1/2		63		
	3		100		
V5011A & D, V5011B & E	2-1/2	Flanged	63	1-1/2	1/2
	3		100		
	4		160		
	5		250		
	6		360		
V5013A	1/2	Screwed	2 5, 4 0	3/4	1/4
	3/4		6 3		
	1		10		
	1-1/4		16		
	1-1/2		25		3/8
	2		40		
V5013B, C, D & E	2-1/2	Flanged	63	1-1/2	
	3		100		
	4		160		1/2
	5		250		
	6		360		
	8		600	2	

MAINTENANCE

Refer to the specific Service Data sheet covering the operator for maintenance instructions

CLEANING

Remove all dirt and grease accumulation around the packing nut and stem

LEAKAGE INSPECTION

ALL BODY TYPES - Inspect top of packing nut around stem Repack if leakage exists

FLANGED BODY TYPES--Inspect adapter flange gasket and body plug Tighten bolts and/or body plug

REPAIR

Recommended Tools and Materials

WRENCH – 1/8 in Hex - For Stem Button and Set Screw

WRENCH – Seat removal of screwed type V5011

1/2 in NPT	--	Std 7/8 in thin wall socket
3/4 in NPT		Std 1 in thin wall socket
1 in NPT	-	Std 1-1/8 in thin wall socket with O D turned down to 1 49 in
1-1/4 in NPT	–	Std 1-3/8 in thin wall socket
1-1/2 in NPT	-	Std 1-5/8 in thin wall socket
2 in NPT	-	947 (Commercial Division
2-1/2 in NPT	–	948 Warehouse Catalog
3 in NPT		949 Numbers)

PLASTI-LUBE NO 2 - Lubricant for stem and packing 311057 - 2 oz tube

TRICHLORETHYLENE Solvent for removal of dirt or grease Obtain locally

CAUTION Special care should be exercised in the use of solvents Avoid prolonged inhalation and/or contact with the skin Careless handling can result in permanent damage to the respiratory system or skin tissue

If leakage occurs after several years of operation, it is recommended to completely rebuild the valve, replacing all parts subject to wear This normally includes packing, stem, disc, internal springs, seats or seat rings, O-rings, and gaskets as applicable to the valve being rebuilt (See parts lists for part numbers and repair kit numbers) However, any valve with a stem that is still in good condition may be repacked without further repair It is possible to repack the valve without removing the bonnet but use great care not to damage the valve stem or leakage may still occur after the new packing is installed

TO REPACK ONLY

Follow disassembly procedure through Step 3 Replace packing wafers, follower and spring Use packing and quantity shown in parts list Use a small amount of lubricant and thread packings very carefully over stem with concave side up for 150 psi packing and convex side up for 250 psi packing Reinstall packing gland by pushing down to compress spring until threads engage, tighten until snug, be certain the valve stem moves up and down, reinstall button, stem extension (if applicable) and operator

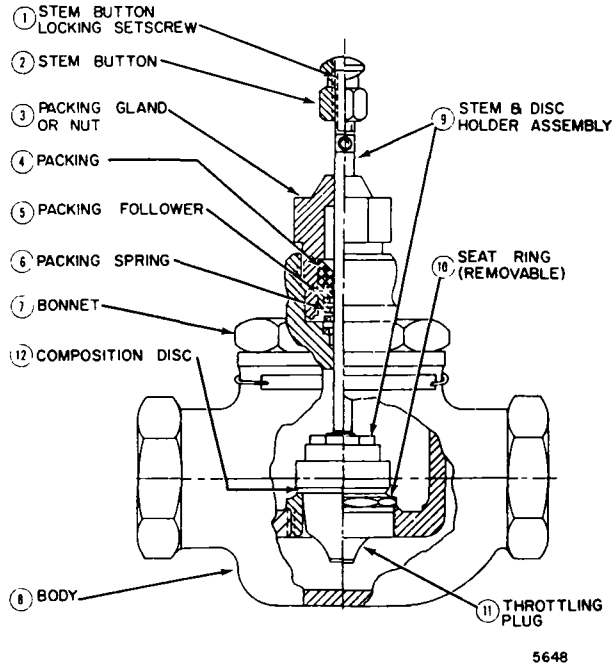


Fig 3 Cutaway of Typical V5011A Screwed Type Body

Table 2 Repack Kits

Stem Size	Low Pressure	High Pressure
1/4	14003294-001	14002920-001
3/8	14003295-001	14002920-002
1/2	14003296-001	----------

TO REBUILD

Follow disassembly procedure as applicable Replace all parts subject to wear and damage Reassemble in reverse order of disassembly, using new parts

CAUTION

Do not tighten nuts and capscrews beyond recommended torque (see Table 3)

Use pipe sealing compound or tape on bonnet threads and screwed piping connections Restore steam or hot water pressure to test for leaks before reinstalling operator Remember that pressure forces the valve open during testing Reinstall the operator and check operation to be certain valve closes completely against normal operating pressure

Table 3 Bonnet Torque Down Value for Nuts and Capscrews

Steel and Alloy Steel Bodies Studs (B-7 and B-16) and Nuts

Stud Size	Recommended Torque, Lbs-Ft
7/16 - 14 UNC	40 - 50
1/2 - 13 UNC	50 - 60
9/16 - 12 UNC	70 - 80
5/8 - 11 UNC	100 - 120
3/4 - 10 UNC	175 - 210
7/8 - 9 UNC	275 - 320
1 - 8 UNC	460 - 500
1-1/8 - 8 UNC	525 - 600

Cast Iron and Bronze Bodies - Capscrews

Screw Size	Recommended Torque, Lbs-Ft
7/16 14 UNC	15 - 25
1/2 - 13 UNC	30 - 40
9/16 - 12 UNC	50 - 70
5/8 - 11 UNC	70 - 100
3/4 - 10 UNC	120 - 170

NOTE Run down all bonnet nuts and capscrews until finger tight, then proceed to torque down evenly using a reduced torque and spacing successive tightening at 180 degrees then 90 degrees etc until the bonnet raised face contacts the body on all sides Then apply the torque as specified above

DISASSEMBLY

1 Relieve steam or water pressure from packing gland and remove valve operator

2 Hold stem by inserting 1/16 in dia rod or nail in hole near top or hold with wrench on flats near top Unscrew button Do not tamper with top locking set screw in button Also remove stem extension if one had to be used to adapt valve to operator (See Table 2 and Fig 8 to obtain proper bonnet face-to-button dimension if set screw was removed)

3 Remove packing gland, old packing wafers, follower and spring

4 Remove stem and plug assembly

a Screwed Body Valves (V5011A and C)–Unscrew the bonnet and the stem and plug assembly can then be lifted out (Fig 3)

b Screwed Body Three-Way Valves (V5013A)–Unscrew the lower port from body to remove stem and plug This requires removing valve from line (Fig 4)

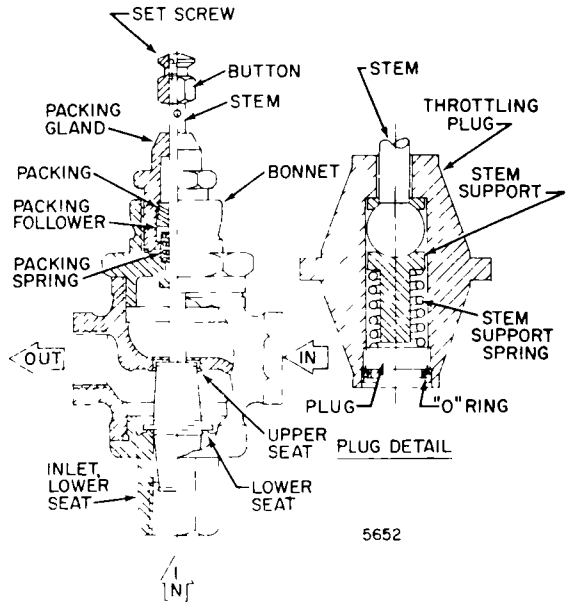


Fig 4 Cutaway of Typical V5013 Screwed Type Body

c Direct Acting Flanged Valves (V5011A) - Remove the bonnet together with the adapter flange that is attached with mounting screws (Fig 5) Lift out the stem and plug assembly

d Reverse Acting Flanged Valves (V5011B) -Unscrew the bonnet but the stem and plug assembly cannot be removed until the adapter flange at the bottom of the valve is removed by unscrewing the mounting screws (Fig 6)

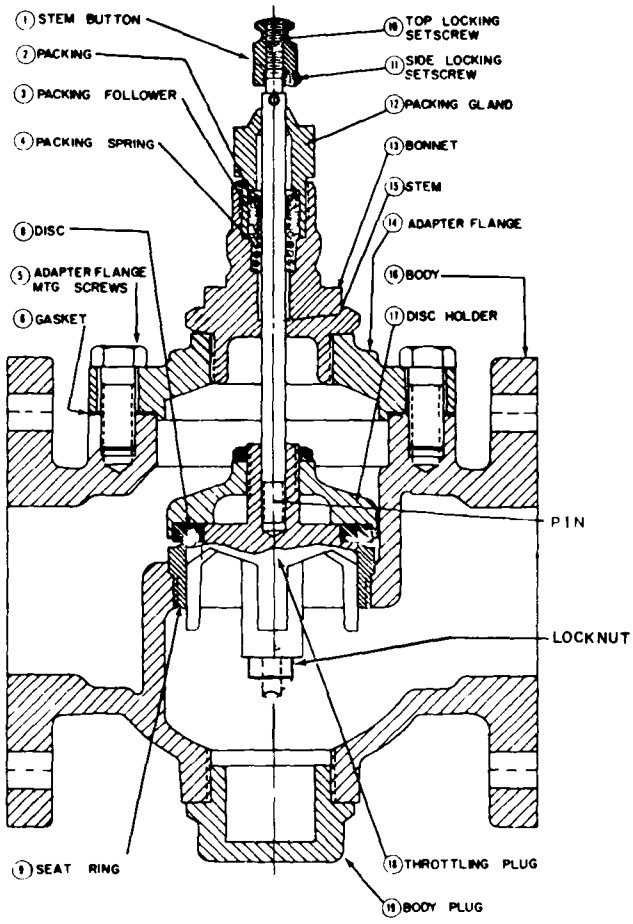


Fig 5 Cutaway of Typical V5011A and D Flanged Type Body

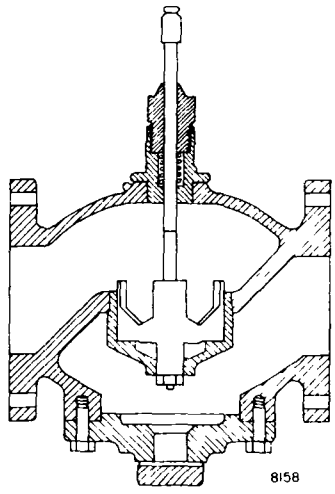


Fig 6 Cutaway of Typical V5011B and E Body

e Old Three-Way Flanged Valves (V5013A)–The bonnet may be removed with the valve in line but the stem and plug assembly cannot be removed until the flange bolts are removed from both side ports and the bottom flange and the lower seat ring is detached from valve body by removing the mounting bolts (Fig 7)

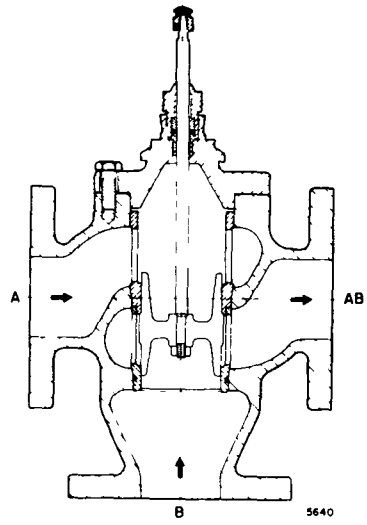


Fig 7 Cutaway of Typical V5013B and D Flanged Type Mixing Valve Body

f Flanged Three-Way Valves (V5013B-E)–Detach the bonnet by removing mounting screws Unscrew the upper seat ring so the stem and plug assembly can be lifted out The lower seat ring can then also be removed through the bonnet opening (Fig 8)

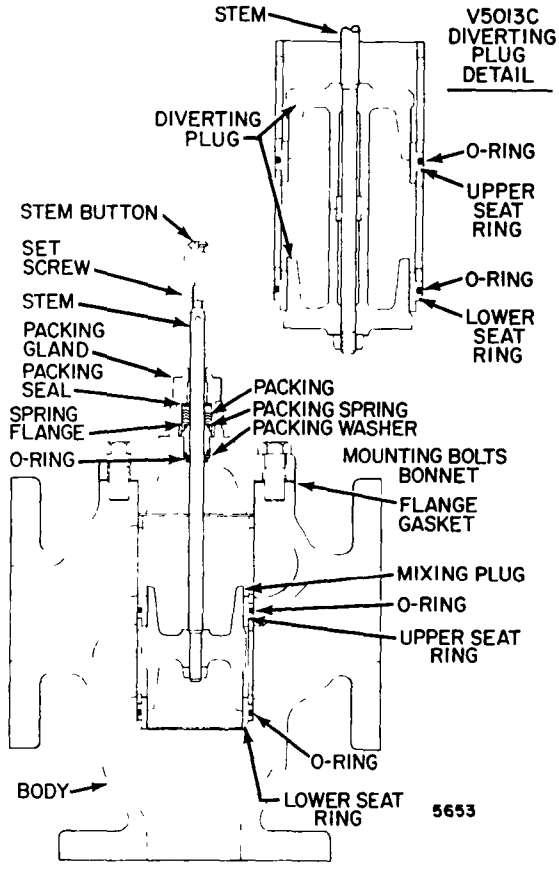


Fig 8 Cutaway of Typical V5013C and D Flanged Type Body and V5013C Diverting Plug

5 Disassemble stem and plug assembly

a Screwed Valves with Discs (V5011A and C) Unscrew throttling plug from stem assembly to remove disc and disc spring The disc may have to be pried out of the disc holder with a screw driver Valves that are 1-1/2 in or larger have separate stems and disc holders Smaller valves have a staked stem and disc holder assembly (Fig 9)

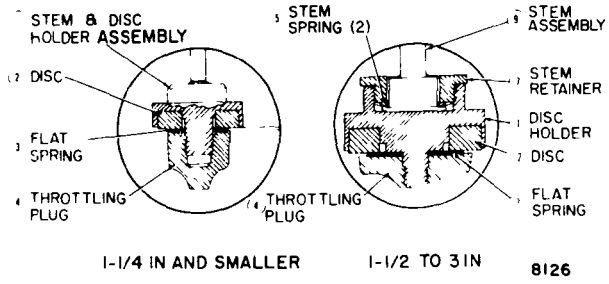


Fig 9 Disc Holder Assemblies Used in V5011A Screwed Type Body

b Screwed Valves with Metal-to-Metal Seats (V5011A and C)–The stem and plug assembly cannot be disassembled

c Screwed Three-Way Valves (V5013A) –Remove the lower plug and O-ring from throttling plug with screwdriver thereby releasing stem support and stem support spring To reassemble, tighten lower plug against support and back off 1/4 turn

d Flanged Valves (V5011)–Remove the disc holder nut to release disc holder and disc Detach the stem by removing pin

e Flanged Three-Way Valves (V5013)–On older valves (V5013A) detach the stem from throttling plug by removing pin On later models (V5013B-E) the plug is attached to the threaded end of the stem with a nut and washer

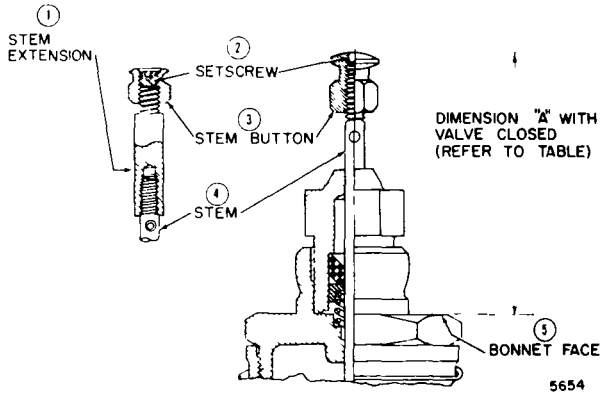


Fig 10 Method of Determining Proper Stem Button Adjustment with or without Stem Extension Refer to Table 4

Table 4

Valve Size	Stem Travel or Lift*	Dimension "A" w/o Stem Extension		Dimension "B" with Stem Extension	
		V5011*	V5013**	V5011*	V5013**
1/2 thru 3 in	3/4 in (19 mm)	3-1/2 in (89 mm)	3-1/2 in (89 mm)	5-1/4 in (133 mm)	5 1/4 in (133 mm)
2-1/2 thru 3 in	3/4 in (19 mm)	3-15/32 in (88 mm)	3-1/2 in (89 mm)	-	5-1/4 in (133 mm)
4 thru 6 in	1 1/2 in (38 mm)	5-1/4 in (133 mm)	5-1/4 in (133 mm)	7 9/16 in (179 mm)	7-9/16 in (179 mm)

*Dimension measured with valve closed (Stem down on V5011A B C, D and E, Stem up on V5011B)

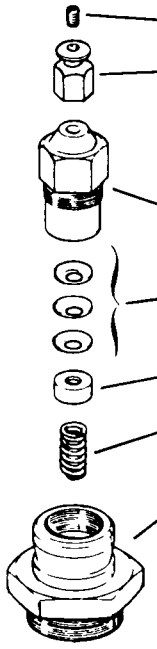
**Dimension measured with plug against lower seat (V5013A)

It is possible to convert standard V5011A & B or V5013A-C valves into high pressure (250 lb) valves for use in *hot or cold water systems only*

Use Bag Assembly 14002920-001 (rubber packing) for V5011 or V5013 1/2 to 1-1/4 in valves with 1/4 in stems Use Bag Assembly 14002920-002 (teflon packing) on V5011 or V5013 1-1/2 to 3 in valves with 3/8 in stems

Refer to instructions packed with the Bag Assembly (Form 95 7212)

V5011 A & C Screwed Body 1/2" to 1-1/4" Composition Disc

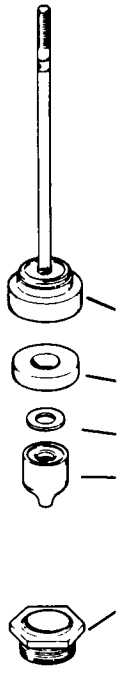


Set Screw	1/4-28 x 1/4 in Socket Hd
Button	310503

3/4 " Travel (19 mm)

Valve Size	1/2"	3/4"	1"	1-1/4"
Packing Gland	310509	←	→	310509
Packing*†	310623 (3)	←	→	310623 (3)
Follower*†	310506	←	→	310506
Follower Spring*†	310498	←	→	310498
Bonnet	311080	311080	311081	310691
Repack Kit	14003294-001			

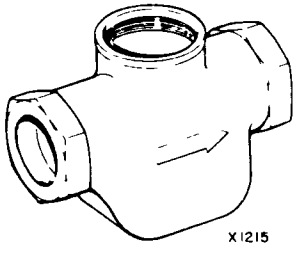
*Repack Kits include these parts and lubricant
†Repair Kits include these parts and lubricant



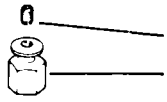
1/2 thru 1 1/4 Composition Disc Valves

Cv	40	63	10	16	25	40	63	10	16
Repair Kit	14002694 001	←			→		14002695 001		14003109 001
Stem & Disc Holder Assembly	x11091 A	←			→	311093A	311094A	311094A	311095A
Disc									
x5 200F (0.9 C)	x13094	←			→	313094	313095	313095	313096
115 275F (46 135C)	x13102	←			→	x13102	313103	313103	313104
275-425F (135 246C)	x13078	←			→	313078	313079	313079	313080
Disc Spring	x11099	←			→	311099	310554	310554	311098
Plug V5011A	x14705	312x49	14000513 001	14000518 001	14000520 001	14000508 001	311087	311088	311091
Plug V5011C	None	14000525 001	14000512 001	14000521 001	14000524 001	14000525 001	314533	314534	314535
Seat									
1/2 Valve	x10558	←			→	310558	311055		
3/4 Valve					10536	310543	310890		
1 Valve						310538	310537	311077	
1 1/4 Valve							310540	310539	311078

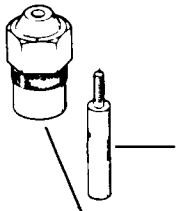
†Repair Kits include these parts and lubricant



V5011 A & C Screwed Bodies 1-1/2" to 3" Composition Disc



Set Screw	1/4-28 x 1/4 in. Socket Hd
Button	310503

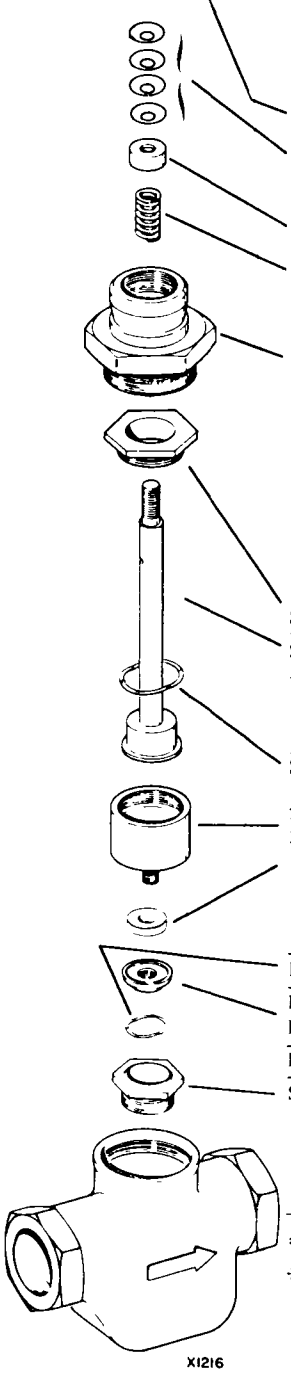


Cv	10	16	25	40	63	100	63	100
Extension 8" Actuators	311857	←						311851

	3/4 in. Travel (19 mm)				1-1/2 in. Travel (38 mm)	
Valve Size	1-1/2"	2"	2-1/2"	3"	2-1/2"	3"
Packing Gland	311431	←		311431	311977	311977
Packing*†	311432 (4)	←				311432 (4)
Follower*†	311430	←				311430
Follower Spring*†	311565	←				311565
Repack Kit	14003295-001 (All)					
Bonnet	311622	311622	311646	311648	312058	312060

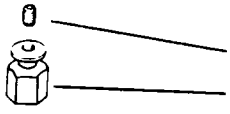
1-1/2 thru 3 Composition Disc Valves

	3/4 Travel (19 mm)						1-1/2 Travel (38 mm)	
Cv	10	16	25	40	63	100	63	100
Stem Retainer Nut	311620	←						311620
Stem Assembly*	311619A	←				311619A	311974A	311974A
Valve Repair Kit	N/A	N/A	14003110-001	14003111-001	N/A	N/A	N/A	N/A
Stem Retainer Spring	311100 (2)	←				311100 (2)	311100 (1)	311100 (1)
Disc Holder	311633	311392	x11453	x11625	x11745	x11746	311745	311746
Disc*								
35-200F (0-93C)	313095	x13096	x13097	x13098	x13099	x13100	313099	313100
115-275F (46-135C)	313103	313104	313105	x13106	x13107	313108	313107	313108
275-475F (135-246C)	313079	x13080	x13081	x13082	x13083	313084	313083	313084
Disc Spring	x10554	x11098	311100	x11127	x11725	311727	311725	311727
Plug V5011A	x11088	x11091	x11089	x11146	11860	311861	311976	312067
Plug V5011C	314534	x14535	314536	x14537	x14538	x14539		
Plug Nut	None	None	None	None	None	311728	None	None
Seat								
1-1/2" Valve	x11289	310541	x10542					
2" Valve		311290	11291	x11624				
2-1/2" Valve			x11729	x11730	x11731		311731	
3" Valve				11732	x11733	311734	311733	311734

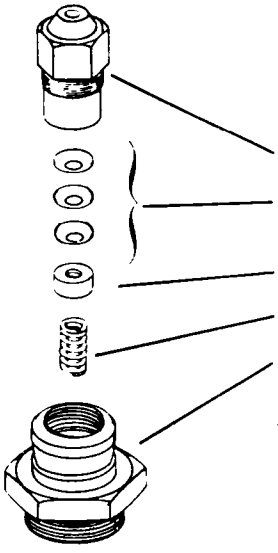


*Repack Kit includes these parts and lubricant
†Repair Kit includes these parts and lubricant

V5011 A & C Screwed Body 1/2" to 1-1/2" Metal to Metal Seat



Set Screw	1/4-28 x 1/4 in Socket Hd
Button	310503



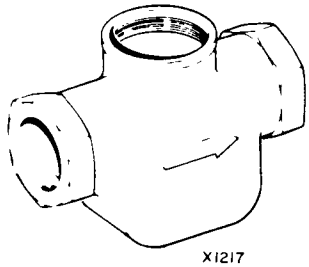
	3/4 in Travel (19 mm)				
Valve Size	**1/2"**	**3/4"**	**1"**	**1-1/4"**	**1-1/2"**
Packing Gland	310509	←	→	310509	311431
Packing*	310623 (3)	←	→	310623 (3)	311432 (4)
Follower*	310506	←	→	310506	311430
Follower Spring*	310498	←	→	310498	311565
Bonnet	311080	311080	311081	310691	311622
Repack Kit	14003294-001				14003295-001

*Repack Kit includes these parts and lubricant

Metal to Metal Seated Valves

NOTE If the STEM & PLUG ASSEMBLY or the SEAT requires replacement it is recommended that both be replaced with the lapped REPAIR ASSEMBLY to assure tight close-off

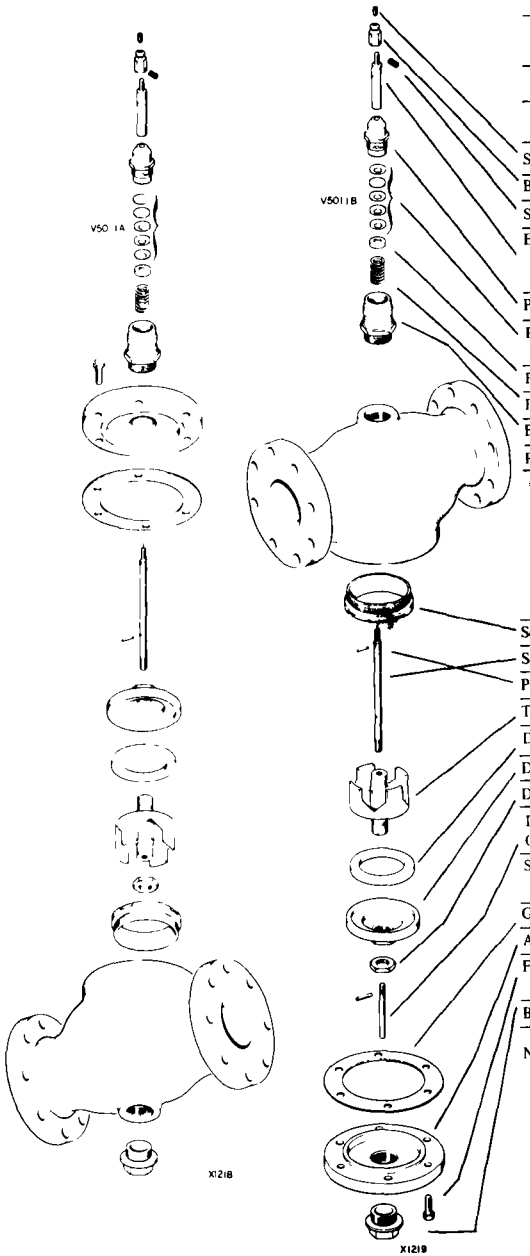
Plug & Seat Repair Assy	**40**	**63**	**10**	**16**	**25**	**40**	**63**	**10**	**16**	**25**
V5011C										
1/2	311936E	311936A	311936B	311936C	311936D	311951A				
3/4"					311938A	314298A	311952A			
1"						314299A	314300A	311953A		
1 1/4"							314301A	314302A	311954A	
1 1/2								314303A	314304A	312055A



X1217

NOTE Repair parts for V5011A Screwed valves (1/2 to 1 1/2 in.) with metal to metal seats are no longer available. It is recommended that the entire valve be replaced with a V5011C if defective.

V5011 A & B Flanged Body 2-1/2" to 6" Composition Disc



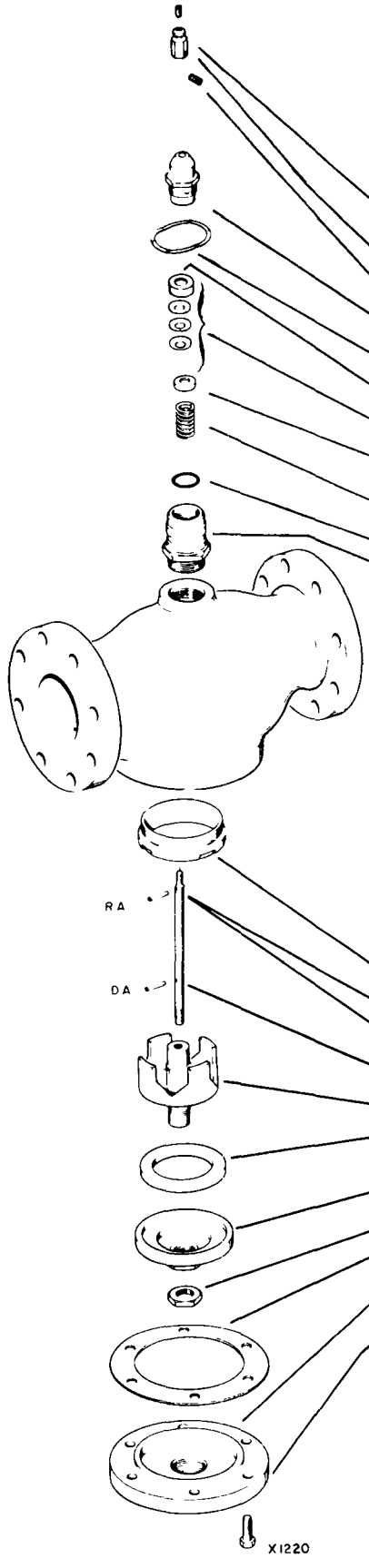
	3/4 in Travel (19 mm)		1 1/2 in Travel (38 mm)				
Valve Size	**2 1/2**	**3**	**2 1/2**	**3**	**4**	**5**	**6**
Cv	**63**	**100**	**63**	**100**	**160**	**250**	**360**
Set Screw Socket Hd	/4 28 x 1/4	←	←	←	←	1 4 28 x 3 4	→
Button	312495	←	→	312495	312496	←	312496
Set Screw	←	←	←	8 32 x 3 16	←	←	→
Extension 8 Actuator 13 Actuator	311851	←	→	311851	312466 and 8 32 x 5/16 Set Screw	←	312466 and 8 32 x 5/16 Set Screw
Packing Gland	311431	311431	311977	311977	312497	←	312497
Packing*	311432 (4)	←	→	311432 (4)	312498 (5)	←	312498 (5)
Follower*	311430	←	→	311430 (2)	312499	←	312499 (2)
Follower Spring*	311565	←	→	311565	312500	←	312500
Bonnet	30040647 760	←	→	30040647 760	30040646 760	←	30040646 760
Repack Kit	14003295 001	←	→	14003295 001	14003296 001	←	14003296 001

*Repack Kit includes these parts and lubricant

Seat Ring	30041027 760	30041028 760	30041027 760	30041028 760	30041029 760	30036547 100	30041031 100
Stem	30731050 001	30731052 001	30041220	30041221	30731054-001	30731056 001	30731058 001
Pin Stop	0064584 322	30064584 322	30036953	30036953	30674008 001	←	30674008 001
Throttling Plug	30731049 001	30731051 001	30731049 001	30731051-001	30731053 001	30731055 001	30731057 001
Disc (All)	30041049 835	30041050 835	30041049 835	30041050 835	30041051 835	30041052 835	30041053 835
Disc Holder	30041054 100	30041055 100	30041054 100	30041055 100	30041056 100	30041057 100	30041058 100
Disc Holder Nut	30048312 322	←	→	30048312 322	30067756 322	←	30067756 322
Drop Pin (Rev Acting) Old Style					30041074	30041075	30041074
Stem Pin Old Style D A (1) R A (2)	30029911	←	→	30029911	30036549	←	30036549
Gasket	30046304 859	30046335 859	30041077 859	30041078 859	30046366 859	30046438 859	30046541 859
Adapter Flange	30046302 200	30041022 200	30041021 200	30041022 200	30041023 200	30046436 200	30046542 200
Flange Bolts Hex Cap	1/2 13 x 1 1/4 (4)	←	→	1/2 13 x 1 1/4 (6)	9 16 12 x 1 1 2 (6)	←	9 16 12 x 1 1 2 (8)
		(6)	(4)			(8)	
Body Plug	30041026 200	←	←	←	←	←	30041026 200

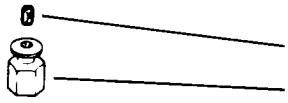
NOTE Part numbers for the V5011 A & B are the same however their sequence is different Refer to the exploded diagrams at left

V5011 D & E Flanged 250 lb. Body 2-1/2" to 6"

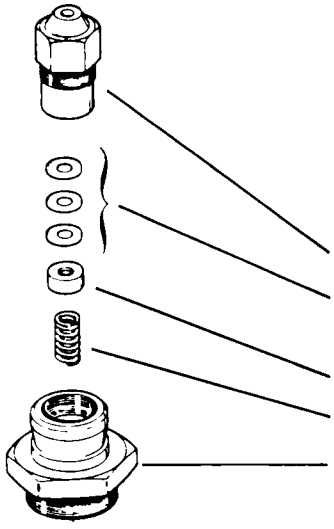


	3/4 in Travel (19 mm)		1 1/2 in Travel (38 mm)		
Valve Size	2 1/2'	3	4"	5	6"
Cv	63	100	160	250	360
Set Screw	Socket Head 1/4 28 x 1/4	Socket Head 1/4 28 x 1/4	Cup Pt Socket 1/4 28 x 3/4	←	Cup Pt Socket 1/4 28 x 3/4"
Button	30041088 107	30041088 107	30041089 235	←	30041089 235
Set Screw	← 8 32 x 3/16 →				
Packing Gland	30683374-002	30683374 002	30683135-001	←	30683135-001
Retaining Ring	30682506 002	30682506 002	30682506-003	←	30682506-003
Female Adapter	30685567 002	30685567 002	30685567 003	30685567 003	30685567 003
Packing (3)	30685565 002	30685565 002	30685565-003	←	30685565-003
Follower	30041086 107	30041086 107	30041087 107 (2)	←	30041087 107 (2)
Follower Spring	30041084 218	30041084 218	30041085 218	←	30041085 218
O Ring	30685440 026	30685440 026	30685540 025	←	30685440 025
Bonnet	30040647 760	30040647 760	30040646 760	←	30040646 760
Seat Ring	30041027 760	30041028 760	30041029 760	None	None
Stem D A	30731050 001	30731052 001	30683263 001	30683263 002	30683263-003
Stem R A	None	None	30731054 001	30731056 001	30731058 001
Pin Stop (D A & R A)	30064584 316	30064584 316	30674008 001	←	30674008 001
Skirt	30731049 001	30731051 001	30731053 001	30731055 001	30731057-001
Disc (35 275F) (0 100C)	30041049 835	30041050 835	30041051 835	30041052 835	30041053 835
Disc Holder	30041054 100	30041055 100	30041056 100	30041057 100	30041058 100
Disc Holder Nut	30043812 322	30043812 322	30067756 322	←	30067756 322
Gasket	30046304 859	30046335 859	30046366 859	30046438 859	30046541 859
Adapter D A	30046 02 200	30041022 200	30041023 002	30046436 002	30046542 002
Adapter R A			30041023 001	30046436 001	30046542 001
Hex Cap Flange Bolts	1/2 13 x 1 1/4 (4)	1/2 13 x 1 1/2 (4)	9/16 12 x 1 1/2 (6)	(8)	9/16 12 x 1 1/2 (8)

V5013 A Screwed Body 1/2" to 2" Metal to Metal Seat

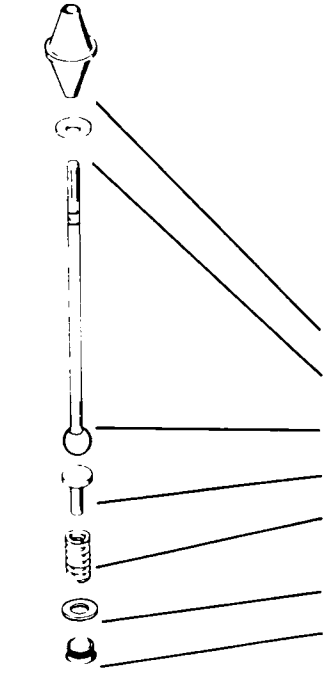


Set Screw	1/4-28 x 1/4" Socket Hd
Button	310503 ← → 310503

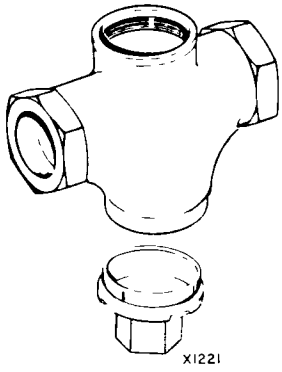


	3/4 in Travel (19 mm)					
Valve Size	**1/2"**	**3/4"**	**1"**	**1-1/4"**	**1-1/2"**	**2"**
Packing Gland	310509 ← →			310509	311431	311431
Packing*	310623 (3) ← →			310623 (3)	311432 (4)	311432 (4)
Follower*	310506 ← →			310506	311430	311430
Follower Spring*	310498 ← →			310498	311565	311565
Bonnet	311081	311081	311348	310691	311427	311429
Repack Kit	14003294-001				14003295-001	

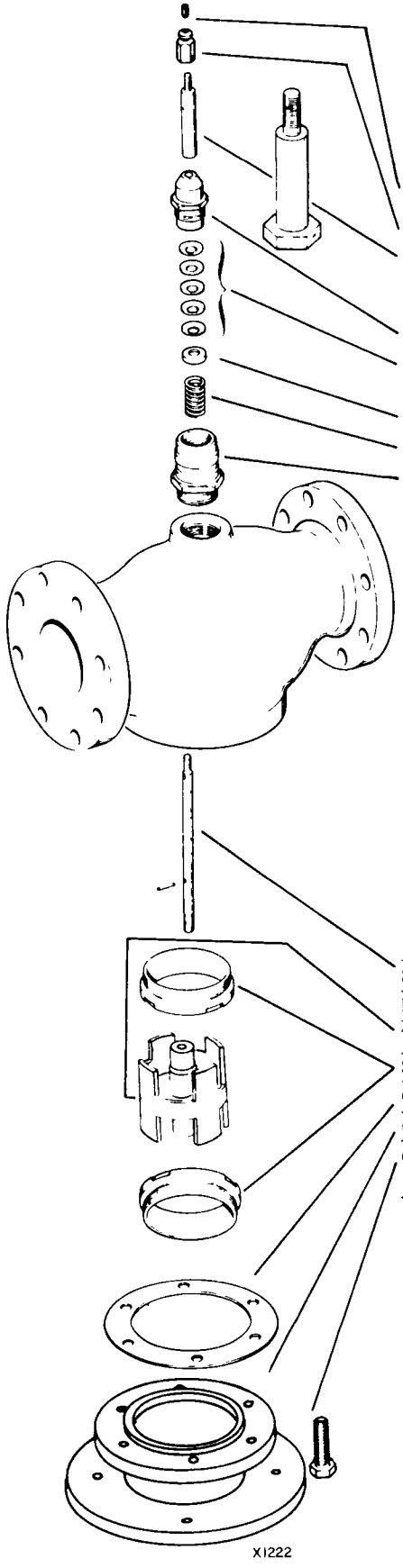
*Repack Kit includes these parts and lubricant



Valve Size	**1/2"**	**1/2 '**	**3/4"**	**1"**	**1-1/4"**	**1-1/2"**	**2"**
Cv	**2 5**	**4 0**	**6 3**	**10**	**16**	**25**	**40**
Plug Throttling	311444	311445	311446	311447	311448	311449	311450
Stem Support	311440 ← →				311440	311442	311442
Stem	313338 ← →				313338	313339	313339
Stem Support	311441 ← →				311441	311443	311443
Stem Support Spring	313941 ← →						313941
O-Ring	311631 ← →				311631	313693	313693
Plug	311436 ← →				311436	311437	311437



V5013 A Flanged Body 2-1/2" to 6" Metal to Metal Seat



	3/4 in Travel (19 mm)		1-1/2 in Travel (38 mm)		
Valve Size	**2-1/2"**	**3**	**4"**	**5"**	**6"**
Cv	**63**	**100**	**160**	**250**	**360**
Set Screw	1/4 28 x 1/4" Socket Hd				
Button	312495	312495	312496	312496	312496
Stem Extensions 8 Actuator 13 Actuator	311851	311851	- -	- -	312466 8 32 x 5/16 Set Screw
Packing Gland	311431	311431	312497	312497	312497
Packing*	311432 (4)	311432 (4)	312498 (5)	312498 (5)	312498 (5)
Follower*	311430	311430	312499	312499	312499
Follower Spring*	311565	311565	312500	312500	312500
Bonnet	40647	40647	40646	40646	40646
Repair Kit	14003295 001		14003296 001		

*Repack Kit includes these parts and lubricant

Stem	30041067 316	30041068 316	30041069 316	30046463-316	30046540-316
Pin Stop Stem	30029911	30029911	30036549	30036549	30032106
Throttling Plug	30046288	30046324	30046363	30046437	30046522
Seat Ring (2)	30041027 760	30041028 760	30041029 760	30041030 760	30041031 760
Gasket	30046304 859	30046335 859	30046366-859	30046438 859	30046541 859
Outlet Lower Seat	30046303	30046337	30046367	30046435	30046539
Cap Screws Hex Hd	1/2 13 x 1 1/4 ' (4)	1/2 13 x 1 1/4 (6)	9/16 12 x 1 1/2" (6)	9/16-12 x 1 1/2" (8)	5/8-11 x 1 1/2" (8)

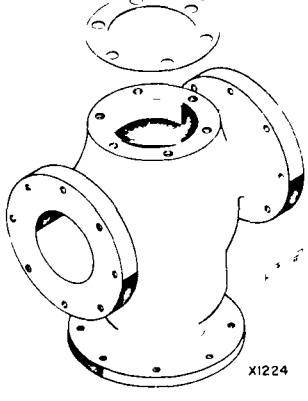
V5013 B & D Flanged Body 2-1/2" to 8"

MIXING

Valve	V5013B1003 V5013D1009	V5013B1011 V5013D1017	V5013B1029 V5013D1025	V5013B1037 V5013D1033	V5013B1045 V5013D1041	V5013B1052 V5013D1058
Size	2 1/2	3	4	5	6	8
Set Screw Socket Hd	1 4 28 x 1 4	←		→	1/4 28 x 1/4	None
Stem Hold	x0041088 107	x0041088 107	30041089 235	→	30041089 235	None
Set Screw Cup Point Socket Head	8 x2 x 3 16	←		→	8 32 x 3/16	None
Nut	None	←		→	None	1/2 13 Hex Nut
Stud	None	←		→	None	30037244 271
Flange	None	←		→	None	30032534 272
Packing Nut	x0067857 107 30683x74 001	30067857 107 30683x74 001	30067858 001 30683135 002	0067858 001 30683135 002	x0067858 001 30683135 002	None None
Upper Wiper Seal	None	←		→	None	30065392 851
Packing	11412 (4)		12498 (5)			30065401 936 (1)
	30685565 002 (5)	30685565 002 (3)	30685565 003 ( )	30685565 003 (3)	30685565 003 (5)	
Packing Follower	11410		12499 (5)			x0037243 30x
Spring	11565		12500			30065380 461
Stem	x00678 7 x16	00678x8 316	30067859 316	x0067840 316	30067841 316	30069132 316
Washer	None	←		→	None	30065410 316
Wiper Seal (Lower)	None	←		→	None	30065418 862

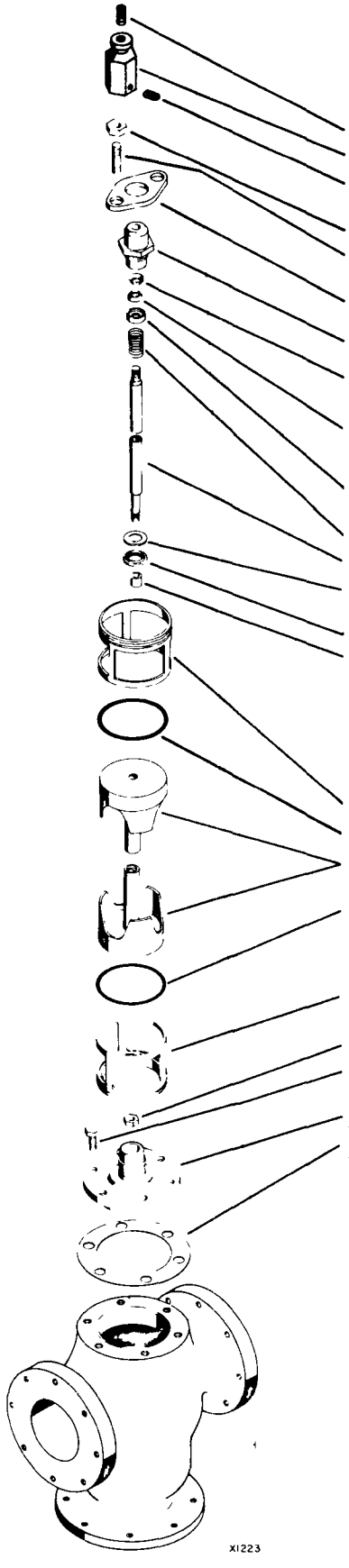
Upper Seat Ring	Same as Lower Seat Ring Numbers Listed Below					
O Ring	Same as O Ring Number Listed Below					
Plug	x0067x 2 760	x0067x5 760	00678x4 76x	x0067835 100	x0067836 100	30069130 100
O Ring	x0684011 001 (2)	x0067x 1 891 (2)	00675 89 (2)	0067853 891 0067855 891 3067 757 891 (2)	x0067856 891	30069137 891
Seat Ring (Subassembly) (2)	30067x4 905	x0067x4 905	x0067844 905	06883x6 001	0067849 100	x0069135 100
Nut Hex Lock	5 16 24	5 16 24	3 16 20	→	3 16 20	5/8 18
Screw Hex Cap	1 24 x 1 1 4 (4)	1 24 x 1 1 4 (6)	9 16 12 x 1 1 2 (6)	9 16 12 x 1 1/2 (8)	5/8 11 x 1 1 2 (8)	3/4 10 x 2 1/4 (8)
Bonnet	x0067827 200	x0067x5 200	x0067829 200	x0067830 200	x0067831 200	30069128 200
Gasket	30067x59 x59	30067x61 x59	0067861 859	0067862 859	x0067863 859	30069134 859

Shaded areas represent part numbers for V501 D 2501b 1 dies. Not interchangeable with V5013B



V5013 C & E Flanged Body 2-1/2" to 8"

DIVERTING



Valve	V5013C1001 V5013E1006	V5013C1019 V5013E1014	V5013C1027 V5013E1022	V5013C1035 V5013E1030	V5013C1043 V5013E1048	V5013C1050 V5013E1055
Size	2 1/2	3	4	5"	6"	8"
Set Screw Socket Hd	1/4 28 x 1/4	1/4 28 x 1/4	1/4 28 x 3/4	←	1/4 28 x 3/4	None
Stem Head	30041088 107	30041088 107	30041089 235	←	30041089 235	None
Set Screw Cut Point Socket	8 32 x 3/16	←			8 32 x 3/16"	None
Hex Nut	None	←			None	1/2 13
Stud	None	←			None	30037244 271 30065377 392
Flange	None	←			None	30065377 392
Packing Nut	30067857 107 30683374-001	30067857 107 30683374-001	30067858-001 30683135-002	←	30067858-001 30683135-002	None
Wiper Seal Upper	None	←			None	30065392 854
Packing	311452 (4) 30685565-002 (3)	30685565-002 (3)	312498 (5) 30685565-003 (3)	←	30685565-003 (3)	30065401 936
Packing Follower	311450		312499 (2)			30037243 303
Spring	311565		312500			30065380-461
Stem	30067871 316	30067872 316	30067873 316	30067874 316	30067875 316	30069131 316
Washer	None	←			None	30065410 316 (9)
Wiper Seal Lower	None	←			None	30065418 862
Bushing	30067876 107	30067876 107	30067877 107	←	30067877 107	30069133 107

Seat Ring (Subassembly)	Same Part Number as Listed Below					
O Ring	Same Part Number as Listed Below					
Plug	30067866 760 (2)	30067867 760 (2)	30067868 760 (2)	30067869 100 (2)	30067870 100 (2)	30069129 100 (2)
O Ring	30684011 001 (2)	30067531 891 (2)	30067533 891 (2)	30067853 891 30067855 891 30067535 891 (2)	30067856 891 (2)	30069137 891 (2)
Seat Ring (Subassembly)	30067842 905 (2)	30067845 905 (2)	30067844 905 (2)	30685316-001 (2)	30067849 100 (2)	30069135 100 (2)
Nut (Hex Lock)	5/16 24	5/16 24	7/16 20	←	7/16 20	5/8 18
Screw (Hex Cap)	1/2 13 x 1 1 4 (4)	1/2 13 x 1 1 4 (6)	9 16 12 x 1 1/2 (6)	9/16 12 x 1 1/2 (8)	5/8 11 x 1 1/2 (8)	3/4 10 x 2 1/4" (8)
Bonnet	30067827 200	30067828 200	30067829 200	30067830 200	30067831 200	30069128 200
Gasket	30067859 859	30067860 859	30067861 859	30067862 859	30067863 859	30069134 859

Shaded areas represent parts for V5013E 250 lb bodies Not interchangeable with V5013C

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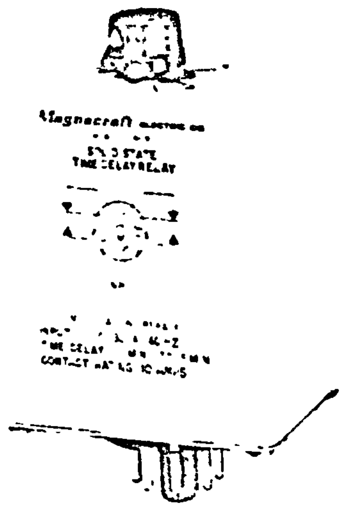
†First city listed is head office location
*Includes manufacturing facilities

CLASS 211CP

± 2% REPEATABILITY
DPDT 10 AMPS
SLOW OPERATE OR SLOW RELEASE & INTERVAL



The Class 211CP Time Delay Relay [illegible] use of Hybrid Circuitry, combining Solid State Circuitry for timing function with an E[illegible]R for DPDT 10 Amperes output switching. The 211CP [illegible] following outstanding features

FEATURES

1. Ava[illegible] 9 different timing ranges (see chart)
2. AC or DC [illegible]tion
3. Funct[illegible] on operate [illegible] and [illegible] are listed [illegible] chart. (Oth[illegible] consult [illegible])
4. P[illegible]
5. Knob adjustable timing
6. Nylon [illegible]
7. [illegible] protection (DC [illegible])

SPECIFICATIONS

Repeat Accuracy ± 2% of setting at nominal voltage at 25°C
Contact Combination DPDT Standard
Reset Time 100 ms Typically
Temperature Range Operate 10°C to 55°C
Storage - 55°C to 85°C
Transient Protection Available Standard on all AC models
See graph on page 4

SLOW OPERATE

MODEL NUMBER	NOMINAL INPUT VOLTAGE	VOLTAGE RANGE	TIMING RANGE	APPROX STEADY STATE CURRENT
W211ACPSOX 18	120 VAC	100 130	2 to 1 Sec	4 [illegible]
W211ACPSOX 5			1.0 to 10 Sec	
[illegible]211ACPSOX 6			1.0 to 60 Sec	
[illegible]211ACPSOX 7			1.0 to 180 Sec	
W211ACPSOX-8			2.0 to 300 Sec	
W211ACPSOX 60			1 to 15 Min	
W211ACPSOX 61			2 to 30 Min	
W211ACPSOX 62			4 to 60 Min	
[illegible]			[illegible]	
[illegible]	[illegible]	[illegible]	[illegible] Sec	6[illegible]
[illegible]			[illegible]	
211[illegible]SOX 3			[illegible]	
211[illegible]SOX 4			2.0 [illegible] 300 Sec	
211ACPSOX 64			1 to [illegible] Min	
211ACPSOX-65			2 to 30 Min	
211ACPSOX 66			4 to 60 Min	
[illegible]			[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	
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211AC[illegible] 7				
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[illegible]				
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[illegible]				
W211[illegible] 4				
[illegible]				
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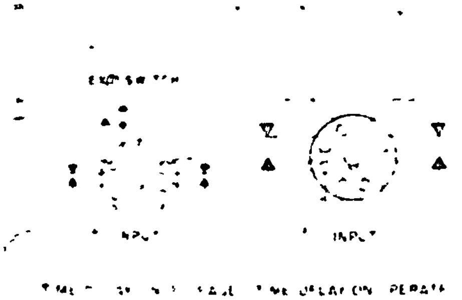

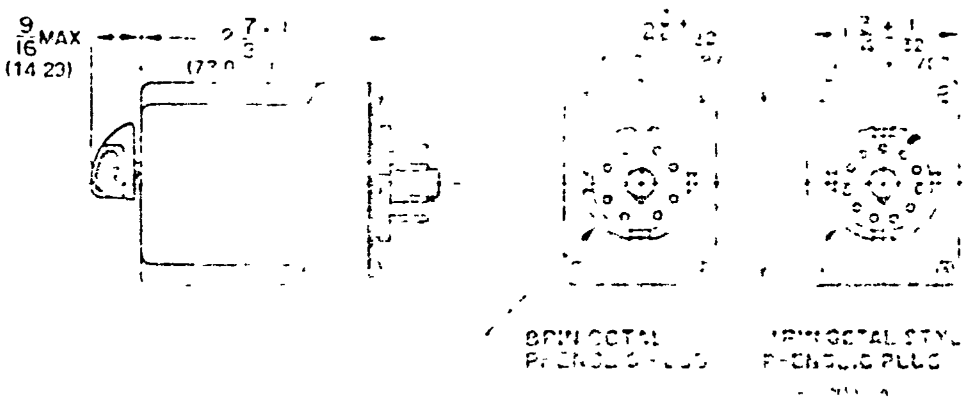

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C-100

Differential Temperature Control and Performance Monitoring in a Single Unit.

FOR SOLAR DOMESTIC WATER HEATING SYSTEMS

Monitors up to six temperature sensors Control's up to three outputs

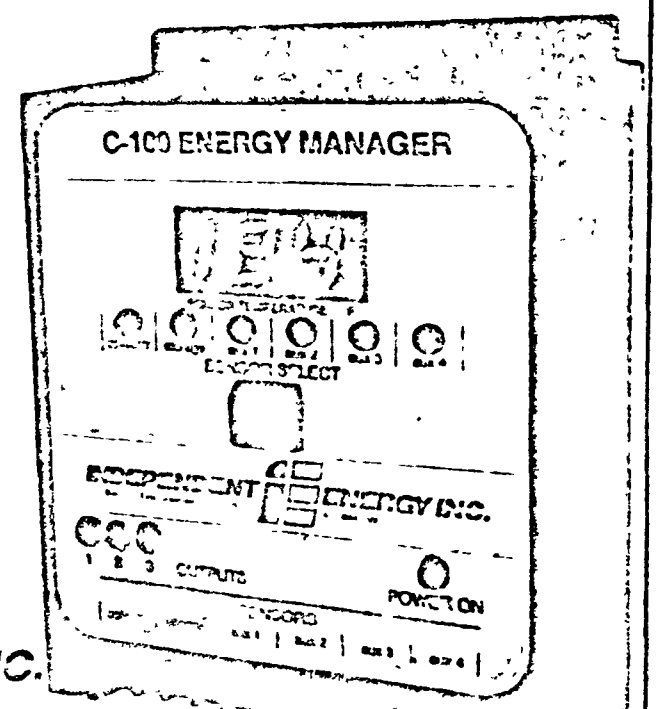
Callbacks stealing your solar profits?

Specify the control with the digital performance display from Independent Energy

With a C-100 Series solar control you'll see exactly how your domestic water, space or pool heating system is performing. Just press the display select button for fast temperature readouts. Those big red numbers help spot trouble at system startup or on service calls. You leave when the system proves it can deliver what it's designed for ... with no guess work that leads to expensive callbacks.

IE builds cost effective solar controls that solve system problems at the design stage and in the field. Controls with factory calibration, computer testing, and solid state construction. Controls with the latest microcomputer technology for maximum energy efficiency, and faster system payback.

Protect your system, and your solar profits. Specify the control with differential temperature control and performance monitoring. From IE.



INDEPENDENT ENERGY INC.

Specifications - subject to change without notice

Input Power 105-130 VAC, 60Hz

Output Power Outputs 1 2 — 1/10 HP 115 VAC [illegible] continuous

Output 3 — 115 VAC 1A continuous

Higher output ratings available Consult Factory

1 HP relay available for any on/off-type output (see Ordering Information)

Power Consumption 15 watts maximum

Shipping Weight 4 5 lb

Mounting Dimensions overall – 6' x 8½' x 3'

Control Accuracy ±1 F

Control Operating Environment 32°F-104°F, 95% relative humidity (non-condensing)

Features

Digital Performance Monitoring Allows fast detection of system malfunction, continuous fine tuning of system performance, faster and easier system installation Helps provide faster system payback

Unit Construction. **Integrated control and monitoring gives single source responsibility and cost economy over other control/monitor combinations**

Versatile **Multiple outputs available** No need to buy a second control to operate complex or combination systems such as DHW/Fireplace Grate DHW/Pool DHW/Hot Tub, etc

Reliable Computer-tested for performance and function at the factory Helps stop expensive service calls

State-Of-The-Art Technology Microcomputer operation helps provide maximum system energy efficiency

Safe Low voltage sensors completely isolated from AC line voltages

Ready-To-Use Factory calibrated for fast installation with standard tools

Protected 1 year limited warranty Immune to interference from noise of other equipment and lightning surges Protects system components from brownouts by shutting off outputs when input voltage drops below 95 VAC

Sensors

SW ST SB SC

SW Well type

ST Strap on ST-½ for ½" & ¾" tubing ST-1 for 1" tubing

SB Bolt on for flat surfaces

SC Screw-in for ½" NPT

Note Sensors not suitable for direct immersion. Protect sensors and sensor connections from direct contact with rain.

Type Thermistor, 10K ohm @ 77°F

Operating Temperature Range -40°F to 400 F

Accuracy ±0 5°F (32 F-212 F)

Leads 18 AWG stranded Teflon insulated

Case Material 5/16 dia copper tubing SC type is brass

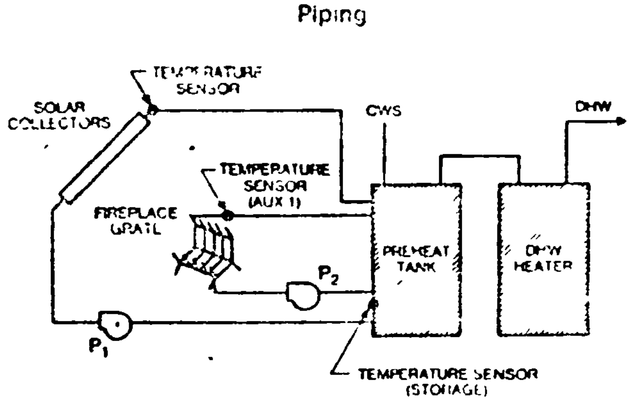
Interchangeability All IE sensors are interchangeable

RESISTANCE vs TEMPERATURE
SPECIFICATIONS OF IE SENSORS

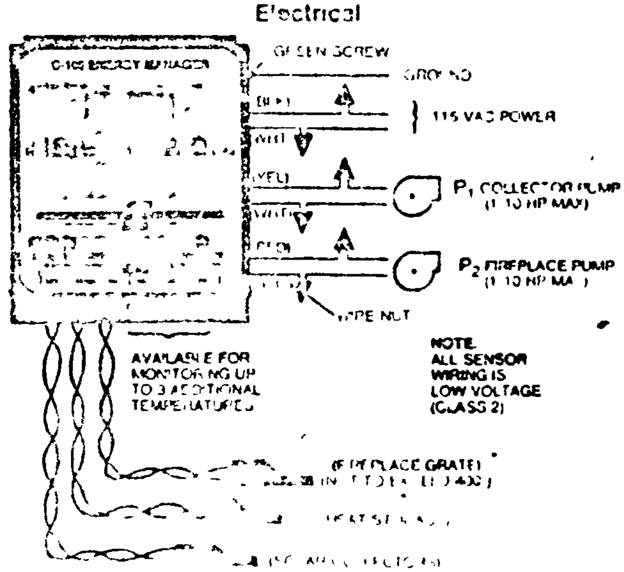
TEMP °C	TEMP °F	RESISTANCE (K ohm)	TEMP °C	TEMP °F	RESISTANCE (K ohm)
0°	32°	32 6?0	60°	140°	2 488
10°	50°	[illegible]	[illegible]	[illegible]	1 751
20°	68°	12 430	80°	176°	1 256
30°	86°	[illegible]	[illegible]	194°	[illegible]
40°	104°	5 327	100°	212°	679
50	122°	3 602			

Schematic - Solar/Fireplace DHW System – Model C100-1S-2S

Piping



Electrical

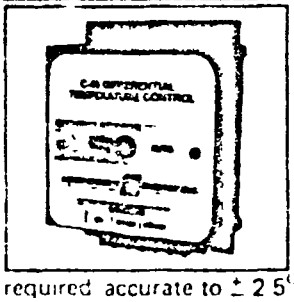


NOTICE

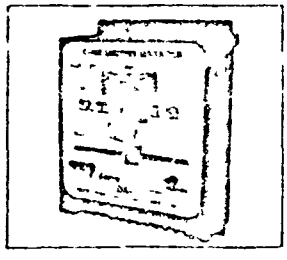
The application notes or suggestions for installation of Independent Energy products are hereby submitted are [illegible] any actual installation without engineering or technical [illegible] properly licensed in the jurisdiction where the [illegible]

BUILD A BETTER SYSTEM AROUND AN INDEPENDENT ENERGY CONTROL.

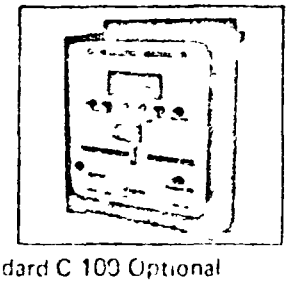
IE controls give your system the performance edge . . . from domestic water, space, and pool heating right through solar assisted heat pump space conditioning. You're ahead at the design stage — with the right price, microcomputer technology, and warranty protection. Ahead in the marketplace — with the reliability of computer testing and controls that help the system pay for itself faster. All from a single source, with features and options to drive your system to the performance you're designing for. Get real control power! Specify IE.



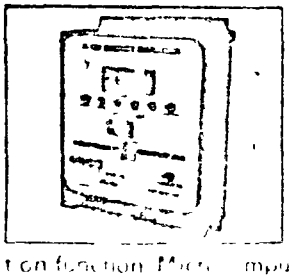
From basic
C 60 Differential Temperature Control for domestic water heating and pool heating
Delivers full performance at lower cost through superior design. Compact, quiet solid state, no calibration required, accurate to ± 2.5° F. Options include AC line cord and outlets, 230 VAC operation, auxiliary output, freeze protection



Through sophisticated
C 100 Energy Manager
Differential Temperature Control and Performance Monitoring in a single unit
For domestic water heating
Microcomputer based
Integrated control and monitoring means lower cost. Performance monitoring allows operational testing at system startup and continuous fine tuning of performance. Helps spot malfunctions. Makes maximum energy efficiency possible. Lets a system pay for itself faster. Offers C 60 features plus monitoring of up to 6 sensors. Controls up to 3 outputs (the 2nd output may be used for fireplace grate). Three-digit LED temperature display. Accurate to ± 1° F. Offers C-60 options plus proportional control of outputs 1 and 2. Read out in °C or °F



C 110 Energy Manager
Integrated Differential Temperature Control and Performance Monitoring for swimming pool applications
Adds standard adjustable high temperature limit and rain tight enclosure to standard C 100. Optional nocturnal cooling available. Microcomputer based

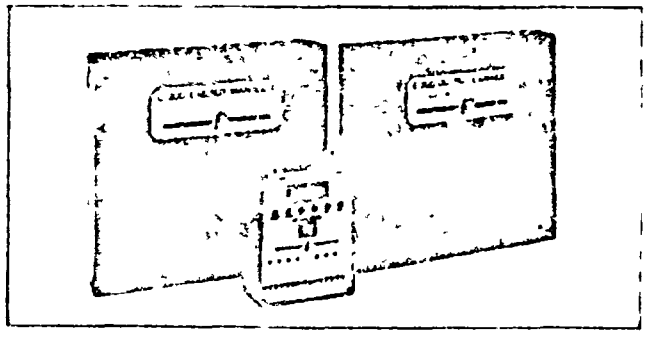


C 120 Energy Manager
Integrated Differential Temperature Control and Performance Monitoring for space heating or space and domestic water heating
Adds control of energy distribution to the collection function. Micro[illegible]

source) or direct heating (storage tank or collectors as heat source)

To state of the art
C 200 Energy Manager
Complete Space Conditioning (Heating/Cooling) in conjunction with solar assisted heat pumps, plus domestic water heating control. Operates solar collectors, domestic water heating, indirect or direct/indirect space heating and cooling, fireplace grates, boiler/furnace, and up to two heat pumps.

Offers up to 6 temperature sensors, up to 10 T stat inputs, and up to 8 solid state outputs. Accurate to ± 1° F. Microcomputer based



E 200 Output Expander
Expands 8 output capacity of C 200 to 16 solid state outputs. Ideal for systems with sophisticated control function requirements

S 200 System Monitor
Designed for use with C 200. Displays status of C 200 inputs, outputs, and temperature sensors. Offers 3 digit LED temperature readout and an individual LED for each input and output. Allows fast operational testing at system startup, continuous fine tuning of system performance. Helps spot system malfunctions quickly. Available for wall mounting up to 50' from C 200, or in serviceman's portable case

ENERGY SYSTEMS, INC.
P O Box 59
Charlotte C H, Va 23923
804-542-5311

[illegible] ENERGY SYSTEMS, INC.

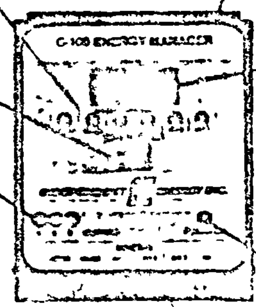
Operation

C100 is capable of controlling most air and hydronic solar systems. Multiple outputs allow control of complex and combination systems such as DHW/Fireplace Grate, DHW/Pool, DHW/Hot Tub, etc.

DISPLAY INDICATORS
Indicates which sensor or storage high limit temperature is displayed

EXTERNAL MOUNTING FLANGE
(bottom flange deleted)

SENSOR SELECT BUTTON
Depress sensor select until control sequences to desired sensor/high limit location. Release and read temperature in window. To single-step monitoring points, momentarily depress button.



LED DIGITAL TEMPERATURE READOUT
[illegible]

OUTPUT INDICATORS
Output 1 Differential Temperature Control operates in on/off (indicator light on) or proportional (light flashes at pump/blower rate) modes. On/off control is standard. Proportional control is optional (see ordering information). Microcomputer uses difference in temperature between collector sensor and storage sensor to make control decision.
Output 2 Optional 2nd Differential Temperature Control or Drain Down Freeze Protection [illegible]
Output 3 Optional Drain Down Freeze Protection [illegible] collector temperature

AC POWER [illegible]

EXTERNAL SENSOR TERMINAL STRIP

Ordering Information/Procedure

- Follow chart from left to right selecting the outputs and options for your application(s) (see sample below chart)

Output 1 115 VAC 1/10 HP

Output Type (select 1)	Order Code
20°F on/5°F off std) Differential Temperature Control — Optional Thresholds 16/3, 12/4, 8/3	1S( ) if optional threshold is selected, place in parenthesis
Proportional Speed † Differential Temp Control 5°F Diff Start 16°F Diff Full Speed (std threshold) — Optional Thresholds 20/7, 12/5, 8/4	1P( ) if optional threshold is selected, place in parenthesis

Output 2 115 VAC 1/10 HP

Output Type (select 1)	Order Code
20°F on 5°F off (std) Differential Temperature Control — Optional Thresholds 16/3 12/4 8/3	2S( ) if optional threshold is selected place in parenthesis
Proportional Speed † Differential Temp Control 5°F Diff Start 16°F Diff Full Speed (std threshold) — Optional Thresholds 20/7, 12/5, 8/4	2P( ) if optional threshold is selected place in parenthesis
Drain Down ** Freeze Protection Based on Collector Temp <33°F off >43°F on	2F

Output 3 115 VAC 1 AMP

Output Type	Order Code
Drain Down Freeze Protection 33°F off 43°F on	3F

Options - Output 1	Order Code
Storage High Temperature* Limit (140°F std) — Optional Limits 120 160 180 200°F	H( ) if optional limit is selected place in parenthesis
Adjustable High Temp Limit 70°F 180°F for DHW*	H(ADJ)
Adjustable High Temp Limit* 65°F-120°F/for Pool/Hot Tub	H(PADJ)
Recirculate Freeze Protection Based on Collector Temp <33°F on >43°F off	L

Options - Output 2	Order Code
Storage High Temperature* Limit (140°F std) — Optional Limits 120 160 180 200°F	H( ) if optional limit is selected place in parenthesis
Adjustable High Temp Limit 70°F 180°F for DHW*	H(ADJ)
Adjustable High Temp Limit* 65°F-120°F for Pool/Hot Tub	H(PADJ)
Auxiliary Storage for Dual Storage Systems ***	A

General Options	Order Code
1 HP Relay for 1S or 2S output	(1HP)
Line Cord and Outlets	LC
Transformer for 24 VAC output 20 VA Max	24 VAC)

* - If specified, control turns off if storage reaches limit regardless of other sensor temperatures
If specified, displayed at aux 4 control position
- If specified for both outputs 1 & 2, limits must be same for [illegible]

** To be effective, collector sensor must be mounted on coldest part of absorber plate

*** Makes aux 2 the storage sensor for output 2

† Proportional Control to be used only in conjunction with permanent capacitor or shaded pole motors. Acceptable pumps include, but are not limited to Taco (007, 008) and Grundfos (20-42, 25-18, 25-42, 25-64, 26-64)

Ordering Example

Select a C100 Differential Temperature Control with Display	with Differential Temperature Control with 20/5 thresholds on output 1 and a high temp limit of 160°F	and proportional control of output 2 with 12/5 thresholds with high temp limit of 160°F	with optional AC line cord and outlets
C-100 —	1S H(160) —	2P(12/5)H(160) —	LC

GENERAL MAINTENANCE

OF

PNEUMATIC CONTROL SYSTEMS

HONEYWELL INC. **COMMERCIAL DIVISION**

Minneapolis, Minnesota 55408 • Toronto 17, Ontario

7-66
D F

Form Number **77-9367**
Commercial Div

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INTRODUCTION

Your Honeywell Automatic Control System has been engineered and installed to meet your individual needs, and it represents a great deal of study and planning by control experts

Each of the parts that make up your control system has been designed and built to give you many years of trouble-free service After installation, our technicians have carefully adjusted every component and given the entire system an operational check to make sure that we have not overlooked a thing in giving you accurate, dependable control

However, mechanical devices must be serviced periodically if they are expected to give continued satisfactory performance, and controls are not an exception How accurate, dependable, and economical your control system will remain in the years to come depends largely on the maintenance given it This booklet has been designed to cover all general aspects of the maintenance required to help you keep your system in proper operating condition You are urged to observe the schedule of maintenance procedures listed on page 1 Unusually severe conditions would dictate more frequent attention, of course

For those who prefer professional maintenance, Honeywell provides, and recommends, a plan of regular, expert maintenance service performed by our own trained specialists You will find information about Honeywell Maintenance Service on page 14 in this booklet

A NOTE OF CAUTION

In several sections of this booklet the suggestions for cleaning various parts of your control system refer to the use of solvents. All solvents, flammable or not, should be handled very carefully. Do not inhale their vapors or permit them to contact the skin unnecessarily. Careless handling can result in permanent injury to the skin or the respiratory system.

MAINTENANCE SCHEDULE

The rusting, dirt accumulation, and general wear that controls sustain over a period of time depends upon the actual "in-service" time and general operating conditions The following maintenance schedule is based on the average installation and can be used as a guide in determining how often the various control devices should be serviced

Frequency	Service Required	See Page
Once a week	Drain compressor tank, filter bowl, and any air lines furnished with drain cocks	3
	Check compressor crankcase oil level	4
	Check compressor safety-relief valve	5
Once a month	Inspect the discharge-air filter	4
	Check the pressure-reducing valve setting	5
Once every three months	Change the crankcase oil	4
	Oil the compressor motors	4
	Check the compressor pressure switch	5
Once every six months	Check for moisture, oil, or dirt in the lines	4
	Clean the intake air filter, felt and screen types	4
	Check the compressor belt	4
	Check the pressure-relief valve	5
	Check the calibration and operation of	
	Sensors	6
	Thermostats	7
	Humidity controllers	8
	Pressure controllers	9
	Check the nozzle and restrictors of	
	Sensors	6
	Thermostats	8
	Humidity controllers	9
	Pressure controllers	9
	Clean elements of	
	Humidity sensors	6
	Humidity controllers	8
	Check piping of	
	Pressure sensors	6
	Pressure controllers	9
	Lubricate dampers	12
	Check damper travel and close-off	13
Once a year	Replace cartridge-type, intake-air filter	4
	Check calibration and proportional band of sensor-control system	6
	Check throttling range of	
	Thermostats	8
	Humidity controllers	8
	Pressure controllers	9
	Lubricate packing[a]	10
	Adjust packing[a] or repack valves	10
	Check valves for tight closeoff	10
	Check e-p and p-e relay operation	11
	Check Gradutrol* relay operation	11
	Check diverting switch operation	13
	Check graduate switch operation	13

[a]Not required on valves with Teflon packing
*Trademark

GENERAL MAINTENANCE INSTRUCTIONS

Pneumatic Systems

An automatic control system is composed of several mechanical devices, each designed to perform a specific function Accurate control is possible only when each component of the system performs its function properly To ensure the proper operation of each device, the system must be checked periodically and repaired when needed

Service suggestions and methods of adjustment for every device may be found in the individual installation instructions or maintenance and repair instructions for the particular device The following General Instructions will be of value to anyone responsible for the maintenance of automatic controls and will aid him in making an intelligent periodic check of a pneumatic control system

VISUAL INSPECTION

Study the drawings of your control system to get a general picture of what devices are involved, and to thoroughly understand the sequence of operation Then a visual inspection of the system can be made to determine the following

1 MISSING EQUIPMENT OR PARTS

Equipment is not likely to be missing from a system that is periodically checked and serviced It is the "forgotten" system that eventually has some of the components missing Occasionally covers or small accessories will disappear, and these should be replaced promptly to avoid getting dirt into the controls which may impair their operation

2 LEAKING OR RESTRICTED AIR LINES

Excessive compressor operation frequently indicates that there are leaks in the system Two methods are commonly used to locate hard-to-find leaks A soapy solution may be applied with a brush to all piping connections and fittings The leak can be located by the bubbling action The other method is to introduce an odorant, such as wintergreen or motor ether, into the system near the compressor The leak may be located by the odor near the leak

It is possible for a leak to occur in air piping within a wall, ceiling, or floor, due to a settling of the building If the air lines are imbedded in concrete, it will be necessary to cut into the concrete to repair the line or to disconnect the leaking line and install a new one In some instances it might be possible to run the new line behind a baseboard or molding If the leak is located in a false ceiling or partition, it is often possible to pull in a new line as the old one is pulled out Since there are several conditions to be considered in each case, one must use good judgment and common sense to accomplish the job, using the least amount of time and effort

A damaged air line that restricts the flow of air can also cause trouble If the main-line air pressure (supply) at a controller drops when the controller is attempting to build up branch-line pressure, there may be a restriction in the main line To locate a damaged or restricted air line, check the supply air pressure to each device in the system The defective line will be the supply line to the farthest upstream device that has a reduced supply air pressure

3 DIRTY EQUIPMENT

Dirt acts as an insulator and can make a control sluggish in operation if it accumulates on the control element Remove covers and check for dirt and corrosion Chlorothene or Vythene, containing trichloroethane, or other similar cleaning agents are recommended for removing dirt and grease from all metal surfaces Evidence of rust or corrosion indicates the presence of moisture, the source of which should be determined and eliminated

WARNING. Special care should be exercised in the use of solvents Avoid prolonged inhalation and/or contact with the skin Careless handling can result in permanent injury to the respiratory system or skin tissue

Check for binding and worn or loose connections of linkages on dampers and valves Linkages may be damaged or may shift as a result of binding dampers or valves When originally installed, all equipment is properly lubricated and adjusted to eliminate binding If points of wear are kept well lubricated and free of dirt, satisfactory operation will result, and costly replacement of linkages and damper operators will be avoided

Compressor — Air Supply:

OPERATION

Compressed air for the control system may be supplied by a central source or a separate air compressor The air must be clean and dry, and the pressure reduced to 18 psi If the moisture content of the outside air is normally lower than that of the inside air, the compressor should be supplied with air piped from outside If moisture condenses in the air lines or controls, serious damage may result Piping and internal parts of the instrument may corrode, and plugging may result in immobilizing the mechanisms In many systems, particularly year-round systems, it is advisable to install an air dryer to eliminate moisture from the air supply

The intake air is cleaned through a screen filter before it enters the compressor The air leaving the compressor is delivered to a storage tank To eliminate oil in the air supply to the controls, an oil filter with a replaceable cartridge is installed in the air line leaving the storage tank

Dirty filters do not clean the air efficiently, and they restrict air flow, thus reducing the effective capacity of the compressor and causing it to run longer This causes unnecessary wear For these reasons the filters should be cleaned regularly

The air pressure maintained in the tank is reduced to 18 psi through a pressure reducing valve (prv) The disc and diaphragm in the prv will need replacing more often if the air lines contain oil vapor A clean oil filter will protect the prv and other controls by removing oil vapor from the air supply

If the prv fails to close off properly as the downstream pressure rises to its setting, or if the valve diaphragm ruptures, the air pressure to the controls will build up and cause serious damage To prevent such damage, an integral relief valve is provided on the downstream side of the prv to act as a safety device The relief valve is set to relieve pressures in excess of 20 psig

The entire control system operation is dependent upon the air supplied by the compressor The air must be clean and dry to safeguard the controls and to guarantee that each will function properly It is, therefore, of utmost importance to maintain the compressor and its related parts in efficient operating condition

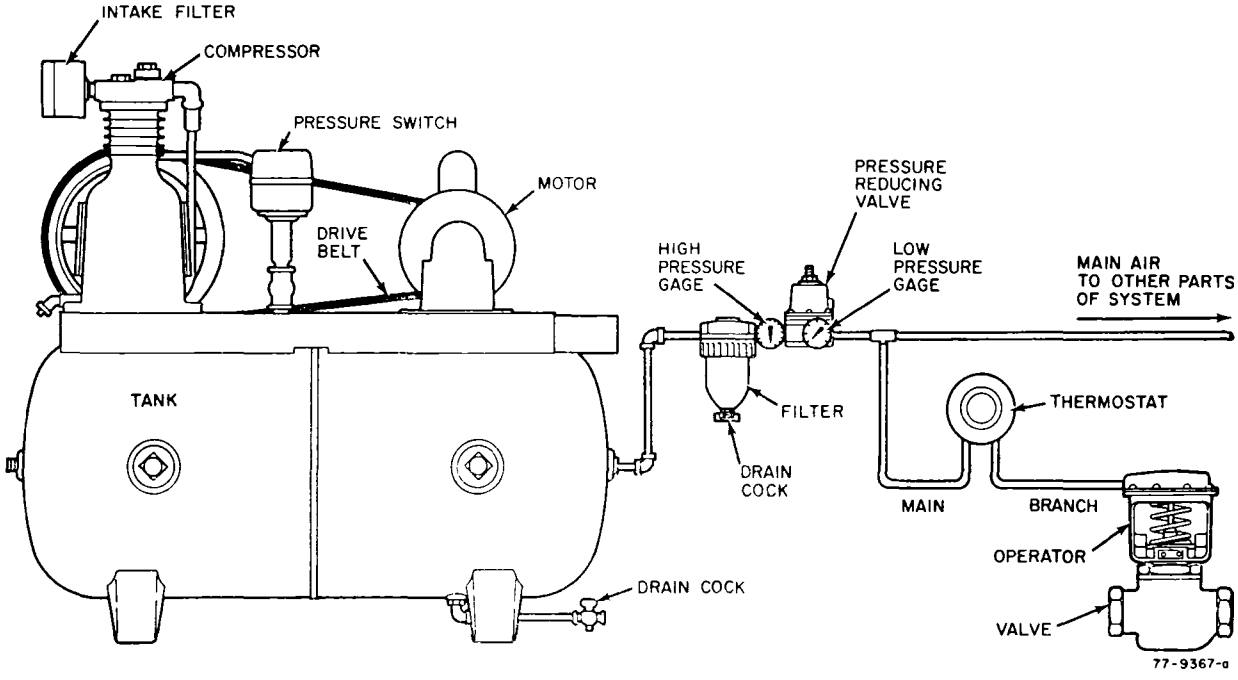


Fig 1—Diagram of a Typical Pneumatic System

MAINTENANCE

1 TANK, FILTER BOWL AND AIR LINES FURNISHED WITH DRAIN COCKS Drain once a week

Accumulated water and oil can be drained from the compressor tank by opening the drain cock on the bottom of the tank Evidence of oil in the tank indicates that the compressor is pumping oil and the compressor unit should be repaired or replaced Drain the pressure-reducing valve and filter-station bowl by opening the cock on the bottom of the bowl Clean the bowl if it is dirty Drain any lines leading from the compressor if cocks are provided Weekly draining is the minimum requirement In humid climates, daily draining may be required

2 MOISTURE, OIL, OR DIRT IN LINES Check every 6 months

Remove a thermostat to check for moisture and oil in the lines If any is found, it should be blown out and more thermostats checked Oil will be more evident in thermostats near the compressor

If moisture is present in the lines, the reason for it must be determined This condition can be caused by high relative humidity in a boiler room where the air is being drawn in by the compressor If this is the case, the intake air should be piped from outside, an air dryer should be installed, or both Check to see whether the air lines run through a cold room, or duct, or are fastened to a cold wall or other surface These conditions will cause condensation in the lines Be sure the moisture in the air-storage tank is drained often and not allowed to accumulate

3 CRANKCASE OIL Change every 3 months (or every 100 operating hours)

Check the oil level in the crankcase every week Change oil every 3 months or 100 operating hours, whichever occurs first If operating conditions are exceptionally dirty, change oil more often Do not overfill the crankcase This will cause excessive oil consumption Use only nondetergent oil that contains rust-and-oxidation inhibitors For ambient temperatures below 32 F, use SAE 10-W grade oil For temperatures of 32 to 100 F, use SAE 10, and for temperatures over 100 F, use SAE 20

4 INTAKE AIR FILTER

A Cartridge type—replace once a year

B Felt type—clean every 6 months

The felt in the intake filter should be removed and cleaned in trichloroethane or other NON-FLAMMABLE cleaning solvent NEVER USE GASOLINE' Do not use oil type filters

C Screen element type—clean every 6 months

The air intake filter-silencers have an oil-wetted screen filter element Remove the screen filter element and wash it in trichloroethane or other standard NON-FLAMMABLE cleaning solvent NEVER USE GASOLINE' Allow the filter element to dry and then dip in SAE 30 to 50 engine oil Drain off excess oil and reassemble the unit The interior silencer chamber requires no attention or service

5 DISCHARGE AIR FILTER Inspect once a month

The cartridge must be replaced periodically It will be necessary to replace it more often when the compressor unit is worn If the filter material appears damp with oil when squeezed with the fingers, it should be replaced If the filter becomes oil-soaked within a month or less, the compressor should be repaired or replaced Clean the resin-impregnated filters with a commercial cleaning solvent such as trichloroethane DO NOT USE GASOLINE'

6 COMPRESSOR MOTOR Oil every 3 months

The electric compressor motor should be oiled as specified on the manufacturer's nameplate Once every three months is sufficient under most operating conditions Before oiling, disconnect the power supply as a safety precaution

7 COMPRESSOR BELT Check once every 6 months

The compressor belt will wear longer if the tension is properly adjusted Proper tension will also ensure maximum compressor efficiency and a minimum of noise Correct tension allows approximately 1/2 inch of belt deflection Check belt tightness when oiling the motor and make any needed adjustment by shifting the motor on its mounting plate

WARNING Shut off power to the motor before handling the compressor belt

8 COMPRESSOR SAFETY RELIEF VALVES Check once a week

Safety relief valves are factory-set to release at approximately 15 psig higher than the rated pressure of the compressor Safety relief valves are located next to the pressure switch on the tanks Check each safety relief valve by pulling on the ring to unseat it MALFUNCTIONING VALVES SHOULD BE REPLACED OR REPAIRED IMMEDIATELY

9 PRESSURE REDUCING VALVE Check once a month

The prv setting should be checked A permanently installed gage downstream from the prv will indicate if the correct pressure is being maintained Reset the prv if necessary

10 PRESSURE-RELIEF VALVE Check once every 6 months

Make sure that the valve setting has not shifted (20 psig maximum setting) This valve is located integrally in the prv shown in Figure 1 Allow air to blow through for a few seconds This will prevent any sticking action caused by the valve remaining in the closed position for long periods of time

11 PRESSURE SWITCH Check once every 3 months

The cut-in and cut-out setting of the pressure switch should be noted by operating the compressor safety-relief valve and observing the pressure gage indicating the tank air pressure The Maintenance and Repair sheet for the compressor used provides cut-in and cut-out settings as well as the required pump-up time for given compressors

Sensor-Controller System:

OPERATION

The sensor-controller system performs two functions measuring and controlling The sensor, for measuring, is located at the point of measurement and is connected by conventional pneumatic tubing to a controller which can be located in a remote equipment room or on a central panel

Sensors

The sensor provides a 3 to 15 psig pressure in the sensor line to pilot the controller Sensors are available with averaging, temperature-measuring elements for duct mounting, bimetal temperature-measuring elements for wall, light-troffer, or Dew Probe* sensor mounting, rod-and-tube elements for duct mounting or immersion in liquids, nylon humidity-measuring elements for duct mounting, and diaphragm-type elements for duct-static or differential-pressure measurement

Controllers

Operating on a force balance principle, the controller takes only a small pressure change from the sensor amplifies it through a main lever, proportional band lever, and proportional relay unit, and provides a 3 to 13 psig branch-line pressure output in proportion to changes in input pressure from the sensor

Controllers are available for either a single input from one sensor or dual input from two sensors The dual input model is used in compensated systems Either model may also have, in addition, an input from a remote, control-point adjustment (CPA) switch

Air Supply and Filtering

For sensor-controller systems it is essential that a clean air supply be maintained as described previously The supply should have good oil separation from the compressor operation, adequate moisture removal, and be free from all impurities

Each of the various sensors includes a sensing element a small nozzle and flapper, and a filter and screen A restriction is also used This is usually located in the controller, but it may be in a separate main-air line to the sensor The controller is also furnished with filters and screens The filters and screens are included to protect the nozzle and restriction from impurities

*Trademark

1 SENSOR CALIBRATION AND OPERATION Check every 6 months

A Checking calibration Sensor calibration may be checked by taking a reading—temperature pressure, or humidity—at the sensing element location and comparing it with the reading on an indicating, receiver gage in the sensor line

NOTE Sensors are factory calibrated and should be compared only with highly accurate measuring devices, properly used

If the sensor appears to be out of calibration, check for the following

1) Dirty filters and screens in controller (acts the same as a clogged restriction) will result in a "droop" or reduced readings on the receiver gage If this is the case, replace the filters and screens Dirty filters and screens at the sensor increase the gage reading

2) A clogged restriction will also result in reduced readings on the gage If replacement of the filters and screens does not correct the readings, also replace the restriction

3) A faulty sensor line will result in either a droop or an increased reading on the receiver gage, depending on the relative location of the fault with respect to the restriction, gage, and sensor Leaks result in reduced gage readings Kinks between the compressor and gage result in a drop in readings Kinks between the gage and sensor result in high gage readings Check for kinks or leaks if suspected

4) A clogged sensor nozzle will result in an increased reading on the gage

NOTE Do not attempt to clean the nozzle or otherwise repair a sensor Return it for repair

B The duct-static or differential-pressure sensor can be recalibrated in the field This has a 2 in water operating span The span may be set to operate anywhere in a range from 0 to 5 in water Piping should also be checked between the pressure pickups and the sensor to see that it is tight and free from dirt If calibration or adjustment is needed, the instructions furnished with the sensor should be followed

C Humidity sensors have a nylon element which should be cleaned every six months The element may be cleaned by gently swirling the device in a shallow tray of clean acetone Be careful not to allow the acetone to enter the nozzle-flapper area The element may stick together when wet but will separate after drying Use a soft, dry brush to clean the bracket and lever assembly

WARNING Acetone is a highly flammable solvent and must be handled with extreme care Avoid breathing the vapor and unnecessary contact with the skin

2 CONTROLLER CALIBRATION AND OPERATION Check every year

A General In general, the instructions for the controller should be referred to for checking controller calibration The following provides a simple check of calibration and proportional band for a single-input controller

B Calibration check Turn the setpoint adjustment screw or remote CPA dial until the controller branch-line pressure equals 8 psig For a properly calibrated controller, the setpoint scale reading should then be the same as a reading taken on a sensor-line receiver gage

C Proportional bank check

1) Determine the span of the sensor The span is the total range of the sensor such as

Sensor Range of	Equals Span of
-40 to 160 F	200 F
50 to 100 F	50 F

2) Convert the proportional band setting on the controller to throttling range The proportional band is the percent of the span change required to change the branch-line pressure from 3 to 13 psig

For example, a proportional band setting of 10 percent with a 200 F span sensor provides a throttling range of 20 F (0 10 x 200 = 20 F)

This means that as the sensor senses a change of 10 percent of its span, or 20 F, the branch-line output of the controller will change from 3 to 13 psig

3) Determine the exact number of turns of the setpoint adjustment screw required to change the branch-line pressure from 3 to 13 psig through the proportional-band setting The setpoint adjustment screw has 10 marked divisions One division equals 1/2 percent of the sensor span Twenty complete turns covers the whole span The number of turns of the setpoint screw required to cover the adjusted proportional band setting is as follows

$$\text{Turns} = \frac{\text{proportional band setting}}{0\ 05}$$

For the example, the number of turns of the setpoint adjustment screw required to cover the proportional band setting is

$$\text{Turns} = \frac{0\ 10}{0\ 05} = 2$$

NOTE Turning the setpoint screw through the proportional band will also move the setpoint scale pointer through the throttling range For the example, this equals 20 F for 2 complete turns

4) Check the proportional band as follows

a) Adjust the setpoint screw of the controller for 3 psig branch-line pressure for direct acting (13 psig for reverse acting)

b) Turn the setpoint screw through the proportional band the exact number of turns calculated (2 in the example) in the direction required to obtain 13 psig branch-line pressure for direct action (3 psig branch-line pressure for reverse acting)

c) For a properly calibrated controller, the branch-line pressure should change from 3 to 13 psig as described If recalibration is required, refer to the individual Installation Instructions for the controller

Thermostats:

OPERATION

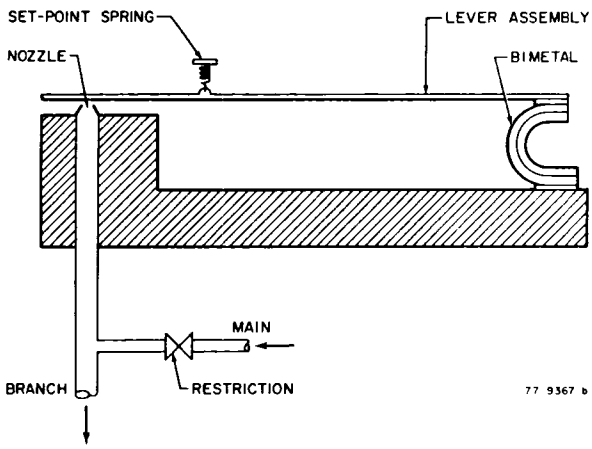


Fig 2—View of Bleed-Type, One-Pipe Thermostat

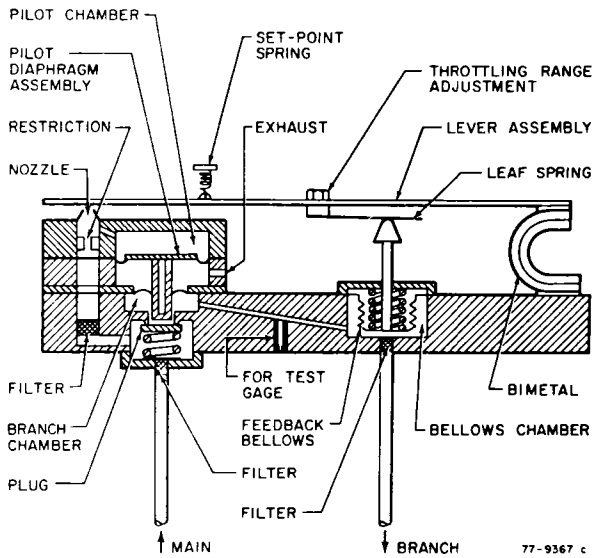


Fig 3—View of Pilot-Bleed, Two-Pipe Thermostat

Pneumatic thermostats may be divided into two groups the bleed type (ordinarily one pipe), Figure 2, and the pilot bleed (two pipe), Figure 3 They may also be classified by application, as room-type, or as insertion-type (designed for controlling the temperature of a medium in a pipe line or duct system) The room and insertion thermostats may be of either bleed or pilot-bleed type

The bleed-type thermostat varies branch-line pressure by regulating the position of a flapper against a nozzle Air is exhausted continuously at varying rates except when the lever assembly (or flapper) seats against the nozzle A restrictor is installed in the main-air supply serving the thermostat The restrictor may be adjustable or fixed, and its function is to restrict the flow of air to an extent that will permit the thermostat to bleed off air and reduce the control line pressure to 1 psig or less

There are several types of pilot-bleed thermostats which can perform special functions Among these types are

1 The Day-Night thermostat which acts to control at a lowered night temperature It can be switched automatically from day operation to night operation and back again from a remote location This is accomplished by using a main supply pressure of 18 psig for night control and 13 psig for day control

2 The Summer-Winter thermostat changes action when a remote switch raises the main air pressure from 13 psig for summer to 18 psig for winter, or vice versa The standard summer-winter thermostat operates as a reverse-acting thermostat in summer, and as a direct-acting thermostat in winter It is also available in a model that is direct-acting in both seasons

3 The Submaster type thermostat has an auxiliary bellows to set up the control point on signal from a remote master controller A simple means is provided for adjusting the amount of set-up

MAINTENANCE

1 CALIBRATION AND OPERATION Check every 6 months

Check the calibration of each thermostat when giving the control system its periodic checkup It is very important on room-type thermostats not to warm the bimetal by breathing on it or by keeping the hands near it while checking or adjusting the calibration A thermostat is said to be "in calibration" when a temperature equal to the indicator setting produces a branch-line pressure of 8 psig ± 1 psig

Calibration may be checked by raising or lowering the thermostat indicator to a value equal to the space

(or other controlled medium) temperature and observing the branch-line air pressure If the branch-line pressure is more than 9 or less than 7 psi, the thermostat should be recalibrated Follow the calibration procedure outlined in the various individual Maintenance and Repair sheets

A simple operational check may be done on the thermostat by blowing on or otherwise warming the bimetal and observing whether the appropriate change in pressure follows

Submaster type thermostats should be checked for the amount of set-up provided This procedure may be found on the installation instructions sheets for the Submaster thermostats

2 THROTTLING RANGE Check once a year

The throttling range may be checked by manually raising and lowering the setpoint and noticing the number of degrees change necessary to vary the branch line pressure from 3 to 13 psig Set the throttling range adjustment button as near to the minimum setting as the system will permit without causing a hunting or cycling condition Normally, 3 to 4 degrees range is satisfactory for room comfort control

3 NOZZLE AND RESTRICTOR Check every 6 months

Make sure that the nozzle is free of dirt so that the flapper will seat firmly to build up a branch-line pressure to within one psig of main supply pressure The branch-line pressure should drop to one psig or less as the flapper is moved away from the nozzle by changing the setpoint of the device If the pressure fails to drop to nearly zero, or if there is excessive lag in doing so, the filter at the nozzle connection may be partially plugged If so, replace it If the branch pressure lags when attempting to build up, the restrictor or restrictor filter may be partially plugged (Also see "Leaking or Restricted Air Lines"—page 2)

The restrictor plate on pilot bleed thermostats will sometimes become clogged so badly as to impair the operation of the device Honeywell makes available a package assembly for replacing this plate See "Nozzle Plate Repair Assembly" in the Maintenance and Repair sheet for the thermostat in question

Humidity Controls:

OPERATION

Humidity controllers are bleed-type instruments and operate on the same principle as bleed-type thermostats The sensing element, however, is actuated by changes in relative humidity The length of the element varies with the relative humidity and, through a series of levers regulates the branch air pressure

MAINTENANCE

1 CALIBRATION Check every 6 months

A periodic check should be made to keep the controller in calibration To make sure that the throttling range is correct, it is not necessary to check more than once a year Calibration and throttling-range adjustments are similar to those for thermostats Refer to the proper Maintenance and Repair sheet for the humidity controller being checked

2 CLEAN ELEMENT Every 6 months

It is important that the hair element be kept clean so that it will respond properly to changes in the relative humidity An accumulation of grease and dust will widen the throttling range of the control after long use Therefore, periodic cleaning is recommended A thorough washing of the element with a camel's hair brush and clean ether (obtainable at any drug store) followed by a complete wetting with distilled water, will restore the controller to its original sensitivity Critical applications may require washing with distilled water as often as every week

WARNING Ether is a highly flammable solvent and must be handled with extreme care Use only in a well ventilated area and in small amounts Avoid breathing the vapor and unnecessary contact with the skin

3 NOZZLE AND RESTRICTOR Check every 6 months

(Maintenance is the same as outlined for thermostats See Thermostats MAINTENANCE, section 3)

Pressure Controls:

OPERATION

There are three types of pneumatic pressure controllers, each designed for different applications

1 The standard bellows type pressure controller may control from pressure as low as a few ounces or as high as 300 psig, depending upon the pressure range of the instrument

2 The static pressure regulator is designed to control the static pressure in a duct system or in a space supplied with air by a fan system and operates from positive or negative pressures of zero to 6 in water column This controller utilizes a relatively large area diaphragm to measure pressure changes

3 The third type is the differential pressure controller which reacts to changes in the difference between two pressures

MAINTENANCE

1 CALIBRATION Check every 6 months

Refer to the proper Maintenance and Repair sheet for calibrating the pressure controller being checked as well as for checking throttling range This latter, however, need not be done more than once a year

2 PIPING FROM CONTROLLER TO CONTROLLED MEDIUM Check every 6 months

The piping from the controlled medium to any of the pressure controllers must be kept airtight and free of dirt Check the piping at the reference locations of the static pressure regulator and the differential pressure controller to make certain the open end is not plugged in any way

3 NOZZLE AND RESTRICTOR Check every 6 months

(Maintenance is the same as outlined for thermostats See Thermostats, MAINTENANCE, section 2)

Valves:

OPERATION

Valves are designed for many different applications Each design has certain temperature and pressure ratings as well as specific flow characteristics If valve trouble occurs, make sure that the valve or its actuator has not been subjected to conditions beyond their limitations Under normal operating conditions, a valve will give long, trouble-free service

Valves are referred to as being "normally open" or "normally closed " A normally open valve will close when air pressure is applied to the actuator, and will return to an open position when the air pressure is removed A normally closed valve, on the other hand, opens when air pressure is applied, and closes when the pressure is removed

1 PACKING LUBRICATION Check once a year

Valves with a rubber packing may be operated annually to check for smooth operation The packing itself may be lubricated if necessary Valves with Teflon packing require no periodic lubrication Refer to Honeywell Form 77-5602 for proper lubricating procedures and lubricants

2 PACKING ADJUSTMENT AND REPACKING Check once a year

A small leak that is hardly noticeable is sometimes overlooked as a trivial matter In fact, on hot pipes, the moisture will often evaporate before any dripping occurs However, the vapors eventually may corrode and rust the acutator so badly as to require replacement

To stop the leaking of a valve that does not have a self-adjusting packing gland, tighten the packing nut not more than 1/2 turn Allow the valve to operate a while before any further tightening Never tighten the packing nut more than is necessary to prevent leakage Replace the packing if the leakage is not stopped before the packing nut is tightened solidly

To stop the leaking of a valve that has a spring-loaded, self adjusting packing gland (all Teflon-packed valves), replace the packing and spring, if necessary The packing nut should be turned down tight and requires no further tightening thereafter throughout the life of the packing

When repacking, inspect the valve stem, bonnet, and packing nut for excessive wear, and particularly for scoring of the stem Excessive wear of the bonnet or packing nut impairs its function of guiding the stem, and greatly reduces packing life Packing will not seal when used with a scored stem If any of these parts are not in good condition, replace them

Refer to Honeywell Form 77-5602 for detailed repacking procedure for specific valves

3 TIGHT CLOSE-OFF Check once a year

It is important to check valves periodically for proper close-off action If a valve does not close entirely, over-heating or over-cooling (depending upon the application) may result under light load conditions This trouble is often due to chips or scale lodged between the valve disc and seat Excessive wear of the valve seat and disc will occur when a valve does not seat firmly This is caused by the erosive action of the fluid leaking through the valve

Check the air pressure supplied to each normally open valve to make sure it is 13 psig for day-night systems and 18 psig for single temperature systems when the controller is calling for the valve to be closed Each normally closed valve should be checked to see that it is closed when the air pressure from its controller has dropped to zero psig

Determine whether or not the stem is operating through full travel Check for sticking or binding of the stem The pressure of the medium being controlled should also be observed to make sure it is not exceeding the close-off rating of the valve being checked

Three-way mixing valves may be checked in a similar manner However, they have two inlets and one outlet, and must close off against fluid flow on both the upward and the downward stroke They are normally open to one port and normally closed to the other and should therefore be checked for proper close-off with both 18 psig and zero psig air supplied to the actuator

If tight shut-off does not occur when stem travel is correct, the valve should be disassembled and checked for foreign matter lodged between the valve seat and disc Inspect the discs and seat to determine if replacement of either or both is necessary Since valve discs are made of several different materials to accommodate various controlled media, pressures, and temperatures, care must be taken to choose a replacement that is suitable for the application

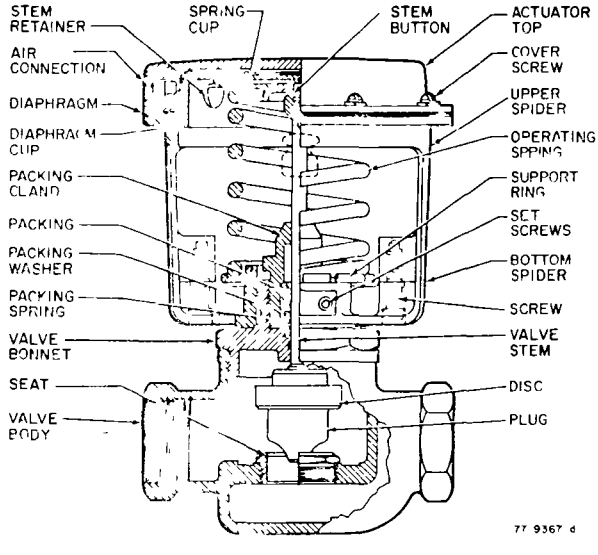


Fig 4—Sectional View of Typical, Normally Open Valve

Relays:

OPERATION

Many types of relays are used, some of which can perform a variety of functions in a pneumatic control system

To accomplish certain control action, it is often necessary to make or break an electric circuit by a gradual change in air pressure from a controller This is accomplished by the use of a pneumatic electric or p-e relay

It is also necessary in many cases to switch a pneumatic circuit by an electric impulse This is accomplished by the use of an electric pneumatic or e-p relay

The Gradutrol relay is used to provide positive positioning of damper and valve operators It also provides for a complete range of adjustment of the controlled device

Other purposes for which relays are designed are

(1) To average the demands of two controllers,
(2) To switch a pneumatic circuit at any desired pressure setting,
(3) To select the higher or lower of two control pressures,
(4) To reverse control action, and
(5) To increase the capacity of a controller

Those relays which are entirely enclosed require no maintenance and will give continued trouble-free service if the air supply is kept free of dirt, oil and moisture

Some e-p relays have integral filters These should be checked according to information in their individual Maintenance and Repair sheets

MAINTENANCE

1 E-P AND P-F RELAY OPERATION Check once a year

To check an e-p relay, first energize the electric circuit and observe the result of switching the control line Make certain the relays are kept dry, for moisture will shorten the life of the coil and rust the various metal parts Check the relay unit for proper switch action of the air lines and for any leaking of air

Check the operation of p-e relays by observing the pressure at which the electric switch trips to make sure it is in proper sequence with other control settings

The wiring to the e-p and p-e relays should be checked to make sure the connections are safe and secure

2 GRADUTROL RELAY OPERATION Check once a year

This relay should be checked to make sure its settings are correct and its action not hampered by dirt or corrosion The actual starting point and operation range should be checked and adjusted if necessary

Refer to the specific instructions for the particular relay involved

Dampers and Damper Operators:

OPERATION

The subject of damper maintenance can be presented with greater clarity when combined with a discussion of damper operators

Pneumatic damper operators require little maintenance under normal operating conditions However, the linkage between the operator and the damper that it operates should be cleaned and lubricated regularly to minimize wear due to friction

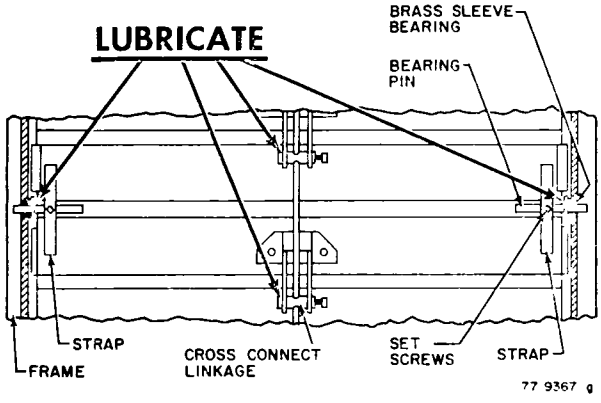
Dampers being used for modulating service must be kept in good operating condition to prevent the jerky action that occurs as a result of sticking dampers This is especially true when the operator is not equipped with a positive-positioning relay

Dampers are often operated in unison with other dampers or equipment A common example of unison operation would be the fresh-air damper opening while the return-air damper closes If one operator is operating both dampers, check to make sure the cross connecting linkage is working properly If one operator is used to operate each damper, check for correct unison operation of the operators

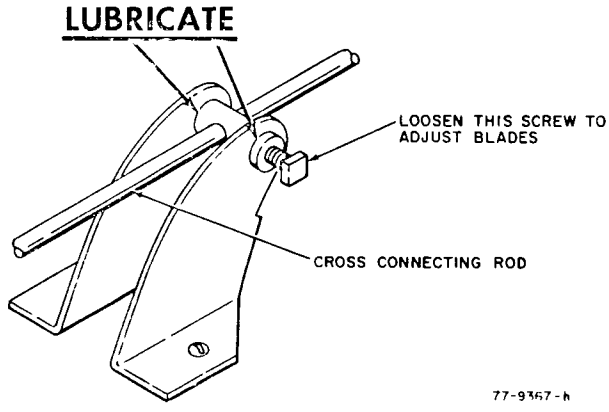
1 LUBRICATE BEARINGS Every 6 months

Lubricate all damper bearings with a mixture of powdered graphite and penetrating oil Squirt it on with a pressure oil can This lubricant will not pick up dust or lint as the penetrating oil soon evaporates Use the same lubricant for all points of friction on the linkage if the operator is mounted inside the duct A light weight machine oil may be used on the operator and linkage if the operator is mounted outside the duct

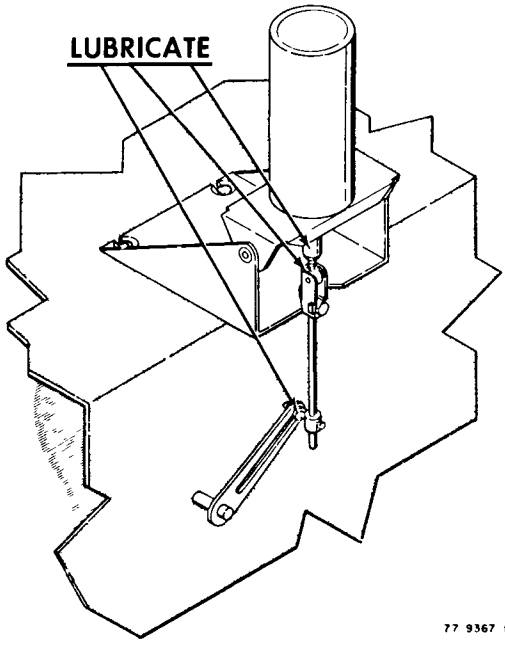
Lubricate the operator shaft with Lubriplate #630AA (Honeywell #310879 1-3/4 oz)



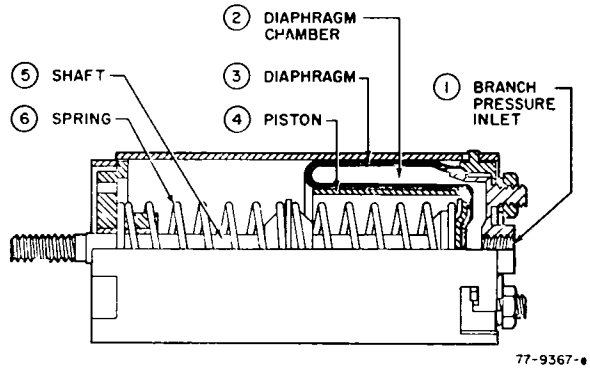
View of Damper Blade with Section Through Brass Sleeve Bearing



Detail of Cross Connection



Pneumatic Operator Mounted Externally on a Damper to Operate the Damper Through a Pushrod



Sectional View of a Typical Pneumatic Operator

Lubricants recommended may be ordered from
HONEYWELL INC , COMMERCIAL DIVISION
1885 Douglas Drive North
Minneapolis, Minnesota 55422

2 COMPLETE TRAVEL AND TIGHT CLOSE-OFF Check every 6 months

Inspect the damper blades for bends or distortions that might prevent them from closing along their entire length Such damage can be caused by the force of the operator if one or more of the damper bearings "freezes" due to ice or the lack of proper lubrication Improper use of heavy maintenance tools or distortion of the duct work can also cause damper blade damage

Check the operation of the operator to make sure it is performing the function intended Observe the opening and closing action of the damper blades as the control line pressure to the operator is changed over the spring range of the operator If the operator is equipped with a positive positioning relay, it should be checked for proper operating range and starting point If the damper does not open as wide or close as tight as it should, it may be due to linkage which has loosened and slipped Check, readjust, and tighten all connections The trouble may be due to an overloaded condition That is, the force required to move the damper through its full travel may exceed the rating of the operator Damper load ratings are based on the force necessary to operate standard dampers in good mechanical condition, and the operators for them are selected on this basis according to the total damper area However, if the damper bearings and linkage are not serviced periodically to keep them clean and well lubricated, the operator may soon be unable to position the damper properly

Switches:

OPERATION

Switches may be classified as diverting or proportioning The diverting switch is used to manually transfer or connect air lines between controllers and controlled devices The proportioning type switch is used to manually vary the air pressure to a controlled device The most common application of the proportioning switch is to manually position dampers from a remote location

Identification plates are provided with all switches Make sure that each switch has identification displaying the correct information about its type and function

MAINTENANCE

1 DIVERTING SWITCHES Check operation once a year

A Tapered-plug type (SP47B, C & D only)

Under normal conditions they will require very little maintenance The need for servicing can be noted by the effort required to turn the switch If the switch does not operate with ease, it should be disassembled, cleaned and greased with Dow-Corning DC-11 lubricant This lubricant is available in 8 oz jars and may be ordered by specifying Honeywell No 314047 lubricant

B O'-Ring type

If the switch does not operate easily, clean the internal metal parts with trichloroethane or a similar solvent Do not allow any of the solvent to touch the 'O'-rings' Lubricate the rotor, O-rings, inside of the switch body and other working parts with Honeywell No 309535 lubricant

2 GRADUAL SWITCHES Check calibration once a year

If the switch has an indicating plate the calibration may be checked by positioning the indicator knob to read zero just as the controlled line begins to indicate pressure

The operating parts not within the sealed unit are protected by a dust cover which should be kept firmly in place

HONEYWELL MAINTENANCE SERVICE

These general maintenance instructions on the proper upkeep of your temperature control system together with the information found on the instruction sheets for the individual controls, should allow you to perform the maintenance necessary to keep your system in good operating condition

However, there are some who would rather have their control systems maintained by trained control specialists It takes several years of training and experience with control systems to be able to pinpoint sources of trouble and to know how to handle them before they cause system breakdowns The technicians employed in Honeywell's Service Departments have just such training and experience Honeywell, through its branch offices, offers Maintenance Agreements to provide regular, expert service for all temperature control systems equipped with Honeywell controls These agreements may be obtained to supplement installation contracts or supervision contracts and are available also where equipment has been purchased on a delivered basis

Even if you have your own maintenance department, you will find Honeywell Maintenance valuable in giving you the benefit of consultation with trained technicians It is economical, too, because it prevents costly rush service calls Inspection is made at regular intervals in accordance with the Maintenance Agreement There is no waiting for service when the rush starts at the first cold spell, or on the first hot day And, perhaps most important, you can always be sure that your automatic control system is operating at the level of efficiency designed into it

For detailed information about Honeywell Maintenance Agreements, write or phone the nearest Honeywell Branch Office (see the list of branches on the back cover of the this booklet) or write

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2753 Fourth Avenue South
Minneapolis, Minnesota 55408

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C773A

Honeywell

ELECTRONIC TEMPERATURE SENSORS

THE C773 IS A PLATINUM FILM SENSOR WHICH HAS A POSITIVE TEMPERATURE COEFFICIENT. ON A RISE IN AMBIENT TEMPERATURE THE RESISTANCE OF THE SENSOR INCREASES.

- C773A contains a single sensor for water tank or solar collector application
- C773B contains a double sensor for water tank or solar collector applications
- C773C contains a single sensor with a flattened end and mounting flange for solar collector installation
- C773D contains a double sensor with a flattened end and mounting flange for solar collector installation
- Available with a medium or high ambient temperature range (specify when ordering)
- Immersion well and remote sensor wiring compartment available separately

CERAMIC

R.L.
10.77 (.3)

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 AVAILABLE

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

C773B Temperature Sensor. Double sensor mounts in storage tank using 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.

LEADWIRE:

C773A,C–two black 18 inch [457.2 mm] No 22 NEC Class 1

C773B,D–two black, two white 18 inch [457.2 mm], No 22 stranded, NEC Class 1

TEMPERATURE RANGE Minus 50 to plus 450 F [minus 46 to plus 232 C]

DIMENSIONS See Figs 2 and 3

ACCESSORIES

Immersion Well for mounting sensor in storage tank See Table 1 and Fig 1

Remote Sensor Wiring Compartment -for wiring storage tank sensor, Part No 111892F.

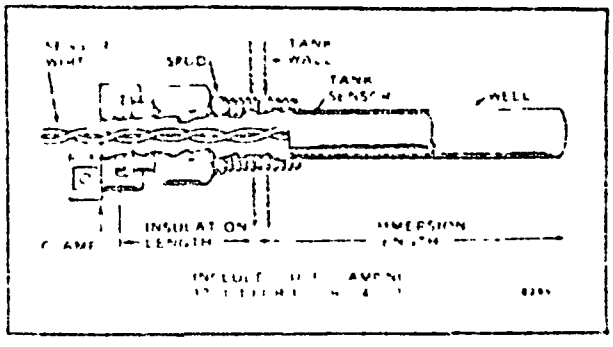

FIG 1–TANK SENSOR INSERTED IN IMMERSION WELL

TABLE 1 IMMERSION WELL TABLE

IMMERSION LENGTH		INSULATION LENGTH		SELECT WELL MATERIAL AND ORDER NUMBER BELOW			
				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	38 1	121731A	121731B	121371E	121371F
3 3/8	85 7	1-1/2	38 1	–	121371K[a]	–	–
3 3/8	85 7	3	76 2	121371L	121371M	–	–
3 3/8	85 7	4	101 6	122554A[a]	122555A[a]	–	–
5 3/8	136 5	4	101 6	122551B[a]	122555B[a]	–	–
6	152 4	1 1/4	31 8	112620BB	–	–	–

[a]Has plastic sleeve on insertion well

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. Order number *
2. Accessories (immersion well remote sensor wiring compartment)

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)
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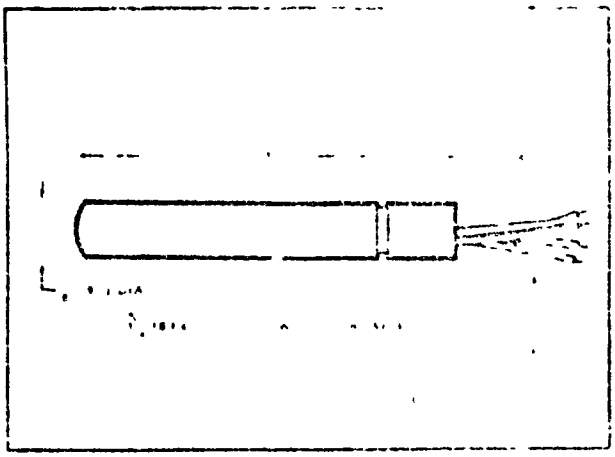


FIG 2–C773A,B DIMENSIONS IN INCHES (MILLIMETRES IN BRACKETS.

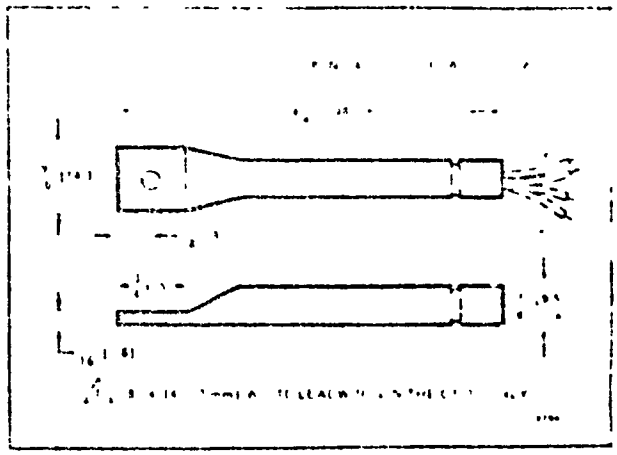


FIG 3–C773C,D DIMENSIONS IN INCHES (MILLIMETRES IN BRACKETS)

INSTALLATION

CAUTION

1. Installer must be trained and experienced
2. Disconnect power supply before connecting wiring to prevent electrical shock or equipment damage
3. Always conduct a thorough checkout as outlined in the instructions with the primary control when installation is complete

LOCATION

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

MOUNTING SENSOR

Mount C773A,B as a storage tank sensor using an immersion well as follows.

1. Drain system fluid to a point below the sensor fitting.
2. Screw the well into the threaded fitting. Use an approved pipe dope or Teflon tape to seal the threads.
3. Refill system and check for leaks.
4. Insert the sensor probe into the immersion well until it bottoms. See Fig. 1.
5. Attach retainer clamp over groove on well spud. Fit wires in clamp groove and lightly tighten screw. Do not overtighten.

Install C773A,B as a collector sensor using the mounting clip provided and No. 8 screw. Mount C773C,D as a collector sensor using the flattened end with mounting hole and a No. 8 or 10 screw.

Temperatures in excess of 450 F (232 C) will damage the sensor. Shield the sensor against possible overtemperature conditions prior to system operation. To mount collector sensor to collector [illegible]

WIRING

WARNING

1. Shield the sensor against possible overtemperature conditions prior to system operation.
2. On unglazed collectors mount the sensor with leadwires down to keep sensor from accumulating water.
3. Wire additions to the leadwires must be capable of withstanding a temperature of 450 F (232 C).

All wiring must comply with applicable codes and ordinances. The C773 can be used for numerous applications in solar energy systems. Fig. 4 shows the sensors wired to an R7412 Differential Temperature Controller.

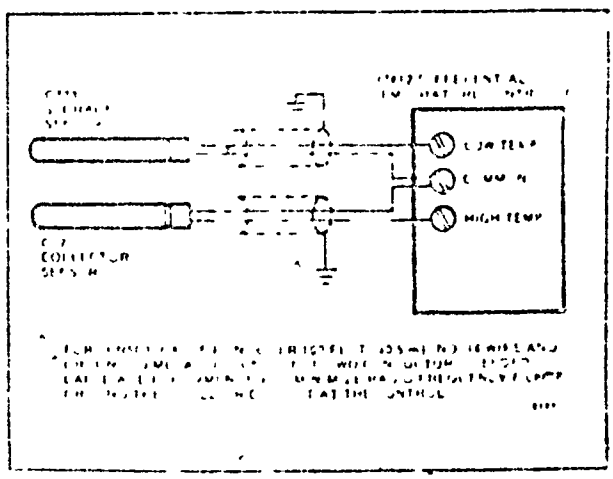


FIG 4 WIRING C773 TO R7412 DIFFERENTIAL TEMPERATURE CONTROLLER

For the C773 and C775 Temperature Sensor the two black leadwires belong to one sensor and the two white leadwires belong to the other sensor.

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

Resistance Matching Component (Part No. 1119925) is available for long sensor wiring (see Accessories).

OPERATION AND CHECKOUT

OPERATION

The C773 is a platinum film sensor packaged in a copper capsule. The sensor has a positive temperature coefficient, so a rise in ambient temperature the resistance of the sensor increases (Fig. 5).

CHECKOUT

Make certain that each sensor is securely mounted. When observing the system in operation, check that the sensors are correctly located. Each sensor should be located so that it experiences the most useful temperature for proper system operation.

To determine the temperature which the sensor is experiencing, use a high resistance ohmmeter (20,000 ohm/volt or greater) to measure the resistance of the sensor. This measurement may be converted to a temperature reading using Fig. 5. Check a variety of temperature locations to insure that the sensor reading is providing the most accurate temperature for proper system operation.

If the sensors are not providing correct temperature readings because of location, change the location and mount properly.

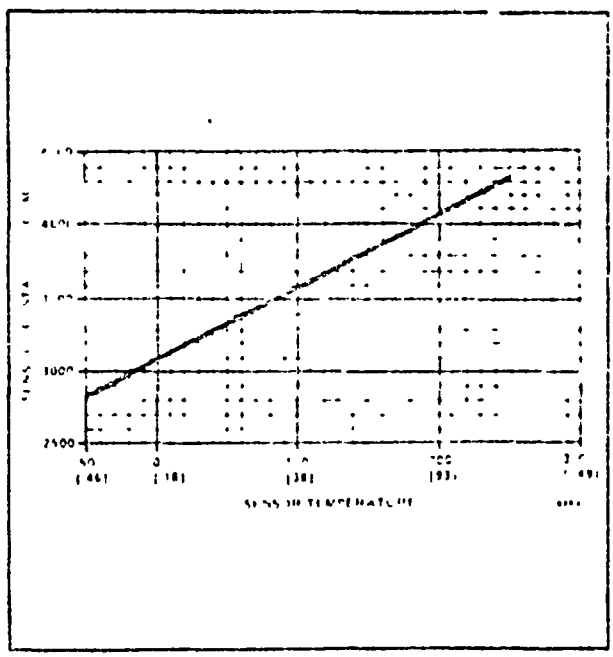


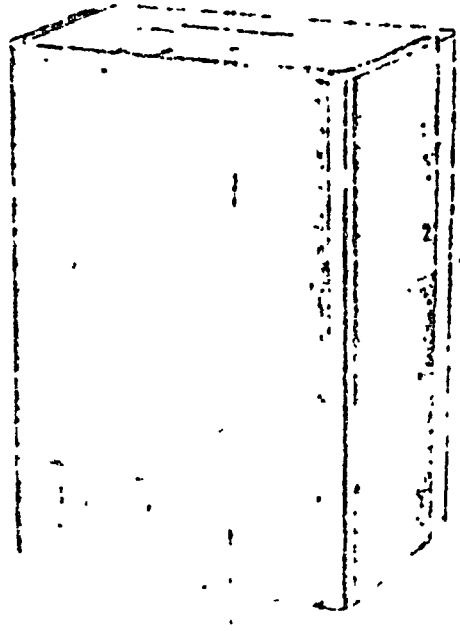
FIG. 5—CONVERTING SENSOR RESISTANCE INTO DEGREES F [C].

R7412A

Honeywell

DIFFERENTIAL TEMPERATURE CONTROLLER

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 includes freeze protection
- R7412C includes freeze protection and an auxiliary relay driver
- R7412D includes overtemperature protection
- R7412E includes overtemperature protection and auxiliary relay driver
- R7412F includes freeze and overtemperature protection (field adjustable), and an auxiliary relay driver.
- [illegible] resistors permit changing on temperature differential and adjustable freeze protection temperature
- [illegible] overtemperature and freeze protection adjustable for factory [illegible]
- [illegible] Temperature

R7412A-F

SPECIFICATIONS

THE SPECIFICATIONS GIVEN IN THIS PUBLICATION DO NOT INCLUDE NORMAL MANUFACTURING TOLERANCES. THEREFORE, THIS UNIT MAY NOT MATCH THE SPECIFICATIONS GIVEN IN EVERY RESPECT 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 convenience, accuracy, ease of handling, and maximum replacement value. TRADELINE specifications are the same as 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[a,d]		
R7412C	Yes[a]	Yes[a,d]		Yes[c]
R7412D	Yes[a]		Yes[d]	
R7412E	Yes[a]		Yes[a,d]	Yes[a,c]
R7412F	Yes[a]	Yes[a,c]	Yes[a,c]	Yes[a,c]

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

TEMPERATURE SETTING RANGES

Operating Range (as defined by the temperature at the low temperature sensor) 0 to plus 210 F [minus 18 to plus 99 C]

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 –

Field adjustable (R7412F only) in 5 F [3.2 C] increments from 140 to 190 F [57 to 89 C].

R7412B E set points may be specified in 5 F [3.2 C] increments from 140 to 190 F [57 to 89 C], but they are factory fixed.

Overtemperature differential 10 F [5.5 C].

Freeze differential 3 F [1.7 C].

Overtemperature –

Field adjustable settings (R7412F only) at 37, 42 or 47 F [3, 6, or 8 C].

R7412B E set points may be specified at 37, 42, or 47 F [3, 6, or 8 C], but they are factory fixed.

Factory set at 110 F [66 C].

(continued on page 2)

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. Immersion Well order number.
4. Accessories, if desired.
5. 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 DISTRIBUTOR (SEE YELLOW PAGES OF PHONE DIRECTORY)
2. RESIDENTIAL DIVISION CUSTOMER SERVICE
   HONEYWELL INC., 1985 DOUGLAS DRIVE NORTH
   MINNEAPOLIS, MINNESOTA 55422 (612) 542-7500

(IN CANADA—HONEYWELL CONTROLS LIMITED, PRODUCTS OF THIS AND RELATED DIVISIONS)
INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL COUNTRIES OF THE WORLD.

ELECTRICAL RATINGS
[illegible]
[illegible]
1 N O [illegible] 12 VA [illegible]
1 N C [illegible] 12 VA [illegible]
Auxiliary relay [illegible] 6 VA [illegible]
Power Consumption 7 watts [illegible]
AMBIENT TEMP RATING RANGE
Controller 20 to 115 F [minus [illegible] C]
Temperature Sensor Minus 50 [illegible] [illegible]
46 to plus 232 C]
MOUNTING
Controller two screw holes [illegible] of case Mounting [illegible]
Electronic Temperature [illegible] for mounting [illegible] with a mounting [illegible] [illegible]
WIRING CONNECTIONS 9 screw [illegible]
DIMENSIONS See Fig 2

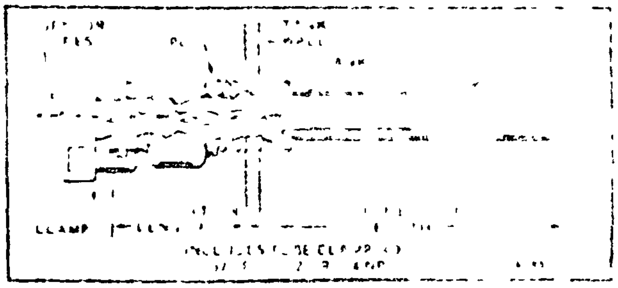
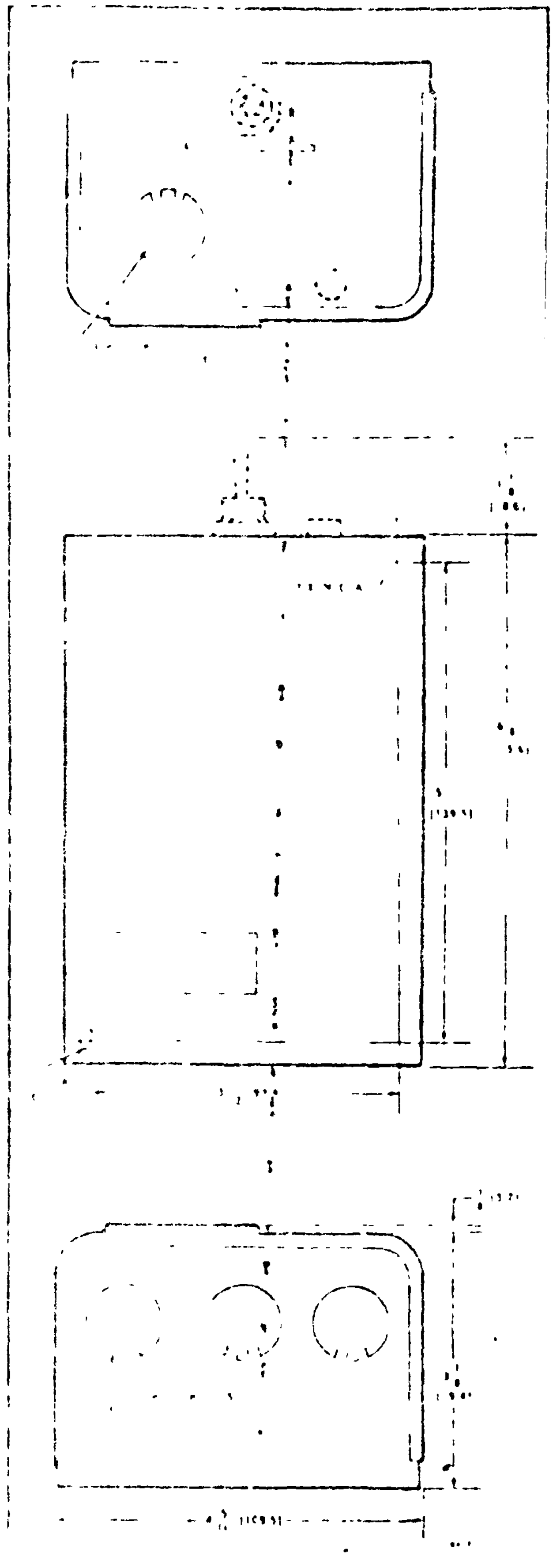


FIG 1—TANK SENSOR INSERTED IN IMMERSION WELL

AUXILIARY RELAYS
R8[illegible] Fan Centers
Line voltage spst [illegible] 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 [illegible] switching [illegible] normally open [illegible] and [illegible] pole
OPTIONAL SPECIFICATIONS
Indicator Light [illegible] operating
Auto Off On Switch [illegible] permits automatic [illegible] or allows the controller to be [illegible] and OFF [illegible] the [illegible]
Freeze [illegible]
[illegible]
is 37 F [[illegible] C [illegible]
[6 or 8 C] [illegible]
[illegible]
[3 2 [illegible]
[illegible]



[illegible] MOUNTING DIMENSIONS IN INCHES [illegible] IN BRACKETS)

ACCESSORIES

C77A Temperature Sensor
storage tube with immersion well
with mounting clip

C77SB Temperature Sensor Double
storage tube with immersion well
with mounting clip

C77SC Temperature Sensor Single
tened end with mounting hole for collector
stallation

[illegible] Well [illegible] immersion
[illegible] Well Fig 1
[illegible] Compartment mounts to im
mersion well Part No. 111892-

SELECT WELL MATERIAL AND
[illegible] NUMBER BELOW

WELL DIMENSIONS

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	121371	121371E	121371F
3 3/8	85.7	1 1/2			121371K		
3 3/8	85.7	3		121371L	121371M		
5 3/8	85.7	4		121364G	121364H		
5 3/8	136.5	4		121364A	121364A		
6	152.4	1 1/4	31.8	112020B8			

a) Has plastic sleeve on insert on 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 base on a vertical surface near the collector or storage tank. Ambient temperature at location should not exceed [illegible] to ensure the controller [illegible]

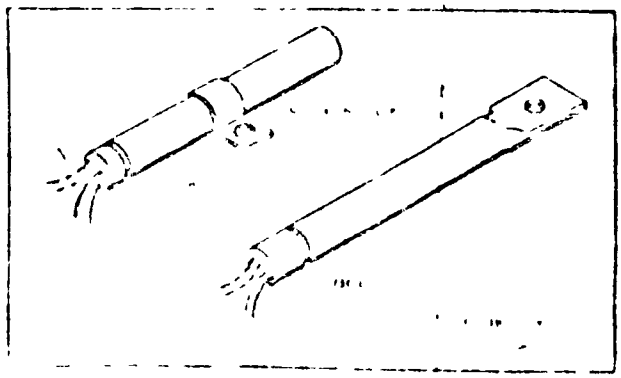
[illegible] controller [illegible]

MOUNTING TEMPERATURE SENSORS

Mount temperature sensors in immersion wells 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 joint compound 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 remote sensor power groove on well and fit wires in clip groove and tightly tighten screw. Do not overtighten.

Mount collector sensor according to the collector manufacturer's recommendations. Insert the sensor into the piping with a [illegible] or 10 gauge (Fig. 3). Do NOT [illegible] sensor [illegible] channels. Do not exceed [illegible] temperature rating.



[illegible] TEMPERATURE

[illegible] the R7412A can [illegible] as a single [illegible] temperature controller such as a high temperature [illegible] or an Aquastat. The R7412A is adapted to this function by changing the ON and OFF [illegible] and the sensor connections. When [illegible] [illegible] result [illegible]

Use the following [illegible] differential [illegible] function temperature control [illegible] Figs 10 and 11.

1. Remove cover. R[illegible] with an 11,500 ohm [illegible] shown in Fig 9.

2. To adjust the temperature [illegible] the ON resistor and select a [illegible] according to Table 1. Install the selected resistor.

3. To adjust the temperature set[illegible] select a resistor value according to the graph in Fig 12. Connect the selected [illegible] to the low temperature and common terminals for make on temperature rise control (Fig 10). C[illegible] 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.

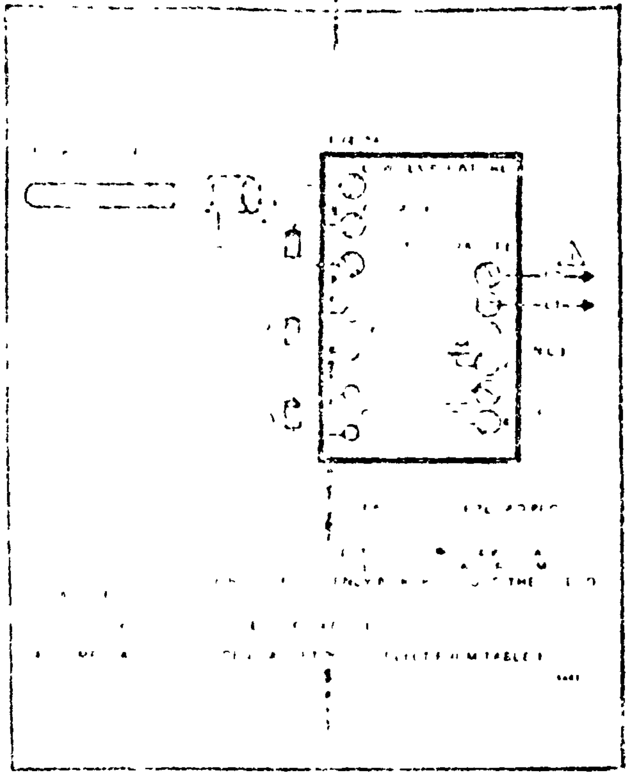


FIG. 11—SINGLE FUNCTION SET POINT CONTROL. CONTROL MAKES ON TEMPERATURE FALL TO SET POINT MINUS DIFFERENTIAL, BREAKS ON TEMPERATURE RISE TO SET POINT.

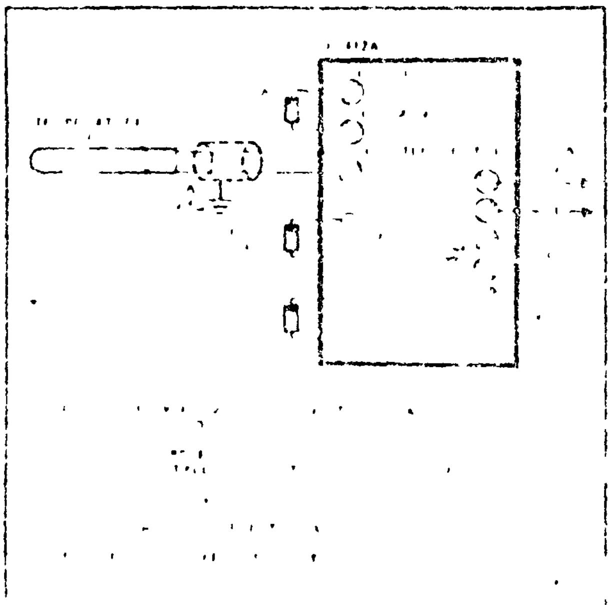


FIG. 10—SINGLE FUNCTION SET POINT CONTROL. CONTROL MAKES ON TEMPERATURE RISE TO SET POINT [illegible] DIFFERENTIAL, BREAKS ON TEMPERATURE FALL TO [illegible] POINT.

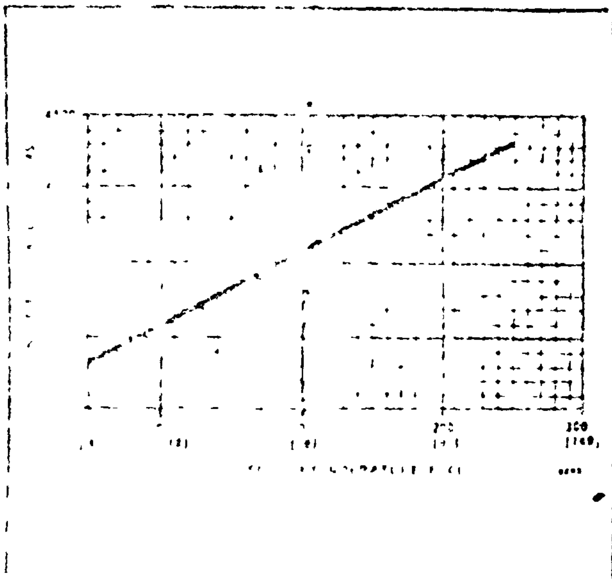


FIG. 12—R7412A SINGLE FUNCTION TEMPERATURE SETTING. CHOOSE A RESISTANCE [illegible] TO DESIRED SET POINT.

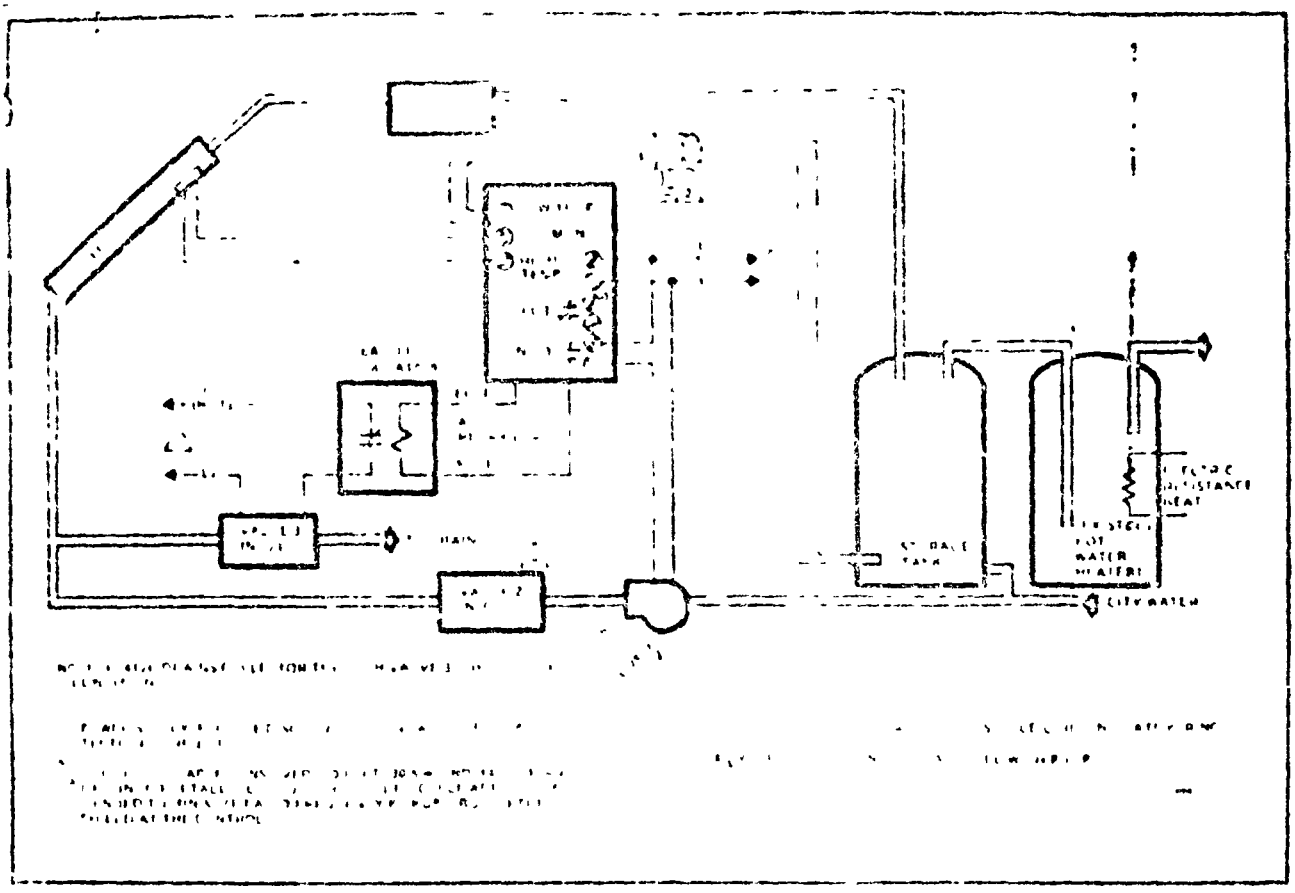


FIG 6–INSTALLING THE R7412C IN A SOLAR HOT WATER HEATING SYSTEM

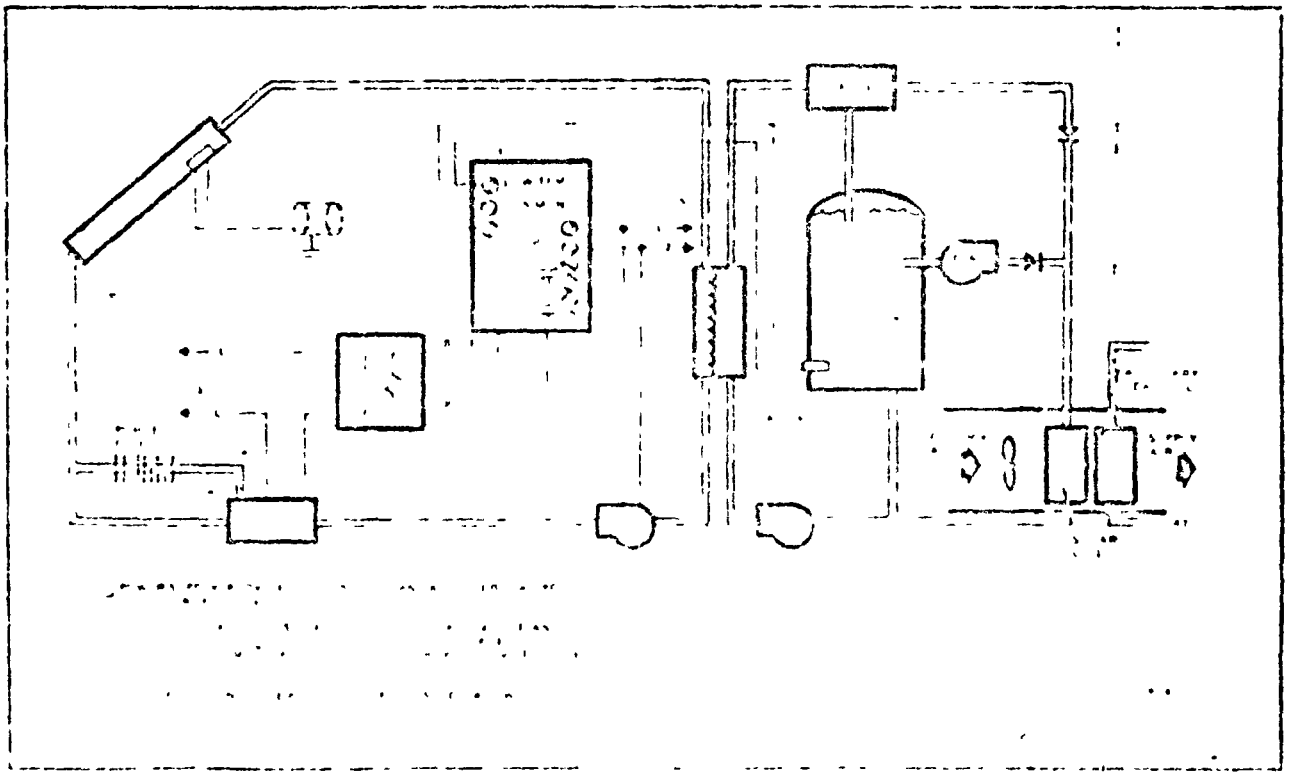


FIG 7–TYPICAL INSTALLATION OF THE R7412C IN A SOLAR HOT WATER HEATING SYSTEM

DIFFERENTIAL TEMPERATURE SELECTION

The control setting may be [illegible] by changing the ON and OFF plug in [illegible] (see Fig. 8). The R7412 is factory set for [illegible] 15 F [10 C] temperature difference with a 4750 ohm ON [illegible] drop out is set for 3 F [1.7 C] temperature difference with a 9760 ohm OFF resistor.

To change the setting, refer to Table 1 to select the [illegible] See Fig. 9 [illegible] then [illegible] the old [illegible] replacement. Repeat for the OFF resistor. Be sure the correct resistor is inserted in the proper position. Use 1/8 watt, 1 percent resistors, available locally.

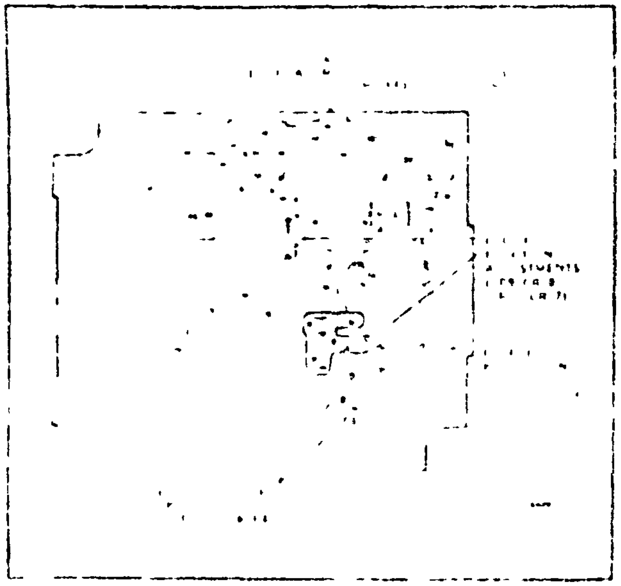


FIG. 8—ADJUSTMENT COMPONENTS OF THE R7412.

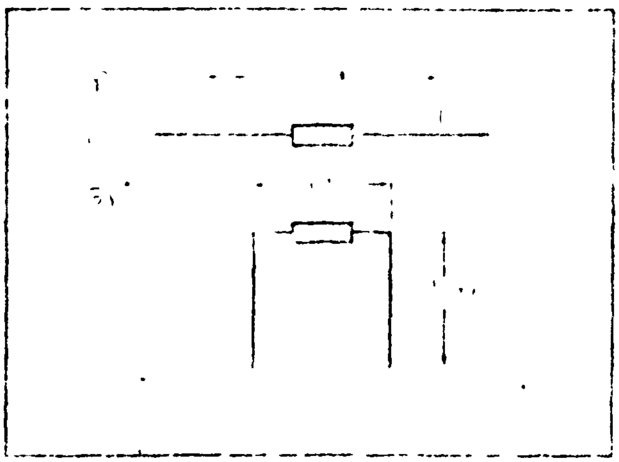


FIG. 9—[illegible]

TABLE 1—DIFFERENTIAL TEMPERATURE CONTROL

FOR TEMPERATURE DIFFERENCE OF F	C	USE RESISTANCES BELOW FOR BOTH ON AND OFF RESISTORS (IN OHMS)
10	[illegible]	27500
5	3.0	15400
[illegible]	[illegible]	11500
1	0.6	[illegible]
2	1.0	[illegible]
3	1.7	[illegible]
4	2.2	[illegible]
5	3.0	[illegible]
6	3.3	[illegible]
7	4.0	[illegible]
8	4.4	7500
9	5.0	7150
[illegible]	6.0	6810
12	[illegible]	6340
14	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	10.0	4750
[illegible]	11.0[a]	[illegible]
25	14.0	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
40	22.0	[illegible]

[a] [illegible] must not exceed 20 F [11 C], [illegible] than 4220 ohms.

R7412F FREEZE PROTECTION TEMPERATURE SELECTION

[illegible] protection setting is [illegible] by [illegible] the freeze protection plug in resistor, R40 (see Fig. [illegible] 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 [illegible] OT2 (R[illegible]6) (see Fig. 8). The R7412 overtemperature [illegible] is factory set at 140 F [66 C].

To change the setting, refer to Table 2 to select the [illegible]. See Fig. 9 to prepare resistor for [illegible] the [illegible] overtemperature resistors and [illegible] in the proper position. Use 1/8 [illegible]

WIRING

...ation depicts the R7412 using only one temperature sensor.

The temperature sensors are wired to the controller through the 1/2 inch knockout f... on the top of the controller case. Wire the power, pump/valve contacts and auxiliary relay driver using the knockouts for ... conduit in the bottom of the controller case.

If the run of sensor cable used exceeds 100 feet (30 m), use No. 14 wire and grounded metal 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.

111592 Remote Sensor Wiring Compartment is available for tank sensor wiring (see ACCESSORIES).

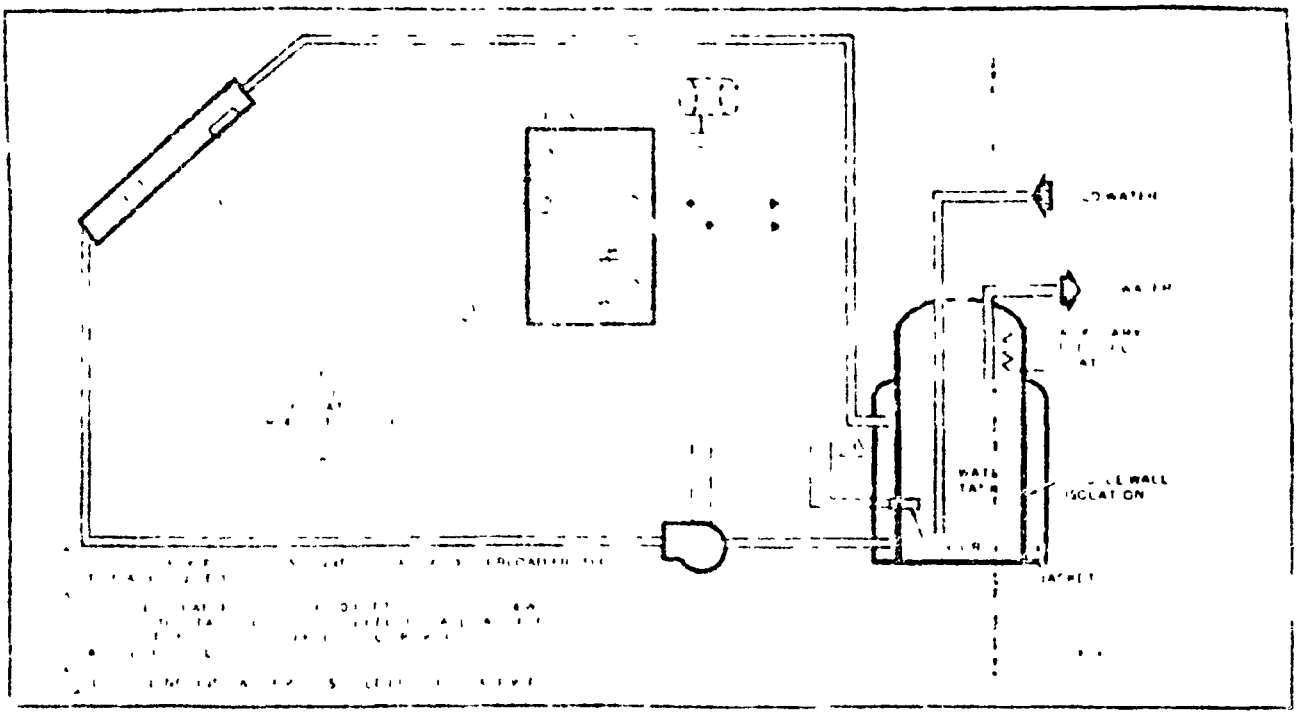


FIG. 4—USING THE R7412A,D WITH A SOLAR WATER HEATER

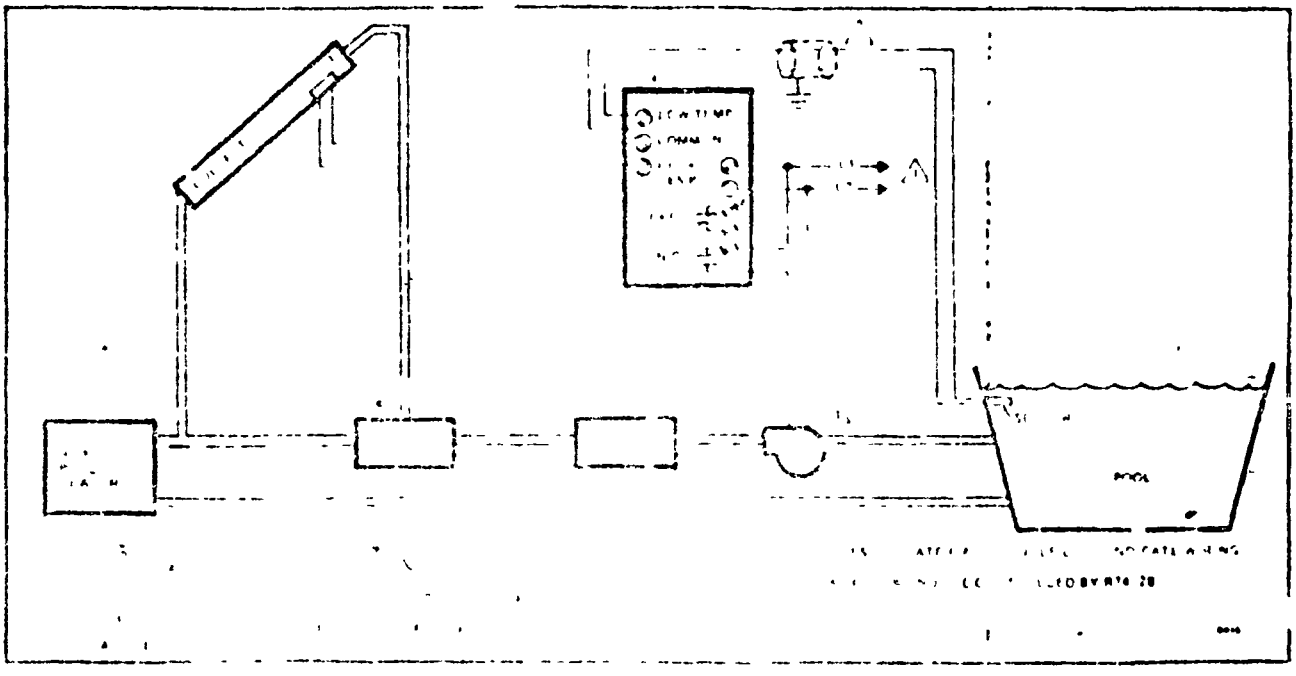


FIG. 5—USING THE R7412B WITH A SOLAR POOL HEATER. CONTROLLER ENERGIZES PUMP DURING ... COLLECTION.

TABLE [illegible]

FOR OVER TEMPERATURE LIMIT OF		CHANGE RESISTOR OT1 (R41) TO (OHMS)	OT2 (R26) TO (OHMS)
F	C		
130	60	11,800	174,000
135	63	16,900	113,000
140	66	19,100	[illegible]
145	68	22,100	44,200
150	71	25,500	33,200
155	73	30,000	27,400
160	77	38,300	22,200
165	79	52,300	20,000
170	82	78,700	17,800
175	85	154,000	15,800
180	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.

[illegible] or CR11 is removed to provide freeze [illegible] is provided by either the internal [illegible] auxiliary relay or both.

[illegible] 7412F 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 energized and the auxiliary relay will be energized. Removing CR10 disables the internal relay, 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.

Removing 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, see 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, CR11	CR10, CR12

OPERATION AND CHECKOUT

OPERATION

The controller relay contacts make when the differential temperature is greater than the [illegible] and they break when the temperature differential is [illegible] the OFF setting.

CHECKOUT

Check control for proper operation as follows:

1. Disconnect [illegible]

2. [illegible] relay should drop out.

Observe system operation for one automatic cycle. Make certain that system comes on and turns off in response to [illegible] Differential Temperature Control is functioning for proper operation of freeze and overtemperature protection and of controlled equipment.

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SEQUENCE OF OPERATION

Pump P-1: Pump P-1 will be energized by differential temperature control DTC-1 whenever, both collectors, in Row #1 and Row #6 are 20°F above the storage tank temperature and de-energize when this temperature drops to 3°F. Whenever the storage tank temperature rises to 180°F Pump P-1 will be de-energized

Pump P-2: Pump P-2 will be controlled by an outdoor thermostat and a storage tank thermostat, with a 15 minute "on" time delay. Whenever the outdoor air temperature is below 50°F and the storage tank temperature is above 100°F and 15 minutes has elapsed with both temperature conditions met Pump P-2 will be energized.

Pump P-3: Pump P-3 is controlled by differential temperature controller, DTC-2. Pump P-3 is energized whenever the storage tank temperature is 30°F above the temperature in the heat exchanger and Pump P-2 is off.

Valve V-1: Valve V-1 the hot water return valve is a normally closed valve and is opened only when Pump P-2 or Pump P-3 is energized.

Valve V-2 Valve V-2 the solar drain down valve is a normally open valve and is closed only when Pump P-1 is energized

Valve V-3: Valve V-3 the solar space agin heating valve is a normally closed valve and is opened only when Pump P-2 is energized.

Valve V-4: Valve V-4 is controlled by the air handling units existing zone thermostat The thermostat modulates in sequence the three-way valve on the solar coil and the existing three-way valve on the existing hot water coil to maintain its setting The three-way valve on the existing hot water coil will start to open to the coil when the three-way valve on the solar coil is full open to the coil.

Valve V-5: Valve V-5 is controlled by the air handling units existing zone thermostat. The thermostat modulates in sequence the three-way valve on the solar coil and the existing three-way valve on the existing hot water coil to maintain its setting The three-way valve on the existing hot water coil will start to open to the coil when the three-way valve on the solar coil is full open to the coil

SOLAR COLLECTORS

TT-4 SB (TYPE) MOUNTING PROCEDURE SAME AS TT-3 BELOW EXCEPT ROW #6

TT-5 SB(TYPE) MOUNT BEHIND ABSORBER PLATE WITHIN 1' OF RETURN HEADER ROW #1 ON ONE OF THE TOP COLLECTORS

C 100 — AC INPUT — OUTPUT 1 — OUTPUT 2 — GND — BLK (H) — WHT (N) 120VAC, 60HZ — YEL — WHT — RED — WHT

R-1 R4222D1013 WIRE IN SERIES WITH AUTO SIDE OF P-1 H O A SWITCH (MOUNT IN SAME PANEL)

R4222D 1013

160 K Ω

DT-1
C 100 1SH 180-2S (INDEPENDENT ENERGY INC)
OUTPUT #1 DIFF BETWEEN TT-4 & TT-5 20°F 120 VAC OUTPUT
5°F 0 VAC OUTPUT, STORAGE TEMP. 180° 0 VAC OUTPUT
OUTPUT #2 DIFF BETWEEN TT-5 & TT-8 20°F 20 VAC OUTPUT,
5°F 0 VAC OUTPUT
MOUNT ON SOLAR CONTROL PANEL.

CONNECT TO EXISTING HEATING VALVE BRANCH LINE

AUX-4

TT-8 SC TYPE 1/2" NPT

V-1 (ASM-1) V5011A1767 MP953D1131 3" FLG (4-13#) CV=100 GPM=125 ΔP=1.6 PSI.

AUX-3 TT-7 SC TYPE 1/2" NPT

V-2 (ASM 2) V5011A1213 MP953C1000 1" NPT (2-7#) CV=10

T" 3 SC (TYPE) 1/2" NPT, NUTE-2

SOLAR WATER STORAGE TANK

P-1

P-2

TT-6 SC TYPE 1/2" NPT

AUX-2

WELL # 112622AA 1/2" NPT, NOTE #2

WELL # 12173 A 1/2" NPT NOTE #2

T-1 T675A1540 SET 100°F DIFF 3.6

TT-1 C773A -50 to 450°F

EP-1 RP417A1041

EP-2 RP417A1009

EP-3 RP417A1041

TO LOAD SIDE OF P-1 START CIRCUIT (208VAC)

TO LOAD SIDE OF P-3 START CIRCUIT. (20 VAC)

TO LOAD SIDE OF P-2 START CIRCUIT (208 VAC)

WIRE IN SERIES W/AUTO SIDE OF PUMP P 2 H O A SWITCH

SUNSHIELD 3466CA

T-2 T675A1508 SET: 50°F DIFF. 3

TT-2 C773A1006 -50 to 450°F

WELL #12173A 1/2 NPT

CONVERTER

H W

C W

SEE NOTE #1

SEE NOTE #1

(MOUNT IN SOLAR CONTROL PANEL)

TD-1 MAGNECRAFT #W211ACPS07-61 SET 15 MIN.

120VAC SCHE

V-3 (ASM-3) V5011A1767 MP953D1131 3" FLG (4-13#) CV=100 GPM=125 ΔP=1.6 PSI

AHU #4 V 4 (ASM 4) V5013A1062 MP953C1018 2" NPT (8-12#) CV=40 GPM=68 ΔP=2.6 PSI

AHU #2 V-5 (ASM 5) V5013A1062 MP953C1018 2" NPT (8-12#) CV=40 GPM=62 ΔP=2.6 PSI

CONNECT TO EXISTING HEATING COIL VALVE BRANCH LINE

9760Ω ±1% 1/8 W

2430Ω ±1% 1/8 W

HIGH, COM, LOW, OFF, ON

(H) 120VAC INPUT (N)

WIRE IN SERIES WITH AUTO SIDE OF PUMP P-3 H O A SWITCH

DTC-2 R7412A1004 "ON" SETTING 10°F "OFF" SETTING 3°F

NOTES,

1. FOR SENSOR CABLE RUNS OVER 100' NM14 WIRE & GROUNDED METALLIC CONDUIT OR TWO CONDUCTOR SHIELDED CABLE IS REQUIRED. GROUND THE SHIELD OR CONDUIT AT THE CONTROLLER
2. MOUNT WELLS AT SENSOR LOCATION TE-2 AS SHOWN ON MECH. DWGS. SHEET SL-4
3. THIS SHEET COVERS CHANGES MADE TO EXISTING JOB # 954-77541 BY JOB # 954-80305

AS BUILT

ARCHITECT	WILLIAMS & TAZEWELL ASSOC.		
ENGINEER	INTERTECHNOLOGY/SOLAR		
CONTRACTOR	PITTMAN MECHANICAL CONTRACTORS		
APPLICATION ENGINEER	BOB DEFREITAS		

APPROVED
AS BUILT 12-17-80
FINAL

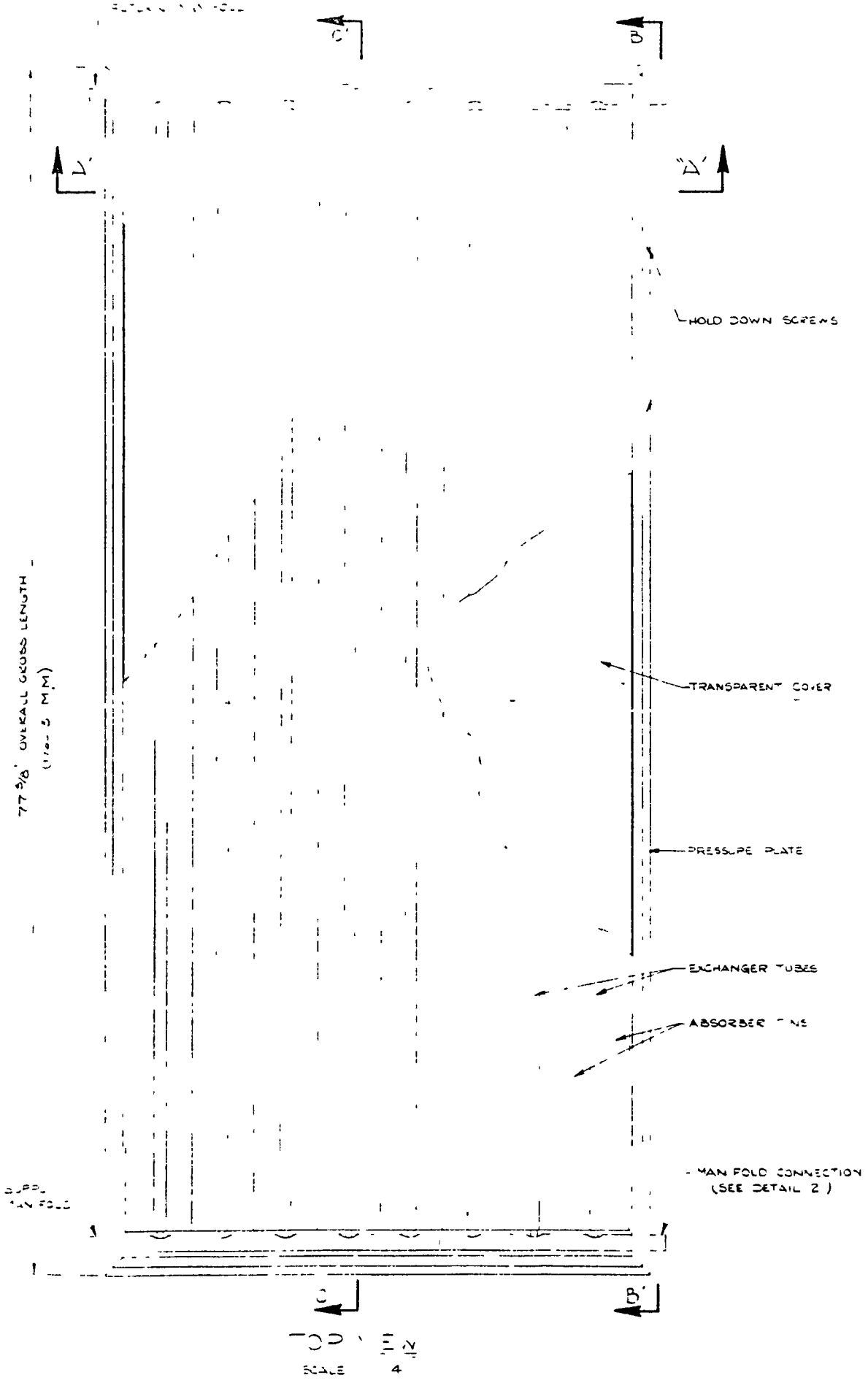
HONEYWELL INC.
#18 KOGER EXECUTIVE CENTER, SUITE 250 NORFOLK, VIRGINIA

C				
B				
A	AS BUILT	12 17 80	PN	
Revisions		Date	Appd.	
Supersedes	Drawn By Ray	Date 08/15/80		
Superseded By See Note #3	Approved By DMJ	Sheet 9 of 9		

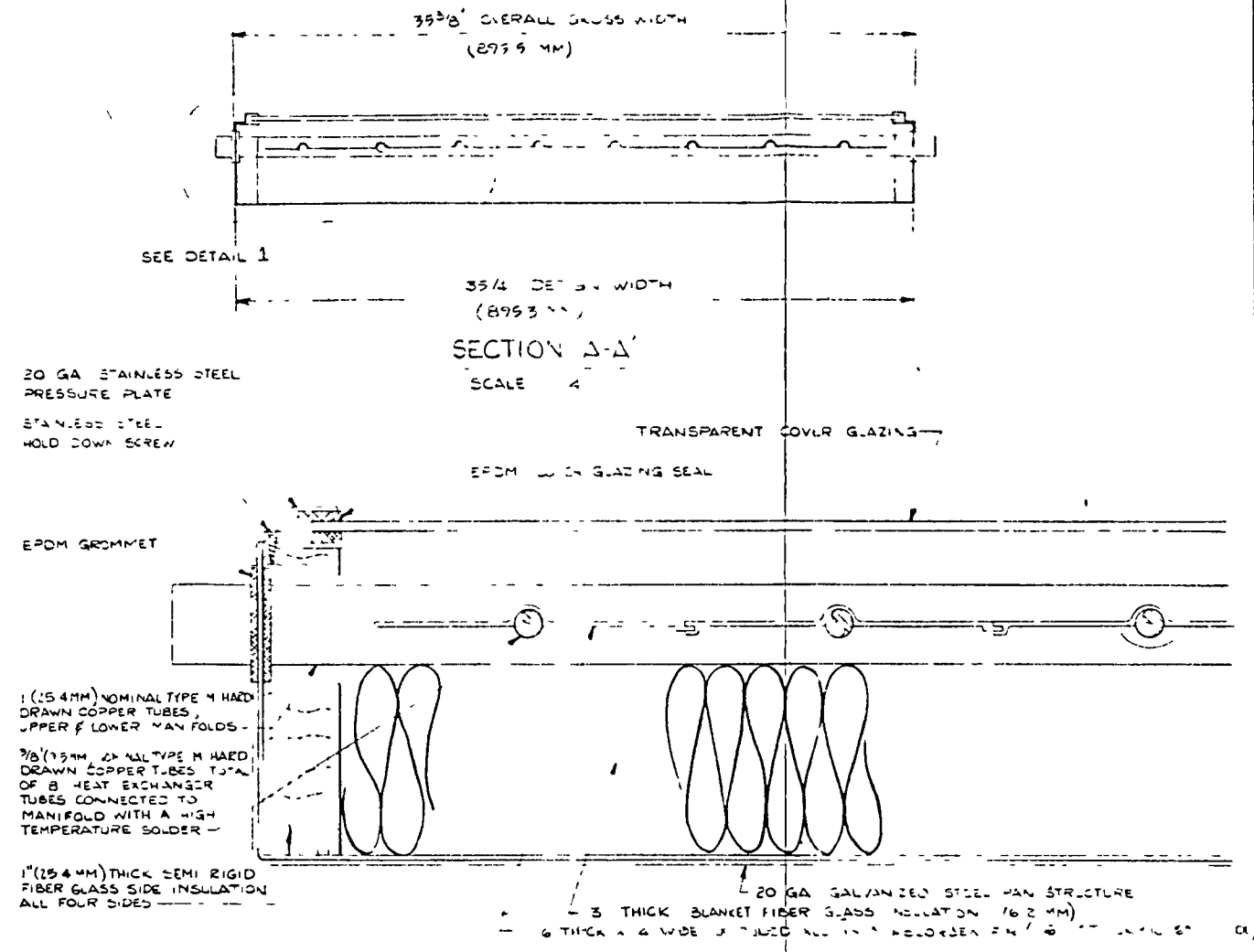
JAMES HURST ELEMENTARY SCHOOL — PORTSMOUTH — VIRGINIA

DRAWING NUMBER 954-77541-9X1 Rev A

COLLECTORS

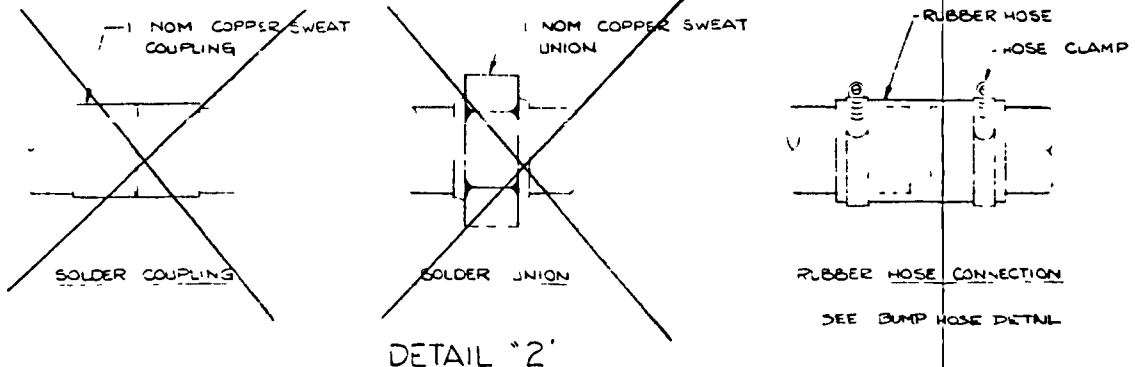


TOP VIEW
SCALE 4



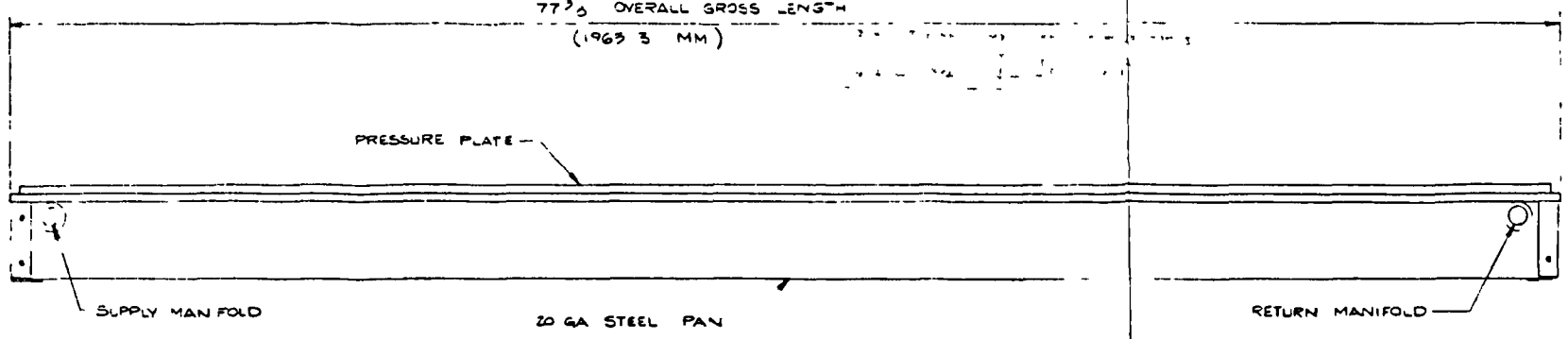
SECTION A-A'
SCALE 4

DETAIL "1"
SCALE FULL SIZE



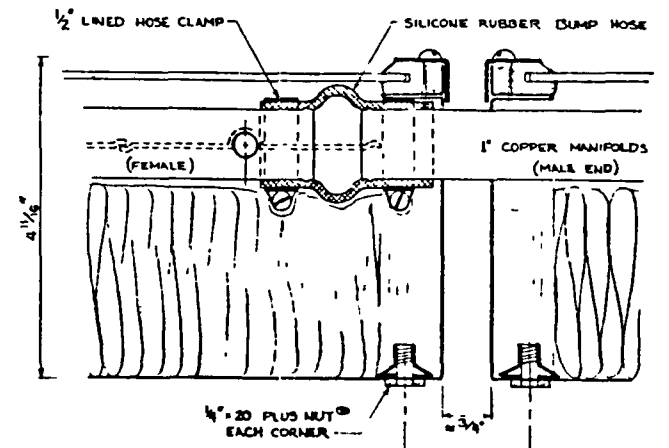
DETAIL "2"
(TYPICAL CONNECTION DETAILS)
SCALE NONE

DATE	29 Sept 80
REVISIONS	Bump Hose 29 SEP 80
DRAWN BY	DE LUSHNIKOV
DATE	29 AUG 80
CHECKED BY	
SCALE	AS NOTED
APPROVED BY	
JOB NO	2315G
SHEET TITLE	SECTION "A-A", DETAILS 1 & 2
JOB TITLE	MARK V SOLAR COLLECTOR
	INTERTECHNOLOGY/Solar CORPORATION
SHEET NO	1

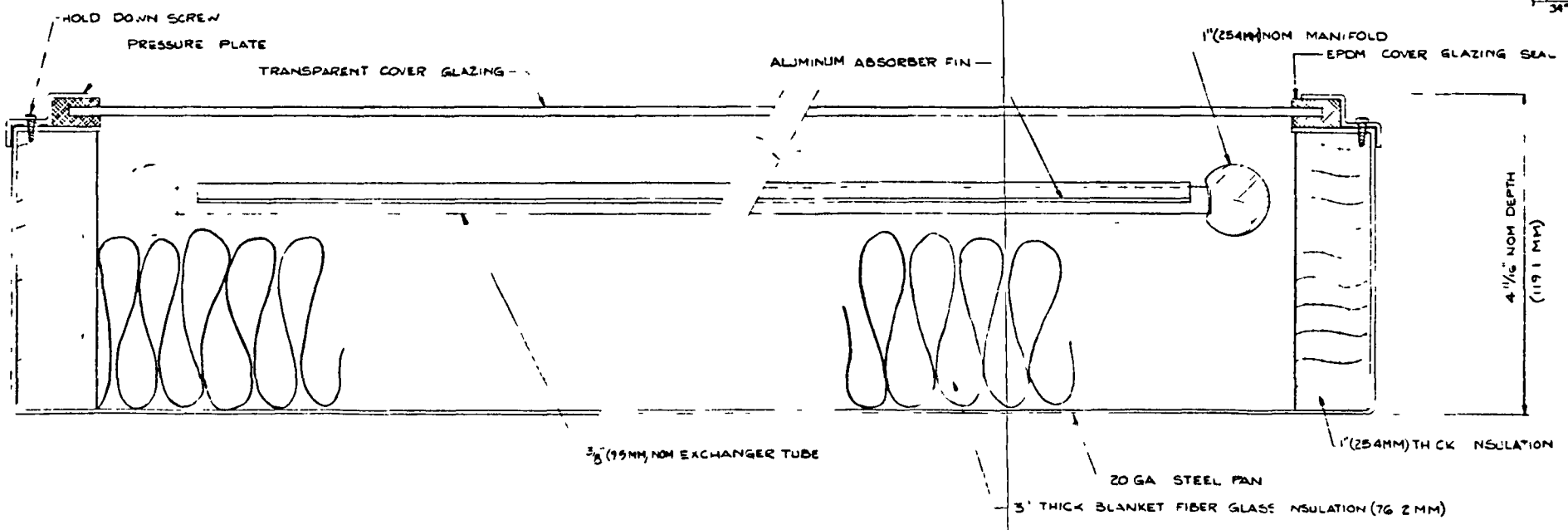


SECTION "B-B"
SCALE 1 4

DO NOT SCALE DRAWING



TYPICAL BUMP HOSE DETAIL



SECTION "C-C"
SCALE FULL SIZE

DRAWN BY DEE BAUGH
CHECKED BY
DATE 29 AUG 80
SCALE AS NOTED
APPROVED BY
JOB NO 2313G

REVISIONS	DATE
Clamp Hose MJB	29 Oct 80

SHEET TITLE: SECTIONS "B-B" & "C-C"

JOB TITLE: MARK V SOLAR COLLECTOR

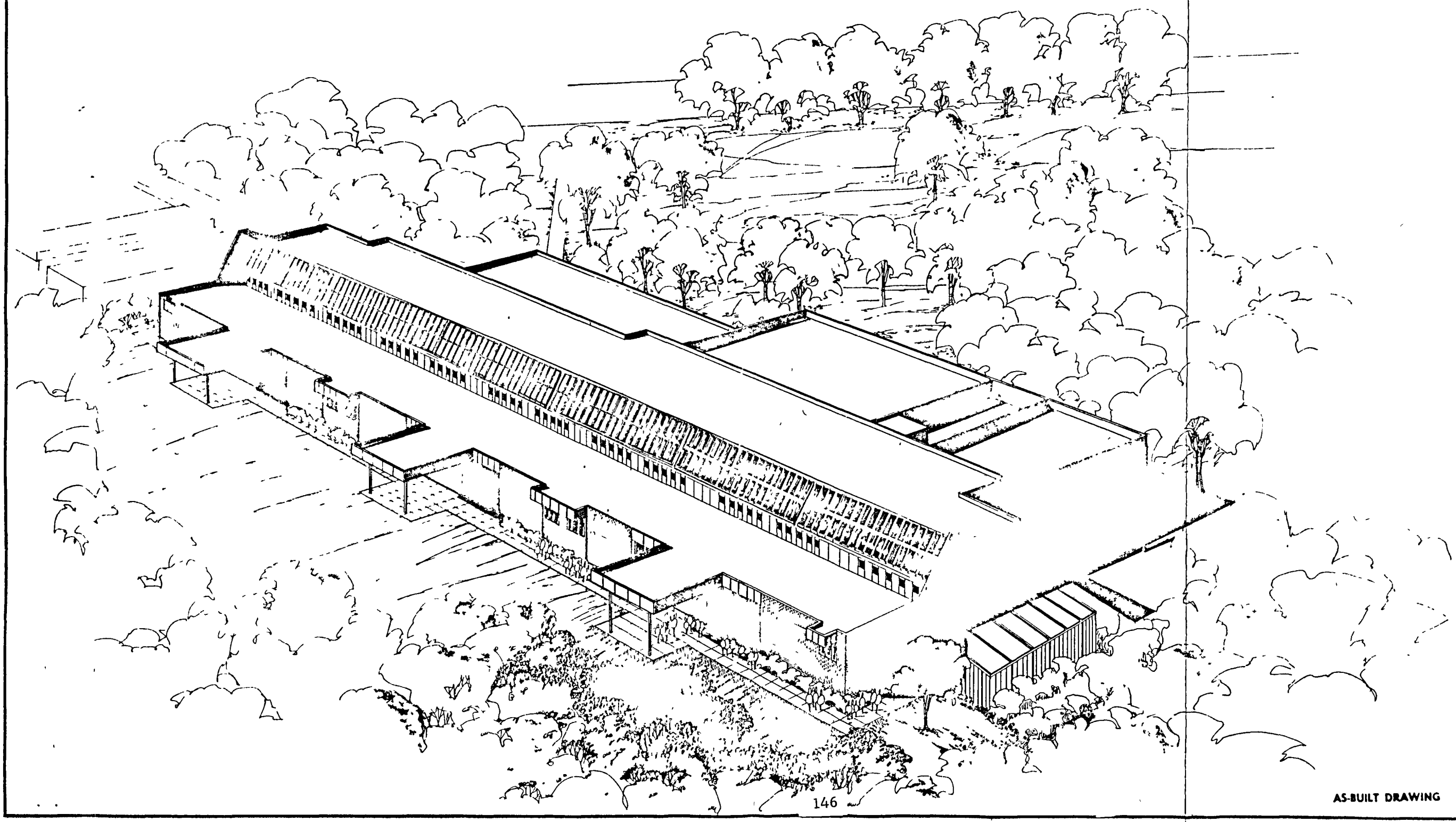
INTERTECHNOLOGY/Solar CORPORATION

SHEET NO 2

APPENDIX C: PROJECT DRAWINGS

SOLAR HEATING AND HOT WATER SYSTEM

JAMES HURST ELEMENTARY SCHOOL
PORTSMOUTH , VIRGINIA



AS-BUILT DRAWING

REVISIONS	DATE
GENERAL	5-79
GENERAL	12-12-79

DRAWN BY	DATE	JOB NO
-B	28 FEB 79	23136
CHECKED BY	SCALE	
A.K.J.	NONE	
APPROVED BY		
A.K.J.		

SHEET TITLE: PERSPECTIVE

JOB TITLE: JAMES HURST ELEMENTARY SCHOOL

INTERTECHNOLOGY/Solar CORPORATION

SHEET NO: SL-1

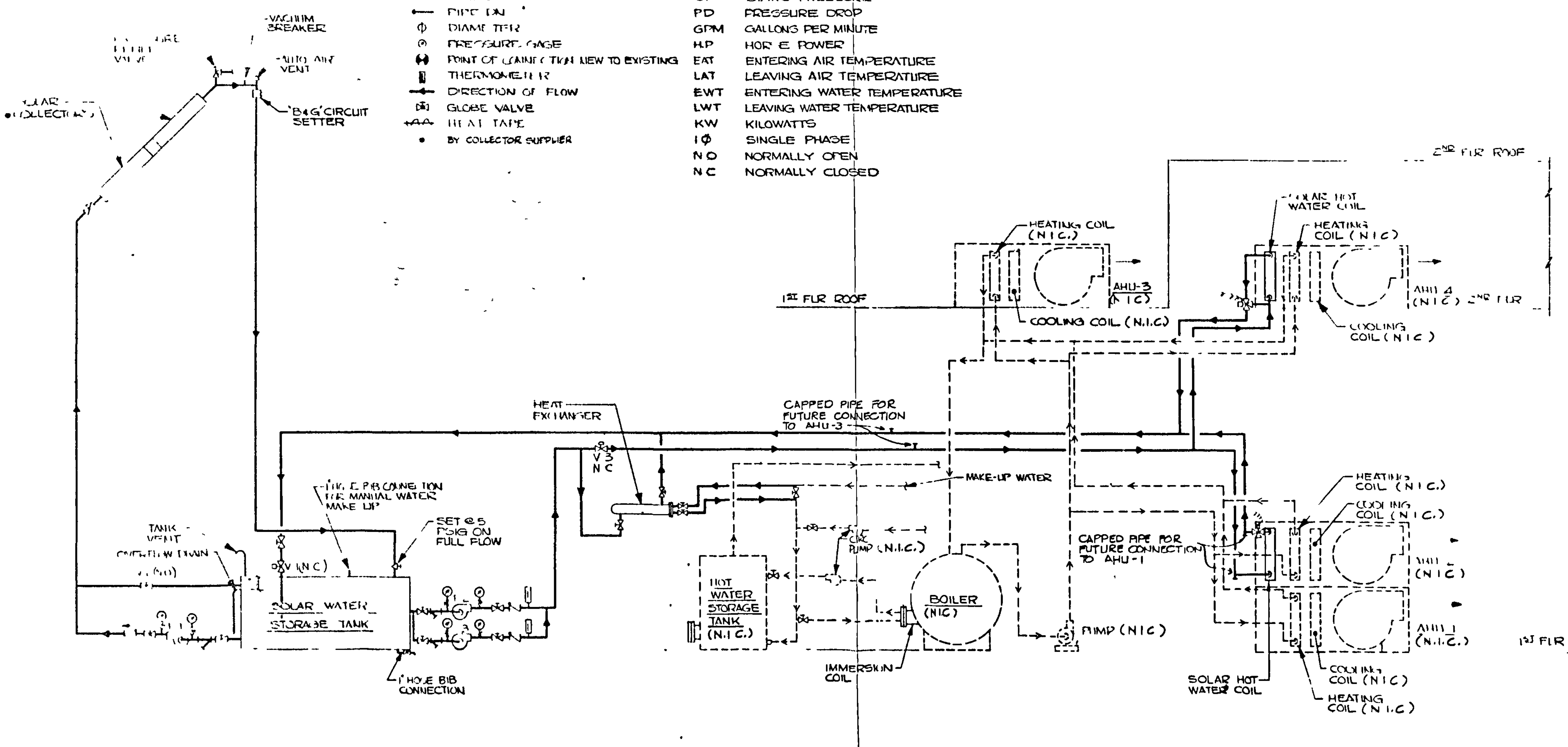
SYMBOL LIST

SYMBOL	
	GATE VALVE
	GATE VALVE
	GATE VALVE
	VALVE
	VALVE
	VALVE
	VALVE
	BALANCING COCK
	CHECK VALVE
	VALVE
	METER
	METER
	AUTO AIR VENT
	UNION
	CIRCUIT SETTER
	PIPE UP
	PIPE DN
	DIAMETER
	PRESSURE GAGE
	POINT OF CONNECTION NEW TO EXISTING
	THERMOMETER
	DIRECTION OF FLOW
	GLOBE VALVE
	HEAT TAPE
•	BY COLLECTOR SUPPLIER

ABBREVIATIONS	
SWS	SOLAR WATER SUPPLY
SWR	SOLAR WATER RETURN
HWS	HOT WATER SUPPLY
HWR	HOT WATER RETURN
DHWS	DOMESTIC HOT WATER SUPPLY
NPT	NATIONAL PIPE THREAD
PSIG	POUNDS PER SQUARE INCH GAGE
FD	FLOOR DRAIN
(E)	EXISTING
AFF	ABOVE FINISHED FLOOR
TS	TEMPERATURE SENSOR
FCU	FAN COIL UNIT
CFM	CUBIC FEET PER MINUTE
RPM	REVOLUTIONS PER MINUTE
W.G.	WATER GAGE
SP	STATIC PRESSURE
PD	PRESSURE DROP
GPM	GALLONS PER MINUTE
HP	HORSE POWER
EAT	ENTERING AIR TEMPERATURE
LAT	LEAVING AIR TEMPERATURE
EWT	ENTERING WATER TEMPERATURE
LWT	LEAVING WATER TEMPERATURE
KW	KILOWATTS
1 ϕ	SINGLE PHASE
NO	NORMALLY OPEN
NC	NORMALLY CLOSED

GENERAL NOTES

1. CONTRACTOR SHALL VISIT THE ... WITH THE EXTENT OF ...
2. THAT ... PIPING ... TOWARDS THE STORAGE TANK WITH SOME SLOPE.
3. CONTRACTOR SHALL SUBMIT COMPLETE SHOP DRAWINGS ... FOR APPROVAL. SHOP DRAWINGS TO SHOW ALL ANCHORS ... OF EXPANSION AND DATA ON ANCHORS AND THE MEANS OF ...
4. COLLECTORS SHALL BE MOUNTED SO THAT ... CAN BE EASILY REPLACED WITHOUT REMOVING THE ...
5. ALL SURROUNDING WORK SHALL BE RESTORED TO A CONDITION SIMILAR TO EXISTING AS SOON AS SOLAR WORK IN THAT AREA IS FINISHED.



FLOW DIAGRAM

SCALE: NONE

NOTE: ALL EXISTING WORK IS SHOWN IN BROKEN LINES

AS-BUILT DRAWING

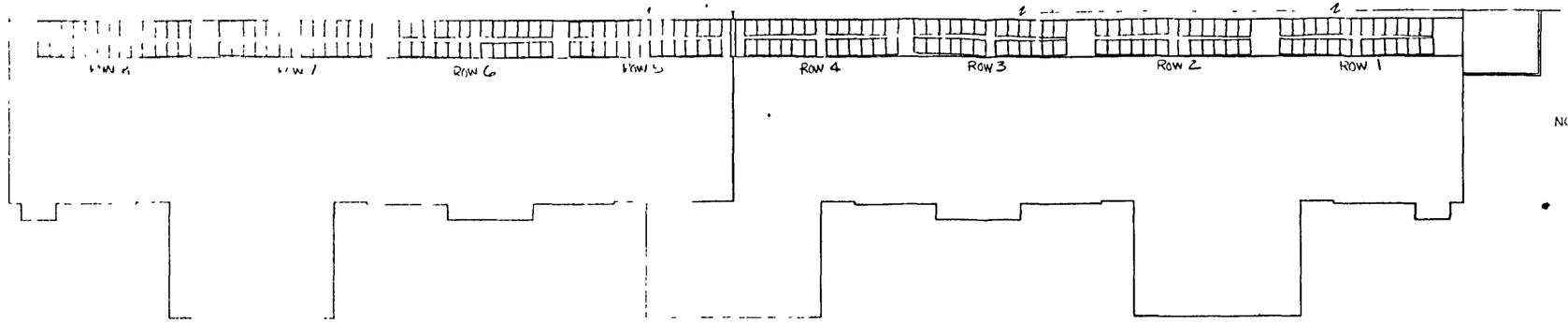
DRAWN BY	T.W.A.
DATE	28 FEB 78
CHECKED BY	A.K.J.
SCALE	AS SHOWN
APPROVED BY	A.K.J.
JOB NO.	23135

SHEET TITLE: FLOW DIAGRAM, SYMBOL LIST & GENERAL NOTES

JOB TITLE: JAMES HURST ELEMENTARY SCHOOL

INTERTECHNOLOGY/SOLAR CORPORATION

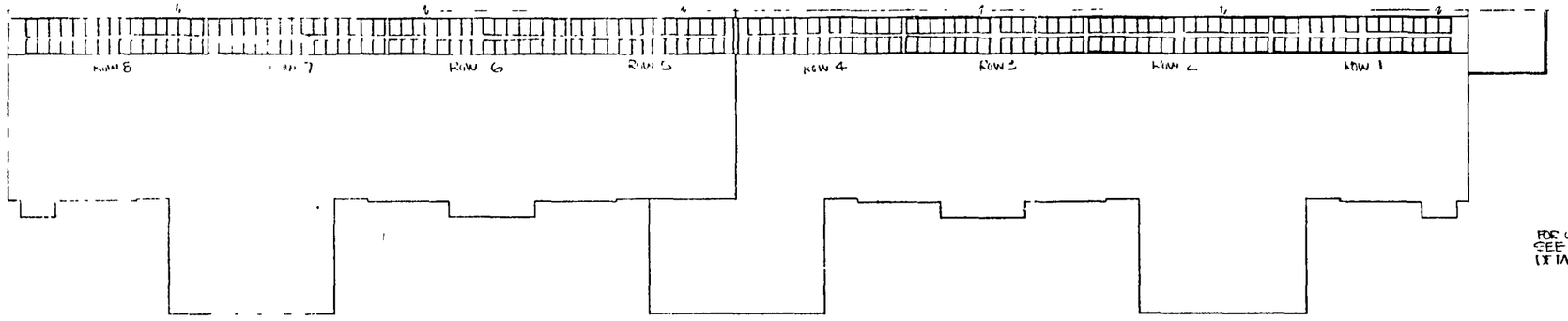
SHEET NO. SL-2



PARTIAL ROOF PLAN (BASE BID)

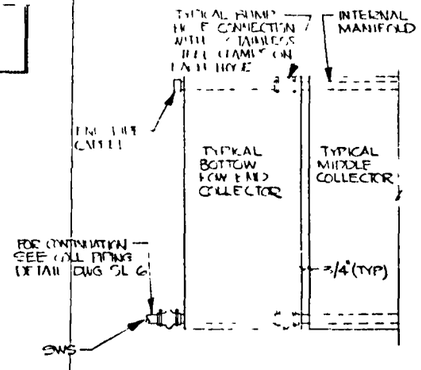
SCALE 1/16"=1'-0"

N



NOTES:

1. TOTAL NO. OF COLLECTORS IS 172 OF BASE BID FOR THE BASE BID FOR ALTERNATE BID NO 1 PROVIDE AN ADDITIONAL 4 COLLECTORS OR 216 TOTAL (3751 SF)
2. ALL EXTERIOR PIPING PREINSULATED (CONTRACTOR OPTION) COPPER W PVC & ULTRA VIOLET PROTECTION



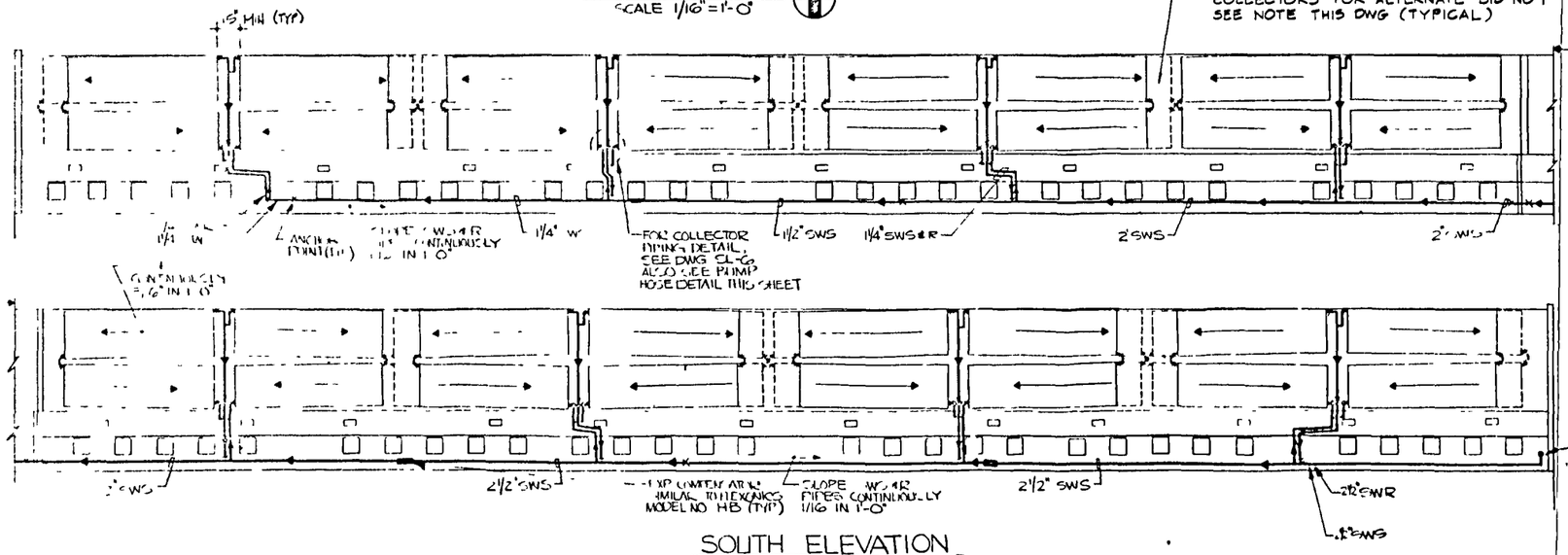
BUMP HOSE CONN DETAIL

SCALE NONE

PARTIAL ROOF PLAN ALTERNATE BID NO 1

SCALE 1/16"=1'-0"

N



SOUTH ELEVATION

SCALE 1/8"=1'-0"

NOTE ALL EXTERIOR MAIN HEADER PIPING SHALL RUN BELOW ALL CLERESTORY WINDOWS

NOTE: SWR & SWS RETURN THRU WALL AND DOWN INTO CRAWL SPACE SEE SHEET NO SL-5

AS-BUILT DRAWING

DRAWN BY	DATE	REVISIONS	DATE
TWA	28 FEB 79	GENERAL	5-[illegible]
CHECKED BY	SCALE	GENERAL	2 & 27
AKJ	AS SHOWN		
APPROVED BY	JOB NO		
AKJ	23136		

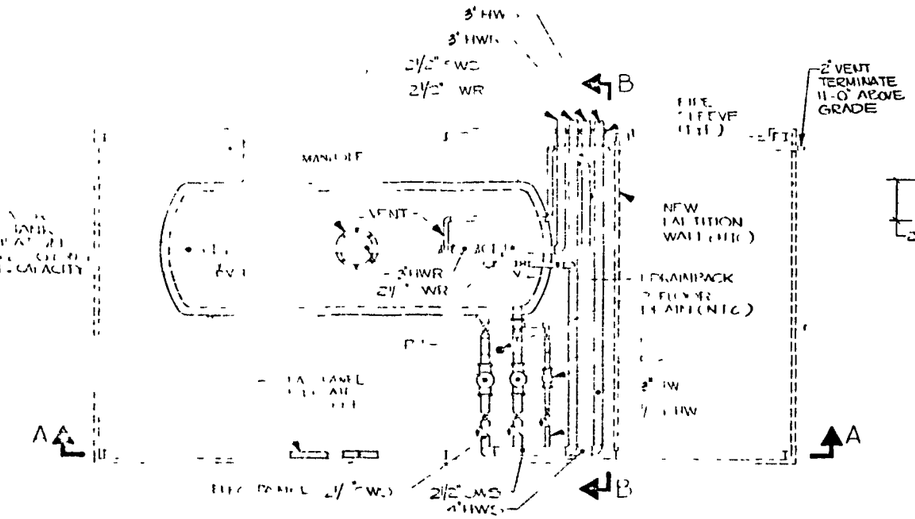
SHEET TITLE: ROOF PLAN AND SOUTH ELEVATION

JOB TITLE: JAMES HURST ELEMENTARY SCHOOL

INTERTECHNOLOGY/Solar CORPORATION

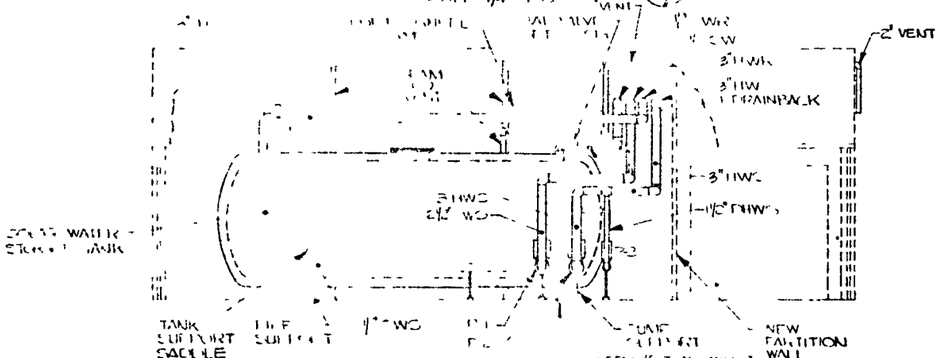
[illegible] Solar

SHEET NO SL-[illegible]



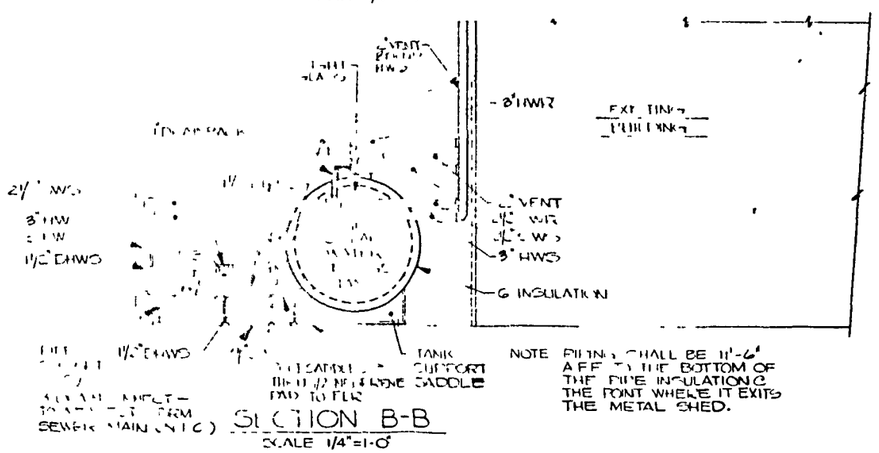
STORAGE TANK PLAN

SCALE 1/4"=1'-0"



SECTION A-A

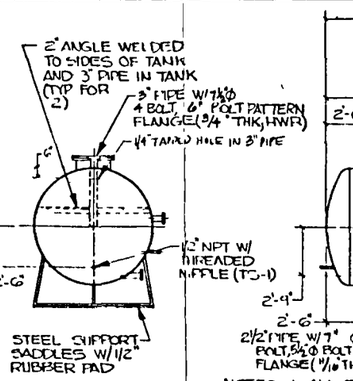
SCALE 1/4"=1'-0"

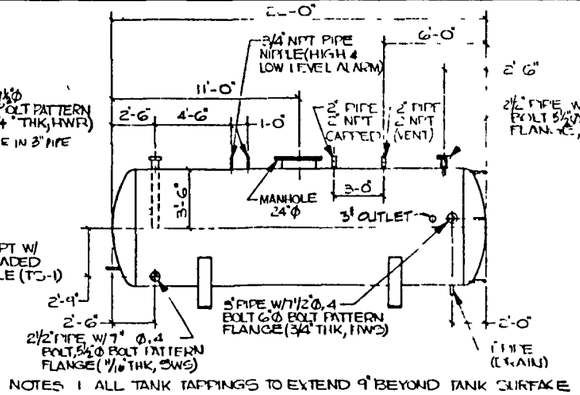


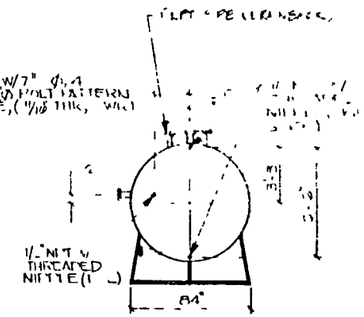
NOTE PIPING SHALL BE 11'-6" AFF TO THE BOTTOM OF THE PIPE INSULATION @ THE POINT WHERE IT EXITS THE METAL SHED.

SECTION B-B

SCALE 1/4"=1'-0"





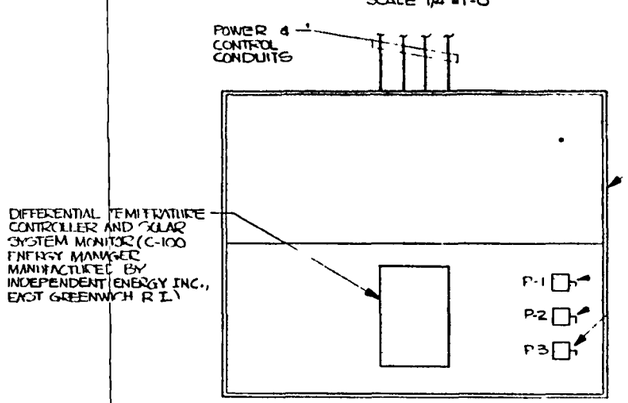


NOTES 1 ALL TANK TAPPINGS TO EXTEND 9" BEYOND TANK SURFACE.

2 ALL PIPE AND ANGLES INSIDE THE TANK TO BE COATED WITH SAME MATERIAL AS THE INSIDE OF THE TANK.

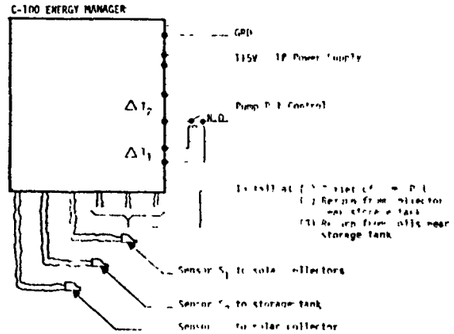
SOLAR STORAGE TANK DETAIL

SCALE 1/4"=1'-0"



SOLAR PANEL DETAIL

SCALE NONE



S_1 - Collector sensor mount behind absorber plate within 1'-0" of return header on one of the top row collectors in row #1

S_2 - Storage tank sensor mount within 1'-0" of Pump P-1 intake pipe

S_3 - Collector sensor mount behind absorber plate within 1'-0" of return header on one of the top row collectors in row #6

Pump P-1 to energize whenever both collectors, in row #1 and row #6 are 25°F above the storage tank temperature and de-energize when this temperature difference drops to 3°F. When the storage tank temperature rises to 180°F Pump P-1 shall stay energized

NOTE Install relays as required for higher pump horsepower

COLLECTOR PUMP CONTROL

SCALE NONE

NOTES:

1. THE METAL SHED IS NOT PART OF THIS CONTRACT. IT SHALL BE ERECTED BY OTHERS AFTER THE MECHANICAL CONTRACTOR HAS INSTALLED THE STORAGE TANK AND PUMPS, ETC.
2. MECHANICAL CONTRACTOR SHALL PROVIDE THE FOUNDATION AND SUPPORTS FOR THE STORAGE TANK.
3. MECHANICAL CONTRACTOR SHALL COORDINATE THE LOCATION AND SIZE OF PIPE SLEEVES FOR PIPES LEAVING AND ENTERING THE METAL SHED WITH THE METAL SHED CONTRACTOR.
4. PIPING LAYOUT IS DIAGRAMMATIC. PRECISE PIPING TO BE DETERMINED IN THE FIELD.

AS-BUILT DRAWING

DRAWN BY	TWA	DATE	28 FEB 79
CHECKED BY		SCALE	AS SHOWN
APPROVED BY		JOB NO.	

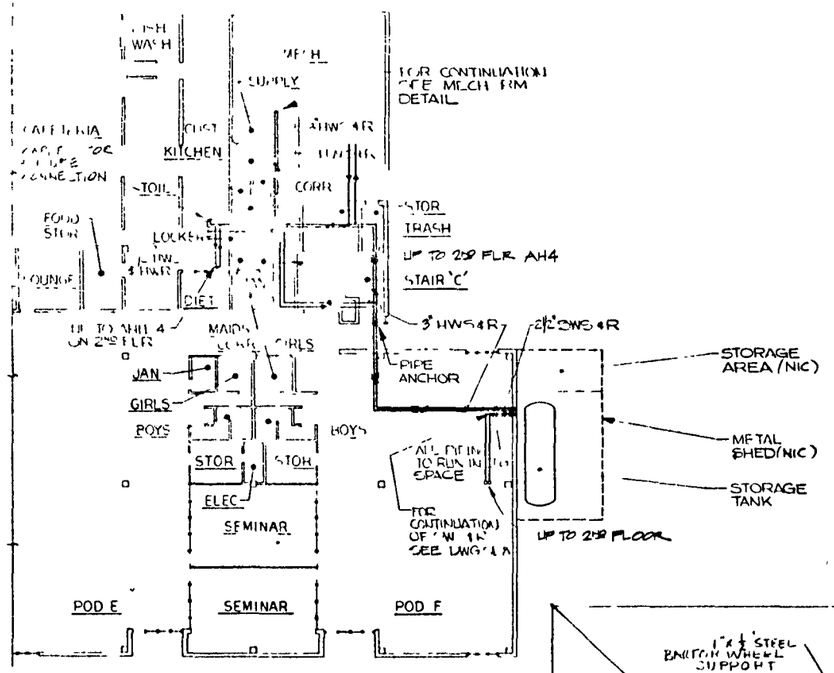
METAL SHED PLAN AND DETAILS

JAMES HURST ELEMENTARY SCHOOL

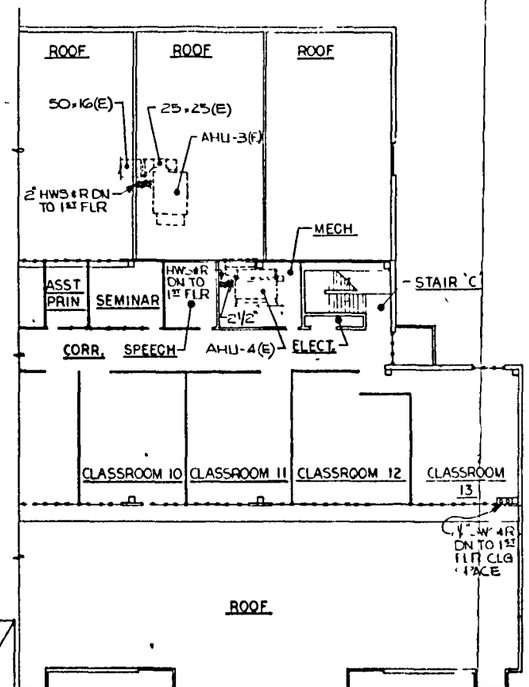
JOB TITLE

INTERTECHNOLOGY/Solar CORPORATION

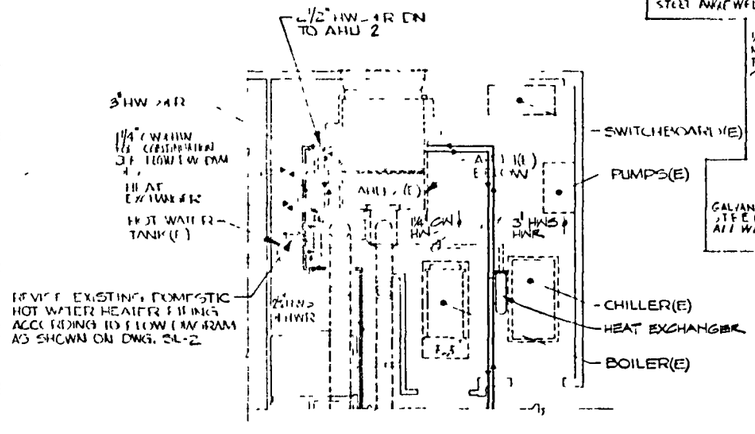
SHEET NO. 5



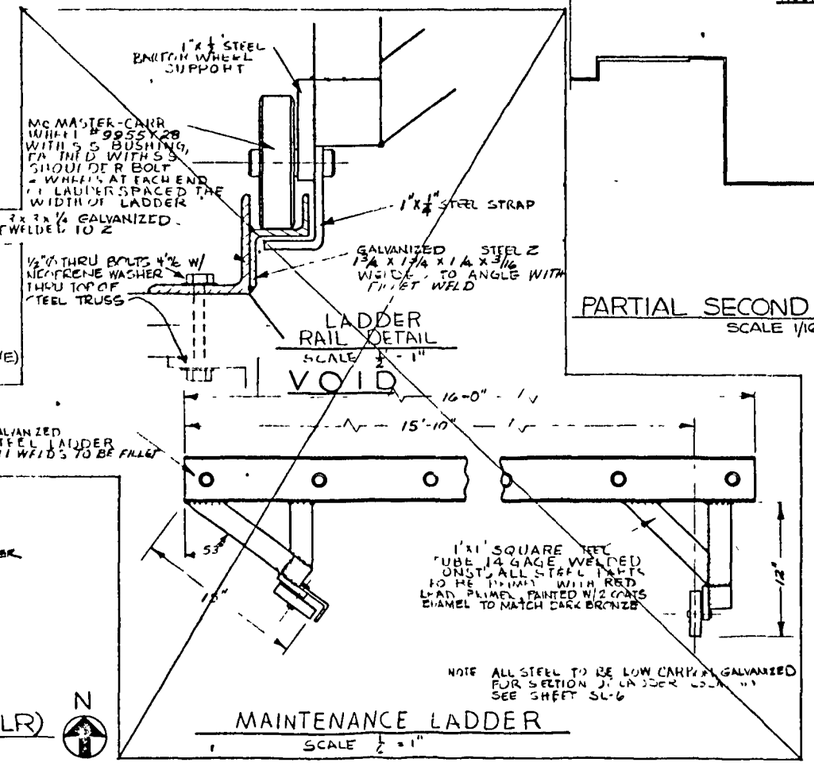
PARTIAL FIRST FLOOR PLAN
SCALE 1/16"=1'-0"



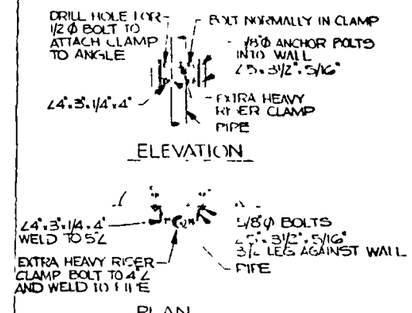
PARTIAL SECOND FLOOR PLAN
SCALE 1/16"=1'-0"



LOWER LEVEL MECH. ROOM (1ST FLR)
SCALE 1/8"=1'-0"



MAINTENANCE LADDER
SCALE 1/2" = 1"



PIPE ANCHOR TO VERTICAL WALL
SCALE: NONE

AS-BUILT DRAWING

DRAWN BY	TWA
DATE	28 FEB 79
CHECKED BY	AKJ
SCALE	AS SHOWN
APPROVED BY	AKJ
JOB NO	23136

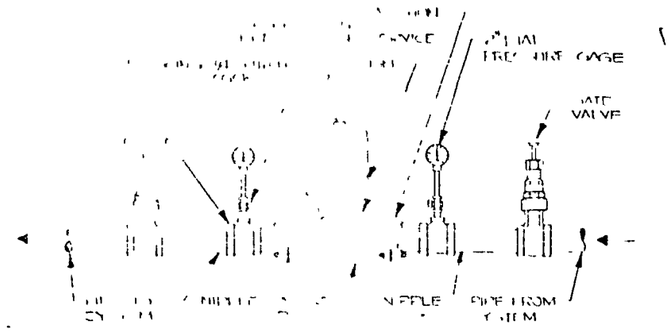
REVISIONS: GENERAL 5-2-79; GENERAL

SHEET TITLE: FLOOR PLANS

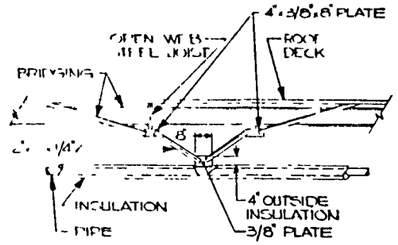
JOB TITLE: JAMES HURST ELEMENTARY SCHOOL

INTERTECHNOLOGY/Solar CORPORATION
100 MAIN STREET WOBURN, MASSACHUSETTS 01801 (617) 933-7160

SHEET NO: SL-5

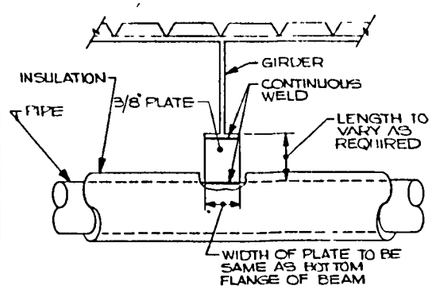


INLINE CIRCULATING PUMP DETAIL
SCALE NONE

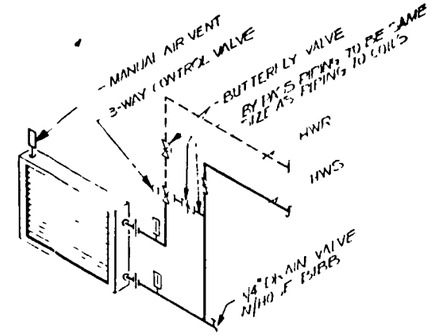


NOTE ANCHOR SHOULD BE LOCATED NEAR BRIDGING, WELD ALL CONNECTIONS

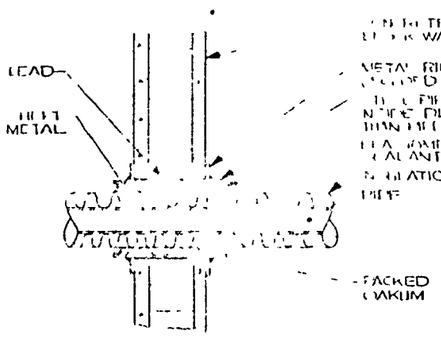
PIPE ANCHOR WITH JOISTS PERPENDICULAR TO PIPE
SCALE NONE



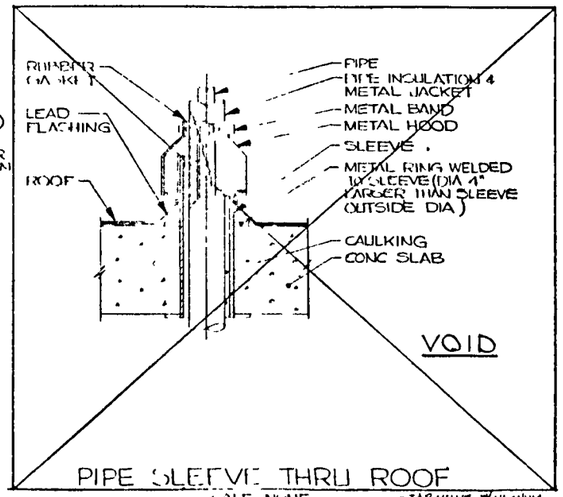
PIPE ANCHORED FROM GIRDER
SCALE NONE



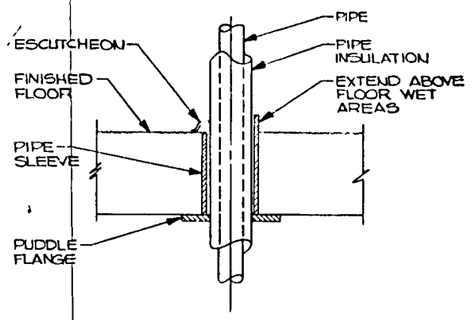
TYPICAL HOT WATER COIL PIPING DIAGRAM
SCALE NONE



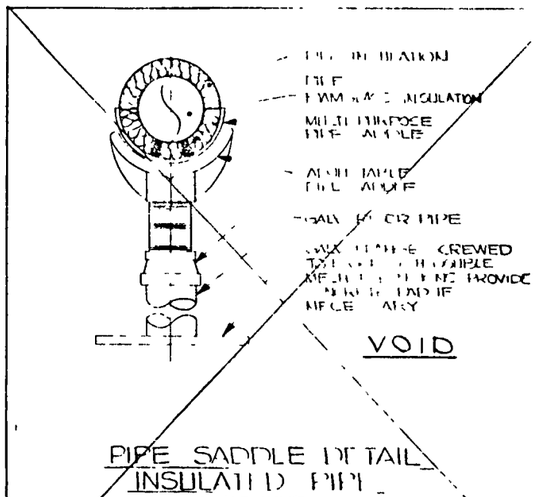
PIPE SLEEVE THRU CONCRETE WALL
SCALE NONE



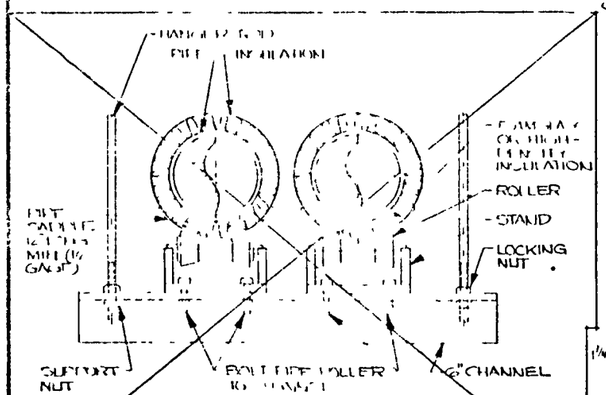
PIPE SLEEVE THRU ROOF



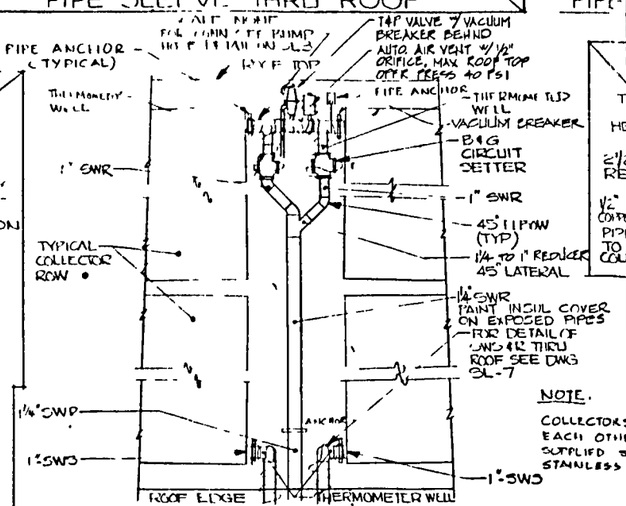
PIPE SLEEVE PASSING THRU FLOOR
SCALE NONE



PIPE SADDLE DETAIL INSULATED PIPE
SCALE NONE

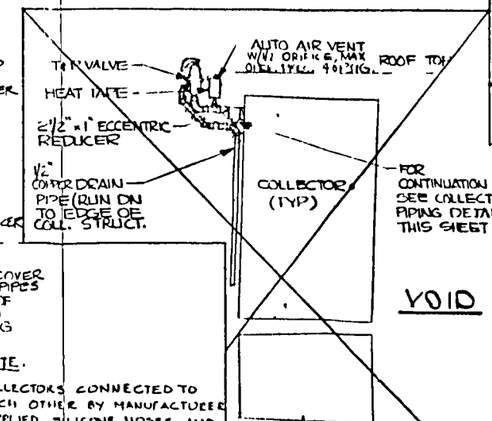


PIPE HANGER DETAIL
SCALE NONE

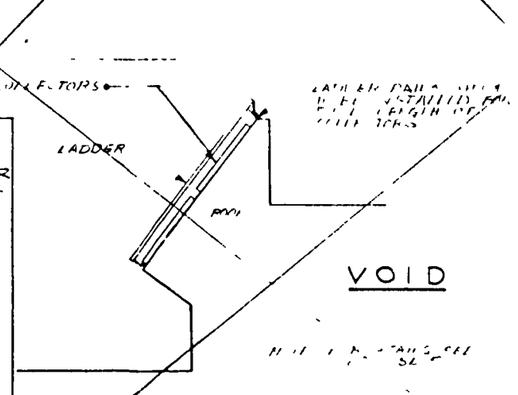


NOTE.
COLLECTORS CONNECTED TO EACH OTHER BY MANUFACTUERER SUPPLIED SILICONE HOSES AND STAINLESS STEEL CLAMPS

COLLECTOR PIPING DETAIL
SCALE: NONE (INSULATION OMITTED FOR CLARITY)



AUTO AIR VENT DETAIL
SCALE NONE



LADDER LOCATION
NOT TO SCALE

AS-BUILT DRAWING

DRAWN BY	TWA
DATE	23 FEB 79
CHECKED BY	AKJ
SCALE	AS SHOWN
APPROVED BY	AKJ
JOB NO	23136

REVISIONS

DETAILS

JAMES HURST ELEMENTARY SCHOOL

INTERTECHNOLOGY/Solar CORPORATION

SHEET TITLE

JOB TITLE

SHEET NO

SL-6

VOID

FAN COIL UNIT SCHEDULE

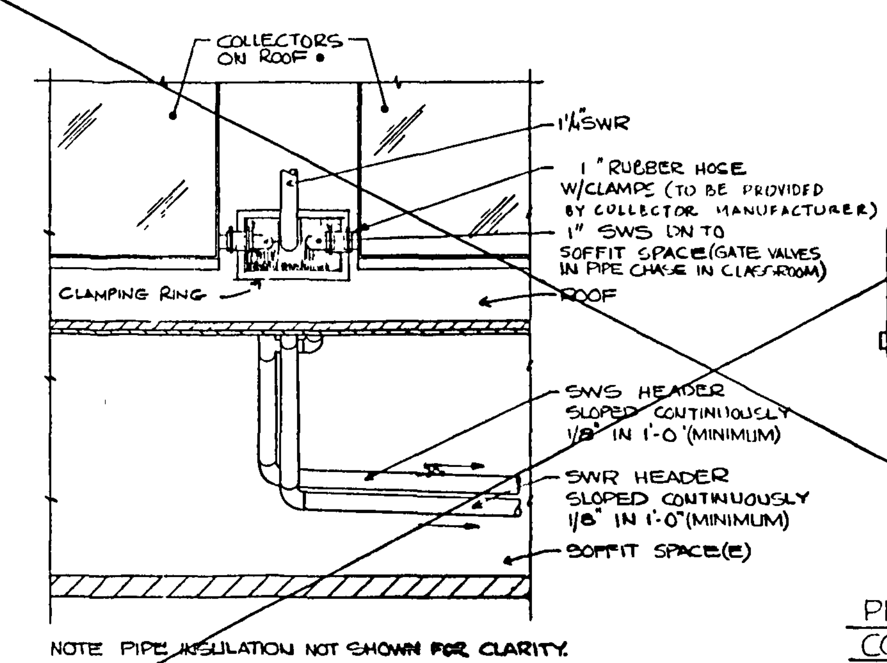
[illegible]	[illegible]	[illegible]	KW	VOLTS	PHASE	RPM	H.P.	VOLTS	PHASE	REMARKS
[illegible]	[illegible]	[illegible]	[illegible]	208	1	500	1/30	115	1	

[illegible] SCHEDULE

[illegible]	[illegible]	[illegible]	[illegible]	5
[illegible]	[illegible]	[illegible]	[illegible]	5
[illegible]	[illegible]	[illegible]	[illegible]	5
[illegible]	[illegible]	[illegible]	[illegible]	5

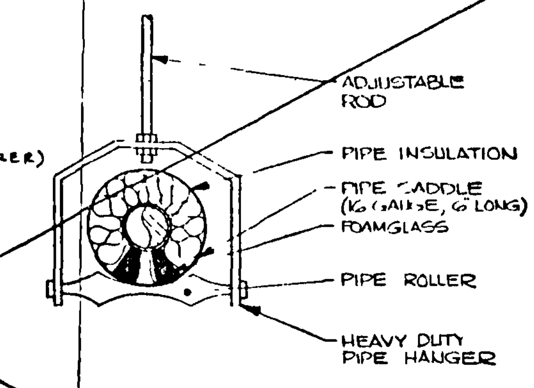
[illegible] SCHEDULE

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	TYPE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	INLINE CENT
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	INLINE CENT
3	[illegible]	[illegible]	[illegible]	1/3	115	1	INLINE CENT



SECTION B-B
SCALE NONE

VOID

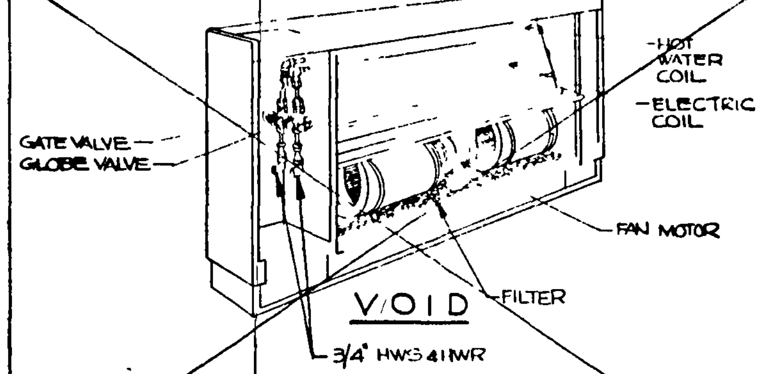


PIPE HANGER DETAIL AT COIL PIPING IN SOFFIT
SCALE NONE

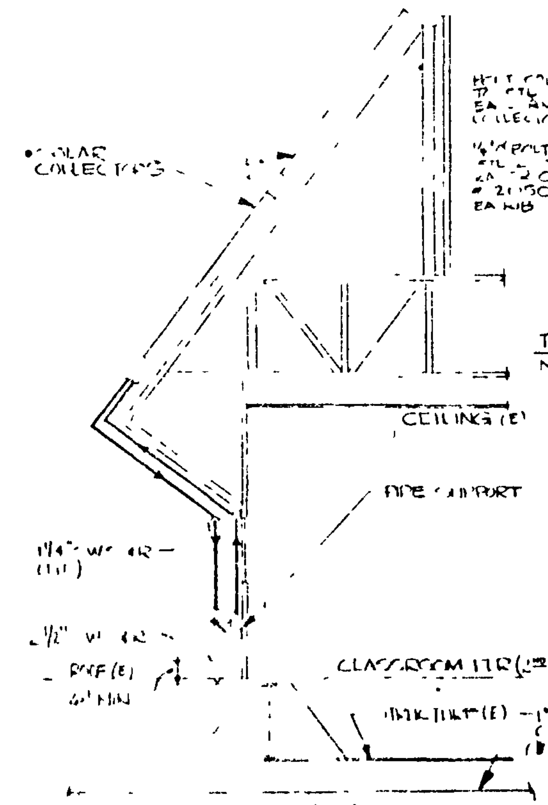
*HEAT EXCHANGER SCHEDULE

UNIT NO	SERVICE	HEATING WATER GPM	EWT	LWT	PD	NO OF PASSES	FOULING FACTOR	HEATED WATER GPH	EWT	LWT
HE-1	DHW	25	140°F	120°F	10'	2	.0005	500	50°F	110°F

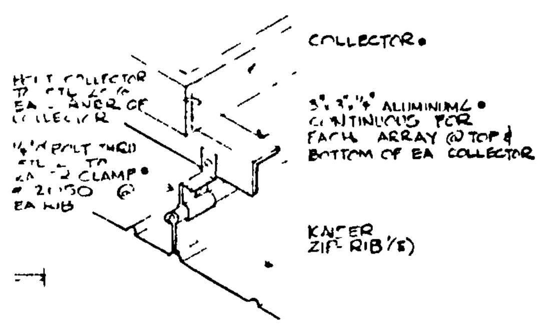
*SIMILAR TO B&G MODEL-WU



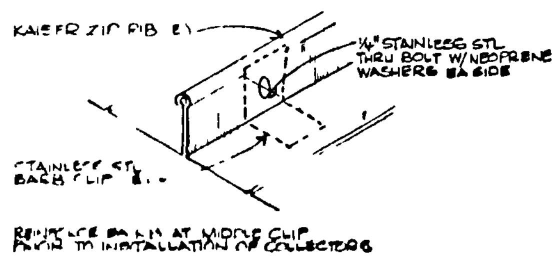
FAN COIL UNIT DETAIL
SCALE NONE



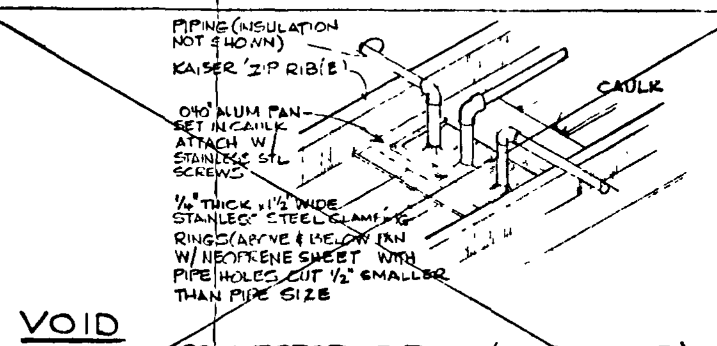
SECTION A-A
SCALE 1/8"=1'-0"



TYPICAL COLLECTOR ATTACHMENT
NO SCALE



ROOF PANEL REINFORCING
NO SCALE



COLLECTOR PIPING (SWS & SWR) THRU ROOF DETAIL
SCALE NONE

AS-BUILT DRAWING

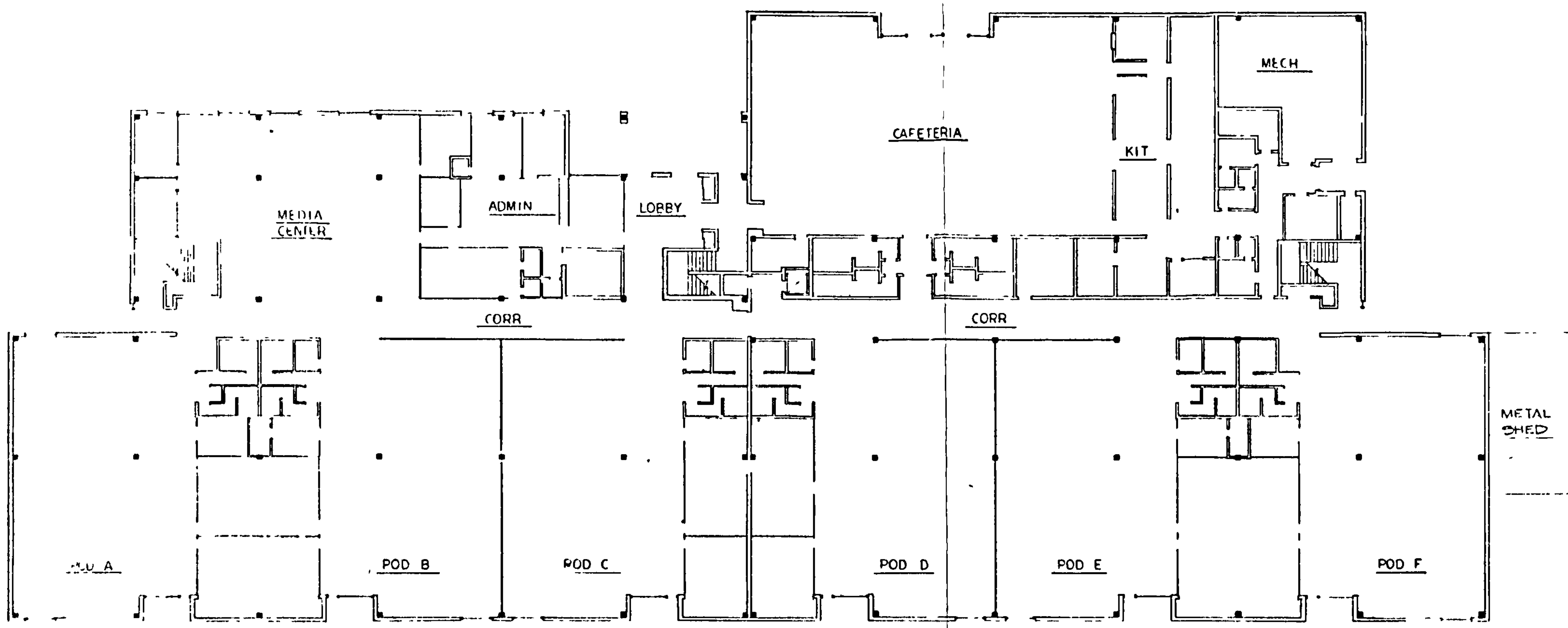
DRAWN BY T W A	DATE 28 FEB 79	REVISIONS GENERAL		
CHECKED BY A K J	SCALE AS SHOWN	GENERAL		
APPROVED BY A K J	JOB NO. 23136			

SHEET TITLE: SCHEDULES

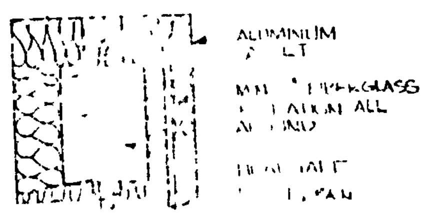
JOB TITLE: JAMES HURST ELEMENTARY SCHOOL

INTERTECHNOLOGY/Solar CORPORATION
100 MAIN STREET WARRENTON VIRGINIA 22186 USA

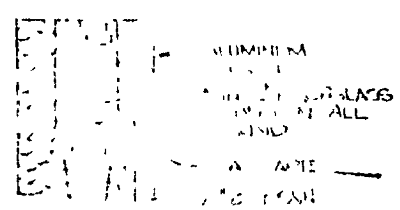
SHEET NO SL-7



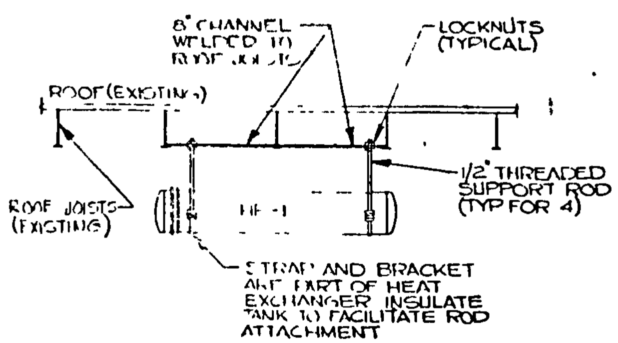
FIRST FLOOR PLAN
SCALE: 1/16" = 1'-0"



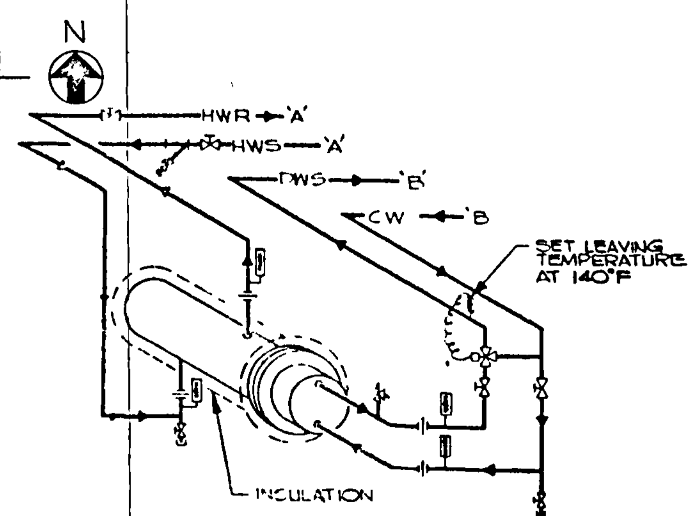
AUTO AIR VENT DETAIL W/INSULATION & HEAT TAPE
SCALE NONE



VACUUM [illegible] DETAIL W/INSULATION [illegible] TAPE
SCALE NONE



HEAT EXCHANGER SUPPORT DETAIL
SCALE NONE



NOTES

1. PROVIDE UNIONS AND ARRANGE WATER PIPING TO FACILITATE TUBE BUNDLE REMOVAL.
2. FOR PIPE SIZES 'A' & 'B' SEE PLANS.

WATER TO WATER HEAT EXCHANGER
SCALE NONE

NOTES

1. ALL MAIN HEADER PIPING IN [illegible] CLG SPACE SHALL HAVE AUTO AIR VENTS AT [illegible] HIGH POINTS.
2. ALL PIPING IN CLG SPACE SHALL RUN CLEAR OF ALL OBSTACLES & SHALL HAVE NO [illegible] OR RISE TO CLEAR OBSTACLES.
3. [illegible] EXPANSION [illegible] EXPANSION COMPENSATORS FOR COPPER PIPES AND [illegible] EXPANSION COMPENSATORS FOR STEEL PIPES. PIPE GUIDES SHALL BE [illegible] ALL [illegible] GUIDES AND EXPANSION COMPENSATORS TO BE [illegible] AND INSTALLED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.

AS-BUILT DRAWING

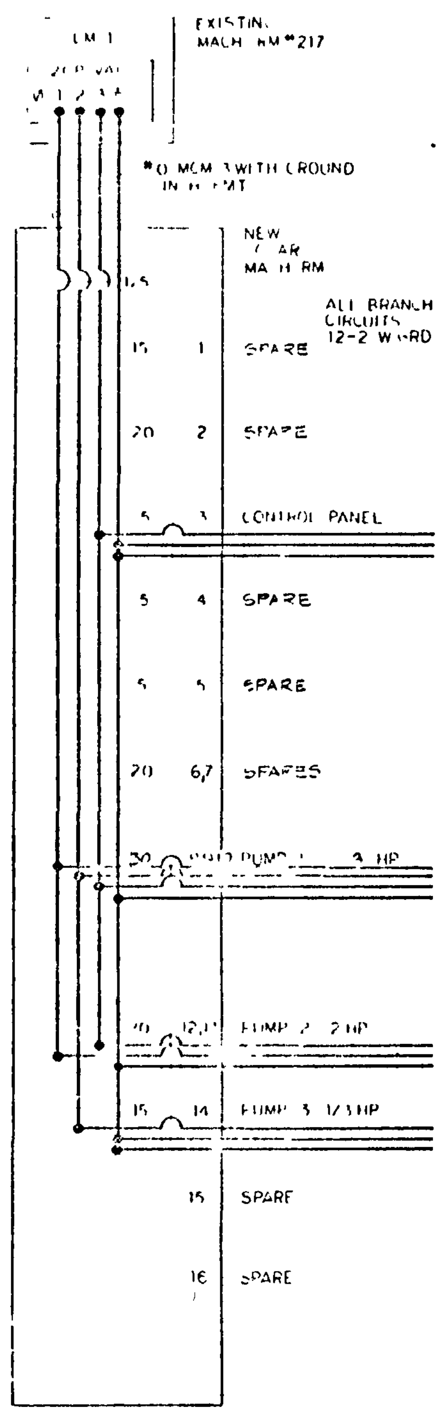
DRAWN BY	TWA
DATE	23 FEB 7[illegible]
CHECKED BY	AKJ
SCALE	AS SHOWN
APPROVED BY	AKJ
REVISIONS	GENERAL [illegible]

SHEET TITLE: FIRST FLOOR PLAN AND GENERAL NOTES

JOB TITLE: JAMES HURST ELEMENTARY SCHOOL

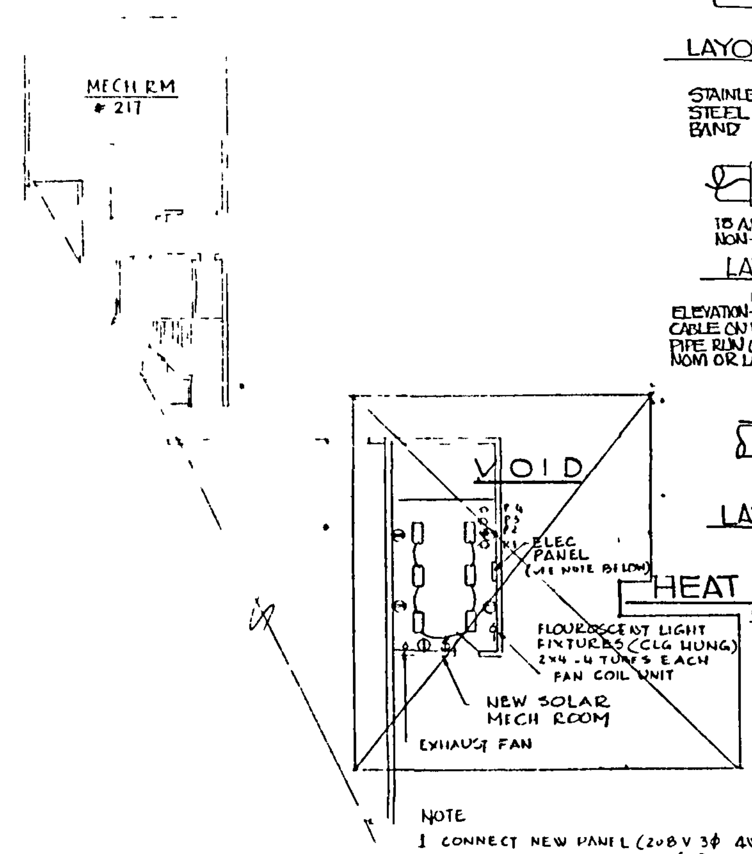
INTERTECHNOLOGY/SOLAR CORPORATION

SHEET NO: SL-8



DISTRIBUTION PANEL

SCALE NONE



PARTIAL FIRST FLR PLAN

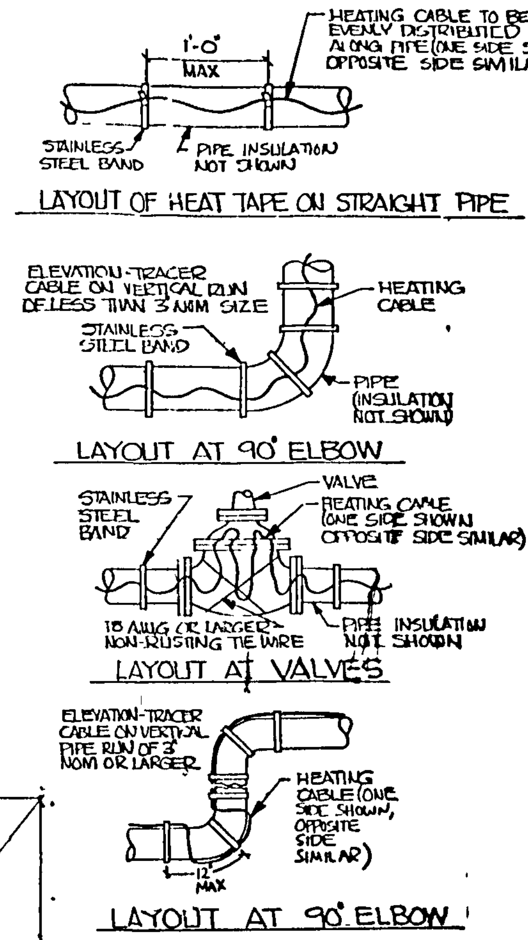
SCALE 1/16" - 1' 0"

NOTE

1 CONNECT NEW PANEL (208 V 3Ø 4W) TO EXISTING PANEL LM1 (3P SPACE #16) LOCATED IN MECH ROOM # 217 WITH 4 #0 (COPPER) MCM CONDUCTORS IN 2 INCH CONDUIT PROVIDE NEW CIRCUIT BREAKER IN PANEL LM 1

2 RUN HEAT TAPE CIRCUITS FROM EXISTING PANEL EH1 IN ME. RM 217 (EXISTING SPARES #21 & #23) PROVIDE NEW CIRCUIT BREAKERS, CONDUITS & CONDUCTORS RUN 3 #12 (COPPER) AWG CONDUCTORS IN 3/4" CONDUIT

~~3 FLOURESCENT FIXTURE TO BE WESTINGHOUSE NO 2H 240 RV CEILING HUNG WITH SINGLE STEM SWIVEL RODS WESTINGHOUSE CAT # 320G692G10~~ VOID



HEAT TAPE DETAILS

SCALE: NONE

Heat Tape Installation Requirements

1. All heat tape will be installed in strict accordance with manufacturer's recommendations

2 Each heater shall be factory-fabricated to the length required This shall consist of length required for pipe, and equipment to be heated plus an allowance for areas of additional heat loss for valves, flanges, fittings, and the likes, plus a reasonable excess to allow for field variations The cold lead section shall be seven feet long It shall be seamless copper sheathed type MI cable manufactured by Chromalox or equal

3 Heating cables shall be sized by the manufacturer for a temperature difference of 60°F (20F to 40F) for the pipe and valve sizes shown on the mechanical drawings

4. All valves and piping shall not, under any circumstances, receive less watts per linear foot than that calculated by the manufacturer Contractor shall make allowances for the 'hot section' lost due to splicing of heat tape

5 All heating circuits shall be thermostatically controlled Bulbs or capillary of thermostats should not be placed closer than 2 inches to heating cable On small diameter pipe, place bulb on opposite side of pipe Set thermostat at 40°F

No heat tracing circuit shall extend more than two feet beyond a point where two or more pipes join when such junctions permit optional flow paths In such cases, separately controlled traces shall be used

Thermostats shall be located in the vicinity of the downstream end of the sections of pipe being controlled

Where the rating of the thermostat would be exceeded it shall be used in conjunction with a relay or contractor

Circuits fed from overhead lines shall be protected by secondary lightening arrestors

6. Field testing of insulation resistance and continuity of the units shall be carried out with a 500 volt meggar and recorded by the electrical contractor Testing shall be done when received on the jobsite after installation on the pipe, and after the heat insulation has been installed Insulation resistance shall be consistently not less than 50 megohms with no decline in reading

Heating cables shall not be installed until a written release is received indicating that the pipes are completely installed and welded and have passed all necessary tests

Heating cables to be laid out along sections of piping to be traced to ensure reasonable uniform distribution of heat It is recommended that the cable first be "roughed in" using tape or rubber bands which are to be removed after permanent banding The cable shall not be pulled taut, but allowed reasonable waving along axis of pipe

Cable sheaths shall not cross or touch one another nor shall cables be installed directly on top of pipe

Heating cable shall be strapped to 2 inch and larger pipe using 1/2" wide stainless steel banding at intervals not exceeding one foot per 1975 NEC Article 427-12 Stainless steel tie wire #18 AWG, or larger, shall be used to hold the cable to irregular surfaces such as valves. Tie wire and strapping shall be snug but not so tight as to indent cable sheath

Extra cable to be provided at areas of increased heat loss such as valves, and flanges to allow dismantling and removal of equipment

Thermostat bulb to be located as far away from heating cable as possible Thermostat capillary and control wire shall have mechanical protection between the equipment rack and the pipe line

7. Where source of supply does not coincide with location of thermostat Emerson Chromolox Type MI Power cable, or equal, shall be run along the pipe under the insulation, to the thermostat

8 All junction boxes shall be located above grade level Covers shall be kept on boxes at all times when not working therein Where allowable, a hole shall be provided in bottom of junction boxes to permit moisture to escape

All terminations shall be protected from the weather and from physical damage

Any field alterations, or deviations, shall proceed only after authority via signed change order has been issued by engineer All changes shall be accurately recorded by the contractor and shall be turned over to the engineer upon completion of that phase of the work

Advice mechanical contractor--that all lines shall be insulated within 24 hours upon tracer installation and acceptance, at least one week before tracer installation, and again on completion of tracer installation

Junction boxes, thermostats, transformers and the like shall not be attached to the insulation, but shall be mounted on brackets fabricated of galvanized angle, channel or other material of sufficient strength to support equipment mounted on them Brackets shall not be mounted on pipe, but rather on separate supports

GENERAL NOTES

1 Electrical contractor shall visit the job site before bidding this job to determine the extent of work involved

2 All power lines shall be run in galvanized conduits

3 Motor Controllers and starters shall be furnished and mounted by the mechanical contractor Electrical contractor shall run electrical service to all electrical devices and wire them

4. All control wiring to be furnished and installed under mechanical work by a control subcontractor Electrical contractor shall provide service to control panel

5. Electrical contractor shall furnish and install all heat tape and its controls

AS-BUILT DRAWING

REVISIONS	GENERAL / GENERAL
DATE	10 - 2-12 79
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DATE	19 FEB 79
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SCALE	AS SHOWN
APPROVED BY	
JOB NO	
SHEET TITLE	ELECTRICAL
JOB TITLE	JAMES HURST ELEMENTARY SCHOOL

InterTechnology/Solar Corporation

SHEET NO

SL-9

TECHNICAL REPORT STANDARD TITLE PAGE

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DOE/NASA CR-161830		

4. TITLE AND SUBTITLE	5. REPORT DATE
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	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT #
9. PERFORMING ORGANIZATION NAME AND ADDRESS Portsmouth Public Schools P. O. Box 998 Portsmouth, VA 23705	10. WORK UNIT NO.
	11. CONTRACT OR GRANT NO. EM-78-F01-5205
12. SPONSORING AGENCY NAME AND ADDRESS U. S. Department of Energy Conservation and Solar Energy Washington, D. C. 20585	13. TYPE OF REPORT & PERIOD COVERED Contractor Report Final
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

This work was done under the technical management of Mr. Jim Hankins, George C. Marshall Space Flight Center, Alabama.

16. ABSTRACT

This document is the final report on the Solar Heating and Hot Water System installed at the James Hurst Elementary School in Portsmouth, Virginia.

The building was zoned into 4 heating/cooling areas. Each area was equipped with an air handling unit that is monitored and controlled by a Honeywell DELTA 1000 Central Control and Monitoring System. The Solar System for the building uses a collector area of 3,630 sq. ft. of InterTechnology/Solar Corp. flat plate liquid collectors, and a 6,000 gallon storage tank.

Included in this final report are system descriptions, maintenance reports, detailed component specifications, and the design drawings necessary to evaluate this solar system.

17 KEY WORDS	18 DISTRIBUTION STATEMENT UC-59a Unclassified-Unlimited William A. Brooksbank, Jr. Mgr. Solar Energy Applications Project

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