FINAL TECHNICAL REPORT

Amity Elementary School
Boise, Idaho

FG02-78CS32146

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

DISCLAIMER

Table of Contents

Project Participants

KEY PERSONNEL

Project Identification No: EM-78-F-03-2146 **Date:** August 20, 1980

Project Title: Amity Elementary School **Prepared by:** Neil H. Smull
Garry L. Rose

1. **Demonstration Project Location**

   Name Amity Elementary School

   Street 10000 West Amity Road

   City Boise State Idaho Zip 83705

2. **Owner:**

   Name Independent School District of Boise City

   Street 1207 Fort Street

   City Boise State Idaho Zip 83702

   Contact Dr. Dick Kuntz Phone (208) 336-1370

3. **Solar Designer:**

   Name Systems Engineering, Inc.

   Street P.O. Box 1281

   City Boise State Idaho Zip 83701

   Contact Garry L. Rose Phone (208) 345-4051

4. **Architect**

   Name Cline Smull Hamill Associates

   Street 910 Bank of Idaho Building

   City Boise State Idaho Zip 83702

   Contact Neil H. Smull Phone (208) 343-4635

5. **Mechanical Engineer:**

   Name Systems Engineering, Inc.

   Street P.O. Box 1281

   City Boise State Idaho Zip 83701

   Contact Garry L. Rose Phone (208) 345-4051

6. **Builder:**

Name M.G.M. Construction Co., Inc.

Street P.O. Box 1915

City Salt Lake City State Utah Zip 84110

Contact T.D. Mahas, President Phone (801) 532-3443

7. **Contract Officer Representative:**

Organization DOE, San Francisco Operations Office

Program Cooperative Agreement No. EM-78-F-03-2146

Location

City Oakland State California Zip 94612

Cor Ken Jew Phone (415) 273-4271

8. **Project Manager:**

Name Ken Jew Phone (415) 273-4271

Organization DOE, San Francisco Operations Office

Street 1333 Broadway Avenue

City Oakland State California Zip 94612

System Description

AMITY ELEMENTARY SCHOOL

ACTIVE/PASSIVE SOLAR SPACE AND HOT WATER SYSTEM

INTRODUCTION

The children play on the roof, on the grass, of the earth integrated Amity Elementary in Boise, Idaho. The building features concrete and masonry with an earth covering to accomodate the passive aspects of the energy conservation.

The Solar System is a space heating, domestic hot water system. The collectors are single glazed, with a selective surface, and are liquid cooled. The space heating and domestic water systems are piped separately with approximately 370 square feet of collector area for the domestic hot water system and 1,830 square feet of collector for the space heating system. Both systems utilize an inhibited heat transfer fluid in the collector loop with shell and tube heat exchangers to storage.

The collector area is somewhat smaller than an optimum area based on installed cost per million BTU's delivered. Because of limited area for collector installation, the roof area above the mechanical room and multipurpose room becomes the limiting facor. To eliminate self-shading of the collectors, a total of 2,180 square feet of net collector area is possible to be installed on the only exposed roof area of this earth integrated structure.

The cost to add collector area to increase the cost effectiveness of the solar system by itself would have imposed large cost penalties on the overall project cost and effectively lowered the total cost effectiveness. By this analysis the cost effectiveness on a project basis was maximized.

DESIGN PHILOSOPHY

Amity Elementary School is designed to accomodate 780 students, kindergarten through grade 6, in 26 classrooms. Support spaces include a multipurpose gymnasium, special education services, library media center, guidance rooms, health, cafeteria, general purpose classroom, and the normally associated auxillary spaces. The gross square footage totals 51,400 square feet including mechanical areas.

The structure consists of a precast concrete double tee roof system supported by poured in place concrete exterior walls, with columns and concrete masonry unit bearing walls inside.

The concrete shell supports earth sloped against vertical perimeter walls with two feet of earth cover placed on the roof. This develops an extremely high thermal mass, delaying the impact of outside air temperatures on the interior temperatures. Exposed portions of the roof are used as a grass play area.

This earth covered, solar integrated elementary school is located on the northwestern part of the 15-acre site. The eastern 5 acres were leveled and the soil placed over the structure which shifted the topography within the boundaries of the site to create a large flat grassy play area for a future community park. A major road, accompanied by a large landscaped buffer zone along the southern border, provides bus and automobile access to the building. To separate the buses from the automobile traffic, separate parking and loading areas are provided. Sidewalks surround the perimeter of the school for pedistrian access from the adjacent residential neighborhood separating the pedestrian access from the vehicular traffic.

By grouping flexible teaching areas around the multipurpose gymnasium, media center and support facilities, the required square footage was reduced from 58,000 square feet to 51,400 square feet. This reduced the building perimeter and, in turn, allowed less heat flow through the building skin.

Insulation is provided by rigid insulation and earth cover at the walls and roof. The building walls have a U-factor of .06 and the roof a U-factor of .04. The perimeter walls have insulated glass with a U-factor of .65. Insulated ducts have a U-factor of .25 and all domestic hot water piping is wrapped with thick glass fiber.

Exterior soffits shade the windows and only 6% of the gross wall area is glazed. Windows for each classroom are double glazed allowing visual contact with the outside. Classroom doors access directly to the exterior. The total glass area is significantly reduced from that of a conventional school; however, through careful design, glass area is afforded each classroom to alleviate possible negative psychological effects to the occupants of the "earth integrated" school.

One advantage realized by incorporating the earth material into this structure is a saving of energy required to produce the building materials. A conventinal school, which utilizes totally synthetic materials, requires great amounts of energy to produce.

OPERATION OF THE SYSTEM

The HVAC system is a medim-pressure single-duct variable volume cooling system with a recirculated air perimeter heating system. The variable volume system operates only during occupied hours. A perimeter heating system offsets infiltration and transmission losses from the building.

The cooling system incorporates an economizer cycle utilzing outside air for cooling when possible. The perimeter heating system is complemented with liquid cooled flat plate solar collectors. Solar energy also provides hot water for domestic use.

Eight million pounds of internal mass, high R values in roof and walls, small glass areas and reduced lighting load, combine to reduce the HVAC system size to 55% of that required for a conventional school. HVAC fan horsepower is further reduced by the use of heat extract luminaires. The auxiliary fuel source is electricity.

Installed lighting capacity does not exceed 1.6 watts per square foot. Parabolic louvered luminaires are used throughout for increased lighting efficiency and visual comfort. The heat extract feature is utilized to reduce fan horsepower on the HVAC system and reduces the number of fixtues required due to increased light output. Dual switching allows variation of lighting levels as tasks change.

The methodology used to arrive at target annual energy comsumptin was achieved by hand calculatins which resulted in the ofllowing:

1. With Solar System Installed - 21,660 BTU/GSF/YR.

2. Without Solar System - 27,000 BTU/GSF/YR.

The solar collectors selected for this project are manufactured by Sunworks, Inc., Guillford, CT. The collectors are the liquid cooled "Solecor" model with single glazing and selective surface.

Within the expected temperature range of operation, the single glazed collector with selective surface will result in the optimum performance efficiency.

This collector was selected for the folowing reasons:

1. Past experience of the collector manufacturer.

2. Past performance and service from the authorized sales representative of Sunworks.

3. Flexibility of the collector piping arrangements for either side or back entry-exit piping.

4. Ease of collector to support structure mounting.

The building heating system consists of a hot water loop serving two fan coil units and two unit heaters to provide heat as required to specific areas in the building. The temperature of the water being circulated is on a reset schedule based on outdoor temperture. Heat is provided to the water loop by either the solar storage, or by the electric boiler. The solar storage and boiler are piped in series so that if the solar storage cannot provide the proper water temperature, the electric boiler will add additional heat as required. The electric boiler has been sized to provide 100% of the heating requirement at designconditions.

The domestic hot water system is similar to the bulding heating system with an electric water heater replacing the electric boiler. The water heater can provide 100% of the required domestic hot water.

The energy system is a total integrated architectural-engineering package. This energy-efficient system, excluding the solar heating portion, will reduce the annual operating costs for heating and cooli the bulding over a conventinal system. With the addition of solar domestic hot water and space heating, this figure is 74% over a conventional system from $19,830 annually to $5,088 annually. The initial building cost is $3.55 per square foot over the average conventional school. The expected payback period including the solar system is estimated to be 16 years. This estimate payback period is based on fuel costs increasing at a conservative rate of ten percent per year. Based on a fifteen percent per year fuel escalation per year, the payback period would be 8 years.

What about the "efficiency" of the structure?

A comparison of 3 schools in the Boise School District show:

1.	Amity May 1979 to May 1980 ..... 51,400 square feet	$ 5,088	Electric
2.	Franklin May 1979 to May 1980 ..... 58,714 square feet	$ 5,226	Electric
		$ 14,604	Gas
		$ 19,830	Total (74.35% more)
3.	Garfield May 1979 to May 1980 ..... 49,855 square feet	$ 5,147	Electric
		$ 13,146	Gas
		$ 18,293	Total (72.19% more)

The cooling load, because of transmission and solar gain, is estimate to be 4.8 BTUH per square foot and the heat loss due to transmission and infiltration is estimated to be 8.5 BTUH per square foot.

The cooling load attributable to ventilation is estimated to be 1 BTU per square foot. The heating of ventilation air is not anticipated. When the building is not occupied, the ventilation air is shut off.

The total design cooling load, including fan motor heat gain, is estimated to be 17.3 BTUH per square foot. The total heating load at design conditions is estimated to be 11.9 BTUH per square foot.

The control system for the solar heating and domestic hot water system is part of the control system for the entire HVAC system. The sequence of control is shown in the operation manual.

The total interior fixed load including sensible and latent heat gain is estimated to be 4 BTUH per square foot.

The lights add 6.8 BTUH per square foot of heat gain to the refrigeration system. The use of heat extract luminaries reduces the amount of heat radiated to the room and thereby reduces the necessary air quantity to the rooms for a savings of fan horsepower.

SUMMARY

It is hoped that the combined active and passive systems described provide yet another avenue for the economical application of solar energy in the educational facilities planning sector.

Both the inherent advantages and availability of the earth as a building mateiral and the existence of the sun as an unending energy supply, point to a direction that we dare not fail to pursue in the development of the character of man's future environment. They are the decisive factors in the quest for a harmonious existence with nature.

SITE DESCRIPTION

Project Identification No: EM-78-F-03-2146 Date: August 20, 1980

Project Title: Amity Elementary School Prepared by: Neil H. Smull
Garry L. Rose

1. Latitude: 42 °N
2. Altitude: 2850 FT
3. Area Climate Description:
   - A • Yearly Heating Degree Days 5800
     reference ASHRAE location Boise, Idaho
   - B • Equivalent Full Load Cooling Hours N.A.
     reference N.A. location N.A.
   - C • Average Insolation for January 518.8 BTU/SF/Dav
     reference ASHRAE location Boise, Idaho
   - D • Average Insolation for..... N.A.
     reference N.A. location N.A.
4. Site Topographic Description _____
5. Special Topographic or Climatic Conditions None
6. Collector Shading
   - A • Cause Self
   - B • Extent < 5 %
7. Regulatory Codes

	State X	Local X		Edition (Year)
A.	X	Uniform	ICBO	
B.		Basic Building Code	BOCA	
C.		Southern Building Code	SBCC	
D.		National Building Code	AIA	
E.		Minimum Property Standards	HUD	
F.		Other (Specify)_____		
G.	None			

BUILDING DESCRIPTION

Project Identification No: EM-78-F-03-2146 **Date:** August 20,1980

Project Title: Amity Elementary School **Prepared by:** Neil H. Smull
Garry L. Rose

1. **Occupancy** Elementary School
2. **Total Area** 51,400 Ft²
3. **Solar Conditioned Area** 43,300 Ft²
4. **Heating Design Temperatures**
   - A. Outdoor for 97.5% 0 °F
   - B. Indoor 70 °F
5. **Cooling Design Temperatures**
   - A. Outdoor 96 °F Dew Point 67 °F
   - B. Indoor 75 °F
6. **Total Height Above Ground** 28 Ft
7. **Roof Slope** 1.9 °
8. **Structure**

A • Walls

- Frame Earth & Concrete Block & Pre-Cast
- Exterior Finish Earth & Concrete
- Insulation Type Styrofoam
  - — Manufacturer Dow
  - — Thickness 2" + Earth
  - — Material Plastic Board - Polystyrene
  - — R-Value 17 + Earth
- Interior Finish Gyp-Board-Painted
- Windows 1" Colar Bronze Insulated
- Doors HM - Insulated

B • Roof

- Frame Pre-cast T's
- Exterior Finish Earth & Concrete
- Insulation Styrofoam
  - — Manufacturer Dow
  - — Thickness 4" + 24" Earth

— Material Polystyrene Plastic Board

— R-Value 25 + 15 for earth = 40

• Interior Finish Spray-on Foam & Suspended

C • Floor Concrete with Carpet

9. Mechanical System

A • Heating

• Solar Active - Liquid Flat Plate

• Backup Boiler - Electric

• Distribution Hot Water

B • Cooling

• Solar None

• Backup Recip. Chiller

• Distribution Water

C • Domestic Hot Water

• Solar Active - Liquid Flat Plate

• Backup Electric

• Daily Hot Water Demand 425 gal/day

10. Energy Conservation and Recovery Devices

_____ Condenser Water Used for Heating

_____ Demand Limiters

__X__ Energy Storage

_____ Heat Recovery Wheels

_____ Recuperators

_____ Other

_____ None

Explanation: Water Storage for Solar Collectors

11. Design Load and System Performance Summary

Month	Total Load (MBtu)			Energy Supplied By (MBtu)		Solar System Power Usage (Kwh)
	Hot Water	Heating	Cooling	Solar System	Auxiliary System	
JANUARY	10900	120400		23500	108000	843
FEBRUARY	9900	92800		31800	70900	784
MARCH	10900	76800		35900	51800	843
APRIL	10600	45300		34600	21300	816
MAY	10900	33000		31800	12100	843
JUNE				-	-	-
JULY				-	-	-
AUGUST				-	-	-
SEPTEMBER	10600	11500		22100	-	816
OCTOBER	10900	42500		39500	13800	843
NOVEMBER	10600	85500		26800	69300	816
DECEMBER	10900	110000		21100	99800	843

Type of Predictive Model Used

Performance Calculations X

Steady State ___

Transient ___

Analytic model designation Sun Sym

Simulation Time Period

Hourly ___

Daily ___

Monthly ___

Other (specify) 15 min. intervals

Precicted Performance

SOLAR SYSTEM ARRAY PERFORMANCE

COLLECTOR TYPE: Liquid Flat Plate LOCATION: Boise, Idaho

ARRAY AREA: 2183 FT^2; LATITUDE: 43-34 °; TILT ANGLE FROM HORIZONTAL: 55 °; AZIMUTH: 0.0 (+=West, 0=Due South, -=East)

LINE	DESCRIPTION	UNITS	MONTH											
			J	F	M	A	M	J	J	A	S	O	N	D
(1)	Number of days		31	28	31	30	31	30	31	31	30	31	30	31
(2)	Average Temp. - (Tamb)* (1)	°F	29.1	34.5	41.7	50.4	58.2	65.8	75.2	72.1	62.7	51.6	38.6	32.2
(3)	Max Average Temp (Tmax)* (2)	°F	29.5	36.5	45.0	53.5	62.1	69.3	79.6	77.2	66.7	56.3	42.3	33.1
(4)	Average Ambient (Ta)1/2 (2) + (3)	°F	29.3	35.5	43.4	52.0	60.2	67.6	77.4	74.6	64.7	54.0	40.4	32.6
(5)	Clearness Factor (See Note)(3)	-	7.6	7.2	6.7	6.3	5.8	4.8	2.5	3.1	3.6	5.0	6.9	7.6
(6)	Average Collector Temp - (Tc) = 1/2(Tin+Tout)	°F	120	120	120	120	120	120	120	120	120	120	120	120
(7)	Collector Efficiency	-	22	36	40	42	43	50	55	55	54	49	36	24
(8)	Clear Air Daily Insolation on Tilted Collector Surface	BTU/ft^2	1906	2202	2284	2168	2040	1974	2006	2104	2182	2098	1870	1740
(9)	Percentage Sunshine* (4)		40	48	59	67	68	75	89	86	81	66	46	37
(10)	Monthly Probable Insolation (5)	BTU/ft^2	30752	39424	48205	50580	51181	50280	55831	55490	56250	50685	36000	28985
(11)	Collected Energy (Qc)	Million BTU	14.3	29.1	39.0	43.4	45.2	45.3	55.3	54.9	60.6	49.5	26.8	14.7
(12)	Q Loss (Piping & Losses)	Million BTU	1.2	2.6	3.5	3.8	4.0	45.3	55.3	54.9	39.6	4.5	2.3	1.3
(13)	Q Usable	Million BTU	13.1	26.5	35.5	39.6	41.2	-0-	-0-	-0-	21.0	45.0	24.5	13.4
(14)	Total Load Bld (Solar Conditioned)	Million BTU	131.3	102.7	87.7	55.9	43.9	-0-	-0-	-0-	22.1	53.3	96.1	120.9
(15)	Auxiliary Energy Required	Million BTU	118.2	76.2	52.2	16.3	2.7	-0-	-0-	-0-	1.1	8.3	71.6	107.5
(16)	% Solar Contribution		10.0	25.8	40.5	70.8	93.8	-0-	-0-	-0-	95.0	84.4	25.5	11.3
(17)	Time of Collector Operation	Hours	9.4	10.5	11.9	13.4	14.7	15.4	15.1	13.9	12.5	11.0	9.7	9.0
(18)	Electric Power for Collection Subsystem	KWH	583	588	738	804	911	924	936	862	750	682	582	558
(19)	Electric Power for Storage to Load Subsystem	KWH	292	294	369	402	456	-0-	-0-	-0-	375	341	291	279
(20)	Total Solar System Electric Power	KWH	875	882	1107	1206	1367	924	936	862	1125	1023	873	837

*Source of Data to be Specified: _____

NOTE:
(1) NOAA; Ashville, N.C.
(2) "Low Temperature Engineering Application of Solar Energy' Ashrae, 1967
(3) NOAA; Ashville, N.C. - "Mean Sky Cover"
(4) "Design Criteria for Solar Heated Bldgs." Barber & Watson, May 1975
(5) Calculated Using Method Outlined in Reference (2) Above

PROJECT COST DATA

SOLAR SYSTEM ANNUAL OPERATION & MAINTENANCE (O&M) COSTS

o SOLAR SYSTEM OPERATING COST

1. TYPE OF ENERGY CONSUMED: Electricity
   (e.g., gas, electricity, etc.)

2. UNIT OF ENERGY CONSUMED: KWH
   (e.g., cu. ft, kwh, etc.)

3. ANNUAL SYSTEM OPERATING COST

   0.025 (rate per unit*) x 12,017 (annual energy requirements) = $ 300.00 /yr

o BACK-UP ENERGY COST

4. TYPE OF ENERGY CONSUMED: Electricity
   (e.g., gas, electricity, etc.)

5. UNIT OF ENERGY CONSUMED

6. ANNUAL BACK-UP ENERGY COST

   0.025 (rate per unit*) x 134,260 (annual energy requirements) = $ 3,356.00 /yr

o OTHER SOLAR SYSTEM COSTS

7. ANNUAL MAINTENANCE COST: $ 250.00

8. INSURANCE & TAXES: $ (undetermined)

9. OTHER (Specify) None: $ —

*Based on December 1977 rates.

PROJECT COST DATA

o TOTAL SOLAR SYSTEM O&M COSTS

10. TOTAL ANNUAL O&M COSTS (A3+A6+A7+A8+A9)	$ 3,906.00

CONVENTIONAL SYSTEM ENERGY COSTS

1. TYPE	Electricity
2. UNIT	KWH
3. ANNUAL FUEL COSTS*	$5,260.00

SOLAR SYSTEM ECONOMICS

1. NET ANNUAL BENEFIT OF SOLAR SYSTEM (B3-A10)	$ 1,354.00
2. FIXED COST TO SAVINGS RATIO; TOTAL INSTALLED COST/NET ANNUAL BENEFITS (E, App.D, Exhibit 2 ÷ C1)	$ 79.12

*Based on December 1977 Rates

ENERGY UTILIZATION

1. ANNUAL UNIT SOLAR ENERGY COLLECTED, BTU/YR - FT^2 119,011

2. TOTAL SOLAR ENERGY COLLECTED, BTU/ YR 259,800,000

	ANNUAL SOLAR USAGE (10^6 BTU)	ANNUAL ENERGY CONSUMPTION (10^6 BTU)	AUXILIARY ENERGY CONSUMED (10^6 BTU)
3. HEATING DEMAND SATISFACTION	222.6	650	427.4
4. HOT WATER DEMAND SATISFACTION	37.2	63.9	26.7
5. COOLING DEMAND SATISFACTION	N/A	N/A	N/A
6. TOTAL DEMAND SATISFACTION	259.8	713.9	454.1

7. TOTAL YEARLY COST OF OPERATING SOLAR SYSTEMS $ 3,906.00
(FROM APP. D, EXHIBIT 3, ITEM A-10)

FUNDING AND COST-SHARING SUMMARY (FOR RETROFIT, FILL IN ITEM F.3 ONLY)

1. TOTAL CONVENTIONAL BUILDING COST (for new buildings) $ 2,228,192.00

2. TOTAL BUILDING COST WITH SOLAR ENERGY SYSTEM (for new buildings) $ 2,335,314.00

3. SOLAR SYSTEM COST DIFFERENTIAL (for new or retrofit bldgs.) $ 107,122.00
(Line 2 minus Line 1 should equal item C-1 from Appendix D)

4. COST SHARING PROVISIONS

PROPOSER		ERDA	
$ 37,493.00	35 %	$ 69,629.00	65 %

(Proposed Cost sharing of Solar System Cost Differential stated in Line 3.)

5. SOLAR SYSTEM COST EFFECTIVENESS:

a. ANNUAL ENERGY COST WITH CONVENTIONAL SYSTEM (APP. D, EXHIBIT 3, ITEM B-3) $ 5,260.00

b. ANNUAL ENERGY AND OPERATING COST WITH SOLAR SYSTEM (APP. D, EXHIBIT 3, ITEM A-10) $ 3,906.00

c. ANNUAL SAVINGS (Line a minus Line b) $ 1,354.00

6. FIXED COST TO ANNUAL SAVINGS RATIO $ 79.12
(Line 3, Solar Systems Cost Differential; divided by Line 5c, Annual Savings)
(based on 1977 energy costs)

SYSTEM PERFORMANCE/TECHNICAL DATA

ELECTRICAL POWER

1. OPERATING REQUIREMENTS

a. THE ELECTRICAL ENERGY REQUIRED TO DRIVE THE SOLAR COLLECTION PORTION OF THE SYSTEM IS 2 kw

1. PUMPS 2 kw FUNCTION Fluid Circulation
2. FANS N/A kw FUNCTION N/A
3. CONTROLS Negligible kw FUNCTION Differential T-Stat and Safety
4. OTHER N/A kw FUNCTION N/A

b. THE ELECTRICAL ENERGY REQUIRED TO DRIVE THE STORAGE TO LOAD PORTION OF THE SYSTEM IS 1 kw

1. PUMPS 1 kw FUNCTION Fluid Circulation
2. FANS N/A kw FUNCTION N/A
3. CONTROLS Negligible kw FUNCTION 3-Way Valve Temp. Control
4. OTHER N/A kw FUNCTION N/A

2. DESIGN LOAD DATA:

INCLUDE LOAD DUE TO VENTILATION REQUIREMENTS

BUILDING LOAD TABLE

MONTH	HEATING (BTU)	HOT WATER (BTU)	COOLING (BTU)
January	124.2×10^6	7100000	N/A
February	95.6	7100000	N/A
March	80.6	7100000	N/A
April	48.8	7100000	N/A
May	36.8	7100000	N/A
June	-0-	None	N/A
July	-0-	None	N/A
August	-0-	None	N/A
September	15.0	7100000	N/A
October	46.2	7100000	N/A
November	89.0	7100000	N/A
December	113.8	7100000	N/A
YEARLY TOTAL	650×10^6	63900000	N/A
DESIGN PEAK (BTUH)	450,000	180,000	N/A

Acceptance Test Plan

Consulting Engineers SEI Systems Engineering Incorporated

February 1, 1980

Mr. Ken Jew, Project Manager
Department of Energy
San Francisco Operations Office
1333 Broadway Ave.
Oakland, California 94612

Re: D.O.E. Solar Elem. School
Boise, ID (7719)

Dear Ken:

Enclosed are copies of the Amity Solar Maintenance Manual, the Acceptance Test Plan and the results of the Acceptance Test Plan. In addition to this I have sent some extra data requested by Sherwood Peters.

Sincerely,

Garry L. Rose, P.E.

GLR/krs

Encls.

cc: Neil Smull - CSHQA
Sherwood Peters

P.O. BOX 1281 • BOISE, IDAHO 83701 • PHONE (208) 345-4051

AMITY ELEMENTARY SCHOOL ACCEPTANCE TEST PLAN

A. Balance all water flow rates to the valves specified on the enclosed "Requirements for Acceptance Test Plan".

B. Submit Operation & Maintenance Manuals as required by Section 15A90 of the specifications.

C. Complete items on enclosed sheet titled "Items to be Completed Prior to Final Acceptance".

D. Verify compliance with Sequence of Control as specified on Sheet 15.8A.

ITEMS TO BE COMPLETED PRIOR TO FINAL ACCEPTANCE

1. Install shut off and balancing valves on each side of main heating loop pump.

2. Install shut off valve between expansion tank T-2 and pump P-2.

3. Check all connections to pumps and "Petes Plugs" for leaks.

4. Label all equipment as required in Section 15A80.

REQUIREMENTS FOR ACCEPTANCE TEST PLAN

WATER FLOW RATES

Balance Water Flow - All Pumps Running

Pump No.	GPM	Head	
P-1	85	35	V-1 open
P-2	67	15	V-1 closed
P-3	67	15	
P-3	67	15	
P-4	67	20	
P-5	67	15	

Measure GPM with Following Combinations

1. Heating System Pump - V-1 open thru storage
2. Heating System Pump - V-1 closed thru storage

3. P-1, P-2, H.S. - V-1 open thru storage
4. P-1, P-2, H.S. - V-1 closed thru storage

5. P-1, P-2 - V-1 open
6. P-1, P-2 - V-1 closed

7. P-3, P-4, P-5, H.S. - V-1 open
8. P-3, P-4, P-5, H.S. - V-1 closed

9. P-3, P-4, P-5 - V-1 open
10. P-3, P-4, P-5 - V-1 closed

11. P-1, P-2, P-3, P-4, P-5 - V-1 open
12. P-1, P-2, P-3, P-4, P-5 - V-1 closed

ACCEPTANCE TEST PLAN RESULTS

RESULT OF FLOW RATE ADJUSTMENTS

Pump No.	Name Plate Amps	Actual Running Amps	Required AP (psi)	Actual AP (psi)
P-1	3.6	3.4	19	No Data
P-2	10.8	10.0	10.8	11.0
P-3	10.8	8.5	10.8	10.0
P-4	10.8	8.5	10.8	10.0
P-5	10.8	8.5	10.8	10.0

Pump No.	Required GPM	Actual GPM
P-1	85	No Data
P-2	67	67
P-3	67	77
P-4	67	77
P-5	67	77

NOTE:

Flow rates through the pumps did not vary with different combinations of pump and valve operation.

Remarks and Recommendations

CONSTRUCTION/INSTALLATION PROBLEMS

The following minor problems were encountered during construction. The solutions and recommendations are also discussed.

1. There were minimal problems regarding the sequencing of construction. In the future a detailed pre-construction conference and sequence schedule should be followed. In our case the mechanical room roof was in place prior to installation of the storage tank which was known in advance to be wider than the door opening. This necessitated a change to two tanks and extra piping, insulation, etc.

2. Further evaluation of collector mounting systems should occur. While the square tube system used performed as needed; some of the detailing could be better. Increased coordination with mechanical trades prior to final support design would have eliminated most of the problems. After collector installation a number of supports were removed and the remaining structure braced and gusseted to accomodate piping. This resulted in connections which were not primed and painted at the time of the original supports. The solution to the problem is to build a mock-up with the collectors prior to fabrication of the support system.

3. There were minor problems involving the balancing and measuring of flow rates during start-up. More instrumentation should be provided to measure flow rates, line pressure and temperature in further detail. This would allow greater fine tuning of the system over a period of time.

4. Normal construction questions were asked by the Contractor. These were usually answered by consultation with the Eningeers or manufacturer's representatives.

5. Because the project was bid by the General Contractor before all requirements of DOE were known, a lack of funds prohibited including some of the items desired by DOE.

Verification Statements

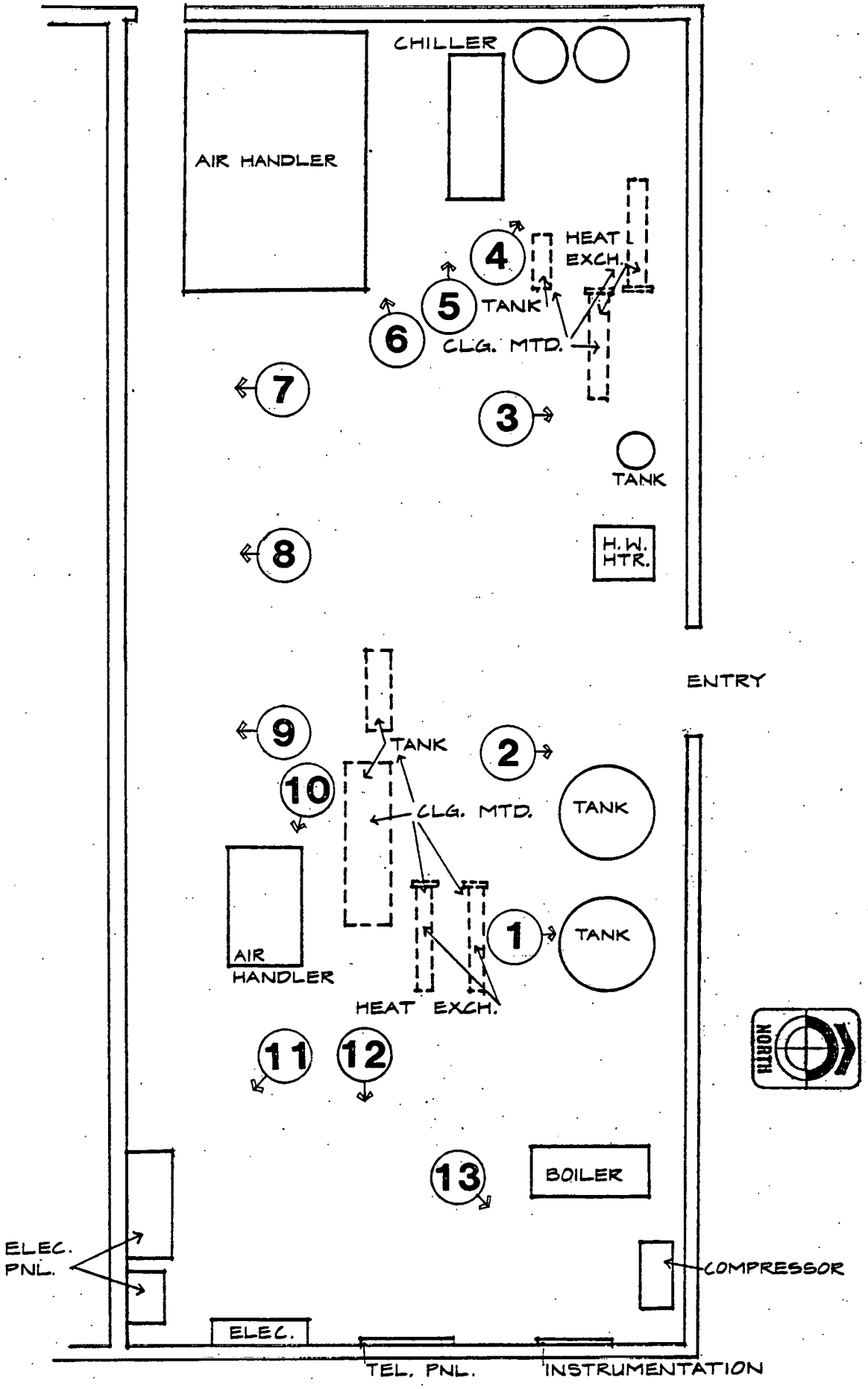
VERFICATION STATEMENTS

1. The Amity Elementary School Solar Heating System described herein was installed as per the drawing of record included in Appendix C.

2. The acceptance test plan provisions were met and approved July 24, 1980 at a meeting held on-site at Amity Elementary School. Present were Ken Jew, DOE Project Manager, Neil Smull, CSHQA Project Architect, Garry Rose, SEI Project Engineer, Don Gribble and Joe Schultz, Boise School District.

3. To the best of our knowldege the Project has met the Interim Performance Criteria requirements.

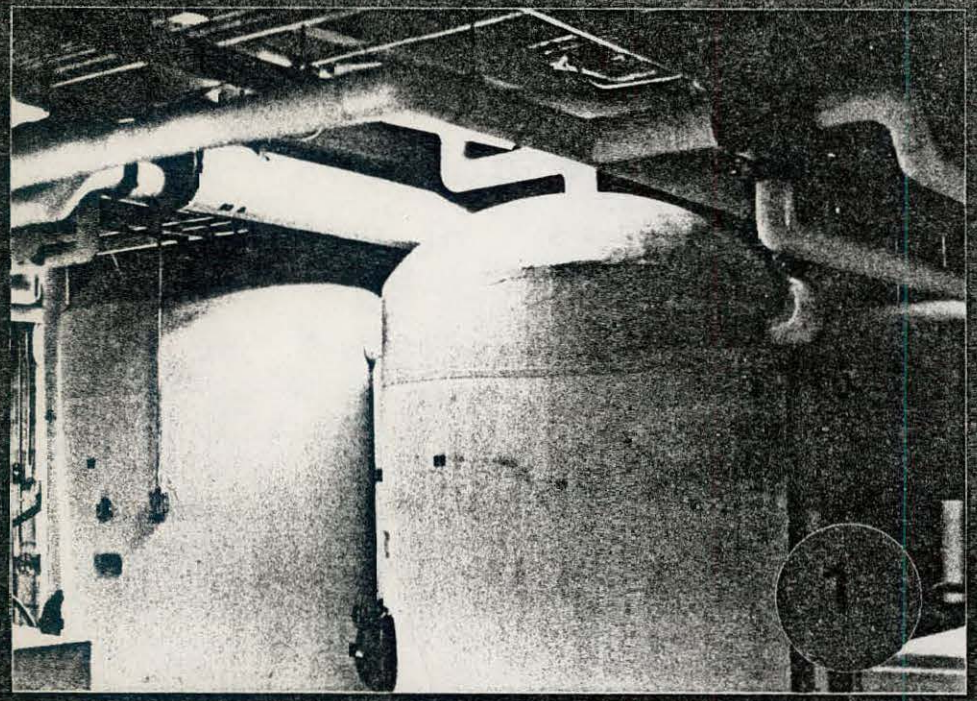
Appendix A



MECH. ROOM PHOTO KEY

PHOTOGRAPH KEY

1 Storage tanks
2 Entry, storage tank (north wall)
3 Domestic hot water heater (north wall)
Domestic hot water storage
4 Domestic hot water
5 Chiller (west wall)
6 Air handler (south west corner)
7 Supply duct (south wall)
8 Supply trunk ducts (southwall)
9 Air handler
10 Air handler
11 Electrical control panels (south east corner)
12 Telephone board (east wall)
13 Instrumentation (north east corner)
14 West side - support system
15 West side - supply and return lines
16 East side - return lines
17 South west entry - collector array
18 South east entry - collector array
19 Collector array - north side return line
20 Collector array - south side collection surface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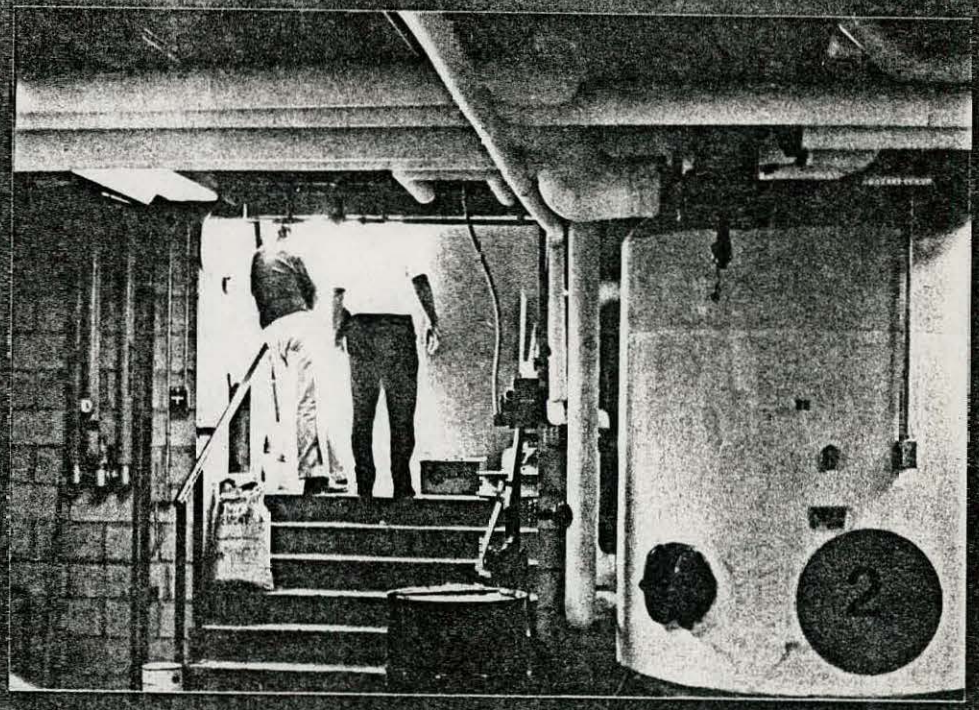
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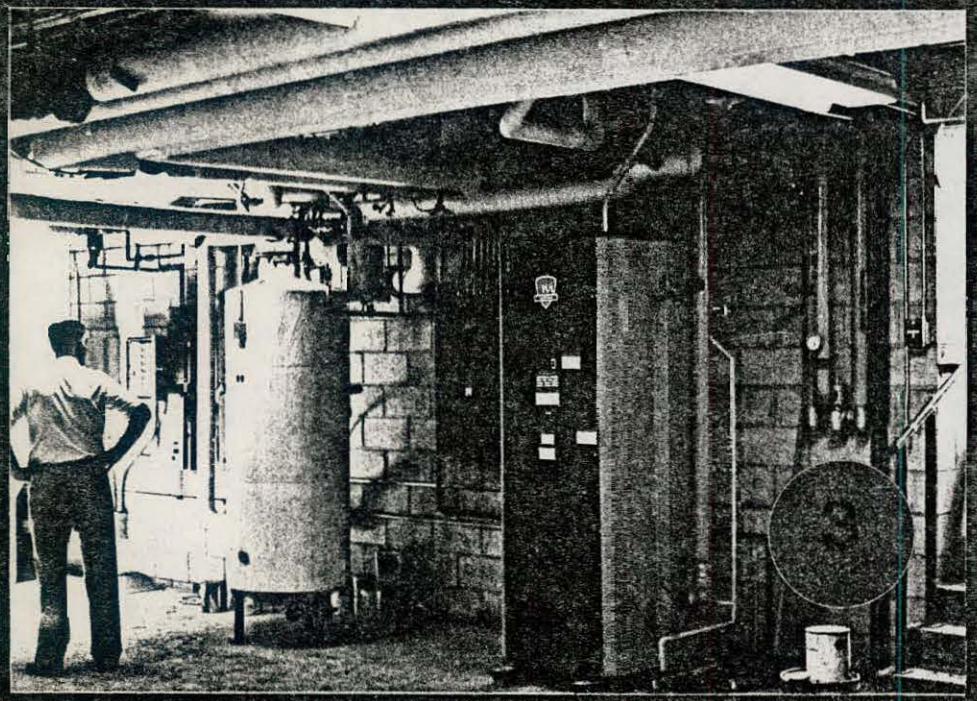
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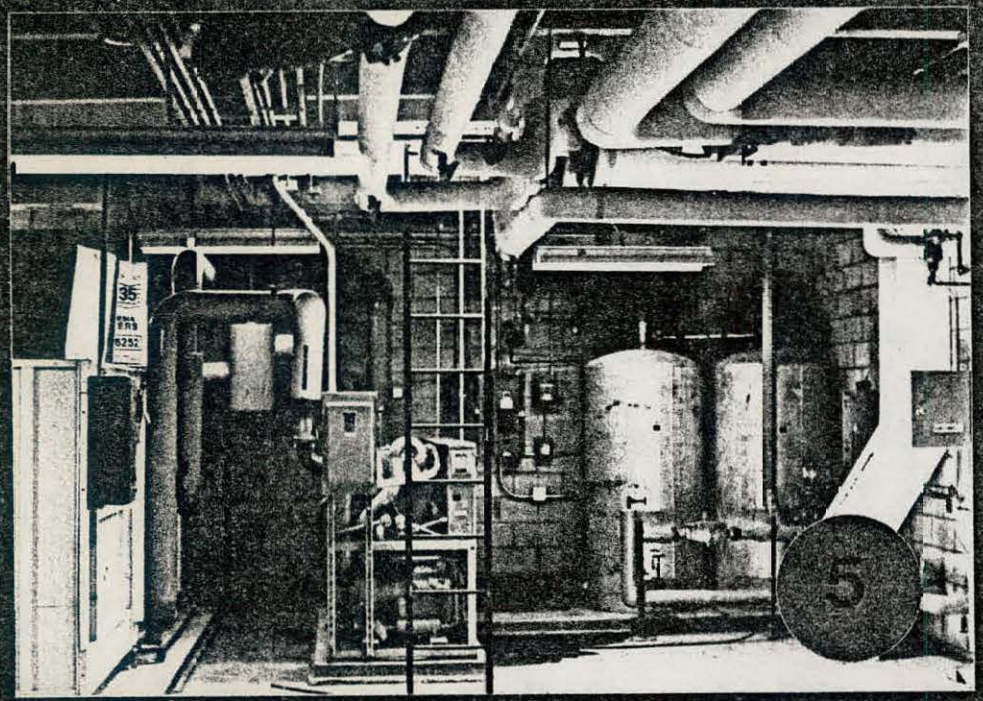
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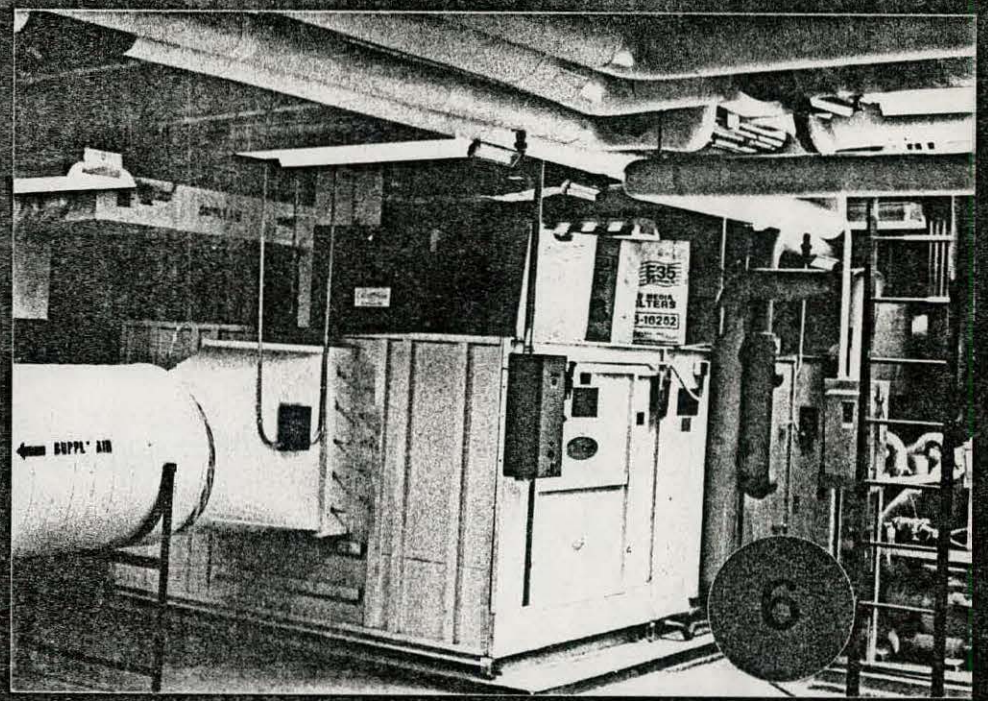
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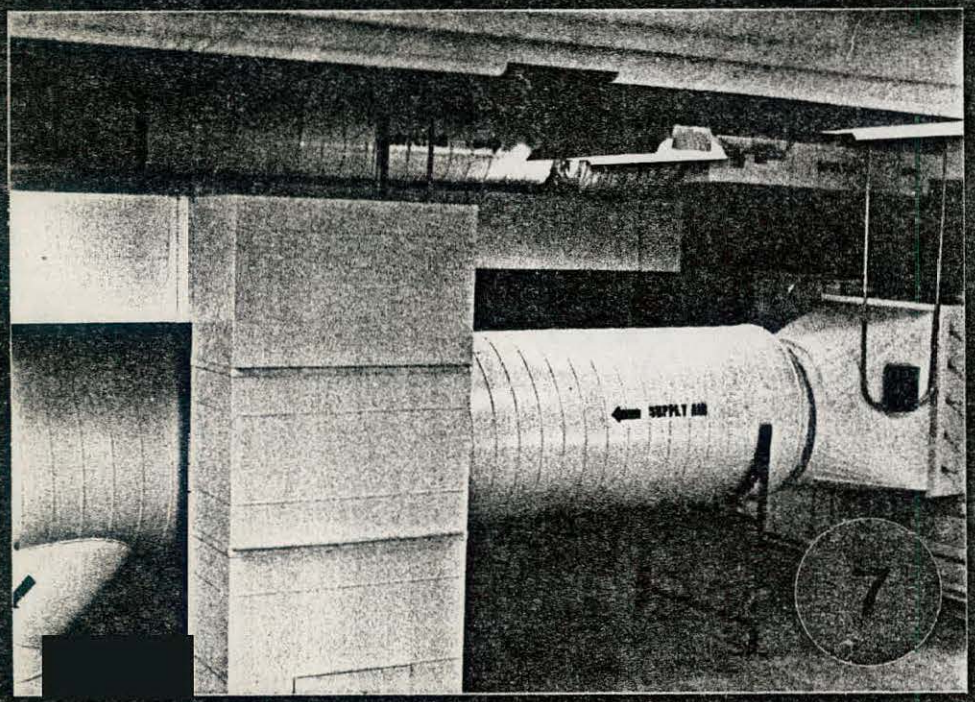
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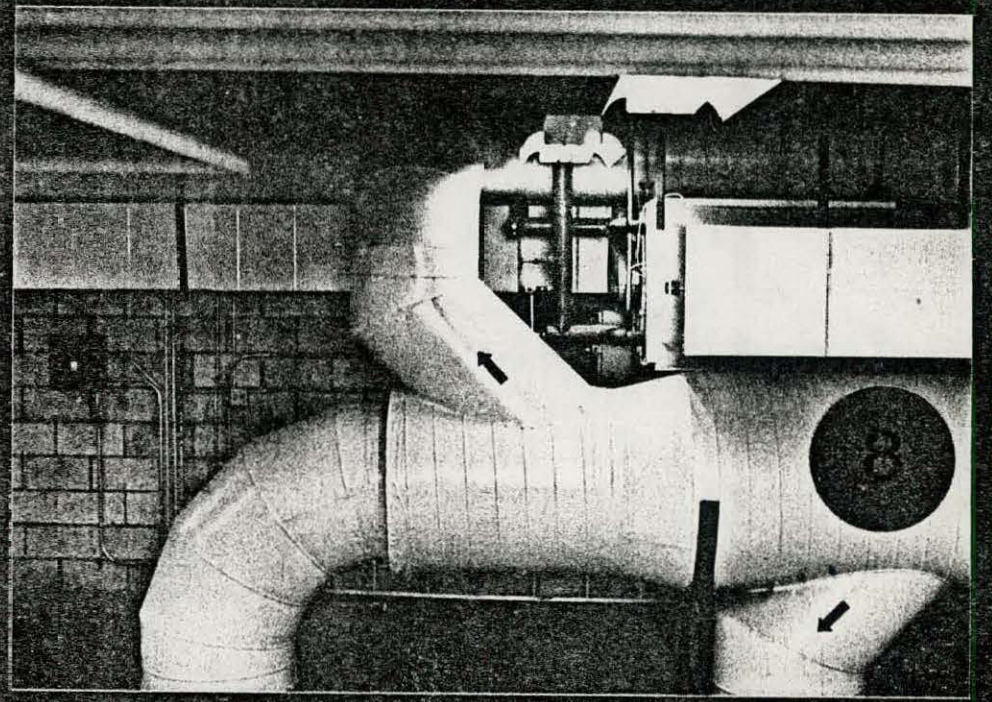
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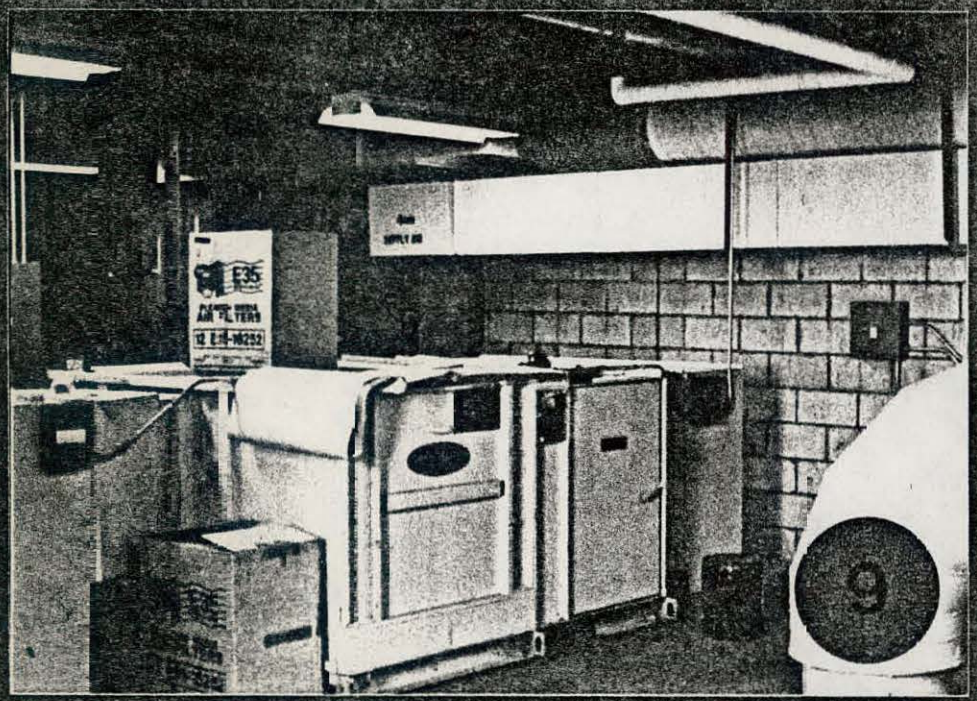
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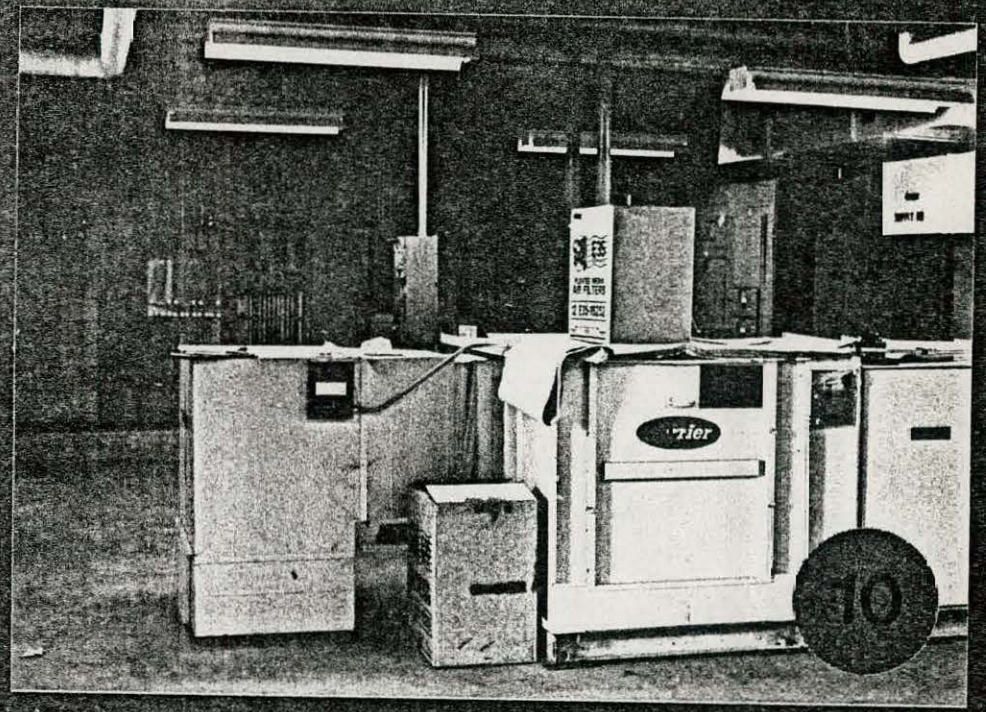
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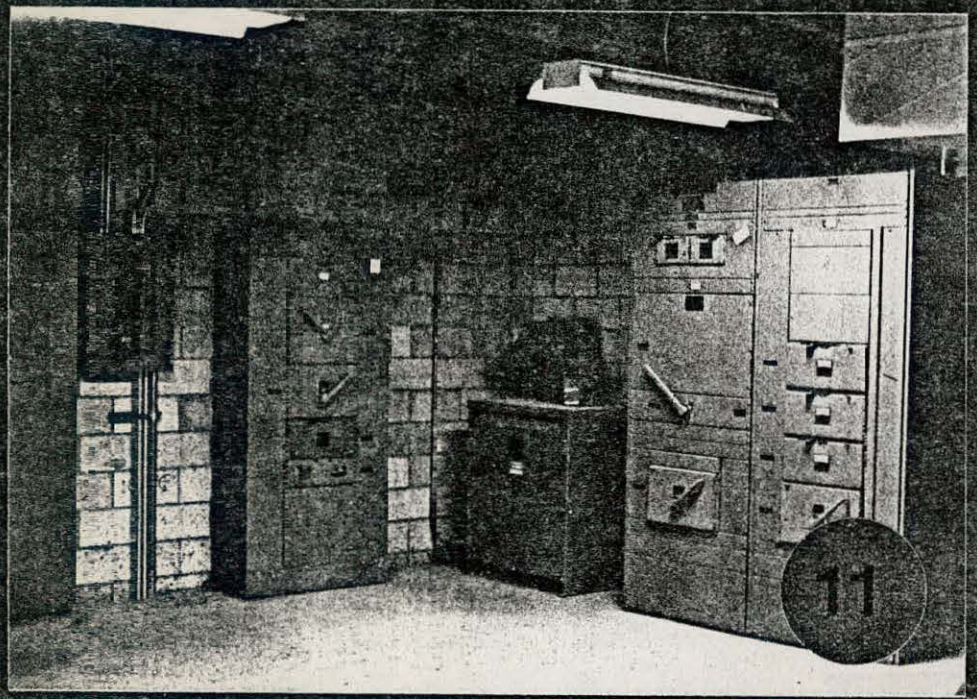
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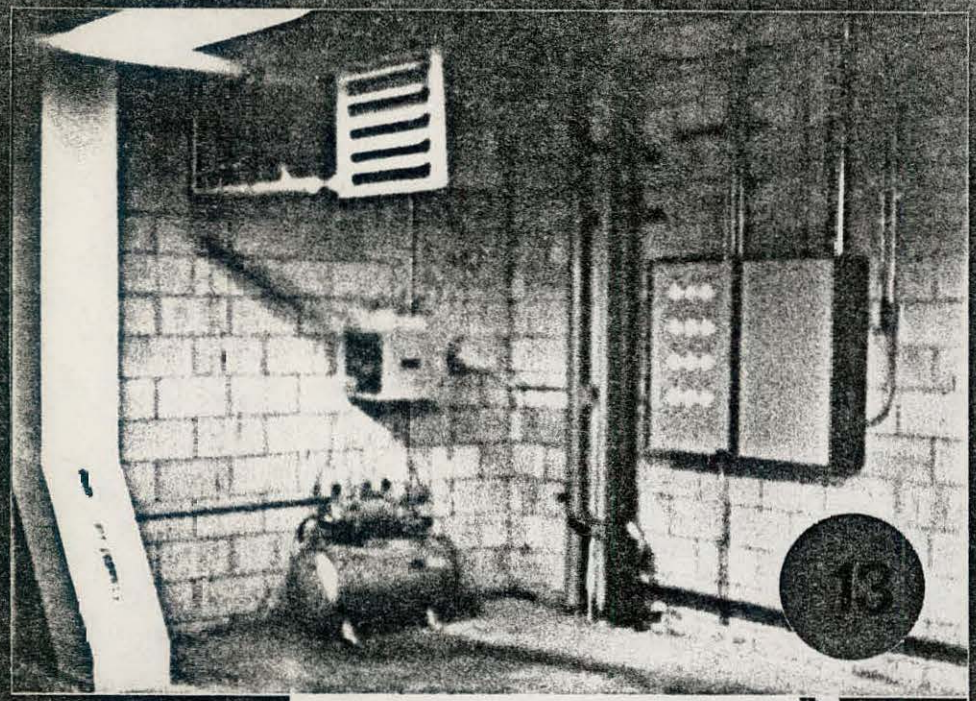
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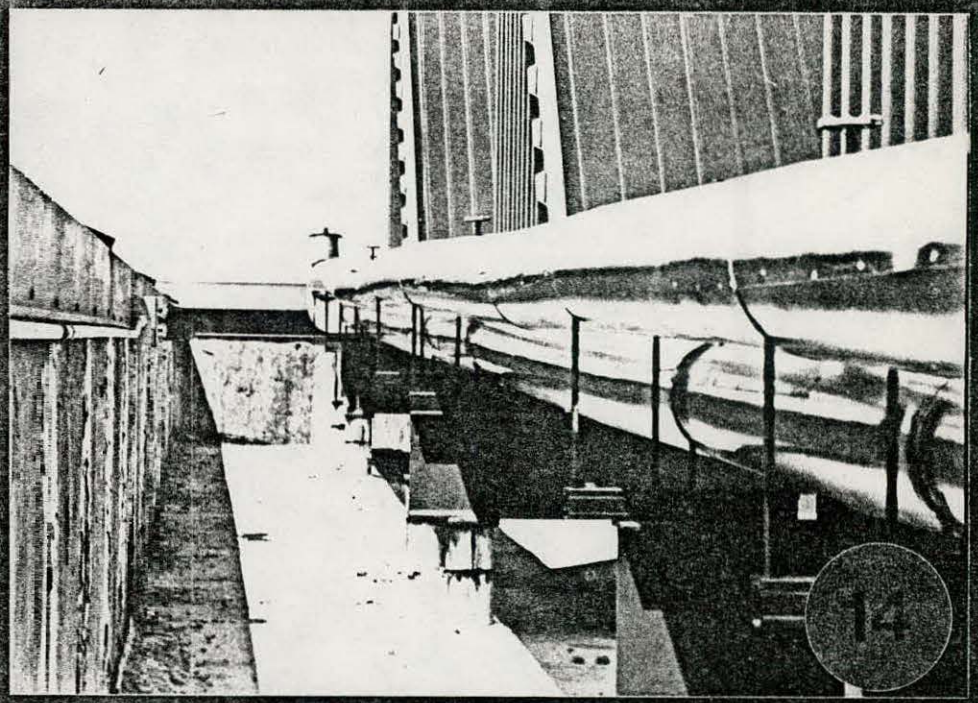
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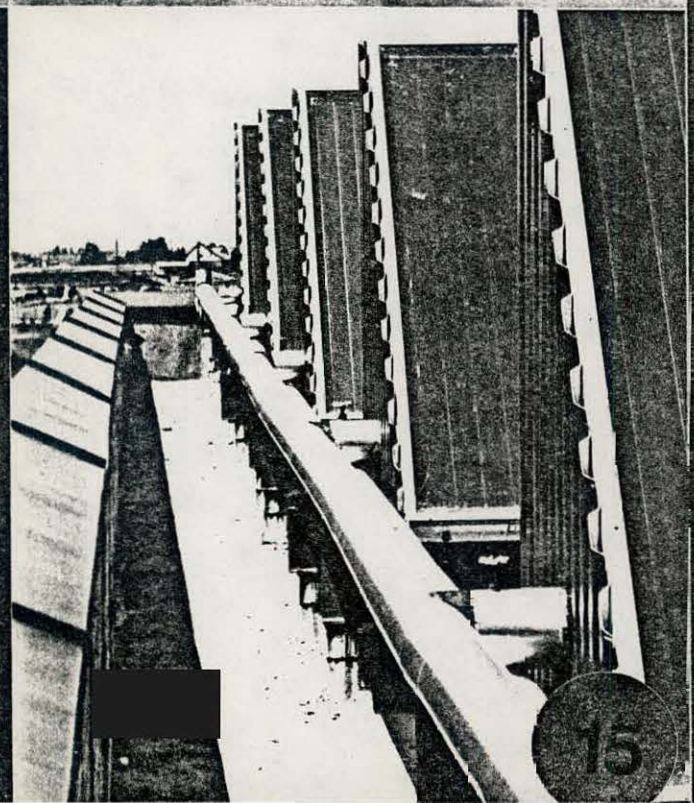
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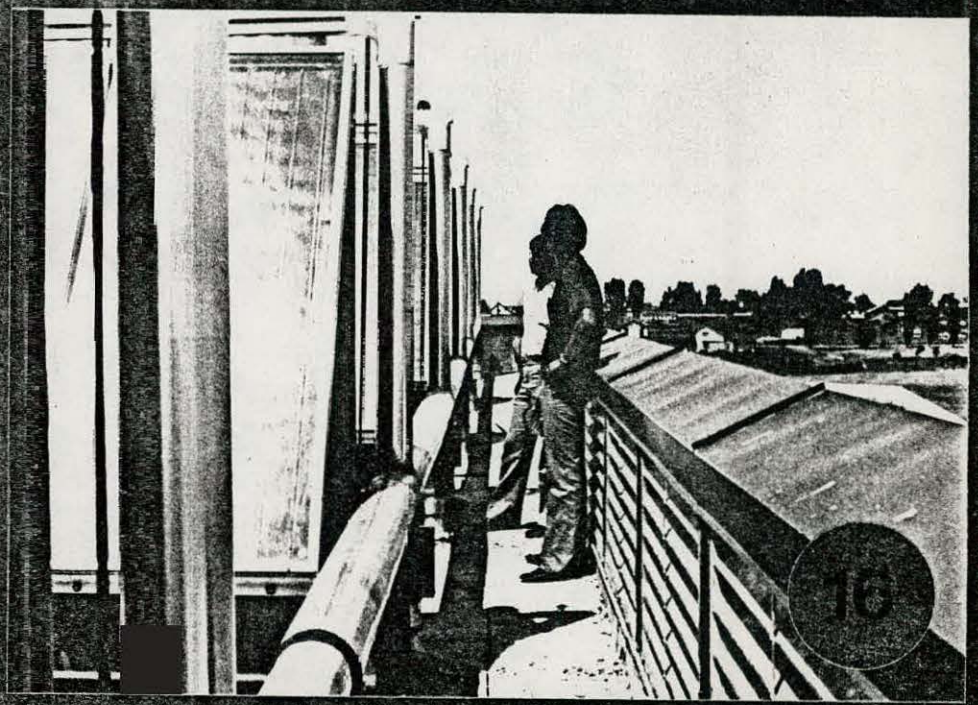
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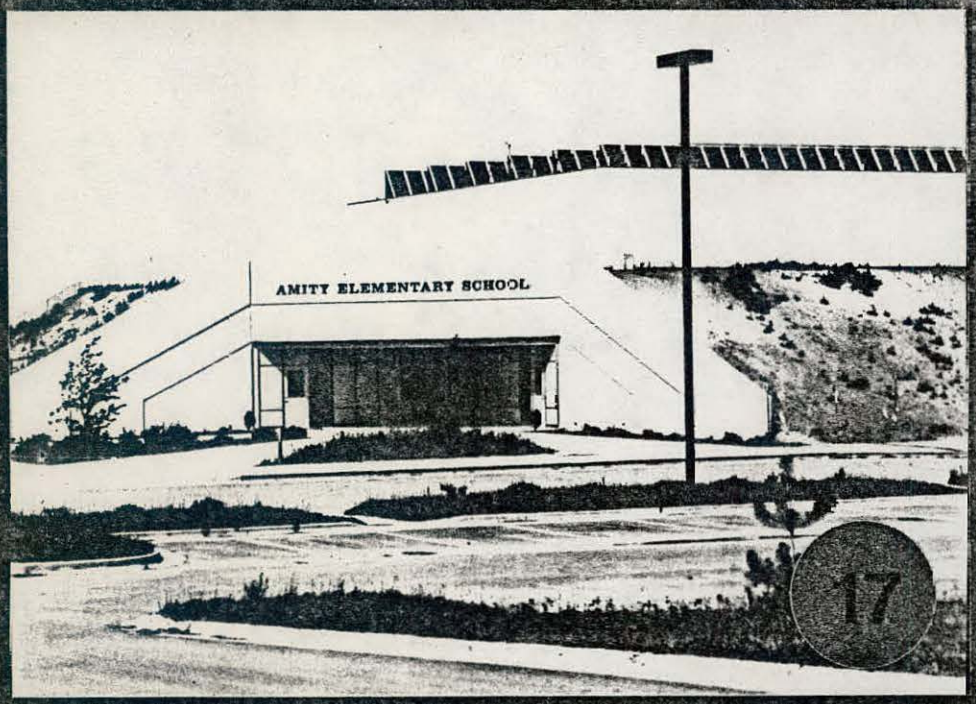
AMITY ELEMENTARY SCHOOL
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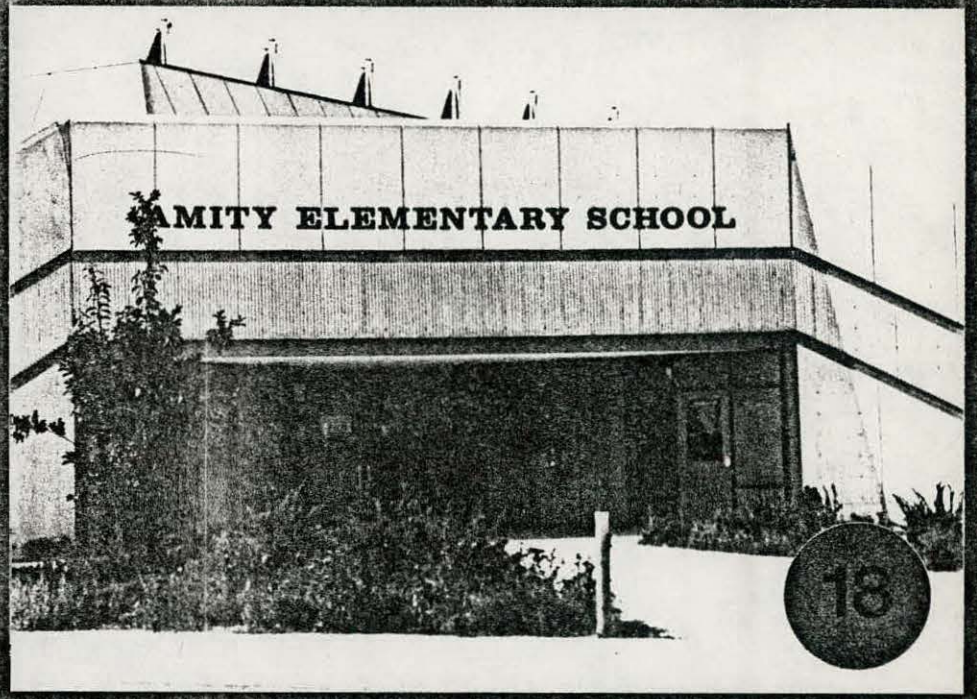
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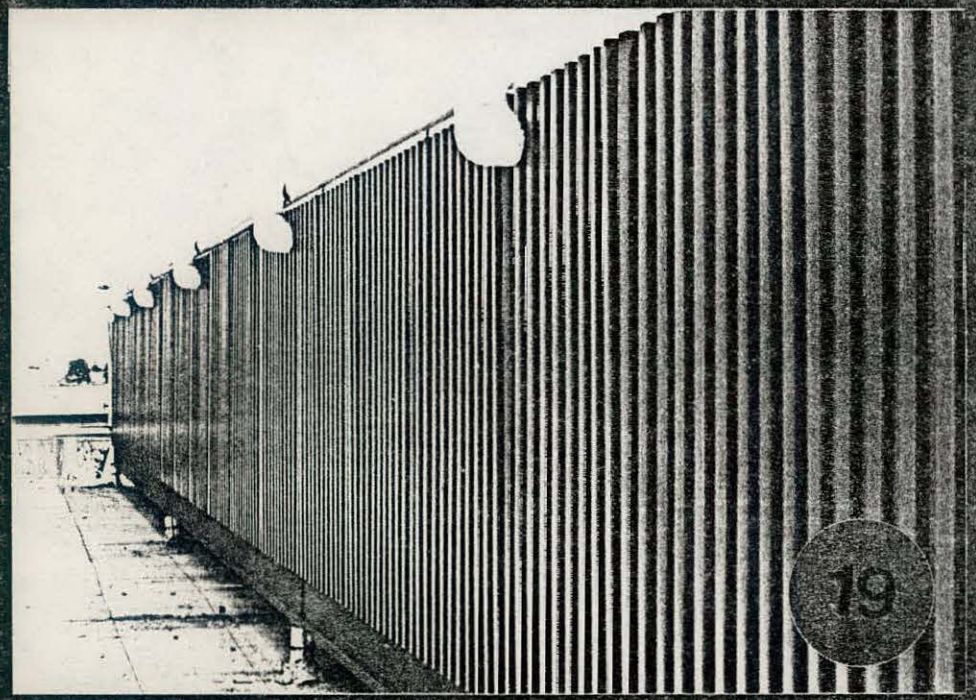
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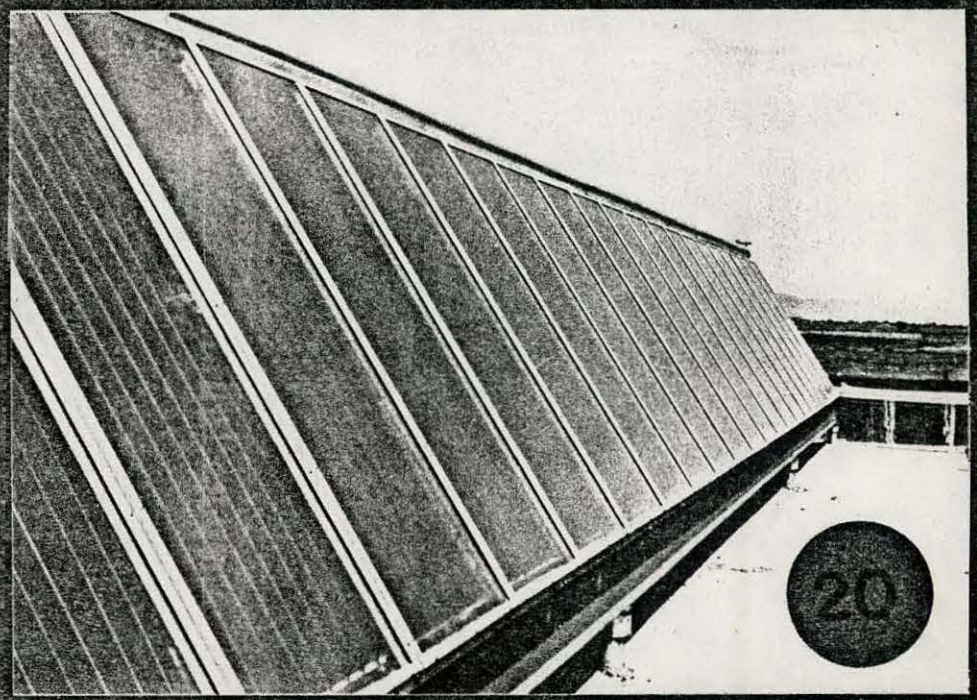
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Appendix B

Ope ation & Maintenance Manuals

Amity Elementary School
Solar Heating System

Maintenance Schedule

A. Heat Exchanger

1. Provide means for frequently cleaning heat exchangers as suggested below:

   (a) Some cleaning compounds on the market, such as "Oakite" may be used to advantage for removing sludge or coke, provided hot wash oil or water does not give satisfactory results.

   (b) If the above described method is ineffective for the removal of hard scale, a mechanical means may be used.

2. At intervals of six months observe interior and exterior condition of all tubes and keep them clean. Neglect in keeping all tubes clean may result in complete stoppage of flow through some tubes with consequent overheating of these tubes as compared to surrounding tubes, resulting in leaking tube joints.

3. Do not attempt to clean tubes by flowing steam through individual tubes.

4. Do not open heads until all pressure is off equipment and the unit drained.

5. Do not handle tube bundles with hooks or other tools which might damage tubes. Bundles should be moved about on cradles or skids.

6. Exchangers subject to fouling should be cleaned periodically. A marked increase in pressure drop and/or reduction in performance usually indicates cleaning is necessary. Since the difficulty of cleaning increases rapidly as the scale thickens or deposit increases, the intervals between cleanings should not exceed six months.

7. In shutting down, flow of hot medium should be shut off first. If it is necessary to stop circulation of cooling medium, the circulation of hot medium should also be stopped by by-passing or otherwise.

8. When removing tube bundles from exchangers for inspection or cleaning, care should be exercised that they are not damaged by improper handling. Tube bundles are often of great weight, yet the tubes are small and of relatively thin metal.

   In cleaning a tube bundle, tubes should not be hammered on with any metallic tool and in case it is necessary to use scrapers, care should be exercised that the scraper is not sharp enough to cut the metal of the tubes.

9. When placing a unit in operation, open the vent connections and start to circulate the cold medium only. Be sure that the passages in the exchanger are filled with the cold fluid before closing the vents. The hot medium should then be introduced gradually until all passages are filled with liquid.

10. Start operation gradually. Do not admit hot fluid to the unit suddenly when empty or cold. Do not shock unit with cold fluid when unit is hot.

11. Do not operate equipment under conditions in excess of those specified on name plate.

12. Drain all fluids when shutting down to eliminate possibility of freezing and corrosion. To guard against water hammer, condensate should be drained from steam heaters and similar apparatus both when starting up and when shutting down.

B. Pressure Relief Valves

Exercise relief valves on a mothly basis to avoid valve becoming frozen closed.

C. Expansion Tanks

1. Clean and inspect gauge glass every six months.

2. Exercise drain valve to insure that valve isn't frozen.

D. Solar Collectors

1. Wash collectors every three months with a solution designed to remove any mineral build up which may accumulate on transparent surface of collector.

2. Inspect piping every six months for signs of leaks.

3. Inspect collector frame assembly for signs of corrosion.

E. Shut-Off Valves

1. Exercise valves to insure against freezing.

(a) Exercise shut-off valves "ONLY". Balancing valves are set precisely and should not be tampered with.

F. Air Separators/Strainers

Blow down strainers on a six month basis.

G. Dumps

1. Keep motor and bearings lubricated.

(a) 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.

(b) 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.

(c) 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.

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

3. Pump shaft should always turn freely by hand.

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

5. 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.

6. DO NOT RUN PUMP DRY. Before starting, these pumps must 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.

H. Glycol/Water Solution

1. Check Ph level of ethelene glycol (sun-sol 60). Recommended Ph is between 7.0 and 7.4

2. On an annual basis send ½ pint (200 ml.) minimum to:

Sunworks
P.O. Box 3900
Summerville, NJ 08876

The Sunworks Company will analyze the solution "free of charge" and will give their recommendations.

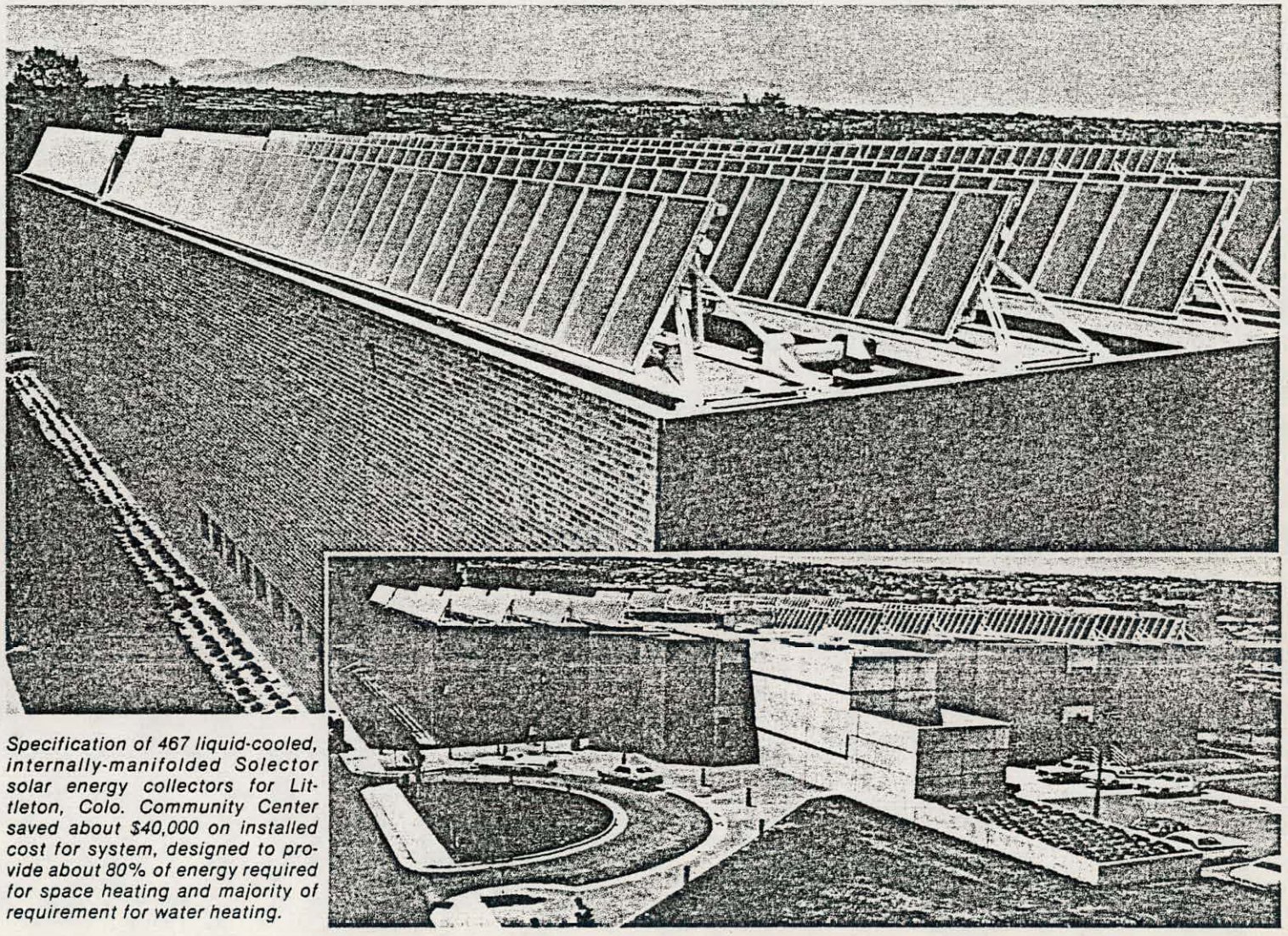
J. Controls

Call an authorized "Honeywell" serviceman to have system calibrated and inspected annually.

Solar Collectors

sunworks

- *SOLECTOR® SOLAR ENERGY COLLECTORS FOR SYSTEMS DESIGNED TO PROVIDE ENERGY FOR WATER HEATING, SPACE HEATING, AND PROCESS HEATING.*
- *SOLECTOR-PAK® DOMESTIC HOT WATER SYSTEMS.*



Specification of 467 liquid-cooled, internally-manifolded Solector solar energy collectors for Littleton, Colo. Community Center saved about $40,000 on installed cost for system, designed to provide about 80% of energy required for space heating and majority of requirement for water heating.

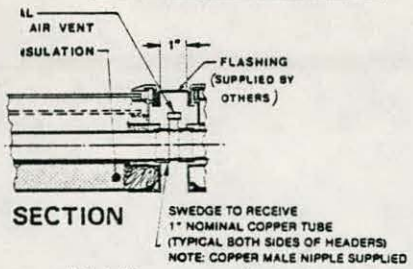
Sunworks is a division of Enthone, Inc., a leading supplier in the metal finishing industry. Enthone is a subsidiary of ASARCO Incorporated, one of the world's leading producers of nonferrous metals.

Our Solector solar energy collector is specially designed to maximize BTU's generated per dollar of installed cost, and our solar-experienced architectural engineering staff offers Solector specifiers valuable help with system design, including computer simulations of collector performance, systems sizing, and return-on-investment analysis.

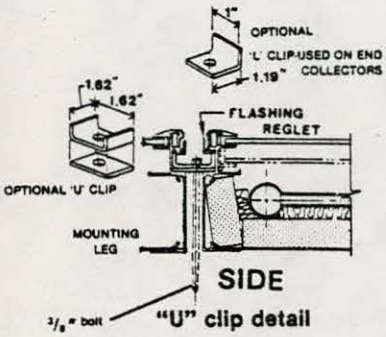
Our field representatives are experienced HVAC manufacturer's representatives trained by Sunworks in solar energy technology. To contact yours, call the Sweet's Buyline (800-255-6880).

SOLECTOR® INSTALLATION DETAILS AND PRODUCT DATA

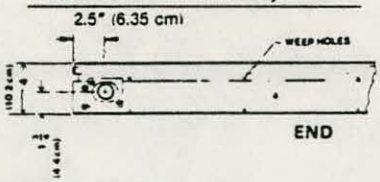
IM, LC
Internally manifolded, liquid cooled for closed loop systems

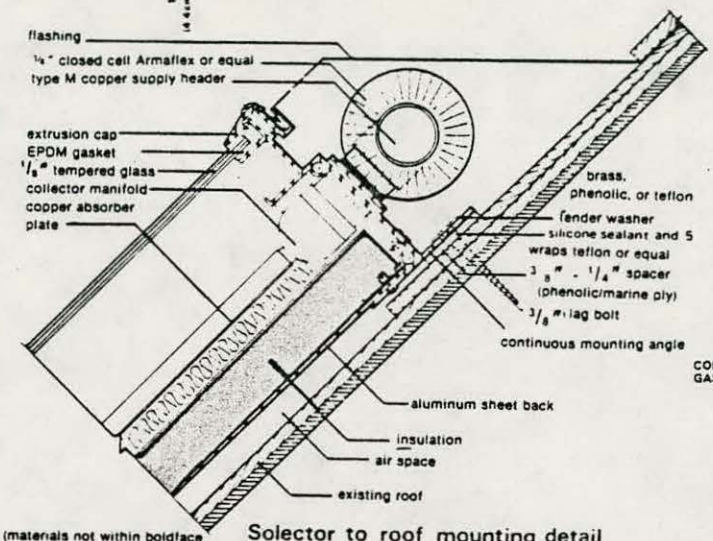


side/side connection

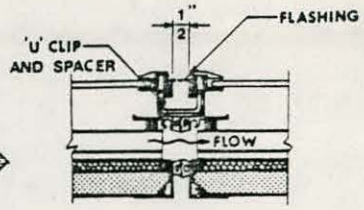


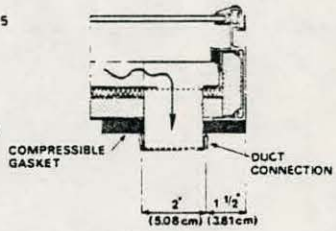
EM, LC
Externally manifolded, liquid cooled for drain-down or drain-back systems





ID, AC
Internally ducted, air cooled for warm air systems





DESIGN PARAMETER	IM, LC	EM, LC	ID, AC
DIMENSIONS (OUTSIDE; SURFACE MOUNTED)	35½" (90.2cm) wide x 84" (213.4cm) long x 4" (10.2cm) thick. Add 1¼" (3.2cm) each end for continuous mounting leg.		
MANIFOLDS AND RISERS (LIQUID COOLED SOLECTORS)	1" type M copper manifolds. Brazing alloy connections to riser tubes. Risers in parallel grid pattern, high temperature solder bond between tube and absorber sheet with 270° wrap.		not applicable
Riser spec.:	3/8" (0.95 cm) O.D., type L copper		not applicable
WEIGHT PER MODULE	107 lbs. (48.5 kg) filled; 104 lbs. (47.2 kg) empty for standard 3' x 7' unit.	98 lbs. (44.5 kg) filled; 95 lbs. (43.1 kg) empty for standard 3' x 7' unit	112 lbs. for standard 3'x7' unit
	Add 32 lbs. (14.5 kg) for double glazed unit. Liquid in Solector: 0.48 gal. (1.82 l)	0.36 gal. (1.4 l)	137 lbs. for double-glazed unit
RECOMMENDED FLOW RATE	13-26 lbs/ft²/hr (0.5-1.0gpm; 0.032-0.063 l sec)		6-10 cfm/ft² of collector
EXTERNAL CONNECTIONS	1" type M copper tube. Ends can be capped, or routed out back, top, or bottom as required.	1" type M copper tube, extending 1⅞" (4.76cm) beyond collector frame; supply, bottom left; return, top right (when viewed from glazing side)	side/side compression gasket and/or back inlet/outlet rigid duct connector.
COVER	Tempered glazing, edges swiped; glass area 18.88 ft² (1.76 m²); condensate removal via weep holes		
	Low-iron ⅛" (0.32cm); Solar transmissivity 89.8%, double glazing 80.6%. No-iron ⅛" (0.32cm), solar transmissivity 91.6% avail. as special order.		Low-iron, ⅛" (0.32cm); solar transmissivity 89.8%, double glazing 80.6%
ABSORBER CONTAINER	Sides, 6063-T6 aluminum extrusion, standard mill finish; baked black enamel as special order		
	Back, aluminum sheet 0.032" (0.081cm), pop rivet to extrusion. Air space between cover and absorber approx. ¾-1", depending on glazing type.		Back, aluminum sheet 0.32" (0.081cm) pop rivet to extrusion. Air chamber ⅞" (2.22cm) high, silicone bonded aluminum core to absorber.
ABSORBER	Copper sheet, 0.010" (0.25cm) thick (7 oz.). Black chrome coating, min. absorptivity .94/.96, max. emissivity .08/.12		Copper sheet, 0.016" (0.04cm) thick (12 oz.). Selective black coating, min. absorptivity 0.87/0.92, max. emissivity 0.07/0.35. Man. by Enthone, Inc., guar. durable to 400°F
EFFECTIVE ABSORBER AREA	18.50 ft² (1.72 m²)	18.68 ft² (1.74 m²)	
USABLE ABS. AREA + TOTAL INSTALLED SURFACE	0.89	0.90	

sunworks

We believe the Solector® solar energy collector offers the lowest *cost/Btu/ft² installed* in the industry.

Excellent thermal performance

- proven effective and efficient in over five years of field experience and numerous independent testing programs.
- black chrome coatings for copper absorber plate maximize absorptivity and minimize emissivity of solar radiation.
- absorber and external connections thermally isolated from remainder of collector.
- high transmissivity, tempered glass cover sheet.
- weathertight container.
- built for long term durability and reliability; backed by five-year materials and workmanship warranty.

Optimized solar system efficiency and total contribution

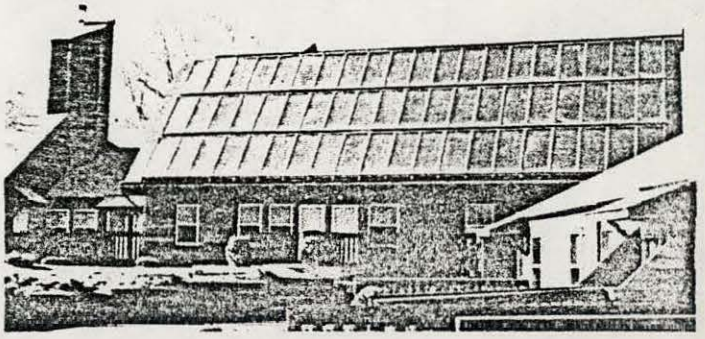
- high installed net-to-gross ratio; about 90% of total surface covered by collectors is usable absorber area.
- internal manifolding or ducting option significantly reduces costs for materials and labor during installation, while maximizing the number of collectors that can be placed in a given area.

Highly adaptable in application

- variety of liquid and air-type panel designs and connection arrangements allow for coupling in parallel or series, and to suit varying system designs.
- suitable for domestic/service water heating and space heating/cooling for commercial, industrial, institutional, and residential buildings, as well as for industrial process heating, low-temperature steam production, and special drying applications.

Easy and economical to install and maintain

- patented snap-in flashing reglet around entire frame permits easy flashing without removal of cover glass; cover may be removed later without disturbing collector unit installation or flashing. Entire collector modules may be removed without disturbing adjacent modules.
- continuous mounting flange, integral with frame across top and bottom, facilitates installation, especially on residential retrofit applications.
- extrusion that forms the frame allows for secure anchoring at both ends, minimizing need for further reinforcement to resist wind loads.
- manifolds pitched in liquid-type collectors for rapid draining, and elimination of air pockets during filling.
- cover glass is swiped to minimize breakage risk. Weep holes allow for draining of condensate.
- absorber floats free on insulation to allow for thermal expansion and contraction.



PRESCRIPTIVE SPECIFICATION (liquid-cooled internally manifolded Solector)

13.11a Solar Collectors

A. General

Provide (no.) solar collectors by Sunworks as shown on the drawings. Collector installation shall be as per the collector manufacturer's recommendations. Collector shall be designed to withstand 100 mph winds.

B. Collectors

1. **Size:** Each collector shall be 3'x7' overall with a net effective area of 18.50 square feet minimum.
2. **Waterways:** All piping shall be of the parallel grid design consisting of ⅜" O.D. type L copper tubing, with 1⅛" O.D. Type M copper headers. Tubing and headers shall be connected by means of brazing alloy. Manifold and tubes shall be capable of withstanding 250 psig factory test and 125 psig working pressure.
3. **Absorber Surface:** The absorber surface shall be copper sheet 0.010 inches thick, black chrome with a 270° wrap around each tube bonded between tubes and sheet with high temperature solder. Minimum absorptivity shall be .94/.96; maximum emissivity .08/.12. Entire absorber surface shall be guaranteed durable to 400°F.
4. **Absorber Frame:** Frame sides shall be extruded aluminum with a rear aluminum sheet of 0.032 inches minimum and pop riveted in place.
5. **Insulation:** Insulation shall be capable of withstanding stagnation temperatures without outgassing; shall conform to UL fire ratings; and shall have a minimum "R" value of 10.
6. **Glazing:** The glazing shall be single low-iron ⅛" tempered, edges swiped.
7. **Sealing:** Gasketing material shall be "U" shaped EPDM.
8. **Joining:** Collector-to-collector and collector-to-supply and return mains shall be joined with 95-5 tin/antimony solder.
9. **Condensation Removal:** Removal of condensate from the collector shall be via mechanical weeping through frame weep holes.
10. **Serviceability:** Easy removal of each collector is required. Glazing shall be replaceable without removal of collector.
11. **Warranty:** Except for cover glazing, collectors shall carry a five year limited materials and workmanship warranty from date of installation.
12. **Manufacturer:** Sunworks Division of Enthone, Inc.

C. Mounting

Collectors shall be mounted in accordance with drawings. Use of integral mounting legs and/or adjustable U-clip and spacer as required. See manufacturer's recommendations.

D. Flashing

Flashing shall be minimum 0.032" thick aluminum stock finished to match collector frame, V-groove for snap-in flashing reglet integral to collector frame. See drawings.

SUNWORKS SOLECTOR® PERFORMANCE SPECIFICATION

Thermal Performance

The collector shall be tested in accordance with ASHRAE STD. 93-77 by an independent testing laboratory. The following test results shall be submitted:

a) Raw test data (solar and weather)
b) Instantaneous efficiency equation, employing a second order least squares polynomial fit, and plotted on a graph showing instantaneous efficiency on the ordinate versus (T inlet – T ambient) ÷ Insolation on the abscissa.
c) Time constant
d) Incident angle modifier

The instantaneous efficiency, determined by the above test, shall be equal to or greater than that defined by the following six points on the performance curve:

$\frac{T_i - T_a}{Q_i}$	Efficiency (η) (single glazed, %)	Efficiency (η) (double glazed, %)
0.00	73	67
0.10	65	61
0.20	56	53
0.30	46	45
0.40	36	37
0.50	24	27

The incident angle modifier shall be equal to or greater than that defined by the following four points:

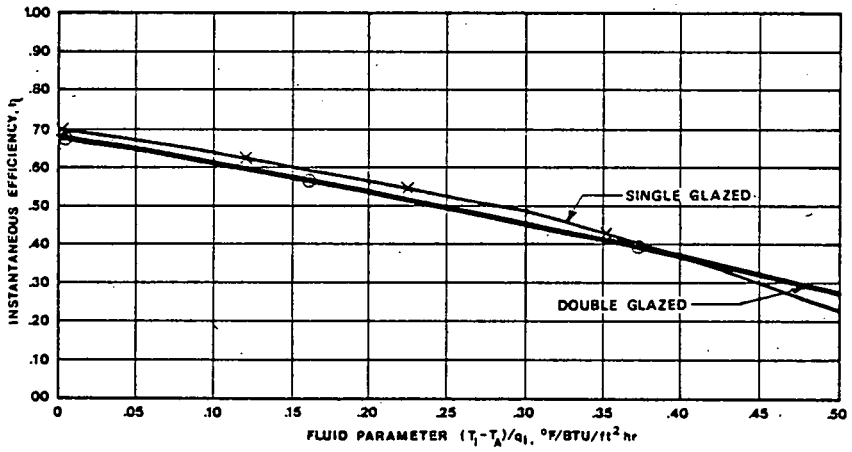
$\frac{1}{\cos\phi} - 1$ (ϕ = incident angle)	Incident Angle Modifier single glazed	Incident Angle Modifier double glazed
0	1.00	1.01
0.2	.97	.97
0.4	.94	.93
1.0	.86	.81

Mechanical Performance

The collector, including all materials and components, shall be able to withstand conditions of extended periods of solar flux under stagnant condition. All materials utilized shall be able to withstand temperatures up to 400°F without outgassing or structural deformation. The entire collector shall allow for expected expansion and contraction of various components over a temperature range of – 25°F to 400°F.

The collector shall be able to withstand wind loads up to 100 mph. Piping penetration through the extrusion shall be sealed with a flexible gasket, permitting expansion and contraction while preventing moisture infiltration. The collector shall be hydrostatically tested in the factory to a pressure equal to at least 1.5 times the working pressure of the solar system.

Liquid-Cooled Solector®, Black Chrome Coating

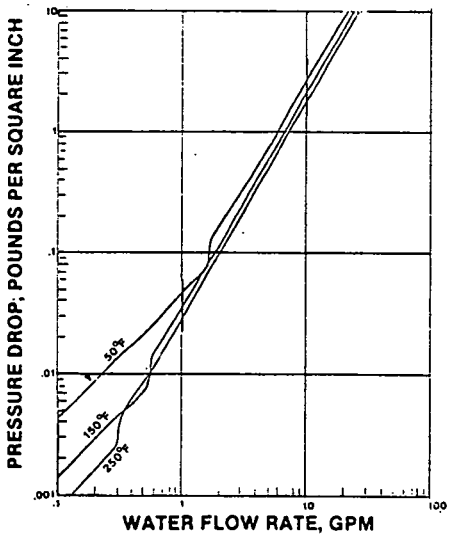


Single glazed, low-iron:
Av. flow rate, 278.2 lbs/hr.; 0.56 gpm
av. amb. temp. 73-60°F.
(x) Field data

Double glazed, low-iron:
Av. mass flow 278.85 lbs/hr.; 0.56 gpm
av. amb. temp. 100.56°F.
(o) Field Data

Tests conducted by Solar Energy Analysis Laboratory; Desert Sunshine Exposure Test, Inc.

Calculated Pressure Drop vs. Flow Rate Standard 3'0 x 7'0 Liquid Cooled Solector®



The instantaneous (slope - intercept method) thermal efficiency test is conducted by maintaining constant mass flow and varying the inlet temperature. The fluid parameter is based on the *inlet* temperature minus the ambient temperature divided by the insolation incident in the plane of the collector. The thermal efficiency calculation is based on the *gross* collector area (outermost dimensions). Items above are requirements of ASHRAE Standard 93-77 and have a significant effect on the profile efficiency curve. The curve representing most collectors is not linear as suggested by the basic slope intercept method. Because the heat loss coefficient is temperature dependent, increasing with plate temperature in a non-linear fashion, a higher or second order polynomial is needed to fit the curve to the data. This plotting method has been employed in the above curves. This method incorporates all of the provisions of the ASHRAE 93-77 Method.

sunworks
DIVISION OF
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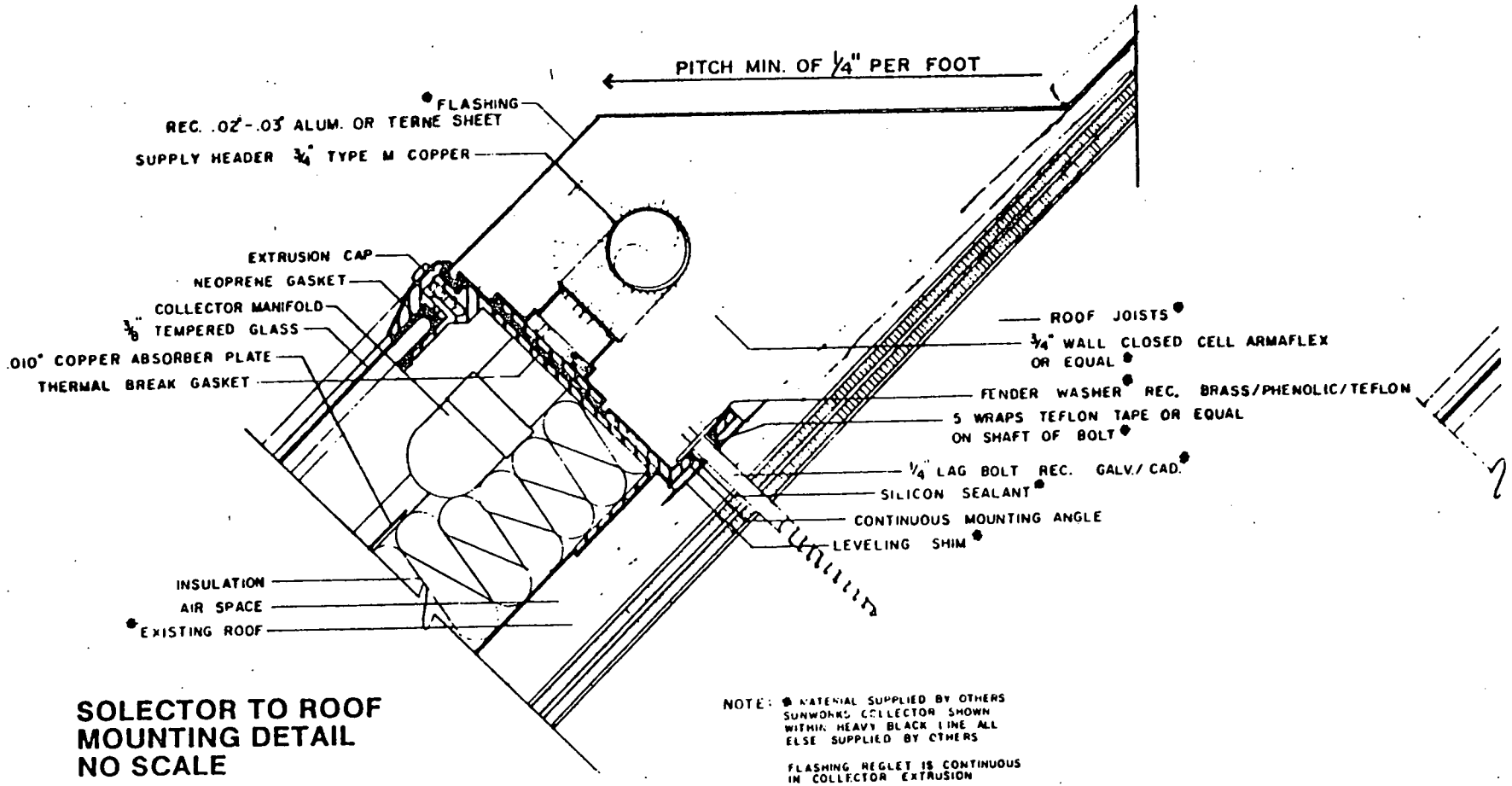
P.O. Box 1004
New Haven, Ct. 06508
Tel: (203) 934-6301

A subsidiary of
ASARCO

Fig. 7



SOLECTOR TO ROOF MOUNTING DETAIL NO SCALE

NOTE: ● MATERIAL SUPPLIED BY OTHERS
SUNWORKS COLLECTOR SHOWN WITHIN HEAVY BLACK LINE ALL ELSE SUPPLIED BY OTHERS

FLASHING REGLET IS CONTINUOUS IN COLLECTOR EXTRUSION

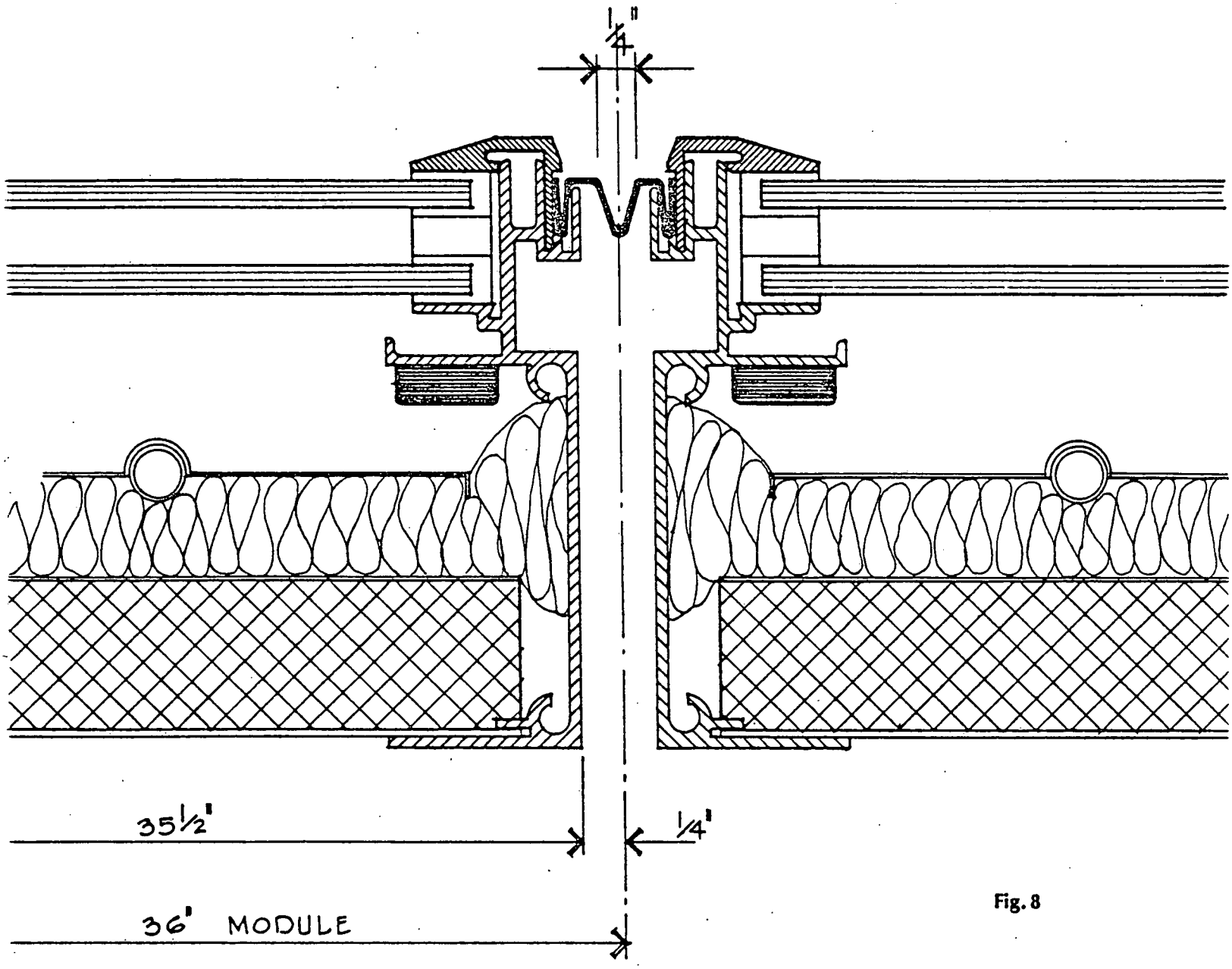


Fig. 8

Typical cross section showing Sunworks Solector with flashing. Full size.

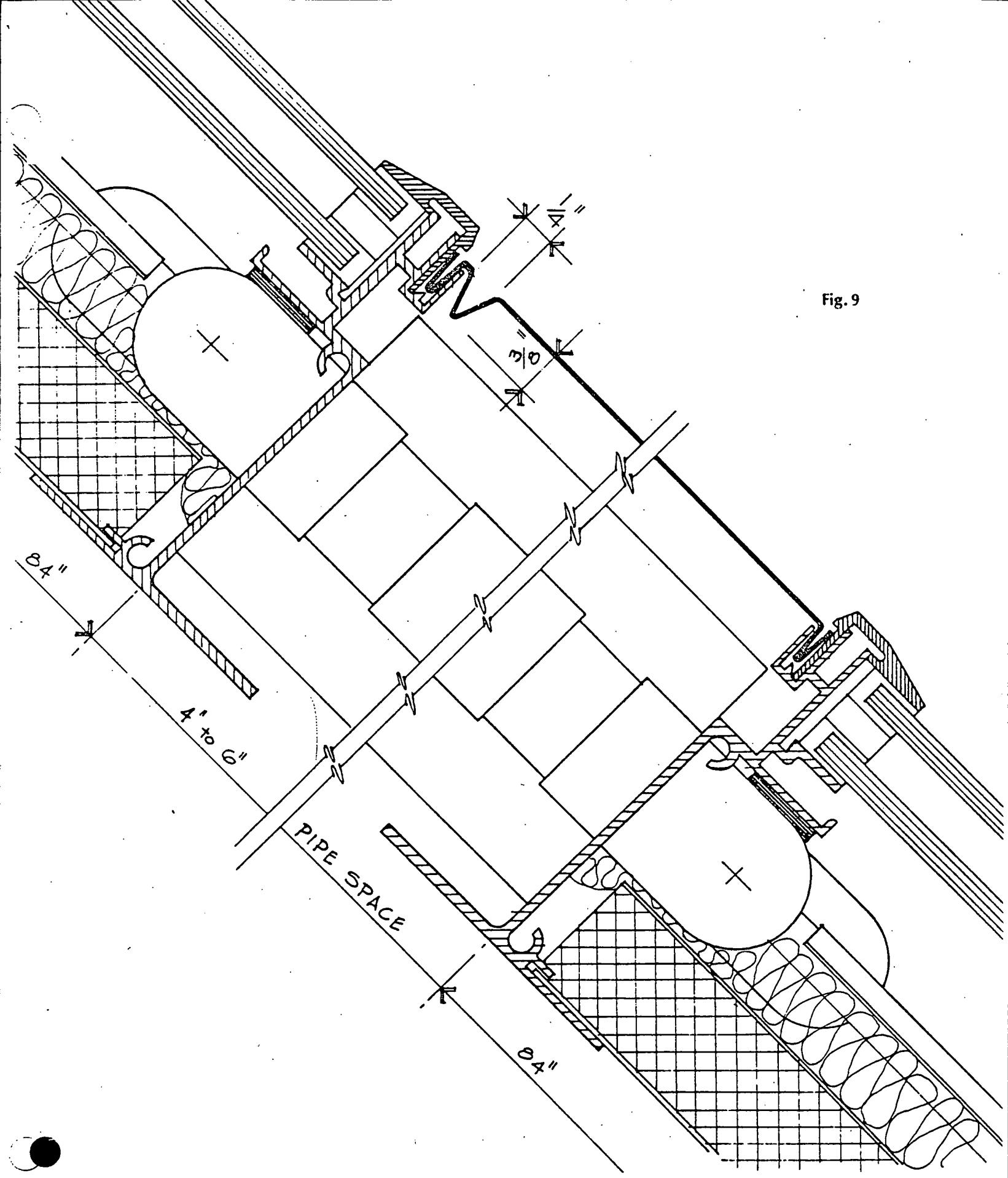


Fig. 9

Typical longitudinal section for Sunworks Solector with 4" to 6" pipe space and flashing. Full size.

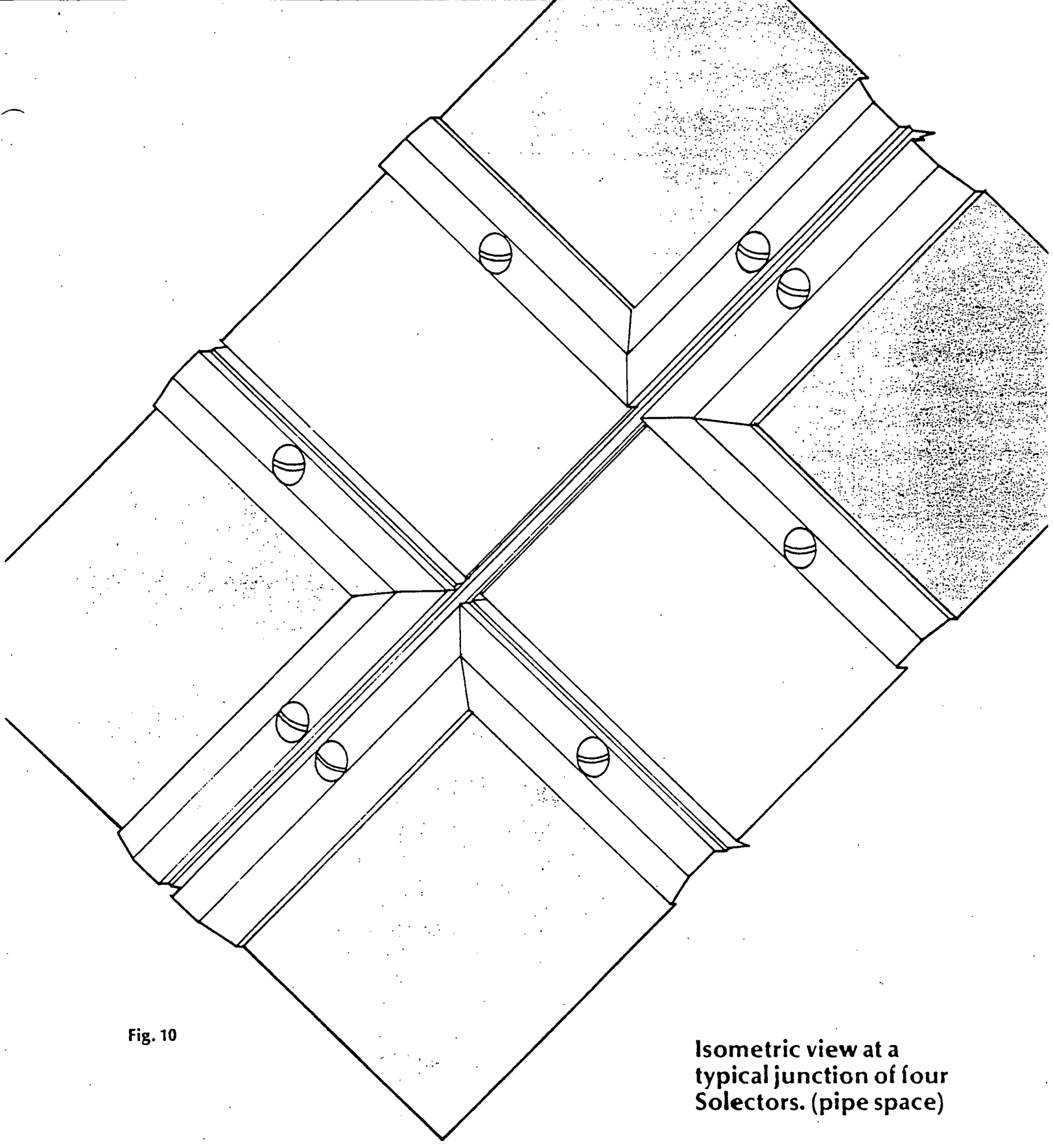


Fig. 10

Isometric view at a typical junction of four Solectors. (pipe space)

Trouble-shooting guide for the installer

I. Introduction

Over the past few years Sunworks' personnel have had a fair amount of experience in trouble shooting solar equipment installations. The problems encountered have been discovered most often by Sunworks staff making field inspections to check system performance. It is less often that the system owner has called a problem to our attention, unless the solar portion of the system has become totally inoperative. If the system is performing at something less than optimum, say 50% of its designed capability, then the owner usually does not notice the loss of performance, because the auxiliary heater will provide whatever the solar heating system cannot.

Thus we recommend that installers make programmed visits to their installations to be certain that the systems are performing as designed, very much like the situation when air conditioners were first marketed. After the owner has developed a year of operating information (fuel or electric bills) then he can be relied upon to contact the installer if system performance drops off.

One simple, though fairly rough test that can be suggested to the owner is to draw a lot of hot water from the tap (thus draw a lot of cold water into the bottom of the storage tank). This should be done at near noon on a sunny day if the collectors face due south, or at a time when the sun's rays are nearly perpendicular to the collector cover if the collector faces away from due south.

The temperature difference between the inlet and outlet to the heat exchange coil should be recorded when the system is known to be operating properly, such as shortly after installation. This should be done on a clear day. At some future date the owner should repeat the process and if the temperature differences are significantly different from the earlier values, the installer should be called to find what may be the cause of the change in condition.

II. Collectors

We have rarely encountered problems with the collectors themselves. The few problems we have encountered are as follows:

Symptoms:

a. The cover glass on the collector is hot, or warm to the touch.
b. The collector array does not seem to be delivering the amount of heat that it should.

Solutions:

In this case the collector has probably been mounted incorrectly. The headers inside the collector are pitched so they can vent and drain easily. If the collector has been mounted at an incorrect tilt then it will not vent properly. The collector should be re-mounted so that it can vent and drain properly. Trapped air blocks the solution flow, thus reducing the amount of heat removed resulting in a hot air space and hot glass cover. Bleed the system of entraped air. (see procedure for filling the closed loop)

Symptons:

a. The piping circuit will not retain test pressure (125 psig).
b. There is a slow leakage of liquid from the weep holes at the bottom of the collector (the weep holes closest to the roof).

Solution:

The collectors are guaranteed against leaks for five years. The collector can be removed from its mounting and sent back to Sunworks for replacement.

Symptom:

On a clear day the temperature difference between the Sunsol 60 solution entering and leaving the storage tank is not as great as it has been on other clear days immediately after drawing a large amount (20 gals.) of hot water from the tank.

Solution

There are a number of possible causes of the above problem. But one possible cause of a loss in performance of the system is that the collector cover glass is dirty. Wash the cover glass if it is dirty. Washing may be necessary every three or four months in areas where there is considerable atmospheric pollution or little precipitation.

Another possible cause of the loss of performance is fouling of the heat exchange coil inside the Sunworks tank. There is very little that can be done to remedy this problem short of buying a new tank. In areas where there may be a large amount of fouling caused by city or well water then the system should be somewhat (10%) oversized to compensate for the fouling. The Sunworks tank should be drained every six months until the water runs clear to remove sediment from the bottom of the tank. The sediment can seriously impair the efficiency of heat transfer between the Sunsol 60 solution and the potable water in the tank if a sufficient amount accumulates to engulf the heat exchange coil. If the loss of performance occurs during the winter time after a heavy snowfall the collectors may be covered with snow. If the snow is a few inches deep it should melt off in a few hours, but if it is more than a foot deep it should be brushed off the collectors. Another way to rid the collectors of snow is to circulate the Sunsol 60 solution through the collectors. This will help melt away the snow, but it will also cool the water in the tank.

In several cases we have found the collectors mounted in pockets in the roof, where the owner or architect wanted them placed so they would be out of sight. These pockets have been found filled full of blown leaves in the fall and drifted snow in the winter. The collectors should be moved to a more windswept location if this condition is found.

III. Storage Tank

Problems with the storage tank have, so far, been limited to placement of sensors for the electric heating elements. This problem was mainly confined to the early model tanks we were using.

Symptom:
The pressure and temperature relief valve is frequently releasing hot water.

Solution:
Move the thermostat for the electric element from its location in the lower part of the tank to the upper part of the tank. Place it several inches above the upper electric heating element. A high temperature cut-out control should also be installed with the thermostat.

Symptom:
The owner claims there is not enough hot water.

Solution:
This is a frequently encountered complaint, particularly from those owners who have switched from some other type of system with a larger recovery capacity, or a larger storage capacity. While there are a number of possible causes of this problem, from a burned out electric heating element, or a faulty control for the electric element, it is most likely on new equipment that is performing correctly that the owner is using a lot of hot water, particularly in the evening hours.

One solution to the problem is to set the temperature of the thermostat for the electric immersion heater to as high as it will go. This will increase the amount of hot water on reserve. A mixing valve should be provided if this is done so that persons at the hot water outlet will not be burned.

If the above measure does not satisfy the homeowner's demand for hot water the following may be done:

a. The owner should consider reducing the amount of hot water used.
b. A larger storage tank with electric element and internal coil should be used.
c. A second storage tank, identical to the first, should be installed in parallel with the first (with solar heated water going into the bottom of it.)
d. A second, smaller electric water heater storage tank should be installed in series with the first. This tank would receive the warmed water from the solar storage tank. It would provide the remaining auxiliary heating that the solar storage tank could not provide and would increase the volume of hot water available to the owner.
e. Add another Solector.

IV. Controls

The problems with controls have centered around the best location for the sensors, rather than around malfunctions of the controls.

Symptom:
The circulator runs until late into the night.

Solution:
There can be a number of causes for this condition.

a. If the outside air temperature is high and the water in the bottom of the storage tank is quite low (45°-50°) the collectors may actually be picking up heat from the warm outside air, and not from solar radiation. If this is the case the system should be allowed to operate.
b. There is an open electrical circuit between one of the sensors and the differential controller. Find the break in the line and repair it.
c. One of the sensors has fallen away from the storage tank or from the collectors and is sensing some very different temperature than intended.
d. The sensor on the Solector is sensing the temperature of the liquid coming directly from storage, prior to its passing through the Solector. On controllers with a small temperature differential needed for cut-off of the circulator, this may particularly be a problem. Change the location of the sensor so that the liquid passes through the Solector before it reaches the sensor.

Symptom:
The circulator does not operate or operates erratically.

Solution:
If the circulator operates erratically then there is probably a poor electrical contact somewhere in the circuitry. Breaks in the electrical circuit can be found fairly easily with an ohm meter. The problem may also be caused by a poor thermal contact between the sensors and the surface they are to be in contact with. If a mechanical connection cannot be made tight then a thermally conductive epoxy should be used to insure good thermal contact.

The controller itself may be defective. This can be determined by connecting the sensor leads to a new controller to see if that will actuate the circulating pump. If the pump operates as it should then replace the existing controller.

The sensors may be faulty, or have been damaged during installation. This can best be determined by disconnecting the existing sensor leads and connecting a new pair of sensors to the sensor terminals on the existing controller. These sensors should be put in water containers at different temperatures. The collector sensor should go in the warmer water. If the circulator starts, then one of the sensors is faulty, and the controller is in good condition. Replace the faulty sensor.

The circulator may operate intermittently on partially cloudy or cloudy days. When the heat collected can be removed faster than it arrives from the sun then the sensor at the Solector may sense near storage tank temperatures and therefore cause the circulator to shut off. After the Solector has warmed up a bit the circulator will come on for a few minutes, then turn off again. This operation is quite normal. Such a condition of cycling on and off may also occur on a summer night when the storage tank temperature is low and the outside air temperature is high. Setting the temperature differential between the collectors and storage tank to a higher level (say 20°) will minimize this short cycling, but it will also reduce the amount of heat collected.

V. Piping

In general, the largest number of problems that we have encountered with solar heating systems have arisen from air trapped in the piping somewhere between the collector and storage tank.

Symptoms:

a. The circulating pump is on between the Solector and Sunworks tank but the temperature of the liquid entering and leaving the heat exchanger at the Sunworks storage tank are the same. Normally a differential of 3° to 20° should occur between inlet and outlet to the heat exchanger.

b. The collector glass covers feel hot, or at least warm, to the touch. When operating properly, with liquid flowing through the absorber, the Solector covers should be cool to the touch.

c. The header at the end of the Solectors where the liquid exits the Solector varies considerably in temperature from one end of the Solector row to the other. When operating properly the header should be of uniform temperature across the Solector array.

d. The pressure gauge on the closed loop between the Solectors and storage tank indicates a low, or 0 gauge pressure. The system pressure should be sufficient to maintain about 5 psig at the Solectors.

Solution:

The automatic air vents at the top and bottom of the Solector piping circuit should be checked to be certain they are functioning correctly. If they are tilted at an angle too much toward the horizontal they will not work well.

Connect the fill line on the Solector circuit to the domestic water line, using a hose with a female connection on each end (such as a washing machine hose). Fill the closed system to between 40 and 60 psig. The circulator should then be cycled on and off (by switch) and the automatic vents operated manually to purge the air from the system. This process may take an hour or more, and require 10 or more on-off cycles of the pump.

Note that filling the system in this manner will tend to dilute the percentage of Sunsol 60 solution in the circuit, and thus lower its freeze point. Once air has been purged from the system the Sunsol 60 solution should be drawn off until the pressure at the Solectors is about 5 psig. If the fill-drain process has been repeated more than once then some additional Sunsol 60 solution should be forced into the system after the excess (diluted) solution has been removed.

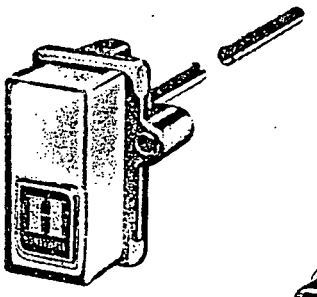
On some occasions, even on our own installations, we have found high points in the piping circuit that were not vented. These of course are ideal places for air pockets to develop and, eventually if they are large enough, to entirely block the flow of liquid through the pipe at that point. Automatic air vents should be installed at these points.

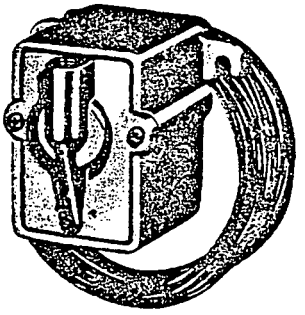
MAINTENANCE AND REPAIR

LP914A & LP915A PNEUMATIC TEMPERATURE SENSOR

INTRODUCTION

These instructions cover general maintenance, repair and parts replacement for the LP914A and LP915A Pneumatic Temperature Sensor. Exploded view drawings and parts lists are included to facilitate repair. The parts are listed by part number and description. Standard tools may be used to maintain this device. For ordering information, see the note following the drawings.





MAINTENANCE

INSPECTION AND CLEANING

Visually inspect the LP914 and LP915 sensor for any physical damage. Remove accumulated dust, dirt or grease with a soft brush using inhibited 1, 1, 1-trichloroethane available locally as Chlorothene or Vythene.

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

Change filters and screens if necessary.

Because of the need for highly specialized precision calibration equipment, further periodic maintenance, repair, or adjustment in the field, is not recommended.

The LP914 and LP915 sensors are sealed after factory calibration. If the sensor should fail to perform as expected, the entire device should be returned to Honeywell for repair or replacement.

OPERATIONAL CHECK

A quick operational check may be performed by raising the temperature at the sensing element. The output pressure should increase. Lower the temperature and the output pressure should decrease.

PARTS LIST

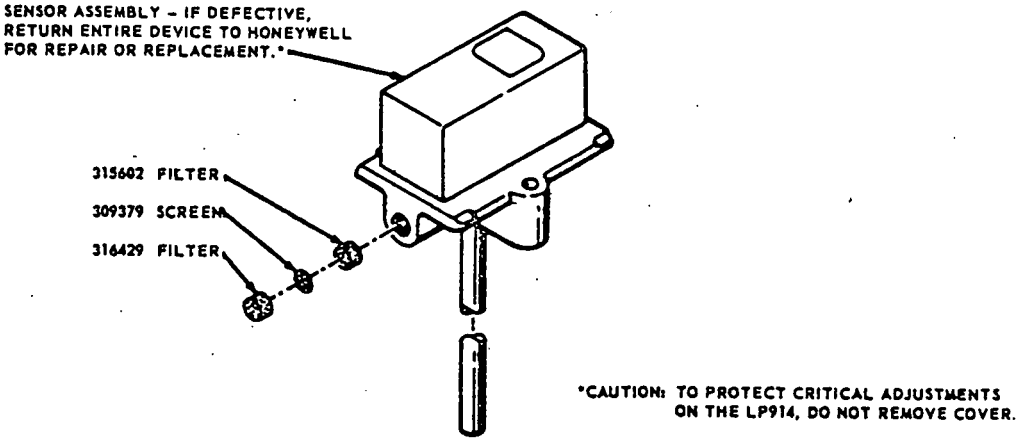
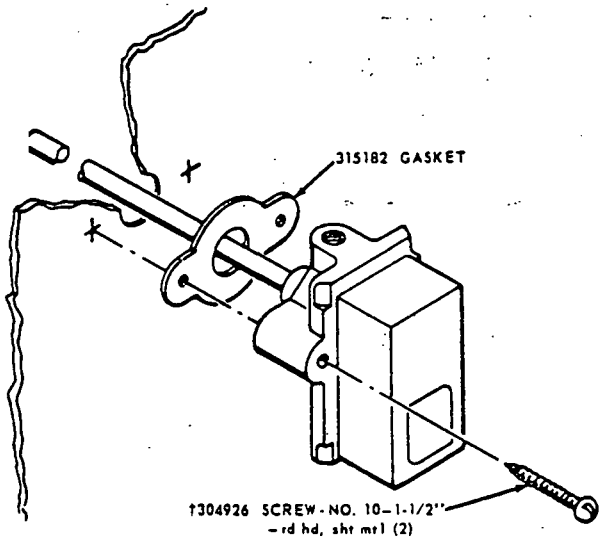


Fig. 1—LP914A Pneumatic Temperature Sensor.

Rev. 3-67
N.H./D.E.L.

Form Number 75-5527
Commercial Div.



†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.

Fig. 2—LP914A (Duct-mounted).

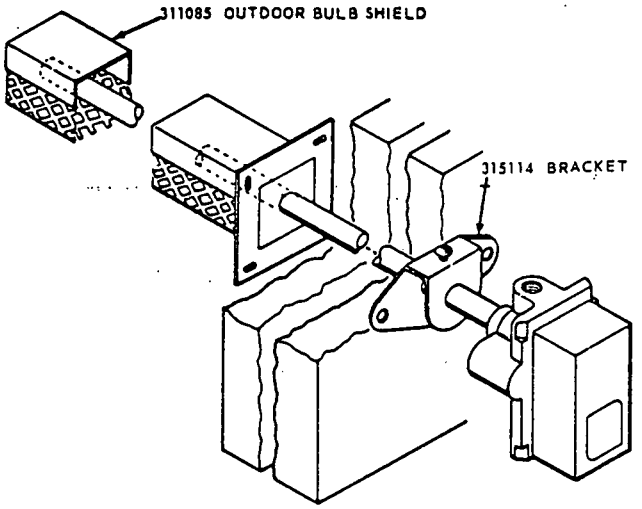
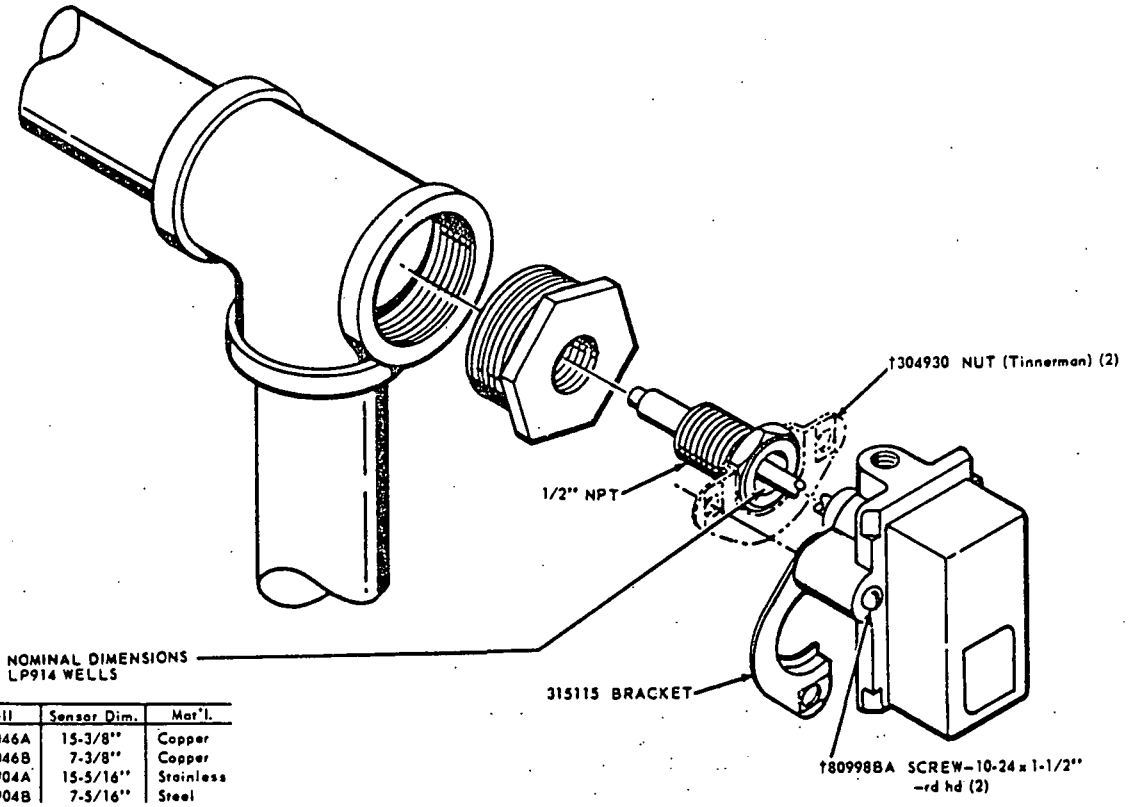


Fig. 4—LP914A (Wall-mounted with inert section).



Well	Sensor Dim.	Mat'l.
315046A	15-3/8"	Copper
315046B	7-3/8"	Copper
315904A	15-5/16"	Stainless
315904B	7-5/16"	Steel

†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.

Fig. 3—LP914A (Well-mounted).

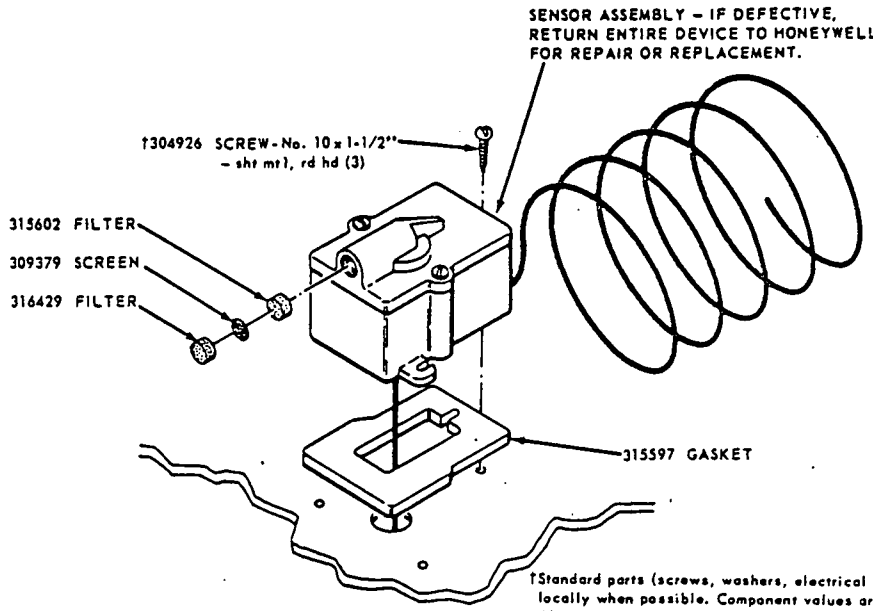


Fig. 5—LP915A (Duct-mounted).

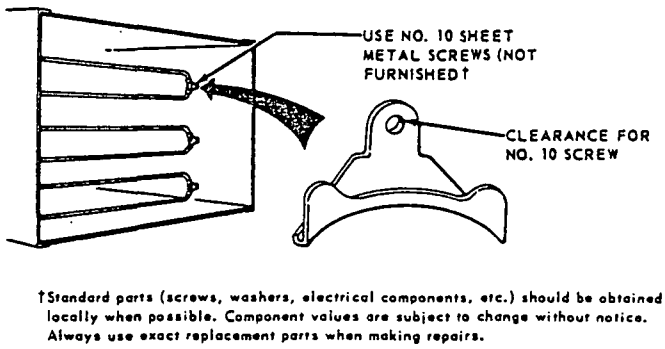


Fig. 6—314439 Capillary Clip (For mounting LP915 tubing in duct).

ORDERING INFORMATION: (In United States.)

—Repair Parts or Assemblies.
Repair parts or assemblies only should be ordered from Honeywell Inc., 1885 Douglas Drive, Minneapolis, Minnesota 55422. Please order by Part No. and Description. Also, give complete Order Specification Number of the sensor. The number is stamped on the sensor body. It may be necessary to return the entire device to our factory for complete repair and reconditioning.

—Return of Complete Device.
When a complete device is returned for repairs, it should be mailed with a repair order to Honeywell Inc., 8330 North Austin Avenue, Morton Grove, Illinois 60053.

—Inquiries on Orders.
Direct all inquiries on orders to Honeywell Inc., 1885 Douglas Drive, Minneapolis, Minnesota 55422.

(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.

MAINTENANCE AND REPAIR

MO953A, B, C & D
MP953A, B, C & D
PNEUMATIC ACTUATORS

INTRODUCTION

These instructions outline periodic maintenance and provide a parts list for the MO953 and MP953 series pneumatic actuators. Standard tools may be used throughout.

NOTE: Contact your local Honeywell branch office for handling of repairs, pricing information and assistance. When ordering repair parts, please furnish the Part Number and Description of parts required. Also, provide the complete Order Specification number of the device in which the parts are to be used.

The Series Number is on the label affixed to one leg of the frame.
EXAMPLES: MP953 B1036 2
MO953 B6 2
The last number (2) is the Series Number.

The table at right provides additional information to further identify various models.

MO953A & MP953A
Direct acting pneumatic actuator with attached relay.

MO953B & MP953B
Reverse acting pneumatic actuator with attached relay.

MO953C & MP953C
Direct acting pneumatic actuator without relay.

MO953D & MP953D
Reverse acting pneumatic actuator without relay.

TABLE I MO953 & MP953 MODEL IDENTIFICATION

	ORDERING SPEC. NUMBER	SPRING RANGE-psi	DIAMETER	TRAVEL	DIAPHRAGM MATERIAL*	CORROSION RESISTANT
MP953A & MO953A	1087, 1004, A1	[illegible]	5"	3/4"	Neoprene	No
	1095, 1012, A2	[illegible]			Silicone	Yes
	1103, 1046, A6	[illegible]				
	1111, 1079, A9	[illegible]		1/2"	Neoprene	No
	A5	[illegible]		3/4"		
	1145, 1020, A3	[illegible]	8"	1-1/2"		
	1152, 1038, A4	[illegible]		3/4"		Yes
	1178, 1053, A7	[illegible]	13"	1-1/2"		No
	1202, 1186, 1061, A8	[illegible]	7-1/8"	3/4"		Yes
MP953B & MO953B	1002, 1036, B6	[illegible]		1/2"		
	1010, 1044, B7	[illegible]				
	1028, 1051, B8	[illegible]				
MP953C & MO953C	1000, C1XH	2-7	5"	3/4"		No
	1018, C1XK	8-12				
	1026, C1XL	4-11				
	1034, C2XH	2-7			Silicone	
	1042, C2XK	8-12				
	1059, C2XL	4-11				
	1067, C3XH	2-7	8"		Neoprene	
	1075, C3XK	8-12				
	1083, C3XL	4-11				
	1091, C4XH	2-7		1-1/2"		
	1109, C4XK	8-12				
	1117, C4XL	4-11				
	1141, C9XH	2-7	5"	1/2"		
	1158, C9XK	8-12				
	1166, C9XL	4-11				
	1174, C5XH	2-7		3/4"		Yes
	1182, C5XK	8-12			Silicone	
	1190, C5XL	4-11				
	1208, C6XH	2-7				
	1216, C6XK	8-12				
	1224, C6XL	4-11				
	1232, C7XH	2-7	8"		Neoprene	
	1240, C7XK	8-12				
	1257, C7XL	4-11				
	1414				Silicone	
	1471, 1125, C8XH	2-7	13"	1-1/2"	Neoprene	No
	1489, 1133, C8XL	4-11				
MP953D & MO953D	1008, 1107, D1	8-13	7-1/8"	3/4"		
	1016, 1115, D2			1/2"		
	1024, 1123, D3			3/4"		Yes
	1073, 1131	4-11				No
	1081, 1149			1/2"		
	1099, 1156			3/4"		Yes

*NOTE: Diaphragm color varies with material; black=neoprene; white=silicone

MAINTENANCE AND REPAIR

PERIODIC MAINTENANCE

The only periodic maintenance required is an occasional visual check for leaks, loose fittings, etc. The actuator may be cleaned with CHLOROTHENE or VYTHENE. Keep solvent away from the diaphragm as it will cause deterioration.

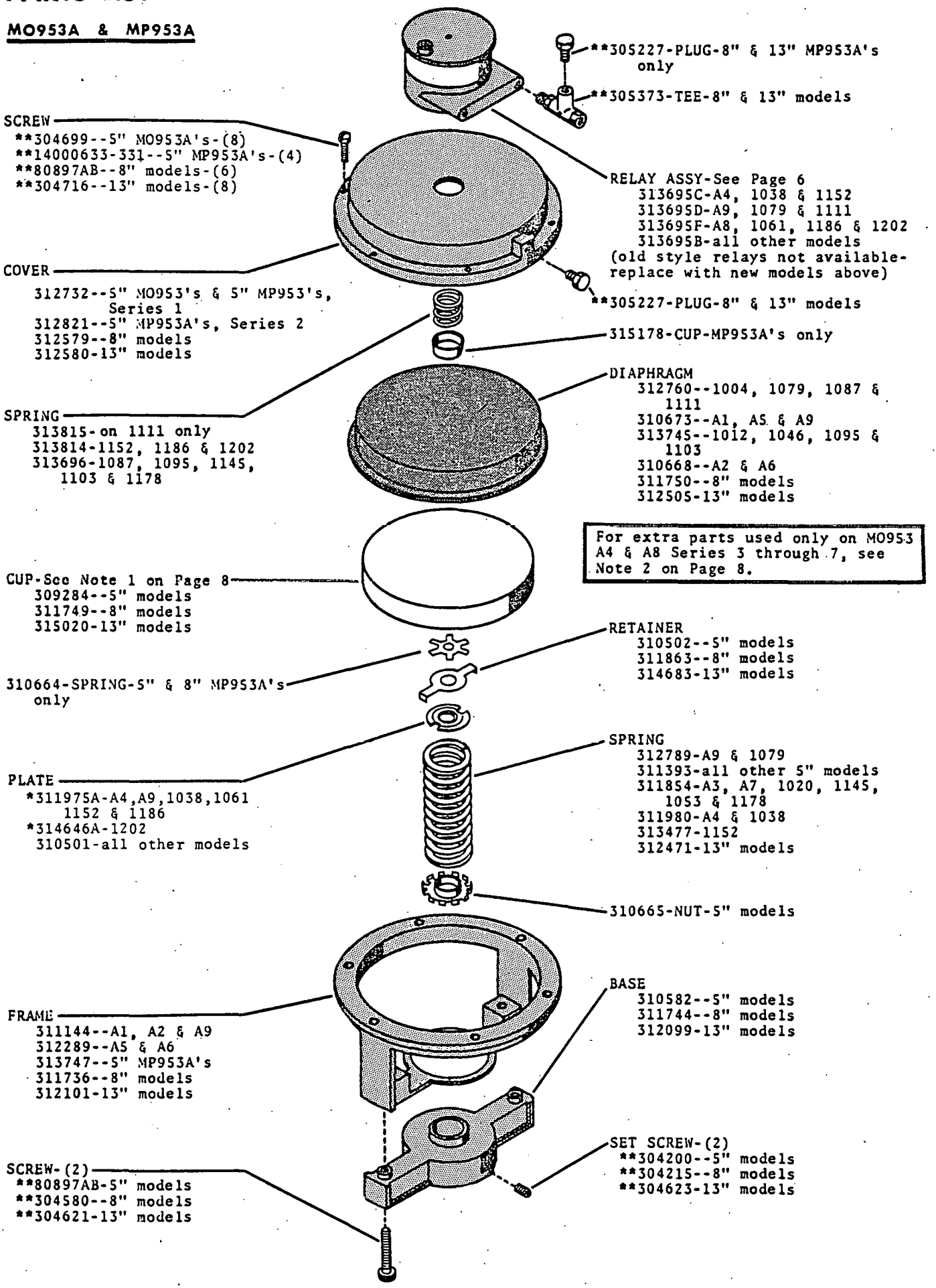
CAUTION: SPECIAL CARE SHOULD BE EXERCISED IN THE USE OF SOLVENTS. AVOID PROLONGED INHALATION AND/OR CONTACT WITH THE SKIN. CARELESS HANDLING CAN RESULT IN PERMANENT DAMAGE TO THE RESPIRATORY SYSTEM OR SKIN TISSUE.

OPERATION CHECK

Vary the branch line pressure. The actuator should operate smoothly to open or close the valve.

PARTS LIST

MO953A & MP953A



**305227-PLUG-8" & 13" MP953A's only

**305373-TEE-8" & 13" models

SCREW
**304699--5" MO953A's-(8)
**14000633-331--5" MP953A's-(4)
**80897AB--8" models-(6)
**304716--13" models-(8)

RELAY ASSY-See Page 6
313695C-A4, 1038 & 1152
313695D-A9, 1079 & 1111
313695F-A8, 1061, 1186 & 1202
313695B-all other models
(old style relays not available-replace with new models above)

COVER
312732--5" MO953's & 5" MP953's, Series 1
312821--5" MP953A's, Series 2
312579--8" models
312580--13" models

**305227-PLUG-8" & 13" models

315178-CUP-MP953A's only

DIAPHRAGM
312760--1004, 1079, 1087 & 1111
310673--A1, A5 & A9
313745--1012, 1046, 1095 & 1103
310668--A2 & A6
311750--8" models
312505-13" models

SPRING
313815-on 1111 only
313814-1152, 1186 & 1202
313696-1087, 1095, 1145, 1103 & 1178

For extra parts used only on MO953 A4 & A8 Series 3 through 7, see Note 2 on Page 8.

CUP-See Note 1 on Page 8
309284--5" models
311749--8" models
315020-13" models

RETAINER
310502--5" models
311863--8" models
314683-13" models

310664-SPRING-5" & 8" MP953A's only

SPRING
312789-A9 & 1079
311393-all other 5" models
311854-A3, A7, 1020, 1145, 1053 & 1178
311980-A4 & 1038
313477-1152
312471-13" models

PLATE
*311975A-A4,A9,1038,1061 1152 & 1186
*314646A-1202
310501-all other models

310665-NUT-5" models

BASE
310582--5" models
311744--8" models
312099-13" models

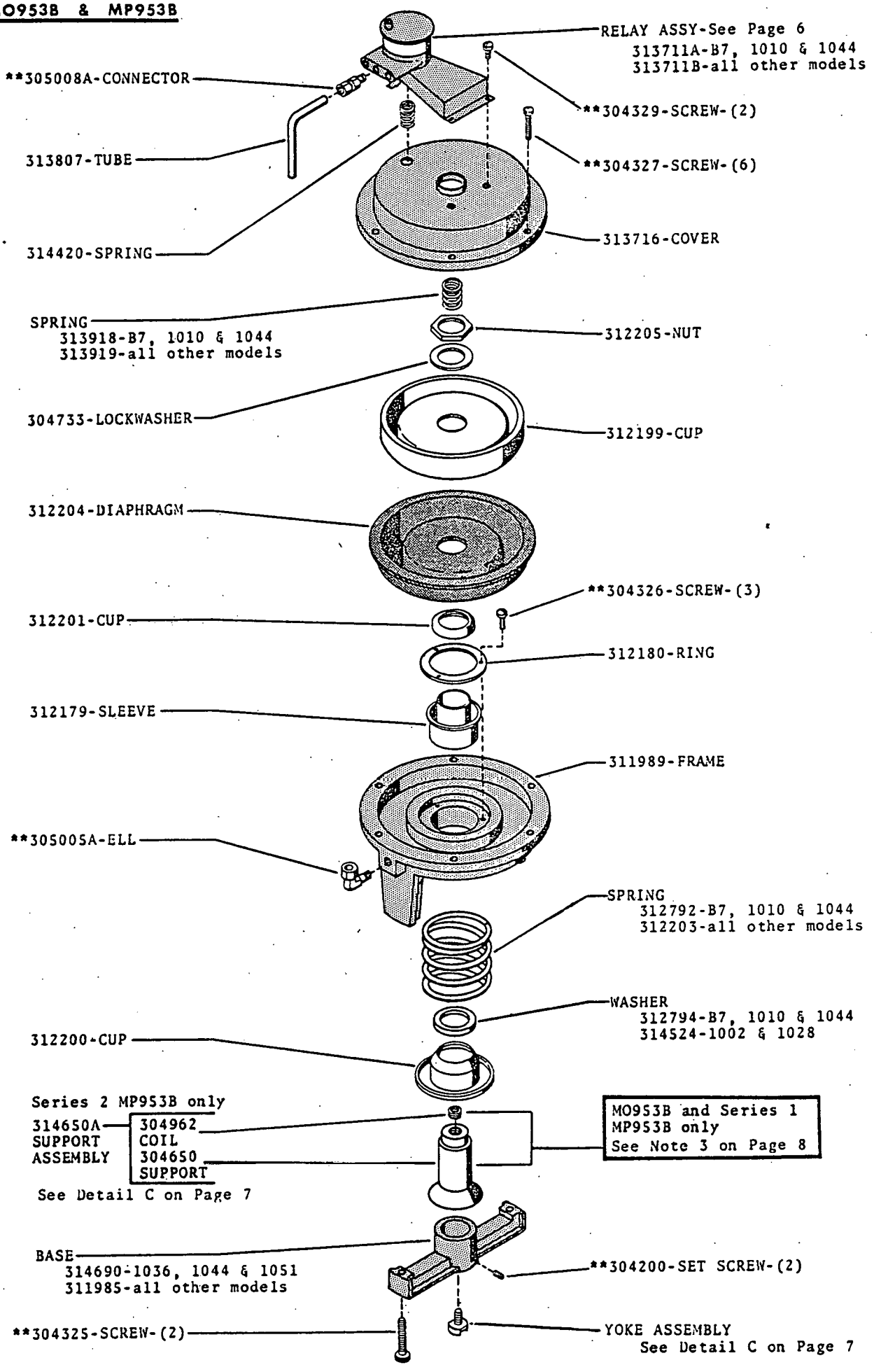
FRAME
311144--A1, A2 & A9
312289--A5 & A6
313747--5" MP953A's
311736--8" models
312101-13" models

SET SCREW-(2)
**304200--5" models
**304215--8" models
**304623-13" models

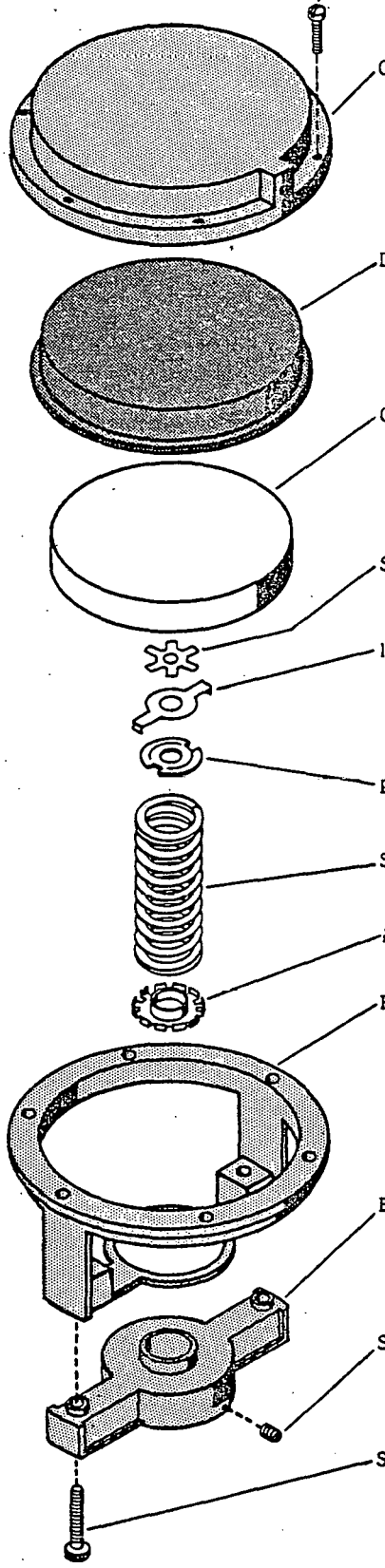
SCREW-(2)
**80897AB-5" models
**304580--8" models
**304621-13" models

* These parts are welded together, therefore it is recommended that the complete assembly be ordered.
** Standard hardware item-see Table 4 on Page 7 for description.

MO953B & MP953B



** Standard hardware item-see Table 4 on Page 7 for description.



SCREW
**14000633-331--5" Series 2 MP953C's-(4)
**304699--all other 5" models-(8)
**80897AB-8"models-(6)
**304716--13" models-(8)

COVER
312817--5" Series 2 MP953C's
310546--all other 5" models
311748--8" models
312103-13" models

DIAPHRAGM
MP953C Series 2-See Table 2 Column 4
All other models-See Table 2 Column 3

CUP-See Note 4 on Page 8
309284--5" models
311749--8" models
315020-13" models

SPRING-310664-5" & 8" models only

RETAINER
310502--5" models
311863--8" models, C8, 1125 & 1133
314683--1471 & 1489

PLATE-See Table 2 Column 5

SPRING-See Table 2 Column 2

NUT-310665-5" models only

FRAME
313747--5" Series 2 MP953C's
311144--all other 5" models
311736--8" models
312101-13" models

BASE
310582--5" models
311744--8" models
312099-13" models

SET SCREW-(2)
**304200--5" models
**304215--8" models
**304623-13" models

SCREW-(2)
**80897AB-5" models
**304580--8" models
**304621-13" models

TABLE 2 PART NUMBERS

1	2	3	4	5
O.S. Nos.	SPRING	DIAPH.	DIAPH.	PLATE
1000, C1XH	311616			
1018, C1XK	311618	310673	312760	
1026, C1XL	311393			
1034, C2XH	311616			
1042, C2XK	311618	310668	313745	310501
1059, C2XL	311393			
1067, C3XH	311852			
1075, C3XK	311855			
1083, C3XL	311854		311750	
1091, C4XH	311980			
1109, C4XK	314081			
1117, C4XL	313477			311975A
1125, C8XH	312469		312505	311975B
1133, C8XL	312471			
1141, C9XH	312788			
1158, C9XK	312790			
1166, C9XL	312791	310673	312760	
1174, C5XH	311616			
1182, C5XK	311618			
1190, C5XL	311393			
1208, C6XH	311616			310501
1216, C6XK	311618	310668	313745	
1224, C6XL	311393			
1232, C7XH	311852			
1240, C7XK	311855		311750	
1257, C7XL	311854			
1414			314153	
1471	312469		312505	314646A
1489	312471			

314646A-PLATE ASSY; consists of:
314646-PLATE
312468-PLATE

*311975A & B--PLATE ASSY;consists of:
311975-CUP
312468-PLATE

* These parts are welded together, therefore it is recommended that the complete assembly be ordered.
** Standard hardware item-see Table 4 on Page 7 for description.

MO953D & MP953D

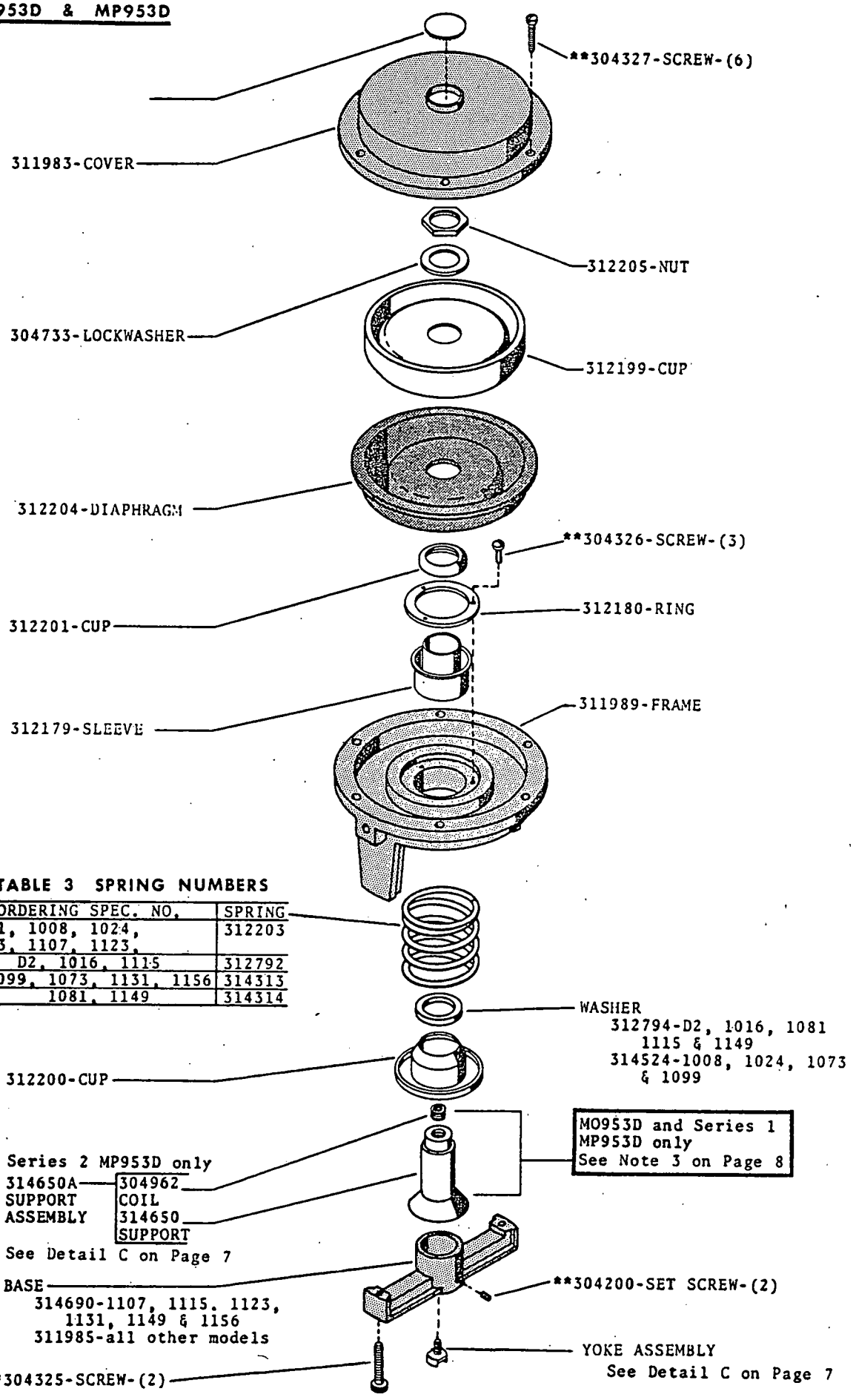


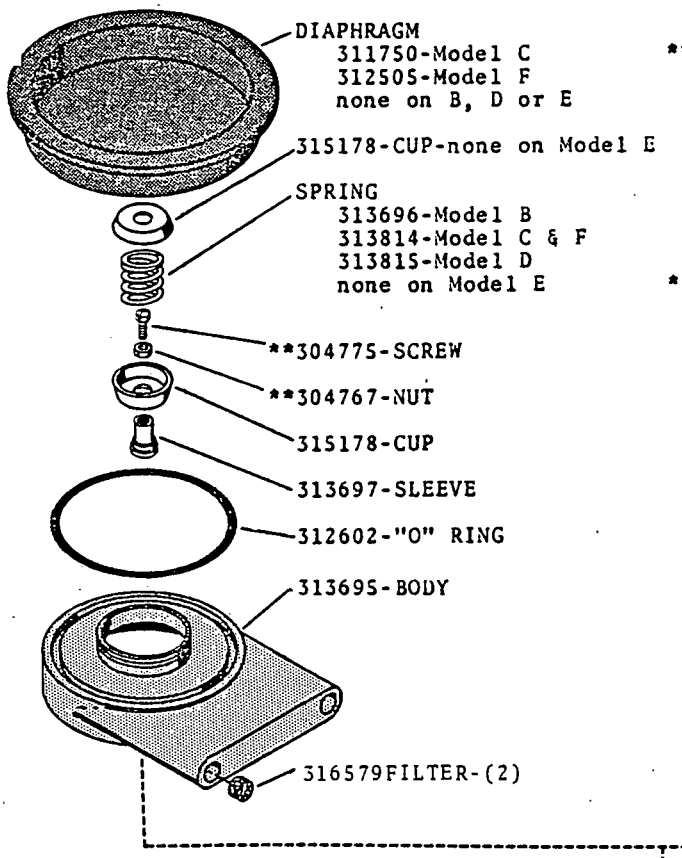
TABLE 3 SPRING NUMBERS

ORDERING SPEC. NO.	SPRING
D1, 1008, 1024, D3, 1107, 1123, D2, 1016, 1115	312203
1099, 1073, 1131, 1156	312792
1081, 1149	314313
	314314

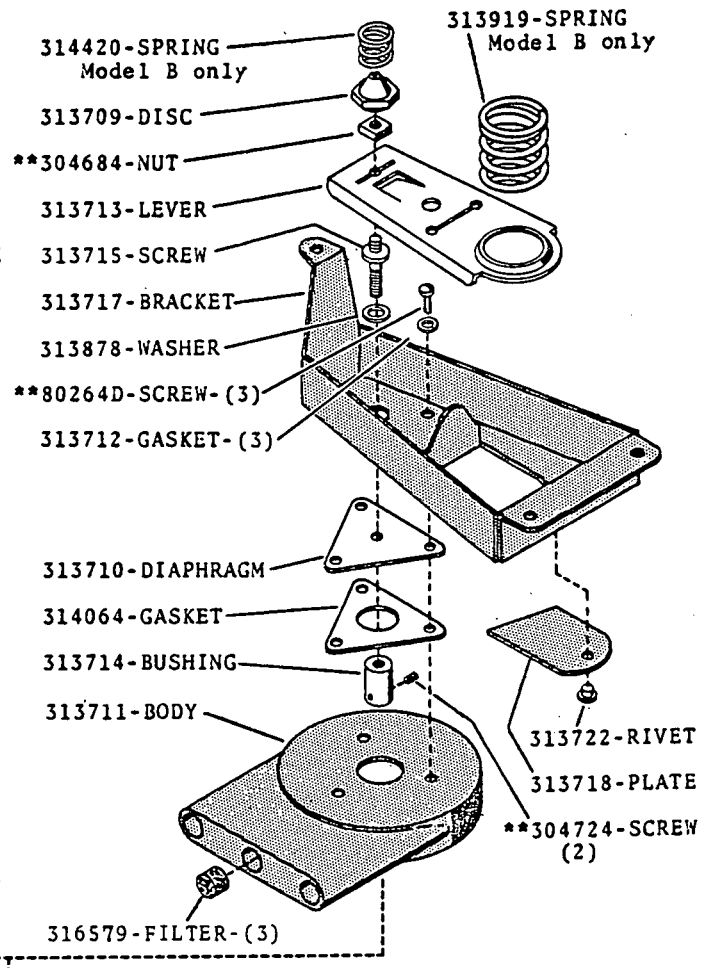
** Standard hardware item-see Table 4 on Page 7 for description.

RELAY ASSEMBLIES

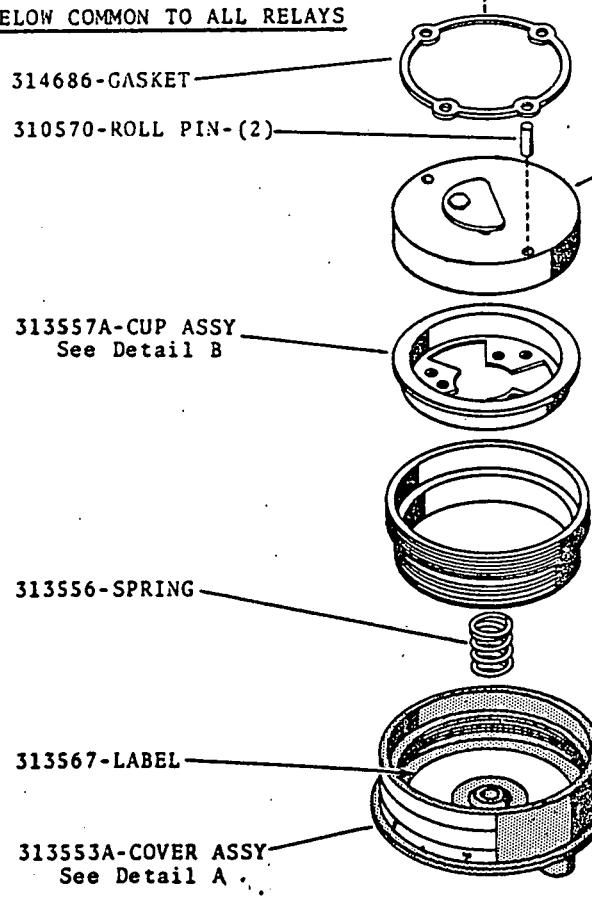
313695B, C, D, E & F



313711A & B



PARTS BELOW COMMON TO ALL RELAYS



PARTS BELOW COMMON TO ALL RELAYS

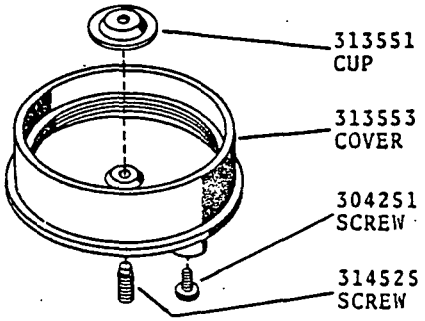
*313560B--VALVE UNIT ASS'Y; CONSISTS OF:

303674-SCREW	313766-LEVER
303646-BALL-(2)	303635-SPRING
303072-SPRING	312608-SPRING
304767-NUT	304747-WASHER
313878-WASHER	304717-WASHER
316869-DIAPH.	313560-BODY
311961-BALL	313614-SCREW
313563-BUSHING	304748-WASHER
313564-DIAPH.	313568-RING
313569-RING	313566-SPIDER

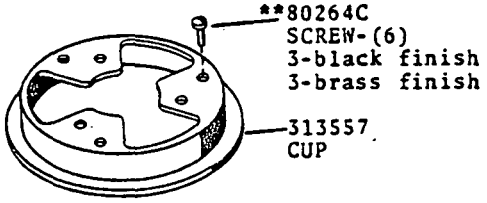
* These parts require special equipment for assembly, therefore it is recommended that the complete assembly be ordered.

** Standard hardware item-see Table 4 on Page 7 for description.

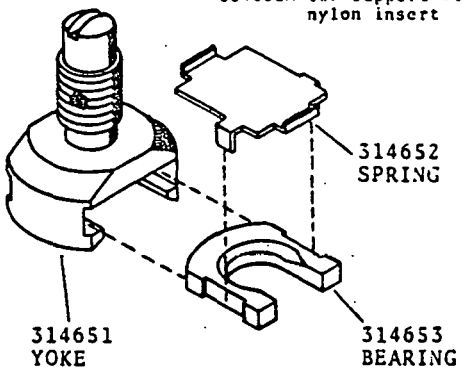
DETAIL A
COVER ASSEMBLY-313553A



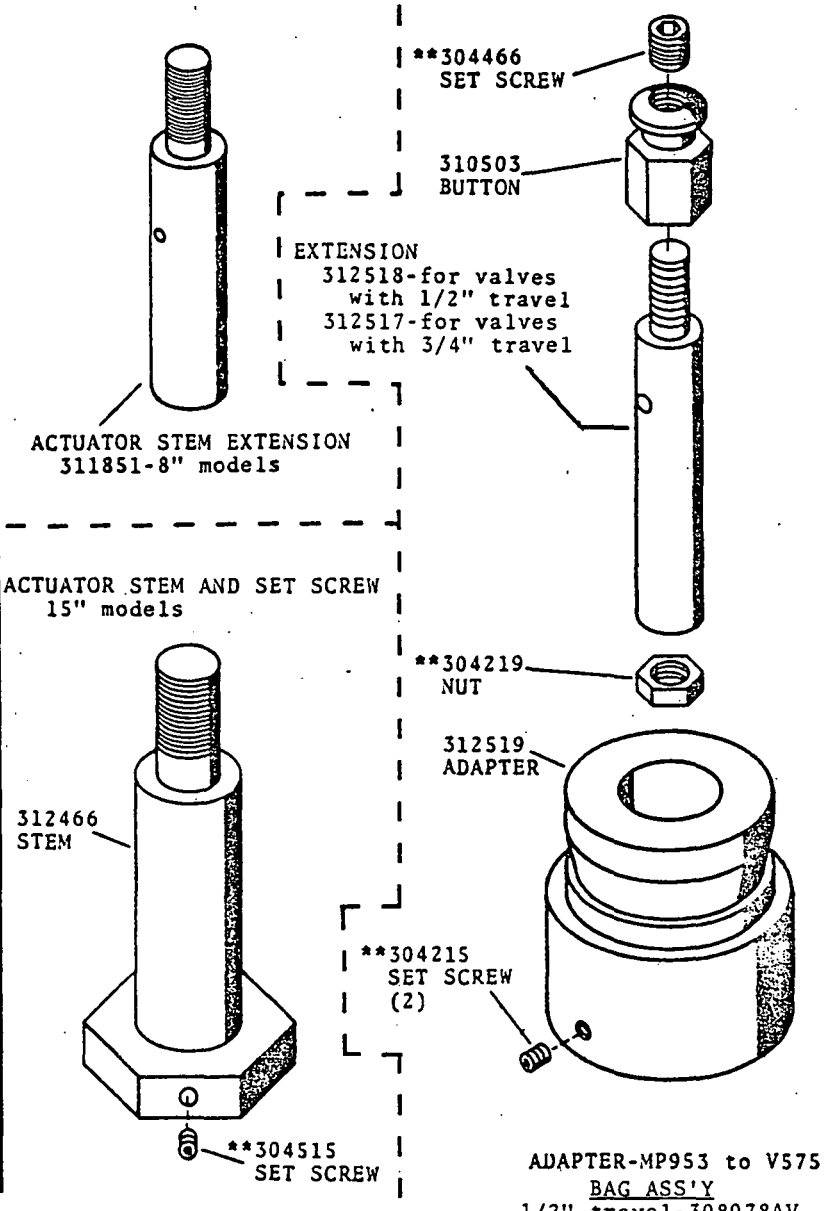
DETAIL B
CUP ASSEMBLY-313557A



DETAIL C
YOKE ASSEMBLY- 316059A-for support with heli-coil insert
for MP953B & D 314651A-for support with nylon insert



ACCESSORIES



ADAPTER-MP953 to V575
BAG ASS'Y
1/2" travel-308078AV
3/4" travel-308078AW

** Standard hardware items-see Table 4 below for description.

TABLE 4 STANDARD HARDWARE ITEMS

Obtain these items locally when possible.

PART	DESCRIPTION
80264C---SCREW	6-32 x 3/16" Rd Hd
80264D---SCREW	6-32 x 1/4" Rd Hd
80897AB--SCREW	1/4-20 x 3/4" Fil Hd
304200---SET SCREW	1/4-20 x 3/8" Socket Hd
304215---SET SCREW	5/16-18 x 3/8" Socket Hd
304219---NUT	1/4-18 x 5/32" thick
304325---CAP SCREW	1/4-20 x 1-3/4" Socket Hd
304326---SCREW	4-40 x 3/8" Rd Hd
304327---SCREW	10-24 x 3/4" Hex Hd w/ Lk Wash,
304329---SCREW	10-24 x 5/16" Hex Hd w/ Lk Wash,
304466---SET SCREW	1/4-28 x 1/4" Socket Hd
304515---SET SCREW	8-32 x 5/16" Socket Hd
304580---CAP SCREW	1/2-13 x 1-1/2" Socket Hd
304621---CAP SCREW	1/2-13 x 2" Socket Hd
304623---SET SCREW	3/8-16 x 1" Socket Hd
304684---NUT	4-40 x 3/32" thick
304699---SCREW	6-32 x 1/2" Hex Hd w/ Lk Wash,
304716---SCREW	5/16-18 x 7/8" Hex Hd w/ Lk Wash,
304724---SET SCREW	2-56 x 1/16" Socket Hd
304767---NUT	0-80 x .05" thick
304775---SCREW	0-80 x 5/16" Rd Hd
304790---SCREW	8-32 x 1/2" Hex Hd w/ Lk Wash,
305005A--ELL	3/16" O.D. x 1/8" MPT
305008A--CONNECTION	3/16" O.D. x 1/8" MPT
305227---PLUG	1/8" MPT Hex Hd
305373---GAGE TEE	1/4" O.D. x 1/8" MPT x 1/8" FPT

Obtain these items locally when possible.

NOTE 1

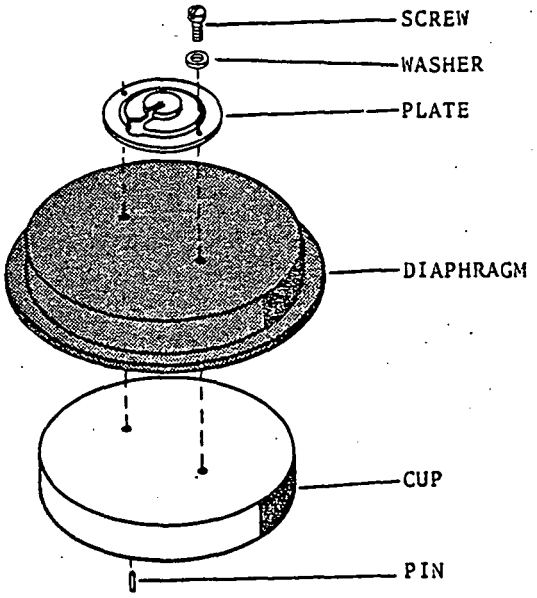
Replacement of CUP on models A8 and 1061 requires simultaneous installation of new RETAINER #314683 and PLATE ASSY #314646A. Also (except on Series 1 and 2 A8 devices) replace relay with RELAY ASSY #313695F.

NOTE 2

The figure below illustrates parts used in M0953 A4 & 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 below:

To convert A4 device:
RELAY ASSY-313695C
CUP-311749

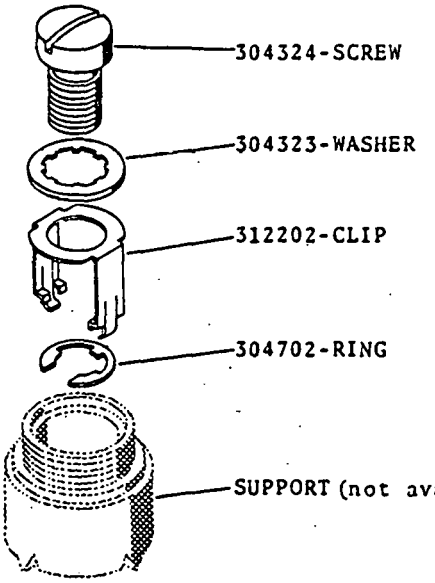
To convert A8 device:
RELAY ASSY-313695F
CUP-315020



NOTE 3

All parts pictured below are available for repair except the SUPPORT. Should the SUPPORT require repairs, convert the actuator to a new style device by replacing all parts shown below with SUPPORT ASSY #314650A and YOKE ASSY #316059A

These parts found on M0953B & D and Series 1 MP953B & D.



NOTE 4

Replacement of CUP on models C8, 1125 & 1133 requires simultaneous installation of new RETAINER #314683 and PLATE ASSY #314646A.

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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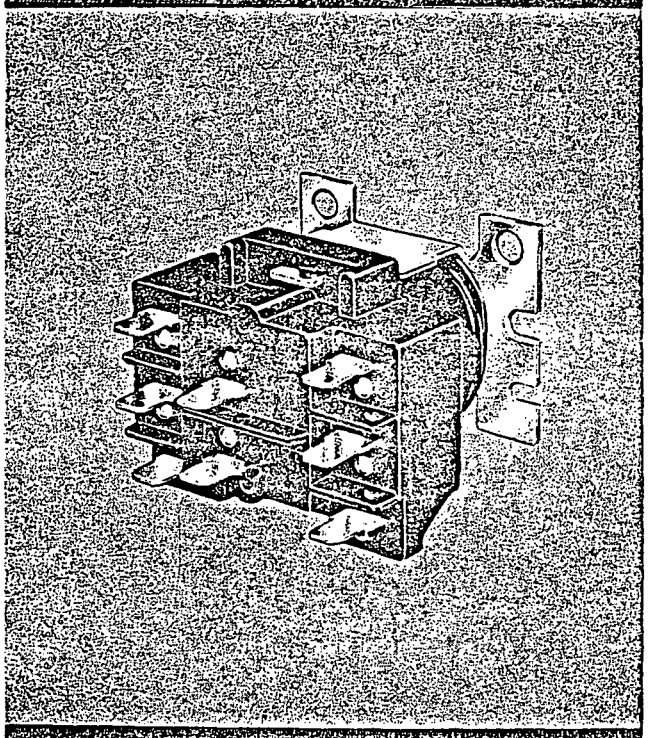
SWITCHING RELAYS



R4222, R8222, R4228, R8228

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.

Form Number 60-2056-2

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
4222 &	Coil	Std.	Opt.
8222	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.

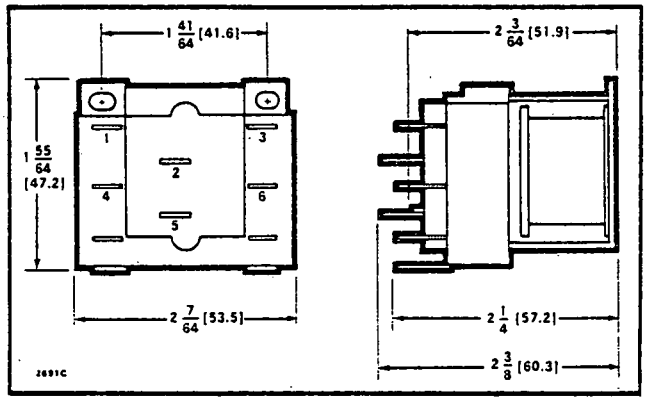


FIG. 1–RELAY DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

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)	1 4 3 6	A
SPDT, (DOUBLE QUICK-CONNECTS)	1 4 2 5 3 6	B
SPST, N.O.	1 3	C
DPST, N.O.	1 4 3 6	D

TABLE II–R4222, R8222

SWITCHING CONFIGURATION	TERMINALS	R4222 OR R8222 MODEL SUFFIX	
		POWER RATED	PILOT DUTY RATED
SPST, N.O.	1 3	A	K
SPDT	1 2 3	B	L
DPST, N.O.	1 4 3 6	C	M
DPDT	1 2 3 4 5 6	D	N
SPST, N.C.	1 2	E	P
DPST, 1-N.O. AND 1-N.C.	1 4 3 5	F	Q
DPST, N.C.	1 4 2 5	G	R
SPDT AND SPST, N.O.	1 2 3 4 6	H	S
SPDT AND SPST, N.C.	1 2 3 4 5	J	T
DPST N.O. (ONE POWER AND ONE PILOT DUTY)	1 4 3 6	†U	
DPDT (ONE POWER AND ONE PILOT DUTY)	1 2 3 4 6 5	†V	
SPDT AND SPST, N.O. (ONE POWER AND ONE PILOT DUTY)	1 2 3 4 6	†W	
SPDT AND SPST, N.O. (ONE POWER AND ONE PILOT DUTY)	1 4 3 6 5	†Y	
DPST, N.C.	1 4 2 5	†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. 137881A 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.

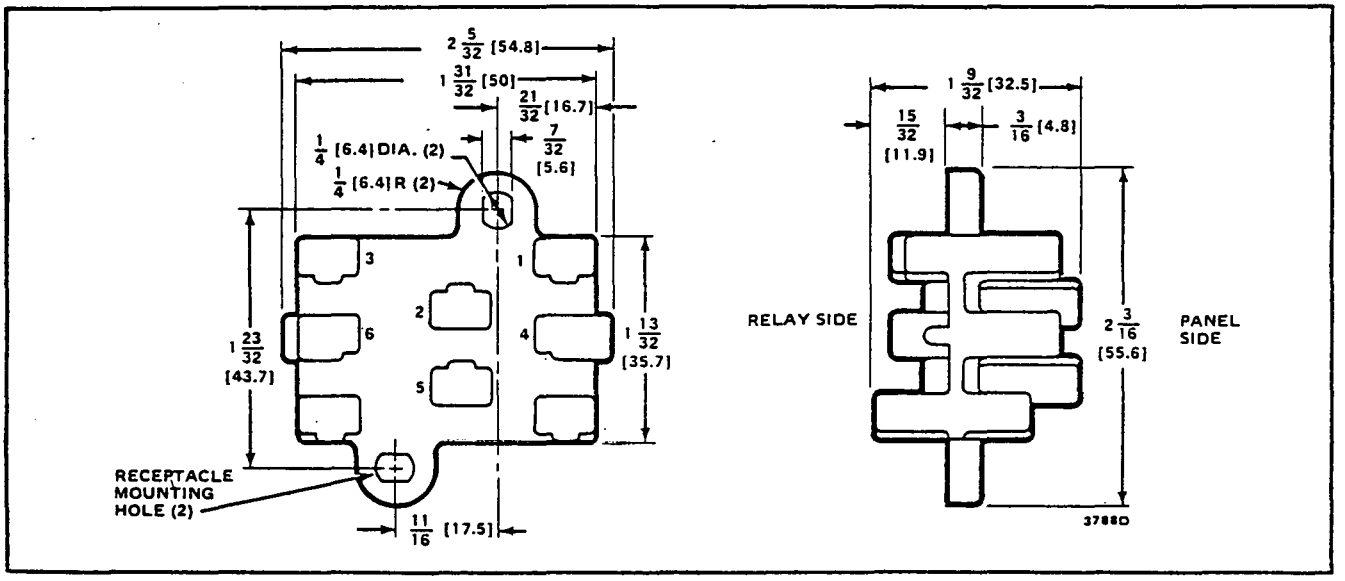


FIG. 2–DIMENSIONS OF WIRING RECEPTACLE.

INSTALLATION

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.

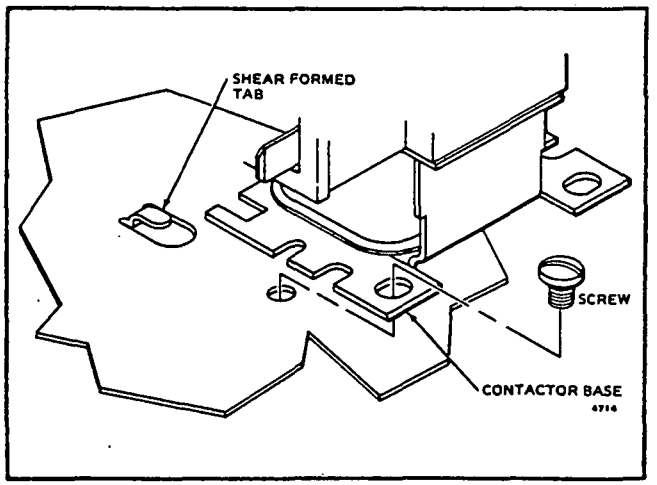


FIG. 3–MOUNTING RELAY ON PANEL WITH SHEAR FORMED TAB AND 1 SCREW.

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.

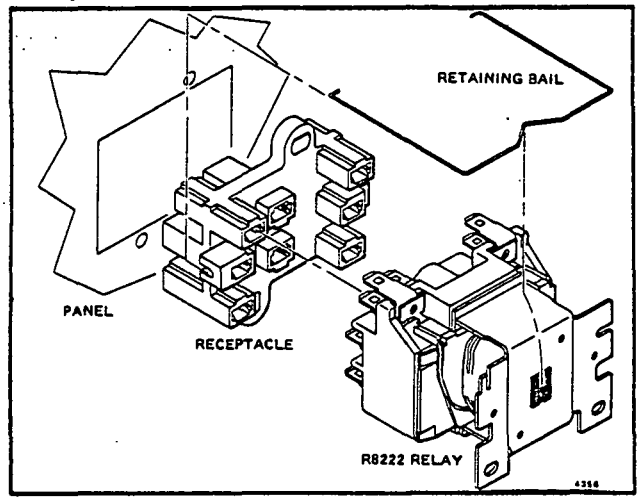


FIG. 4–RELAY MOUNTING USING RECEPTACLE AND RETAINING BAIL.

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.

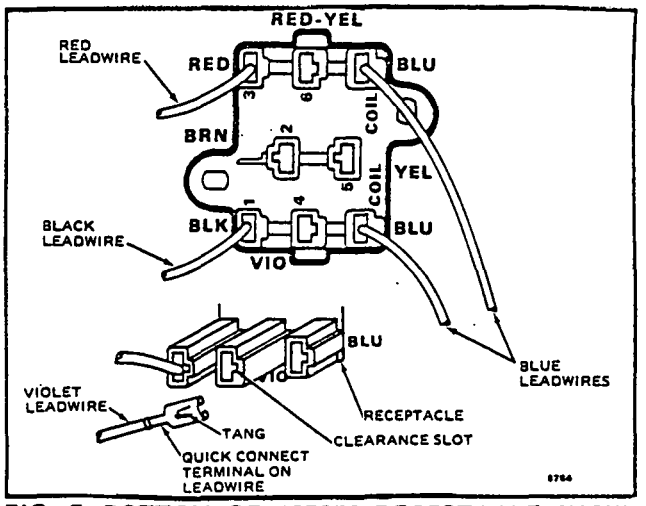


FIG. 5–BOTTOM OF 135959 RECEPTACLE SHOWING LEADWIRE INSTALLATION.

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.

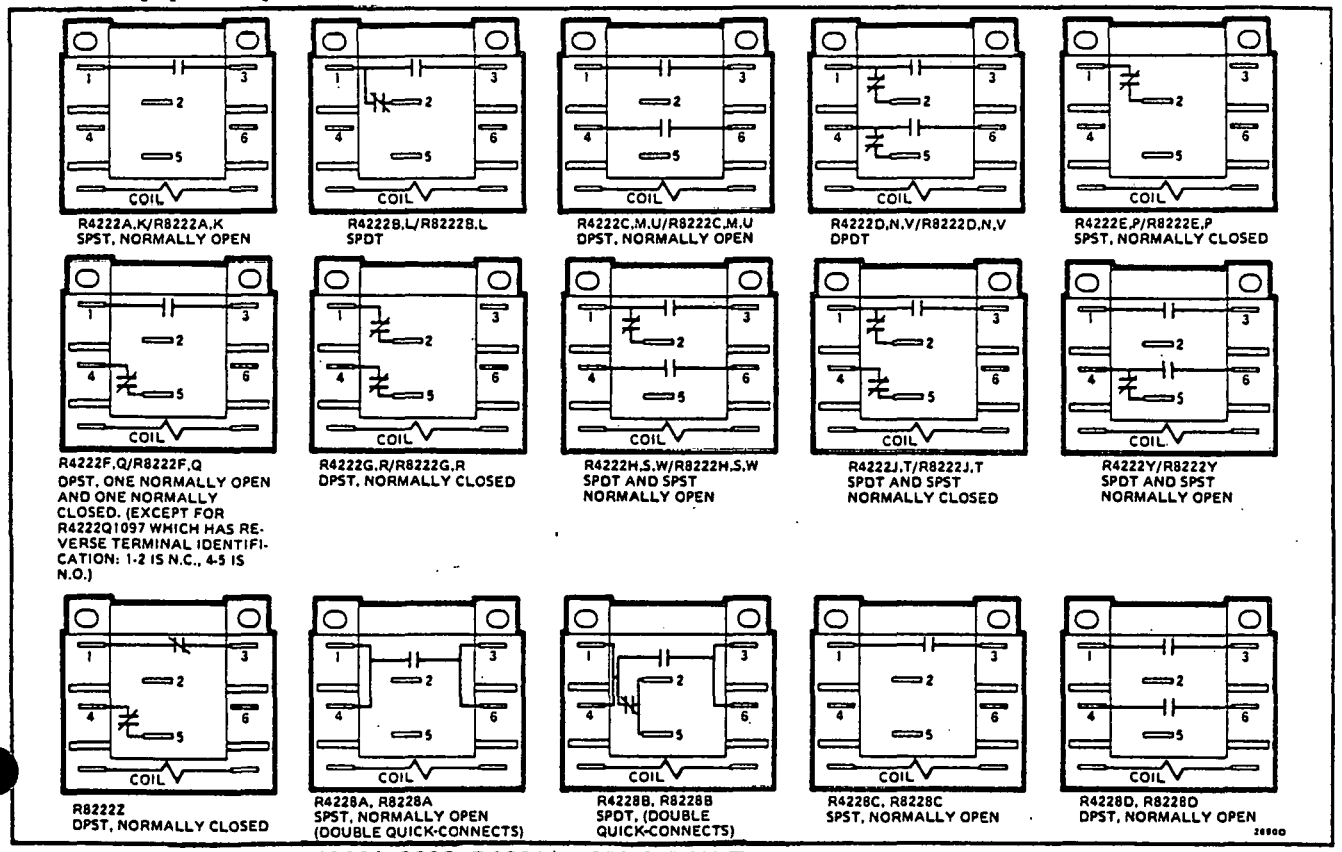


FIG. 6–R4222/R8222, R4228/R8228 CIRCUIT AND TERMINAL DESIGNATION.

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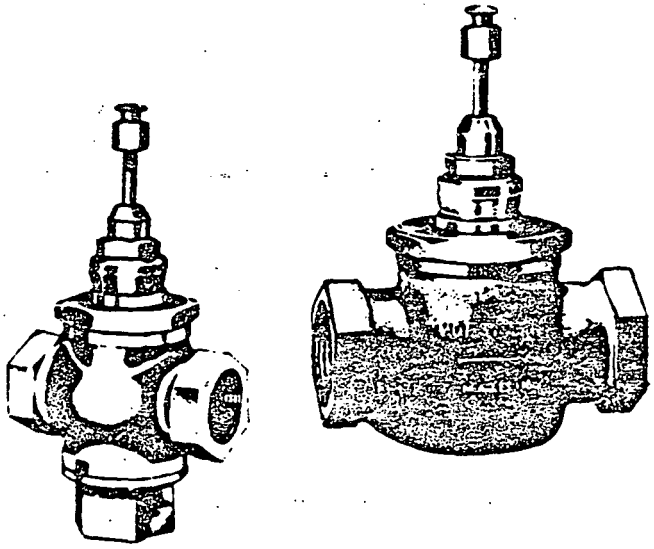
Honeywell

Comfort Control Systems

V5011A-E & V5013A-E VALVE BODIES

Service Data



INTRODUCTION

This sheet covers maintenance and repair of V5011 and V5013 valve bodies. Since it is possible to use any of several different pneumatic, electric, or electronic actuators, specific instructions must be found in the instruction sheet accompanying the motor.

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 of your system.

ORDERING INFORMATION

Please order parts and repair kits by part number and description from the nearest Honeywell Commercial Division Branch Office. Be certain to include entire part number with your order.

For assistance in identifying threaded V5011 valves by their O.S. number, refer to V5011 Valve Repair Cross-Reference Matrix (Form 77-5102). That sheet also cross-references valve repair kits which are available.

Valve O.S. Numbers can be found on a band around the valve body directly under the bonnet.

Table 1—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.

PERIODIC MAINTENANCE

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

CLEANING

Remove all dirt and grease accumulation around the packing nut and stem. Use solvent listed in Table 1.

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 PROCEDURE

If leakage occurs after several years of operation, it is recommended to completely rebuild the valve, replacing all parts subject to wear. This would normally include 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 great care must be taken not to damage the valve stem or leakage may still occur after the new packing is installed.

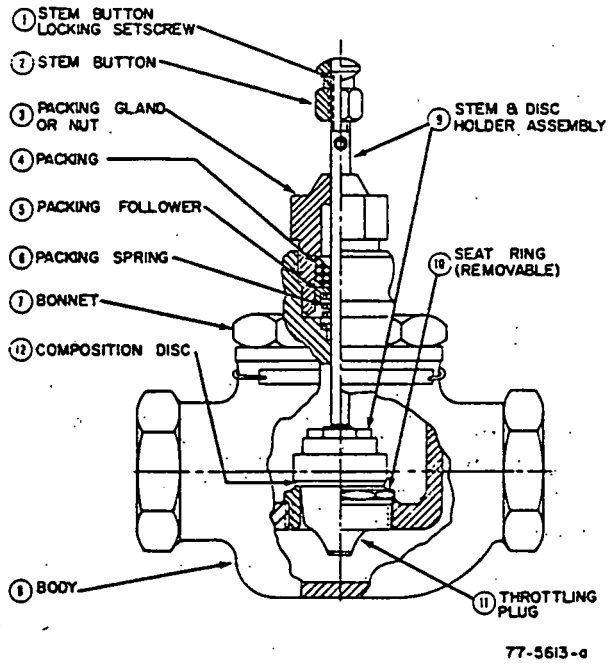


Fig. 1–Cutaway of Typical V5011A Screwed Type Body.

TO REPACK ONLY

Follow disassembly procedure through Step 3. Replace packing wafers, follower and spring. Use three (3) packing wafers on valve 1-1/4 in. and less in size, four (4) on valves 1-1/2 through 3 in., and five (5) on valves on 4 in. or larger. Use a small amount of lubricant and thread packings very carefully over stem with CONVEX SIDE UP. Reinstall packing gland by pushing down to compress spring until threads engage. Tighten until snug but be sure valve stem will move up and down. Reinstall button, stem extension (if applicable) and operator.

TO REBUILD

Follow disassembly procedure as applicable. Replace all parts subject to wear and damage. Reassemble in reverse order of disassembly, using new parts. 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 will force the valve open during testing. Reinstall the operator and check operation to be certain valve will close completely against normal operating pressure.

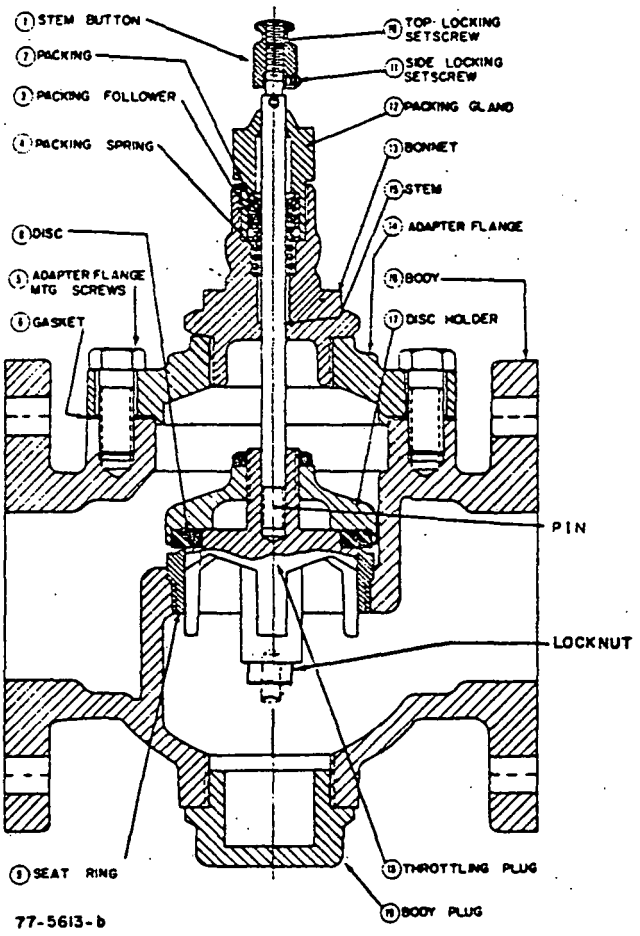


Fig. 2–Cutaway of Typical V5011A Flanged Type Body.

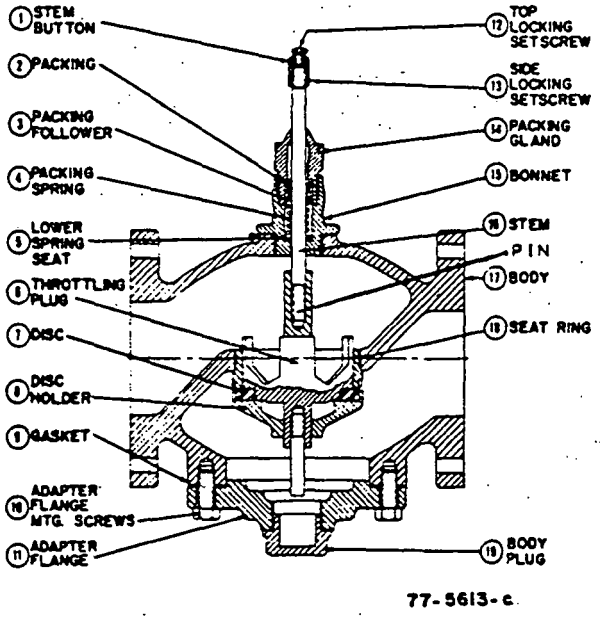


Fig. 3–Cutaway of Typical V5011B Body.

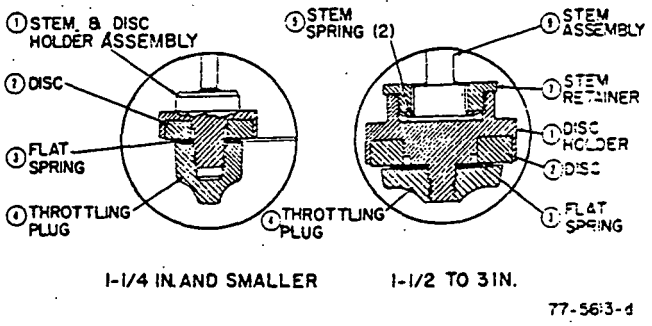


Fig. 4–Disc Holder Assemblies Used in V5011A Screwed Type Bodies.

DISASSEMBLY

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

2. Insert 1/16 in. dia. rod or nail in hole near top of stem and 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 & C) – The bonnet may be unscrewed and the stem and plug assembly can then be lifted out (Fig. 1).

   b. Screwed Body 3-Way Valves (V5013A) – Lower port must be unscrewed from body to remove stem and plug. This requires removing valve from line (Fig. 6).

   c. Direct Acting Flanged Valves (V5011A) – The bonnet is removed together with the adapter flange that is attached with mounting screws (Fig. 2). The stem and plug assembly may then be lifted out.

d. Reverse Acting Flanged Valves (V5011B) – The bonnet may be unscrewed 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. 3).

e. Old 3-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. 5).

f. Flanged 3-Way Valves (V5013B-E) – The bonnet may be detached by removing mounting screws. The upper seat ring can then be unscrewed so the stem and plug assembly can be lifted out. The lower seat ring can then also be removed through the bonnet opening (Fig. 7).

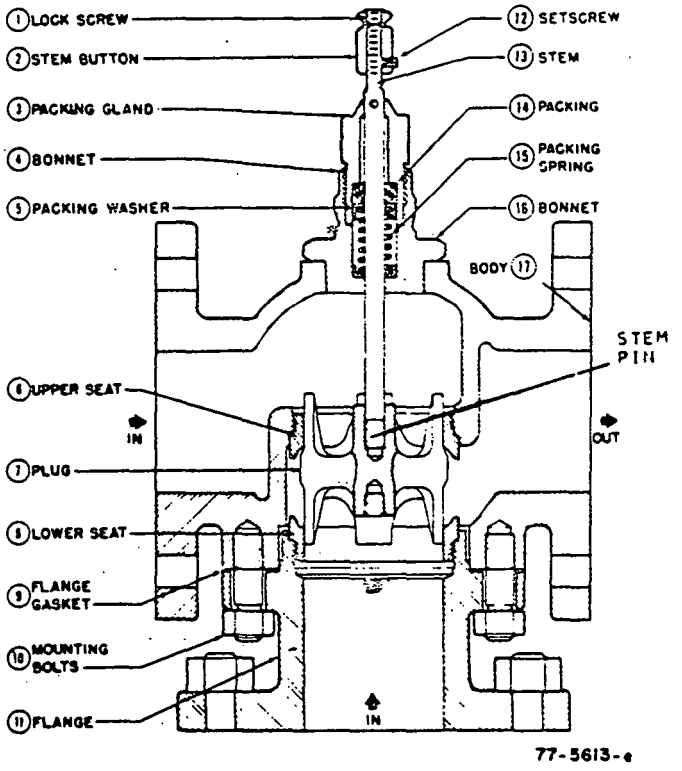


Fig. 5–Cutaway of Typical V5013A Flanged Type Body.

5. Disassemble stem and plug assembly.

a. Screwed Valves with Discs (V5011A & 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. 4).

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

c. Screwed 3-Way Valves (V5013A) – Lower plug and O-ring may be removed from throttling plug with screwdriver thereby releasing stem support and stem support spring.

d. Flanged Valves (V5011) – Disc holder nut may be removed to release disc holder and disc. Stem may be detached by removing pin.

e. Flanged 3-Way Valves (V5013) – On older valves (V5013A the stem can be detached 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.

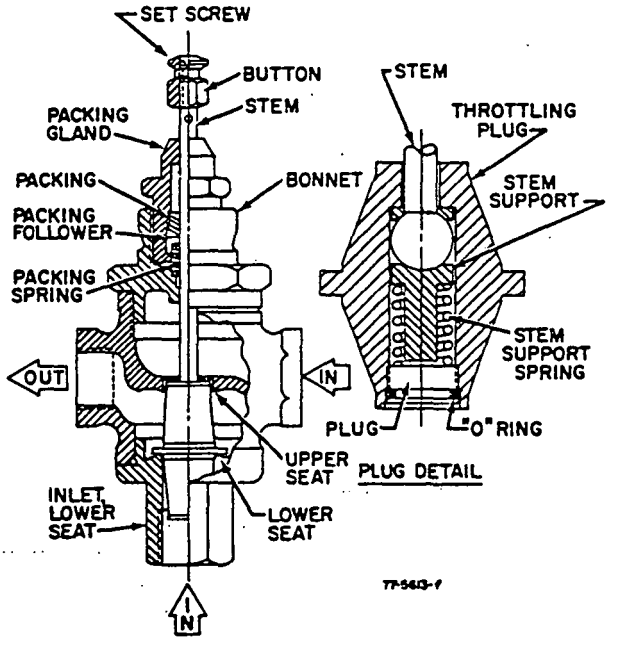


Fig. 6–Cutaway of Typical V5013A Screwed Type Body.

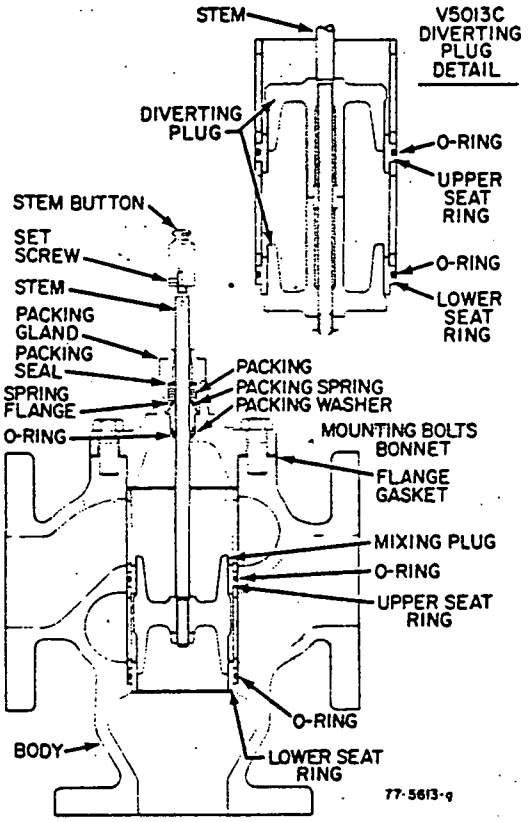


Fig. 7–Cutaway of Typical V5013B Flanged Type Body and V5013C Diverting Plug.

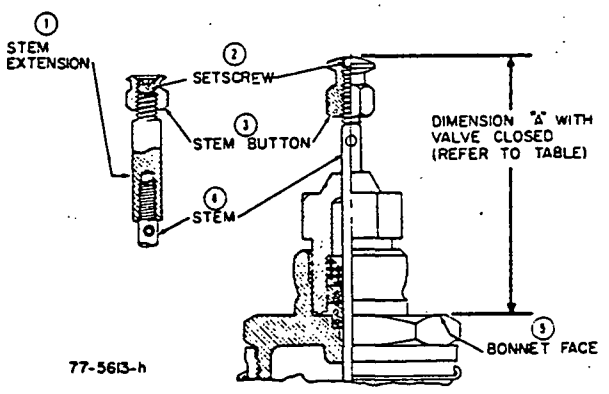


Fig. 8–Method of Determining Proper Stem Button Adjustment With or Without Stem Extension. Refer to Table 2.

Table 2.

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 & C; Stem up on V5011B).

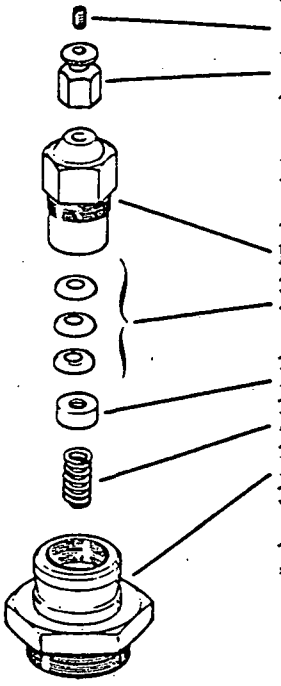
**Dimension measured with plug against lower seat (V5013A).

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

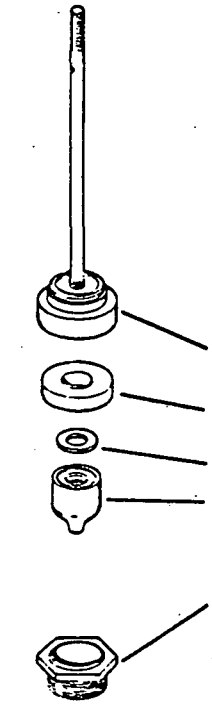


Set Screw	1/4-28 x 1/4 in. Socket Hd
Button	310503

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
Valve Repack Kit	14003294-001			

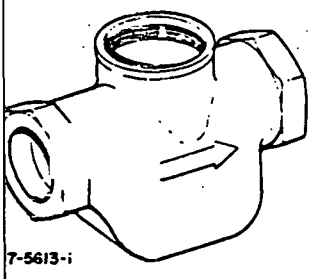
*Valve Repair Kits include these parts and lubricant.



1/2" thru 1-1/4" Composition Disc Valves

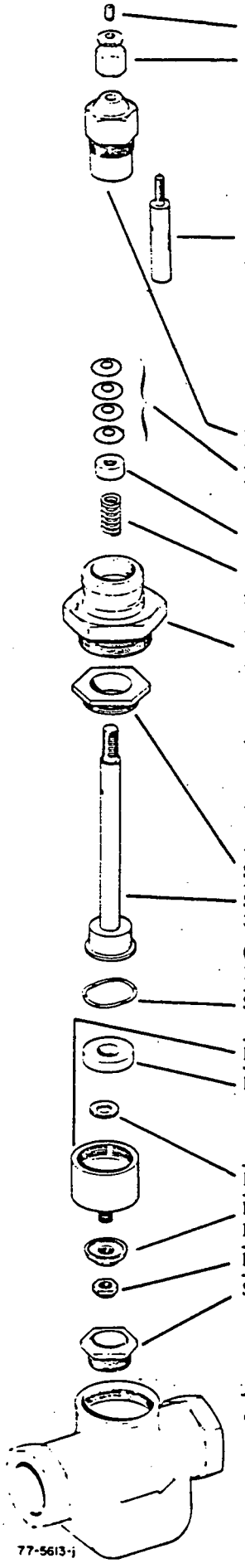
Cv	.40	.63	1.0	1.6	2.5	4.0	6.3	10	16
Valve Repair Kits (Include Parts & Lubricant*)	14002694-001	←				→	14002695-001		14003109-001
Stem & Disc Holder Assembly*	311093A	←				311093A	311094A	311094A	311095A
Disc*									
35-200F (0-93C)	313094	←				313094	313095	313095	313096
115-275F (46-135C)	313102	←				313102	313103	313103	313104
275-425F (135-246C)	313078	←				313078	313079	313079	313080
Disc Spring	311099	←				311099	310554	310554	311098
Plug - V5011A	314705	312349					311087	311088	311091
Plug - V5011C	None	14000523-001 14000519-001	14000522-001 14000518-001	14000521-001 14000520-001	14000524-001 14000508-001	14000525-001	314533	314534	314535
Seat									
1/2" Valve	310535	←			→	311055			
3/4" Valve					310536	310543	310890	------	------
1" Valve	------	------	------	------	------	310538	310537	311077	------
1-1/4" Valve			------				310540	310539	311078

*Valve Repair Kits include these parts and lubricant.



7-5613-i

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	308077AQ	←	←	←	←	←	←	308077AQ

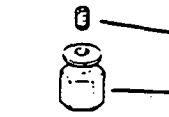
	3/4 in. Travel (19 mm)				1-1/2 in. Travel (38 mm)	
Valve Size	1-1/2"	2"	2-1/2"	3"	2-1/2"	3"
Packing Gland	311431	←	→	311431	311977	311977
Packing*	311432 (4)	←	←	←	←	311432 (4)
Follower*	311430	←	←	←	←	311430
Follower Spring*	311565	←	←	←	←	311565
Valve Repack Kit	14003295-001 (All)					
Bonnet	311622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

1-1/2" thru 3" Composition Disc Valves

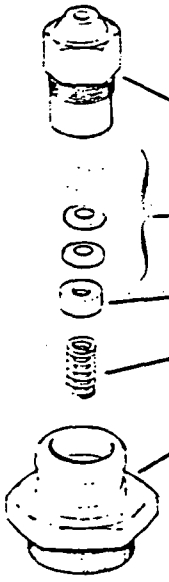
	3/4" Travel (19 mm)						1-1/2" Travel (38 mm)	
Cv	10	16	25	40	63	100	63	100
Stem Retainer Nut	311620	←	←	←	←	←	←	311620
Stem Assembly*	311619A	←	←	←	←	311619A	311974A	311974A
Valve Repair Kit (Includes Parts & Lubricant*)	N/A	N/A	14003110-001	14003111-001	N/A	N/A	N/A	N/A
Stem Retainer Spring	311100 (2)	←	←	←	←	311100 (2)	311100 (1)	311100 (1)
Disc Holder	311633	311392	311433	311623	311745	311746	311745	311746
Disc*								
35-200F (0-93C)	313095	313096	313097	313098	313099	313100	313099	313100
115-275F (46-135C)	313103	313104	313105	313106	313107	313108	313107	313108
275-475F (135-246C)	313079	313080	313081	313082	313083	313084	313083	313084
Disc Spring	310554	311098	311100	311327	311725	311727	311725	311727
Plug - V5011A	311088	311091	311089	311146	311860	311861	311976	312067
Plug - V5011C	314534	314535	314536	314537	314538	314539		
Plug Nut	None	None	None	None	None	311728	None	None
Seat								
1-1/2" Valve	311289	310541	310542					
2" Valve		311290	311291	311624				
2-1/2" Valve			311729	311730	311731		311731	
3" Valve				311732	311733	311734	311733	311734

*Valve Repair Kit includes these parts and lubricant.

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



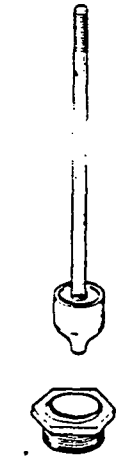
Set Screw	1/4-28 x 1/4 in. Socket Hd
Button	310503



	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
Valve Repack Kit	14003294-001				14003295-001

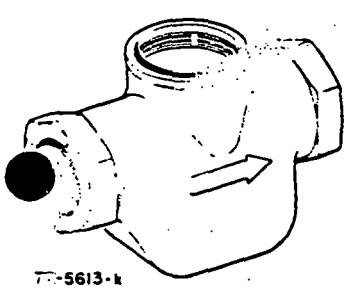
Metal to Metal Seated Valves

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.



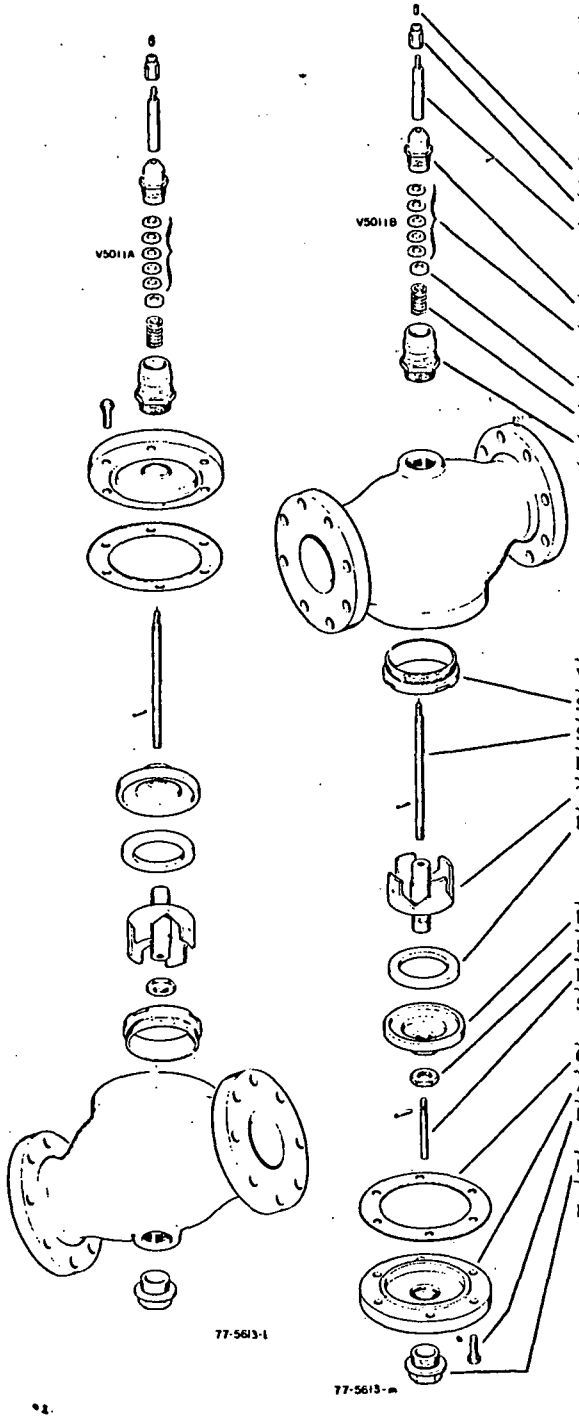
Plug & Seat Repair Assy	.40	.63	1.0	1.6	2.5	4.0	6.3	10	16	25
V5011C										
1/2"	311936E	311936A	311936C	311936D	311951A	311951A				
3/4"					311938A	314298A	311952A			
1"						314299A	314300A	311953A		
1-1/4"							314301A	314302A	311954A	
1-1/2"								314303A	314304A	312055A

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.



77-5613-k

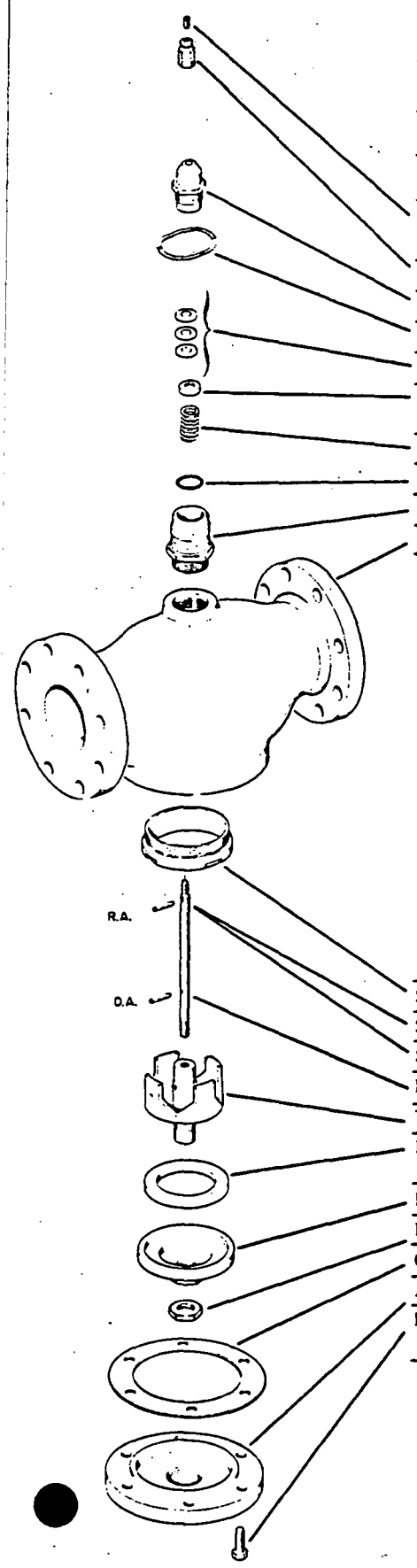
V5011 A & B Flanged Body 2-1/2" to 6" Composition Di



	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	1/4-28 x 1/4"	←	←	←	←	←	1/4-28 x 1/4"
Button	312495	←	←	312495	312496	←	312496
Extension 8" Actuator 13" Actuator	308077AQ	←	←	308077AQ	308077AT	←	308077AT
Packing Gland	311431	311431	311977	311977	312497	←	312497
Packing	311432 (4)	←	←	311432 (4)	312498 (5)	←	312498 (5)
Follower	311430	←	←	311430	312499	←	312499
Follower Spring	311565	←	←	311565	312500	←	312500
Bonnet	30040647-760	←	←	30040647-760	30040646-760	←	30040646-760
Valve Repack Kit	14003295-001	←	←	←	14003296-001	←	←
Seat Ring	30041027-760	30041028-760	30041027-760	30041028-760	30041029-760	30041030-760	30041030-760
Stem	30731050-001	30731052-001	300410220	30041221	30731054-001	30731056-001	30731058-001
Pin Stop (D.A.)	30064584-322	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 35-200F (0-93C) 115-275F (46-135C) 200-425F (145-246C)	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)					30041074	30041075	30041074
Stem Pin D.A. (1), R.A. (2)	30029911	←	←	30029911	30036549	←	30036549
Gasket	30046304-859	30046335-859	30041077	30041078	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)	(6)	(4)	1/2-13 x 1-1/4" (6)	9/16-12 x 1-1/2" (6)	(8)	9/16-12 x 1-1/2" (8)
Body Plug	30041026-200	←	←	←	←	←	30041026-200

NOTE: Part numbers for the V5011A & B are the same, however their sequence is different. Refer to the exploded diagrams at left.

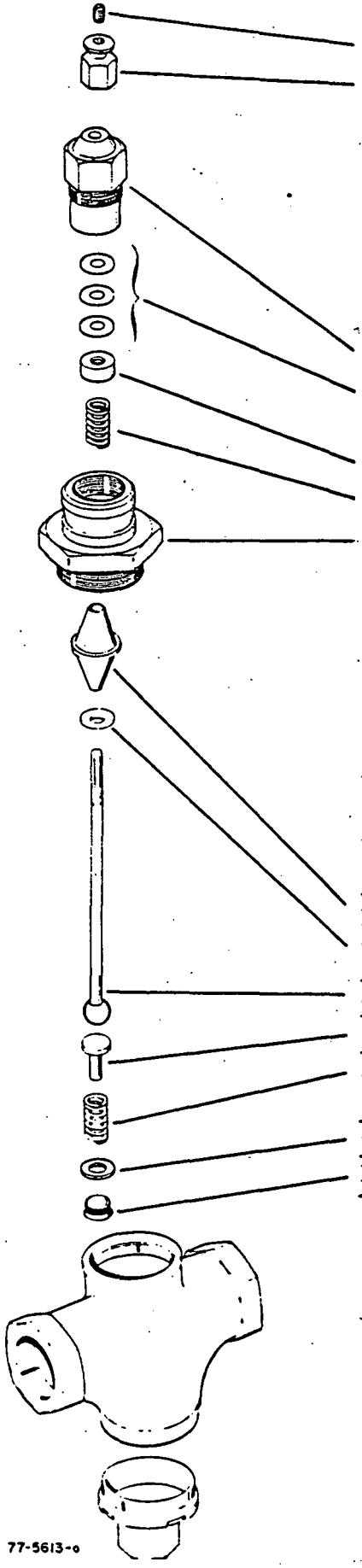
V5011 D & E Flanged 250 lb. Body 2-1/2" to 6"



	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
Packing Gland	30683374-002	30683374-002	30683135-001	←	30683135-001
Retaining Ring	30682506-002	30682506-002	30682506-003	←	30682506-003
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
Body					
Seat Ring	30041027-760	30041028-760	30041029-760	None	None
Stem D.A.	30731050-001	30731050-001	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
Throttling Plug	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., R.A.)					
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)

77-5613-n

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



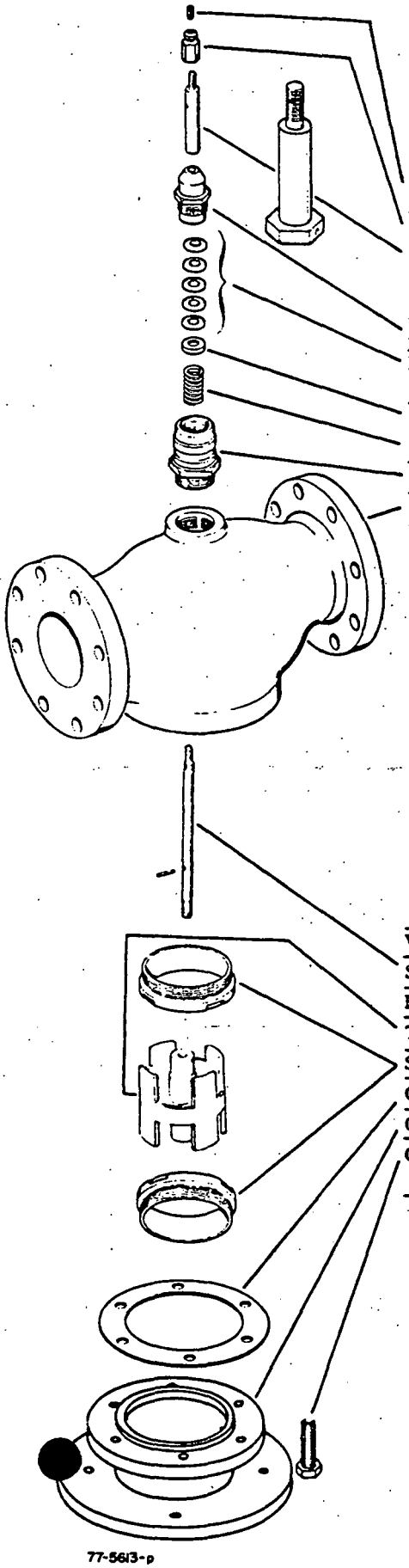
Set Screw	1/4-28 x 1/4" Socket Hd
Button	310503 ← → 310503

	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
Valve Repack Kit	14003294-001				14003295-001	

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

77-5613-o

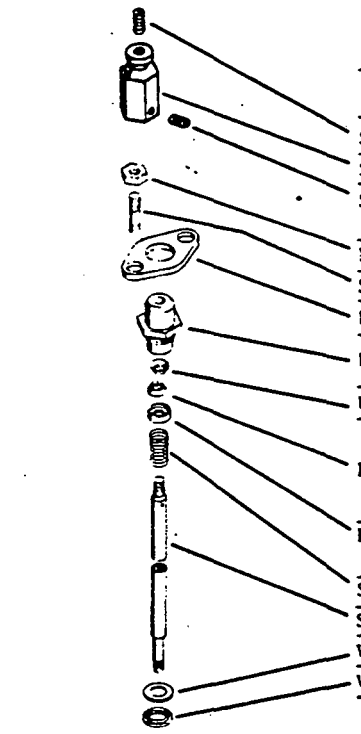
V5013 A Flanged Body 2-1/2" to 6" Metal to Metal Seat



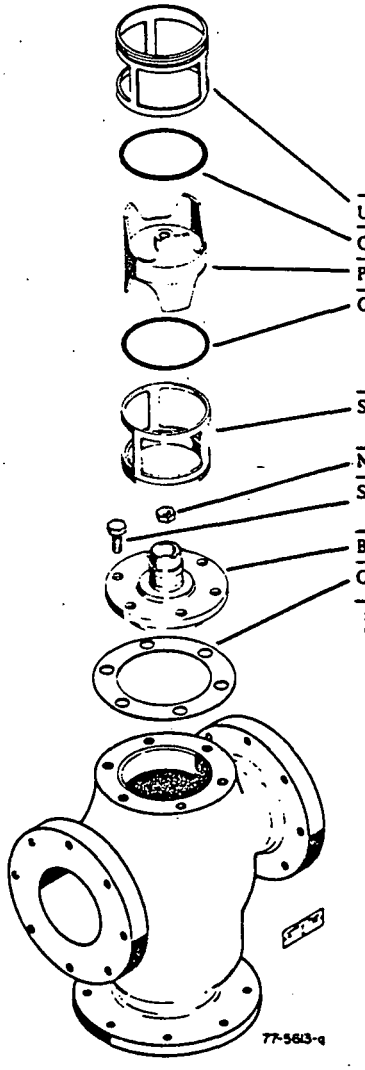
	3/4 in. Travel (19 mm)		1-1/2 in. Travel (38 mm)		
Valve Size	2-1/2"	3"	4"	5"	6"
Cv	63	100	160	250	360
Set Screw	1/4-28 x 1/4" Socket Hd				
Button	312495	312495	312496	312496	312496
Stem Extensions 8" Actuator 13" Actuator	 308077AQ ------	 308077AQ ------	 ------ 308077AT	 ------ 308077AT	 ------ 308077AT
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
Body					

Valve Repack Kit	14003295-001		14003296-001		
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"



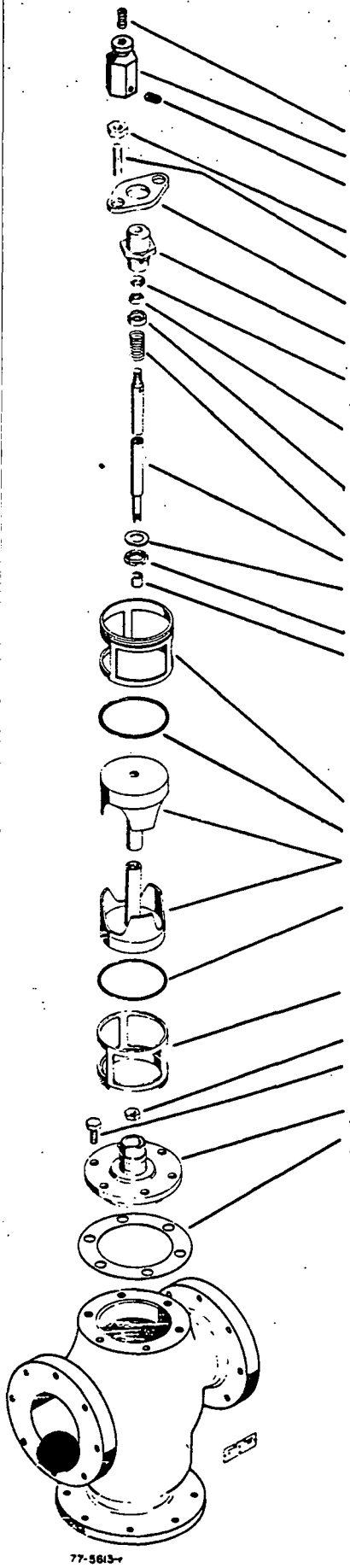
Valve	V5013B1003 V5013D1009	V5013B1011 V5013D1017	V5013B1029 V5013D1025	V5013B1037 V5013D1033	V5013B1045 V5013D1041	V5013B1052 V5013D1058
Size	2-1/2"	3"	4"	5"	6"	8"
Set Screw Socket Hd	1/4-28 x 1/4"	←	←	←	1/4-28 x 1/4"	None
Stem Head	30041088-107	30041088-107	30041089-235	←	30041089-235	None
Set Screw Cup Point Socket Head	8-32 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	30067857-107 30683374-001	30067857-107 30683374-001	30067858-001 30683135-002	30067858-001 30683135-002	30067858-001 30683135-002	None None
Upper Wiper Seal	None	←	←	←	None	30065392-854
Packing	30041035-854 (4) 30685565-002 (3)	30041035-854 (4) 30685565-002 (3)	30041036-854 (5) 30685565-003 (3)	30041036-854 (5) 30685565-003 (3)	30041036-854 (5) 30685565-003 (3)	30065401-936 (1)
Packing Follower	30041086-107	30041086-107	30041087-107 (2)	←	30041087-107 (2)	30037243-303
Spring	30041084-218	30041084-218	30041085-218	←	30041085-218	30065380-461
Stem	30067837-316	30067838-316	30067839-316	30067840-316	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 Numbers Listed Below.					
Plug	30067832-760	30067833-760	30067834-760	30067835-100	30067836-100	30069130-100
O-Ring	30684011-001 (2)	30067531-891 (2)	30067533-891 (2)	30067853-891 30067855-891 30067535-891 (2)	30067856-891	30069137-891
Seat Ring (Subassembly) (2)	30067842-905	30067843-905	30067844-905	30685316-001	30067849-100	30069135-100
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 part numbers for V5013D - 250 lb. bodies. Not interchangeable with V5013B.

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



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	30041035-854 (4) 30685565-002 (3)	30041035-854 (4) 30685565-002 (3)	30041036-854 (5) 30685565-003 (3)	←	30041036-854 (5) 30685565-003 (3)	30065401-936
Packing Follower	30041086-107	30041086-107	30041087-107 (2)	←	30041087-107 (2)	30037243-303
Spring	30041084-218	30041084-218	30041085-218	←	30041085-218	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)	30067843-905 (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 x2-1/4" (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.

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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Comfort Control Systems

RP908A & B PNEUMATIC CONTROLLERS

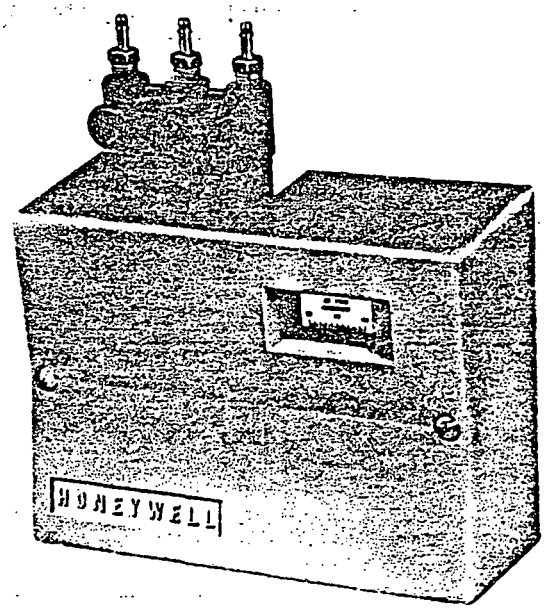
Service Data

GENERAL DESCRIPTION

The RP908A and B controllers are force balance pneumatic amplifiers, with adjustable proportional bands. All models are corrosion resistant for high humidity or salt service (not in direct spray); and may be set for either direct or reverse action.

The RP908A controller, in conjunction with its remote sensor, provides proportional direct control or limit control in air conditioning systems.

The RP908B dual input controller has an adjustable authority setting for the compensating sensor relative to the system effect on the primary sensor. It is applied to compensating systems by using an additional compensating signal to change the control point of the controller. Temperature, humidity, pressure or dewpoint may be controlled by using the appropriate sensors.



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Both A and B controllers have an optional model that features remote control point adjustment (CPA). This feature changes the control point from a remote location by varying the pressure on the CPA port.

Table 1.

Model	Single Input	Single Input Limit	Dual Input	With Cover	Without Cover	With CPA	Without CPA	With Calibration Knob	Without Calibration Knob
RP908A 1005	X			X			X	X	
RP908A 1013	X			X		X		X	
RP908A 1021	X				X		X		X
RP908A 1039	X				X	X		X	
RP908A 1047		X		X			X	X	
RP908A 1054	X			X			X	X	
RP908A 1062		X			X		X		X
RP908B 1003			X	X			X	X	
RP908B 1011			X	X		X		X	
RP908B 1029			X		X		X	X	
RP908B 1037			X		X	X		X	

Rev. 11-77
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Form Number 75-5531
Commercial Div.

SPECIFICATIONS

Supply Air Pressure: 18 psi (124 kPa).

Maximum Safe Air Pressure: 25 psi (172 kPa).
Ambient Temperature Limits: 40 to 120 F (4 to 90 C).

TYPICAL OPERATION

RP908A (See Fig. 1)

When used in a heating system with the controller set for direct action, a drop in temperature at the sensor lowers the branch line pressure, opening the valve to increase the flow of heating medium to the coil. If the control point adjustment model (CPA—not shown) is used, an increase in air pressure on the CPA port raises the setpoint of the controller and a decrease lowers it.

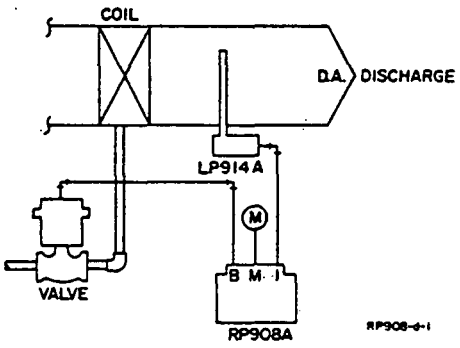

Fig. 1. RP908A.

RP908B (See Fig. 2)

An increase in outdoor temperature causes the compensating (outdoor) sensor to raise the branch line pressure. If changes occur at both the outdoor and discharge sensors, the resulting change in branch line pressure is dependent on the authority setting on the controller.

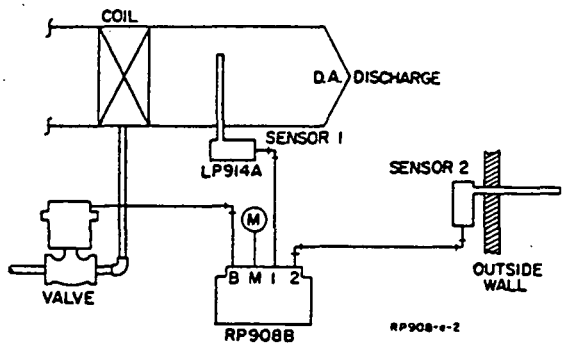

Fig. 2. RP908B.

RP903A LIMIT CONTROLLER (See Fig. 3)

When used as an economizer controller in a mixed air system, the primary controller and the mixed air sensor act to modulate outside and return air dampers to maintain a constant mixed air temperature. When the mixed air temperature exceeds the setpoint of the primary controller, the outdoor damper opens farther and the return air damper drives toward its closed position. As the outdoor air reaches the setpoint of the primary controller, 100 percent outdoor air is taken in.

As the outdoor air temperature continues to rise and reaches the limit controller setting, its branch line pressure reduces, closing the outdoor dampers while opening the return air dampers. The dampers remain in this position as long as the outside air temperature exceeds the limit controller setpoint.

On all limit control applications, a model with a factory blocked restriction or a field modification to block the internal restriction is necessary. When a restriction is blocked, the port number is shown in a box on the drawing and a separate restricted source of air must be furnished to the sensor. When more than one controller is connected to a single sensor, the same technique of blocking the internal restriction and supplying air to the sensor(s) through a separate external restricted main is used. If there is variable pressure on the "M" port, the separate main assures proper calibration of the limit control and accurate indication of its sensor temperature.

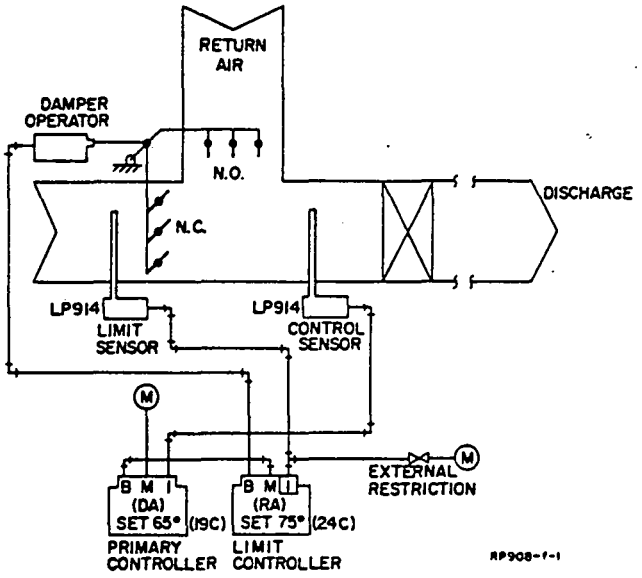

Fig. 3. RP908A Limit Controller.

RP908A LOW LIMIT CONTROLLER (See Fig. 4)

Used as a low limit controller, the RP908A reduces branch line pressure to open a heating valve to maintain the discharge temperature at its setpoint when the primary controller is partially or completely satisfied.

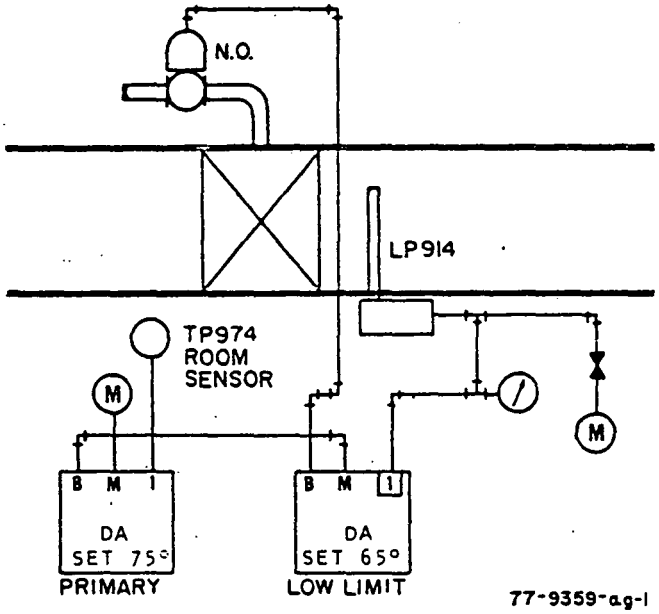

Fig. 4. Low Limit Controller.

MAINTENANCE

The only preventive maintenance necessary is an annual visual check for leaks, loose fittings, etc and an operational and calibration check.

Use PLASTILUBE* (311057, 2 oz. tube) for "O" rings, screw threads, etc. Use MOLYCOTE* or similar commercial powdered lubricant for pivots and plungers in units with CPA.

OPERATIONAL CHECK

Vary the pressure slowly in ports 1 and 2. The main lever should move smoothly, and the branch line pressure should change gradually in the proper direction.

CALIBRATION CHECK

RP908A—Change the setpoint of the controller to the existing sensor temperature if the two don't already match. The branch line pressure should be at its calibration pressure (8 ±1 psi [55 ±7 kPa]) unless otherwise noted. If recalibration is necessary, see Calibration Procedure.

RP908B—Determine the existing calibration temperature from the reset schedule. Measure the temperature at the port 1 sensor. These temperatures should agree within 2 percent of the sensor range span and the branch line pressure should be within the operating range of the controlled device. See Calibration Procedure for RP908B if recalibration is necessary.

FIELD MODIFICATIONS

CHANGE FROM DIRECT ACTING TO REVERSE ACTING

The change from direct to reverse is made by following the three steps listed in Figure 5.

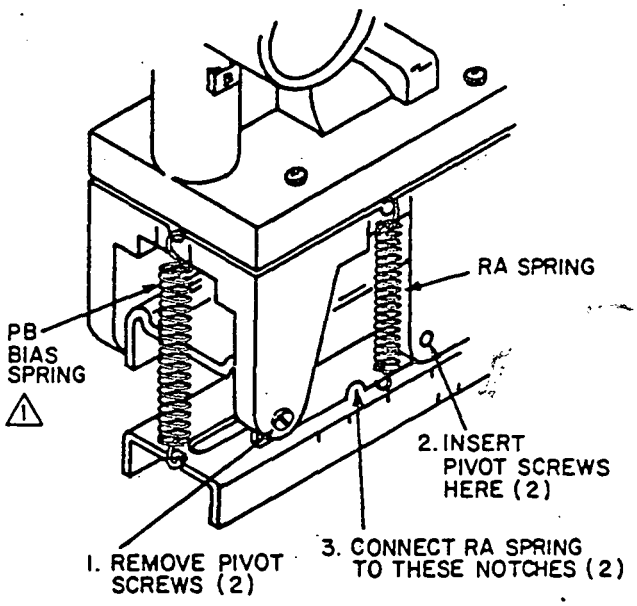

Fig. 5. Set-Up for Reverse-Acting Operation.

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REPLACEMENT OF RESTRICTION WITH BLANK PLATE

The internal restriction must be replaced with a blank ate when the sensor is supplied with an external source restricted air. This occurs when the air supply to the "M" port of the controller may be varied by other controls or when a single sensor is connected to more than one controller (see Fig. 6). To replace the restriction with a blank plate, refer to Figure 10 for RP908A or Figure 12 for RP908B and proceed as follows.

1. Remove the manifold and gasket.
2. Remove the port 1 "O" ring, restriction, screen, filter, and washer and replace them with the blank plate No. 316125.
3. Reassemble the "O" ring, gasket, and manifold, carefully noting the orientation of the gasket.

When using only one port of an RP908B controller and the restriction is not blocked, do not plug the unused port but leave it open to avoid building up to main line pressure in the sensor chamber. Two models of the RP908A are provided with a factory installed blank. These models are identified by a red manifold. When field installing a blank, the manifold should be marked indicating that the restriction is blocked.

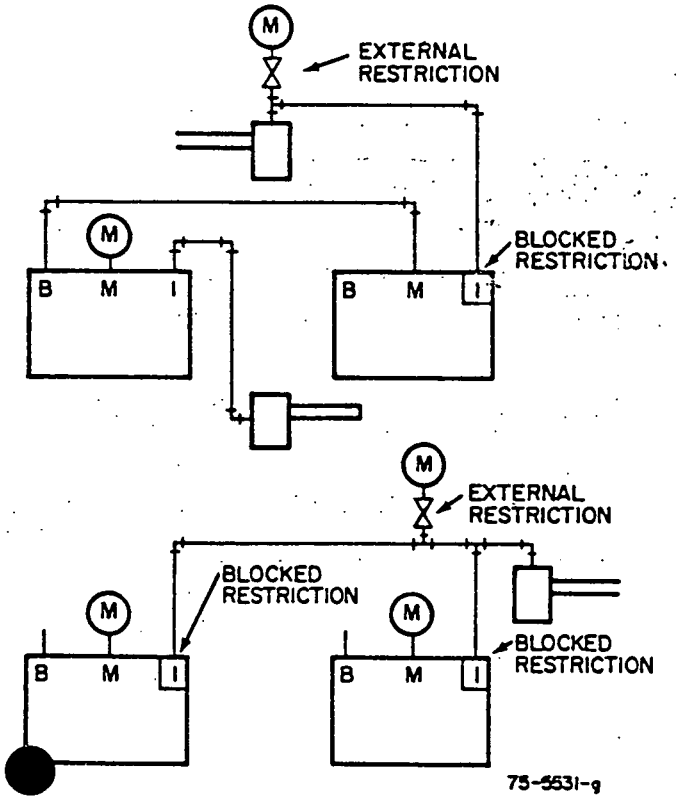


Fig. 6. Blank Plate Used to Block Restrictions.

ADJUSTMENTS

PROPORTIONAL BAND ADJUSTMENTS (Refer to Fig. 7)

1. Loosen the proportional band adjustment knob and slide the indicator to the desired proportional band.
   NOTE: When a proportional band of more than 15 percent is used, fasten the proportional band bias spring to the main lever. (This spring is left unconnected if proportional band is 15 percent or under.)
2. The controller must be recalibrated whenever the proportional band is changed.

REMOTE CONTROL POINT ADJUSTMENT

A pressure change from 3 to 13 psi (20 to 90 kPa) in the remote CPA, changes the control point proportionately by 20 percent of the sensor span.

SETPOINT ADJUSTMENT (See Fig. 8)

The setpoint is raised by turning the setpoint adjustment screw counterclockwise. This increases the force from the setpoint spring on the main lever so that a greater force from the sensor chamber is required to cause an increase in branch line pressure.

The setpoint adjustment screw has a vernier for fine adjustment. The screw has 10 marked divisions; each division equals 1/2 percent of the sensor span (1 F per division for a 200 degree sensor span, or 20 turns for the whole span).

CALIBRATION

Always calibrate with 18 psi (124 kPa) main air pressure. On CPA models, set CPA to 8 psi (55 kPa). A 0 to 30 psi (0 to 207 kPa) gage must be installed in branch port line during calibration and a temperature, humidity or pressure gage should be installed in port 1 (and port 2, if RP908B is used). If the reset signal on an RP908A is produced by the output of a room thermostat or pressure control, a 30 psi (207 kPa) gage must be installed in the No. 2 port. Otherwise, the scale range on the gage should match the range of the sensor for ports 1 and 2.

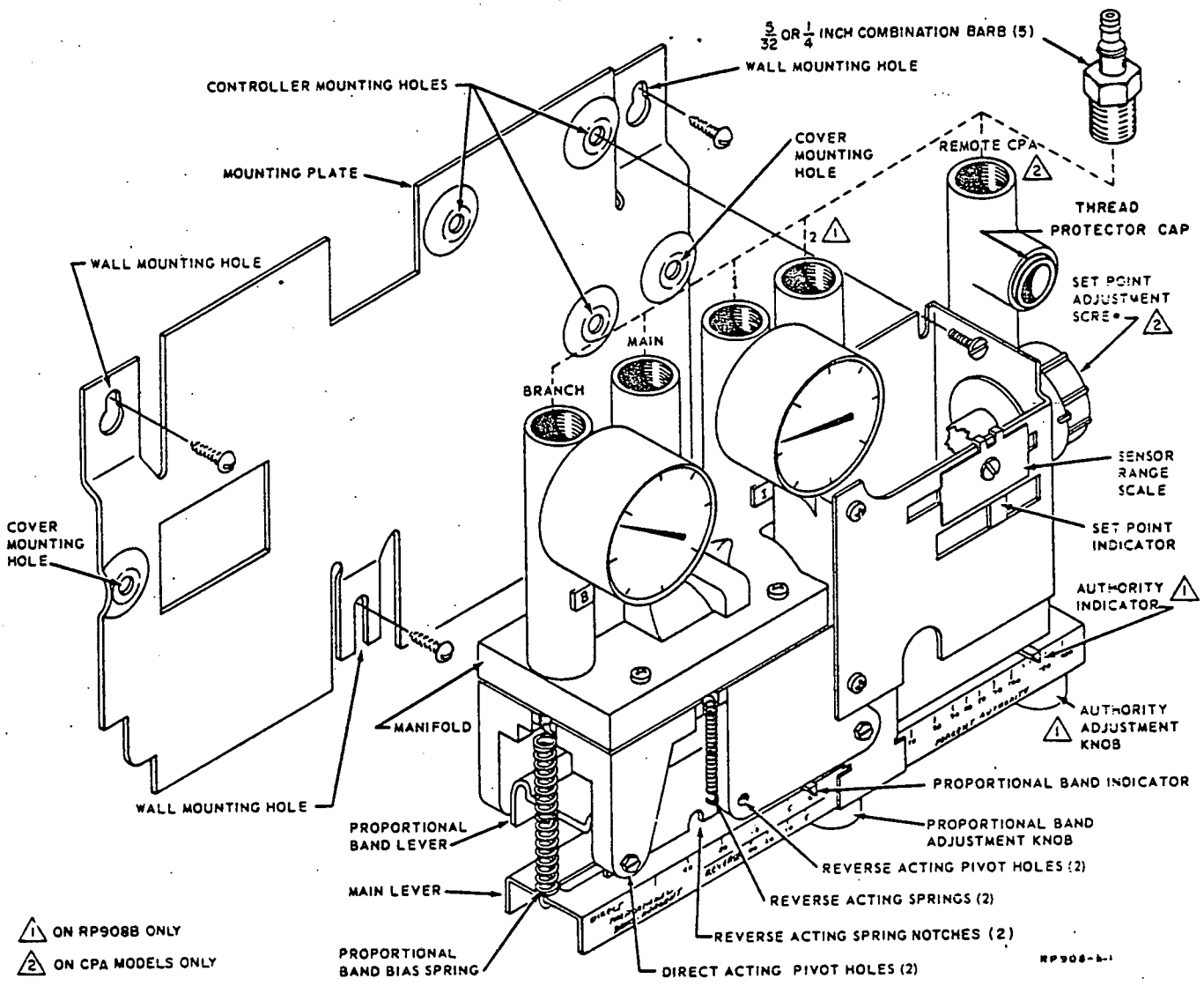


Fig. 7. RP908 Controller.

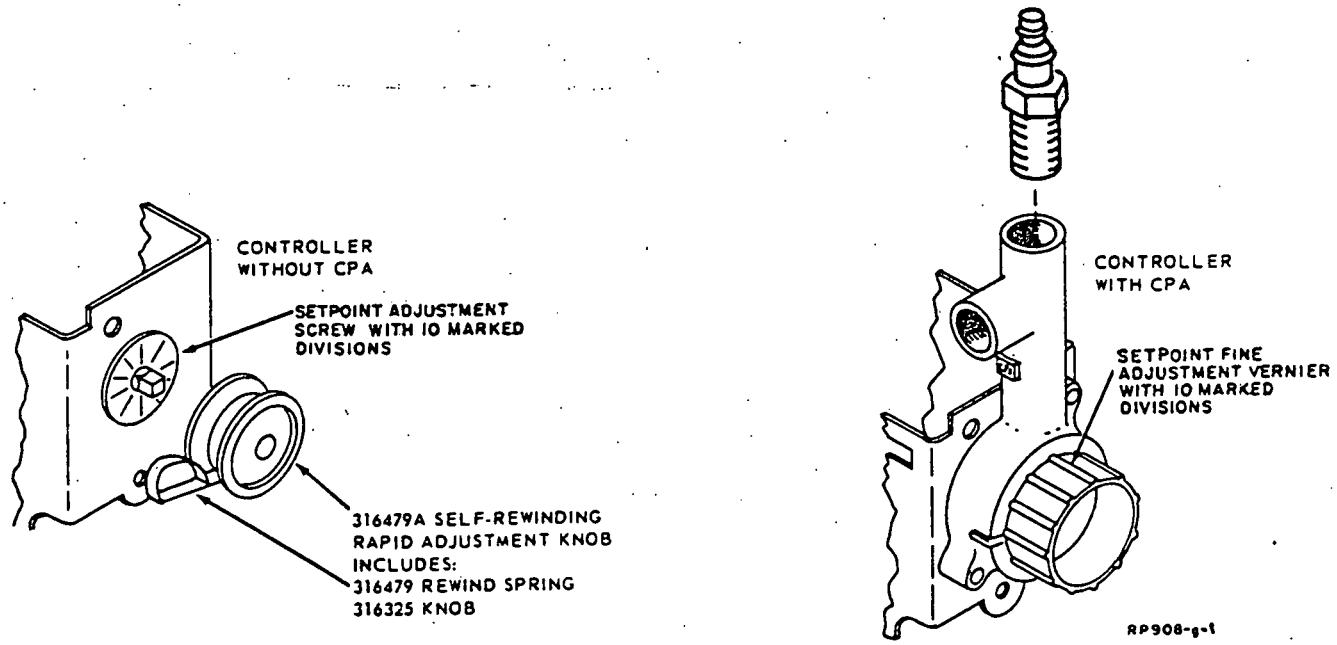


Fig. 8. RP908A & B Setpoint Adjustment.

RP908A

There are two methods of calibrating the RP908A en 18 psi (124 kPa) main air is supplied to the con-ller and the internal restriction is not blocked.

CALIBRATION USING THE ADJUSTABLE RESTRICTION

1. Install the proper sensor range scale plate on the controller if not installed already.
2. Disconnect the port 1 sensor and connect an adjustable restriction to port 1.
3. Choose a setpoint and adjust the restriction until the gage in port 1 shows this setpoint.
4. Turn the setpoint adjustment screw until the BLP reads 8 psi (55 kPa). This is standard calibration. On some applications the calibration branch line pressure may be set at a different point that relates to the spring range of the device being operated.
5. Move the sensor range scale plate to the setpoint and tighten the scale. The controller is now in calibration.
6. Disconnect the adjustable restriction and reconnect the sensor.

CALIBRATING WITH GAGES ONLY

1. Install gages in ports 1 and B (Port 1–gage must match sensor, port B–30 psi [207 kPa] gage is used).
2. Install the proper sensor range scale plate on the controller if not already done.
3. Turn the setpoint adjustment screw until BLP is 8 psi (55 kPa) or other selected calibration pressure. (See step 4 above.)
4. Move the scale until the setpoint indicator is at the reading shown on the port 1 gage and tighten the scale.
5. Adjust the setpoint to the desired control setting.

RP908B

The only method of calibrating the RP908B dual input controller is to use an adjustable restriction. If e settings are known, proceed to step No. 1 of the procedure. If they must be calculated, read the following information and calculate as shown. The authority calculator (Part No. 813) may be used to simplify these calculations.

CALCULATIONS

Although this typical example is shown for a hot water reset system, the formulae also apply to other reset systems.

Four separate parameters must be known in order to properly calibrate a reset system: Reset Schedule, Throttling Range, Proportional Band, and Authority.

Reset Schedule

The reset schedule will be plotted by determining the outdoor air temperature at which designed maximum heating water temperature is needed and the outdoor air temperature at which no heating is required. Minimum water temperature of 90 F (32 C) is recommended at this point for direct radiation systems. Use 80 F (27 C) for systems with heating coils, and 75 F (24 C) for radiant floor panels.

Throttling Range (TR)

Throttling range indicates the change in water temperature at the sensor to cause the valve to move from fully open to fully closed (full heat to no heat). It is desirable to have a TR as narrow as possible for efficient valve control and yet wide enough to produce stable valve operation. A TR of 10 F (5 C) is a recommended trial setting. If the system will not stabilize after being in operation for a short period of time, the TR should be increased (this will require recalculation of the proportional band and authority). An unstable system can be recognized by frequent, repetitive changes in branch line pressure, known as hunting or cycling.

When the throttling range has been selected, it must be converted to a proportional band value that can be set on the controller.

Proportional Band (PB)

Proportional Band is similar to TR except it is expressed in terms of percent of temperature change rather than degrees. Proportional band can be determined by using the following formula:

$$\frac{TR}{\text{Sensor Span}} \times 100 = PB\ \%$$

Example:

When a sensor having a 200 degree span is used and a 10 degree TR has been selected:

$$\frac{10}{200} \times 100 = 5\%$$

Authority

Authority indicates the amount of effect that the change in outdoor air temperature will have on the control point. Authority can be determined by the following formula:

$$\text{Authority} = \frac{\Delta T_1 + TR}{\Delta T_2} \times 100$$

Where:

TR = Throttling Range

ΔT_1 = Change in Hot Water Temperature

ΔT_2 = Change in Outdoor Air Temperature

Example:

Determine settings for a system where hot water should be controlled at 180 F when outdoor air temperature is -10 F, and reduced to 90 F when outdoor air is 65 F. Assume a TR of 10 F.

Reset Schedule

Outdoor Air Temperature (T_2) Sensor 2	Hot Water Temperature (T_1) Sensor 1
-10 F	180 F
65 F	90 F

$\Delta T_2 = 65 - (-10\ F) = 75\ F$

$\Delta T_1 = 180 - 90 = 90\ F$

TR = 10 F (assumed)

$$PB = \frac{10}{200} \times 100 = 5\%$$

$$\text{Authority} = \frac{90 + 10}{75} \times 100 = 133\%$$

RP908B CALIBRATION PROCEDURE

1. Install the sensor range scale plate matching the port 1 sensor on the controller if not already done.
2. Disconnect the sensors to ports 1 and 2 and connect an adjustable restriction to each port. If an external main has been connected to the sensor line, install the adjustable restriction on the sensor side of the tee.
3. Select the low end of the sensor 1 schedule (90 F or 32 C). Adjust the No. 1 restriction until the sensor 1 gage reads that temperature.
4. Select the high end of the sensor 2 schedule (65 F or 18 C). Adjust the No. 2 restriction until the sensor 2 gage reads that temperature.
5. Set the Authority and Proportional band into the controller. Adjust the setpoint adjustment screw until the branch line gage reads 12 psi (89 kPa), or until it reads the "valve close" pressure if the valve has other than a standard 4 to 11 psi (27 to 76 kPa) spring range.
6. Move the sensor range scale plate until the desired setpoint lines up with the setpoint indicator and tighten the scale plate. The controller is now in calibration.

REPAIR

To replace internal filters, screens, restrictions, and "O" rings, use repair kit Part No. 14002696-001.

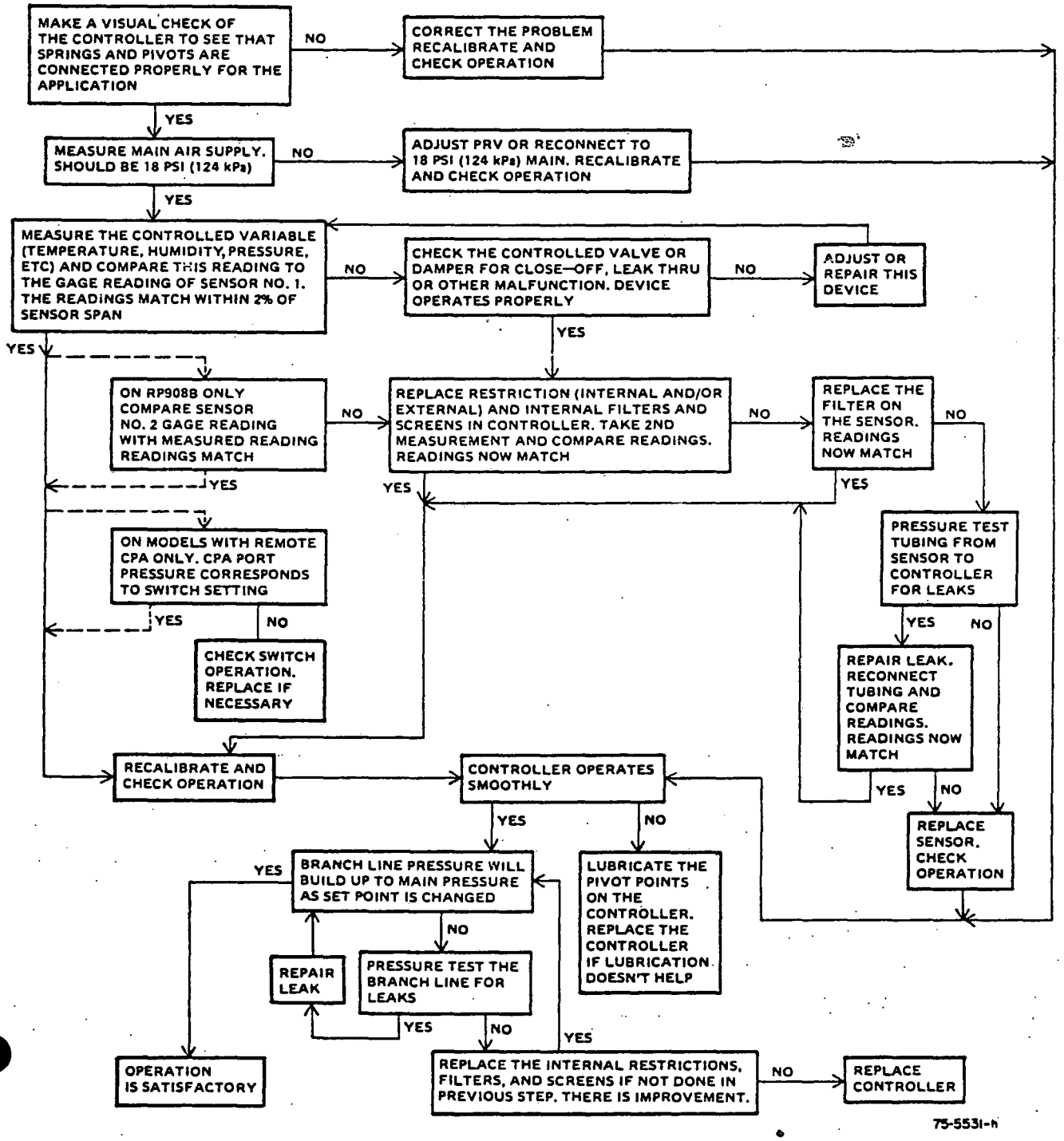
1. Remove four (4) manifold screws and save.
2. Lift the manifold from controller body.
3. Remove the gasket and discard.
4. Note location of filters and restrictions in controller body. The RP908A may have two or three filters and the RP908B may have three or four. Some controllers may have a blank plate in place of a restriction, filter, screen and washer.
5. Remove washers, filters, screens, restriction(s) and "O" rings, and discard.
6. Remove restriction blank, if installed, and save.
7. With the new parts from the kit, install the washers, filters, screens and restriction(s). See Figure 10 for RP908A and Figure 12 for the RP908B.
8. Reinstall the restriction blank.
9. Add the "O" rings and the gasket. Orient the gasket in the way that blocks no ports.
10. Place the manifold in position on the gasket and install the original four screws. Tighten securely.

TROUBLESHOOTING

See Flowchart.

NECESSARY TEST EQUIPMENT–CALIBRATED GAGE SET (No. 816A)

If the sensor-controller is not maintaining control:



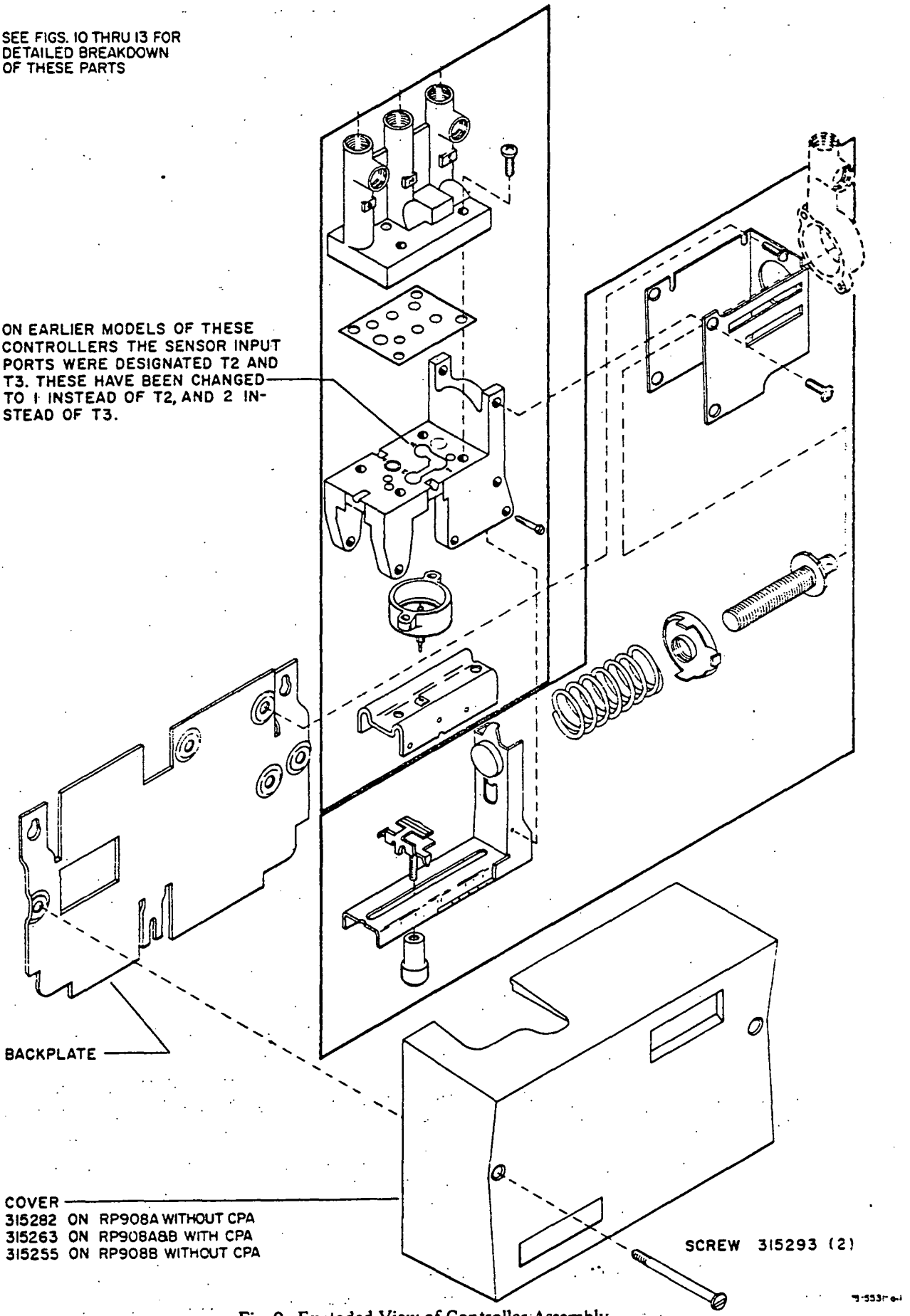


Fig. 9. Exploded View of Controller Assembly.

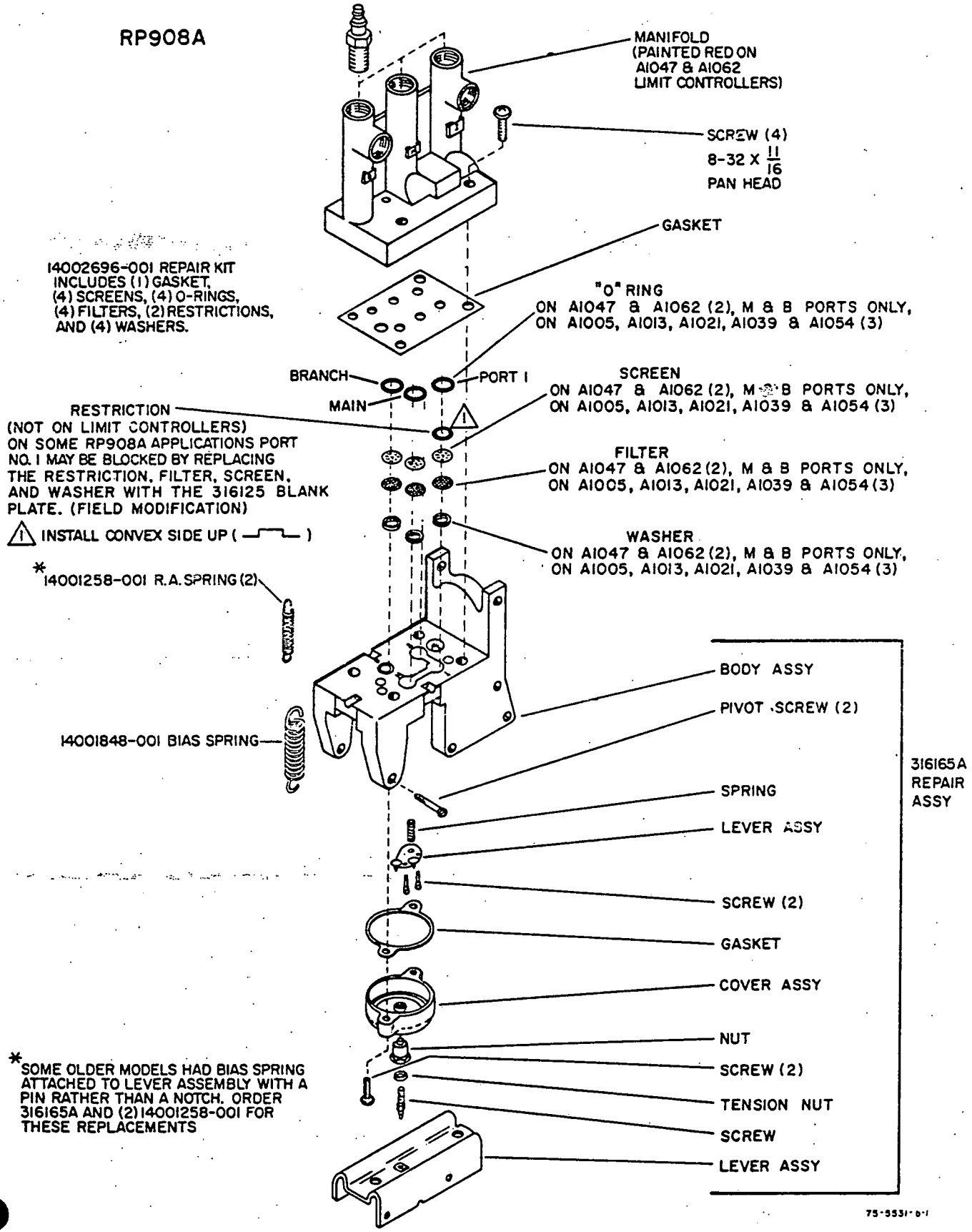


Fig. 10. Detail of RP908A Manifold and Body Assembly.

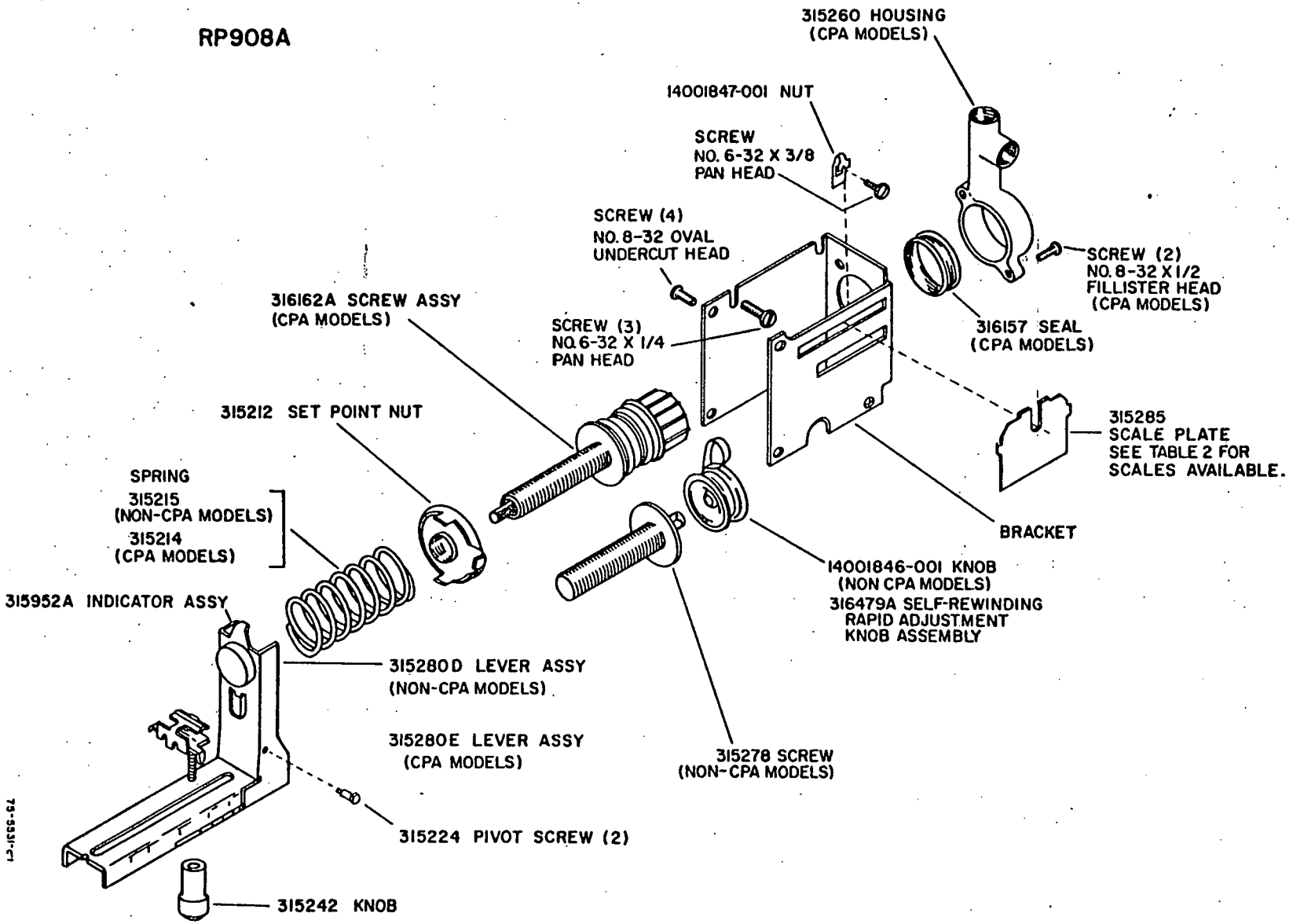


Fig. 11. Detail of RP908A Bracket and Indicator Assembly.

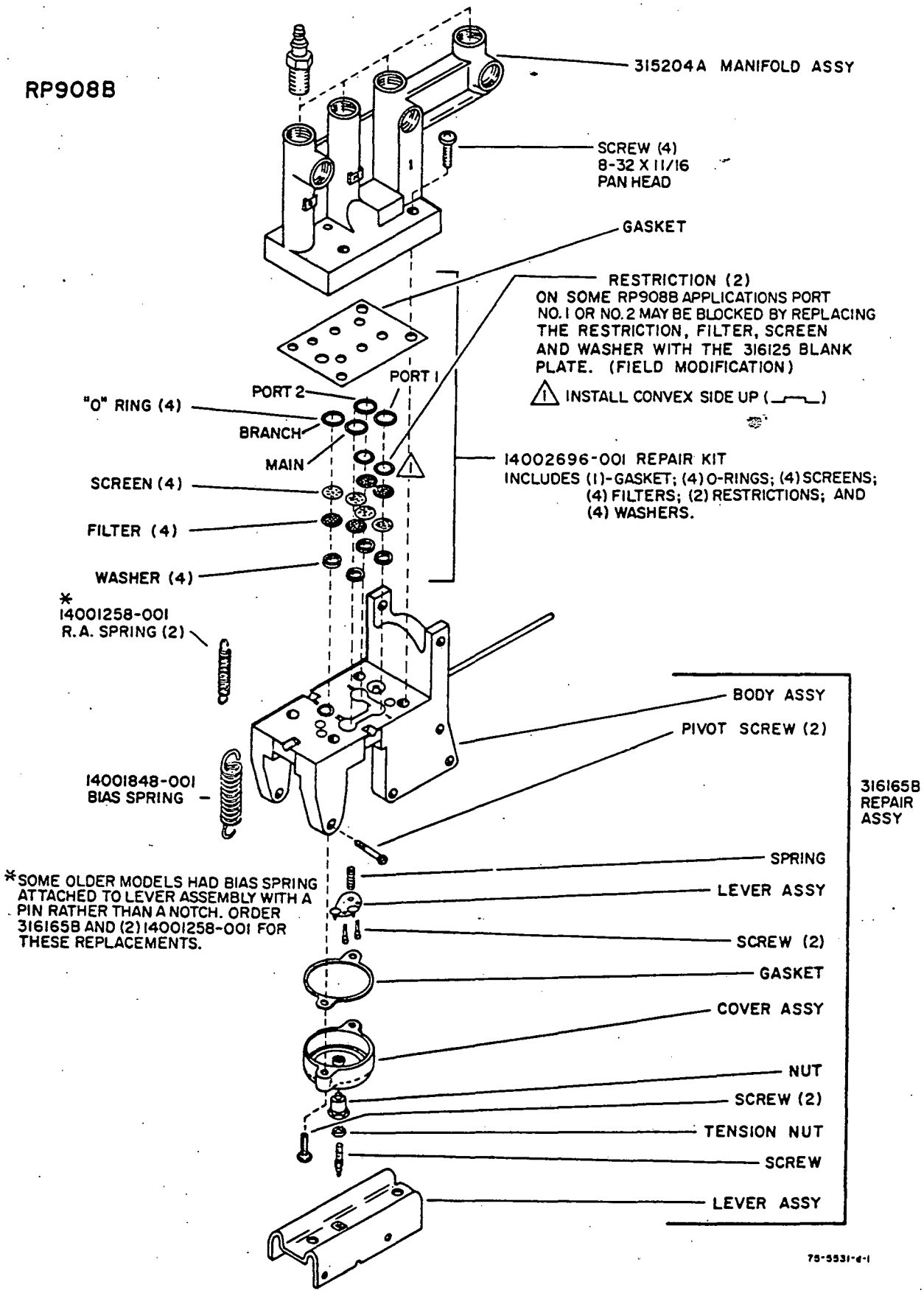


Fig. 12. Detail of RP908B Manifold and Body Assembly.

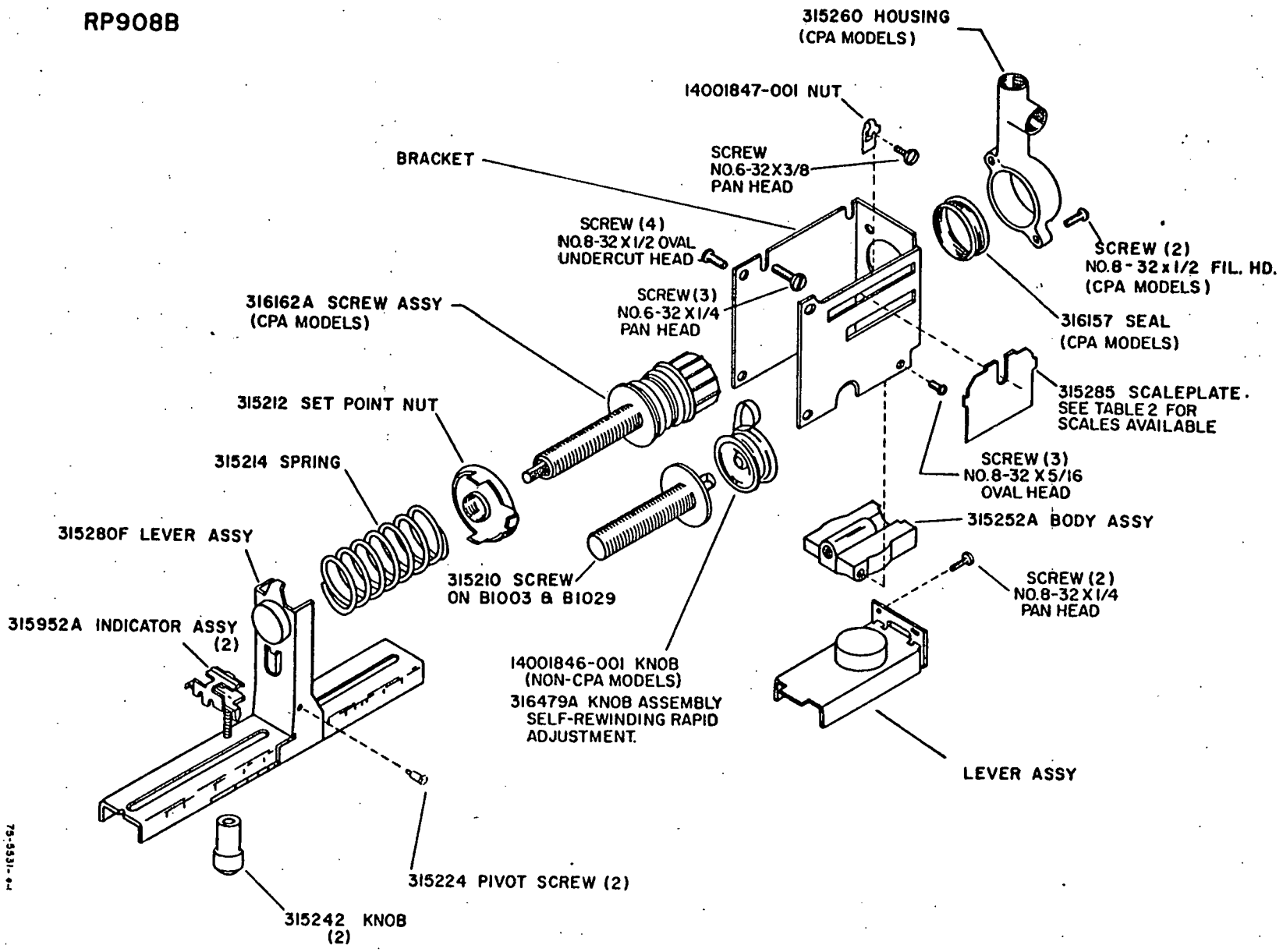


Fig. 13. Detail of RP908B Bracket and Indicator Assembly.

ACCESSORIES

SCALE PLATE KITS

Four scale plate kits are available. Each kit contains a different set of stick-on decals. Specific decals are listed with proper order numbers in the table below.

Table 2. Scale Plate Kits.

No. 315993A	
0 to 200 F	-20 to 80 C
-40 to 160 F	5 to 105 C
-40 to 240 F	10 to 40 C
50 to 150 F	-30 to 30 C
3 to 15 psig	30 to 80% RH
Warmer/Cooler	0.2 to 1.0 kg/cm^2
No. 316193	
40 to 75 F Dew Point	
-20 to 80 F	
-40 to 60 C	
-5 to 25 C Dew Point	
No. 316005A	
0 to 6 inches	
No. 316089A	
0 to 150 mm	

GAGES

The 1-1/2 inch gages are listed below. 2-1/2 and 3-1/2 inch gages are also available. They are found on Form No. 74-1269.

Table 3. Gages.

Gages (1-1/2 in. dia back conn. 1/8 NPT)	Scale Range	For Use with Sensor
14000786-001	25 to 125 F	LP914
14000786-002	-5 to 55 C	LP914
305929	-40 to 160 F	LP914
305932	-40 to 70 C	LP914
305931	40 to 240 F	LP914
305934	5 to 115 C	LP914
305986	-20 to 80 F	LP914
305987	-30 to 30 C	LP914
305930	0 to 200 F	LP915
305933	-18 to 93 C	LP915
305972	50 to 100 F	TP924, TP974 & TP925
305973	10 to 38 C	TP924, TP974 & TP925
	Relative Humidity	
305974	30 to 80%	HP901 & HP902
14000786-003	15 to 75%	HP971
14000786-004	65 to 95%	HP971
	Dew Point	
305988	40 to 75 F DP	TP925A1018
305989	5 to 25 C DP	TP925A1018
	Pressure	
305965	0 to 30 psi	
305615	-1 to 1 in. of WC	PP905
305621	-25 to 25 mm of WC	PP905
305616	0 to 2 in. of WC	PP905
305622	0 to 50 mm of WC	PP905
305617	1 to 3 in. of WC	PP905
305623	25 to 75 mm of WC	PP905
305618	2 to 4 in. of WC	PP905
305624	50 to 100 mm of WC	PP905
305619	3 to 5 in. of WC	PP905
305625	75 to 125 mm of WC	PP905
305620	4 to 6 in. of WC	PP905
305626	100 to 150 mm of WC	PP905

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

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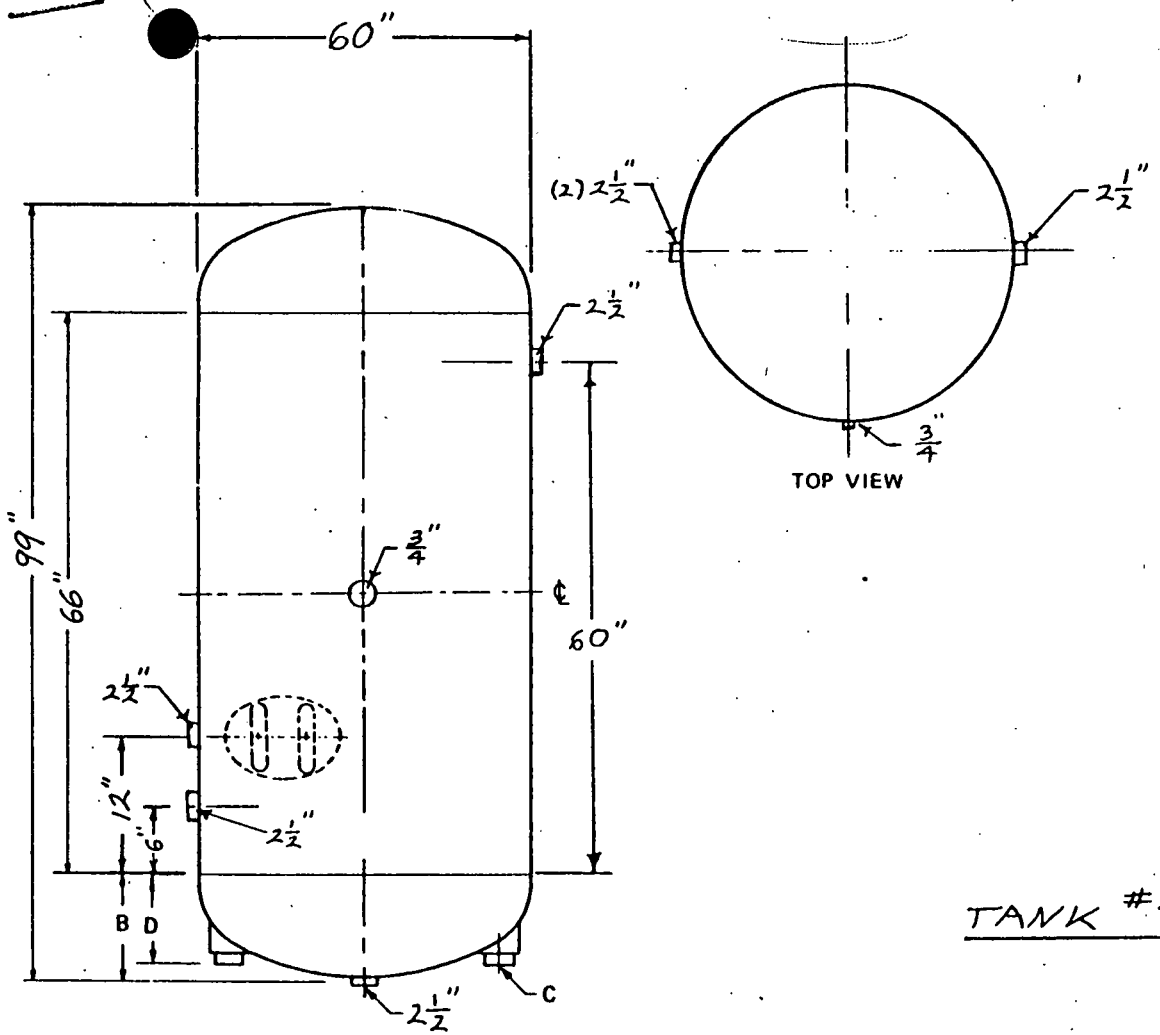


TANK # T-4

M.E.

TANK DIA. IN.	B HEAD DEPTH	C LEG CPLG.	D DIMEN. IN.	TANK DIA. IN.	B HEAD DEPTH	C LEG CPLG.	D DIMEN. IN.
18	6	3–1	5	54	15½	3–2	8
24	7½	3–1½	7	60	16½	4–2	8
30	9	3–1½	7	66	17½	4–2½	8
36	10½	3–1½	7	72	20	4–2½	10
42	12	3–2	8	84	22	4–2½	12
48	13½	3–2	8	96	24½	4–2½	13

11x15 Manhole standard only on Cement, Phenolic, Copper Lined & all tanks 42" dia. & over. All others to have inspection openings as required by ASME Code.

NUMBER REQ'D. 1

DIA. 60" S.L. 66" O.A. 99"

CAPACITY: 1010 GALLONS

FINISH: INTERIOR UNLINED

EXTERIOR PRIME COAT

CUSTOMER CPM MECHANICAL

JOB AMITY SCHOOL SOLAR

SUBMITTED BY RO-BAR EQUIP.

DATE 2/28/79

ACE TANK & HEATER CO.
10847 SO. PAINTER AVENUE
SANTA FE SPRINGS, CALIF. 90670
TELEPHONE (213) 941-0221

VERTICAL ASME PSI STORAGE TANK

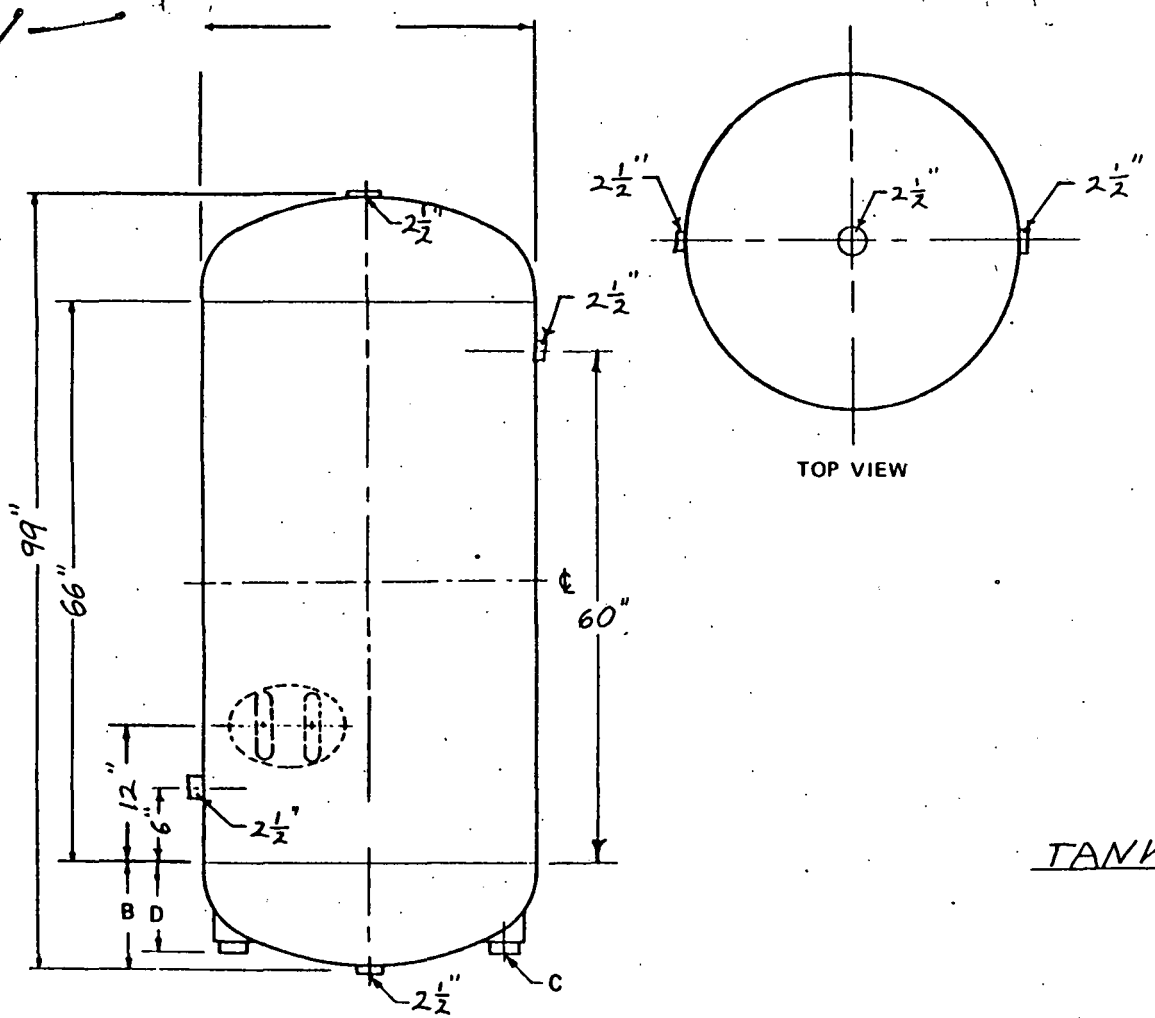
MODEL NO. S60 – 5.5 U

MANUFACTURED IN ACCORDANCE WITH SECTION VIII, ASME PRESSURE VESSEL CODE

Fitting locations to be dimensioned from head and shell joint. Tolerance ±2%

SCALE: NONE

DWG. NO. 510-3



TANK # T-5

M.E.

TANK DIA. IN.	B HEAD DEPTH	C LEG CPLG.	D DIMEN. IN.	TANK DIA. IN.	B HEAD DEPTH	C LEG CPLG.	D DIMEN. IN.
18	6	3–1	5	54	15½	3–2	8
24	7½	3–1½	7	60	16½	4–2	8
30	9	3–1½	7	66	17½	4–2½	8
36	10½	3–1½	7	72	20	4–2½	10
42	12	3–2	8	84	22	4–2½	12
48	13½	3–2	8	96	24½	4–2½	13

11x15 Manhole standard only on Cement, Phenolic, Copper Lined & all tanks 42" dia. & over. All others to have inspection openings as required by ASME Code.

NUMBER REQ'D. 1
DIA. 60" S.L. 66" O.A. 99"
CAPACITY: 1010 GALLONS
FINISH: INTERIOR UNLINED
EXTERIOR PRIME COAT
CUSTOMER CPM MECHANICAL
JOB AMITY SCHOOL SOLAR
SUBMITTED BY RO-BAR EQUIP.
DATE 2/28/79

ACE TANK & HEATER CO.
10847 SO. PAINTER AVENUE
SANTA FE SPRINGS, CALIF. 90670
TELEPHONE (213) 941-0221

VERTICAL ASME PSI STORAGE TANK

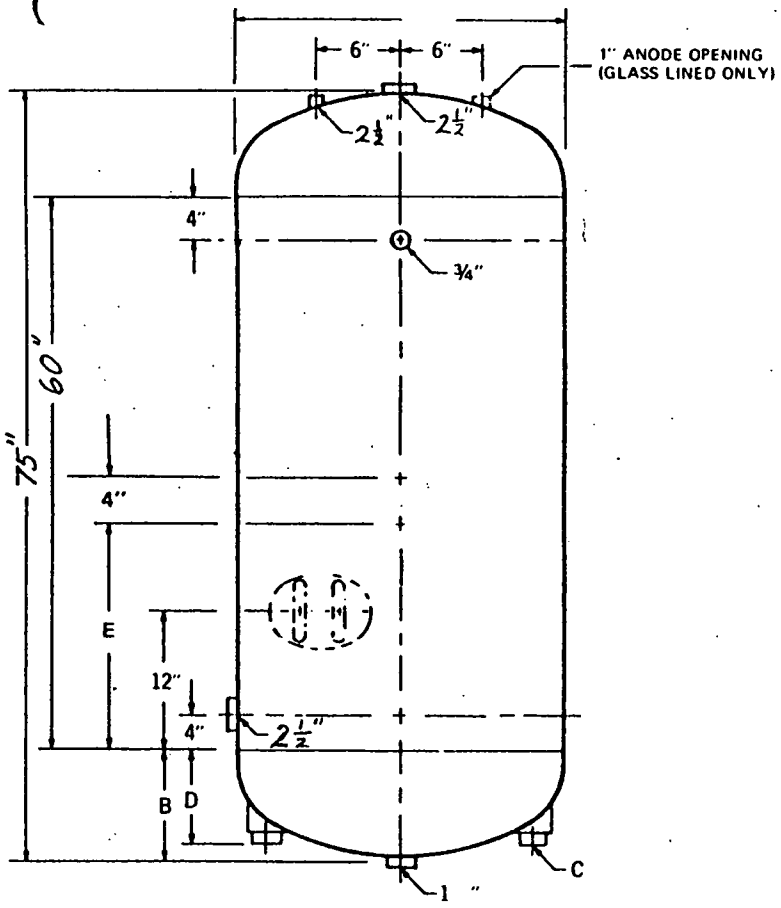
MODEL NO. S60 – 5.5 U

MANUFACTURED IN ACCORDANCE WITH SECTION VIII, ASME PRESSURE VESSEL CODE

Fitting locations to be dimensioned from head and shell joint. Tolerance ±2%

SCALE: NONE

DWG. NO. 510-3



TANK # T-6

TANK DIA. IN.	A WATER CONN.	B HEAD DEPTH	C LEG CPLG.	D DIMEN. IN.	E	TANK DIA. IN.	A WATER CONN.	B HEAD DEPTH	C LEG CPLG.	D DIMEN. IN.	E
12"	1½	4½	3–1	5	22"	54"	2½	13½	3–2	8	20"
18"	1½	6	3–1½	5	22"	60"	2½	15	4–2	8	20"
24"	1½	7½	3–1½	7	22"	66"	2½	16	4–2½	8	20"
30"	2	9	3–1½	7	22"	72"	2½	18½	4–2½	10	20"
36"	2	10½	3–1½	7	22"	84"	3	20	4–2½	12	14"
42"	2	12	3–2	8	22"	96"	3	23	4–2½	13	11"
48"	2½	12	3–2	8	22"						

	TANK LEG LENGTHS FOR "D" MODEL HEATERS									
	HEATERS WITH SKID					HEATERS ONLY (W/O Skids)				
TANK DIA.	F2D F4D	F5D F6D	F7D F10D	F12D	F14D	F2D F4D	F5D F6D	F7D F10D	F12D	F14D
12"	7½	11½	15½	17½	21½	3½	7½	11½	15½	17½
18"	7½	11½	15½	17½	21½	7½	7½	11½	13½	17½
24"	5½	9½	13½	15½	19½	5½	5½	9½	11½	15½
30"–36"	9½	9½	13½	15½	19½	9½	9½	9½	11½	15½
42"–48"	8½	8½	12½	14½	18½	8½	8½	8½	10½	14½
54"–60"		12½	14½	16½	20½		12½	14½	12½	16½
66"			14½	16½	20½			14½	16½	16½
72"			12	14	18			12½	14½	14½

11x15 Manhole standard only on Cement, Phenolic, Copper, Lined & all tanks 42" dia. & over. All others to have inspection opening as req'd. by ASME code.

M.E.

NUMBER REQ'D. 1

DIA. 24" S.L. 60" O.A. 75"

CAPACITY: 140 GALLONS

FINISH: INTERIOR GLASS LINED

EXTERIOR PRIME COAT

CUSTOMER CPM MECHANICAL

JOB AMITY SCHOOL SOLAR

SUBMITTED BY RO-BAR EQUIP.

DATE 2/28/79

ACE TANK & HEATER CO.
10847 SO. PAINTER AVENUE
SANTA FE SPRINGS, CALIF. 90670
TELEPHONE (213) 941-0221

TYPE S STANDARD ASME 125 PSI STORAGE TANK

MODEL NO. S 24 – 5 G

MANUFACTURED IN ACCORDANCE WITH SECTION VIII, ASME PRESSURE VESSEL CODE

TOLERANCE: ± 2%

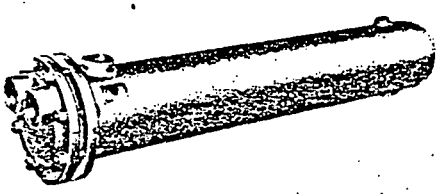
SCALE: NONE

DWG. NO. 510-1

BELL & GOSSETT

SUBMITTAL

C-131.1
REVISION 4



6" Series Type "WU" Heat Exchangers

"U" Tube Design

JOB		B & G REPRESENTATIVE	
UNIT TAG NO.	HE-1	ORDER NO.	DATE
ENGINEER		SUBMITTED BY	DATE
CONTRACTOR		APPROVED BY	DATE

DESCRIPTION

B&G "WU" Heat Exchangers are of the shell and tube type. The tube bundle is of "U" bend construction with tube ends expanded into a stationary tube sheet. This construction permits ample expansion or contraction for wide temperature variations. A fluid entering the tubes is heated or cooled by a fluid being circulated through a baffled shell. The unit is designed primarily for pumped circulation through the shell.

Standard "WU" Heat Exchangers are constructed according to A.S.M.E. requirements for pressures and temperature noted in table on the rear. A Manufacturers' Data Report for Pressure Vessels, Form No. U-1 as required by the provisions of the A.S.M.E. Code Rules is furnished with each unit.

This form is signed by a qualified inspector, holding a National Board Commission, and who is employed by an authorized inspection agency, certifying that construction conforms to the latest A.S.M.E. code for pressure vessels. The A.S.M.E. "U" symbol is stamped on each vessel.

RECOMMENDED "WU" HEAT EXCHANGER

MODEL NO. QWU 63-21.5

HEATING SURFACE (SQ. FT.) 12.7

APPROVALS

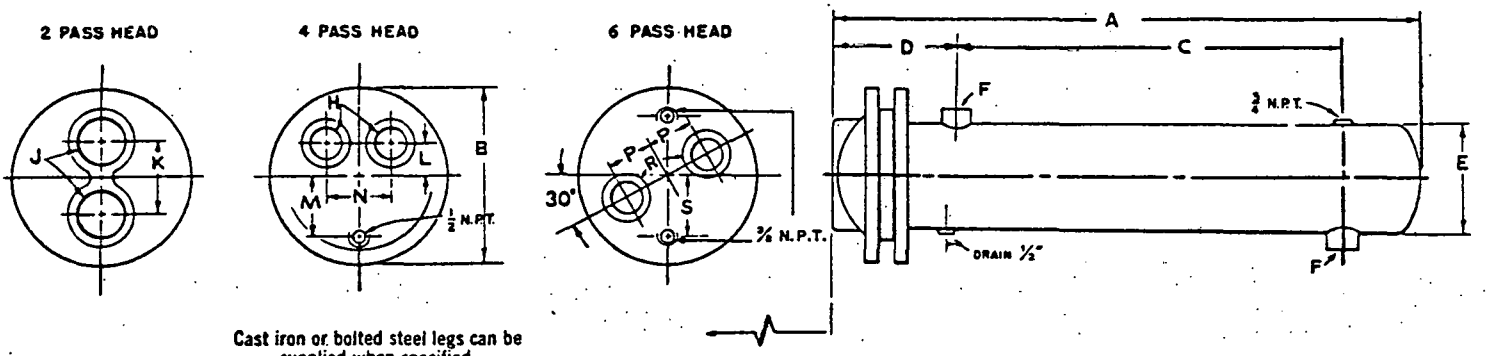
OPERATING DATA

	TUBE SIDE	SHELL SIDE
1. Fluid Circulated	Water	50% Ethylene Glycol
2. Total Flow* (*Expressed in GPM, GPH, or lbs./hr.)	85 GPM	25 GPM
3. Temperature In/Out	240° /225°	55 / 110
4. Transfer BTU/hr	597,575	
5. Pressure Drop (Maximum)	1.5	8 Ft.
6. Fouling Factor or Percentage of Additional Surface	.001	
Note: Following applies only for fluids other than water.		
7. Specific Gravity		1.06
8. Specific Heat		.82
9. Latent Heat		
10. Viscosity**		
. Thermal Conductivity		

**Expressed in Proper Units and Temperature such as centipoises @ °F.

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

6" Series TYPE "WU" HEAT EXCHANGERS ("U" Tube Design)



Cast iron or bolted steel legs can be supplied when specified.

Room for removal of tube bundle, equal to or greater than "A", should be provided.

DIMENSIONS

"WU" type "U" tube
Shell diameter in inches
Tube bundle length in feet
Number of tube passes
Baffle spacing in inches

Complete sales number consists of example: WU66-43

UNIT NUMBER			DIMENSIONS IN INCHES															HEATING SURFACE (SQ. FT.)			APPROX. SHIPPING
			2 PASS		4 PASS				6 PASS			2, 4 AND 6 PASS									
2 PASS	4 PASS	6 PASS	J	K	H	L	M	N	P	R	S	A	B	C	D	E	NPT F	2 Pass	4 Pass	6 Pass	WT. (LBS.)
WU63-23	WU63-43	WU63-63	2 NPT	3¼	1½ NPT	1 19/32	2 13/16	3 5/16	2 11/32	1¼ NPT	2 13/16	40⅛	10½	27½	6⅞	6⅝	2½	12.7		9.6	125
WU64-23	WU54-43	WU64-63	2 NPT	3¼	1½ NPT	1 19/32	2 13/16	3 5/16	2 11/32	1¼ NPT	2 13/16	52⅛	10½	39½	6⅞	6⅝	2½	17.4		13.1	150
WU65-23	WU65-43	WU65-63	2 NPT	3¼	1½ NPT	1 19/32	2 13/16	3 5/16	2 11/32	1¼ NPT	2 13/16	64⅛	10½	51½	6⅞	6⅝	2½	22.1		16.7	175
WU66-23	WU66-43	WU66-63	2 NPT	3¼	1½ NPT	1 19/32	2 13/16	3 5/16	2 11/32	1¼ NPT	2 13/16	76⅛	10½	63½	6⅞	6⅝	2½	26.8		20.2	200
WU67-23	WU67-43	WU67-63	2 NPT	3¼	1½ NPT	1 19/32	2 13/16	3 5/16	2 11/32	1¼ NPT	2 13/16	88⅛	10½	75½	6⅞	6⅝	2½	31.5		23.8	225
WU68-23	WU68-43	WU58-63	2 NPT	3¼	1½ NPT	1 19/32	2 13/16	3 5/16	2 11/32	1¼ NPT	2 13/16	100⅛	10½	87½	6⅞	6⅝	2½	36.2		27.3	250

DESIGN PRESSURES—A.S.M.E. CONSTRUCTION CAST IRON & BRASS UNITS

DESIGN PRESSURES*				DESIGN TEMPERATURES* TUBE & SHELL SIDE	
TUBE SIDE		SHELL SIDE			
DESIGN	TEST	DESIGN	TEST	CAST IRON	BRASS
150 psi	300 psi	150 psi	300 psi	375 F	300 F

*For design pressures and temperatures higher than shown, consult B & G Representative for specifications and dimensions.

Caution:

properly sized relief valve must be installed on the ated water side to protect heat exchangers from possible damage due to volumetric expansion.

MATERIALS

PART	STANDARD CAST IRON UNIT	BRASS UNIT
	2, 4 & 6 Pass	2 & 4 Pass
Shell	Steel	Steel
Head	Cast Iron	Cast Brass
Tubes ¾" O.D.	Copper	Copper
Tube Sheet	Steel	Rolled Naval Brass
Baffles	Steel	Steel
Nuts & Bolts	Steel	Steel

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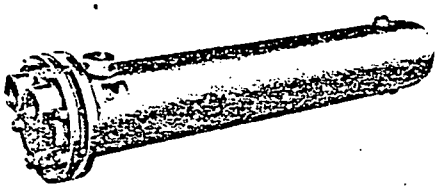
C-131.2
REVISION 5



8" Series Type "WU" Heat Exchangers

"U" Tube Design

JOB

B & G REPRESENTATIVE _____

UNIT TAG NO. HE-2

ORDER NO. _____ DATE _____

ENGINEER _____

SUBMITTED BY _____ DATE _____

CONTRACTOR _____

APPROVED BY _____ DATE _____

DESCRIPTION

B&G "WU" Heat Exchangers are of the shell and tube type. The tube bundle is of "U" bend construction with tube ends expanded into a stationary tube sheet. This construction permits ample expansion or contraction for wide temperature variations. A fluid entering the tubes is heated or cooled by a fluid being circulated through a baffled shell. The unit is designed primarily for pumped circulation through the shell.

Standard "WU" Heat Exchangers are constructed according to A.S.M.E. requirements for pressures and temperature noted in table on the rear. A Manufacturers' Data Report for Pressure Vessels, Form No. U-1 as required by the provisions of the A.S.M.E. Code Rules is furnished with each unit upon request.

This form is signed by a qualified inspector, holding a National Board Commission, and who is employed by an authorized inspection agency, certifying that construction conforms to the latest A.S.M.E. code for pressure vessels. The A.S.M.E. "U" symbol is stamped on each vessel.

RECOMMENDED "WU" HEAT EXCHANGER

MODEL NO. QWU88-23

HEATING SURFACE (SQ. FT.) 67

APPROVALS

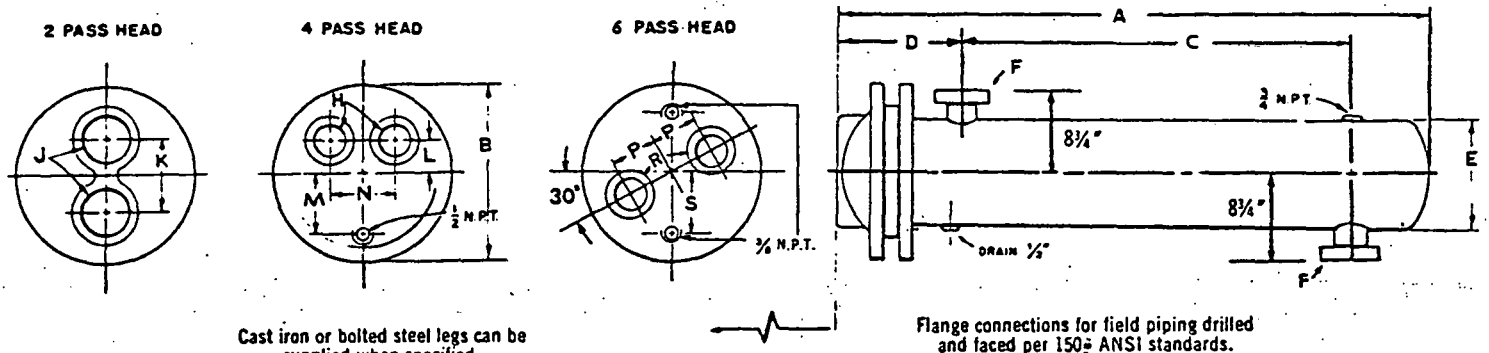
OPERATING DATA

	TUBE SIDE	SHELL SIDE
1. Fluid Circulated	Water	50% Ethylene Glycol
2. Total Flow (Expressed in GPM, GPH, or lbs./hr.)	85 GPM	67 GPM
3. Temperature In/Out	170° / 156°	120° / 140°
4. Transfer BTU/hr	588,126	
5. Pressure Drop (Maximum)	1.5 Ft.	16 Ft.
6. Fouling Factor or Percentage of Additional Surface	.001	
Note: Following applies only for fluids other than water.		
7. Specific Gravity		1.045
8. Specific Heat		.84
9. Latent Heat		
10. Viscosity**		
11. Thermal Conductivity		

**Expressed in Proper Units and Temperature such as centipoises @ °F.

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

8" Series TYPE "WU" HEAT EXCHANGERS ("U" Tube Design)



Cast iron or bolted steel legs can be supplied when specified.

Flange connections for field piping drilled and faced per 150# ANSI standards.

Room for removal of tube bundle, equal to or greater than "A", should be provided.

DIMENSIONS

"WU" type "U" tube
Shell diameter in inches
Tube bundle length in feet
Number of tube passes
Baffle spacing in inches

Complete sales number consists of example: WU86-44

UNIT NUMBER			DIMENSIONS IN INCHES															HEATING SURFACE (SQ. FT.)			APPROX. SHIPPING
			2 PASS		4 PASS				6 PASS			2, 4 AND 6 PASS									
2 PASS	4 PASS	6 PASS	J	K	H	L	M	N	P	R	S	A	B	C	D	E	FLG F	2 Pass	4 Pass	6 Pass	WT. (LBS.)
WU84-24	WU84-44	WU84-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	53	12½	37	8½	8⅜	4	32		26	222
WU85-24	WU85-44	WU85-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	65	12½	49	8½	8⅜	4	41		33	?
WU86-24	WU86-44	WU86-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	77	12½	61	8½	8⅜	4	49		41	254
WU87-24	WU87-44	WU87-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	89	12½	73	8½	8⅜	4	58		48	330
WU88-24	WU88-44	WU88-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	101	12½	85	8½	8⅜	4	67		55	366
WU89-24	WU89-44	WU89-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	113	12½	97	8½	8⅜	4	75		62	402

DESIGN PRESSURES—A.S.M.E. CONSTRUCTION CAST IRON & BRASS UNITS

DESIGN PRESSURES*				DESIGN TEMPERATURES* TUBE & SHELL SIDE	
TUBE SIDE		SHELL SIDE			
DESIGN	TEST	DESIGN	TEST	CAST IRON	BRASS
150 psi	300 psi	150 psi	300 psi	375 F	300 F

*For design pressures and temperatures higher than shown, consult B & G Representative for specifications and dimensions.

Caution:
A properly sized relief valve must be installed on the heated water side to protect heat exchangers from possible damage due to volumetric expansion.

MATERIALS

PART	STANDARD CAST IRON UNIT	BRASS UNIT
	2, 4 & 6 Pass	2 & 4 Pass
Shell	Steel	Steel
Head	Cast Iron	Cast Brass
Tubes ¾" O.D.	Copper	Copper
Tube Sheet	Steel	Rolled Naval Brass
Baffles	Steel	Steel
Nuts & Bolts	Steel	Steel

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BELL & GOSSETT

SUBMITTAL

C-131.2
REVISION 5

8" Series Type "WU" Heat Exchangers

"U" Tube Design

JOB

B & G REPRESENTATIVE _____

UNIT TAG NO. HE-3

ORDER NO. _____ DATE _____

ENGINEER _____

SUBMITTED BY _____ DATE _____

CONTRACTOR _____

APPROVED BY _____ DATE _____

DESCRIPTION

B&G "WU" Heat Exchangers are of the shell and tube type. The tube bundle is of "U" bend construction with tube ends expanded into a stationary tube sheet. This construction permits ample expansion or contraction for wide temperature variations. A fluid entering the tubes is heated or cooled by a fluid being circulated through a baffled shell. The unit is designed primarily for pumped circulation through the shell.

Standard "WU" Heat Exchangers are constructed according to A.S.M.E. requirements for pressures and temperature noted in table on the rear. A Manufacturers' Data Report for Pressure Vessels, Form No. U-1 as required by the provisions of the A.S.M.E. Code Rules is furnished with each unit upon request.

This form is signed by a qualified inspector, holding a National Board Commission, and who is employed by an authorized inspection agency, certifying that construction conforms to the latest A.S.M.E. code for pressure vessels. The A.S.M.E. "U" symbol is stamped on each vessel.

RECOMMENDED "WU" HEAT EXCHANGER

MODEL NO. WU89-44

HEATING SURFACE (SQ. FT.) 75

APPROVALS

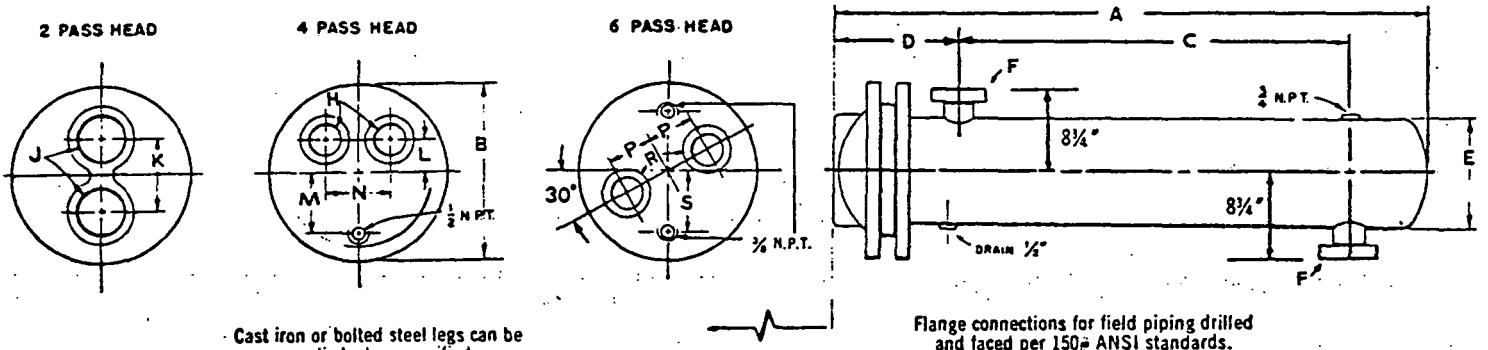
OPERATING DATA

	TUBE SIDE	SHELL SIDE
1. Fluid Circulated	Water	Water
2. Total Flow (Expressed in GPM, GPH, or lbs./hr.)	67 GPM	67 GPM
3. Temperature In/Out	90° / 110°	140° / 120°
4. Transfer BTU/hr	670,000 BTU	
5. Pressure Drop (Maximum)	7 Ft.	9 Ft.
6. Fouling Factor or Percentage of Additional Surface	.001	
Note: Following applies only for fluids other than water.		
7. Specific Gravity		
8. Specific Heat		
9. Latent Heat		
10. Viscosity**		
11. Thermal Conductivity		

**Expressed in Proper Units and Temperature such as centipoises @ °F.

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

8" Series TYPE "WU" HEAT EXCHANGERS ("U" Tube Design)



Cast iron or bolted steel legs can be supplied when specified.

Flange connections for field piping drilled and faced per 150# ANSI standards.

Room for removal of tube bundle, equal to or greater than "A", should be provided.

DIMENSIONS

"WU" type "U" tube
Shell diameter in inches
Tube bundle length in feet
Number of tube passes
Baffle spacing in inches

Complete sales number consists of example: WU86-44

UNIT NUMBER			DIMENSIONS IN INCHES															HEATING SURFACE (SQ. FT.)			APPROX. SHIPPING
			2 PASS		4 PASS				6 PASS			2, 4 AND 6 PASS									
2 PASS	4 PASS	6 PASS	J	K	H	L	M	N	P	R	S	A	B	C	D	E	FLG F	2 Pass	4 Pass	6 Pass	WT. (LBS.)
WU84-24	WU84-44	WU84-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	53	12½	37	8½	8⅜	4	32		26	222
WU85-24	WU85-44	WU85-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	65	12½	49	8½	8⅜	4	41		33	258
WU86-24	WU86-44	WU86-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	77	12½	61	8½	8⅜	4	49		41	294
WU87-24	WU87-44	WU87-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	89	12½	73	8½	8⅜	4	58		48	330
WU88-24	WU88-44	WU88-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	101	12½	85	8½	8⅜	4	67		55	366
WU89-24	WU89-44	WU89-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	113	12½	97	8½	8⅜	4	75		62	402

DESIGN PRESSURES—A.S.M.E. CONSTRUCTION CAST IRON & BRASS UNITS

DESIGN PRESSURES*				DESIGN TEMPERATURES* TUBE & SHELL SIDE	
TUBE SIDE		SHELL SIDE			
DESIGN	TEST	DESIGN	TEST	CAST IRON	BRASS
150 psi	300 psi	150 psi	300 psi	375 F	300 F

*For design pressures and temperatures higher than shown, consult B & G Representative for specifications and dimensions.

MATERIALS

PART	STANDARD CAST IRON UNIT	BRASS UNIT
	2, 4 & 6 Pass	2 & 4 Pass
Shell	Steel	Steel
Head	Cast Iron	Cast Brass
Tubes ¾" O.D.	Copper	Copper
Tube Sheet	Steel	Rolled Naval Brass
Baffles	Steel	Steel
Nuts & Bolts	Steel	Steel

Caution:
A properly sized relief valve must be installed on the heated water side to protect heat exchangers from possible damage due to volumetric expansion.

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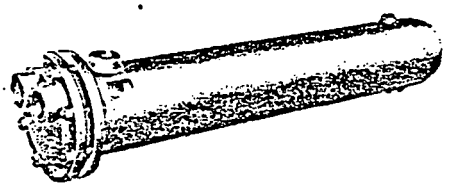
C-131.1
REVISION 4



6" Series Type "WU" Heat Exchangers

"U" Tube Design

JOB	B & G REPRESENTATIVE
UNIT TAG NO. HE-4	ORDER NO. DATE
ENGINEER	SUBMITTED BY DATE
CONTRACTOR	APPROVED BY DATE

DESCRIPTION

B&G "WU" Heat Exchangers are of the shell and tube type. The tube bundle is of "U" bend construction with tube ends expanded into a stationary tube sheet. This construction permits ample expansion or contraction for wide temperature variations. A fluid entering the tubes is heated or cooled by a fluid being circulated through a baffled shell. The unit is designed primarily for pumped circulation through the shell.

Standard "WU" Heat Exchangers are constructed according to A.S.M.E. requirements for pressures and temperature noted in table on the rear. A Manufacturers' Data Report for Pressure Vessels, Form No. U-1 as required by the provisions of the A.S.M.E. Code Rules is furnished with each unit.

This form is signed by a qualified inspector, holding a National Board Commission, and who is employed by an authorized inspection agency, certifying that construction conforms to the latest A.S.M.E. code for pressure vessels. The A.S.M.E. "U" symbol is stamped on each vessel.

RECOMMENDED "WU" HEAT EXCHANGER

MODEL NO. QWU 67-24

HEATING SURFACE (SQ. FT.) 31.5

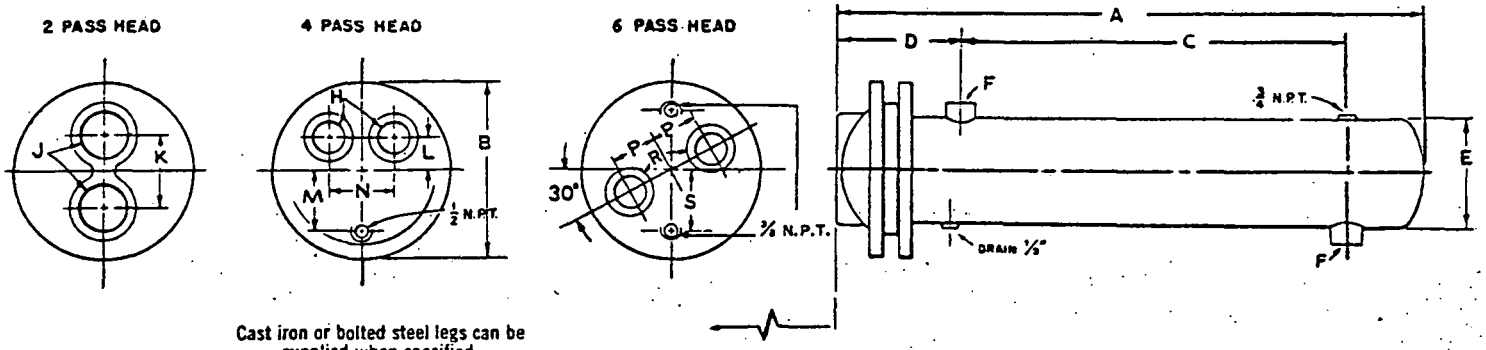
APPROVALS

OPERATING DATA	TUBE SIDE	SHELL SIDE
1. Fluid Circulated	Water	Water
2. Total Flow* (*Expressed in GPM, GPH, or lbs./hr.)	67 GPM	67 GPM
3. Temperature In/Out	110° / 100°	70° / 80°
4. Transfer BTU/hr	335,000	
5. Pressure Drop (Maximum)	2.5 Ft.	11 Ft.
6. Fouling Factor or Percentage of Additional Surface	.001	
Note: Following applies only for fluids other than water.		
7. Specific Gravity		
8. Specific Heat		
9. Latent Heat		
10. Viscosity**		
11. Thermal Conductivity		

**Expressed in Proper Units and Temperature such as centipoises @ °F.

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

6" Series TYPE "WU" HEAT EXCHANGERS ("U" Tube Design)



Cast iron or bolted steel legs can be supplied when specified.

Room for removal of tube bundle, equal to or greater than "A", should be provided.

DIMENSIONS

"WU" type "U" tube
Shell diameter in inches
Tube bundle length in feet
Number of tube passes
Baffle spacing in inches

Complete sales number consists of example: WU66-43

UNIT NUMBER			DIMENSIONS IN INCHES															HEATING SURFACE (SQ. FT.)			APPROX. SHIPPING WT. (LBS.)
			2 PASS		4 PASS				6 PASS			2, 4 AND 6 PASS									
2 PASS	4 PASS	6 PASS	J	K	H	L	M	N	P	R	S	A	B	C	D	E	NPT F	2 Pass	4 Pass	6 Pass	
WU63-23	WU63-43	WU63-63	2 NPT	3¼	1½ NPT	1 9/32	2 13/16	3 1/16	2 11/32	1¼ NPT	2 13/16	40⅛	10½	27½	6⅞	6⅝	2½	12.7		9.6	125
WU64-23	WU64-43	WU64-63	2 NPT	3¼	1½ NPT	1 9/32	2 13/16	3 1/16	2 11/32	1¼ NPT	2 13/16	52⅛	10½	39½	6⅞	6⅝	2½	17.4		13.1	150
WU65-23	WU65-43	WU65-63	2 NPT	3¼	1½ NPT	1 9/32	2 13/16	3 1/16	2 11/32	1¼ NPT	2 13/16	64⅛	10½	51½	6⅞	6⅝	2½	22.1		16.7	175
WU66-23	WU66-43	WU66-63	2 NPT	3¼	1½ NPT	1 9/32	2 13/16	3 1/16	2 11/32	1¼ NPT	2 13/16	76⅛	10½	63½	6⅞	6⅝	2½	26.8		20.2	200
WU67-23	WU67-43	WU67-63	2 NPT	3¼	1½ NPT	1 9/32	2 13/16	3 1/16	2 11/32	1¼ NPT	2 13/16	88⅛	10½	75½	6⅞	6⅝	2½	31.5		23.8	225
WU68-23	WU68-43	WU68-63	2 NPT	3¼	1½ NPT	1 9/32	2 13/16	3 1/16	2 11/32	1¼ NPT	2 13/16	100⅛	10½	87½	6⅞	6⅝	2½	36.2		27.3	250

DESIGN PRESSURES—A.S.M.E. CONSTRUCTION CAST IRON & BRASS UNITS

DESIGN PRESSURES*				DESIGN TEMPERATURES* TUBE & SHELL SIDE	
TUBE SIDE		SHELL SIDE			
DESIGN	TEST	DESIGN	TEST	CAST IRON	BRASS
150 psi	300 psi	150 psi	300 psi	375 F	300 F

*For design pressures and temperatures higher than shown, consult B & G Representative for specifications and dimensions.

Caution:

properly sized relief valve must be installed on the heated water side to protect heat exchangers from possible damage due to volumetric expansion.

MATERIALS

PART	STANDARD CAST IRON UNIT	BRASS UNIT
	2, 4 & 6 Pass	2 & 4 Pass
Shell	Steel	Steel
Head	Cast Iron	Cast Brass
Tubes ¾" O.D.	Copper	Copper
Tube Sheet	Steel	Rolled Naval Brass
Baffles	Steel	Steel
Nuts & Bolts	Steel	Steel

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BELL & GOSSETT

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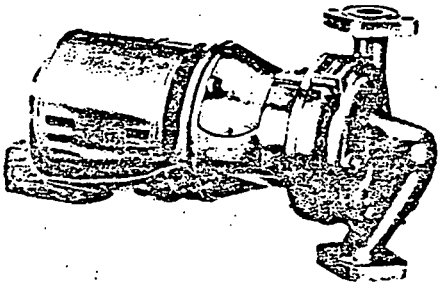
B-130
REVISION 6



STOCK SIZES SERIES "60"

In-Line Mounted Centrifugal Pumps

JOB

UNIT TAG NO. P-1

ENGINEER

CONTRACTOR

B & G REPRESENTATIVE

ORDER NO. DATE

SUBMITTED BY DATE

APPROVED BY DATE

DIMENSIONS

FIG. 1 AA SIZES

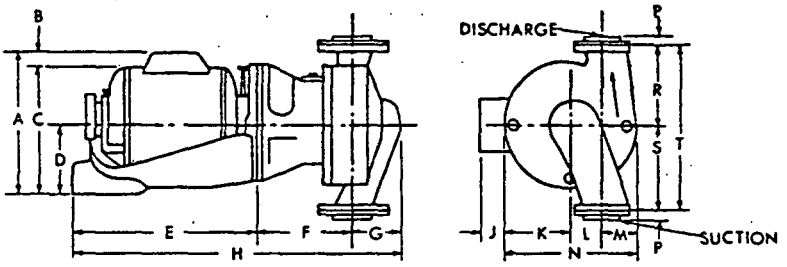
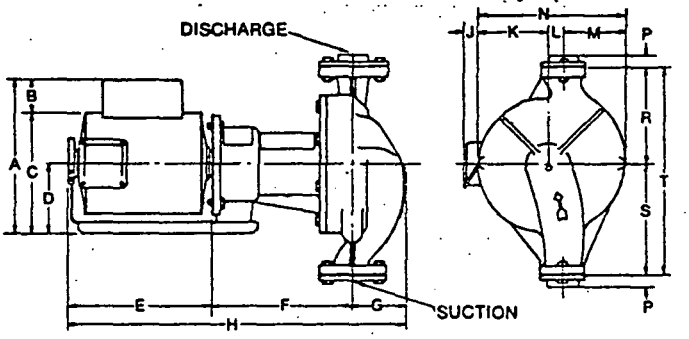


FIG. 2 A SIZES



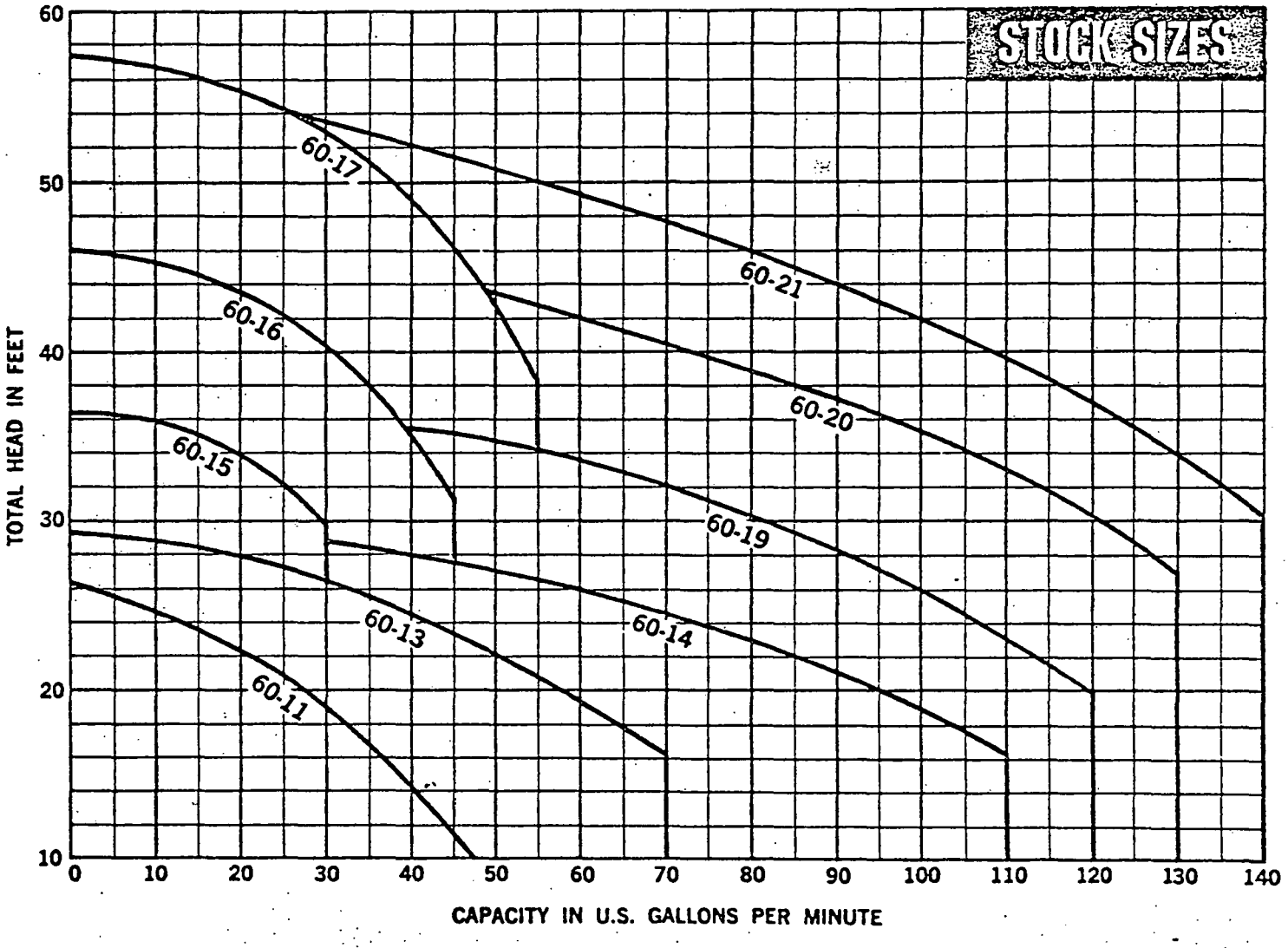
ALL SINGLE PHASE MOTORS INCLUDE BUILT-IN THERMAL OVERLOAD PROTECTORS.
BRONZE FITTED CONSTRUCTION—COMPANION FLANGES FURNISHED FOR SUCTION AND DISCHARGE.
MOTORS—OPEN DRIPPROOF ENCLOSURE. SINGLE PHASE—UNIT NO. ENDING IN "S" 115/230 VOLT 60 CYCLE 1 PHASE 1750 RPM.
THREE PHASE—UNIT NO. ENDING IN "T" 208-230/460 VOLT 60 CYCLE 3 PHASE 1750 RPM. MAXIMUM WORKING PRESSURE 175 PSI

MODEL NO.	PUMP SIZE	SUCTION & DISCHARGE SIZE INS. NPT	MOTOR H.P.	PHASE	DIMENSIONS—IN INCHES																
					A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
60-11S	1¼AA	1¼	¼	1	7⅜	—	7⅜	4⅜	10	5 13/16	3 7/16	19¼	—	3⅜	1⅜	2½	7½	¾	5	6	11
60-11T	1¼AA	1¼	¼	3	7⅜	—	7⅜	4⅜	9¾	5 13/16	3 7/16	19	—	3⅜	1⅜	2½	7½	¾	5	6	11
60-13S	1½AA	1½	½	1	9½	2⅛	7⅜	4⅜	11½	6	3⅜	21⅛	—	3¼	1⅜	2¾	7⅞	¾	5	6½	11½
60-13T	1½AA	1½	½	3	7⅜	—	7⅜	4⅜	11	6	3⅜	20⅝	—	3¼	1⅜	2¾	7⅞	¾	5	6½	11½
60-14S	2AA	2	¾	1	9½	2⅛	7⅜	4⅜	12	6⅛	3¾	21⅞	—	3¼	1⅜	2⅞	8	13/16	5	6½	11½
60-14T	2AA	2	¾	3	7⅜	—	7⅜	4⅜	11½	6⅛	3¾	21⅜	—	3¼	1⅜	2⅞	8	13/16	5	6½	11½
60-15S	1½A	1½	½	1	9½	2⅛	7⅜	4⅜	11½	9¾	3¼	24½	—	4⅝	1	3⅜	9½	¾	6½	7	13½
60-15T	1½A	1½	½	3	7⅜	—	7⅜	4⅜	11	9¾	3¼	24	—	4⅝	1	3⅜	9½	¾	6½	7	13½
60-16S	1½A	1½	¾	1	9½	2⅛	7⅜	4⅜	12	9¾	3¼	25	—	4⅝	1	3⅜	9½	¾	6½	7	13½
60-16T	1½A	1½	¾	3	7⅜	—	7⅜	4⅜	11½	9¾	3¼	24½	—	4⅝	1	3⅜	9½	¾	6½	7	13½
60-17S	1½A	1½	1	1	10 5/16	2⅛	8 5/16	4¾	9¾	9¾	3¼	22¾	⅜	4⅝	1	3⅜	9½	¾	6½	7	13½
60-17T	1½A	1½	1	3	8 5/16	—	8 5/16	4¾	10	9¾	3¼	23	⅜	4⅝	1	3⅜	9½	¾	6½	7	13½
60-19S	2A	2	1	1	10 5/16	2⅛	8 5/16	4¾	9¾	9¾	3½	23	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-19T	2A	2	1	3	8 5/16	—	8 5/16	4¾	10	9¾	3½	23¼	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-20S	2A	2	1½	1	10 5/16	2⅛	8 5/16	4¾	10⅜	9¾	3½	23⅝	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-20T	2A	2	1½	3	8 5/16	—	8 5/16	4¾	10⅜	9¾	3½	24⅛	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-21T	2A	2	2	3	8 5/16	—	8 5/16	4¾	11⅜	9¾	3½	24⅞	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14

(See Reverse Side for Capacity Chart)

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

SERIES "60" PERFORMANCE CURVES



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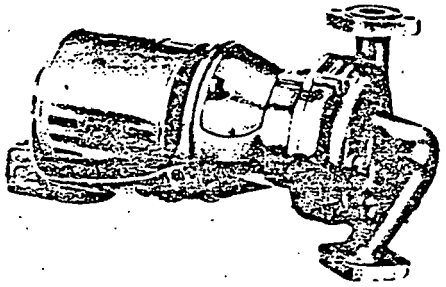


STOCK SIZES SERIES "60"

In-Line Mounted Centrifugal Pumps

JOB _____ B & G REPRESENTATIVE _____

UNIT TAG NO. P-2 ORDER NO. _____ DATE _____

ENGINEER _____ SUBMITTED BY _____ DATE _____

CONTRACTOR _____ APPROVED BY _____ DATE _____

DIMENSIONS

FIG. 1 AA SIZES

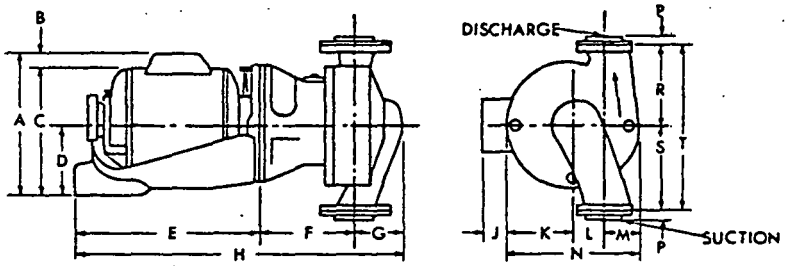
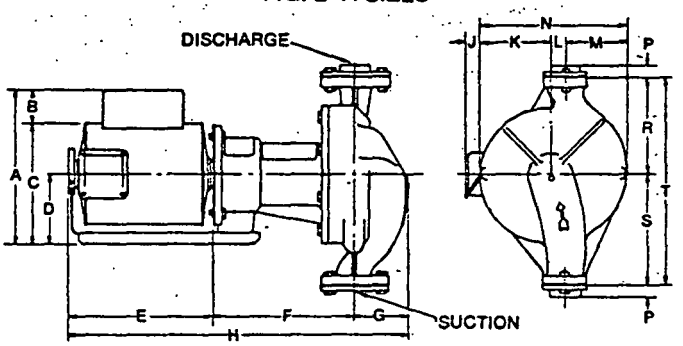


FIG. 2 A SIZES



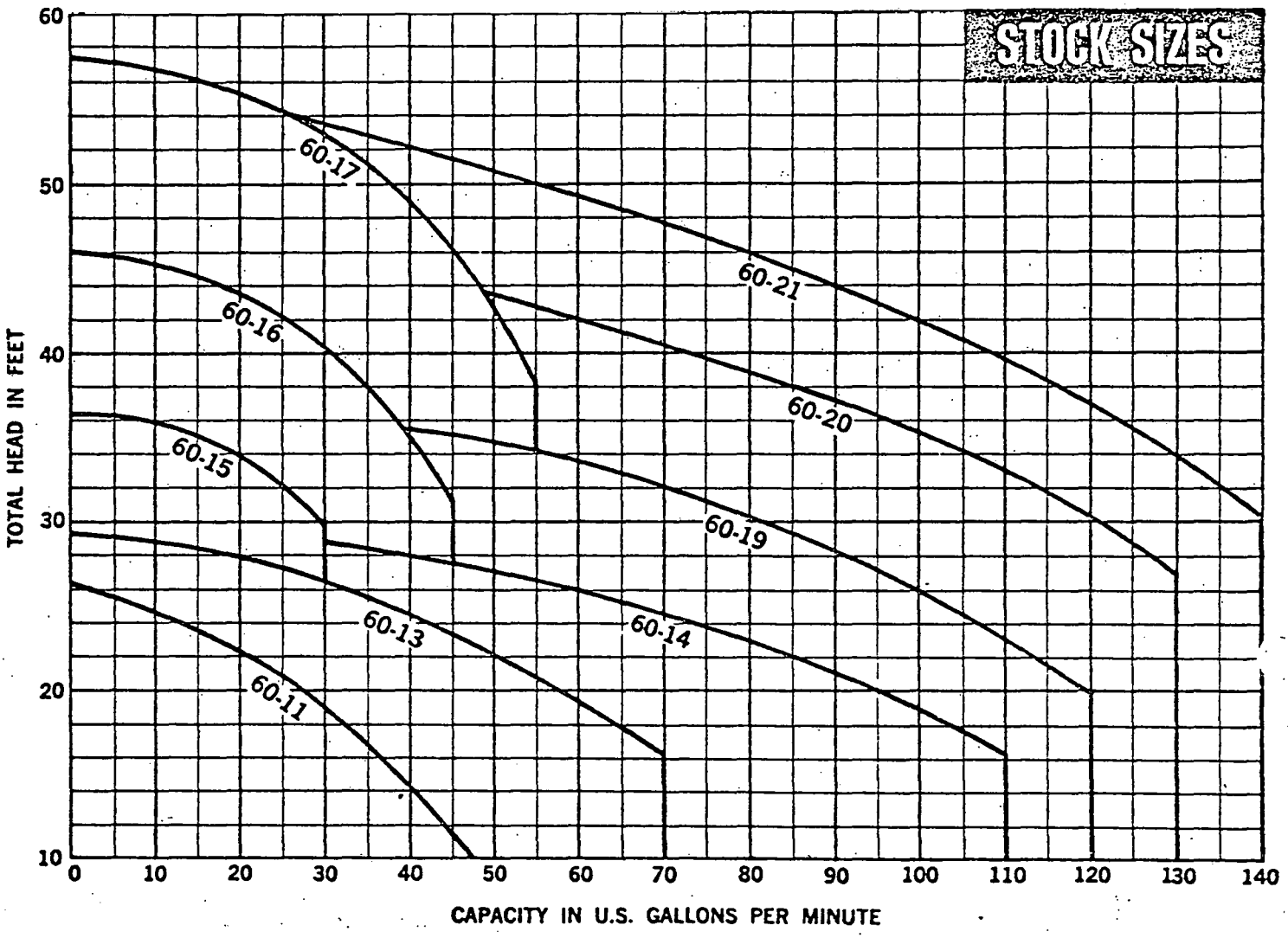
ALL SINGLE PHASE MOTORS INCLUDE BUILT-IN THERMAL OVERLOAD PROTECTORS.
BRONZE FITTED CONSTRUCTION—COMPANION FLANGES FURNISHED FOR SUCTION AND DISCHARGE.
MOTORS—OPEN DRIPPROOF ENCLOSURE. SINGLE PHASE—UNIT NO. ENDING IN "S" 115/230 VOLT 60 CYCLE 1 PHASE 1750 RPM.
THREE PHASE—UNIT NO. ENDING IN "T" 208-230/460 VOLT 60 CYCLE 3 PHASE 1750 RPM. MAXIMUM WORKING PRESSURE 175 PSI

MODEL NO.	PUMP SIZE	SUCTION & DISCHARGE SIZE INS. NPT	MOTOR H.P.	PHASE	DIMENSIONS—IN INCHES															
					A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
60-11S	1¼AA	1¼	¼	1	7⅜	—	7⅜	4⅜	10	5 13/16	3 7/16	19¼	—	3⅜	1⅜	2½	7½	¾	5	6	11
60-11T	1¼AA	1¼	¼	3	7⅜	—	7⅜	4⅜	9¾	5 13/16	3 7/16	19	—	3⅜	1⅜	2½	7½	¾	5	6	11
60-13S	1½AA	1½	½	1	9½	2⅛	7⅜	4⅜	11½	6	3⅜	21⅛	—	3¾	1⅜	2¾	7⅞	¾	5	6½	11½
60-13T	1½AA	1½	½	3	7⅜	—	7⅜	4⅜	11	6	3⅜	20⅝	—	3¾	1⅜	2¾	7⅞	¾	5	6½	11½
60-14S	2AA	2	¾	1	9½	2⅛	7⅜	4⅜	12	6⅛	3¾	21⅞	—	3¾	1⅜	2⅛	8	13/16	5	6½	11½
60-14T	2AA	2	¾	3	7⅜	—	7⅜	4⅜	11½	6⅛	3¾	21⅜	—	3¾	1⅜	2⅛	8	13/16	5	6½	11½
60-15S	1½A	1½	½	1	9½	2⅛	7⅜	4⅜	11½	9¾	3¼	24½	—	4⅜	1	3⅜	9½	¾	6½	7	13½
60-15T	1½A	1½	½	3	7⅜	—	7⅜	4⅜	11	9¾	3¼	24	—	4⅜	1	3⅜	9½	¾	6½	7	13½
60-16S	1½A	1½	¾	1	9½	2⅛	7⅜	4⅜	12	9¾	3¼	25	—	4⅜	1	3⅜	9½	¾	6½	7	13½
60-16T	1½A	1½	¾	3	7⅜	—	7⅜	4⅜	11½	9¾	3¼	24½	—	4⅜	1	3⅜	9½	¾	6½	7	13½
60-17S	1½A	1½	1	1	10 5/16	2⅛	8 1/16	4¼	9¾	9¾	3¼	22¾	⅞	4⅜	1	3⅜	9½	¾	6½	7	13½
60-17T	1½A	1½	1	3	8 1/16	—	8 1/16	4¼	10	9¾	3¼	23	⅞	4⅜	1	3⅜	9½	¾	6½	7	13½
60-19S	2A	2	1	1	10 5/16	2⅛	8 1/16	4¼	9¾	9¾	3½	23	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-19T	2A	2	1	3	8 1/16	—	8 1/16	4¼	10	9¾	3½	23¼	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-20S	2A	2	1½	1	10 5/16	2⅛	8 1/16	4¼	10⅜	9¾	3½	23⅜	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-20T	2A	2	1½	3	8 1/16	—	8 1/16	4¼	10⅞	9¾	3½	24⅛	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-21T	2A	2	2	3	8 1/16	—	8 1/16	4¼	11⅝	9¾	3½	24⅞	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14

(See Reverse Side for Capacity Chart)

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

SERIES "60" PERFORMANCE CURVES



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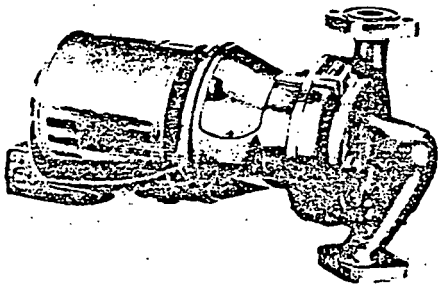


STOCK SIZES SERIES "60"

In-Line Mounted Centrifugal Pumps

JOB _____ B & G REPRESENTATIVE _____

UNIT TAG NO. P-3 ORDER NO. _____ DATE _____

ENGINEER _____ SUBMITTED BY _____ DATE _____

CONTRACTOR _____ APPROVED BY _____ DATE _____

DIMENSIONS

FIG. 1 AA SIZES

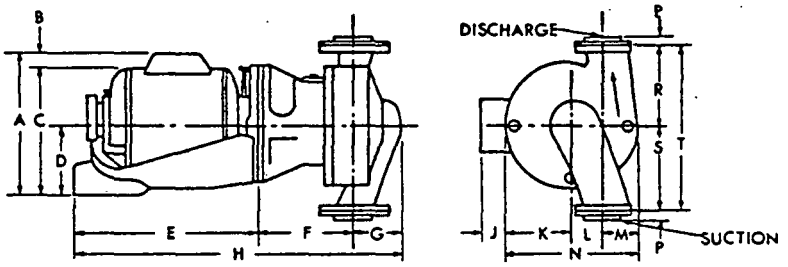
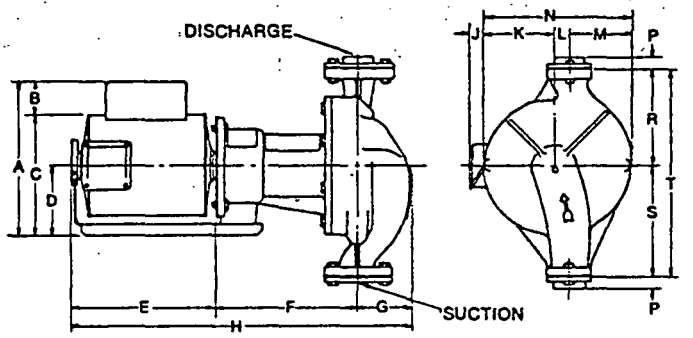


FIG. 2 A SIZES



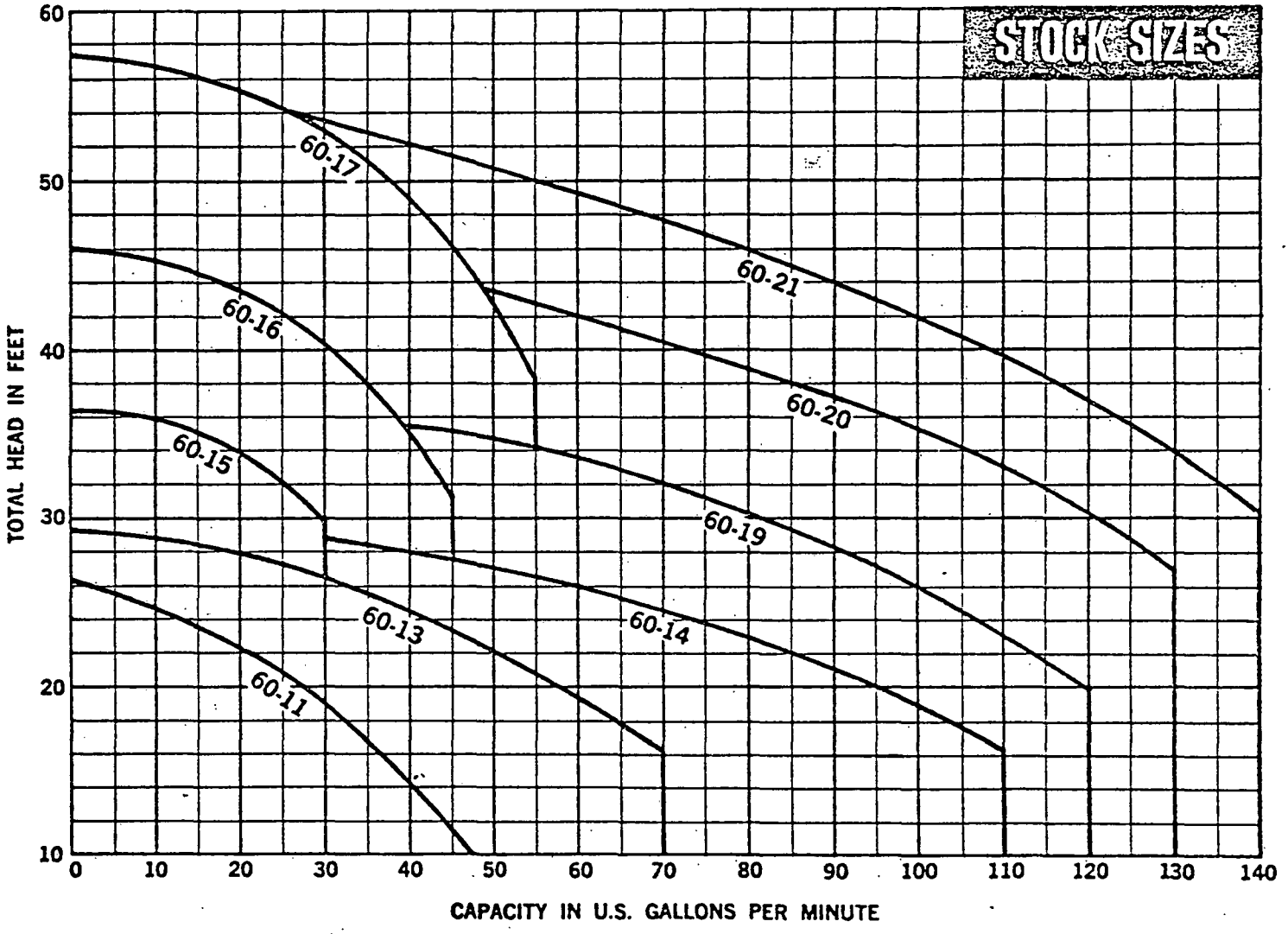
ALL SINGLE PHASE MOTORS INCLUDE BUILT-IN THERMAL OVERLOAD PROTECTORS.
BRONZE FITTED CONSTRUCTION—COMPANION FLANGES FURNISHED FOR SUCTION AND DISCHARGE.
MOTORS—OPEN DRIPPROOF ENCLOSURE. SINGLE PHASE—UNIT NO. ENDING IN "S" 115/230 VOLT 60 CYCLE 1 PHASE 1750 RPM.
THREE PHASE—UNIT NO. ENDING IN "T" 208-230/460 VOLT 60 CYCLE 3 PHASE 1750 RPM. MAXIMUM WORKING PRESSURE 175 PSI

MODEL NO.	PUMP SIZE	SUCTION & DISCHARGE SIZE INS. NPT	MOTOR H.P.	PHASE	DIMENSIONS—IN INCHES																
					A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
60-11S	1¼AA	1¼	¼	1	7⅜	—	7⅜	4⅜	10	5 13/16	3 7/16	19¼	—	3⅝	1⅜	2½	7½	¾	5	6	11
60-11T	1¼AA	1¼	¼	3	7⅜	—	7⅜	4⅜	9¾	5 13/16	3 7/16	19	—	3⅝	1⅜	2½	7½	¾	5	6	11
60-13S	1½AA	1½	½	1	9½	2⅛	7⅜	4⅜	11½	6	3⅝	21⅛	—	3¼	1⅜	2¾	7⅞	¾	5	6½	11½
60-13T	1½AA	1½	½	3	7⅜	—	7⅜	4⅜	11	6	3⅝	20⅝	—	3¼	1⅜	2¾	7⅞	¾	5	6½	11½
60-14S	2AA	2	¾	1	9½	2⅛	7⅜	4⅜	12	6⅛	3¼	21⅞	—	3¼	1⅜	2⅞	8	13/16	5	6½	11½
60-14T	2AA	2	¾	3	7⅜	—	7⅜	4⅜	11½	6⅛	3¼	21⅜	—	3¼	1⅜	2⅞	8	13/16	5	6½	11½
60-15S	1½A	1½	½	1	9½	2⅛	7⅜	4⅜	11½	9¼	3¼	24½	—	4⅝	1	3⅞	9½	¾	6½	7	13½
60-15T	1½A	1½	½	3	7⅜	—	7⅜	4⅜	11	9¼	3¼	24	—	4⅝	1	3⅞	9½	¾	6½	7	13½
60-16S	1½A	1½	¾	1	9½	2⅛	7⅜	4⅜	12	9¼	3¼	25	—	4⅝	1	3⅞	9½	¾	6½	7	13½
60-16T	1½A	1½	¾	3	7⅜	—	7⅜	4⅜	11½	9¼	3¼	24½	—	4⅝	1	3⅞	9½	¾	6½	7	13½
60-17S	1½A	1½	1	1	10 5/16	2⅛	8 3/16	4¾	9¾	9¼	3¼	22¾	⅞	4⅝	1	3⅞	9½	¾	6½	7	13½
60-17T	1½A	1½	1	3	8 3/16	—	8 3/16	4¾	10	9¼	3¼	23	⅞	4⅝	1	3⅞	9½	¾	6½	7	13½
60-19S	2A	2	1	1	10 5/16	2⅛	8 3/16	4¾	9¾	9¼	3½	23	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-19T	2A	2	1	3	8 3/16	—	8 3/16	4¾	10	9¼	3½	23¼	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-20S	2A	2	1½	1	10 5/16	2⅛	8 3/16	4¾	10⅜	9¼	3½	23⅝	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-20T	2A	2	1½	3	8 3/16	—	8 3/16	4¾	10⅞	9¼	3½	24⅛	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-21T	2A	2	2	3	8 3/16	—	8 3/16	4¾	11⅝	9¼	3½	24⅞	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14

(See Reverse Side for Capacity Chart)

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

SERIES "60" PERFORMANCE CURVES



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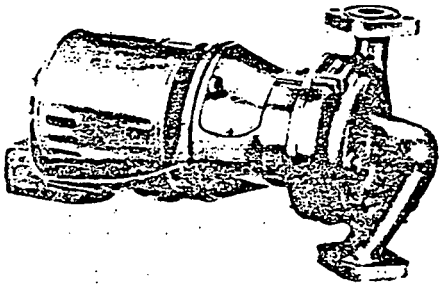
REVISION 6



STOCK SIZES SERIES "60"

In-Line Mounted Centrifugal Pumps

JOB _____ B & G REPRESENTATIVE _____

UNIT TAG NO. P-4 _____ ORDER NO. _____ DATE _____

ENGINEER _____ SUBMITTED BY _____ DATE _____

CONTRACTOR _____ APPROVED BY _____ DATE _____

DIMENSIONS

FIG. 1 AA SIZES

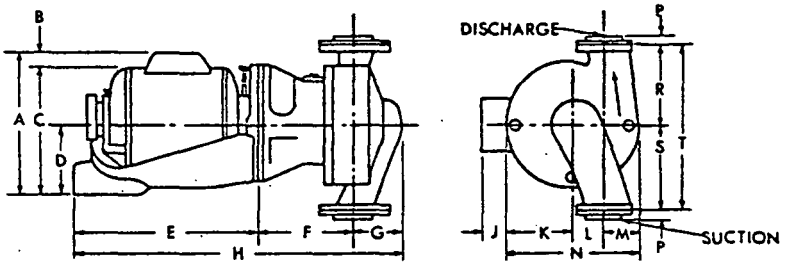
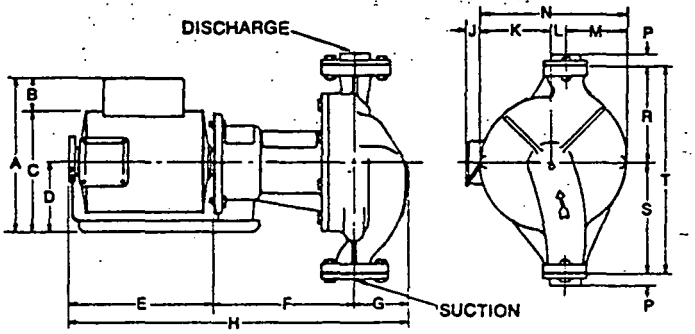


FIG. 2 A SIZES



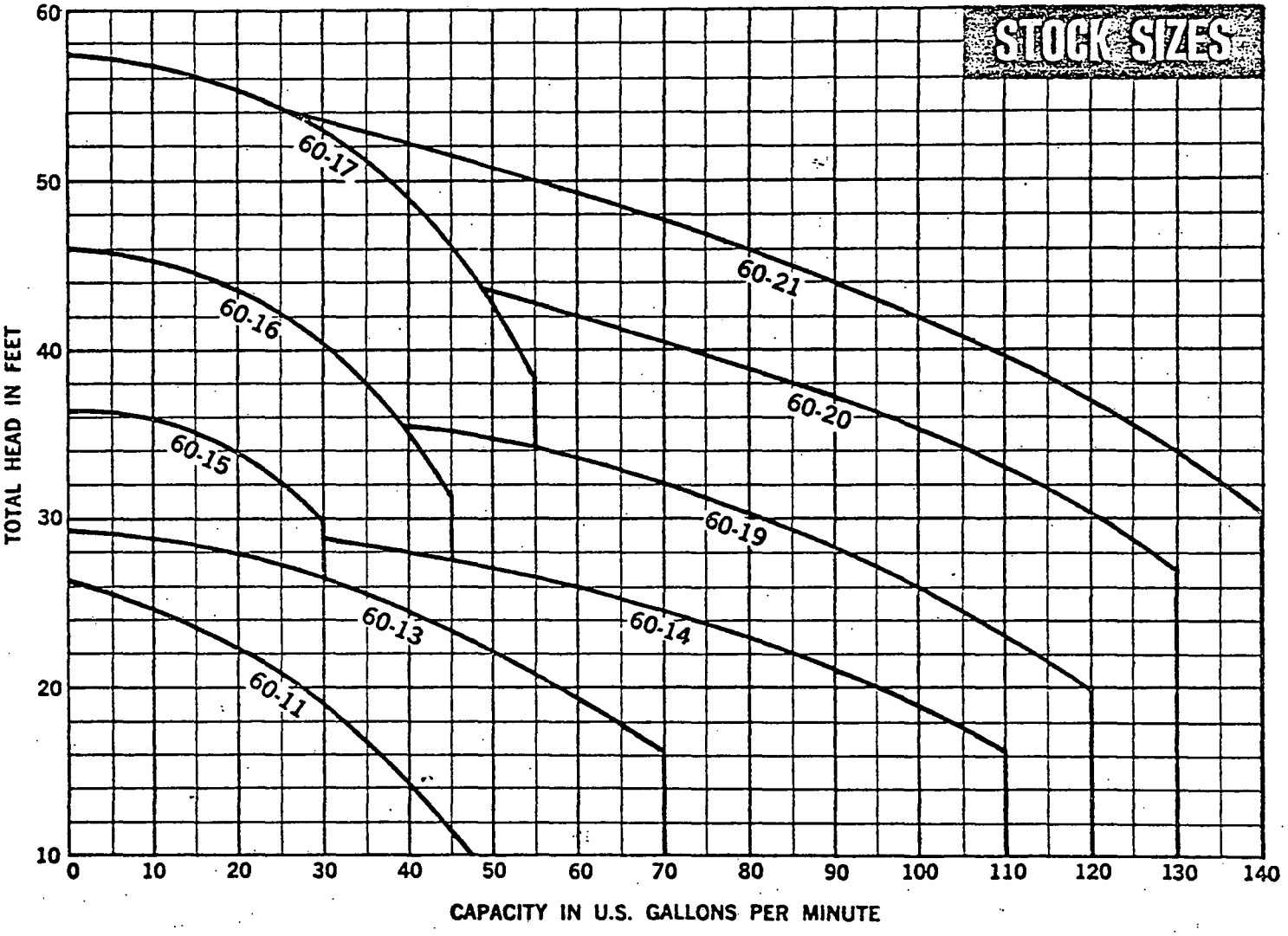
ALL SINGLE PHASE MOTORS INCLUDE BUILT-IN THERMAL OVERLOAD PROTECTORS.
BRONZE FITTED CONSTRUCTION—COMPANION FLANGES FURNISHED FOR SUCTION AND DISCHARGE.
MOTORS—OPEN DRIPPROOF ENCLOSURE. SINGLE PHASE—UNIT NO. ENDING IN "S" 115/230 VOLT 60 CYCLE 1 PHASE 1750 RPM.
THREE PHASE—UNIT NO. ENDING IN "T" 208-230/460 VOLT 60 CYCLE 3 PHASE 1750 RPM. MAXIMUM WORKING PRESSURE 175 PSI

MODEL NO.	PUMP SIZE	SUCTION & DISCHARGE SIZE INS. NPT	MOTOR H.P.	PHASE	DIMENSIONS—IN INCHES																
					A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
60-11S	1¼AA	1¼	¼	1	7⅜	—	7⅜	4⅜	10	5 13/16	3 7/16	19¼	—	3⅜	1⅜	2½	7½	¾	5	6	11
60-11T	1¼AA	1¼	¼	3	7⅜	—	7⅜	4⅜	9¾	5 13/16	3 7/16	19	—	3⅜	1⅜	2½	7½	¾	5	6	11
60-13S	1½AA	1½	½	1	9½	2⅛	7⅜	4⅜	11½	6	3⅜	21⅛	—	3¾	1⅜	2¾	7⅞	¾	5	6½	11½
60-13T	1½AA	1½	½	3	7⅜	—	7⅜	4⅜	11	6	3⅜	20⅝	—	3¾	1⅜	2¾	7⅞	¾	5	6½	11½
60-14S	2AA	2	¾	1	9½	2⅛	7⅜	4⅜	12	6⅛	3¾	21⅞	—	3¾	1⅜	2⅞	8	13/16	5	6½	11½
60-14T	2AA	2	¾	3	7⅜	—	7⅜	4⅜	11½	6⅛	3¾	21⅜	—	3¾	1⅜	2⅞	8	13/16	5	6½	11½
60-15S	1½A	1½	½	1	9½	2⅛	7⅜	4⅜	11½	9¾	3¼	24½	—	4⅜	1	3⅞	9½	¾	6½	7	13½
60-15T	1½A	1½	½	3	7⅜	—	7⅜	4⅜	11	9¾	3¼	24	—	4⅜	1	3⅞	9½	¾	6½	7	13½
60-16S	1½A	1½	¾	1	9½	2⅛	7⅜	4⅜	12	9¾	3¼	25	—	4⅜	1	3⅞	9½	¾	6½	7	13½
60-16T	1½A	1½	¾	3	7⅜	—	7⅜	4⅜	11½	9¾	3¼	24½	—	4⅜	1	3⅞	9½	¾	6½	7	13½
60-17S	1½A	1½	1	1	10 5/16	2⅛	8 3/16	4¾	9¾	9¾	3¼	22¾	⅛	4⅜	1	3⅞	9½	¾	6½	7	13½
60-17T	1½A	1½	1	3	8 3/16	—	8 3/16	4¾	10	9¾	3¼	23	⅛	4⅜	1	3⅞	9½	¾	6½	7	13½
60-19S	2A	2	1	1	10 5/16	2⅛	8 3/16	4¾	9¾	9¾	3½	23	¼	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-19T	2A	2	1	3	8 3/16	—	8 3/16	4¾	10	9¾	3½	23¼	¼	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-20S	2A	2	1½	1	10 5/16	2⅛	8 3/16	4¾	10⅜	9¾	3½	23⅜	¼	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-20T	2A	2	1½	3	8 3/16	—	8 3/16	4¾	10⅜	9¾	3½	24⅛	¼	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-21T	2A	2	2	3	8 3/16	—	8 3/16	4¾	11⅝	9¾	3½	24⅞	¼	4¾	1	4⅛	9⅞	13/16	6½	7½	14

(See Reverse Side for Capacity Chart)

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

SERIES "60" PERFORMANCE CURVES



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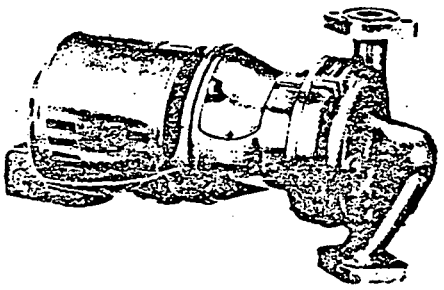
REVISION 6



STOCK SIZES SERIES "60"

In-Line Mounted Centrifugal Pumps

JOB

UNIT TAG NO. P-5

ENGINEER _____

CONTRACTOR _____

B & G REPRESENTATIVE _____

ORDER NO. _____ DATE _____

SUBMITTED BY _____ DATE _____

APPROVED BY _____ DATE _____

DIMENSIONS

FIG. 1 AA SIZES

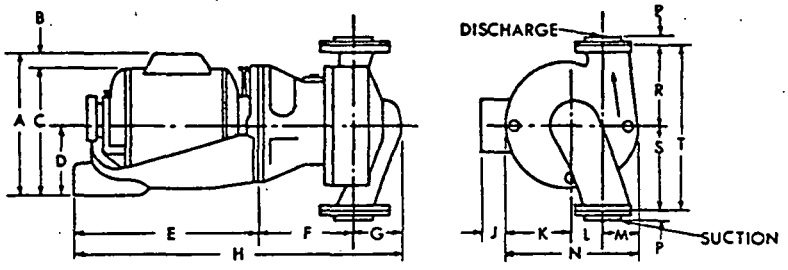
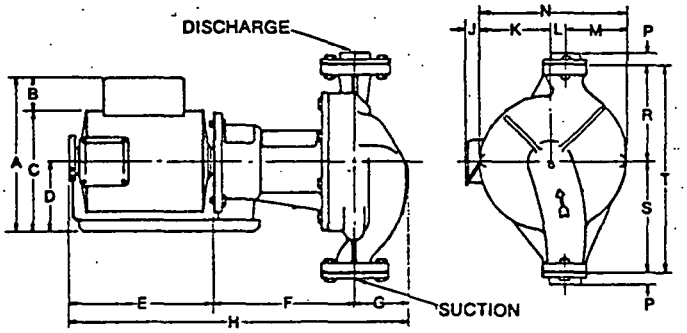


FIG. 2 A SIZES



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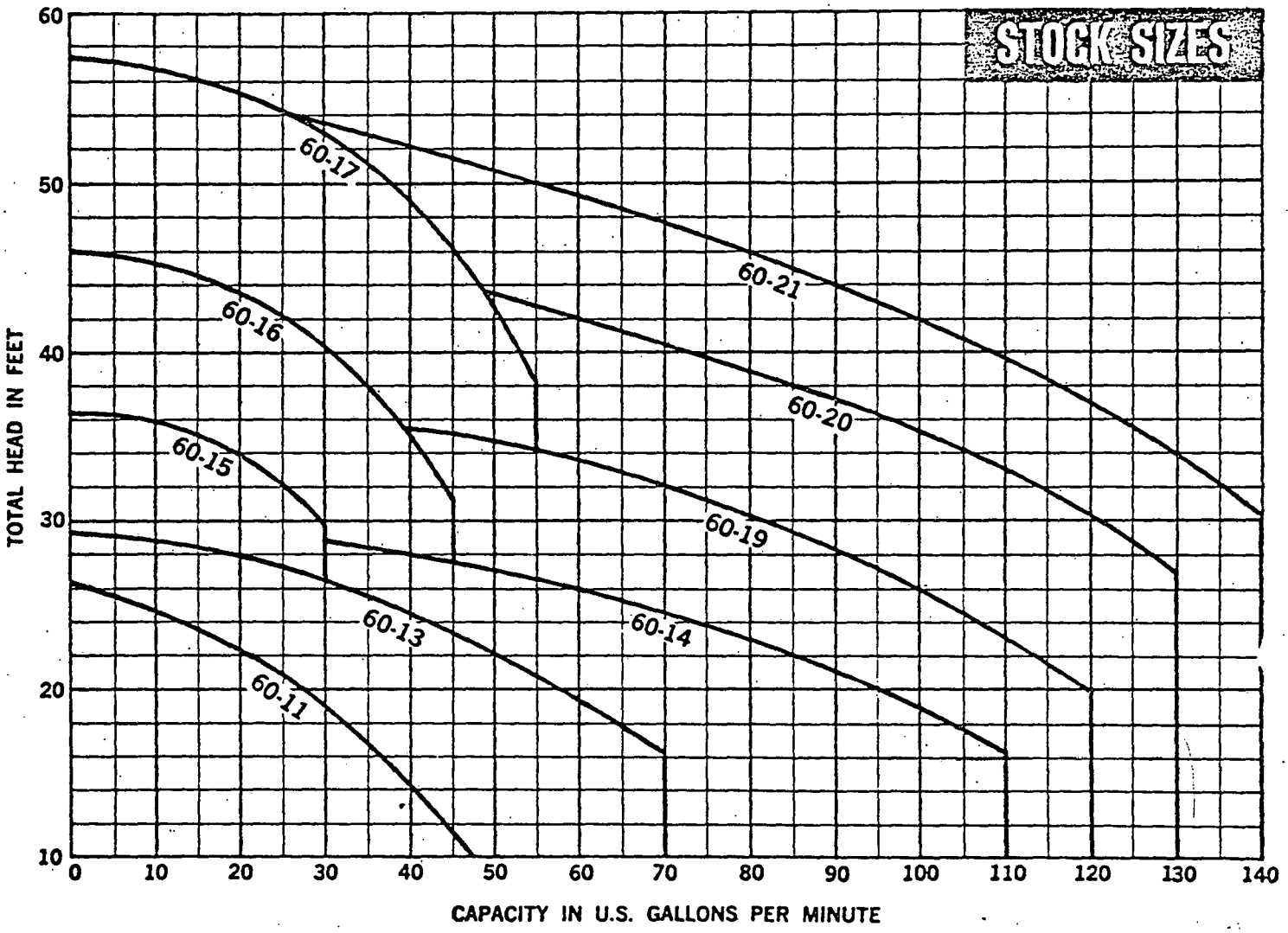
THREE PHASE—UNIT NO. ENDING IN "T" 208-230/460 VOLT 60 CYCLE 3 PHASE 1750 RPM. MAXIMUM WORKING PRESSURE 175 PSI

MODEL NO.	PUMP SIZE	SUCTION & DISCHARGE SIZE INS. NPT	MOTOR H.P.	PHASE	DIMENSIONS—IN INCHES															
					A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
60-11S	1¼AA	1¼	¼	1	7⅜	—	7⅜	4⅜	10	5 13/16	3 7/16	19¼	—	3⅜	1⅜	2½	7½	¾	5	6	11
60-11T	1¼AA	1¼	¼	3	7⅜	—	7⅜	4⅜	9¾	5 13/16	3 7/16	19	—	3⅜	1⅜	2½	7½	¾	5	6	11
60-13S	1½AA	1½	½	1	9½	2⅛	7⅜	4⅜	11½	6	3⅜	21⅛	—	3¾	1⅜	2¾	7⅞	¾	5	6½	11½
60-13T	1½AA	1½	½	3	7⅜	—	7⅜	4⅜	11	6	3⅜	20⅝	—	3¾	1⅜	2¾	7⅞	¾	5	6½	11½
60-14S	2AA	2	¾	1	9½	2⅛	7⅜	4⅜	12	6⅛	3¾	21⅞	—	3¾	1⅜	2⅞	8	13/16	5	6½	11½
60-14T	2AA	2	¾	3	7⅜	—	7⅜	4⅜	11½	6⅛	3¾	21⅜	—	3¾	1⅜	2⅞	8	13/16	5	6½	11½
60-15S	1½A	1½	½	1	9½	2⅛	7⅜	4⅜	11½	9¾	3¼	24½	—	4⅜	1	3⅜	9½	¾	6½	7	13½
60-15T	1½A	1½	½	3	7⅜	—	7⅜	4⅜	11	9¾	3¼	24	—	4⅜	1	3⅜	9½	¾	6½	7	13½
60-16S	1½A	1½	¾	1	9½	2⅛	7⅜	4⅜	12	9¾	3¼	25	—	4⅜	1	3⅜	9½	¾	6½	7	13½
60-16T	1½A	1½	¾	3	7⅜	—	7⅜	4⅜	11½	9¾	3¼	24½	—	4⅜	1	3⅜	9½	¾	6½	7	13½
60-17S	1½A	1½	1	1	10 5/16	2⅛	8 3/16	4¾	9¾	9¾	3¼	22¾	⅞	4⅜	1	3⅜	9½	¾	6½	7	13½
60-17T	1½A	1½	1	3	8 3/16	—	8 3/16	4¾	10	9¾	3¼	23	⅞	4⅜	1	3⅜	9½	¾	6½	7	13½
60-19S	2A	2	1	1	10 5/16	2⅛	8 3/16	4¾	9¾	9¾	3½	23	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-19T	2A	2	1	3	8 3/16	—	8 3/16	4¾	10	9¾	3½	23¼	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-20S	2A	2	1½	1	10 5/16	2⅛	8 3/16	4¾	10⅜	9¾	3½	23⅜	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-20T	2A	2	1½	3	8 3/16	—	8 3/16	4¾	10⅜	9¾	3½	24⅛	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14
60-21T	2A	2	2	3	8 3/16	—	8 3/16	4¾	11⅝	9¾	3½	24⅛	¾	4¾	1	4⅛	9⅞	13/16	6½	7½	14

(See Reverse Side for Capacity Chart)

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

SERIES "60" PERFORMANCE CURVES



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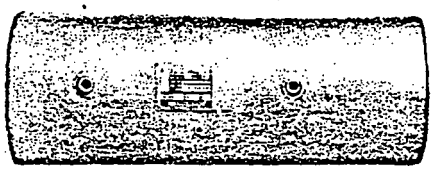
A-332
REVISION 7



ASME Compression Tanks

Air Control

JOB

B & G REPRESENTATIVE _____

UNIT TAG NO. T-1 ORDER NO. _____ DATE _____

ENGINEER _____ SUBMITTED BY _____ DATE _____

CONTRACTOR _____ APPROVED BY _____ DATE _____

DESCRIPTION

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

CONSTRUCTION

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

PERFORMANCE LIMITATIONS
Maximum Design Pressure 125 PSIG
Maximum Design Temperature 375°F

SCHEDULE

MODEL NO. AND GALLON CAPACITY	REQUIRED AIRTROL TANK FITTING	TAGGING INFORMATION	QUANTITY
15	ATF-12		
24			
30			
40	ATF-16		
60			
80	ATF-20		
100	ATFL		
120			
144			
163			
202			
238			
270			
306			
337			
388			

TYPICAL SPECIFICATION

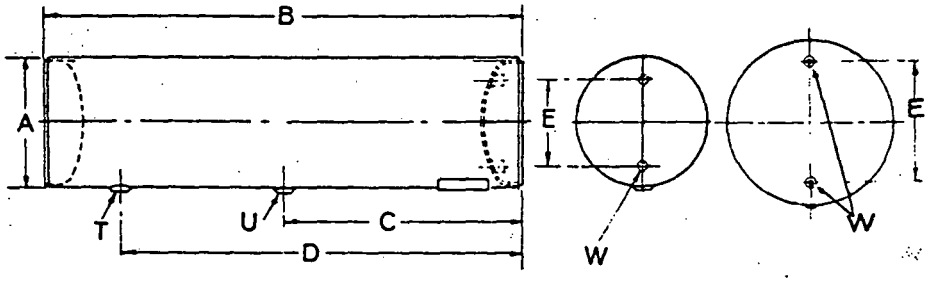
Furnish and install as shown on the plans a _____ gallon, _____ " X _____ " compression tank with 1/2" gauge glass tappings. The unit must be constructed in accordance with A.S.M.E. boiler and pressure vessel code and stamped 125 PSIG design pressure.

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

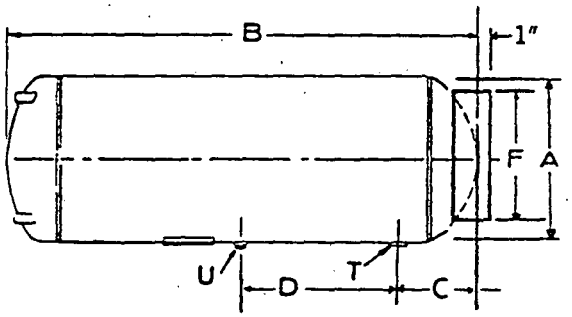
Each compression tank shall be ITT Bell & Gossett Model No. _____ or equal.

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

ASME COMPRESSION TANKS (Air Control)



Nos. 15 thru 144



Nos. 163 thru 388

DIMENSIONS & WEIGHTS

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

N/A - Not Applicable

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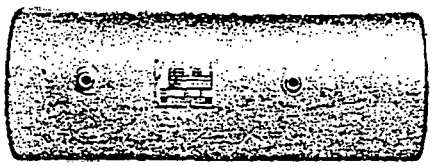


ASME Compression Tanks

Air Control

JOB

B & G REPRESENTATIVE _____

UNIT TAG NO. T-2

ORDER NO. _____ DATE _____

ENGINEER _____

SUBMITTED BY _____ DATE _____

CONTRACTOR _____

APPROVED BY _____ DATE _____

DESCRIPTION

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

CONSTRUCTION

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

PERFORMANCE LIMITATIONS
Maximum Design Pressure 125 PSIG
Maximum Design Temperature 375°F

SCHEDULE

MODEL NO. AND GALLON CAPACITY	REQUIRED AIRTROL TANK FITTING	TAGGING INFORMATION	QUANTITY
15	ATF-12		
24			
30			
40	ATF-16		
60			
80	ATF-20		
100	ATFL		
120			
144			
163			
202			
238			
270			
306			
337			
388			

TYPICAL SPECIFICATION

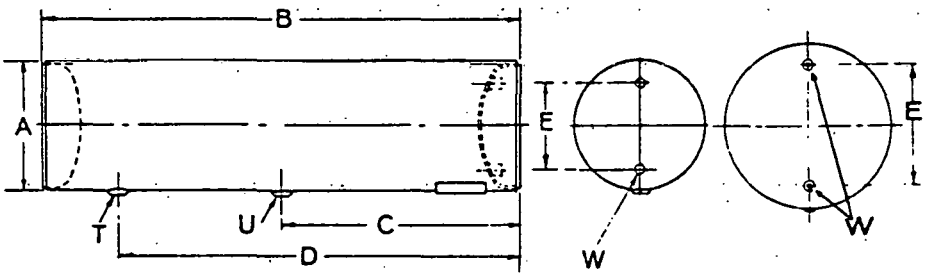
Furnish and install as shown on the plans a _____ gallon, _____ " X _____" compression tank with 1/2" gauge glass tappings. The unit must be constructed in accordance with A.S.M.E. boiler and pressure vessel code and stamped 125 PSIG design pressure.

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

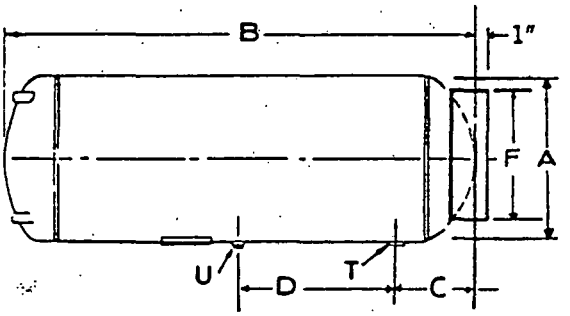
Each compression tank shall be ITT Bell & Gossett Model No. _____ or equal.

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

ASME COMPRESSION TANKS (Air Control)



Nos. 15 thru 144



Nos. 163 thru 388

DIMENSIONS & WEIGHTS

MODEL NUMBER	DIMENSIONS IN INCHES						TAPPINGS NPT			APPROX. SHIP. WGT.—LBS.
	A	B	C	D	E	F	T	U	W	
15	13	34½	17¼	24¾	7½	N/A	½	½	½	63
24		51	25½	38						86
30		61½	30¾	46¼						99
40	16¼	53	26½	39¼	10					119
60		76½	38¼	58						157
80	20¼	68	34	50¾	14			1		205
100		82	41	61¾						236
120	24¼	71½	35¾	53¼	18					267
144		83½	41¾	62¾						298
163	30	60	13⅞	16⅞	24	27				396
202		72		22⅞						456
238		84		28⅞						515
270		96		34⅞						574
306		108		40⅞						633
337	36	84	14¾	27 5/16	30	30½				599
388		96		33 5/16						669

N/A - Not Applicable

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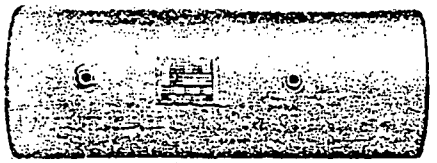


ASME Compression Tanks

Air Control

JOB

B & G REPRESENTATIVE _____

UNIT TAG NO. T-3

ORDER NO. _____ DATE _____

ENGINEER _____

SUBMITTED BY _____ DATE _____

CONTRACTOR _____

APPROVED BY _____ DATE _____

DESCRIPTION

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

CONSTRUCTION

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

PERFORMANCE LIMITATIONS

Maximum Design Pressure 125 PSIG
Maximum Design Temperature 375°F

SCHEDULE

MODEL NO. AND GALLON CAPACITY	REQUIRED AIRTROL TANK FITTING	TAGGING INFORMATION	QUANTITY
15	ATF-12		
24			
30			
40	ATF-16		
60			
80	ATF-20		
100	ATFL		
120			
144			
163			
202			
238			
270			
306			
337			
388			

TYPICAL SPECIFICATION

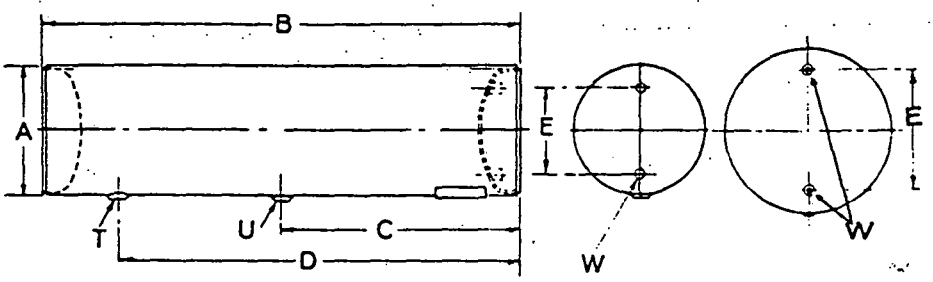
Furnish and install as shown on the plans a _____ gallon, _____ " X _____" compression tank with 1/2" gauge glass tappings. The unit must be constructed in accordance with A.S.M.E. boiler and pressure vessel code and stamped 125 PSIG design pressure.

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

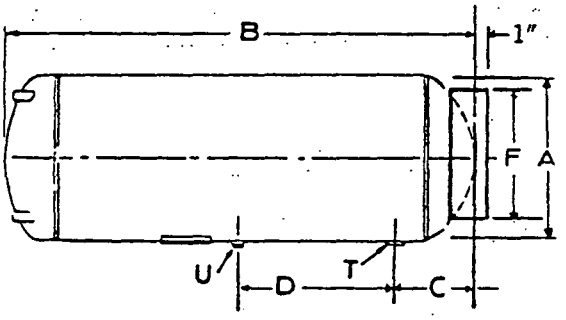
Each compression tank shall be ITT Bell & Gossett Model No. _____ or equal.

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

ASME COMPRESSION TANKS (Air Control)



Nos. 15 thru 144



Nos. 163 thru 388

DIMENSIONS & WEIGHTS

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

N/A - Not Applicable

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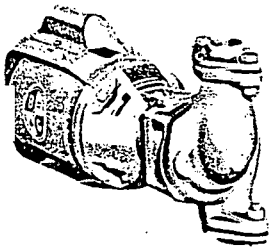
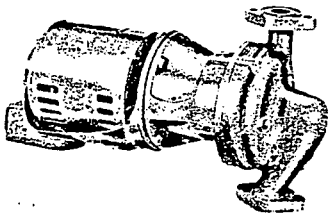




INSTRUCTION SHEET

S16946
REVISION 4
Also replaces
Instruction Manual S17630

BOOSTER AND SERIES "60" IN-LINE CENTRIFUGAL PUMPS

INSTALLATION, OPERATION AND SERVICE INSTRUCTIONS

INSTALLATION INSTRUCTIONS

LOCATION

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

ALIGNMENT

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

PIPING

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

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

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

Do not support under motor, misalignment will occur.

SYSTEM PREPARATION

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

PRIMING

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

LUBRICATION

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

Lubricate as follows:

1. Pump Bearings—Fill the bearing frame per oiling instruction tag with SAE #20 oil until oil flows from the overflow hole on the side of the bearing bracket. PD38, PD40 and Series 60 "A" size pumps are to be lubricated until oil level is up to the side hole. Relubricate as necessary to maintain this level.
2. Sleeve Bearing Motor—Lubricate thru the two motor oil cups per motor lubrication tag once every four months. Use ten to fifteen drops in each oil cup if required.
3. Ball Bearing Motor—Relubricate every six months to two years depending on operating conditions with a good soda-soap or lithium base grease.

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

OPERATING INSTRUCTIONS

1. Be sure to operate the pump in the proper direction. All PD and Series 60 run clockwise when looking at the pump from the motor end. All boosters run counterclockwise when looking at the pump from the motor end. All pumps are provided with arrows showing direction of rotation.
2. Keep pump and motor bearings lubricated.
3. Do not disassemble pump unless absolutely necessary as impeller has been accurately adjusted and tested before leaving factory.
4. Pump shaft should always turn freely by hand.
5. Ask for information or help if trouble is experienced that cannot be rectified since this pump is guaranteed to operate as recommended.
6. If pumps are to be idle for a very long period of time the interior of the volute should be cleaned and oiled. This prevents parts from rusting together and assures a longer period of satisfactory operation.
7. The motor should be protected against overload and under-voltage. Control devices for this purpose can be obtained at a very low cost. They are inexpensive insurance.

(OVER)

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

SERVICE INSTRUCTIONS

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

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

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

HOW TO REPLACE THE COUPLER ASSEMBLY

A — Turn off current to motor.

B — Remove bearing bracket cover.

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

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

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

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

HOW TO REPLACE THE RING MOTOR MOUNTINGS

A— Turn off current to motor.

B— Disconnect motor leads.

C— Remove coupler from motor shaft.

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

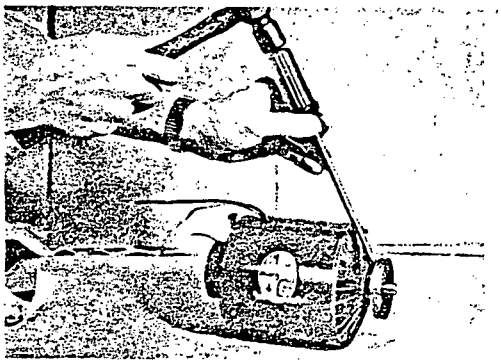
E— Place screwdriver between front mounting and end-bell of motor and strike firmly with a hammer on handle of screwdriver, forcing inner ring of motor mounting off the boss of end-bell. (Figure 1)

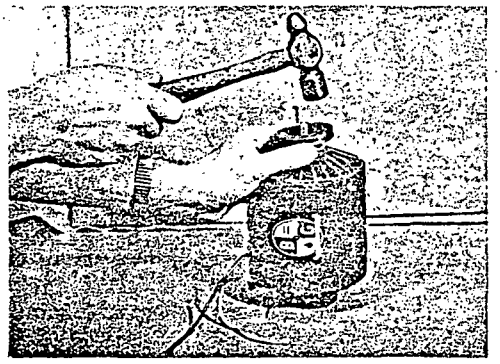
F— To install motor mounts, hold mounting firmly against boss of end-bell and tap inner ring lightly until mounting has started. Continue to tap around the inner ring (compression ring) until mounting is flush with end of boss. (Figure 2) Repeat procedure with rear mount, however, do not rest motor on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

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

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

I— Reconnect motor leads and turn current back on.





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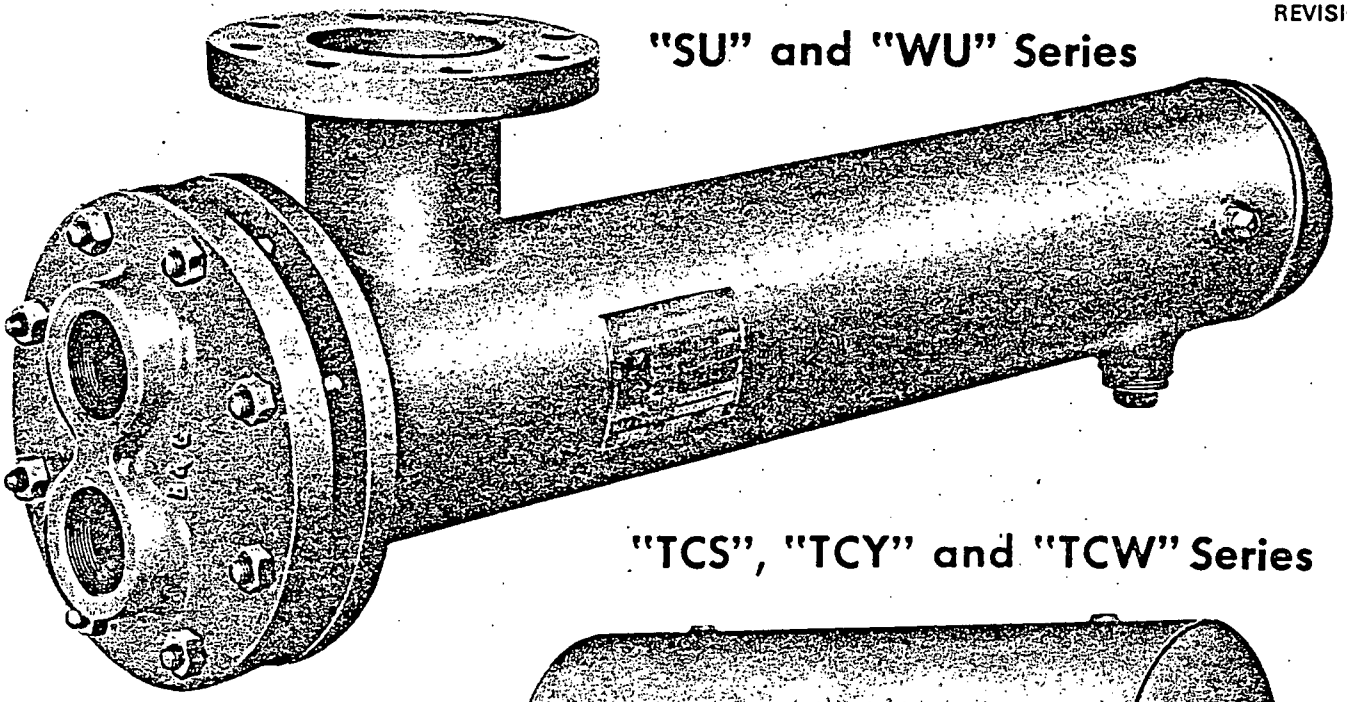
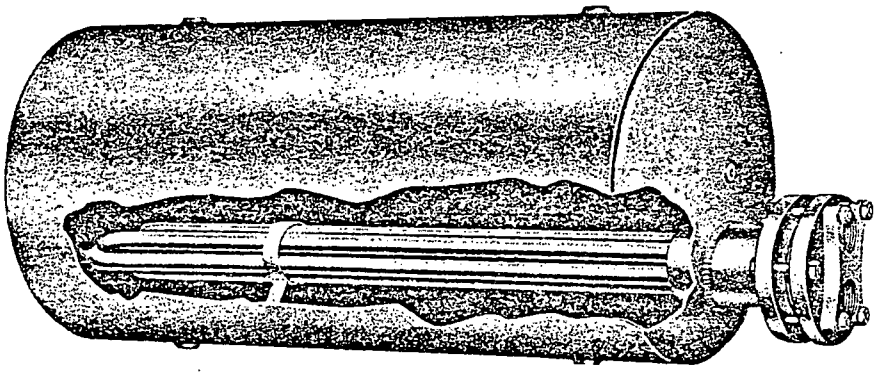
INSTRUCTION MANUAL

HT-50-10M
REVISION 1

"SU" and "WU" Series



"TCS", "TCY" and "TCW" Series



Installation, Operation and Maintenance Manual

for B & G "U" Series Heat Exchangers

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

INSTRUCTIONS FOR B&G "U" SERIES HEAT EXCHANGERS

INSTALLATION

1. Provide sufficient clearance at the head of unit to permit removal of tube bundle from shell.

2. Provide valves and by-passes in the piping system so that both the shells and tube bundles may be by-passed to permit cutting out the unit for inspection or repairs.

3. Provide thermometer wells and pressure gauge connection in all piping to and from the unit and located as near the unit as possible.

4. Provide air vent cocks for unit so it can be purged to prevent or relieve vapor binding of either the tube bundle or the shell.

5. Foundations must be adequate so that exchangers will not settle and cause piping strains.

6. Loosen foundation bolts at one end of unit to allow free expansion of shells. Oval holes in foundation brackets are provided for this purpose.

7. Set exchangers level and square so that pipe connections may be made without forcing.

8. Inspect all openings in exchanger for foreign material. Do not expose units to the elements with pads or other covers removed from nozzles since rain water may enter the unit and cause severe damage due to freezing.

9. Be sure entire system is clean before starting operation to prevent plugging of tubes with sand or refuse.

10. Steam hammer can cause serious damage to the tubes of any Heat Exchanger. A careful consideration of the following points before an installation is made can prevent costly repairs which may be caused by Steam hammer.

(a) A vacuum breaker and/or vent, should be used in accordance with the type of steam system installed.

(b) The proper trap for the steam system installed should be used.

(c) The trap and the condensate return line to the trap should be properly sized for the total capacity of the convertor.

(d) The trap should be sized for the pressure at the trap, not the inlet pressure to the steam controller.

11. For further exemplification of the above installation instructions see typical installation examples on page 3.

CAUTION: During times of shut down, volumetric expansion can occur. Therefore, we recommend the installation of a properly sized relief valve on the discharge side of the exchanger.

OPERATION

1. When placing a unit in operation, open the vent connections and start to circulate the cold medium only. Be sure that the passages in the exchanger are filled with the cold fluid before closing the vents. The hot medium should then be introduced gradually until all passages are filled with liquid.

2. Start operation gradually. Do not admit hot fluid to the unit suddenly when empty or cold. Do not shock unit with cold fluid when unit is hot.

3. In shutting down, flow of hot medium should be shut off first. If it is necessary to stop circulation of cooling medium, the circulation of hot medium should also be stopped by by-passing or otherwise.

4. Do not operate equipment under conditions in excess of those specified on name plate.

5. Drain all fluids when shutting down to eliminate possibility of freezing and corrosion. To guard against water hammer, condensate should be drained from steam heaters and similar apparatus both when starting up and when shutting down.

MAINTENANCE

1. Provide means for frequently cleaning heat exchangers as suggested below:

(a) Some cleaning compounds on the market, such as "Oakite" may be used to advantage for removing sludge or coke, provided hot wash oil or water does not give satisfactory results.

(b) If the above described method is ineffective for the removal of hard scale, a mechanical means may be used.

2. At regular intervals observe interior and exterior condition of all tubes and keep them clean. Neglect in keeping all tubes clean may result in complete stoppage of flow through some tubes, with consequent overheating of these tubes as compared to surrounding tubes, resulting in leaking tube joints.

3. Do not attempt to clean tubes by blowing steam through individual tubes.

4. Do not open heads until all pressure is off equipment and the unit drained.

5. Do not handle tube bundles with hooks or other tools which might damage tubes. Bundles should be moved about on cradles or skids.

6. Exchangers subject to fouling should be cleaned periodically. A marked increase in pressure drop and/or reduction in performance usually indicates cleaning is necessary. Since the difficulty of cleaning increases rapidly as the scale thickens or deposit increases, the intervals between cleanings should not be too great.

7. When removing tube bundles from exchangers for inspection or cleaning, care should be exercised that they are not damaged by improper handling. Tube bundles are often of great weight, yet the tubes are small and of relatively thin metal.

In cleaning a tube bundle, tubes should not be hammered on with any metallic tool and in case it is necessary to use scrapers, care should be exercised that the scraper is not sharp enough to cut the metal of the tubes.

TYPICAL INSTALLATIONS

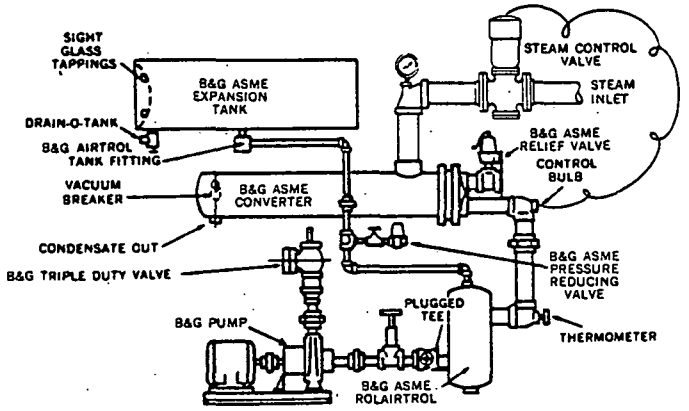


***Figure 1*—Typical installation of "SU" Heat Exchanger when used as a Convertor.**

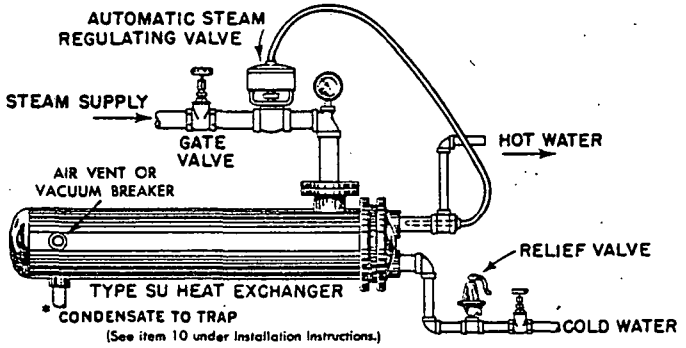


***Figure 2*—Typical installation of "SU" Heat Exchanger when used as an Instantaneous Heater.**

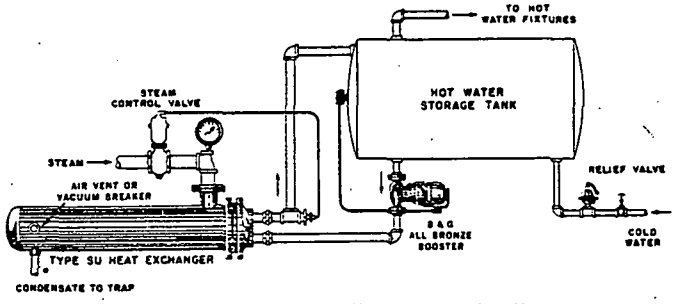
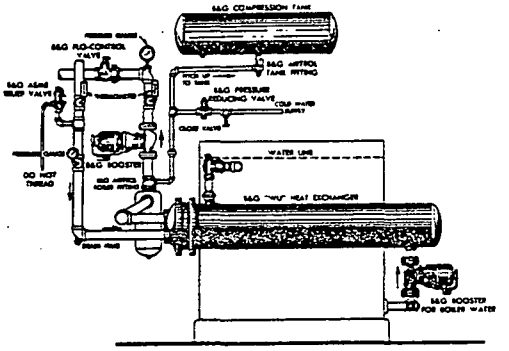


***Figure 3*—Typical installation of "SU" Heat Exchanger when used with storage tank.**

*CAUTION:

Steam hammer can cause serious damage to the tubes of any Heat Exchanger. A careful consideration of the following points before an installation is made can prevent costly repairs which may be caused by steam hammer.

1. A vacuum breaker and/or vent, should be used in accordance with the type of steam system installed.
2. The proper trap for the steam system installed should be used.
3. The trap and the condensate return line to the trap should be properly sized for the total capacity of the convertor.
4. The trap should be sized for the differential pressure across the trap, not the inlet pressure to the steam controller.
5. A properly sized relief valve must be installed on the heated water side to protect heat exchangers from possible damage due to volumetric expansion.



For proper sizing of Airtrol System consult B&G Representative.

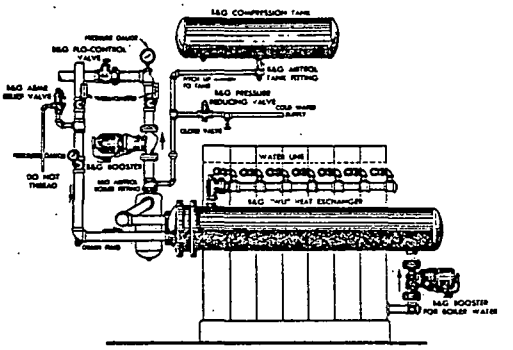
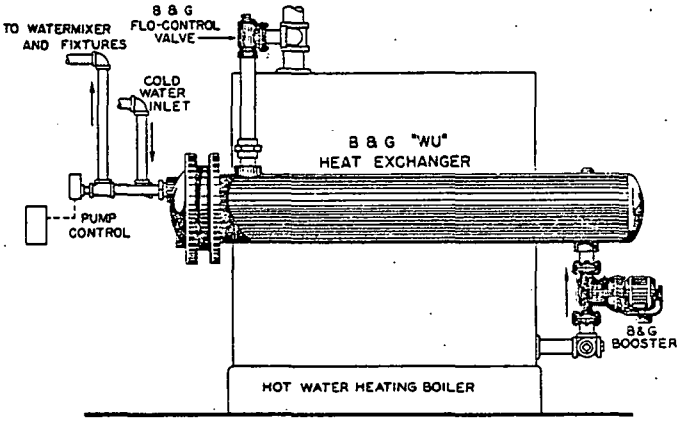
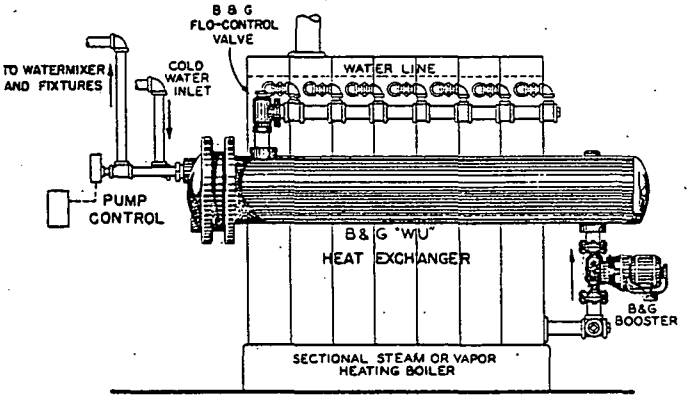


***Figure 4*—Typical installation of "WU" Heat Exchanger when used as a Convertor.**



Installation on hot water boiler

When the "WU" is installed on a hot water boiler as shown, a B&G Flo-Control Valve prevents gravity circulation of boiler water when Booster is not running.

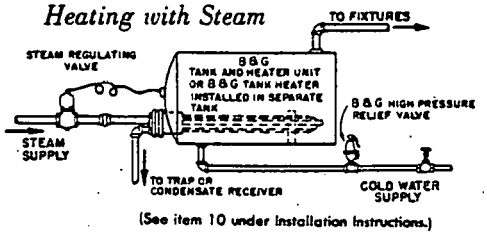


Installation on steam boiler

When installed on a steam boiler, note that boiler water is pumped into the "WU" Heater from the bottom of the boiler.

***Figure 5*—Typical installation of "WU" Heat Exchanger when used as an Instantaneous Heater.**

TYPICAL INSTALLATIONS cont.



(See item 10 under Installation Instructions.)

***Figure 6*—Typical installation of "TCS" or "TCY" Tank Heater.**

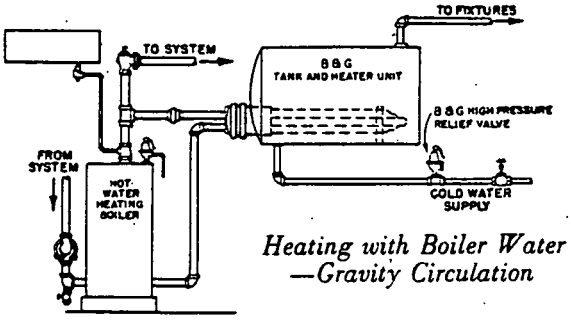


***Figure 7*—Typical installation of "TCW" Tank Heater.**

REPLACEMENT PARTS

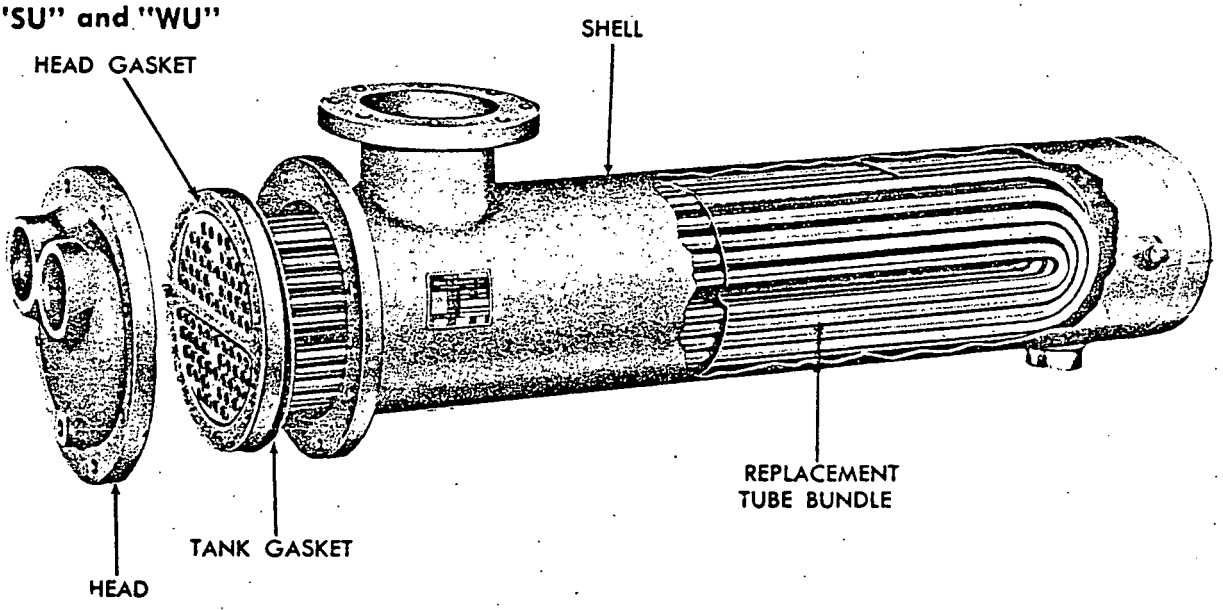
When replacement parts are required, refer to part identified in the drawing of the proper unit. When ordering be sure full nameplate information is given including Nat'l. Bd. No., Catalog, and Factory Number.

EXAMPLE:

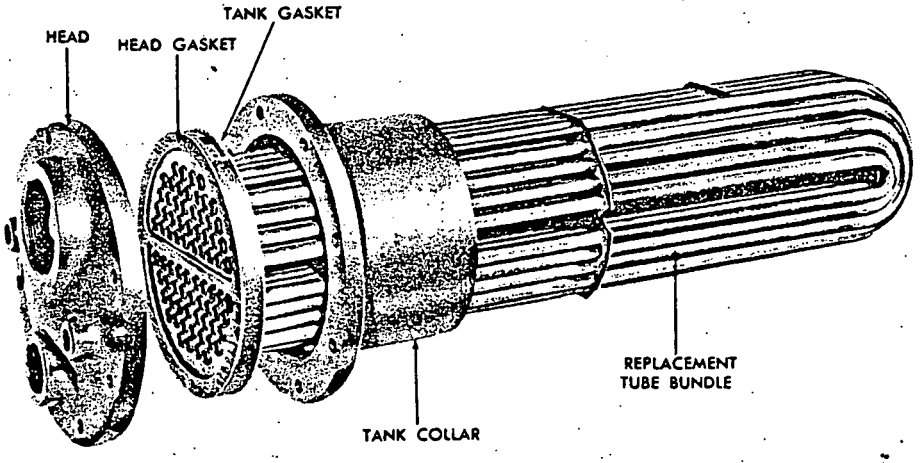
One replacement tube bundle for: Nat'l. Bd. No. 349622
Catalog No. SU-46-2
Factory No. 125022

Note: Gaskets are always furnished with replacement tube bundles and need not be ordered separately.

"SU" and "WU"



"TCS", "TCY" and "TCW"



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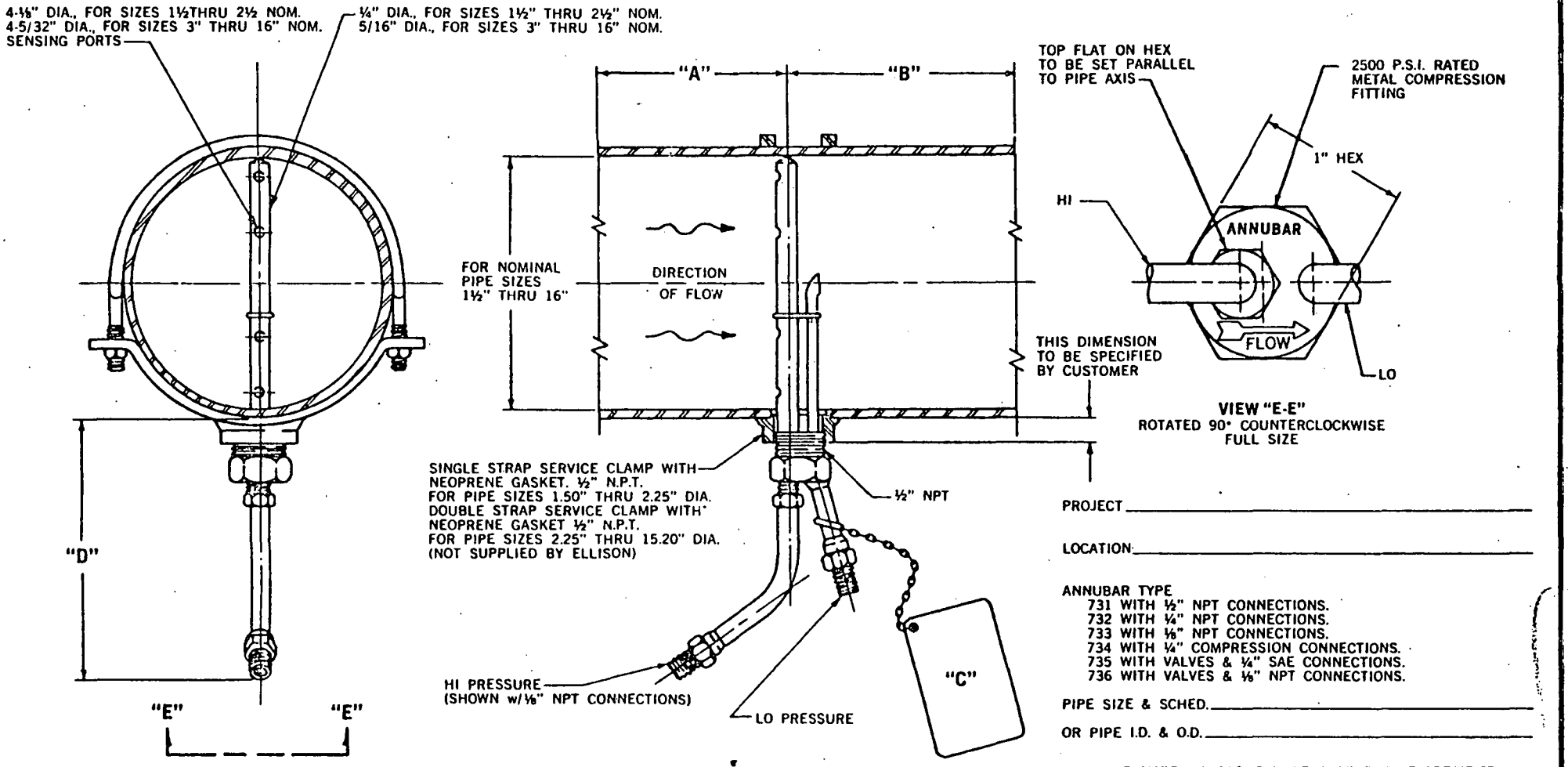
BELL & GOSSETT
8200 N AUSTIN AVE · MORTON GROVE ILL 60053
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION



PROJECT _____

LOCATION _____

ANNUBAR TYPE
- 731 WITH ½" NPT CONNECTIONS.
- 732 WITH ¼" NPT CONNECTIONS.
- 733 WITH ⅛" NPT CONNECTIONS.
- 734 WITH ¼" COMPRESSION CONNECTIONS.
- 735 WITH VALVES & ¼" SAE CONNECTIONS.
- 736 WITH VALVES & ⅛" NPT CONNECTIONS.

PIPE SIZE & SCHED. _____

OR PIPE I.D. & O.D. _____

ANNUBAR MATERIAL 316 SS UNLESS OTHERWISE SPECIFIED

APPROVED BY _____

"A"—6 OR MORE PIPE DIAMETERS IS RECOMMENDED FOR UPSTREAM SIDE OFTER VALVES, ELBOWS, ETC. SEE FORM E-79 BEFORE INSTALLATION.

"B"—3 TO 4 PIPE DIAMETERS IS RECOMMENDED FOR DOWNSTREAM SIDE.

"C"—PERMANENT RUSTPROOF METAL TAG SHOWING MIN., NORM. & MAX. DESIGNED FLOWS, METER READINGS FOR DESIGNED FLOWS, TAG NO., LINE SIZE, SERIAL NO., & METERED FLUID.

"D"—DIM. TO BE DETERMINED BY SADDLE SELECTED.

Dieterich Standard Corporation • Subsidiary of DOVER Corporation
Box 9000 • Boulder, Colorado 80306 USA

731 THRU 736 ANNUBAR® FLOW ELEMENTS—SADDLE MOUNT OPTION

APPROVAL By	APPROVAL Date	LATEST REVISION Letter	LATEST REVISION Date	Form No.
	7/26/77			
Drawn By	**Ck'ed By**	**Date Drawn**	**Scale**	**Part No.**
H. Firth		7/26/77	N.T.S.	

E-165A 8/77

SECTION D

ANNUBAR Flow Sensors
Installation and Operating Instructions

Dieterich Standard Corporation • Subsidiary of HOOVER Corporation

Contents

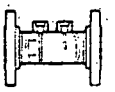
We are happy to welcome you as a user of the proven ANNUBAR primary flow sensor. The ANNUBAR is an annular averaging velocity head sensor for the natural measurement of flow through a pipe. It produces a differential pressure proportional to the square of the fluid velocity and with little permanent pressure loss. The differential pressure produced may be connected to a differential pressure device for transmitting, indicating, recording, integrating, control, or any combination of these functions. The ANNUBAR will provide long, efficient, trouble-free service, provided it is installed and operated properly.

1. Receiving & inspection

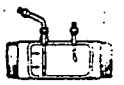
As soon as your order is received, it should be carefully inspected to determine any shortages or damage incurred in shipment. Check the packing list for the particular ANNUBARS and accessories that you have ordered. Each ANNUBAR is identified by an attached metal tag. Shortages should be reported to your supplier and damages to the delivering carrier.

2. ANNUBAR types

Types 61, 62
3/4" - 3"

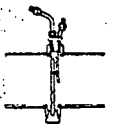


Types 71, 72
1/2" - 2-1/2"

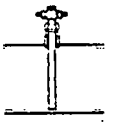


Type 73
1-1/2" - 16"

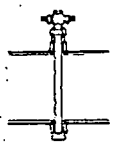
Type 74
3" - 36"



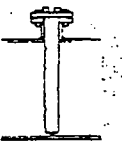
Type 75
3" - 60"



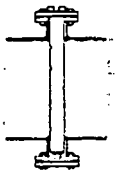
Type 76
10" - 180"



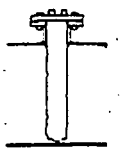
Type 85
12" - 500"



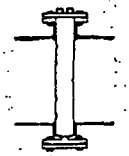
Type 86
36" - 500"



Type 95
36" - 500"



Type 96
60" - 500"



3. Operating limitations

3. Operating limitations

Structural limitations based on differential pressure are included in Charts A and B for operation up to 200°F. For operation at higher temperatures, see Charts C to F. For structural limitations of materials other than the standard 316 stainless steel (Monel, titanium, Hastelloy), consult the factory.

Chart A • Max. DP—Standard ANNUBARS 0-200°F

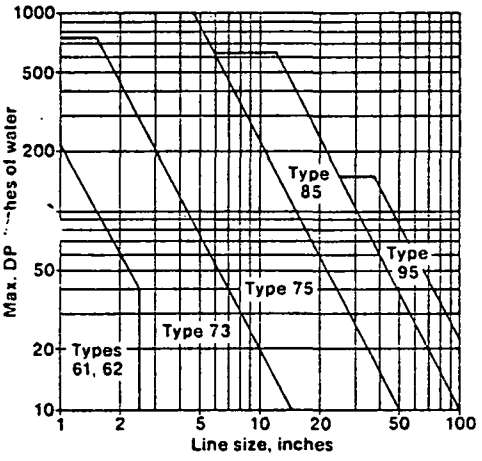


Chart B • Max. DP—End-support ANNUBARS 0-200°F

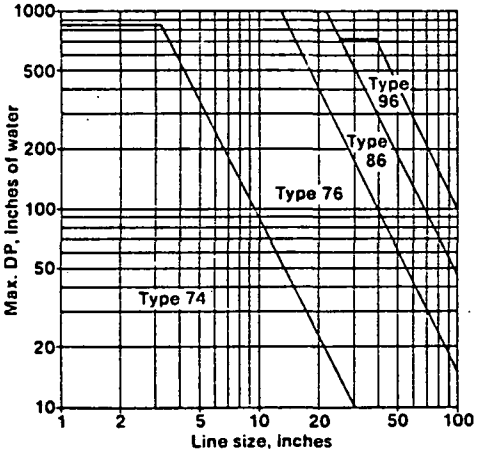


Chart C • Max. DP—Standard ANNUBARS 200-800°F

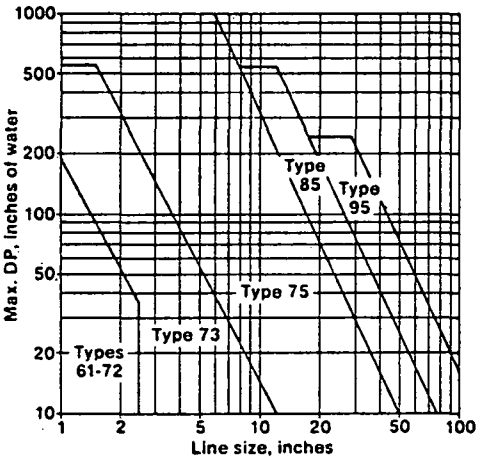


Chart D • Max. DP—End-support ANNUBARS 200-800°F

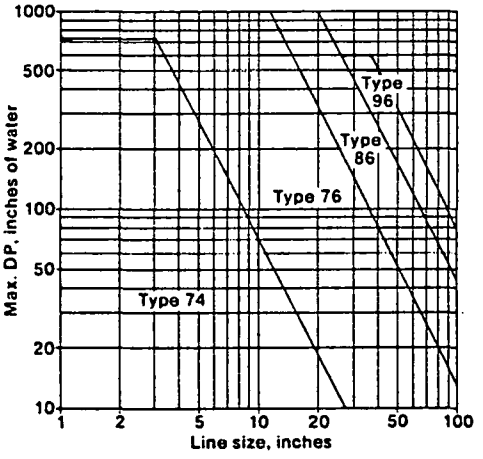


Chart E • Max. DP—Standard ANNUBARS 800-1100°F

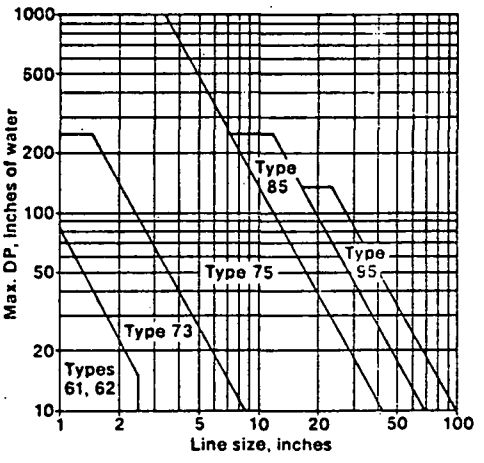
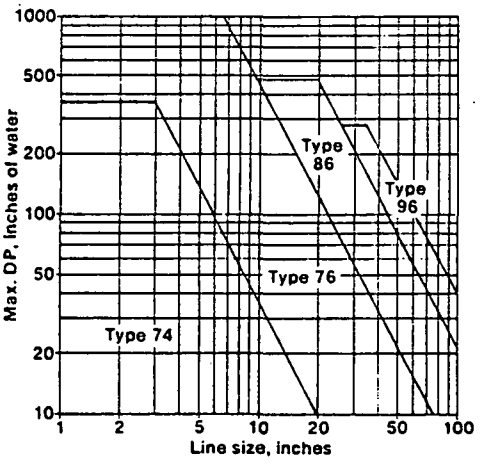


Chart F • Max. DP—End-support ANNUBARS 800-1100°F



Corrosive flows

Complete information concerning corrosive flow applications and ANNUBAR material selection is contained in Catalog E-100.

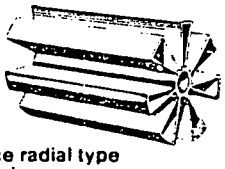
4. Selecting mounting locations

4. Selecting mounting locations

Correct location of the ANNUBAR in the pipeline is important because disturbance in flow produced by pipe layout may affect the accuracy of measurement. The following standard practices should be reviewed before selecting a mounting location:

Fig. 1 • Straightening vanes

Tubular type straightening vane



One-piece radial type straightening vane

Straight run requirements

Chart G shows recommended approach and depart values in terms of straight pipe diameters for normal industrial metering work. For laboratory or high accuracy work, add 25% to the values shown.

Use of recommended straight pipe lengths of uniform diameter upstream and downstream insures that flow measurements will be made in flow with fully developed characteristics. Straightening vanes may be used to reduce the length of straight pipe required in many cases. These are available through plumbing supply houses in several types. (Fig. 1)

Chart G • Minimum diameters of straight pipe

	Upstream dimension					Downstream dimension
	Without vanes		With vanes			
	In plane	Out of plane				
	A	A	A'	C	C'	B
1	7	9				3
1A			6	2.7	3.3	
2	9	14				3
2A			8	3.6	4.4	
3	19	24				4
3A			9	4.1	4.9	
4	8	8				3
4A			8	3.6	4.4	
5	8	8				3
5A			8	3.6	4.4	
6	24	24				4
6A			9	4.1	4.9	

Exceptions: Field experience has proven that ANNUBAR produces a repeatable signal even in pipes with less than the recommended upstream and downstream straight pipe. In such cases, ANNUBAR is an effective flow sensor for control and other applications where repeatability is the most important factor. A field calibration can be accomplished to determine accuracy in a short-run installation. (See page 10.)

Relation to readout device

The distance between the meter and the ANNUBAR should be as short as possible. If the distance from meter to sensor is under 50 feet, 1/4" OD tubing is satisfactory. For each additional 50 feet, use tubing 1/8" larger in size. (See p. 8-9 for further information about meter connections.)

Pulsation & vibration

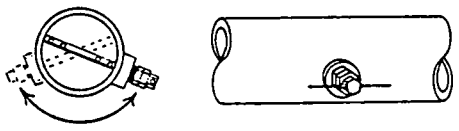
Avoid locating the ANNUBAR in pulsating flow. This may result in "noisy" signal problems. Vibration can also distort the output signal and compromise structural limits of the ANNUBAR. Mount the ANNUBAR in a secure, stable run of pipe to obtain optimum signal output.

Position in the pipe

A' 'JBAR may be installed in any p. . of the pipe (horizontal, vertical, 45°, or any angle in between). However, for trouble-free operation, consideration must be given to the type of flowing fluid and the secondary instrumentation. (See p. 8-9.)

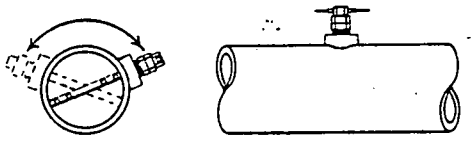
LIQUID FLOW MEASUREMENT—For vertical pipes, the ANNUBAR can be installed in any position of the 360° circumference of the pipe. For horizontal pipes, it is best to install the ANNUBAR into the bottom or side so that the instrument connections are below the pipe center line. This will keep the instrument lines full of liquid and encourage air or gas that may be in the instrument tubing to find its way to the sensor and thus into the flowing fluid.

Fig. 2 • Position on pipe for liquid flow



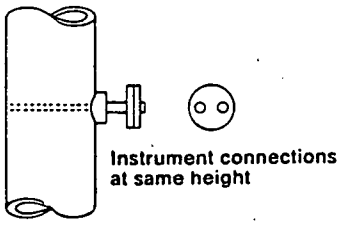
AIR/GAS FLOW MEASUREMENT—On vertical pipes, the ANNUBAR may be installed in any position of the 360° circumference of the pipe. For horizontal pipes, the ANNUBAR should be installed so that the instrument connections are above the pipe center line. This is to prevent moisture or condensation from entering the connecting lines.

Fig. 3 • Position on pipe for gas flow



STEAM/VAPOR FLOW MEASUREMENTS—On vertical pipes, the ANNUBAR may be installed in any position of the 360° circumference of the pipe, with the instrument connections on the same horizontal plane. (ANNUBARS for vertical steam lines must be manufactured with instrument connections at right angle to flow direction.) In horizontal steam lines, install the ANNUBAR horizontally. Steam flow measurement requires special consideration for successful operation. (See Steam Installation Instructions E-213.)

Fig. 4 • Position on pipe for steam/vapor flow



#7/#8 Instrument connections

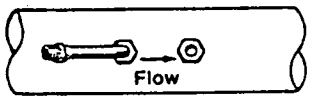
5. Installation Instructions

Types 61, 62, 71 and 72 pipe nipple ANNUBARS

Submittal drawing E-177 & E-164

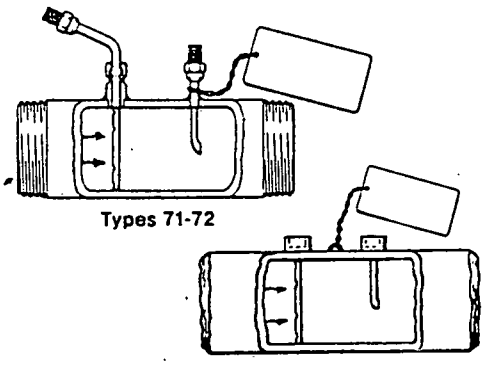
1. Install the nipple with the flow arrow pointing in direction of flow. Types 61/62 nipple ends are designed to be butt welded to the pipe or flanged in place.

Fig. 5 • Types 71-72 flow direction



2. For Types 71 and 72, insert the upstream (high pressure) probe into the fitting until the tip of the probe touches the back side of the pipe. Be sure the bent portion is pointing directly upstream. Tighten the compression nut to securely crimp the compression ferrule.

Fig. 6 • Types 61-72 installation

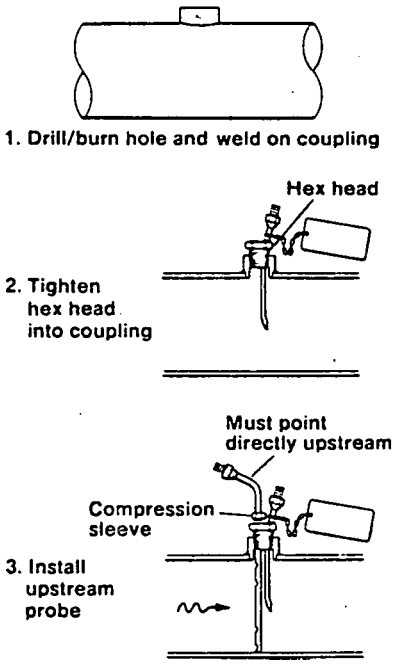


Type 73 ANNUBAR

Submittal drawing E-165

1. Drill or burn a 1" diameter hole in pipe for furnished threaded weld coupling. (Do not use an ordinary weld coupling—ANNUBAR lengths are designed for furnished weld couplings.)

Fig. 7 • Type 73 installation



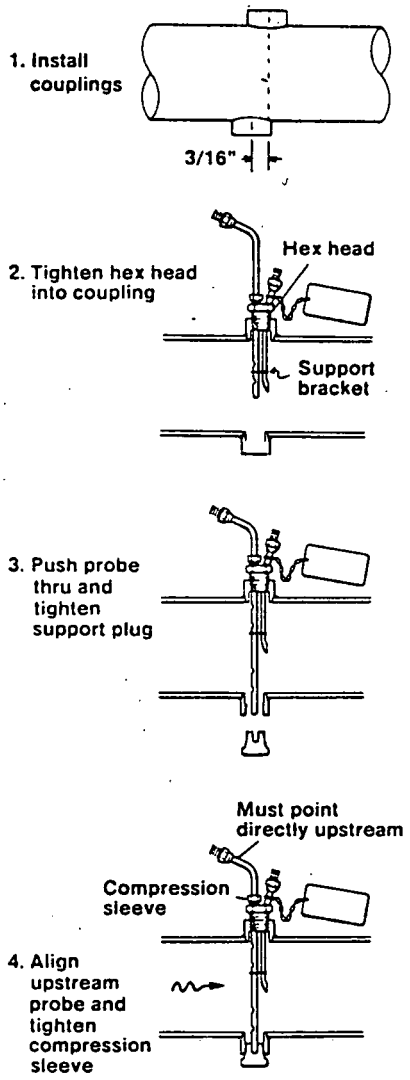
2. Tack weld coupling to pipe and align coupling to pipe so that it is perpendicular to pipe axis and square to its plane. A convenient way to do this is to screw a short piece of pipe into the coupling and use it as leverage for alignment.
3. Complete welding.
4. Loosen upstream probe from element assembly. Use standard pipe thread compound on threads and screw large hex fitting into weld coupling. Tighten hex until it seals, then up to one more turn until flow arrow points directly downstream. A straight-edge on the large hex flat can be used to help alignment of flat parallel to pipe axis.
5. Insert upstream probe until it touches the back side of pipe. Be sure bent portion is pointing directly upstream, then tighten compression sleeve.

e 74 ANNUBAR

Submittal drawing E-166

1. Install first weld coupling as noted in steps 1 and 2 of Type 73 instructions.

Fig. 8 • Type 74 installation



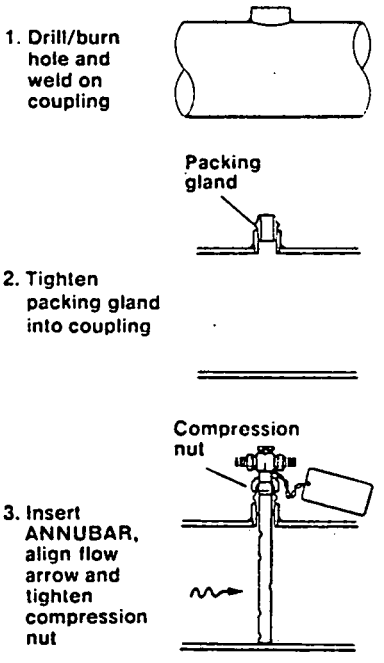
2. Locate position for second weld coupling by putting a piece of soft wire or string around the pipe. Position wire over center of first weld coupling, then draw it back and forth until it locates itself uniformly around the pipe. Measure half way around the pipe from first weld coupling and mark. Locate center of second weld coupling 3/16" upstream from mark. Drill 1" hole in pipe at that point. Tack weld second coupling to pipe, align, and finish welding both couplings.
3. Position upstream (high-pressure) probe until it is one inch through the support bracket (small disk holding upstream and static tubes together).
4. Use standard pipe thread compound on threads and screw the hex head into first installed coupling and tighten until arrow points directly downstream. A straight-edge on the large hex flat can be used to help alignment of flat parallel to pipe axis.
5. Push upstream probe completely through pipe until it enters second coupling on opposite side.
6. Use standard pipe thread compound on thread and screw hex plug into second coupling. Guide probe into it and tighten plug until it is secure.
7. Push probe until it touches bottom of plug. Be sure bent portion is pointing directly upstream, then tighten compression sleeve.

Type 75 ANNUBAR

Submittal drawing E-167

1. Drill or burn 1-3/8" hole in pipe for furnished threaded weld coupling.

Fig. 9 • Type 75 installation

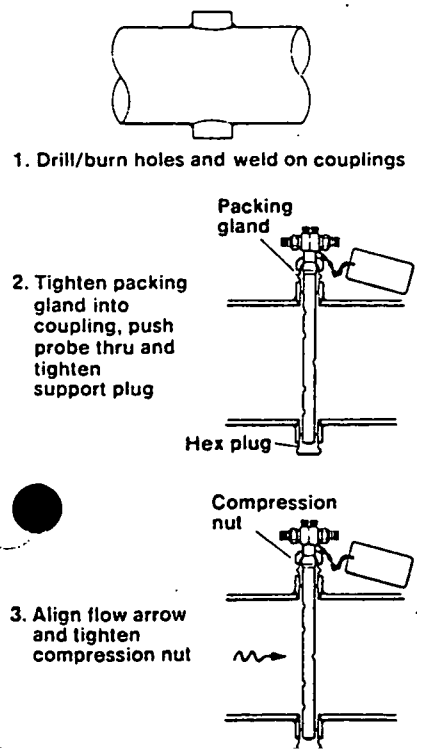


2. Tack weld coupling to pipe and align coupling so that it is perpendicular to pipe axis and square to its plane. A convenient way to do this is to screw a short piece of pipe into the coupling and use it as leverage for alignment.
3. Finish welding.
4. Insert ANNUBAR through weld coupling. Use Dow-Corning #11 silicone compound on threads and securely tighten packing gland into coupling.
5. Be sure ANNUBAR is touching the back side of pipe and that flow arrow is pointing in direction of flow. The metal compression ferrule must have its short tapered end in body of fitting and its long tapered end installed into nut. Tighten compression nut so that no more than one full thread is left exposed under nut. Use of a 2 to 3-ft. wrench is normally required.

Type 76 ANNUBAR
Submittal drawing E-168

1. Install first weld coupling as noted in steps 1 and 2 of Type 75 instructions.

Fig. 10 Type 76 installation

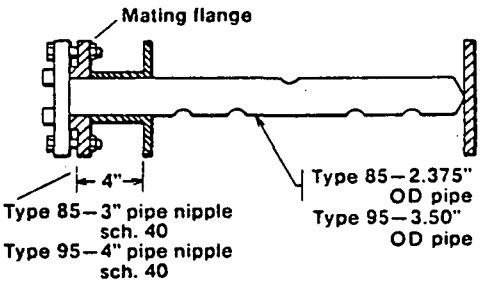


2. Locate position for second weld coupling by putting a piece of soft wire or string around the pipe. Position wire over center of first weld coupling, then draw it back and forth until it locates itself uniformly around the pipe. Measure half-way around the pipe from first weld coupling and mark for center of second weld coupling.
3. Drill or burn a 1-3/8" hole at mark for second coupling.
4. Tack second weld coupling at marked point. Check for correct alignment by inserting ANNUBAR through the couplings. Remove ANNUBAR, finish welding on both couplings.
5. Insert ANNUBAR through first coupling. Use standard pipe thread compound on threads and tighten packing gland into coupling.
6. Push ANNUBAR completely through pipe until it enters opposite-side coupling.
7. Screw hex plug into second coupling and guide ANNUBAR into it. Use pipe thread compound on thread and tighten hex plug until it is secure.
8. Push ANNUBAR until it touches bottom of hex plug. Align until flow arrow points directly downstream, then tighten compression sleeve so that no more than one full thread is left exposed under nut. Use of a 2 to 3-ft. wrench is normally required.

Types 85 and 95 ANNUBARS
Submittal drawing E-172

The standard Type 85 ANNUBAR (2.375" OD sensor) is supplied on a 3", 150# 316SS RF ANSI flange. The standard Type 95 ANNUBAR (3.5" OD sensor) is furnished with a 4", 150# 316SS RF ANSI flange. Both types are designed for mounting to a mating flange furnished by the installer. Unless specified differently, the ANNUBAR is designed for a 4" dimension from pipe wall to face of mating flange. This 4" (or specified) dimension must be maintained when installing mounting hardware.

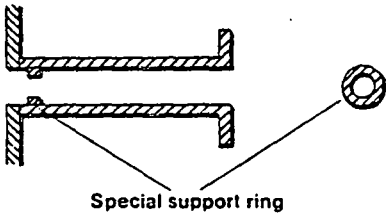
Fig. 11 • Types 85 and 95 installation



If mating flange and nipple are not already installed, proceed as follows:

1. Drill or burn a 3" diameter hole in pipe wall for Type 85 ANNUBAR (4" dia. for Type 95).
2. Obtain a short nipple (3" Sch 40 for Type 85, 4" Sch 40 for Type 95) sized for a 4" dimension between pipe wall and face of mating flange when flange and nipple are aligned perpendicular to each other.
3. Weld nipple to pipe, making sure it is perpendicular to pipe wall.
4. Although the ANNUBAR is sized to a specific dimension, it is wise to avoid installation problems by checking dimensions at this point. Insert ANNUBAR through the nipple until it bottoms at the opposite pipe wall. Note dimension from outer pipe wall to inside face of ANNUBAR flange. Remove ANNUBAR. The noted dimension should agree with specified dimension. If operating temperature is above 200° F, add 3/4" for pipe diameters to 60", 1-1/2" for pipes 60" to 120", and 2-1/2" for pipes above 120" to allow clearance for thermal expansion.
5. Align mating flange to installed nipple. Be sure the 4" or checked dimension is maintained and that mating flange will align with ANNUBAR flange such that flow arrow will point directly downstream. Then weld mating flange to nipple.
6. Install flange gaskets and slide ANNUBAR into the pipe. Complete installation by bolting ANNUBAR flange to mating flange.

Fig. 12 • Special support ring



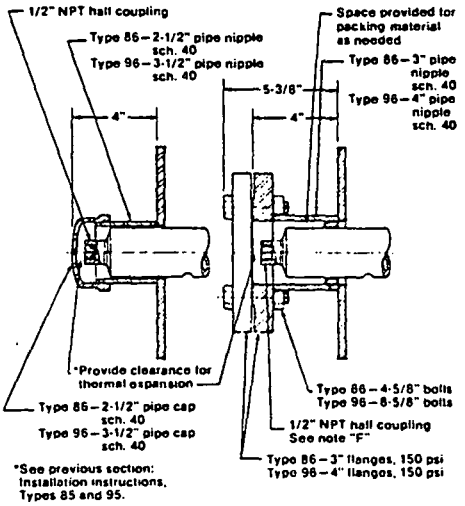
Note: When a distance from pipe wall to mating flange face longer than the normal 4" is specified, additional support for the ANNUBAR may be required. Order special support ring, Part 0297 for Types 85/86 ANNUBAR, or Part 0298 for Types 95/96 ANNUBAR.

Types 86 and 96 ANNUBARS
Submittal drawing E-172

Types 86 and 96 ANNUBARS are designed to extend 4" beyond the opposite pipe wall for end support furnished by the installer. Install mating flange and nipple as noted in previous installation instructions for Types 85 and 95.

2. Locate position for opposite-side end-support by putting a soft wire or string around the pipe. Position wire over center of first mating flange, then draw it back and forth until it locates itself uniformly around the pipe. Measure half-way around the pipe and mark for end-support hole.

Fig. 13 • Types 86 and 96 installation



3. Drill or burn a 3" diameter hole in pipe wall for Type 86 ANNUBAR (4" dia. for Type 96).
4. Obtain a short nipple (3" Sch 40 for Type 86, 4" Sch 40 for Type 96) sized to allow 4" of protrusion of the ANNUBAR beyond the pipe wall. End support may be flanged or capped.
5. Weld nipple and flange or cap, making sure nipple is perpendicular to pipe wall.
6. Insert ANNUBAR sensor and tighten all flanges, making sure flow arrow on ANNUBAR flange points directly downstream.

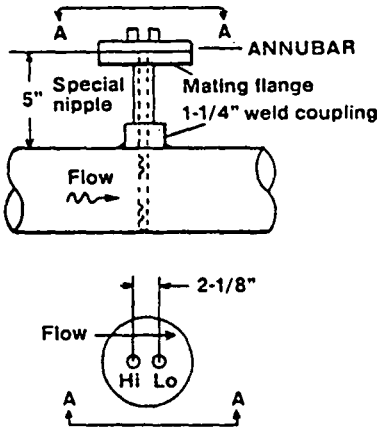
6. Special installations

Flanged ANNUBARS
Submittal drawing E-178

ANNUBAR Types 73, 74, 75 and 76 are available with optional C 07 (1/2" female NPT) or C 08 (socket-weld couplings) mounted on a flange on 2-1/8" centers. Unless otherwise specified, these ANNUBARS are designed for a 5" dimension from pipe wall to face of mating mounting flange. This 5" dimension must be maintained when installing the mounting hardware.

If mating hardware has not been installed, proceed as follows:

Fig. 14 • Flanged ANNUBAR installation



1. Drill or burn a 1-3/8" diameter hole in pipe wall.
2. Tack weld a 1-1/4" socket weld coupling to pipe and align so it is perpendicular to pipe axis and square to its plane. Finish welding coupling.
3. Size a short nipple to obtain the 5" or specified distance from pipe wall to face of mating flange.
4. Weld nipple to weld coupling, making sure it is perpendicular to the pipe.
5. Although the ANNUBAR is sized to a specified dimension, it is wise to avoid installation problems by checking dimensions at this time. Insert ANNUBAR through the nipple until it bottoms at the opposite pipe wall (or into the opposite-side plug in the case of Types 74 and 76.)

   Note dimension from outer pipe wall to inside face of ANNUBAR flange. Remove ANNUBAR. The dimension should agree with the 5" or specified dimension. If operating temperature is above 200° F, add 3/4" for pipe diameters to 60", or 1-1/2" for pipe diameters from 60" to 120" to allow clearance for thermal expansion.

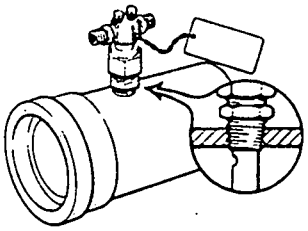
7. Meter connections and location.

6. Align mating flange to installed nipple, again making sure the 5" or specified dimension is maintained. Make sure also that the mating flange will align with the ANNUBAR flange such that the flow arrow will point directly downstream. Then weld mating flange to pipe nipple.
7. Install flange gaskets and slide ANNUBAR into the pipe. Complete installation by bolting ANNUBAR flange to mating flange.

Non-weldable pipes

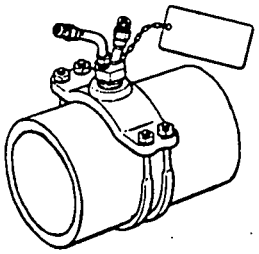
1. Direct-Tapping: On cast iron and other applications where welding is not possible, the ANNUBAR (Types 73 thru 76) may be directly threaded into the pipe wall. For Types 73 and 74, tap pipe wall to 1/2" NPT instead of installing weld coupling. (See previous instructions). For Types 75 and 76, tap pipe wall to 1" NPT. Then install ANNUBAR as directed in previous instructions.

Fig. 15 • Direct tapping



2. Pipe Saddles: Pipe saddles may be purchased from local plumbing supply houses for non-weldable installations. Use 1/2" NPT fittings for Types 73 and 74, and 1" NPT fittings for Types 75/76. Locate saddle fittings in the same manner as weld couplings for standard installations. Submittal drawings E-165A for Types 73 and E-167A for Types 75.

Fig. 16 • Saddle Installation



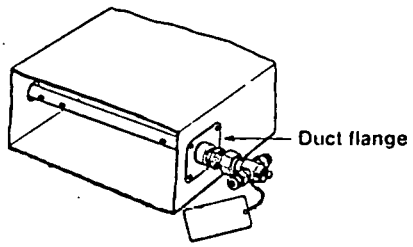
Thin-walled ducts

Although application in a round duct with sufficient straight lengths up and downstream is preferable, ANNUBAR sensors may be used in rectangular or irregular shaped ducts. Approximate differential pressure can be calculated by first finding the equivalent round-duct diameter:

$$D = 2\sqrt{\frac{w \times n}{\pi}}.$$

and then calculating DP using Slide Rule E-87. Field calibration is recommended for absolute accuracy.

Fig. 17 • Duct installation



In systems where short or almost no straight run is available, the ANNUBAR should be installed with approximately 70% of the available straight run on the upstream side. ANNUBAR sensors for use in thin-walled ducts are supplied with a 4" x 4" sheet metal flange for mounting directly on the duct surface. For ANNUBAR Types 73 and 75 with high flow rates, a stiffening plate may be desirable to prevent buckling of the duct. Specifying a Type 74 or 76 with opposite end-support may be the best solution. Gasket material is not supplied for use between mounting flange and duct because of the wide variety of application requirements. In rectangular ducts, install ANNUBAR at the center of the short side so that it traverses the longer dimension of the duct.

7. Meter connections and location

General requirements

Following is a checklist of general instrument practices for meter connecting tubing. Refer to installation instructions provided by the secondary instrument manufacturer to cover all contingencies of your application.

1. Connecting tubing must have a slope of at least one inch per foot and must be supported over its entire length to prevent sagging.
2. The two connecting lines should be run close together to maintain equal temperatures.

CAUTION: Be sure nylon or rubber lines are kept away from hot lines or other heat sources.

3. Run tubing in protected areas such as conduit, channels, I-beams or angles, against walls or ceilings. Protect horizontal runs near the floor or under work areas with steel sheeting for kickplates.
4. Run tubing where it will be accessible for maintenance. On long runs, tubing should be tagged every 30 to 40 feet for easy identification.
5. Tubing must be absolutely air-tight. If vibration is expected set up a periodic inspection procedure for checking all joints for leakage.

Liquids (Figs. 18-21)

Trapped air in the piping system is responsible for the majority of problems associated with liquid flow measurement. Differential pressure must be transmitted from the ANNUBAR to the secondary instrumentation through a solid head of non-compressible liquid. Installation of the instrumentation below the ANNUBAR is preferred for liquid service.

Fig. 18 • Liquid flow applications—vertical line

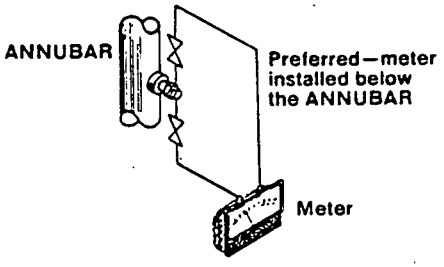


Fig. 19 • Liquid flow applications—horizontal line

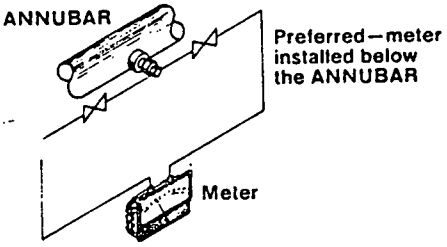


Fig. 20 • Liquid installation when meter must be installed above the line

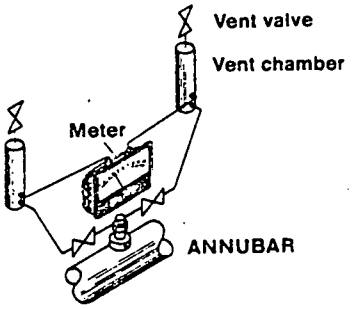
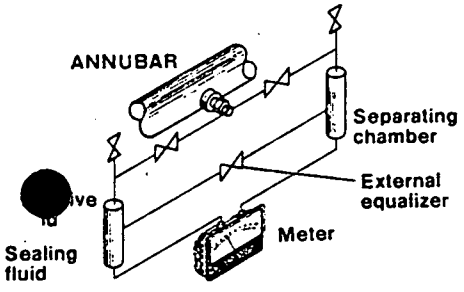


Fig. 21 • Corrosive liquid applications with separating chamber



Air and Gas (Fig. 22-26)

Differential pressure must be transmitted from the ANNUBAR to the secondary instrument without change due to leakage or trapped liquid. For dry air or gas, the secondary instrument may be mounted either below or above the ANNUBAR. For wet or dirty air or gas flow, the secondary instrument should be mounted above the ANNUBAR, or settling traps should be installed in the connecting lines. See figures 22 thru 26 for recommended practices.

Fig. 22 • Air and gas applications—vertical line

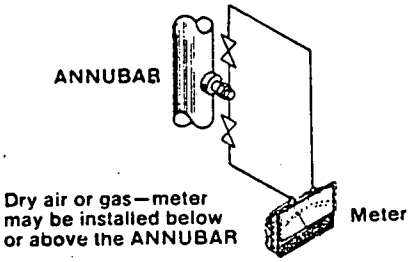


Fig. 23 • Air and gas applications—horizontal line

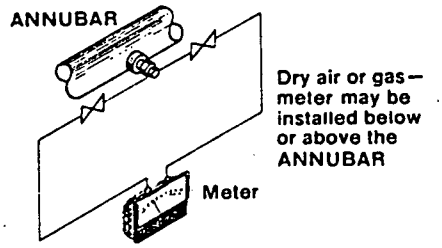


Fig. 24 • Air and gas—wet or dirty

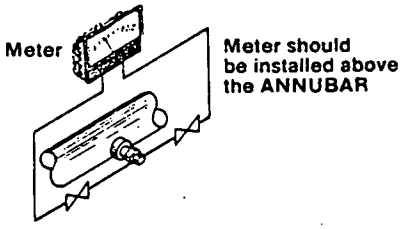


Fig. 25 • Dirty gas or air application with settling chambers. Gas flow when meter must be installed below the line.

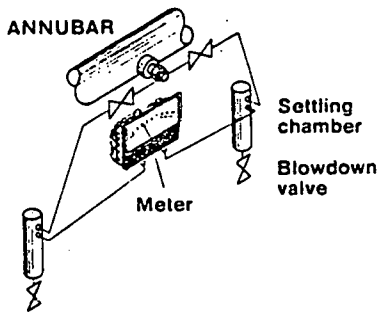
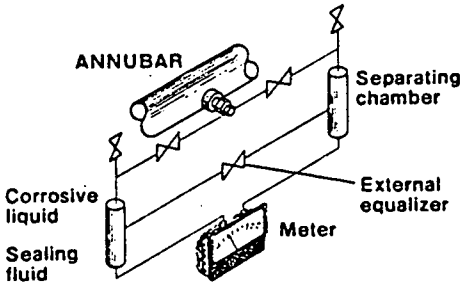


Fig. 26 • Corrosive gas flow to meter



8. Purging

9. Field calibration

10. Maintenance
11. Interchangeability

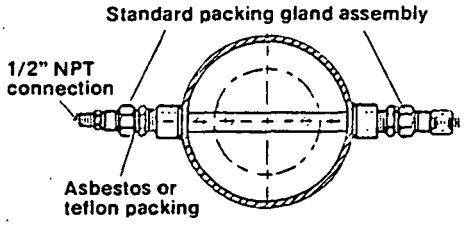
8. Purging

ANNUBARS have been used successfully for measuring flow of very contaminated fluids without purging. Conditions requiring purging are variable, and if the application is questionable, use without purging and plan to use purging as a back-up.

Periodic Purging

Periodic or intermittent purging is the simplest purging method and should be considered first for contaminated flow measurement. To do this, install an air or steam line to the instrument lines (or to the clean-out ports in the case of Type 75/76) and periodically blow through the element to force out contamination. A further extension of periodic purging is available on a special-design Type 76 ANNUBAR (Fig. 27), furnished with the sensor extended through the support coupling and a purge connection provided on the end. Submittal drawing E-168A

Fig. 27 • Periodic purging



Type 76 ANNUBAR with opposite-end purge connection.

9. Field calibration

Field calibration may be indicated when the ANNUBAR installation is less than optimum, as in the case of insufficient straight length of pipe up or downstream.

1. The object of field calibration is to record the output signal at a variety of flow rates of known value. Then a curve showing the output of ANNUBAR versus the known flow rates can be accurately plotted. Exact variance factors can be applied to gauge readings, recorder charts, or programmed into a computer.
2. For the purpose of calibrating an ANNUBAR to a known actual flow rate, it is important to use the most accurate practical means for determining actual flow. Although rough estimates can be made from discharge curves for blowers, fans, etc., it is desirable to use a single opening standard (hemispherical type) pitot tube with a manometer to determine flow rate accurately. When using a single opening pitot tube, it is necessary to stabilize the flow during the entire manual traverse. See instructions furnished with pitot tube for correct test locations and conversion formulas.
3. If a temporarily installed orifice plate or venturi is used, the flow rate may increase when the restriction is removed. It may, therefore, not be possible to calculate the ANNUBAR at the highest flow rates possible during operating conditions.
4. When calibrating the ANNUBAR to another flow measuring device, it is important to compare as many points as possible in the range of anticipated flow rates to insure best accuracy of the resulting curve.

10. Maintenance

The ANNUBAR is virtually maintenance-free. Should cleaning be needed:

1. Remove the element.
2. Flush completely.
3. Hand clean with soft wire brush.
4. Rod interpolating and static tubes with a soft wire.

11. Interchangeability

Each ANNUBAR is designed for a particular line size and type installation. The ANNUBAR may be interchanged among different pipes if the pipe size and installation are identical. This provides great flexibility, especially when a Flo-Tap ANNUBAR is used.

The same ANNUBAR may be used with different fluids. For example, the same ANNUBAR may be used to measure liquid or gaseous propane, air, water or steam, provided line size and installation are identical. Calculation of DP to flow conversion is the only adjustment required.

NOTE: ANNUBAR is not recommended for two-phase (liquid/vapor) flow measurement.

12. Troubleshooting guide

12. Troubleshooting guide

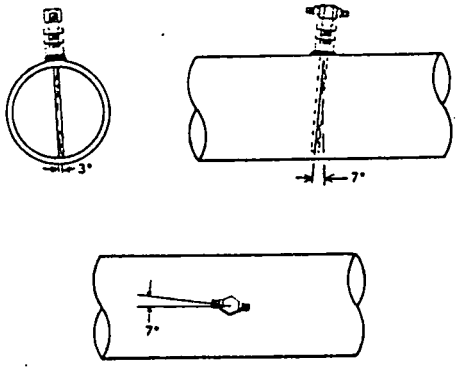
ANNUBAR operates on natural scientific principles. No moving parts are used in the design, and wear has negligible effect on accuracy. If installed correctly ANNUBAR will provide a correct flow indication if there is flow in the pipe. To resolve a discrepancy, interpretation of the ANNUBAR signal and other components of the flow system should be examined closely.

Questionable accuracy

1. ANNUBAR installation: Insure that the ANNUBAR flow arrow is pointed directly downstream. For Types 71, 73 and 74, insure that the upstream probe has its bent portion pointing directly upstream.

   ANNUBAR is not particularly sensitive to installation misalignment in the pipe. Fig. 29 shows permissible misalignment without loss of accuracy.

Fig. 28 • Permissible misalignment



2. Pipe size: The ANNUBAR may have been designed for a different pipe size from that in which it is being used. Measure pipe ID and compare with size printed on identification tag attached to the ANNUBAR.
3. Insufficient straight run: If the ANNUBAR is installed in less than recommended straight uniform pipe length, accuracy may be affected. Refer to P. 3 for straight run requirements.
4. Calculations: The calculation for a particular ANNUBAR may be in error. Recheck the calculation or graph used for conversion. Changes in operating temperature or pressure are critical on air, gas or steam applications. Recheck actual operating temperature and pressure compared to values used in the calculation.

Low signal

1. Leaks: Check for leaks in the instrument piping. Repair and seal all leaks.
2. Contamination/plugging: Remove ANNUBAR and check for contamination. Clean per (10. Maintenance). If removal is not practical, back-flush through instrument lines or through cleanout ports on Types 75 or 76.

Spiking signal

1. Pulsating Flow: If ANNUBAR is installed in this condition, the signal will reflect flow conditions with a spiking signal. If unable to relocate, mechanical pressure snubbers in the instrument lines or electronic damping may alleviate this problem.
2. Two-phase flow (liquid/vapor): Two-phase or alternating-phase flow will cause an erratic spiking signal. ANNUBAR is a head measuring device and will not accurately measure two-phase flow.

Represented by:

Dieterich Standard Corporation • Subsidiary of DOVER Corporation • Boulder, Colorado 80306 • 303/449-9000 • Telex 45-903
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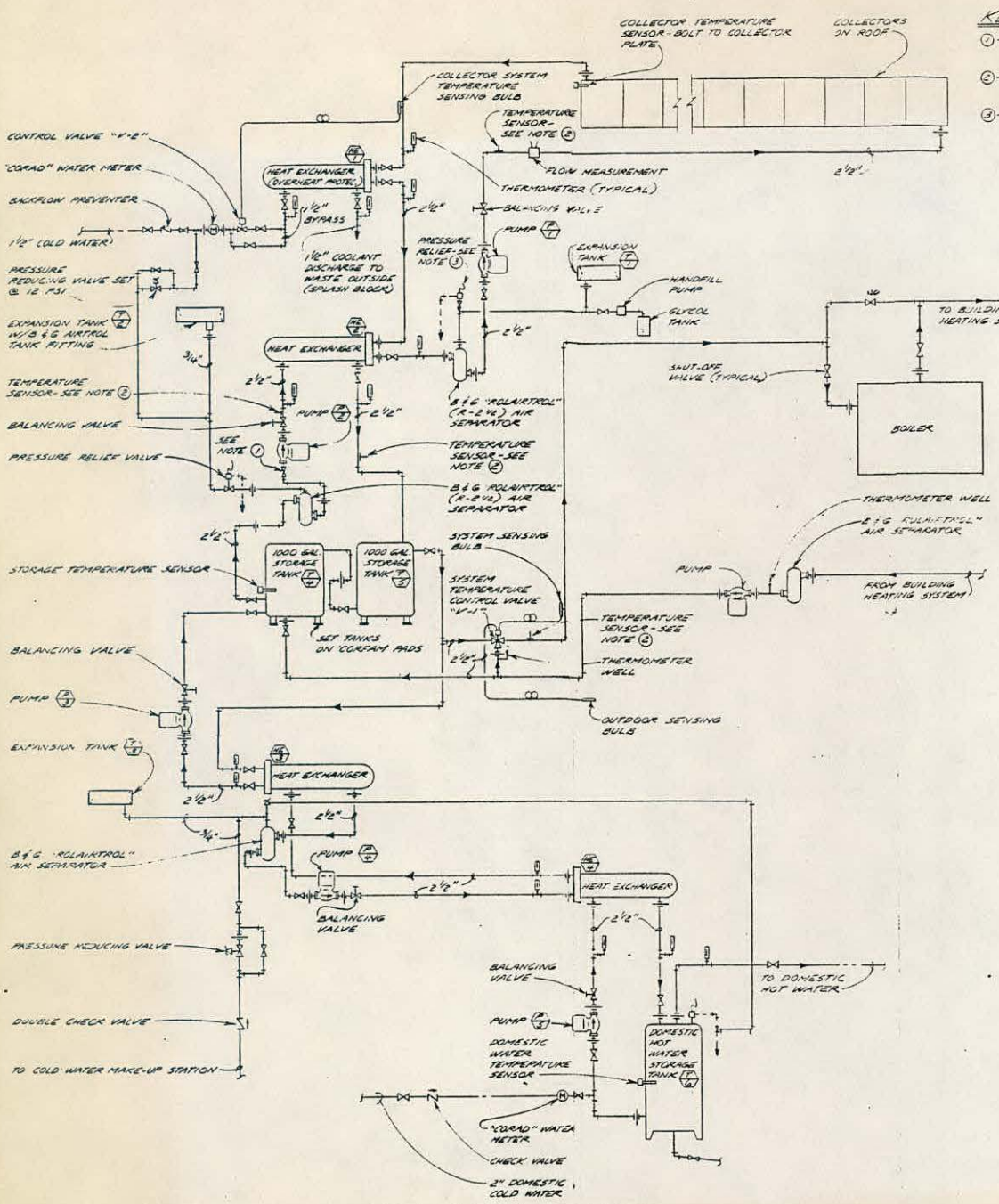
DS-3201 (7/78)

Appendix C



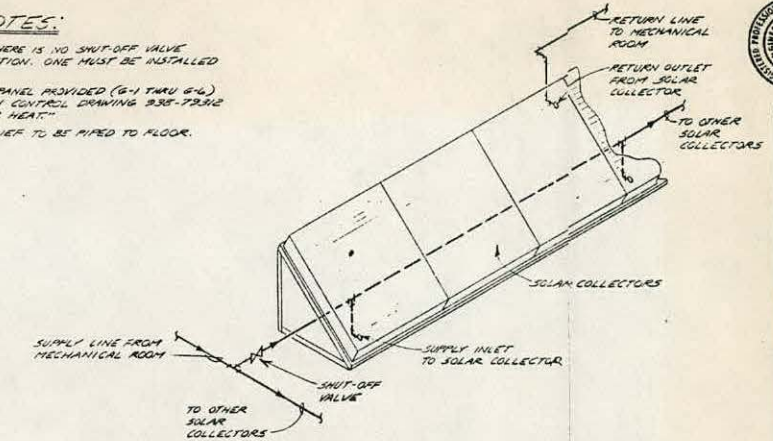
SOLAR SYSTEM SCHEMATIC

KEYED NOTES:

(1) - CURRENTLY THERE IS NO SHUT-OFF VALVE AT THIS LOCATION. ONE MUST BE INSTALLED AS SHOWN.

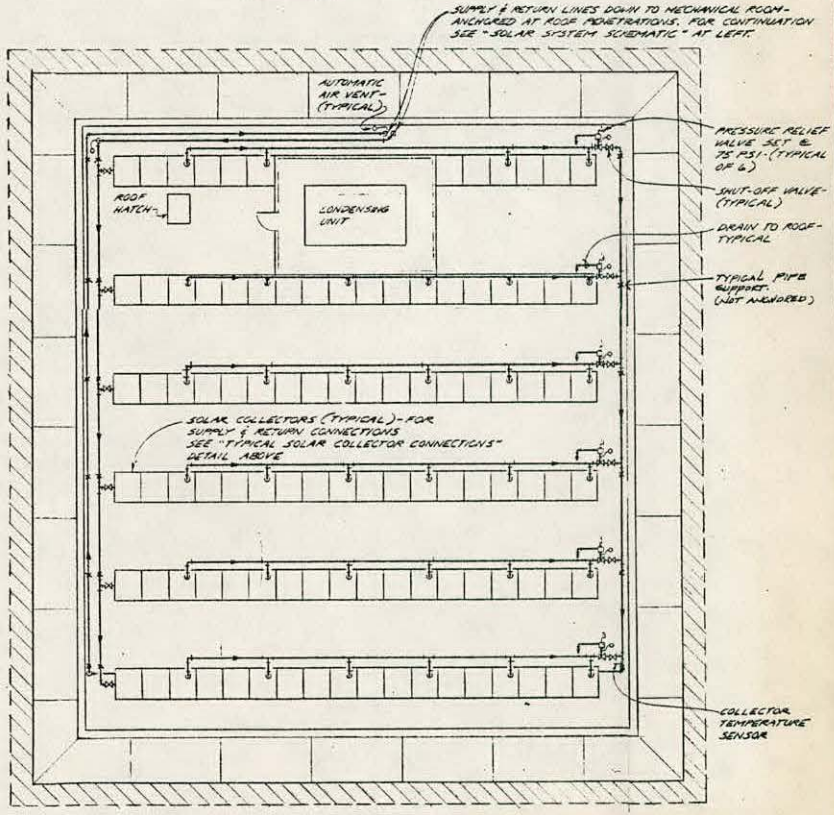
(2) - NO READOUT PANEL PROVIDED (G-1 THRU G-6) AS SHOWN ON CONTROL DRAWING 938-7932 AMITY SOLAR HEAT."

(3) - PRESSURE RELIEF TO BE PIPED TO FLOOR.



TYPICAL SOLAR COLLECTOR CONNECTIONS

NOT TO SCALE



PARTIAL ROOF PLAN SHOWING SOLAR COLLECTORS

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BOISE INDEPENDENT SCHOOL DISTRICT
BOISE, IDAHO
SOLAR SYSTEM AS-BUILTS

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