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(NASA-CR-161437) SOLAR HEATING SYSTEM
INSTALLED AT TELEX COMMUNICATIONS, INC.,
BLUE EARTH, MINNESOTA Final Report (Telex
Communications, Inc.) 177 p HC A09/MF A01

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DOE/NASA CONTRACTOR
REPORT

DOE/NASA CR-161437

SOLAR HEATING SYSTEM INSTALLED AT TELEX COMMUNICATIONS, INC.
BLUE EARTH, MINNESOTA - FINAL REPORT

Prepared by

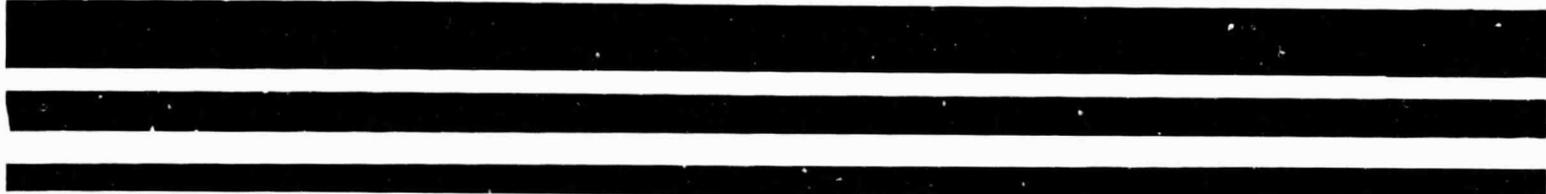
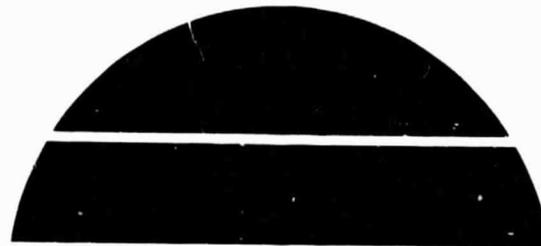
Telex Communications, Inc.
West First Street
Blue Earth, Minnesota 56013

Under Contract E (49-18) 2376 with

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

Final Report

For the U. S. Department of Energy



U.S. Department of Energy



Solar Energy

NOTICE

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TECHNICAL REPORT STANDARD TITLE PAGE

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16. ABSTRACT This document summarizes the final results of contract E(49-18)2376 Telex Communications, Inc., for space heating a 97,000 square foot building which houses administrative offices, assembly areas and warehouse space. This report also provides information on system description, test data, major problems and resolutions, performance, operation and maintenance manual, manufacturer's literature, and as-built drawings. The InterTechnology/Solar Corporation designed the solar space heating system; construction was by Mankato Plumbing. The system began delivering space heating in February 1978. The Telex solar system is composed of four main subsystems; they are the solar collectors, controls, thermal storage and heat distribution. The ITC/Solar Mark III collector was used. The collector array consists of 10 rows of 36 collectors each. The control subsystem controls the operation of the system pumps and control valves. Thermal storage for the system is provided by a 20,000 gallon water storage tank located inside the building. Heating is accomplished by water-to-air heat exchangers and controlled by thermostats.					
17. KEY WORDS			18. DISTRIBUTION STATEMENT UC-59a Unclassified-Unlimited <i>William A. Brooksbank, Jr.</i> WILLIAM A. BROOKSBANK, JR. Mgr., Solar Energy Applications Proj.		
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I. SYSTEM AND BUILDING DESCRIPTION

The Telex plant is located in southern Minnesota near the town of Blue Earth. The plant manufactures tape recorders and other electronic equipment. The 97,000-square-foot building houses administrative offices, assembly areas and warehouse space. The building is of steel construction with 6 inches of fiberglass insulation between the steel skins.

Heat for the building is provided by electric duct heaters mounted in the air handling units and electric unit heaters. During operating hours there is also a considerable amount of heat generated by lights, equipment, and people. During cold weather, the space heating load ranges between 9-12 million BTUs per day. The average number of heating degree days for the Blue Earth area is approximately 8,000. There is very little hot water demand since none of the manufacturing operations require hot water.

Because of the use of electric resistance heating, the Telex plant was considered a good choice for a solar heating retrofit. A proposal for a solar system was submitted under the PON-1 Solar Heating and Cooling Commercial Demonstration Program. In June of 1976 Telex was awarded a contract by ERDA (now DOE) to construct a solar space heating system. InterTechnology/Solar Corporation began the design of the system in August 1976. Construction of the system by Mankato Plumbing began in August 1977. The system began delivering space heating in February 1978.

Figure 1 is a flow schematic of the solar system. The collector array consists of 10 rows of 36 collectors each. The ITC/Solar Mark III collector was used. This collector has gross dimensions of 4' x 8' and features a single glazing of water white glass and a black chrome selective coating. The absorber plate consists of aluminum fins snapped onto

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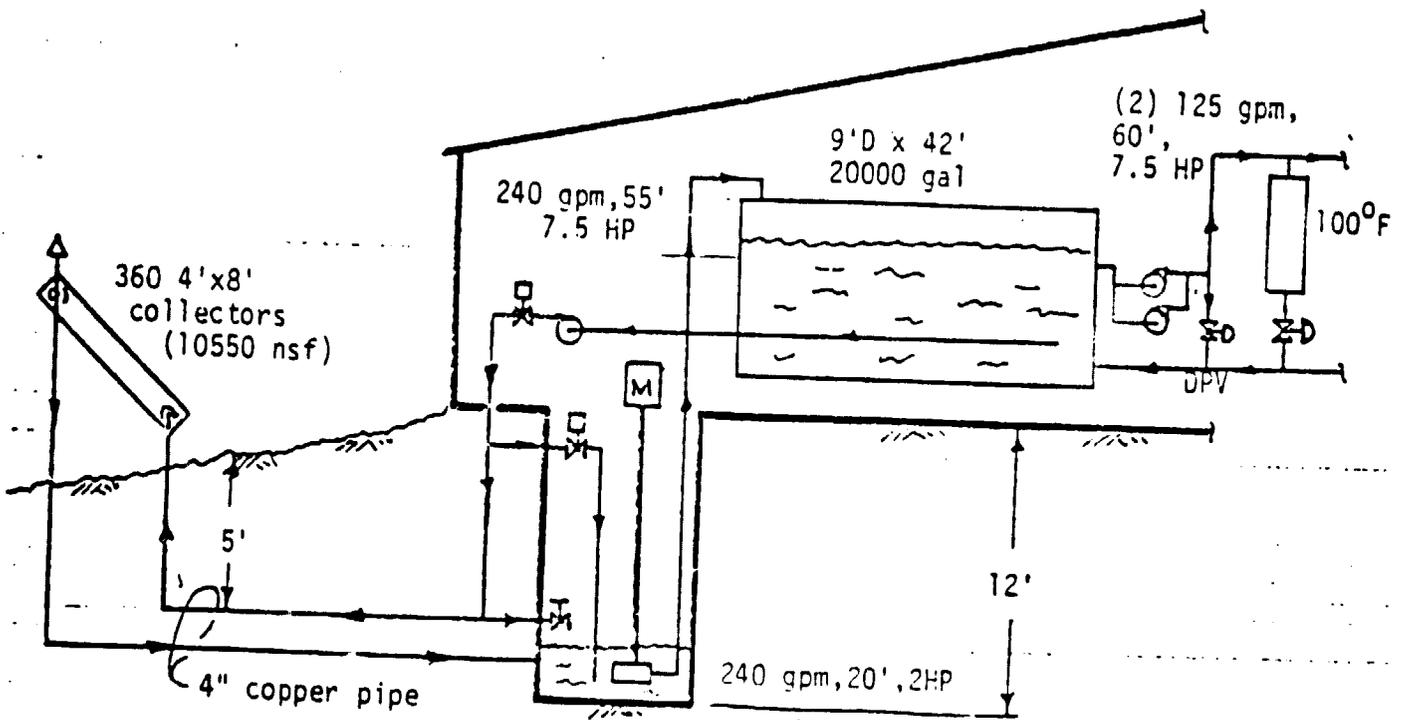


Figure 1: System Flow Schematic

copper tubes. The collectors utilize a 2½" internal manifold allowing each row of 36 collectors to be connected in parallel without the need for external piping.

The collectors are ground-mounted at a 55° tilt angle on a wood truss structure. The wood trusses are supported by concrete piers. The bottoms of the collectors are approximately 3½ feet above the ground. Location of the array is the east side of the building with a parking lot in between. A drain-down type of system was chosen for a number of reasons. Some of these were:

- o efficiency--no collector-to-storage heat exchangers required.
- o simplicity of design
- o no special precautions needed for summer shutdown.

II. ACCEPTANCE TEST PLAN

An acceptance test to verify the thermal performance of the system was conducted by the installation contractor, Mankato Plumbing and Heating in June, 1978.

The test consisted of operating the system on a clear day and measuring the instantaneous efficiency of the collector array. The IBM data acquisition system was used to collect the data using the On-Site Monitor.

The data from the test were plotted as efficiency versus $(T_{in} - T_{amb})/I$. This allows the quantities A and B to be determined. A is the y-intercept and -B is the slope of the efficiency curve. That is,

$$\text{EFFICIENCY} = A - B (T_{in} - T_{amb})/I.$$

A range of A and B values that are considered acceptable was prepared by the engineer. The experimentally determined A and B values fell within this range so the collector installation was considered acceptable. The acceptance test report is given in the following pages.

MANKATO PLUMBING & HEATING CO., INC.

P. O. Box 426

Phone 388-7012

Mankato, Minn. 56002

ACCEPTANCE TEST
TELEX COMMUNICATIONS, INC.
SOLAR HEATING SYSTEM
JULY 24, 1978

ENGINEER: InterTechnology Solar Corporation
100 Main Street
Warrenton, Virginia 22186

OWNER: Telex Communications, Inc.
West First Street
Blue Earth, Minnesota 56013

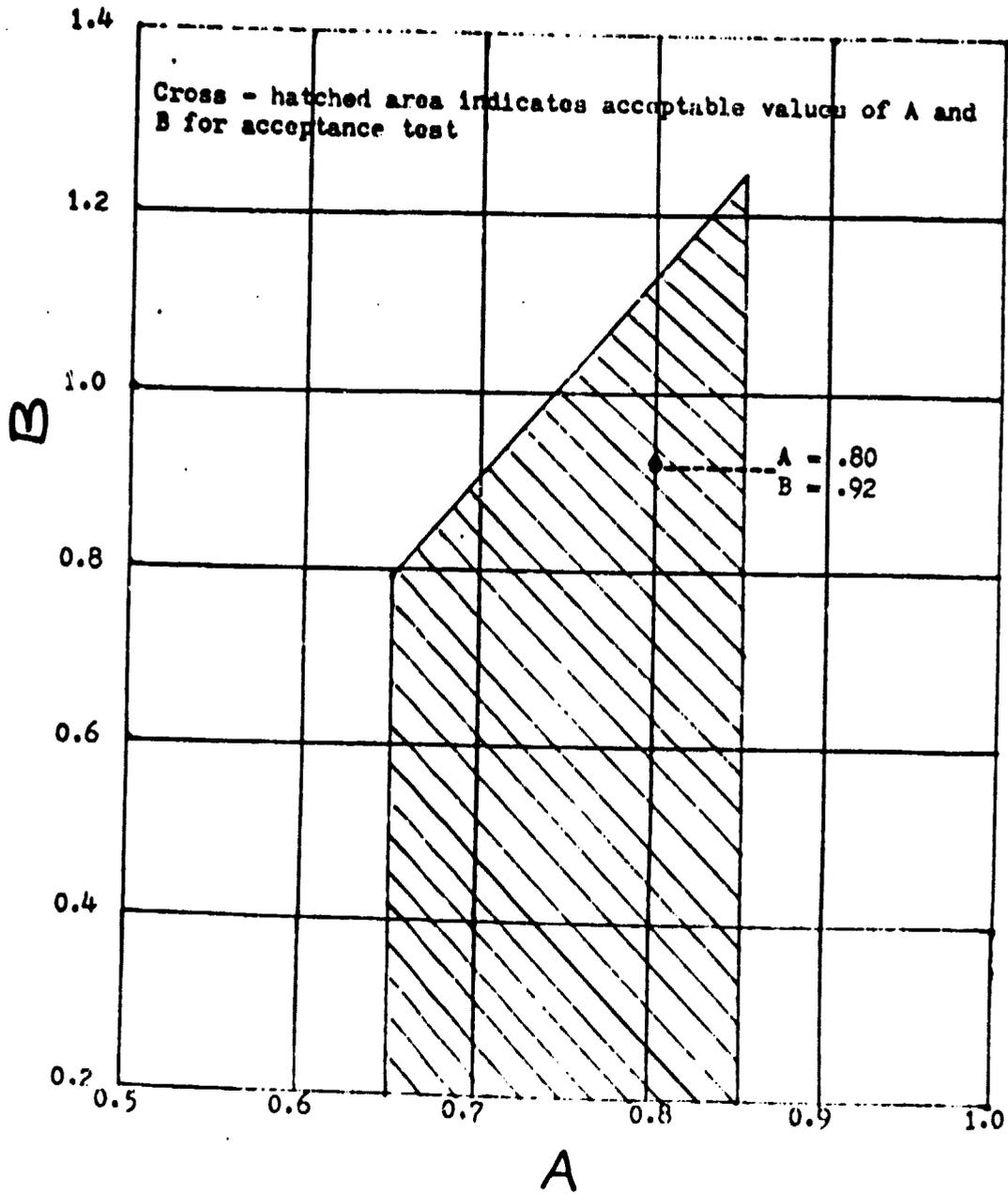
CONTRACTOR: Mankato Plumbing & Heating Incorporated
530 North Front Street
Mankato, Minnesota 56001

MANKATO PLUMBING & HEATING CO., INC.

P. O. Box 426

Phone 388-7012

Mankato, Minn. 56002



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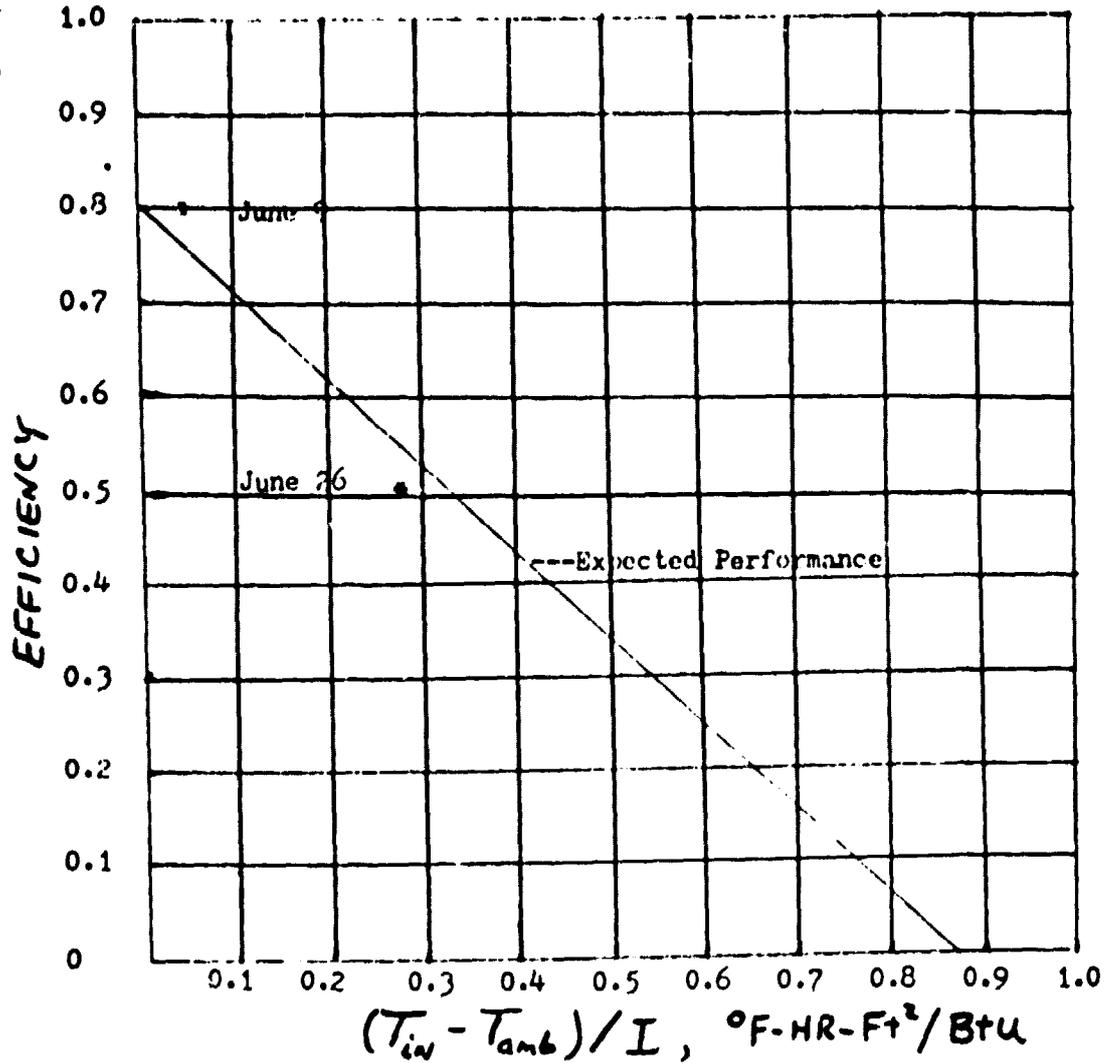
MANKATO PLUMBING & HEATING CO., INC.

P. O. Box 426

Phone 388-7012

Mankato, Minn. 56002

AB DETERMINATION



The test data taken on the Telex Corporation Solar Heating System appears to closely follow the expected performance data as submitted by Intertechnology Solar Corporation.

MANKATO PLUMBING & HEATING CO., INC.

P. O. Box 426

Phone 388-7012

Mankato, Minn. 56002

JUNE 9, 1978 TEST

	<u>TIME</u>	<u>INLET F°</u>	<u>OUTLET F°</u>	<u>ΔT</u>	<u>O.A.F. °</u>	<u>INSOLATION</u>	<u>WIND</u>
Data Used For Test	12:15	89	107	18	83	247	0
	12:25	91	109	18	83	238	2.1
	12:35	94	111	17	83	250	0
	12:45	96	114	18	83	256	2.0
	12:55	98	116	18	82	253	0
	1:05	100	118	18	84	260	0
	1:15	102	120	18	84	256	7.2
	1:25	105	123	18	84	266	.7
	1:35	107	125	18	83	263	2.1

Inlet water average rate of change in F°/hr = 13° F

Average ΔT = 18° F

Average O.A. = 83° F

Average Insolation = 251.43 Btu/hr - ft²

Average inlet Temperature = 96° F

$$\text{Efficiency} = \frac{Q\Delta T}{I} + \text{Correction factor of } \frac{9.82 \times 18}{251.43} = .70 + .09 = .79$$

$$CF = \frac{\Delta T_{in}}{\Delta T} \times \frac{1}{I} \text{ or } \frac{13}{18} \times \frac{29.7}{251.43} = .09$$

$$X = \frac{(96-83)}{251.43} = .05$$

MANKATO PLUMBING & HEATING CO., INC.

P. O. Box 426

Phone 388-7012

Mankato, Minn. 56002

JUNE 26, 1978 TEST

<u>TIME</u>	<u>INLET F°</u>	<u>OUTLET F°</u>	<u>ΔT</u>	<u>O.A.F. °</u>	<u>INSOLA"ION</u>	<u>WIND</u>
1:00	153				247	
1:10	156				250	16
1:20	158				247	
1:30	159			88.9	250	
1:40	161				253	
1:50	162			88.3	250	14
2:00	163				247	

Average Insolation = 249 Btu/hr - ft²

Average O. A. = 88.6° F

Total change in 20000 gal. storage temperature = 8° F

Average inlet Temperature = 159° F

20,000 x 8.33 x 8 = 1,332,800 Btuh

249 x 10692ft² = 2,662,308 Btuh

Eff = .50

$$X = \frac{(159^{\circ} - 89^{\circ})}{249} = .28$$

The collector array efficiency in this test was determined by measuring the total rise in storage temperature for one hour, with no water being circulated thru the inside building system. Therefore, all heat being finally collected was being retained in storage.

III. MAJOR PROBLEMS ENCOUNTERED AND RESOLUTIONS

There have been two major problems encountered with the Telex installation. These are discussed below.

Hose Connections - The collectors are internally manifolded with 2½" headers. Connections from collector to collector were initially made with a reinforced silicone rubber hose. Because of the length of the row (144') and the large temperature range to which the manifolds would be exposed, there could be changes in the length of the row of up to ± 2" due to thermal expansion and contraction. It was anticipated that the silicon hoses would be capable of absorbing this movement. In the actual installation, however, it was found that the axial forces could be transmitted down the manifolds to the hose that was clamped with the weakest pressure. This hose would then slip on the manifold eventually resulting in a leak.

The solution was to change all the hoses to a different type. The new hose has a single "hump" at its midsection which allows it to act as an expansion compensator. The new hump hose is also constructed of silicone rubber and is capable of withstanding the 350°F-400°F stagnation temperatures that the absorber reaches. As a further precaution against leaks, the hoses were bonded to the copper manifolds using a primer and silicone adhesive. An unlined hose clamp was also used. The installation of the hoses took place in the summer and early fall of 1979.

Drain-Down - The Telex system relies on the draining of the collectors for freeze protection. To relieve the vacuum caused by the draining water, air vents and vacuum breakers were installed at the outlet of each row. These were specified to be heat taped and insulated. Over the weekend of December 2 and 3 a freeze-up occurred which was discovered on Monday, December 3. The freeze-up was confined to the lower headers of Rows 7 and 10 (Row 1 is the southernmost row). There was no evidence of freezing in any of the other 8 rows.

The IBM computer listing of the system performance showed no unusual behavior other than some cycling of the solar pump which was to be expected because of the marginal insolation conditions which prevailed over that weekend. A close inspection of the air vent and vacuum breakers showed that under near-zero temperatures the heat tape was not keeping these devices above freezing. This was due partly to the lack of tight contact between the heat tape and the bodies of the vents and breakers and partly to the lack of insulation around the vent holes.

It was not clear, though, how non-operative air vents and vacuum breakers could have led to the freezing of only 2 rows out of 10. This is because all the rows are connected in parallel and if any of the 10 sets of air vents and vacuum breakers operate, the entire system would drain. The actual drain-down time was established by test at less than 10 minutes. It was also found that sections of the pipe and valves that contained ice due to incomplete draining could be cleared in a few minutes after the system pump started.

While the freeze problem was being investigated it was decided to run the system under manual control to eliminate short cycling. The system (8 rows) was then operated through the month of December only on clear days. On January 1, 1979, the system was started up and it was noticed that the absorber plate temperature on row 5 remained high. Upon investigation it was found that the bottom manifold of this row was frozen. Examination of the previous day on which the system operated revealed no abnormalities. At a meeting in January it was decided to install standpipe vents at each row as well as at the north and south ends of the return header. These standpipes were to be heat taped and insulated. Also, piping on the supply side was changed to steeper slope. This work was carried out in February and the system was placed into operation with 7 rows in March with no further freeze problems.

During the summer of 1979 when the hoses were replaced, the 2" flow equalization tubes inside the 2½" internal manifolds were removed. Initial tests showed no apparent problems with flow imbalance although no operational data have yet been accumulated.

IV. SYSTEM PERFORMANCE

The Telex system is one of the commercial demonstration sites that was selected to receive an IBM data collection system. The data collection system became operational in April 1978.

Based on the data that have been accumulated, the collector performance is very good with all-day efficiencies of 40% to 50% obtained on clear days. Tables 1 and 2 are taken from the IBM data summary for December 1978 and show the collector array performance and the space heating subsystem performance respectively. It should be noted that the system was not operated on a number of clear days and for most of the month only 8 rows were in operation.

Calculations using f-chart show that the system is performing as expected.

V. INTERIM PERFORMANCE CRITERIA

The Interim Performance Criteria (NASA George C. Marshall Space Flight Center publication 98M10001) have been reviewed with respect to the solar heating system at Telex Communications, Inc., Blue Earth, Minnesota. In our opinion the system installation complies with all applicable sections of these criteria.

InterTechnology/Solar Corporation



William S. McEver

Project Manager

26 October 1979

Table 1

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SOLAR/2033-78/12

SITE: TELEX CORP. BLUE EARTH, MINN.
REPORT PERIOD: DECEMBER, 1978

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	14.295	11.105	5.073	15	0.355
2	4.417	0.776	0.556	4	0.126
3	5.084	2.898	1.355	8	0.223
4	9.275	4.237	2.359	23	0.255
5	13.548	0.000	0.000	26	0.000
6	24.045	0.000	0.000	1*	0.000
7	7.846	0.173	0.053	3	0.007
8	21.634	17.634	0.123	3	0.468
9	22.631	17.476	0.454	-4	0.418
10	5.330	0.000	0.000	11	0.000
11	6.488*	0.000	0.000	33	0.000
12				*	*
13	15.082	9.141	6.309	27	0.424
14	15.799	14.589	6.733	27*	0.427
15	23.123	19.759	10.542	35	0.460
16	21.706	17.115	9.027	29	0.416
17	21.704	0.000	0.000	22	0.000
18	8.028	6.019	3.224	22*	0.361
19	2.645	0.000	0.000	31	0.000
20	2.021	0.000	0.000	18	0.000
21	14.026	14.061	8.003	23	0.444
22	14.734	10.601	6.010	23*	0.410
23	2.017	0.000	0.000	30*	0.000
24	14.265	0.000	0.000	30*	0.000
25	2.702	0.000	0.000	10	0.000
26	24.130	17.084	8.002	17	0.332
27	7.709	1.156	0.712	14	0.056
28	1.525	0.000	0.000	26	0.000
29	2.400	0.000	0.000	7	0.000
30	21.255	14.088	8.550	27	0.000
31	3.322	0.000	0.000	2	0.402
SUM	371.806	183.865	99.577	-	-
AVG	11.993	5.931	3.212	16	0.268
NBSID	0001		0100		N100

* DENOTES UNAVAILABLE DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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Table 2

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM
MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: TELEX CORP. BLUE EARTH, MINN.
REPORT PERIOD: DECEMBER, 1979

SOLAR/2033-79/12

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	Avg TEMP DEG. F
1	9.102	2.267	1.398	5.835	5.835	NOT APPLICABLE	1.954	N.A.	72	12
2	8.875	1.823	1.413	7.052	7.052	NOT APPLICABLE	1.494	N.A.	70	15
3	10.031	0.955	1.408	9.165	9.165	NOT APPLICABLE	0.823	N.A.	69	13
4	10.256	1.131	1.364	9.125	9.125	NOT APPLICABLE	0.429	N.A.	72	15
5	6.715	0.741	1.377	5.975	5.975	NOT APPLICABLE	0.248	N.A.	71	21
6	10.400	0.574	1.416	9.826	9.826	NOT APPLICABLE	0.503	N.A.	71	13
7	11.367	0.178	1.379	11.546	11.546	NOT APPLICABLE	2.693	N.A.	72	14
8	12.011	3.221	1.710	18.790	18.790	NOT APPLICABLE	3.431	N.A.	72	19
9	15.308	6.264	1.850	9.014	9.014	NOT APPLICABLE	0.270	N.A.	72	15
10	12.810	3.753	1.707	9.057	9.057	NOT APPLICABLE	0.270	N.A.	72	15
11	5.925	0.550	1.401	5.245	5.245	NOT APPLICABLE	1.382	N.A.	73	29
12	9.062	1.692	1.364	7.350	7.350	NOT APPLICABLE	2.999	N.A.	73	22
13	10.423	3.329	1.261	7.025	7.025	NOT APPLICABLE	5.489	N.A.	73	21
14	9.080	5.301	1.348	3.778	3.778	NOT APPLICABLE	1.764	N.A.	73	25
15	10.485	5.793	1.250	4.698	4.698	NOT APPLICABLE	1.089	N.A.	73	26
16	10.158	4.021	1.375	5.330	5.330	NOT APPLICABLE	1.036	N.A.	72	20
17	5.170	2.073	1.269	3.003	3.003	NOT APPLICABLE	0.036	N.A.	74	20
18	4.046	1.393	1.347	3.548	3.548	NOT APPLICABLE	2.747	N.A.	74	19
19	5.570	0.347	1.340	6.229	6.229	NOT APPLICABLE	4.222	N.A.	72	23
20	8.276	3.047	1.347	5.220	5.220	NOT APPLICABLE	2.206	N.A.	74	23
21	7.588	4.524	1.371	3.064	3.064	NOT APPLICABLE	0.122	N.A.	72	25
22	5.901	2.525	1.371	4.370	4.370	NOT APPLICABLE	1.808	N.A.	70	17
23	10.482	0.531	1.395	9.951	9.951	NOT APPLICABLE	0.095	N.A.	70	12
24	8.557	0.210	1.405	8.347	8.347	NOT APPLICABLE	1.418	N.A.	72	12
25	8.325	2.380	1.372	5.945	5.945	NOT APPLICABLE	1.913	N.A.	73	12
26	8.228	2.120	1.365	6.107	6.107	NOT APPLICABLE	3.772	N.A.	73	25
27	5.331	0.412	1.358	5.918	5.918	NOT APPLICABLE	1.418	N.A.	73	19
28	5.825	0.167	1.356	6.658	6.658	NOT APPLICABLE	1.418	N.A.	71	13
29	5.632	4.092	1.383	8.540	8.540	NOT APPLICABLE	59.321	N.A.	71	13
30	12.632	1.393	1.393	10.567	10.567	NOT APPLICABLE	1.913	N.A.	72	13
31	12.316	1.748	1.393	10.567	10.567	NOT APPLICABLE	0.415	N.A.	72	13
SUM	292.379	69.079	43.864	213.299	213.299	N.A.	0.415	N.A.	N.A.	N.A.
AVG	9.109	2.228	1.414	6.880	6.880	N.A.	0.415	N.A.	72	13
NBC	0402	0400	0403	0401	0401	0410	0415	0417	N4J6	N113

* DENOTES UNAVAILABLE DATA.
N.A. DENOTES NOT APPLICABLE DATA.

APPENDIX A

OPERATION AND MAINTENANCE MANUAL

TELEX COMMUNICATIONS, INC.
Blue Earth, Minnesota
Solar Heating System

APPENDIX A
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I.	System Description	A-1
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I. SYSTEM DESCRIPTION

A. Introduction

The Telex Solar Heating System is composed of four main subsystems;

- o solar collectors
- o controls
- o thermal storage
- o heating distribution

The solar collectors used on the project are the Mark III model manufactured by InterTechnology/Solar Corporation, Warrenton, Virginia. A total of 360 collectors are used--10 rows of 36 collectors each. The collectors have nominal 4' x 8' dimensions giving a gross collector area of 11,520 square feet. The collectors are oriented due south and are tilted at an angle of 55° from the horizontal.

B. Solar Collectors

The collector specifications are given on the following page. In order to increase the performance of the collectors, a black chrome selective absorber coating and water white glass are used. The black chrome selective coating is electroplated on a nickel coated aluminum extension. The solar absorptivity and thermal emissivity of the black chrome coating are nominally 0.95 and 0.12 respectively. The low thermal emissivity results in reduced radiative heat losses from the absorber plate and thus increased efficiency.

The water white glass is specially made with a very low iron oxide impurity content (which gives ordinary glass a greenish cast). The solar transmittance of the water white glass is 0.90 to 0.91. The slightly rippled pattern in the glass is due to the method of manufacture and has no effect upon its transmittance. The pattern does, however, tend to diffuse the light reflected from the surface of the glass and thus produce a less intense glare.



INTERTECHNOLOGY/Solar CORPORATION

CORPORATE AND ENGINEERING
100 Main Street
Warrenton, Virginia 22180
Telephone 703-347-9400
FAX 710-839-5450

SOLAR MARKETING AND
MANUFACTURING
276 Broadway Avenue
Warrenton, Virginia 22180
Telephone 703-347-9400

December 1, 1977

Specification 770501 Solar Collector - Medium Temperature Model Mark III

1. Glazing: Glass, 3/16" thick, tempered low iron, single glazed; $\tau=0.88$.
2. Glazing Seal: Continuous molded EPDM rubber.
3. Pressure Plate: 18 Ga. stainless steel type 304.
4. Fasteners: 3/4" x #10 Truss Head stainless steel sheet metal screws @ 12" \pm 0.c.
5. Frame: 20 Ga. galvanized steel, welded corner construction, full metal back.
6. Fin Tube Absorber Assembly.
 - A. Manifolds: Two, harddrawn, type M copper tubes, 2 1/2" \emptyset Nominal.
 - B. Cross Tubes: Eleven harddrawn, type M copper tubes, 1/4" \emptyset Nominal.
 - C. Absorber Fins: Eleven Aluminum Extrusions; .060" x 4.22 x 88.125".
 - D. Absorber Coating = Black Chrome, $\alpha = 0.94$; $\epsilon = 0.12$.
7. Manifold Connectors - High temperature formed rubber hose with hose clamps.
8. Insulation - 1" fiberglass around edges; 3" fiberglass under absorber.
9. Working Pressure - 50 PSIG; maximum 100 PSIG.
10. Area - 32.0 square feet (47 3/8" W x 97 3/8" L x 5 1/4" D overall dimensions).
11. Effective Absorber Area - 29.7 square feet.
12. Mounting Provisions - Consult factory.
13. Dry Weight - 233 pounds.
14. Liquid Volume - .318 ft³ or 19.87 pounds of water.

The collectors in each row are hooked together in parallel using the internal manifolds at the top and bottom of each collector. The connections are made inside the collector box using a reinforced silicone "hump" hose and hose clamps. The hump hoses are also bonded to the copper manifolds using a silicone adhesive. Thermal expansion and contraction is absorbed by the hose.

The collectors are supported by a wood structure which is mounted upon poured concrete piers. The concrete piers were poured to varying heights to give a slope to the structure for collector draining. The east side of the structure is approximately 18 inches below the west end, thus allowing the collectors to drain back to the inlet. The system will drain anytime the solar system pump stops. As the water leaves the collectors, air is bled into the system through standpipes located at the upper west end of each row. These standpipes are heat taped to prevent freezing. It is important to make sure that the heat tapes are in good working order before the onset of freezing weather and that these standpipes remain clear of ice.

Because the collectors are located below the level of the storage tank, a sump pit is used to hold the return water from the collectors. A sump pump takes the water out of the sump and returns it to the storage tank. An engine-driven sump pump serves as a backup to the primary sump pump if it fails or if there is an electrical power failure. In addition, there is an overflow to carry water from the sump to the outside if the backup fails.

C. Controls

The control subsystem controls the operation of the solar system pumps and control valves. The design and installation of the control subsystem was performed by Johnson Controls of Minneapolis according to the specifications of the solar system engineer, InterTechnology/Solar Corporation.

The control panel is located on the east wall of the building adjacent to the solar storage tank. In this panel are located the controls for the solar system pump, the sump pump, the heating distribution pumps and motorized valves. A number of temperature gauges are also provided on the face of the panel to allow the performance of the system to be monitored. The control functions are described in more detail in Section II and in the Johnson Controls manual, Section IV.

D. Thermal Storage

Thermal storage for the solar system is provided by a 20,000-gallon water storage tank located inside the building at the east end. The dimensions of the tank are 9' diameter by 42' long. The tank was constructed from 5/16" thick hot-rolled steel. Insulation for the tank is provided by 6" of fiberglass giving a total R value of 20. This insulation results in a temperature drop of less than 1°F per day due to heat losses.

Piping to and from the storage tank is arranged to make full use of the storage capacity of the tank. The solar water return and the heating system supply pipes are located very close to each other at the top of the south end of the tank. The heating system return water comes back to the tank at the north end. Although the solar pump is physically located at the south end of the tank, it is supplied with water from the bottom of the north end through a 4" pipe mounted inside the tank.

A sight gauge is located on the south end of the tank to allow a visual observation of the water level in the tank. Because the collectors and associated piping hold a significant quantity of water (800 + gallons), the water level will vary due to the operation of the solar pump. Make-up water to the tank is automatically supplied by a low- and high-level control. The makeup water is treated by a resin-type water softener. Under normal conditions, the amount of makeup water required by the system should not be large (less than 1000 gallons/year) since

the only way water is normally lost is through evaporation. Excessive use of water indicates a leak in the system.

E. Heating Distribution System

Heating of the plant is accomplished by water-to-air heating coils located in the nine existing air handling units and with three water-to-air unit heaters. The water coils in the air handling units are located upstream from the existing electric heating elements. This results in more efficient operation of the solar heating system since the coldest air reaches the water coil first and can thus be preheated before it reaches the electric elements. In this way, the water in the storage tank can be used down to temperatures of 80°F or lower.

The operation of each solar hot water coil is controlled by a thermostat located in the area of the plant served by the air handling unit in which the coil is located. The thermostat actually controls the operation of a two-way valve located in the solar hot water supply line leading to the heating coil. The thermostat and valve are of the proportional type. That is, the opening and closing of the valve are controlled by the thermostat in direct proportion to the deviation of the plant air temperature from that set on the thermostat. This proportional action takes place over a $\pm 2^\circ\text{F}$ range. Thus, if the thermostat is set at 66°F the heating valve will be fully closed at 68°F and fully open at 64°F.

If the solar tank temperature is not high enough to provide sufficient heat to meet the requirements of a particular zone, then the temperature of the zone will continue to fall. The electric heating thermostats are set 3°F to 4°F below the solar heating thermostats and will thus turn on the electric heating coils if the tank temperature is too low. Note that even if the electric heaters turn on, some heat is still being extracted from the solar water coil (since it is upstream from the electric heaters).

Some of the hot water coils are located where they might be subjected to cold air from an outside air damper connected to the air handling unit. These water coils are protected from freezing by a low limit or freeze-stat located just after the hot water coil. If the air temperature sensed by any one-foot-long section of the freeze-stat is below 40°F, the fan will be turned off and power to the two-way valves will also be shut off. The two-way valves are specified to fail in the fully open position so that water flow through the coil will be maintained.

Three-unit heaters are located in the areas of the plant that are not served by a central air distribution system. These heaters are controlled by standard on-off thermostats. Whenever the space requires heat, the thermostat turns on the unit heater fan. When the heating demand is met, the fan is turned off.

Hot water from the solar storage tanks is supplied to the heating coils by two hot water supply pumps located at the south end of the tank. These pumps are called P-2 and P-3 on the solar control panel. With the HOA switch in the (Auto) position, the hot water supply pump selected as the "lead" pump by the lead-lag switch on the control panel will run continuously. The other pump (lag pump) will be turned on only if the lead pump cannot supply enough hot water to meet the demands of the hot water coils. Water from the hot water supply pumps flows not only through the heating coils but also directly back to the tank through a short bypass line. The amount of water passing through the bypass line is controlled by two regulating valves in the bypass line. These regulating valves are controlled so that a constant pressure is maintained at the outlet of the pumps. If the heating coils demand more water, the pressure will fall and the regulating valves will throttle down the flow in the bypass line to maintain the pressure. If the flow in the bypass line falls to 10 GPM, a flow switch set to this valve will cause the lag pump to start up. The lag pump will continue to run until the heating demands have been met and the hot water coils require less flow. At

this point the system pressure will start to rise and the regulating valves will open letting more water flow through the bypass line. As the flow through the bypass line reaches 160 GPM a second flow switch senses this and turns the lag pump off. A time delay has been placed in the outlet of the first flow switch to prevent rapid pump cycling due to pressure surges as the lag pump goes off.

II. SYSTEM OPERATION

A brief description of the operation of the solar control system is given in Section IV of the Johnson Controls Manual. Normal operation of the system is with all HOA switches in the A position. The solar system pumps and valves will then operate automatically to provide solar heat to the storage tank whenever conditions are suitable. The following special operating modes are described below:

1. System Shutdown

- a. Solar Collectors - Turn HOA switch of P-1 to the O(ff) position. Leave HOA switch of P-4 (sump pump) in the A position (see note below).
- b. Heating System - Turn HOA switches of pumps P-2 and P-3 to the OFF position.

IMPORTANT NOTE: Always leave sump pump, P-4, switch in the auto position so the sump can be kept pumped. Never run the sump pump in the L(and) position unless the automatic start and stop level sensors malfunction.

2. System Startup (Fall)

- a. Solar Collectors - Turn P-1 switch to AUTO position. P-1 will start if collector sensor temperature is 25°F greater than the storage tank temperature.

NOTE: Never start the system between the hours of 10:00 a.m. and 3:00 p.m. on sunny days. High pressures due to generation of steam could result.

When flow through the collector array is started, verify that sump pump, P-4, comes on and operates in a stable manner. This may take 30 minutes after P-1 has started.

Inspect the solar collectors and connections for leaks. Leaks at hose connectors may be stopped by retightening the hose clamps. A row with a bad leak can be valved off until repaired. To do this, close the shut-off valves at the entrance and exit of the collector row, then open the drain valve at the entrance to the row to allow the row to drain. Remember to close this valve when the row is again operational.

b. Heat Tapes - There are 10 heat tapes to prevent standpipes from freezing. These heat tapes are wired in parallel and connected to a 220-volt line. The heat tapes are controlled by a single outside thermostat. Each heat tape has a resistance of 1850 ohms and draws 0.12 amps. Thus, the entire circuit draws 1.2 amps. This current is read on a meter. If any heat tape is not operating, the meter will read less than 1.2 amps.

c. Heating System - When heat is required in the Fall, the heating pumps can be turned on by switching the HOA switches of P-2 and P-3 to the AUTO position. If there is only a moderate demand for heat, only the pump selected as the lead pump by the lead-lag switch will operate.

The solar thermostats should be checked to see that they are at their proper settings. At the same time the electric thermostat settings should also be checked to make sure they are lower than the solar settings.

If the daytime temperatures are mild but heat is required at night, the heating supply pumps can be shut off during the daytime and turned on at night.

3. Safety Controls

a. Tank high temperature limit - The tank high temperature limit prevents operation of the solar pump, P-1, at storage tank temperatures above 195°F. If higher temperatures are desired, the limit can be raised by adjusting the thermostat control. However, the system should not be operated whenever collector outlet temperatures reach 210°F. Normally, the tank will reach 195°F only during periods of mild, sunny weather during the Fall and Spring. The extra heat storage obtained by operating above 180°F will generally not be utilized during these periods.

b. Sump high level - An alarm electrode is located 2-1/2 feet from the top of the sump. If water reaches that level, an alarm will be sounded on the control panel, the collector pump P-1 will be turned off and valves V-2 and V-3 will be closed and opened respectively.

NOTE: The automatic shutdown of P-1 by the sump high level control will only occur with P-1 switch in the AUTO position.

c. Motor-driven sump pump - The motor-driven sump pump will be activated only if the electrical power fails and there is water in the sump above the float setting of the pump. As long as the power remains off, the pump will operate automatically under the control of its float level detector.

d. Hot water coil freezestats - The hot water coil freezestats are installed on all the air handling units that have provision for bringing in outside air. If the freezestat senses an air temperature of 40°F or less the air distribution fan will be turned off as well as power to the

two-way hot water valve allowing the valve to fail to its normally-open position.

III. SYSTEM MAINTENANCE

A. Solar Collectors

There is no regular maintenance required for the solar collectors. If it becomes necessary to perform any work on the collector such as replacing a broken glazing, refer to Appendix C, the ITC/Solar Collector Parts, Repair, Installation and Maintenance Manual. Regular inspections of the collector array should be made (approximately every two weeks) and the condition of the collectors, connectors, etc. noted.

B. Controls

Maintenance of the control system--thermostats, control valves, etc. is discussed in the Johnson Controls Manual. A log of the system temperatures--storage tank, collector supply and return should be maintained so that any abnormal operation can be detected. Periodically (approximately monthly) the times of day that collection is started and stopped on a clear day should be noted in the log. This will serve as a check on the operation of the differential controller.

The operation of the heating tapes should be checked whenever the log data are taken. The normal current drawn by the heating tapes is marked on the meter. If one or more heating tapes is out of order, the current will be lower. If this occurs, the defective heating tapes should be located and repaired.

C. Pumps

Pumps should be oiled according to the manufacturer's instructions. The setting of the lead-lag switch on the control panel should be alternated monthly to give P-2 and P-3 the same amount of use.

D. Valves

The manual shutoff valves should be operated once a year to make sure they do not become stuck.

E. Standpipes

During extremely cold weather the standpipe openings must be inspected for ice buildup. Any ice buildup must be removed.

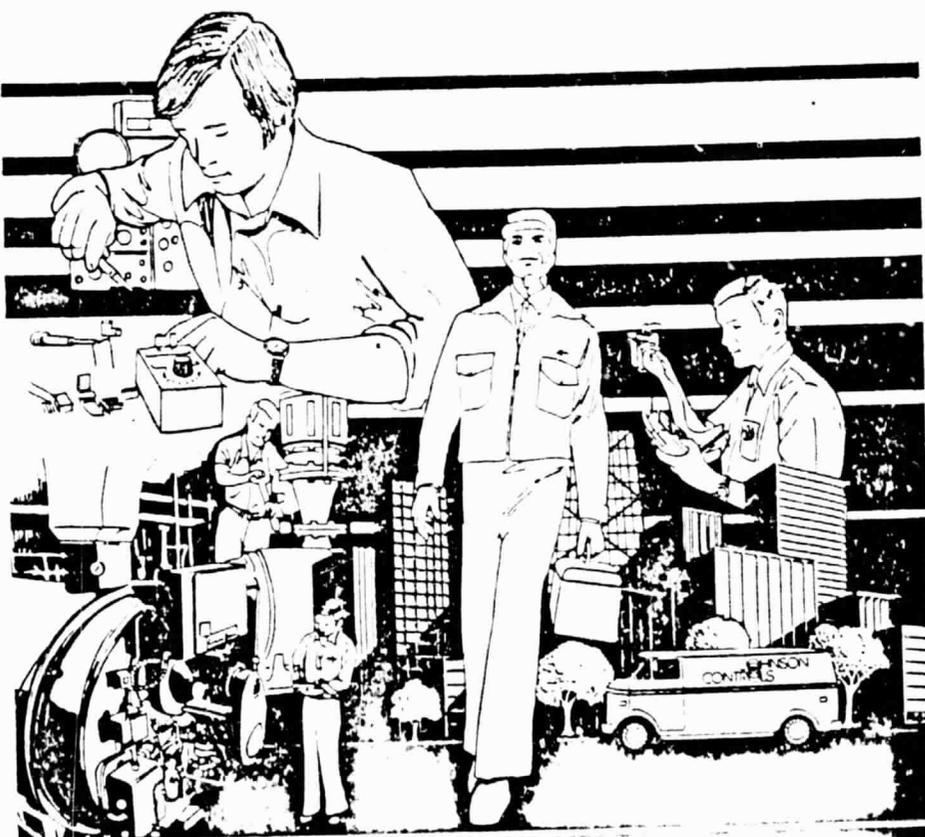
F. Water Conditioning

Follow the recommendations of Culligan for the addition of the rust inhibitor and the regeneration of the water softener.

SECTION IV

JOHNSON CONTROLS

OPERATOR'S MANUAL



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**Electric / Electronic
Controls**

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Electric/Electronic Controls

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FOREWORD

Since 1885, Johnson Controls, Inc. has pioneered the development of automatic control systems to meet the exacting needs of heating, ventilating and air conditioning installations.

Your Johnson Control System is a precision system carefully constructed and installed to provide the highest degree of accuracy possible. It is the result of the work of highly skilled engineers and experienced trade craftsmen. It has been installed for you by Johnson Controls, Inc., a company with nearly 100 years experience in all phases of automatic control design, installation and service. Today's Johnson building automation systems capabilities include heating, ventilating and air conditioning (HVAC) controls, Integrated Control Centers, Energy Conservation Controls, lighting controls, fire alarm, security, sound and communications, clock systems, water treatment and computerized automation systems.

There are certain suggestions which, if followed, will protect your building, improve operating efficiency, and add years of life to your control and mechanical systems. Careful regular maintenance is important if you wish to obtain the best possible results from your control system. Brief inspections are outlined to help you prevent any serious difficulties from occurring.

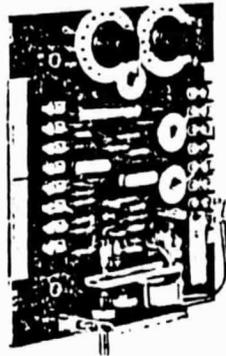
Many service calls result from insufficient knowledge of the operation and limitations of the control system and the heating, ventilating and air conditioning (HVAC) system. The objective of this Operator's Manual, in conjunction with the "as-built" control drawings and Product Directory(s), is to help you better understand your system. The control drawings show the control system "as-built" in your installation. The Product Directory(s) gives you a general description of the different type of controls available from Johnson Controls, Inc. The Operator's Manual will give you specific information on the operation, maintenance and adjustment of the various kinds of equipment.

MAINTENANCE

Prior to performing any work on an electrical apparatus, care must be taken to ensure that the equipment is completely isolated. Electric and electronic equipment are comparatively maintenance free, however, for most efficient operation, the following preventive maintenance should be performed:

CONTROLLERS

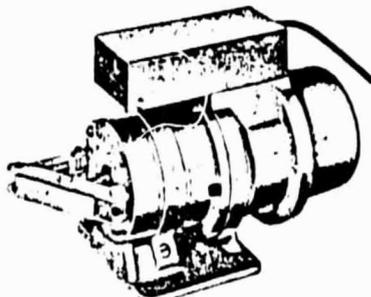
Check and clean the circuit board and its terminals periodically to prevent buildup of dust and dirt.



TC-4100 Temperature Controller

VALVE AND DAMPER ACTUATORS

The actuator shaft should be lubricated periodically with high-temperature lubricant which can be obtained through your local Johnson office. On damper actuators, the friction points in linkage should also be lubricated with the same lubricant.



DA-3200 Actuator

VALVES

Control valves should be visually checked monthly for leaks and sticking stems. Loss of the valve's ability to close tightly will require inspection of valve seats and discs for wear and system contaminant buildup. Valve disassembly and repair may require special tools. Contact your local Johnson branch office for specific recommendations and instructions.



Valve and VA-3200 Actuator

OPEN CONTACT DEVICES

Contacts on relays, switches and thermostats that are exposed to the surrounding atmosphere should be checked periodically to prevent a buildup of dust and dirt. If an excess of dust is allowed to collect on contacts, arcing may occur which would cause the contact surface to pit and corrode. The result will be premature failure of the contact.



KZ-4000 Relay

Never use a file or sandpaper to clean contacts. This removes a special plating which leads to pitting. Clean the contacts by any of the following methods:

- 1) blow contacts clean with forced air stream (CAUTION - air must be clean and dry)
- 2) brush with soft brush
- 3) spray with contact cleaner

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PRIMARY CONTROLS

The following equipment and associated control should be checked periodically. They should always be checked before extremely cold weather and before starting up the air handling system.

1. Hot water and steam supply
2. Chilled water (drained or protected with anti-freeze)
3. All pumps, including hot water, chilled water, condensate, etc.
4. Safety controls.

SECONDARY CONTROLS

On secondary systems, periodic checks should be made to the following whenever they are applicable to the individual system.

1. Outside air dampers
2. Preheat discharge temperature
3. Dew point temperature
4. Hot and cold duct temperature
5. Return air temperature
6. Humidity
7. Local safety controls, such as low limit, high limit, and fire detectors.

HVAC SYSTEM

A control system cannot maintain proper conditions within a building unless the heating, ventilating, and air conditioning system is functioning as designed. It is therefore essential that the maintenance recommended by the manufacturer of such equipment be performed. By the same token, a control system cannot function properly if maintenance is not performed on it. In consideration of this requirement, a sample list of recommended maintenance tasks is listed below showing typical tasks considered essential for the continued efficient operation of the control system(s).

MAINTENANCE CHECK LIST

1. HVAC UNITS

- a) review cycle and sequence of operation
- b) check controllers and recalibrate as required
- c) repair controllers as required
- d) check operation of panel devices
- e) clean control panel
- f) check damper operation
- g) clean and lubricate dampers
- h) check operation and sequence of damper actuators
- i) repair damper actuators as required
- j) check operating range of sequencing networks
- k) check operation and spring range of valves
- l) repair valves as required
- m) check operation of safety limits and minimum positioning devices
- n) clean all instruments, covers, terminals, etc.

2. ROOM AND ZONE CONTROL

- a) check operation of controllers
- b) recalibrate controllers as required
- c) repair controllers as required
- d) check operation of unit valves or dampers
- e) repair unit valves or dampers as required
- f) clean all instruments, covers, terminals, etc.

ADJUSTING INSTRUCTIONS

There are two basic types of controls in heating, ventilation and air conditioning systems, proportional and two-position. Proportional controls typically produce a variable 0-16 V.D.C. output signal, which is used to modulate or proportionally stroke a valve or damper. In an electric/electronic system, the majority of the controllers are proportional electronic which produce the above mentioned variable 0-16 V.D.C. output signal. The remaining electric controllers function in a two-position manner, that is to either start or stop fans or pumps, open or close valves or dampers, or interrupt the variable 0-16 V.D.C. signals of a proportional controller.

signal is within the spring range of the controlled device. This is determined by measuring the output signal with a D.C. meter across the output terminals or wires of the controller. If a signal between 0 and 16 V.D.C. is read, the temperature measured at the controller's sensing element can then be read and compared to the setting of the controller. Complete check-out procedures are given in individual controller installation data sheets available from your local Johnson branch office.

ADJUSTING PROPORTIONAL CONTROLS

A proportional controller is in control of the temperature it is measuring when its output



TC-4550 Temperature Controller



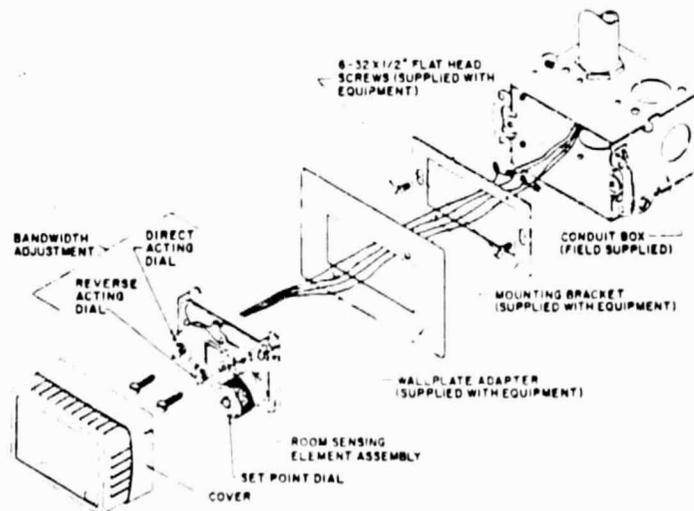
TC-4100
Temperature
Controller



HC-4100
Humidity
Controller

Bandwidth

The dial labeled 'bandwidth' should be positioned as far toward the lower end of its 0-10 scale as possible without causing 'hunting' or cycling to occur in the control system.



HC-4550 Exploded View

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Troubleshooting

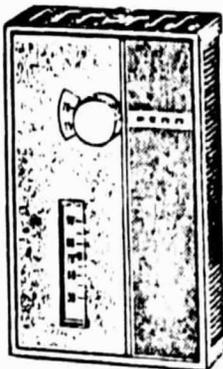
Whenever the controller output signal is at a minimum (0) or maximum (16) value the controller is not in control and the reason for this must be determined and corrected. It must be determined whether the problem lies in the control loop (room) or in the system loop (HVAC equipment). First determine the action of the controller. Then rotate the set point dial slowly toward the temperature at the element to see if the output signal changes. If the voltage changed, the controller also recognized there is a problem and should not be readjusted. Return controller set point dial to its previous set point. The problem then is in the system loop. When the problem is found and corrected, the controller will automatically return the control loop to the correct temperature.

responds. The differential setting of these controllers is factory set, but if caution is exercised, the differential can be readjusted in the field.

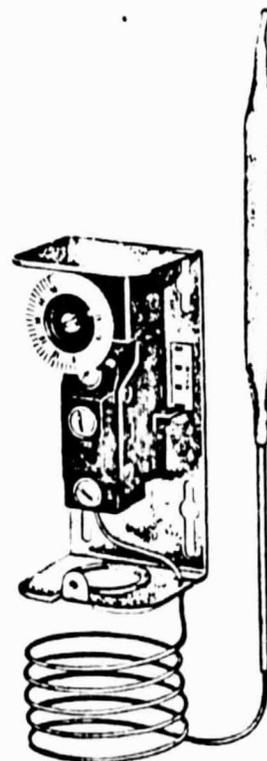
The controller set point position is indicated by the value on the dial. The second position is determined by either adding or subtracting the differential from the set point value. To establish the set point and differential, slowly rotate the set point dial toward the temperature as measured at its element until the contacts close or open. Read the dial value. Slowly rotate the dial in the opposite direction until the contacts open or close. Read the dial value. The difference between these two values is the differential, and the value of the dial that matches the measured temperature at the switchover point is the controller set point. Then turn the dial to the desired value.

ADJUSTING TWO-POSITION CONTROLS

A two-position controller has a point at which the contacts open and a point at which the contacts close. These two points are at different temperature values. The difference is referred to as the "controller differential". Some two-position electric thermostats have an adjustable differential which is established according to the requirements of the control loop to which the electric controller



T26A Controller



A19ABC Controller

LOW LIMIT PROTECTION

The importance of taking every precaution against freeze-up of equipment cannot be over-emphasized. Regardless of the automatic low limit devices furnished, the following procedures should generally be followed when there is any indication that the outside temperature will drop to the pre-determined low limit setting.

PUMPS

All hot water pumps and/or condensate or vacuum pumps should be operational.

BOILERS

Boilers and/or converters should be allowed to cycle on a demand basis.

SUPPLY AND EXHAUST FANS

Supply fans should be allowed to operate on their normal occupied or unoccupied cycles. When on the unoccupied cycle, the outside air and exhaust dampers should be closed and the return air damper open.

LOW LIMIT THERMOSTAT OPERATION

The low temperature limit protection device located at the heating coil discharge senses the lowest temperature along any portion of its sensing element. When one foot or more of any portion of the element senses a temperature as low as the thermostat set point, the instrument will open the circuit. Since the thermostat responds to a "spot" type condition, it is essential that stratification

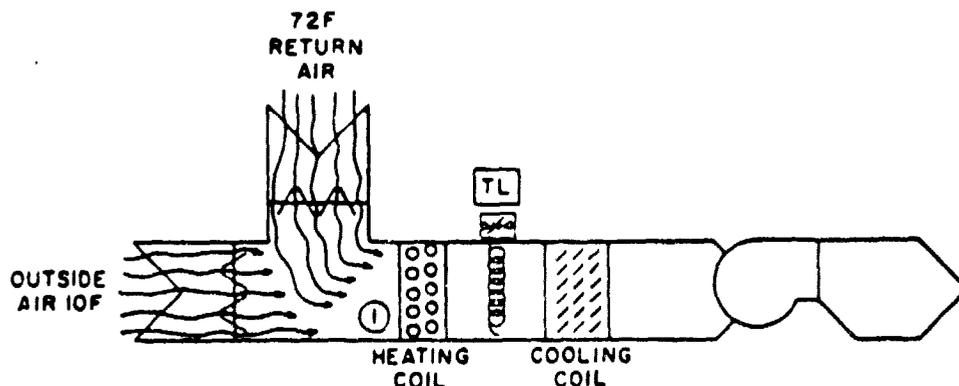
of air in the mixing chamber entering the coil be eliminated if proper operation is to be expected.

Where repeated shut-downs occur as a result of this condition, a greater tendency exists for the operating personnel to override or bypass the low limit protection device in order to keep the unit running. This is a dangerous practice and should be avoided. Further investigation as to the cause of shut-down should take place to determine the cause of the problem with appropriate remedial action.

Low limit protection devices should be checked prior to the arrival of cold weather. This can be done by turning the dial to a warmer setting until the low limit protection device operates. The setting should equal the temperature of the entering air or water. Do not forget to turn the device back to the original setting called for on the control diagram.

SPECIAL PRECAUTIONS

In extremely cold weather, the following added precautions should be taken: Before air supply systems are started, check steam traps and steam pressure and/or water temperature at the air supply system. After supply systems are started, check operation of the control system thermostats and observe for correct functioning with respect to the temperatures being sensed.



Example of Temperature Stratification
(A Stratified condition Could Occur at Point ① in above Illustration)

OCCUPANT DISCOMFORT

The first evidence of trouble with the heating, ventilation or cooling system is very often a complaint from an individual who is too hot, too cold or is bothered with drafts. Go to the person complaining and personally check the complaint. Experience has shown that in the majority of cases the problem behind the complaint is not a malfunction of the control system. To assist in determining this, the various factors, other than automatic control, that can create comfort problems are listed:

1. Zone Control

A person outside of the controlled zone may feel too hot or too cold. A zone control thermostat can only sense the temperature at its particular location. Temperatures in all other areas of the zone are dependent on proper balance of the heating/cooling distribution system.

2. Sun Load

Direct sunlight on the thermostat will cause over-cooling of a zone while direct sunlight on the individual will cause over-heating.

3. Covering of Grills

Frequently occupants will cover part or all of a discharge grill causing improper heating or cooling. Whenever a grill is covered, the heating or cooling medium is not permitted to enter the space to correct for variances from the set point.

4. Occupant Location

If occupants are located adjacent to outside walls or windows they may be subject to cold air leakage through the windows and/or radiant cooling from the wall.

5. Insufficient Conditioned Air Supply

This can be caused by poor air distribution, dirty filters in the air conditioning unit, or lack of proper return or exhaust air outlets.

6. People and Equipment

Over-heating will result if more people or equipment occupy an area than was intended in the original design concept. This can occur when a meeting is held in an area not designed for this type of function.

7. Heating and Cooling System

A malfunction, or lack of capacity in extreme weather, of the primary or secondary mechanical heating or cooling equipment will result in insufficient heating or cooling.

8. Psychological Adjustment

Many complaints are purely psychological. Once a person understands the limitations of a HVAC system, he is more likely to accept the conditions that prevail.

9. Drafts

In systems using air as a means of heating and cooling, there must be movement of air. To many people, even a slight air motion is uncomfortable. This can be a problem when an unbalanced system causes excessive drafts. Minor problems can sometimes be solved by relocation of work stations, however, it is always best to have a balanced system, i.e. proper size, spacing and delivery of air distribution equipment (fans, diffusers, grills, registers, etc.)

10. Wide Fluctuation of Air Temperature

Wide fluctuation of air temperature in an area can be the result of varying load conditions or improperly adjusted controls.

11. Stuffiness

A stuffy or smoky atmosphere will normally result from improper ventilation, i.e. insufficient fresh air supply, air too humid, overpopulation, or inadequate exhaust.

TROUBLESHOOTING - DIAGNOSING THE PROBLEM

HVAC EQUIPMENT

Depending on whether the area is too cold or too warm, and the time of year, check the heating, ventilating and air conditioning equipment that could be involved. This can involve any or all of the following:

1. Boiler
2. Refrigeration Compressor and/or Chilled Water System.
3. Pumps
4. Secondary Heating and Air Conditioning Supply Systems.

AUTOMATIC CONTROLS

When a complaint of improper temperatures has been received, a review of the mechanical system should be made to assure proper operation of the HVAC equipment. If the cause of trouble is not due to the mechanical system, conduct the following check of the control system. (A multi-purpose meter is necessary to make a thorough check, however, a limited check can be made visually).

Disconnect Switch

Check the disconnect switch that switches the power to the control system to make certain that it has not been switched to the "OFF" position.

Fuses and Circuit Breakers

Check the fuses or circuit breakers to make certain they are not blown or tripped. The circuit breaker may be part of the disconnect switch and will throw the switch to the "OFF" position if it trips. On 24 volt A.C. systems, the Johnson transformer is of the energy limiting type. When the maximum current rating is reached, the voltage will begin to decrease. When the overcurrent condition is remedied, voltage will automatically return

to its correct level. If a fuse has been replaced or a circuit breaker reset and it opens again the local Johnson service department should be contacted.

Controlled Devices

Check the automatic valve, damper actuator, etc., to see if they are in the proper position as called for by the controller. If they are not, check the actuator along with the controller to see if the actuator responds to the controller.

Controllers

If the actuator is not in the proper position, check the controller which controls that actuator as follows:

1. Check to see if the controller is at the desired set point value.
2. If the condition at the sensor of the controller has deviated from the controller set point, turn the controller set point slowly to match this condition.
3. Check the actuator again. If it is in the proper position to provide the heating or cooling, chances are the controller is only out of adjustment.
4. If the controller is out of adjustment, it should be readjusted by a qualified serviceman. Call your Johnson service department for adjusting, or parts replacement.
5. If the actuator does not change position when the controller set point is changed, the actuator or controller could be defective. To proceed further requires the use of a multi-purpose meter and a basic knowledge of electronics.
6. If the owner's personnel have a basic knowledge of electronics and wish to troubleshoot malfunctions, a multi-purpose meter with a sensitivity of 20,000 ohms per volt, capable of reading A.C. and D.C. voltage and resistance in ohms is required.

TROUBLESHOOTING PROCEDURE

By following the troubleshooting procedure outlined below, specific malfunctions, such as loose connections, broken wires, defective transformers, sensing elements, controllers, or actuators can be determined. Where maintenance is to be performed by the owner's personnel, replacement equipment should be stocked or ordered from the service department of the local Johnson office.

Controllers

The following procedures will assist in finding minor control problems:

1. The reverse acting and direct acting output signals of the controller should vary from 0 to 16 V.D.C. as the set point is varied.
2. Controller should give either a reverse or direct acting signal. If both signals are present at the same time, the controller is defective.
3. Make certain that elements are in good condition before conducting this test (see next section). Manually change the controller set point. If either output signal remains at a maximum or at "0" while the set point is varied, the controller may be defective. If both outputs are "0", make certain that the controller is getting A.C. power.
4. If either the direct acting or reverse acting output is a constant 16 V.D.C. while the other is "0", the problem may be in the sensing element, remote set point control, or faulty wiring.

Sensing Elements

If it is suspected that a sensing element in a system is faulty, it can be checked using the following procedure:

1. Disconnect leads from sensing element to controller.
2. Using an ohmmeter, check for opens (above 2000 ohms) or shorts through the sensing element.
3. If either of these conditions are detected, the element should be replaced.

Actuators

If the controller is functioning properly, and the actuator is still not responding properly, check the following at the actuator.

1. Check the control signal at the red (+) and blue (-) wires at the actuator. If there is no signal there may be a broken wire or loose connection between the controller and actuator.
2. If the proper signal is getting to the actuator, and it still does not function properly, measure the power supply voltage to the actuator. This reading should be 24 V.A.C. across the yellow and white wires or 120 V.A.C. across the black and black/red wires depending on voltage used. If the power supply voltage is correct, the actuator is defective.
3. If the control signal at the actuator remains at a constant voltage while varying the controller set point, any of the auxiliary devices between the controller and the actuator should be checked for proper operation.

Contact your nearest Johnson branch office if a more complete check-out procedure is required.

REPAIR

Adjustment and repair tool kits can be ordered from the local Johnson office. They can also supply you with repair and replacement equipment. In a majority of cases, it is less expensive to replace equipment under the

Johnson exchange policy. Recommendations on proper replacement equipment should be obtained from the local branch office. When requesting replacements, give the equipment code number shown on the control drawings.

PROGRAMMED MAINTENANCE

Programmed maintenance becomes more important every year. Today's mechanical and electrical systems are designed with closer tolerances than in the past. And they are more interdependent. If one system deteriorates, chances are that other systems will be affected. Therefore, every system must be carefully maintained to operate as closely as possible to design efficiency.

CUT COSTS TWO WAYS

Maintenance becomes more specialized under these conditions. And that's where Johnson can help. Our programmed maintenance plans match your scheduled needs while saving you money two ways. First, we eliminate your expense of hiring and training maintenance personnel. Second, we provide you with trained specialists who are experts in their field. There is no time wasted isolating problems or overcomplicating maintenance procedures. No need to pay full time for part-time services.

PARTS AVAILABILITY WITHOUT INVENTORY EXPENSE

What happens when a critical component failure shuts down part of your system? Do you have to wait for days or weeks before a replacement can be located? And then pay premium prices and expensive shipping charges? Not with programmed maintenance by Johnson. In the first place, preventive maintenance eliminates most failures. But where a rare disruptive failure does occur, our emergency service minimizes expensive downtime. And you're assured of an adequate supply of the necessary replacement parts.

SAVES TEST EQUIPMENT AND TOOL EXPENSE

Servicing building controls for mechanical and electrical systems today requires a wide range of specialized tools and test equipment. This is a sizable investment for a building owner. And the equipment is usually used only part time. Johnson programmed maintenance eliminates this investment while assuring availability of the latest test equipment and tools.

LONGER EQUIPMENT LIFE

A regularly-followed maintenance program extends equipment life by catching minor problems before they become serious. And by replacing worn parts before they can cause serious damage.

HELPS PREVENT MAJOR BREAKDOWNS

Often a serious system breakdown is triggered by failure of a minor system component. This touches off a series of failures that ultimately leads to complete system failure. With a planned maintenance program, no component, no matter how small, is neglected.

UNINTERRUPTED COMFORT, ENERGY CONSERVATION

A programmed maintenance schedule eliminates costly downtime. Uninterrupted, efficient productivity and fewer occupant complaints result. A preventive maintenance program provides you with assurance that these systems are always functioning properly. Efficient operation conserves energy.

PROGRAMMED MAINTENANCE BUDGET

Johnson's wide experience in maintaining controls for electrical and mechanical systems permits establishing a program of preventive maintenance with predetermined costs. You can accurately predict and budget all your maintenance costs. Systematized checklists spell out everything covered in your program. So you know beforehand exactly what is to be done and when, with no surprises, no chances for omissions. It is recommended that you plan and start a maintenance program at the start of your system's guarantee period.

Johnson is ready to handle your needs on any basis you wish, from taking total responsibility for your entire building to simply changing filters regularly.

For a customized programmed maintenance plan for your building, including complete cost information, contact the Johnson office nearest you for full details.

Appendix B

Manufacturer's Product Literature

APPENDIX B
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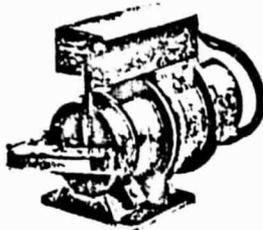
I. CONTROL HARDWARE

Actuators

Section A

DA-3200 Electro-Hydraulic Damper Actuator

For damper control in heating, ventilating and air conditioning systems, the Johnson DA-3200 Electro-Hydraulic Damper Actuator provides direct acting — proportional action. The DA-3200 with linkage to provide a 3 in. (76mm) stroke, will oppose up to 50 lbs. (223 N) of force in any shaft position. For two-position control a PZ-4000 power supply is required.



DA-3200

DA-3400 (Valve Actuator with DA-3400-9600 Lever Arm Kit)

Damper control of large volumes of air in central heating, ventilating and air conditioning systems can be provided when using the VA-3400 Valve Actuator with a DA-3400-9600 Lever Arm Kit. The actuator, furnished for proportional action, responds to the direct or reverse output signal of a Cybertronic controller. The DA-3400-9600 has an adjustable linkage for a 2-3/4 in. (70 mm) to

15 in. (381 mm) stroke, and will oppose 950 lbs. (4226 N) of force extended or 410 lbs. (1840 N) of force retracted.



VA-3400
with
DA-3400-9600
Lever Arm Kit

DA-5000 Thermal Damper Actuator

The compact and noiseless operation of the DA-5000 provides ideal control of zone dampers in multi-zone systems, or mixing-box valves in high velocity double duct systems. This actuator offers highly accurate positioning of dampers in response to proportional low voltage signals from Cybertronic controllers.



DA-5000

VA-3200 Electro-Hydraulic Valve Actuator

The VA-3200 provides direct acting — proportional control of valves in heating, ventilating and

air conditioning systems. With a yoke and stem for direct mounting to an appropriate valve body, the VA-3200 has a 1-1/8 in. (26 mm) stroke and will oppose up to 100 lbs. (447 N) of force. For two-position control a PZ-4000 power supply is required.



VA-3200

VA-3400 Electro-Hydraulic Valve Actuator

The VA-3400 is a heavy duty unit with a 2-1/2 in. (64 mm) stroke. Designed to handle large volumes of fluid, the VA-3400 will oppose 1000 lbs. (4448 N) of force extended or 500 lbs. (2224 N) retracted. With an appropriate valve body, the VA-3400 provides valve proportional control in central heating and air conditioning systems. The actuator may be connected to a Cybertronic controller for either direct or reverse acting control.



VA-3400

ORIGINAL PAGE IS
OF POOR QUALITY

**VA-5000
Thermal Valve
Actuator**

The VA-5000 is suitable for use in fan coil units, in induction units and zone reheat. Fitted with connecting yokes for valves up to 2 in. (51 mm) in size, the actuator will oppose up to 100 lbs. (445 N) of force extended and 50 lbs. (222 N) of force retracted. The VA-5000 has a stroke of 1/2 in. (13 mm) and 7/8 in. (19 mm).



VA-5000

All actuators require a 24 or 120 volts A.C. power source for operation, and a 0 to 16 volts D.C. input signal control.

Valve Bodies

Section B

**VB Series
Valve Bodies**

Johnson Controls manufactures a line of valve bodies to complement the Cybertronic actuators. The valve bodies available are in several styles: Normally Open, Normally Closed, Three-Way Mixing and Three-Way Bypass. The following table lists the valve bodies and their characteristics.



VB-3752



VB-3970



VB-4322

Valve	Size in.	Service	Service Connection	Pressure Temp. Ratings
VB-3752 N.O.	1-1/2 to 2	Water and/or Steam	Screwed Globe	Steam 35 PSIG (241 kPa) @ 281F (139°C)
			Flanged Globe	Water 150 PSIG (1024 kPa) @ 320F (160°C)
VB-3970 N.C.	1-1/2 to 6	Water and/or Steam	Screwed Globe	Steam 35 PSIG (241 kPa) @ 281F (139°C)
			Flanged Globe	Water 150 PSIG (1024 kPa) @ 320F (160°C)
VB-4322 Mixing	1-1/2 to 2	Water	Screwed Globe	150 PSIG (1024 kPa) @ 320F (160°C)
	2-1/2 to 6		Flanged Globe	
VB-5650 Bypass	3 to 6	Water	Flanged Globe	150 PSIG (1024 kPa) @ 320F (160°C)

CAGE TRIM VALVE

All Johnson Cage Trim Valves feature a removeable cage trim design which provides valve plug guiding throughout the travel range and permits high rangeability. The following table lists the valve bodies and their characteristics.



VB-3754

Valve	Size in.	Service	Pressure Temp. Ratings
VB-3754 N.O.	1/2, 3/4, 1	Water and/or Steam	Steam 35 PSIG (241 kPa)
VB-3974 N.C.			Water 400 PSIG (2800 kPa) @ -20 to 150F (-29 to 66°C) Decreasing to 345 PSIG (2415 kPa) @ 281F (140°C)
VB-4324 3-Way	1/2, 3/4, 1	Water	Water 400 PSIG (2800 kPa) @ -20 to 150F (-29 to 66°C) Decreasing to 345 PSIG (2415 kPa) @ 281F (140°C)



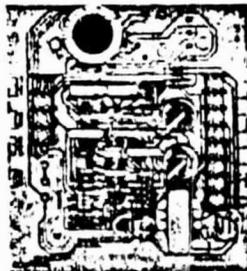
VB-4324

Controllers

Section C

HC-4100 Humidity Controller

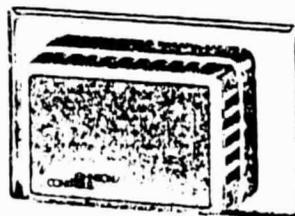
The HC-4100 Humidity Controller is a solid-state Cybertronic device which operates on 24 or 120 volts D.C. The controller will provide an output of 0 to 16 volts D.C. for both sides of null to obtain direct and reverse proportional action. The bandwidth settings for the reverse and direct acting outputs may be adjusted separately from 1.5 to 25% RH.



HC-4100

HC-4550 Room Humidostat

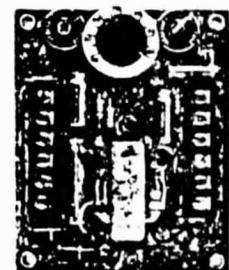
Designed to provide proportional control of space humidity, the HC-4550 Room Humidostat controls 1 or 2 electro-hydraulic actuators or up to 10 thermal actuators. The HC-4550 has a D.C. operating voltage, usually obtained from a VQ-4100 or VQ-4200 power supply, and separate bandwidth adjustments for each side of null. This Cybertronic unit is available with open or closed set point adjustment.



HC-4550

LC-3001 Load Limiting Controller

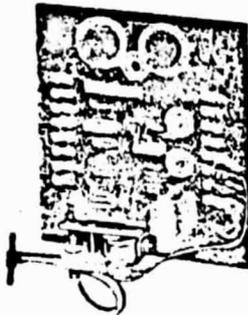
The Load Limiting Controller is utilized in refrigeration and electric heat application to limit current flow. The Cybertronic controller produces a 0 to 16 volt D.C. proportional control signal which varies inversely to the input signal supplied by the toroidal current transformer. The set point is adjustable from 40 to 100% of the rated load current. Bandwidth is adjustable from 5 to 50% of rated load current. Operating voltage is either 24 or 120 volts A.C. and the set point may be either integral or remote.



LC-3001

PC-3001 Electro-Pneumatic Transducer

The PC-3001 Electro-Pneumatic Transducer is designed to convert a 5 volt D.C. output signal from a Johnson Cybertronic Controller into a proportional 3 to 15 PSI output pressure. Output pressure is then used as a standard pneumatic actuator in proportional control systems.

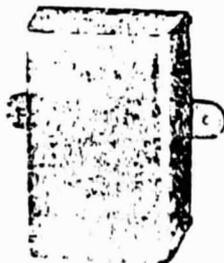


PC-3001 Mounted on TC-4100 Controller

PC-4000 Static Pressure Controller

The PC-4000 Static Pressure Controller is a solid-state electronic device designed to maintain a constant differential between two air pressures.

The controller senses the difference in pressure piped to its two chambers and produces a 5 volt D.C. signal proportional to the differential for the operation of appropriate pneumatic devices. The unit may be connected for direct or reverse output. Maximum operating pressure is 10 in. W.G. The unit is powered by 24 or 120 volts D.C. input.



PC-4000

TC-4100 Temperature Controller

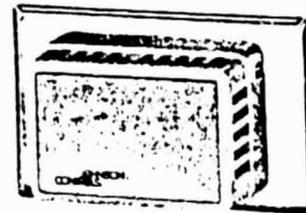
The TC-4100 is a solid-state Cybertronic device designed to provide proportional control of temperature when used with appropriate local and remote sensing elements. The controller will operate one or two electro-hydraulic actuators, up to six thermal actuators on either side of null, or a pneumatic actuator when used with the PC-3001 electro-pneumatic transducer. The unit is available to operate on 24 or 120 volts A.C., has various temperature ranges, and separate bandwidth settings for direct acting and reverse acting signals.



TC-4100

TC-4550 Room Thermostat

The TC-4550 Room Thermostat is available with or without thermometer and with exposed or concealed set point. The TC-4550 operating voltage is usually obtained from a VQ-4100 or VQ-4200 power supply, and has separate bandwidth adjustments for each side of null. Each output will control one or two electro-hydraulic actuators, up to ten thermal actuators or a variety of Cybertronic auxiliary devices.



TC-4550

Elements

Section E

**HE-6000 Series
Humidity Sensing Element**

Johnson Humidity Sensing Elements for Cybertronic control provide accurate, rapid sensing of relative humidity in remote spaces or ducts.

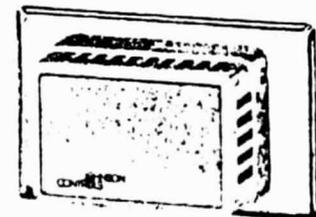
The element is available in a room or insertion model with a carbon impregnated element which changes electrical resistance in response to changes in relative humidity. The element has an operating range of 20 to 90% RH with a high degree of stability and resistance to washout at high humidities.

The sensing portion of the HE-6100 Insertion Element is mounted in a 6-1/4 in. (159 mm) channel and covered with an appropriate protective cap. The HE-6880 is a wall mounted humidity element available for horizontal or vertical mounting.

For use in JC/R0 applications, the HE-6180 is a duct mounted humidity sensor with a 20 to 80% RH. The HE-6880 can be mounted vertically or horizontally for JC/80 use.



HE-6100



HE-6880

**TE-1100 Series
Temperature Sensing Elements**

The TE-1100 Series Temperature Sensing Elements provide a rapid linear response to temperature changes by utilizing a nickel wire wound element. The reference resistance is 1000 ohms at 70F (21°C), with a temperature coefficient of 3 ohms/F°.

The standard tolerance is ± 1% and precision elements are available with a tolerance of ± 1/4%. The following table lists the elements, applications and options available.



TE-1100



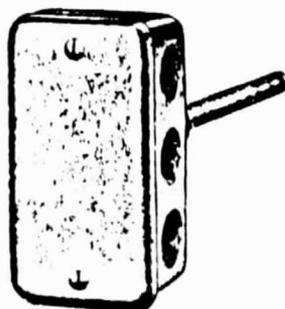
TE-1610



TE-1900



TE-1700



TE-1100

Product	Application	Models & Options
TE-1100	Duct Insertion Well Insertion	Averaging (8 or 17 ft) Dual Wound, High Temperature (Standard or Precision)
TE-1101	Duct Insertion	6 in., Standard Precision or Double Element
TE-1300	Outside Temp. Sensor	Standard or Precision Models
TE-1500	Outside Solar Sensor	Used with TE-1300
TE-1601	Bearing Temp. Sensor	Used with CQ-1001
TE-1610	Surface Temp. Sensor	Used with TC-4100
TE-1700	Strap-on or Well	1000 Ohms ±1 or 1/4%, 500 Ohms ±1% and 333 Ohms ±1% Models with Packing Nut and Handi-Box for use with WZ-1000 Wells
TE-1800	Wall Mounted Room Sensor	Control — With or Without Set Point Concealed or Exposed, Horizontal or Vertical Mounting Indication also Available
TE-1900	Indication Sensor	Mounts Internally on Pneumatic or Cybertronic Room Thermostats, Separate Model for Dewcel*

**TE-1080 Series
Ultra-Precision Sensing
Elements**

The TE-1080 Series Temperature Sensing Elements are ultra-precision nickel wire sensors designed for use with the JC/80 Heating Automation System. All elements are wound to a precise tolerance of 1000 ohms — 0.1% at (21°C).



TE-1380

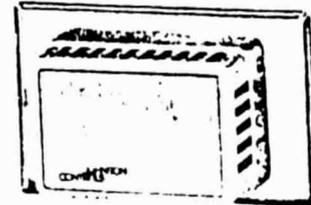


TE-1980

**TE-2800
Temperature Sensing Element**

Designed for use with a solid-state DQ-4000 Series Electric Heat Controller, the TE-2800 Temperature Sensing Element with set point is a thermistor type element.

Models are available with optional concealed or exposed set point adjustment and with an optional thermometer for local temperature indication.



TE-2800

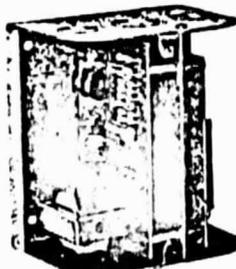
Product	Application	Models and Options
TE-1180	Duct Insertion	Dual or Single Wound, 6 in.
TE-1380	Outside Temp. Sensor	Standard
TE-1780	Strap-on or Well	For Mounting with WZ-1000 Wells, Models come with Packing Nut and Handi-Box
TE-1880	Wall Mounted Room Sensor	Control — Without Set Point, Horizontal or Vertical Mounting, Indication
TE-1980	Indication Sensor	Adhesive Mount for Sensor only, or Sensor with Clip for use with T-4000 Thermostat

Networks

Section N

**DN-4000
Time Proportioning Network**

The DN-4000 Time Proportioning Network is designed to provide accurate proportional control for electric heating applications. The DN-4000 will automatically control "on" time of heating coils in proportion to the 0 to 16 volt D.C. output of a Cybertronic temperature controller. The network has an adjustable time range of 30 seconds to 5 minutes.



DN-4000

**LN-4000
Low Signal Selector**

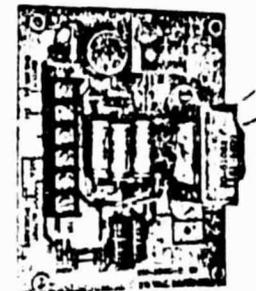
Requiring no external power supply for operation, the LN-3000 Low Signal Selector is a solid-state Cybertronic device. Designed to select the lower 0 to 16 volt D.C. control signal from two Cybertronic controllers, the output of the LN-3000 can then be used to position one or two electro-hydraulic actuators or up to ten thermal actuators.



LN-3000

**RN-3000
Resistance to Voltage
Converter**

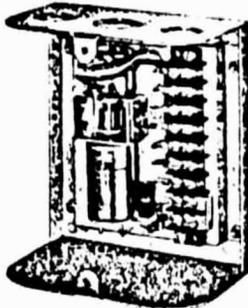
The RN-3000 Resistance to Voltage Converter is a Cybertronic device which converts a variable resistance from a 100, 135 or 150 ohm potentiometer into a 0 to 16 volt D.C. output signal. The RN-3000 requires a 24 volt A.C. supply voltage and is factory set for operation with a 135 ohm input potentiometer.



RN-3000

Auxiliary Devices**Section Q****AQ-4100
Remote Reset Control**

The AQ-4100 Remote Reset Controls are motor-potentiometer assemblies designed for readjustment of manual set point settings from a central control panel or Johnson Control Center. They are used with temperature controllers, measuring bridges and for humidity reset.



AQ-4100

**AQ-5000
Remote Set Point Control**

The AQ-5000 Remote Set Point Control provides remote adjustment for a HC-4100 Humidity Controller or a TC-4100 Temperature Controller. It can also be used in electronic circuits for remote night setback. An indexing knob marked with an arrow, and appropriately marked scales are supplied with each unit.



AQ-5000

**CQ-1001
Bearing Temperature Alarm Unit**

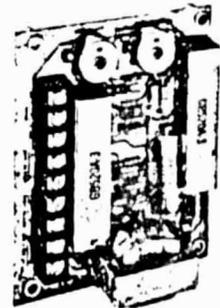
The CQ-1001 is a Cybertronic system designed for measuring and producing an alarm from a high temperature limit on a bearing block. Two devices compose the CQ-1001 system; the TE-1601 Temperature Sensor and the CQ-1001 Temperature Alarm Unit. The unit is direct or reverse acting with an adjustable set point from 140 to 180F (60 to 82°C).



CQ-1001

**CQ-2100
Floating Alarm Unit**

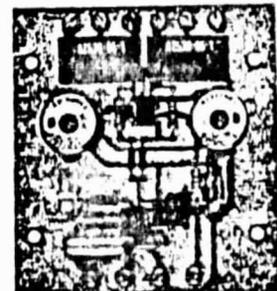
When used with the TC-4100 and HC-4100 Controllers, the CQ-2100 Floating Alarm Unit provides a contact closure for high and low alarm points. Alarm points are individually adjustable for $\pm 10\%$ of controller span or a maximum of 10F (5.5°C), on each side of null, with a differential of 1F (1°C). Alarm points need not be symmetrical about the null point. Changes in set point adjustment cause the alarm point to move accordingly.



CQ-2100

**CQ-2200
Cybertronic Alarm Unit**

The CQ-2200 Alarm Unit is used with the CQ-4100 series of temperature and humidity bridges to provide contact and closures for two adjustable alarm points. The alarm points are individually adjustable from 0 to 100% of the basic bridge range.



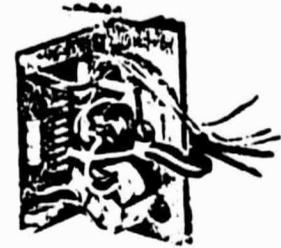
CQ-2200

**DQ-4000 Series
Electric Heat Control**

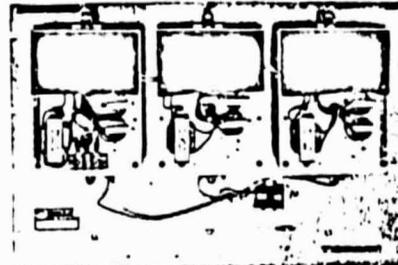
The DQ-4000 Series solid-state Electric Heat Control Units provide time proportioning control of electrical power to electric resistance heaters. The DQ-4100, DQ-4102 and the DQ-4103 are single phase units; the DQ-4400, DQ-4500 and the DQ-4600 are three phase units. All units in the DQ-4000 Series feature a unique zero phase-angle switching technique which minimizes radio frequency interference and waveform distortion in the power lines. Both master and slave units are available in all models.



DQ-4100



DQ-4103
without cover



DQ-4600 without cover

Product	Model Type	Supply Voltage	Signal Inputs	Ambient Temp. Limits
DQ-4100	Single Phase	120, 208, 240, 277 Volts A.C.	0 to 16 Volts D.C. Cybertronic Control Signal	0 to 120F -18 to 49°C
DQ-4102	Single Phase	120, 208, 240, 277 Volts A.C.	0 to 135 Ohms from Transducer or Thermostat	0 to 146F -18 to 63°C
DQ-4103	Single Phase	480 Volts A.C.	Resistance from Thermistor Temperature Sensor or	0 to 150F -18 to 66°C
DQ-4400	3-Phase	208/240, 416/480, 600 Volts A.C.	0 to 20 PSIG (0 to 140 kPa) Signal from Pneumatic Controller	32 to 120F 0 to 49°C
DQ-4500	3-Phase 4-Wire	208/240, 416/480, 600 Volts A.C.		32 to 120F 0 to 49°C
DQ-4600	3-Phase 4-Wire	120/208, 277/480 Volts A.C.		32 to 120F 0 to 49°C

**GQ-4000
Indication System**

Available in five, eight and fourteen channel models, the GQ-4000 Indication Systems provide accurate centralized indication of selected remote variables. Each GQ-4000 system is composed of a regulated 24 volt D.C. power supply, a D.C. measuring bridge unit, a variable resistance input source and a signal readout device. The eight channel model is available with or without the power supply.

The GQ-4100 is a D.C. bridge unit used for relative position, temperature, or relative humidity. The relative position bridge may also be used for reset applications.

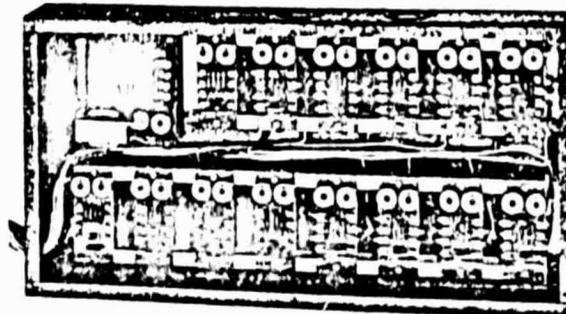
All units have separate zero and span adjustments enabling individual calibration of each point in the system.



GQ-4000-1 5-Point System



GQ-4000-5



GQ-4000-4 14-Point System

**HQ-3000
LQ-3000
Signal Discriminators**

Johnson High (HQ-3000) or Low (LQ-3000) Signal Discriminators are solid-state devices. The units compare the magnitude of 0 to 16 volt D.C. signals of two or more Cybertronic controllers, and reproduce the highest or lowest signal as an output to a separate circuit. This output can be used to start or stop central motors, or modulate central zone actuators at the same value as the highest or lowest control signal. The discriminators have an operating voltage of 120 or 24 volts A.C. and do not affect the output signal of the controllers being monitored.

Discriminators have a maximum capacity of six controller inputs. Two or more units may be interconnected to provide more than six channels for a given function.



HQ-3000



LQ-3000

**MQ-3000
Minimum Position Network**

The MQ-3000 Minimum Position Network is designed for use in electric control circuits to maintain a minimum position of a controlled device, or to provide manual control of one or two controlled devices.

The MQ-3000 has an adjustable output which can be set at any value from zero to maximum voltage (0 to 16 volts D.C.). Furnished for 120 or 24 volt A.C. operation, the unit is available with integral or remote adjustment via an AQ-4100 Remote Reset Control.

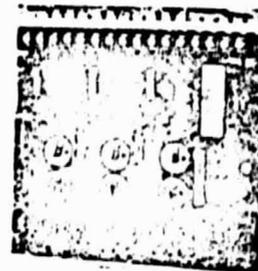


MQ-3000

**NQ-4500
Staging Network**

Used with Cybertronic controllers, the NQ-4500 Staging Network is an auxiliary device designed to provide two-position control as a function of a proportional control signal. The NQ-4500 is normally used to sequence stages on a reciprocating compressor or an electric heating unit.

The staging network is composed of up to three individually adjustable SPDT relays, each operated by a separate trigger circuit. The trigger circuits receive the proportional 0 to 16 volt D.C. output of a controller to actuate corresponding relays.



NQ-4500

**NQ-5002
Solid-State Step Controller**

NQ-5002 Step Controllers provide sequential step control of electrical resistance heaters. The NQ-5002 combines time proportioning control of the DQ-4000 with the sequential step control to provide an economical approach to proportional control of electric heat.

The NQ-5002 is available in four, six, eight, or ten stages with the 24 volt A.C. Triac pilot duty switching for use with appropriate electric heat contactors.

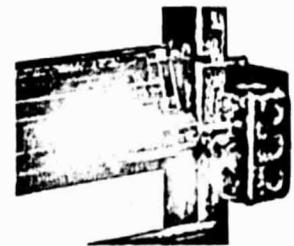
Power input is 24 volts, 50/60 Hz, 275 milliamperes, maximum for electronic section and 0.6 amp for each contactor stage.



NQ-5002

**PQ-1001
Damper Position Indicator**

Proportional variable resistance change in response to damper movement is provided by the PQ-1001 Damper Position Indicator. An auxiliary device, models are available for both inside and outside mounting on ductwork and damper frames.



PQ-1001

**RQ-3000
Reversing Network**

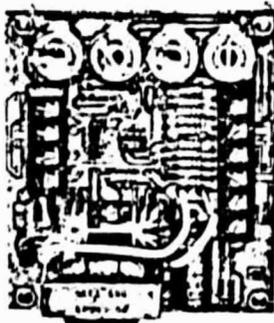
The Johnson RQ-3000 Reversing Network is a solid-state device which reverses the output signal of a Cybertronic controller. The network is designed primarily to provide sequential control of two actuators from a single controller. In practice, the network inverts controller output of one side of null so both controlled devices will receive direct or reverse signals. The reversing network is available for 120 or 24 volt A.C. operation.



RQ-3000

**SQ-3001
Cybertronic Sequencing Network**

The SQ-3001 Cybertronic Sequencing Network is a solid-state auxiliary amplifier used for converting a preselected portion of the output of a Cybertronic controller into two separate 0 to 16 volt D.C. signals. Networks are available for operation on either 24, or 120 volts A.C., 50/60 Hz supply voltages.



SQ-3001

**UQ-3000
Unison Amplifier**

Controlling up to eight electro-hydraulic actuators in unison, the UQ-3000 Unison Amplifier is used when the combined output load of several final control devices exceeds the output load rating of the controller.

The unit accepts a 0 to 16 volt D.C. signal from a controller and produces an output of equal voltage capable of operating the parallel connected actuators. The device operates on a 24 or 120 volt A.C. power supply input.



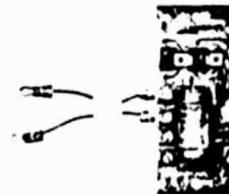
UQ-3000

maximum), and will retain full regulation at any output setting. Line regulation is 0.5% for an input of 21 to 28 volts A.C.

For both power supplies, load regulation is 0.6% from no load to full load, and maximum ripple is 50 mV. Recovery from line and/or load changes is instantaneous.



VQ-4100



VQ-4000

**VQ-4000
VQ-4100
Power Supplies**

Especially designed for use with the GQ-4000 Indication System components, the VQ-4000 is a solid-state, low voltage D.C. power supply. The VQ-4000 is suitable for continuous duty in applications requiring a well regulated source of 25 volt D.C. power (70 mA maximum). Line regulation is 0.5% for an input of 22 to 29 volts A.C.

The VQ-4100 is adjustable for a 20 to 25 volt D.C. output (200 mA

**VQ-4200
Power Supply**

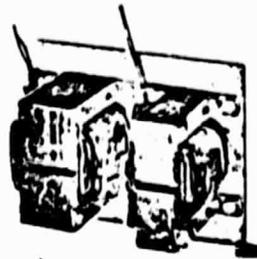
The VQ-4200 is a solid-state, low voltage D.C. power supply suitable for continuous duty with HC-4550 room humidity controllers and TC-4550 temperature controllers. One VQ-4200 Power Supply will operate one HC/TC-4550 with up to two DA/VA-3200 electro-hydraulic actuators connected. The 18 volt D.C. output is transistor regulated and filtered.



VQ-4200

**VQ-5000
Power Supply**

The VQ-5000 supplies 24 volt A.C. power to the heater circuit of a Foxboro Dewcel® element for dew point indication and control applications. Although factory connected for 60 Hz operation, the VQ-5000 is field reconnectable for 50 Hz operation.



VQ-5000

Accessories

Section Z

**BZ-1000 Series
Cybertronic Equipment
Enclosures**

BZ-1000 Series Cybertronic Equipment enclosures are used to house and protect field mounted Cybertronic equipment. Several standard sizes are provided to match various equipment mounting space, wiring and conduit connection requirements.



BZ-1000-2



BZ-1000-7

**KZ-4000
General Purpose Relays**

Listed by both Underwriter's Laboratories and the Canadian Standards Association, the KZ-4000 General Purpose Relays are used to control large electrical loads from Johnson equipment with low power sources. Two relay contacts are available, DPDT and SPDT.



KZ-4000

**KZ-5000
Relays for Cybertronic
Controllers**

The KZ-5000 Relays convert a proportional 0 to 16 volt D.C. output signal of a Cybertronic controller into a contact closure. The relays may also be used in applications requiring two-position control of relatively large amounts of electrical power, using low level D.C. voltage. The pull-in and drop-out points of the SPDT relays are non-adjustable.



KZ-5000

**MZ-7000 Series
Indication Meters**

Magnetically shielded, the MZ-7000 Series Indication Meters are signal readout devices designed for flush mounting (with bezel), surface mounting or back mounting applications. The accuracy of all models is $\pm 2\%$ of the full scale value. Lens, bezel and mounting adapter kits are separately available.



MZ-7006



MZ-7008

**PZ-4000
Accessory Power Supply**

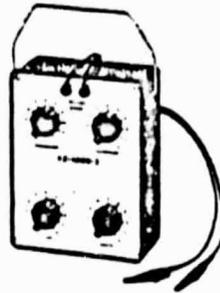
The PZ-4000 Accessory Power Supply is a solid-state Cybertronic device used for two-position operation of a single DA/VA-3200 electro-hydraulic actuator. Two 35 milliampere models are available to operate 24 or 120 volts A.C., 50/60 Hz. Both models produce 16 volts D.C. across 1000 ohms.



PZ-4000

**RZ-4500
Precision Decade Box**

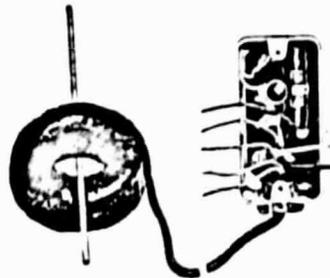
The RZ-4500 Precision Decade Box is a variable precision resistance source for field calibration of Cybertronic control and indication systems. The decade box provides precision resistance value used in operational checkout and adjustment procedure. A total of 11,110 ohms can be obtained in one ohm increments.



RZ-4500

**TZ-4000
Current Transformer**

The TZ-4000 Current Transformer is a Cybertronic device which measures the alternating current flowing through a wire and produces a proportional A.C. voltage output signal. It is designed for use with LC-3001 Series Load Limiting Controllers.



TZ-4000

**TZ-5000
Step-Down Transformers**

Listed by Underwriter's Laboratories Inc., the TZ-5000 Step-Down Transformers are used to supply power to 24 volt A.C. control circuits. These transformers are precision built to ensure rated power, proper voltage regulation and maximum efficiency.

Models are available with 100 to 300 VA ratings at 120 or 200/240 volts, 50/60 Hz line voltages. All 208/240 dual input voltage transformers have a single primary winding with a tap for the lower input voltage.



TZ-5000

**M-8100
Control Cabinets**

The M-8100 Control Cabinets are general purpose utility enclosures designed for use in grouping and protecting various components of pneumatic, electric and Cybertronic control systems.

Listed by Underwriter's Laboratories, the M-8100 is used for line voltage systems or any other application requiring a rated cabinet. The face and back panels are held in place with continuous, solid retaining bars.



M-8100

CHROMALOX

Installation and Operating Instructions

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SERVICE REFERENCE		
DIV.	SEC.	NUMBER
4	PIT	3001A
SALES REFERENCE		(Supersedes PK428-1) PK428-2
DATE		May, 1967



Chromalox General Purpose Industrial Thermostat

Catalog Number PIT-EP with Explosion-Proof Enclosure

Catalog Number PIT with Rain-Tight Enclosure

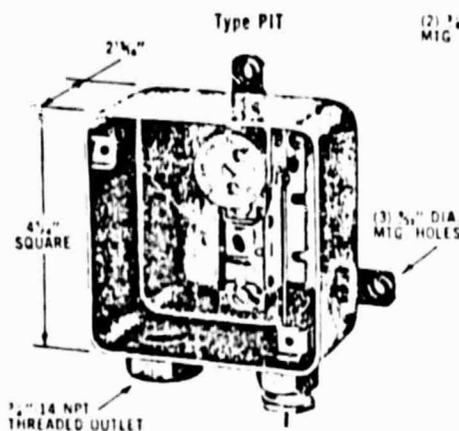


Figure 1 — Interior of Type PIT

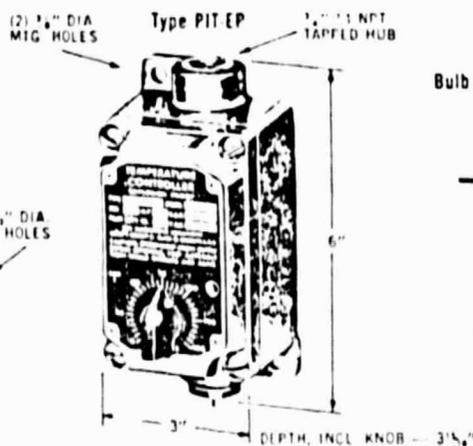
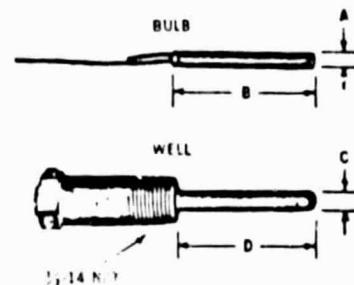


Figure 2 — Type PIT EP

Bulb and protective well for PIT and PIT-EP



Can either open or close a circuit on temperature rise. SPDT, snap-acting switch.

Type PIT — Rain-tight, gasketed enclosure is 0.062" steel. Simple mounting on 3 rubber-cushioned feet. Has adjustable high limit stop. Plain copper bulb and capillary.

Type PIT-EP — Explosion-proof, cast aluminum housing approved for Class I, Group D and Class II, Groups E, F, G. External adjusting knob. Tin-plated copper bulb and capillary.

APPLICATION — Chromalox Type PIT SPDT thermostats are designed for a variety of applications where Rain-tight or Explosion-proof enclosures are necessary or desirable. Typical use is to control the temperature of fluids conveyed through pipes (commonly termed pipe tracing), also used in snow melting applications with electric heating cable. An alarm or signal circuit can be operated by the auxiliary contacts.

OPTIONAL ACCESSORY — Bulb Well — Copper bulb wells with 1/2" NPT brass connectors are supplied when specified. See Specifications for Catalog Numbers.

FEATURES —

1. Liquid-filled element is unaffected by barometric pressure and cross ambient temperature problems.
2. Dependable field proved snap-acting contacts with heavy duty rating for inductive or resistance loads.
3. Choice of four temperature ranges.
4. Copper bulb well available.

Specifications —

Catalog Number (Rain Tight)	Catalog Number (Explosion Proof)	Temp. Range (°F)	Sensitive Bulb with 10" Capillary 1/4" dia.		Nominal Differential (°F)
			"A" Dia.	"B" Lgth.	
PIT 15	PIT 15EP	0-150°	.290"	2 1/4"	6
PIT 25	PIT 25EP	100-250°	.290"	2 1/4"	6
PIT 35	PIT 35EP	200-350°	.66"	2 1/4"	6
PIT 40	PIT 40EP	325-475°	.566"	2 1/4"	6

*Differential based on direct bulb immersion in liquid at 1° per minute rate of change. In a bulb well, differentials will widen. When clamped to a surface such as a pipe, differential may be wider or narrower depending on several variables.

Bulb Wells —

Temperature Ranges	"C" Dia.	"D" Lgth.	Part Number
0-150°, 100-250° F	1/4"	2 1/4"	1-112008
200-350°, 325-475° F	1/4"	2 1/4"	2-112008

Electrical Ratings —

Voltage, A.C. Only	120	208	240	277
Full Load Amperes	16	9.2	8	—
Locked Rotor Amperes	96	55.2	48	—
Non-Inductive or Resistance Load Amperes* (Not Lamp Loads)	22	22	22	22

Pilot Duty — 125 VA, 24-600V A.C.

*S.P.S.T. Rating

GENERAL DESCRIPTION — The Chromalox Type PIT Thermostat has an enclosed SPDT switch contact unit. May be wired to open on temperature rise ("R" to "B"), or to close on temperature rise ("R" to "Y"). See Figure 3, Page 7

The Rain-tight thermostat has a keyed adjustable high limit stop. A special spanner wrench (Part Number V74-836-61), required to adjust the limit stop, is supplied with each control.

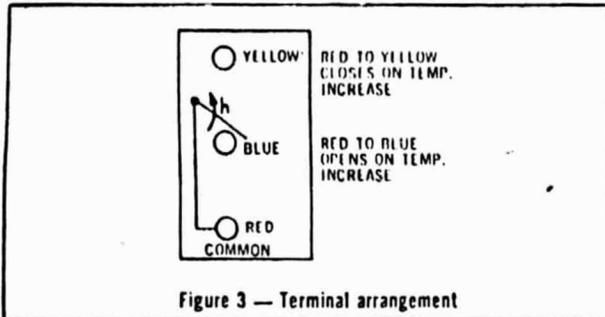


Figure 3 — Terminal arrangement

INSTALLATION — **Caution:** DO NOT subject bulb to temperatures more than 50°F. above maximum dial range of the control.

Wiring should conform to local and National Electric Codes. Wiring terminals are accessible by removing the cover.

Signal Circuit — Self contained pilot lamps are not available. Remote lights or other type of signal circuits may be connected as shown in Figure 4.

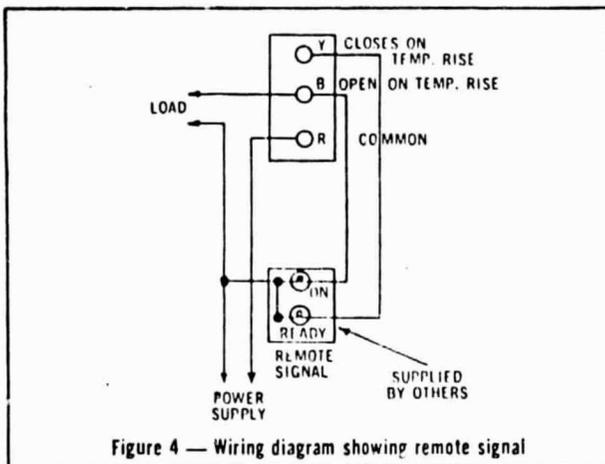


Figure 4 — Wiring diagram showing remote signal

Indoors, the thermostats may be mounted in any position.

RAIN-TIGHT ENCLOSURE TYPE PIT — Outdoors, where exposed directly to weather, the electrical connection and capillary should be on the lower horizontal surface as illustrated in Figure 1.

Where the capillary is exposed and subject to possible mechanical damage, some means of protection should be provided. The capillary outlet is designed to permit the

capillary to run through 1/2" thinwall conduit or through metal hose such as 3/8" Anaconda "Sealite" or equivalent.

Remove the capillary outlet seal nut only, see Figure 5. Push the bulb and capillary through a conduit coupling or suitable hose fitting and on through the conduit or hose. By tightening the conduit coupling or hose fitting to the 1/2" female capillary outlet fitting, the seal around the capillary will be maintained and the conduit or hose will be rigidly attached to the enclosure.

The end of the conduit or hose away from the control should be clamped and bushed and the capillary should be taped to prevent cutting or wear from sharp edges and any strain on the capillary.

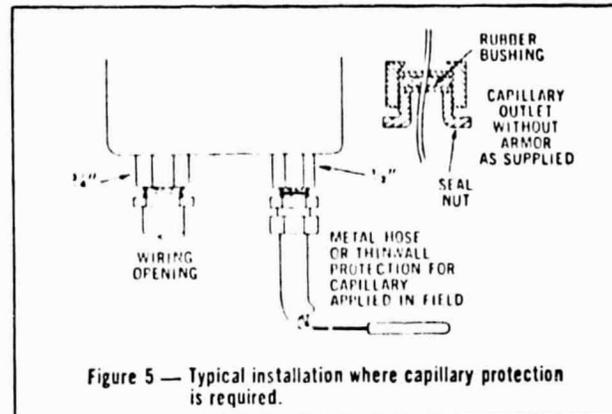


Figure 5 — Typical installation where capillary protection is required.

Adjustments — The setting may be changed to meet the requirements of the installation. To change setting, remove the cover and rotate dial with a screwdriver.

High Limit Stop Adjustment — The high limit stop can be set at any position between 55°F. above the lowest dial range and the highest dial range. For example: The high limit stop can be set between 55°F. and 150°F. on a thermostat with a range of 0°F. to 150°F.

To change the stop setting, loosen the two screws in the dial plate with the wrench packed with the control. Turn the dial so the pointer indicates the stop setting. Move the stop (located behind dial plate) against stop bracket. Tighten screws to lock the stop in position.

REPAIRS AND REPLACEMENT — Repairs are not recommended in the field. Control requiring repair should be returned prepaid to the factory to the attention of the Service Administration Department.

CHROMALOX WARRANTY — The Edwin L. Wiegand Company guarantees its products only to be within regular commercial limits, unless otherwise stated in writing. Parts manifestly defective will be replaced at no additional cost, but no claims will be allowed for labor, material, or damages incident to this replacement. Claims will not be allowed for material damaged or broken in shipping, handling, installing, or by abuse. In addition, the company cannot guarantee products against damage resulting from corrosion, electrolysis, or other operating conditions beyond our control which could result in premature failure of the product.





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PENN CONTROLS A DIVISION OF JOHNSON SERVICE COMPANY
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LOW LIMIT TEMPERATURE CONTROLLER, A11

The A11 Low Temperature Controller provides a warning of low temperature conditions at heating and/or cooling coils. The A11 is designed to respond to the lowest average temperature over any one foot portion of the 20 foot long averaging element. This controller has an operating range of from 35 to 45F. SPST contacts are provided for either manual or automatic reset operation.



A11

GENERAL PURPOSE REMOTE BULB TEMPERATURE CONTROLLER, A19ABC, A19AAF, A19AAC, A19ACA AND A19AAA

The A19 General Purpose Controller provides temperature control for a broad range of applications. Ranges are available for operation between -30 and 240F with either a fixed or adjustable differential. SPST contacts, for open high or open low operation can be provided with either manual or automatic reset operation. The standard capillary is 6 feet long. Optional 10 and 20 foot capillaries are also available. The open high model is available with a Factory Mutual Listing.



A19ABC

LOW LIMIT TEMPERATURE CONTROLLER, A19AAH

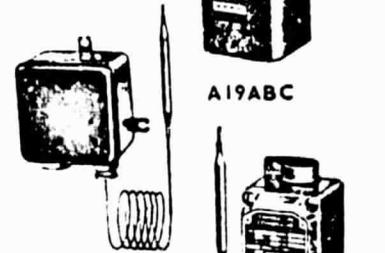
The A19 Low Limit Temperature Controller is for low voltage applications. SPDT contacts for open low operation are supplied. This controller has an operating range of 40 to 120F and a fixed differential of 3/4°F. A 7-1/2 foot long averaging bulb is supplied as an integral part of the controller. This A19 can be used with Cybertronic control systems as an outdoor low-limit temperature controller.



A19AAH

HOT WATER CONTROLLER, A19ABC, A19ADB

The A19 Hot Water Controller is available for either direct or remote well immersion applications. The operating range of the controller is 100 to 240F. The A19, for hot water control applications, has an adjustable differential with SPDT contacts. The open high controller is available with manual reset and a 6 foot capillary for remote mounted well applications.



A19ABC

REMOTE BULB CONTROL WITH RAIN-TIGHT ENCLOSURE, A19ANC

The A19 Remote Bulb Controller is supplied with a gasketed cover to protect against outdoor weather conditions. SPDT contacts are provided to operate over a range of 0 to 150F. This controller has a fixed differential and a 10 foot capillary.



A19ANC

HAZARDOUS LOCATION CONTROLLER, A19AUC, A19BUC

The A19 Controller for hazardous locations is equipped with an integral coiled or remote bulb element. This controller is designed to operate over a range of -30 to 50F or 20 to 80F with a fixed differential. The remote bulb models are supplied with 6 foot capillaries.



A19AUC

SPACE THERMOSTAT, A19BBC, A19BAB, A19BAC

The A19 Space Thermostats are provided with an integral air bulb. Ranges are available for operation between -30 and 110F with either fixed or adjustable differential. SPDT contacts or open high operation can be supplied.



A19BAC

AUTOMATIC CHANGEOVER CONTROLLER, A19CAC

The A19 Automatic Changeover Controller automatically selects the heating or cooling operating mode of a SPDT thermostat. This controller has an operating range of 60 to 90F and a fixed differential. Either local or remote strap-on mounting of the bulb is possible.



A19CAC

HOT WATER STRAP-ON CONTROLLER, A19DAC

The A19 Strap-On Controller can be mounted on either vertical or horizontal running pipes. SPDT contacts are provided to operate with a fixed differential over a temperature range of 100 to 240F.



A19DAC

FLANGE MOUNTED DUCT THERMOSTAT, A19EAF

The A19 Duct Mounted Thermostat is used for rooftop units, make-up heaters, duct heaters and all-air system applications. A flat flange is supplied for mounting. This thermostat is designed to operate over a range of 30 to 110F or 60 to 130F with a fixed differential. Contact operation is SPDT.



A19EAF

DUAL BULB THERMOSTAT, A19FBC

The A19 Dual Bulb Thermostat is used for outdoor air reset control applications. A selected balance between heating requirements and heating capacity is maintained. This controller is supplied with an operating range of 60 to 140F and an adjustable differential. Reset ratios of 1 to 1 or 1 to 1-1/2 are available. The indoor and outdoor elements have capillary lengths of 10 and 30 feet respectively. A bulb shield is supplied with the outdoor element.

A19FBC



MANUAL RESET HIGH LIMIT CONTROLLER, A25AN, A25CN

The A25 High Limit Controller opens on a temperature increase to the set point. The operating range of this controller is 25 to 215F. A stop setting of 125F is also provided. This flange mounted, manual reset controller is available with a Factory Mutual Listing.

TWO-STAGE TEMPERATURE CONTROLLER, A28AA, A28AJ

The A28 Two-Stage Controller is supplied with two SPDT switches, permitting independent control circuit operation of two networks. Controllers with operating ranges between -30 and 140F with either a fixed or an adjustable interstage differential are available. Models can be supplied with an integral coil bulb or with a remote bulb having a 6 foot capillary.

DPDT TEMPERATURE CONTROLLER, A28AB

The A28 Temperature Controller provides simultaneous switching of two circuits for changeover control applications. Two SPDT switches operate in unison. Controllers with operating ranges of 20 to 80F or 60 to 90F are available to operate with a fixed differential.

TWO-STAGE FAN CONTROLLER, A28MA

The A28 Fan Controller can control two single speed or one two-speed fan or pump. The bulb and capillary are neoprene coated for sump pump water control applications. The bulb and capillary are tin plated for air cooled condenser applications. Two SPDT contacts are supplied to operate with a fixed differential over a range of 40 to 120F. The capillary is 6 feet long.

MULTI-STAGE THERMOSTAT, A36AHA, A36AHB

The A36 Multi-Stage Thermostat provides multi-switching operation from one liquid filled sensing element. Four SPDT contacts are supplied to operate over a range of 10 to 80F. Either a 10 or 15 foot, plain or braided armor capillary is available.

PNEUMATIC LIMIT CONTROL A40

The A40 Pneumatic Limit control opens an integral pneumatic switch when the sensed temperature reaches the set point. The A40 low limit control has a sensing element that responds only to the lowest temperature along the entire 20 feet of the sensing element.

The A40 high limit control has a remote bulb that senses the air temperature in a duct and opens a pneumatic switch when the sensed temperature becomes excessively high.

A40 low limit controls are available with or without manual reset. A40 high limit control has manual reset.

A40 low limit have a range of 15/55°F and a non-adjustable 5° differential. A40 high limit controls have a range of 140/220 or 100/170 and a non-adjustable 10° differential.

HIGH LIMIT REMOTE BULB TEMPERATURE CONTROLLER, A70

The A70 High-Limit Temperature Controller provides open high detection of a high-limit condition. A SPST or DPST contact arrangement for 4-wire, 2-circuit applications is supplied. This controller is available with an operating range of 100 to 170F. All models are equipped with a 6 foot capillary.

LOW LIMIT REMOTE BULB TEMPERATURE CONTROLLER, A70

The A70 Low-Limit Temperature Controller provides open low detection of a low-limit condition. A SPST or DPST contact arrangement for 4-wire, 2-circuit applications is supplied. This controller is available with an operating range of 15 to 55F or 35 to 80F. Lockout models require manual reset. B-bulb models are supplied with a 6 foot capillary. Controllers can also be furnished with a 20 foot long averaging bulb.

TWO-POLE TEMPERATURE CONTROLLER, A72AE, A72CE

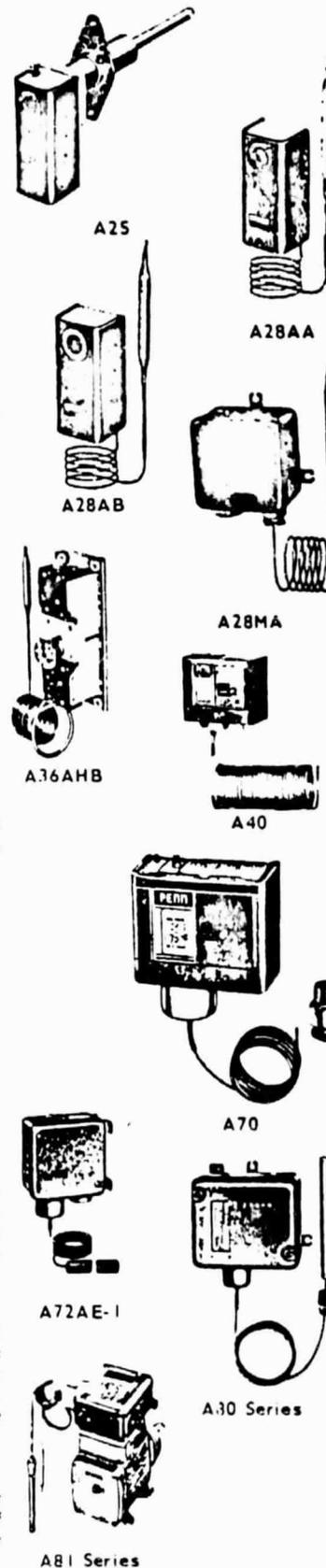
The A72 Temperature Controller can be used as a warning of inadequate head pressure when evaporative condensers or cooling towers are used. Open or close low double pole contacts are included within the NEMA 3 enclosure. The bulb and capillary are neoprene coated for corrosion resistance purposes. This controller has an operating range of 25 to 90F and an adjustable differential.

FLOATING OR PROPORTIONAL BULB TEMPERATURE CONTROLLER, A80 SERIES

The A80 Temperature Controller is provided with a SPDT non-snap-acting switch, one potentiometer, or two potentiometers. The A80 can position motor actuators using the standard 135 ohm or optional 330 ohm potentiometer configuration. When two potentiometers are included, they are capable of operating in unison or in sequence with each other. This controller is available with operating ranges between -20 and 245F. The remote bulb element is 6 feet long, including the capillary.

ECONOMIZER CONTROL PACKAGE, A81AA, A81GA

The A81 Economizer Control positions M80B series actuators in outdoor-return air damper systems. Mixed air control is provided with a 10 foot capillary operating over a range of 10 to 90F. Change over control is provided with a 6 foot capillary and either a SPDT or DPDT contact arrangement, operating over a range of 25 to 90F.





PENN CONTROLS

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PROPORTIONAL TEMPERATURE CONTROLLER, A82

The A82 Temperature Controller is used with M80F and M80H series actuators for industrial heating, air conditioning and ventilating applications. Either a single or dual bulb model is available. The single bulb controller has an operating range of 50 to 90F while the dual bulb model has an operating range of 60 to 140F.

SOLID-STATE TEMPERATURE SENSING ELEMENT, A91AAA, A91NAA, A91PAA

The A91 Solid-State Temperature Sensing Element is used for indoor and outdoor air and immersion applications. This A91 sensor can be used with electronic motor actuators, panels or signal centers. Operating ranges available are 40 to 90F, 60 to 120F, and (for outdoor reset applications) 60 to 100F.

FLOW INTERLOCK SWITCH, F60

The F60 Flow Interlock Switch is supplied with a SPST or SPDT contact arrangement. SPST contacts close in response to a flow increase. SPDT contacts are actuated when a predetermined amount of liquid flow exists. In-line mounting is possible using the two 1/2" N.P.T. pipe connections.

GENERAL PURPOSE FLOW SWITCH, F61KB

The F61 Flow Switch detects a flow or no-flow condition in liquid lines on refrigeration and heating systems. Four flow paddle sizes are available for use in 1", 2", 3" or greater than 6" pipe lines. The flow or no-flow condition is sent via the SPDT contact arrangement. Either NEMA 1 or vapor proof NEMA 4 enclosures are available.

SENSITIVE FLOW SWITCH, F61KD

The F61 Sensitive Flow Switch makes or breaks an electrical circuit when liquid flow starts or stops. Less than one gpm is required to actuate the switch. This large flow capacity flow switch is mounted in-line using either the two 1/2" or two 3/4" (depending upon the model) N.P.T. pipe connections.

AIR FLOW CONTROLLER, F62AA

The F62 Air Flow Controller detects a flow or no-flow condition of air in all-air system ductwork. This controller responds to velocity air movement only because of the stainless steel paddle arrangement. Paddles are available in two sizes: 2-1/8" x 6-7/8" or 3-1/8" x 6-7/8". A SPDT switch is included in the air flow controller.

LIQUID LEVEL FLOAT SWITCH, F63

The F63 is for use in closed tanks where a desired liquid level is to be maintained. SPDT dependable, enclosed snap-acting switch provides proper action for the application. These liquid level switches have a 1" NPT brass pipe connector.

ON-OFF MOTOR ACTUATOR, M40A

The M40A motor actuator is a two position motor (on-off action). Power requirements 40 VA, 120 V.A.C. or 24 V.A.C. (suggest Y65 transformers for use with 24V models). Field adjustable travel from 90 to 160 angular degrees. Requires SPDT low voltage controller. Timing is 60 sec. per 160 angular degrees, torque 35 lb. inches (approx. 25 sq.), non-spring return.

PROPORTIONAL MOTOR ACTUATOR, M40B

The M40B motor actuator positions dampers or valves in response to temperature conditions. Control signal input (low voltage) 135 to 1000 ohms, 1/2 watt, 3 lead potentiometer. Power requirements 40 VA, 120 V.A.C. or 24 V.A.C. (suggest Y65 transformers for use with 24V models). Dual travel of 90 or 160 angular degrees. Solid state drive and limits operating speed is 60 seconds per 160° angular rotation. 35 lb. inches torque. Damper rating for 25 square feet. Non-spring return.

PROPORTIONAL ACTION MOTOR ACTUATOR, M80A

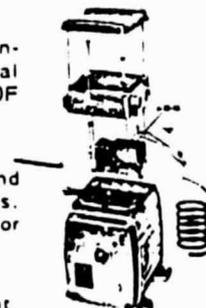
The M80 Proportional Motor Actuator positions dampers or valves in response to temperature conditions. Temperature conditions are sent to the motor actuator in the form of a control signal. The control signal originates from a remote balanced relay or electronic control panel. A 135 ohm potentiometer arrangement is supplied for operation with 24 volt A.C. control systems. Operating speed is 60 seconds for 160° angular rotation.

SOLID-STATE PROPORTIONAL MOTOR ACTUATOR, M80F, M80H

The M80 Solid-State Motor Actuator positions dampers or valves in commercial and industrial control applications. This general purpose actuator is used with 3-lead controllers offering resistances from 135 to 1000 ohms at 1/2 watt. Solid-state drive, adjustable travel limits, and one or two adjustable auxiliary switches are all part of the basic actuator. Models are available with or without spring return for 24 volt A.C. control systems. Operating speed is 60 seconds for 160° angular rotation. M80H is listed by Underwriter's Laboratories, Inc.

ON-OFF MOTOR ACTUATOR, M81A

The M81 Motor Actuator positions dampers and valves in a two-position manner. This 24 volt A.C. actuator is used with 3-wire SPDT controllers having a minimum current rating of 1.0 ampere. Adjustable travel limits and one or two adjustable auxiliary switches are part of the basic Underwriter's Laboratories listed actuator. Both spring return and non-spring return models are available with operating speeds of 60 seconds per 160° angular rotation.



A82 Series



F61KD



A91AAA



F62AA



F61KB



M40A



F63



M40B



M80 Series



M80A



ELECTRONIC TEMPERATURE CONTROL PACKAGE, M90A

The M90 Electronic Control Package positions dampers and valves in HVAC systems. The control package can be used with one or two solid-state temperature sensing elements. This 24 volt A.C. control package has an adjustable ratio, adjustable travel limits, and an operating speed of 60 seconds per 160° angular rotation.



M90A



M-8100

CONTROL CABINETS, M-8000, M-8100

The M-8100 control cabinets are general purpose utility enclosures for use in grouping and protecting electric, electronic control components.

The cabinet frame is 6063-T5 alloy with fluted surfaces. All corners riveted and supported. A face panel and mounting back panel are supplied. The M-8100 is listed by Underwriters' Laboratories and is used for line voltage systems or any other application requiring a rated cabinet. Sizes include widths from 12 to 36", height from 18 to 48", depth from 7 to 9".

STEAM PRESSURE CONTROLLER, P47FA, P47GA, P47AA, P47BA

The P47 Steam Pressure Controller is designed for high-limit and operating control applications. A single, or two-pole contact arrangement for 4-wire, 2-circuit systems, can be supplied to open or close high. Operating ranges between -20" w.g. and 150 psig are available. Lockout models require manual reset.



P47 Series



P67 Series

LOW RANGE PRESSURE CONTROLLER, P67AA

The P67 Low Range Pressure Control is used to operate an electrical device in response to a pneumatic control signal. A DPST contact arrangement is provided to open in response to a decrease in pressure. This controller has an operating range of 3 to 30 psig and an adjustable differential of 1-1/2 to 20 psi.

DIFFERENTIAL PRESSURE CONTROLLER, P74JA

The P74 Differential Pressure Controller is used to operate an electrical device in response to a difference between two input pressures. A SPDT floating contact arrangement is provided. This controller has a differential pressure range of 8 to 60 psi and a fixed differential of 2 psi. A 1/4" SAE male connector is provided for each input.



P74 Series



P80 Series

DIFFERENTIAL PRESSURE CONTROLLER, P74FA

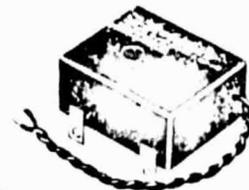
The P74 Differential Pressure Controller is used to operate an electrical device in response to a difference between two input pressures. A SPDT snap-acting contact arrangement is provided. This controller has a differential operating range of 8 to 60 psi and a fixed differential of 3 psi. A 1/4" SAE male connector is provided for each input.

PROPORTIONAL PRESSURE CONTROLLER, P80 SERIES

The P80 Proportional Pressure Controller is used for positioning electronic motor actuators. One 135 ohm potentiometer is part of the pressure controller. This controller has an operating range between -20" w.g. and 500 psig and an adjustable throttling range. The P80 controller is for 24 volt A.C. control systems.

CURRENT SENSING RELAY, R10A, R10B

The R10 series current sensing relays detect a wide variable current flow in a single circuit without being connected to the circuit. Specifications: R10A-Normally Open Contacts, R10B-Normally Closed Contacts, R10A - Current for contact change of state 4 amp to open, 14 amp to close; R10B - Current for contact change of state - 25 amp to open, 10 amp to close. Maximum inrush current - 200 amp, Maximum sustained current - 60 amps. Circuit supply voltage - Max. 550 volts A.C. only. Switching capacity - R10A - 30VA non-inductive, R10B - 3 watts non-inductive.



R10A

PROPORTIONAL STAGING CONTROL, R20A, R20C, R20E

The R20 Proportional Staging Control provides step control for liquid chillers, electric duct heaters, electric boilers, and heat pumps in response to a proportional control signal. The 24 volt A.C. control, capable of accepting resistances of 300 to 1000 ohms, has a thermal power element to operate 4, 6 or 8 stages.



R20 Series



R21 Series

SOLID-STATE SIGNAL CENTER, R21AA, R21AB, R21AD

The R21 Signal Center has an SCR included for "closed-loop" control. The 24 volt A.C. signal center accepts a signal from a solid-state temperature sensing element in order to control damper or valve actuators. This signal center is available with an adjustable set point and will accept resistance inputs between 300 and 1000 ohms.

ELECTRONIC TEMPERATURE CONTROL PANEL, R91BAA

The R91 Electronic Temperature Control Panel is used to position motor actuators connected to valves or dampers. The control panel will accept inputs from two elements simultaneously to provide a reset schedule. The 24 volt A.C. panel should be used with solid state temperature sensing elements. Adjustments are provided beneath the cover.



PENN CONTROLS A DIVISION OF JOHNSON SERVICE COMPANY

2221 CAMDEN COURT • OAK BROOK, ILLINOIS 60521

ELECTRICAL
PRODUCT
DIRECTORY

TWO-POSITION ELECTRONIC RESET CONTROL PANEL, R91BBA

The R91 Reset Control Panel provides outdoor reset of hot water temperature. Two solid-state temperature sensing elements are used with the panel. On-off switching is provided to operate low voltage (1 amp @ 25 volts A.C.) gas valve relays. The 24 volt A.C. reset control panel has adjustments beneath the cover.



R91 Series



R93EA

ELECTRONIC TEMPERATURE CONTROLLER, R93EA

The R93 Temperature Controller is used with a remote sensor and set point to position one or more motor actuators. This controller has a dual output and a scale range of either 40 to 90F or 60 to 120F.

AUXILIARY SWITCH KIT, S91AA, S91BA, S91CA

The S91 Auxiliary Switch Kit is available with one, two or four SPDT snap-acting switches. The switches mount to any motor actuator. Individual adjustable operating points provide for various differentials.



S91 Series



T22

LINE VOLTAGE THERMOSTAT WITH SELECTOR SWITCH, T22 SERIES

The T22 Line Voltage Thermostat is available for heating, cooling, and heating-cooling applications. This standard or heavy duty thermostat can be supplied with an external knob, key hole, or concealed set point adjustment. This thermostat has an operating range of 40 to 90F. A liquid charged sensing element and snap-acting contacts are also supplied. The controller is equipped with field adjustable limit stops.

FAN COIL THERMOSTAT, T23A, T23B

The T23 Fan Coil Thermostat is a line voltage control designed for heating, cooling, or heating-cooling applications. It is equipped with a three speed fan selector switch and field adjustable limit stops. The range of this thermostat is 50 to 90F. Operating voltage is either 120 or 240 volts A.C.



T23A



T25A

TWO-STAGE ROOM THERMOSTAT, T25A

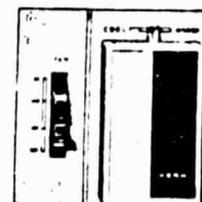
The T25 Two-Stage Room Thermostat is designed for low or line voltage applications. Two SPDT snap-acting contacts switch in response to the temperature changes sensed by the liquid charged element. Either an external knob or key adjustment is provided for set point changes. This thermostat is also provided with field adjustable high limit stops. Operating range is from 40 to 90F.

LINE VOLTAGE THERMOSTAT WITHOUT SELECTOR SWITCH, T26 SERIES

The T26 Line Voltage Thermostat is designed for heating, cooling, or heating-cooling applications. Standard or heavy duty models are available with either an external knob, key hole or concealed set point adjustment. Snap-acting contacts respond to temperature change sensed by the liquid charged element. This thermostat has field adjustable limit stops and an operating range of 40 to 90F.



T26A



T28

FAN COIL THERMOSTAT, T28

The T28 Fan Coil Thermostat is designed for heating, cooling and heating-cooling applications. This thermostat is available for 120, 208 or 240 volt 50/60 Hz operation. Snap-acting contacts respond to temperature changes sensed by bimetal element. When desired, a thermometer can be supplied in the cover. Operating range for this thermostat is 55 to 95F. An optional fan switch is available for one, two and three speed fans.

LOW VOLTAGE WALL THERMOSTAT, T51

The T51 Low Voltage Wall Thermostat is designed for heating, cooling and heating-cooling applications. This thermostat has the sensing unit and wiring sub-base supplied as two separable units. A selector switch is part of the wiring sub-base assembly. Snap-acting contacts respond to a bimetal temperature sensing element. This 24 volt 50/60 Hz thermostat has a range of 55 to 85F.



T51 Series



T52

LOW VOLTAGE AUTOMATIC CHANGEOVER THERMOSTAT, T51B

The T51 Automatic Changeover Thermostat is available for one stage heating and one stage cooling applications. A SPDT contact arrangement, having a neutral center position, responds to temperature changes sensed by the bimetal element. Two separable units, the sensing unit and the wiring sub-base, make-up the thermostat. This 24 volt 50/60 Hz thermostat has an operating range of 55 to 85F.

LOW VOLTAGE MULTI-STAGE THERMOSTAT, T52

The T52 Multi-Stage Thermostat is designed for air conditioning systems where automatic switchover of multiple heating and cooling stages is required. The thermostat is equipped with or without manual switches. Mercury switches are directly coupled to the bimetal sensing elements for quick response to temperature changes. Models are available with one or two-stage heating and one or two-stage cooling. Heating operating range is 50 to 85F, cooling range is 55 to 90F.

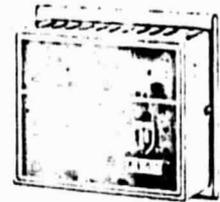


HUMIDOSTAT, W43A

The W43 Humidostat is designed for 3-wire SPDT snap-acting control applications. The human hair sensing element responds over an operating range of 0 to 90% R.H. with a 4% R.H. differential. This humidostat has a 1/4 horsepower rating and field adjustable high and low limit stops.



W43A



W93

ELECTRONIC HUMIDISTAT, W93

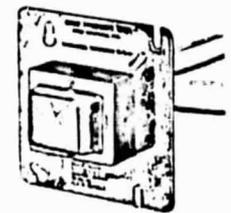
The W93 Humidistat is designed for proportional control of humidifying and dehumidifying equipment. This humidistat positions one or more Penn Series M80F or M80H motor actuator. The human hair sensing element responds over a range of 10 to 70% R.H.

DAMPER AND VALVE LINKAGE, Y20

Series Y20 linkages are supplied for connecting Penn electric and electronic motor actuators with dampers or valve bodies. Y20 damper linkage sets can be supplied which contain all the components for proper linking. Y20A valve linkages are furnished for the various valve bodies. When ordering the type valve body and size must be indicated.



Y20



Y65

TRANSFORMERS, Y65

The Y65 transformer is an improved 40 VA, 24V transformer, which replaces the Y61 40 VA series. The Y65AJ-1 is a plate mount, 120/24 volt transformer. Y65AS-1 is foot mounted, 120/24 volts; Y65BJ-1 is plate mount, 240/24 volts. Foot mounted models have 1/2 - 14 male N.P.S. conduit hub.

MANUAL POTENTIOMETER, Y45

The Y45 Manual Potentiometer is used for manual control of motor actuators. Either one or two potentiometers with either 135 or 350 ohm resistance values are supplied. The mounting plate is equipped with close-open markings.



Y45 Series

REMOTE SET POINT CONTROL, Y45BA

The Y45 Remote Set Point Control is designed to vary a temperature set point of the final controlled device from a remote location. This Remote Set Point Control is designed for use with electronic sensing elements and has operating ranges of 40 to 90F and 60 to 120F available.

40VA TRANSFORMER, Y61AJ, Y61AS, Y61BJ, Y61BS

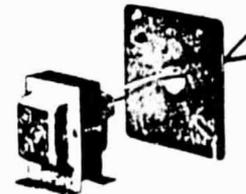
The Y61 Transformer is available with foot mountings and conduit hubs or a mounting plate for a 4" x 4" box. Models can be equipped for 60 Hz primary operation of either 120 or 240 volts to provide 24 volt secondary power. For foot mounted models electrical connections include 8" pigtail leads on the primary side and 30" leads on the secondary side. Plate mounted models have 8" pigtail leads for all connections. This transformer is NEC Class 2 energy limiting.



Foot Mounted

40VA MULTI-MOUNT TRANSFORMER, Y61AR, Y61BR, Y61SR

The Y61 Multi-Mount Transformer is supplied with a combination plate, foot and hub mounting. Models are available with either 120, 208/240 or 240 volt 60 Hz primaries to provide 24 volt secondary power. Electrical connections are completed with 11" pigtail leads on the primary and three terminal screw connectors on the secondary.



Multi-Mounted

50VA TRANSFORMER, Y63

The Y63 Transformer is available with foot mountings and conduit hubs or with a mounting plate for a 4" x 4" box. Models are equipped to operate with a primary voltage of either 120, 208/240, or 480 volts, 50/60 Hz to provide 25 volt secondary power. Electrical connections for foot mounted models include 8" pigtail leads on the primary and 30" leads on the secondary. Electrical connections for plate mounted models are all 8" pigtail leads. This transformer is NEC Class 2 internally fuse protected.

100VA TRANSFORMER, Y64

The Y64 Transformer is available with foot mountings and conduit hubs or with a mounting plate for a 4" x 4" box. Models are equipped to operate from a primary voltage source of 120 or 208/240 volts, 50/60 Hz to provide 25 volt secondary power. Electrical connections for foot mounted units include 8" pigtail leads on the primary and 30" leads on the secondary. All connections on plate mounted units are 8" leads.

75VA TRANSFORMER, Y66

The Y66 Transformer is available with foot mountings and conduit hubs. Primary voltage specifications are 208/240 volts, 50/60 Hz in order to provide 25 volt secondary power. Electrical connections include 8" pigtail leads on both the primary and secondary sides or 8" on the primary side only with terminal screw connectors on the secondary. This transformer is NEC non-energy limiting Class 2 and it contains a manual reset circuit breaker.

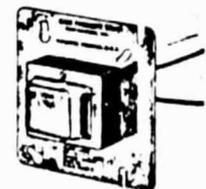


Plate Mounted

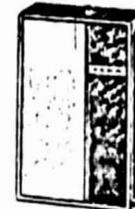


PROPORTIONAL WALL THERMOSTAT, T80 SERIES

The T80 Proportional Wall Thermostat positions motor actuators in response to temperature changes sensed by the liquid charged element. Either one or two potentiometers can operate in sequence or in unison. A 135 ohm resistance is standard, but a 330 ohm resistance is available, for the potentiometers. The operating range of this thermostat is 58 to 83F.



T80 Series



T91 Series

SOLID-STATE ROOM TEMPERATURE SENSING ELEMENT, T91AAA, T91ABA

The T91 Temperature Sensing Element senses room temperature for a signal center. The signal center then positions motor actuators in response to temperature changes. Remote or integral set point adjustment is available. The operating range of this element is 40 to 90F.

SOLID-STATE ROOM TEMPERATURE SENSING ELEMENT WITH SWITCHES, T92A, T92B, T92C

The T92 Temperature Sensing Element is designed for room temperature sensing applications. The thermostat has two separable units, one is a sensing unit and the other is the wiring and switching sub-base with fan and system switches. This sensing element has an integral set point adjustment for an operating range of 55 to 85F.



T92 Series



T93

ELECTRONIC ROOM THERMOSTAT, T93

The T93 Electronic Room Thermostat is designed to position one or more motor actuators in response to room temperature changes. Both direct and reverse acting models are available with an integral set point. This thermostat has an operating range of 40 to 90F.

TEMPERATURE ACTUATED VALVES, V47

Series V47 valves are modulating type valves actuated by a temperature element. They regulate flow of water or other liquids not harmful to the valve. Three temperature ranges are supplied as standard, 75/135F, 115 to 180F and 160 to 230F.



V47

Standard valves are supplied with 6' armored capillary and a 1-1/2" NPT closed tank fitting (style 4). A bypass plug kit is furnished for use where an internal bypass hole is needed.

FAN COIL VALVE, V70

The V70 Zone Valve is available for normally closed two-position motor actuated operation. When normally open operation is desired, the valve is reversed in the field. The valve may be changed from N.O. to N.C. or N.C. to N.O. by rotating the body 180°. This zone valve can be equipped with either 1/2" I.D. inverted flare or 3/4" I.D. sweat connections. This valve requires 24 volts, 50/60 Hz for operation.



V70

ZONE VALVE, V70

The V70 Zone Valve is available for normally closed two-position motor actuated operation. When normally open operation is desired, the valve is reversed in the field. This zone valve can be equipped with either 1/2" I.D. inverted flare or 3/4" I.D. sweat connections. This valve requires 24 volts, 50/60 Hz for operation.



V90AA



V90BA

TWO-WAY, SINGLE-SEAT GLOBE VALVE, V90AA

The V90 Globe Valve regulates the flow of steam or water through air conditioning, heating or cooling equipment. The valve has equal percentage flow characteristics. Connections are as follows: 1/2" through 1-1/2" - one union end, one screwed end; 1-1/2" through 2" - two screwed ends; 2-1/2" through 4" - flanged connections.

TWO-WAY, DOUBLE SEAT GLOBE VALVE, V90BA

The V90 two-way, double seat valve regulates the flow of steam, water or air in either a two position or proportional manner. For applications where the operating differential pressure exceeds the rating on V90 single seat valve and absolute tight shutoff is not required. Connections are as follows: 1-1/2" and 2" - screwed ends; 2-1/2" through 8" - flanged ends. This valve has linear flow characteristics.



V90CA



V90DB

THREE-WAY BYPASS VALVE, V90CA

The V90 Bypass Valve is designed for regulating the flow of hot or cold water in two-position or proportional service applications. Connections are as follows: 1/2" through 2" - screwed connection on bottom port, union connections on side ports; 2-1/2" through 6" - flanged connections on all ports. This valve has quick opening flow characteristics.

THREE-WAY MIXING VALVE, V90DB

The V90 Mixing Valve is designed for proportional control of hot or cold water. Connections are as follows: 1/2" through 2" - screwed ends; 2-1/2" through 4" - flanged connections. The 1/2" through 2" valves have linear flow characteristics. The 2-1/2" through 4" valves have equal percentage flow characteristics.



W42AA

HUMIDOSTAT, W42AA

The W42 Humidostat provides 3-wire, SPDT snap-acting control in response to humidity changes. A human hair sensing element is used in both the low/line voltage humidostat. This humidostat has an operating range of 10 to 90% R.H. with a 4% R.H. differential.

McDONNELL No. FS4-3 AND No. FS4-3-20 FLOW SWITCHES

**Make or Break an Electrical Circuit
When Flow in a Pipe Starts or Stops**

These McDonnell Flow Switches offer an economical and positive way to start or stop almost anything electrically operated. They serve as automatic controls or safety devices in air conditioning, heating and water systems, and in processing work. Design and operation of the two switches are the same, except No. FS4-3-20 includes a 20-second time delay to eliminate false starts from temporary surges or fluctuations. Here are a few specific applications of McDonnell Flow Switches:



Actuate a signal light — signal an attendant to make the right moves in operating valves, pumps and the like — signal him when flow stops in a water cooled compressor, water cooled bearings and so on.



Sound an alarm — when flow stops in a process system or in any water cooled device.



Start or stop motors — start pumps in sequence in multiple stage flow systems; start standby pumps; stop automatically controlled units if cooling water system fails; stop compressors in cooling system when flow stops.



Start or stop automatic burners — start a booster heater when water draw occurs; stop burner if flow is improperly retarded; make sure of circulation in a boiler before burner is permitted to start.



Actuate metering device — open valve in chemical feeder line; start mixing in secondary line whenever flow starts in primary line.

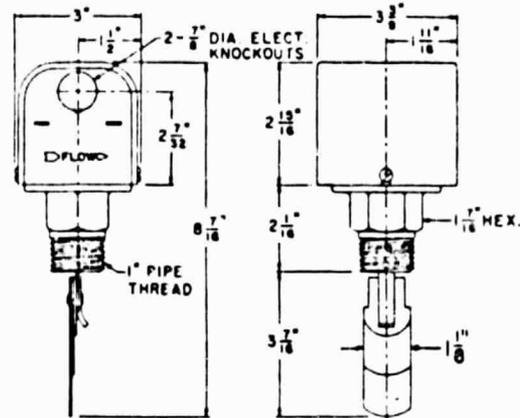
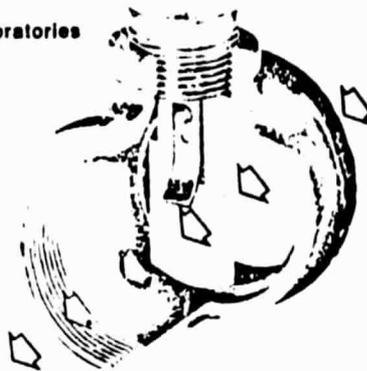
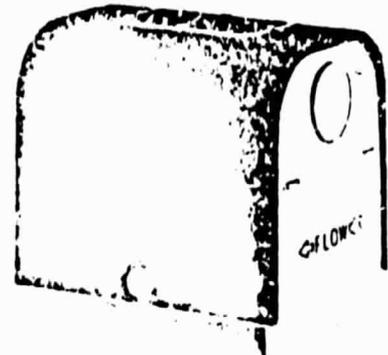
• Underwriters' Laboratories Listed

• Maximum working pressure, 150 psi

• Maximum temperature, 300°F.

• Packed shipping weight, 2½ lbs.

No. FS4-3 Flow Switch shown mounted in a 2-inch tee



McDonnell Quality Throughout

Easy Wiring — Cover completely removable. No cramped quarters, no danger of kinked wires interfering with operation.

Two Knockouts — Connect conduit at either side of housing.

Switch — single pole, double throw. Compact in size. Powerful snap action assures dependable operation.

Knife-Edged Bearings of hardened stainless steel minimize friction.

Adjusting Screw — Provides simple way to adjust sensitivity to flow.

Packless — Heavy duty monel siphon seals switch assembly from line.

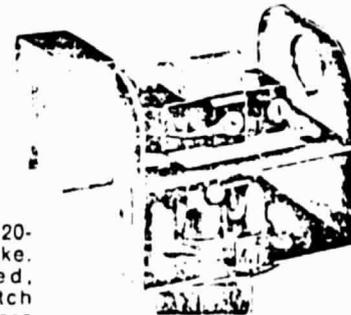
3-in-one Paddle — Segmented monel paddle quickly adaptable for 1" to 3" pipe. Extended monel paddle illustrated also included for larger pipe sizes.



No. FS4-3

No. FS4-3-20 Includes Solid State Time Delay

Provides factory-fixed 20-second delay on make. 100% encapsulated, mounts right on switch housing. For use where temporary surges in flow, water hammer or minor fluctuation in system pressure might cause false starts or switch fluttering. Input—115 volt A.C.; Output—1 ampere RMS steady state maximum, 20 milliamperes minimum.



McDONNELL & MILLER

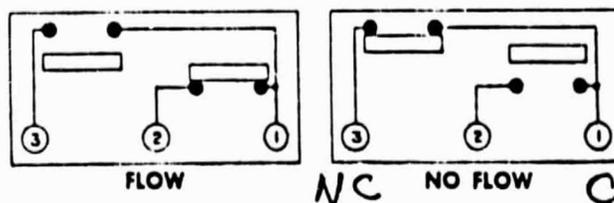
3500 N. Spaulding Avenue, Chicago, Illinois 60618
Tel: (312) 267-1600

MCDONNELL No. FS4-3 AND No. FS4-3-20 FLOW SWITCHES

The table below shows the flow rates required to actuate the No. FS4-3 Flow Switch.

"Flow" means that the switch will close circuit 1-2, and open circuit 1-3, when the flow rate is increased to the GPM shown. (See schematic switch action "Flow" at right.)

"No Flow" means that the switch will open circuit 1-2, and close circuit 1-3, when the flow rate is decreased to the GPM shown. (See schematic switch action "No Flow" at right.)



FLOW RATES REQUIRED TO ACTUATE FLOW SWITCH

Flow rates in gallons per minute (GPM) shown in black. Velocity in feet per second (FPS) shown in color.

*Equipped with extended paddle trimmed to pipe size.

Pipe Size in Which Flow Switch Installed			1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"	5"	6"
Factory or Minimum Adjustment	Flow	GPM	6.00	9.80	12.7	18.8	24.3	30.0	39.7	58.7	79.2
		FPS	2.24	2.11	2.00	1.80	1.63	1.30	1.00	0.94	0.85
	No Flow	GPM	3.60	5.60	7.00	9.40	11.6	12.0	19.8	29.3	39.6
		FPS	1.34	1.21	1.10	0.90	0.78	0.52	0.50	0.47	0.44
Maximum Adjustment	Flow	GPM	10.2	16.8	23.0	32.8	42.4	52.1	73.5	115.0	166.0
		FPS	3.91	3.62	3.62	3.14	2.74	2.26	1.86	1.85	1.84
	No Flow	GPM	9.20	15.0	19.5	24.0	37.5	46.1	64.2	92.0	123.0
		FPS	3.43	3.23	3.07	2.29	2.51	2.00	1.62	1.48	1.37

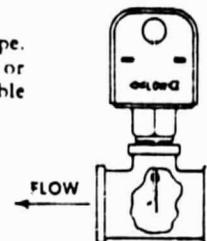
Flow rates are averages which may vary $\pm 10\%$ from tabulated values.

Electrical Ratings (Underwriters' Listed)

	Ampere Rating	
Motor Duty	115 V.A.C.	230 V.A.C.
Full Load	7.4 Amps	3.7 Amps
Locked Rotor	44.4 Amps	22.2 Amps
	115 V.D.C.	230 V.D.C.
	0.3 Amps	0.15 Amps
Pilot Duty: A.C. 125 V.A., 115-230 V.		

Installation

Flow switch should be mounted in a horizontal run of pipe. Avoid locations immediately adjacent to elbows, orifices or valves. Flow switch should be mounted as close as possible to pipe. Use a tee (or reducing tee) with a 1" branch, or, if welding fitting is used select a welding neck of minimum length. In position paddle should be at right angle to flow, with arrow pointing in same direction as flow. If temperature of pipeline exceeds 220° F. use wire suitable for 75° C. (167° F.).



Other McDonnell Flow Switches—All Underwriters' Listed

- Sensitivity to Flow Adjustable
- Single Pole Double-Throw Switches



No. FS1—Actuated by low flow, with large flow-through capacity. Particularly suited for home water purification systems, as well as cooling systems for electronic tubes, bearings, compressors, etc. Has 1/2 inch inlet and outlet tapings. For pressures to 100 psi, temperatures to 225° F.



FS6 Series Similar to No. FS1, but for hook-up to 3/4 inch and 1 inch pipe. Nos. FS6-3/4 IN. and FS6-1 IN. respectively. Applications include small and medium size water treatment systems, booster pumps to increase low city water pressure, etc.



FS4-3T Series—Similar to No. FS4-3 except furnished with a specially designed tee, threaded for 3/4 inch or 1 inch pipe. These are particularly sensitive switches, specially designed for use where flow rates are insufficient to actuate other types of flow switches.

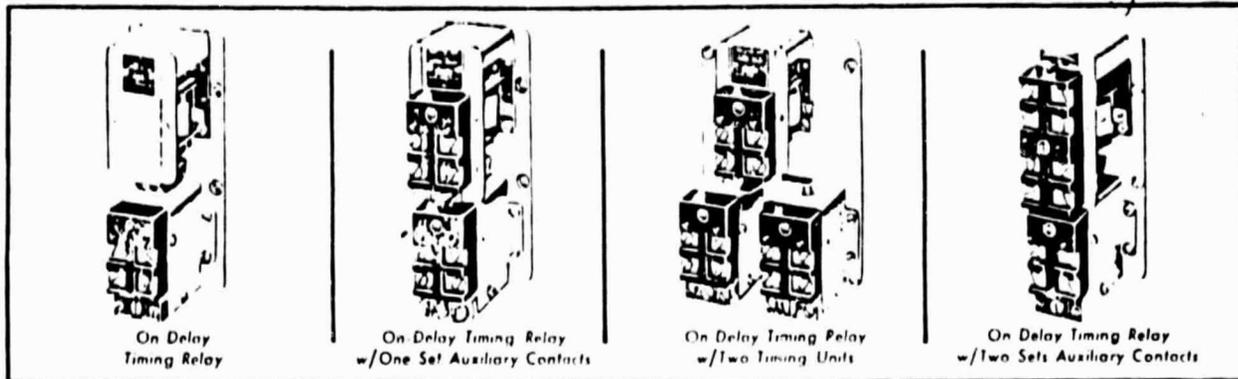


FS7 Series For heavier duty service or for use with process liquids. Standard, vapor-proof or explosion-proof construction, with wetted parts brass or stainless steel. Installed in a tee or welded half-coupling and fits pipe 1 1/4 inch or larger. For pressures to 1000 psi, temperatures to 300° F.

Bulletin No. L-137H
Printed in U.S.A.

MCDONNELL & MILLER **ITT**
3500 N. Spaulding Avenue, Chicago, Illinois 60618
Tel: (312) 267-1600 Telex: 25-3376

AC PNEUMATIC TIMING RELAYS *on heating pumps*



DESCRIPTION — The Bulletin 849 AC timing relay is a pneumatic type relay. A synthetic rubber bellows is actuated by the stroke of an AC solenoid. Timing relays can provide the time delay in either of two basic arrangements. The first arrangement, **On-Delay** provides the time delay **after the coil is energized**. The second arrangement, **Off-Delay** provides the time delay **after the coil is de-energized**. Basic **On-Delay** timing relays can easily be converted to **Off-Delay** operation and vice versa. Refer to Page 4 for converting details.

INSTALLATION — Bulletin 849 timing relays must be mounted in the vertical position, with the solenoid mechanism at the top, timing unit(s) at the bottom. (See illustrations above).

ENGINEERING DATA —

Contact Ratings — The timer contacts and the auxiliary contacts have a control circuit rating as follows:

AC					DC	
Maximum Contact Rating Per Pole NEMA Rating Designation A600					Voltage Range	Ampere Rating
Max AC Voltage 60 or 50 Hz	Amperes		Continuous Carrying Current	Voltamperes		
	Make	Break		Make	Break	
120	60	6	10	7200	720	115-125 0.4
240	30	3	10	7200	720	
480	15	1.5	10	7200	720	230-250 0.2
600	12	1.2	10	7200	720	

Note — Circuits wired to a contact unit must be of the same polarity.

Timing Range — 1/20 second min. to 180 seconds max.

Repeat Accuracy — Approximately ± 10% of time setting. A minimum reset time of 75 milliseconds must be provided to attain the repetitive accuracy.

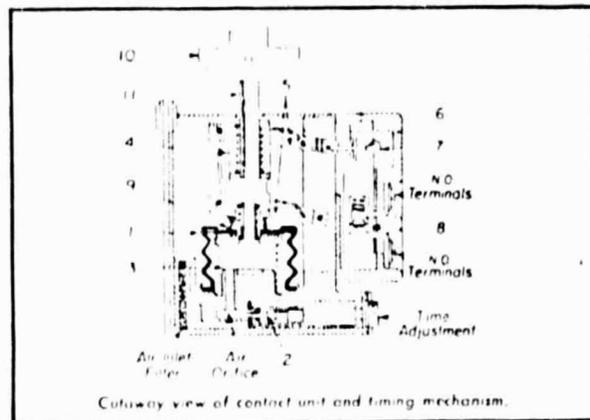
Temperature Range — 0° F. to + 104° F. (Standard)
20° F. to + 150° F. (Wide Range — Silicone rubber bellows.) **Note** — Minimum temperature is based on the absence of freezing moisture or water.

OPERATION — When the solenoid plunger (10) is retracted from the push rod (11) it allows the spring (3) located inside the synthetic rubber bellows (1) to push the timing mechanism plunger (4) upward. As the plunger rises, it causes the over-center toggle mechanism (5) to

move the snap action toggle blade (6) upward which in turn picks up the push plate (7) which carries the movable contacts (8).

The speed with which the bellows can expand is determined by the setting of the needle valve (2). If this needle valve is nearly closed, an appreciable length of time will be required for air to pass it and permit the bellows to expand. The setting of the needle valve determines the time interval which must elapse between operation of the solenoid actuator and expanding of the bellows to operate the contact unit.

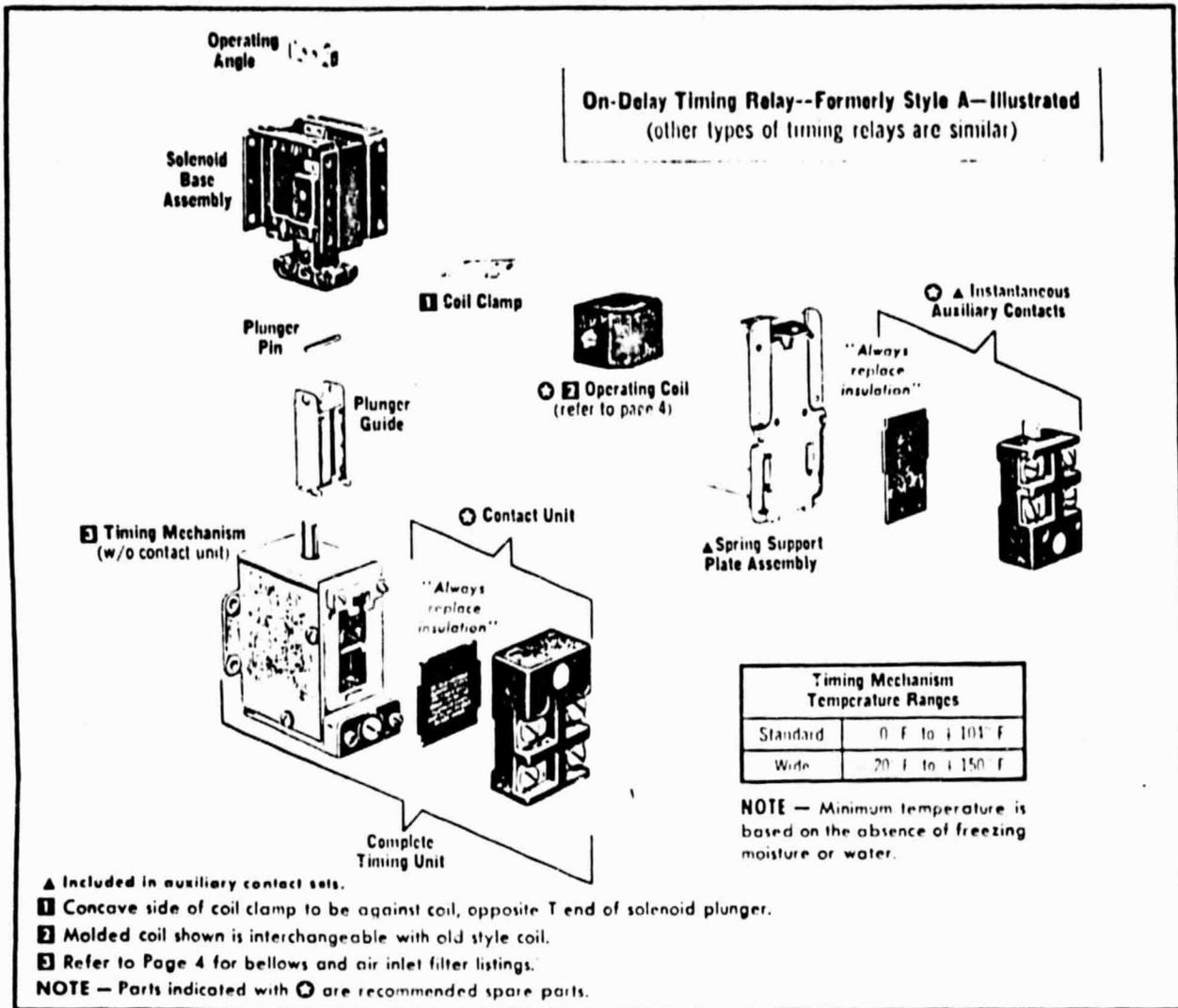
When the push rod (11) is again depressed by the solenoid plunger (10), it forces the timing mechanism plunger (4) to the lower position, exhausting the air through the release valve (9) and resetting the timer almost instantaneously.



REPAIRS — Timing relays can be disassembled as depicted in the illustrations on page 2 of this instruction sheet. Additional consideration should be given to the following technique.

REPLACING CONTACT UNIT — The toggle blade (6) on the timing mechanism **must** be in its down position to fit into the push plate (7) of the contact unit. Refer to cutaway illustration above. Hold down the push rod (11) and flip the toggle blade (6) down. Then place the contact unit in position being sure that the "loose" black phenolic insulation, that isolates the contact cavity is in place. Secure with two mounting screws. After assembly, check for normal contact operation.

ADDING AUXILIARY CONTACTS — Remove original spring support plate assembly from the solenoid mechanism and discard. The return springs on the new spring support plate assembly supplied with the auxiliary contact kit must be inserted into the plunger pin. Be sure toggle is placed over (under when arranged for off delay operation) the operating angle. Then secure new spring support plate to the solenoid frame. Referenced parts illustrated below.



TIMING RELAY IDENTIFICATION — The table below is designed to assist in the accurate identification of a timing relay. Knowledge of the timing relay's catalog number coupled with data from the table will determine the complete description of the relay. Once the description of the timing relay is determined an accurate selection of replacement parts can be made from the table on page 3. EXAMPLE: Catalog number 849-ZOA325; the basic catalog number is 849-ZOA; the suffix identification is 32 (see table); the modification code number is 5 (see table) and a complete description of the relay is "an on-delay timer with a maintained contact timing unit, formerly known as a Style AM timing relay."

Basic Catalog Number Suffix Identification	Description of Timing Relay	Former Style Letter
32	On-Delay Time Delay After Coil is Energized	A
33	Off-Delay Time Delay After Coil is De-energized	B
122	On-Delay with Two Timing Units	H
123	Off-Delay with Two Timing Units	L
124	On and Off Delay Double Unit	AB

Modification Code Number	Description of Modification	Former Modification Letter
1	One set of Instantaneous Auxiliary Contacts (1NO NC)	X
2	Dial Indicator on Timing Mechanism	D
5	Maintained Contact Timing Unit	M
7	Two sets of Instantaneous Auxiliary Contacts (2NO NC)	XX
9	Silicone Rubber Bellows for Wide Temp Range (-20° F. to +150° F.)	Y
3	Combination of modifications, Nos. 1 and 2 (DX)	
4	Combination of modifications, Nos. 2 and 7 (DXX)	
6	Combination of modifications, Nos. 1 and 5 (MX)	

NEWAL PARTS

NOTE — Blank listings in the parts table indicate that timing relays, of the description and modification where the blank exists, have not been manufactured, up to the date on this instruction sheet. To determine the availability of such a timing relay, refer to the nearest Allen Bradley Sales Office or the Sales Office at Milwaukee.

Description of Timing Relay →	On-Delay Formerly Style A	Off-Delay Formerly Style B	On-Delay W/Two Timing Units Formerly Style H	Off-Delay W/Two Timing Units Formerly Style L	On and Off Delay Double Unit Formerly Style AB
Description of Part	Part No.	Part No.	Part No.	Part No.	Part No.
Operating Angle	B 28419	B 28419	B 28419	X 147391	B 28419
<input checked="" type="checkbox"/> Solenoid Base Assembly	X-151136	X-151136	X-278961	X-261399	X-151136
Plunger Pin	B 25169	B 25169	E 12860	B 25169	B-25169
Plunger Guide	E 8675	E 8675	E 8675	E 8675	E-8675
Coil Clamp	E 8676	E 8676	E 8676	E 8676	E-8676
Spring Support Plate Assembly	X 221969	X 221969	X 221970	X 221969	X-221969
Spring Support Plate Assembly (for use on timers modified with one or two sets of instantaneous auxiliary contacts — formerly modifications X and XX)	X 228311	X-228311	X 228310	X 228311	X-228311
<input checked="" type="checkbox"/> One Set of Instantaneous Auxiliary Contacts (formerly modification X)	849-N1A	849-N1A	849-N2A	849-N1A	849-N1A
Two Sets of Instantaneous Auxiliary Contacts (formerly modification XX)	849-N3	849-N3	849-N4	849-N3	849-N3
One Set of Early Break Auxiliary Contacts (special)	Z-17048	Z-17048		Z-17048	Z-17048
<input checked="" type="checkbox"/> Standard Contact Unit	*40262-001-54	*40262-001-54	*40262-001-54	*40262-001-54	*40262-001-54
Maintained Contact Unit Hand Reset (formerly modification M)	*40262-001-55	*40262-001-55			
Timing Mechanism w/o Contact Unit (standard temperature range)	*40262-012-56	*40262-012-56	*40262-012-56	*40262-012-56	*40262-012-56
Timing Mechanism w Dial Indicator w/o Contact Unit (standard temperature range, formerly modification D)	*40262-012-54	*40262-012-54	*40262-012-54	*40262-012-54	*40262-012-54
Timing Mechanism w/o Contact Unit (wide temperature range, formerly modification Y)	*40262-012-52	*40262-012-52			
Timing Mechanism w Dial Indicator w/o Contact Unit (wide temperature range, formerly modification DY)	*40262-012-55				
Complete Timing Unit (with standard contact unit and standard temperature range)	1496-N1	1496-N1	1496-N1	1496-N1	1496-N1
Complete Timing Unit (with maintained contact unit, formerly modification M, and with standard temperature range)	1496-N2	1496-N2			
Complete Timing Unit (with standard contact unit, dial indicator, formerly modification D, and with standard temperature range)	*40262-008-51	*40262-008-51	*40262-008-51	*40262-008-51	*40262-008-51
Complete Timing Unit (with maintained contact unit and dial indicator, formerly modification DM, and with standard temperature range)	*40262-008-52				
Complete Timing Unit (with standard contact unit and wide temperature range, formerly modification Y)	1496-N3	1496-N3			
Complete Timing Unit (with maintained contact unit and wide temperature range, formerly modification MY)	1496-N4				
Complete Timing Unit (with standard contact unit, dial indicator and wide temperature range, formerly modification DY)	*40262-008-54				
<input checked="" type="checkbox"/> Complete Timing Unit (with standard contact unit, special for timing in both directions, formerly modification Z and with standard temperature range)	*40262-007-54				

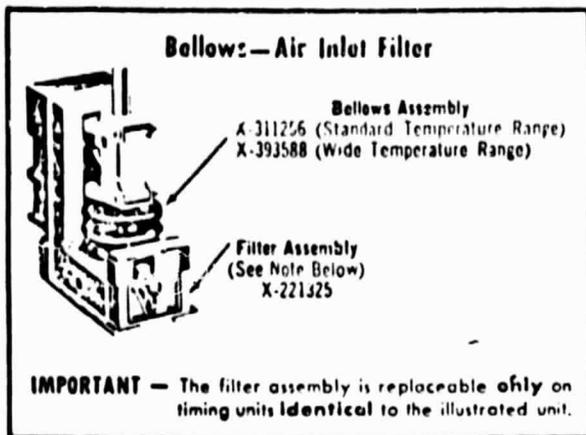
Includes operating angle with screws and washers, coil clamp and plunger guide.

Timing mechanism w/o contact unit not available for this special timing unit.

*Added or changed since previous issue.

NOTE — Parts indicated with are recommended spare parts.

ORDERING INFORMATION—Your order cannot be entered unless the following information is given: Part number, description of part, catalog number and series letter of the timer. This instruction sheet applies also to these timers when used on control apparatus listed under other Bulletin numbers.



Coil Selection		
Description of Timing Relay	Former Style Letter	Select Coil from Table No
On Delay	A	1
Off-Delay	B	1
On Delay with Two Timing Units	M	2
Off Delay with Two Timing Units	L	2
On and Off Delay Double Unit	AB	2

ⓐ OPERATING COILS											
Volts	Hz	Table 1					Table 2				
		Coil Number	Coil Current		Volt-Amperes		Coil Number	Coil Current		Volt-Amperes	
			Inrush	Sealed	Inrush	Sealed		Inrush	Sealed	Inrush	Sealed
120	60	21A244	750	150	90	18	21A86	130	270	155	32
110	50		770	160	85	18		135	305	150	34
110	60	21A237	810	160	89	18	21A01	140	295	155	32
110	25	21A05	525	185	58	20	21A284	720	360	87	40
208	60	21A106	435	085	90	18	21A113	760	155	160	32
240	60	21A75	375	075	90	18	21A83	650	135	155	32
220	50		385	090	85	18		670	155	145	34
220	60	21A238	405	080	89	18	21A06	705	150	155	33
270	25	21A10	260	090	57	20	21A285	335	130	87	40
480	60	21A241	190	075	91	17	21A286	325	085	155	31
440	50		190	080	84	18		335	075	145	33
440	60	21A240	200	080	88	18	21A11	350	075	155	33
440	25	21A15	130	045	57	20	21A286	155	090	86	40
600	60	21A250	150	030	90	18	21A81	255	055	155	33
550	50		150	030	82	16		265	060	145	33
550	60	21A271	160	030	88	16	21A16	290	080	160	33
550	25	21A20	115	035	63	19	21A287	155	070	85	38

1 Values shown are for molded coils only.

2 Coils are rated 25% intermittent duty, based on one minute operation out of every four minutes.

NOTE — Parts indicated with ⓐ are recommended spare parts.

CONVERTING TIMING OPERATION — First, remove the solenoid mechanism from the mounting plate. Rotate the solenoid mechanism 180°, and put it back on the mounting plate, being careful to use the proper screw holes. There are four mounting holes for the solenoid mechanism. The upper-left and lower-right holes are used for on-delay; the upper-right and lower-left holes are used for off-delay. The on-delay mounting holes are so labeled on the mounting plate.

Notice that when the relay is changed from on-delay

to off-delay, the normally open and normally closed time-delay contacts mounted on the timing mechanism are changed. With the relay set up for on-delay, the normal position of the push rod is down, making terminals 1 and 2 the normally open contact terminals and terminals 3 and 4 the normally closed contact terminals. When set up for off-delay, the normal position of the push rod is up, making 1 and 2 normally closed, and 3 and 4 normally open. These numbers are molded on the face of the contact unit.

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ALLEN-BRADLEY
Milwaukee, Wisconsin 53204

Bollows—Air Inlet Filter



Bollows Assembly
 X-311256 (Standard Temperature Range)
 X-393588 (Wide Temperature Range)

Filter Assembly
 (See Note Below)
 X-221325

IMPORTANT — The filter assembly is replaceable **only** on timing units **identical** to the illustrated unit.

Coil Selection

Description of Timing Relay	Former Style Letter	Select Coil from Table No.
On Delay	A	1
Off Delay	B	1
On-Delay with Two Timing Units	H	2
Off-Delay with Two Timing Units	L	2
On and Off Delay Double Unit	AB	2

⊕ OPERATING COILS

Volts	Hz	Table 1				Table 2					
		Coil Number	Coil Current		Volt-Amperes		Coil Number	Coil Current		Volt-Amperes	
			Inrush	Sealed	Inrush	Sealed		Inrush	Sealed	Inrush	Sealed
120	60	21A244	750	150	90	18	21A8C	1.30	270	155	32
110	50		770	160	85	18		1.35	305	150	34
110	60	21A237	810	160	89	18	21A01	1.40	295	155	32
110	25	21A05	525	185	58	20	⊕ 21A284	790	360	87	40
208	60	21A106	435	085	90	18	21A113	760	155	160	32
240	60	21A75	375	075	90	18	21A83	650	135	155	32
220	50		385	080	85	18		670	155	145	34
220	60	21A238	405	080	89	18	21A06	705	150	155	33
270	25	21A10	260	090	57	20	⊕ 21A285	395	140	87	40
480	40	21A241	190	035	91	17	21A288	325	065	155	31
410	50		190	040	84	18		335	075	145	33
440	60	21A240	200	040	88	18	21A11	350	075	155	33
440	25	21A15	130	045	57	20	⊕ 21A286	195	090	86	40
600	60	21A250	150	030	90	18	21A81	255	055	155	33
550	50		150	030	82	16		265	060	145	33
550	60	21A271	160	030	88	16	290	060	160	33	
550	25	21A20	115	035	63	19	⊕ 21A287	155	070	85	38

⊠ Values shown are for molded coils only.

⊡ Coils are rated 25% intermittent duty, based on one minute operation out of every four minutes.

NOTE — Parts indicated with ⊕ are recommended spare parts.

CONVERTING TIMING OPERATION — First, remove the solenoid mechanism from the mounting plate. Rotate the solenoid mechanism 180°, and put it back on the mounting plate, being careful to use the proper screw holes. There are four mounting holes for the solenoid mechanism. The upper-left and lower-right holes are used for on-delay; the upper-right and lower-left holes are used for off-delay. The on-delay mounting holes are so labeled on the mounting plate.

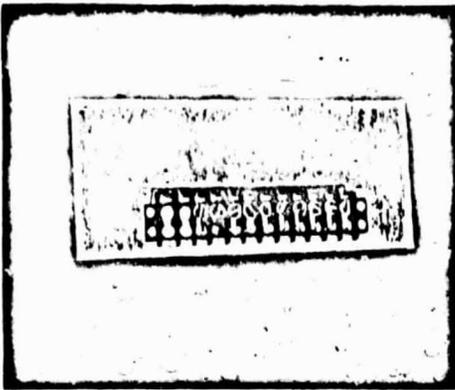
Notice that when the relay is changed from on-delay

to off-delay, the normally open and normally closed time-delay contacts mounted on the timing mechanism are changed. With the relay set up for on-delay, the normal position of the push rod is down, making terminals 1 and 2 the normally open contact terminals and terminals 3 and 4 the normally closed contact terminals. When set up for off-delay, the normal position of the push rod is up, making 1 and 2 normally closed, and 3 and 4 normally open. These numbers are molded on the face of the contact unit.



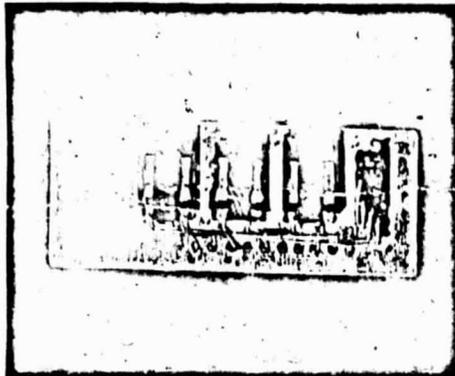
ALLEN-BRADLEY

Milwaukee, Wisconsin 53204



AUTOMATIC START CONTROLS

KLAS 10 1010



Component selection is engineered to provide reliability and accuracy of operation consistent with the application. Time delay relay is of the thermal type to give consistent service. All models feature enclosed contacts for longer life and greater reliability.

Mode of operation is selected by a three or four position switch as specified. In "MANUAL" position the control is energized immediately; in "AUTOMATIC", operation commences only when a remote set of contacts close, such as those of an automatic transfer switch; center position is "OFF". The four position rotary switch gives an additional "TEST" position in which the automatic control is out of the circuit and the engine may be started manually.

Current during cranking period flows thru relay 3, normally closed contact; to energize relay 1. Relay 1 breaks magneto ground, if used, energizes ignition coil or throttle solenoid of diesel units and allows current to start solenoid and time relay 4 thru relay 2.

If engine starts, relay 2 is energized from terminal 10 by voltage from battery charging generator or from battery thru (N.O.) speed switch and start solenoid is deenergized.



3 POSITION SWITCH

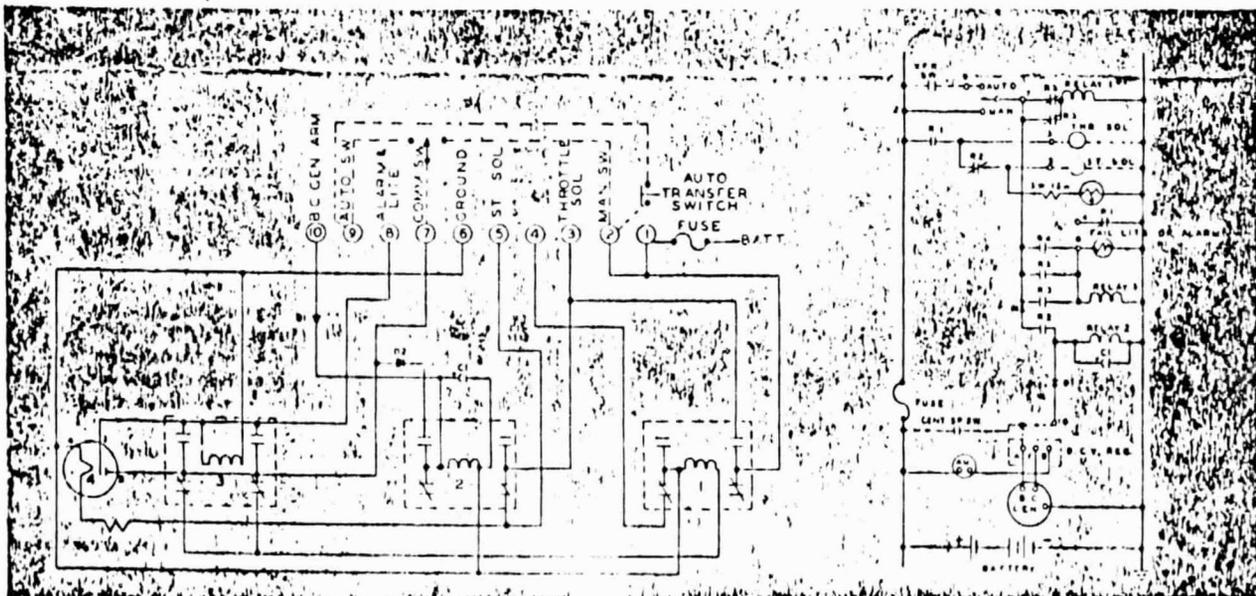


4 POSITION ROTARY SWITCH

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FAILURE INDICATING LIGHT





series M80J

PROPORTIONAL MOTOR ACTUATORS

With Solid State Drive and Travel Limits
Potentiometer and 0 to -2 V. D.C. Controller Input

APPLICATION

These proportional motor actuators position air dampers, control valves, burner fuel valves and similar equipment in ventilating, heating, air conditioning and industrial applications.

Actuators with auxiliary switches may be used in most industrial safety circuits.

Series M80J motor actuators operate on signals from potentiometer controllers, 'MIZER™, Cybertronic®, other V. D.C. controllers or ma D.C. controllers when used with a Penn Series R82 interface module. See Controller Selection Diagram, Figure 5.

FEATURES

- Solid state motor drive — state-of-the-art integrated circuit within motor actuator case. No balance relay or mechanical travel limit switches. No contacts to bounce, arc or weld.
- Travel adjustment — screw driver adjustment located in top wiring compartment (optional field adjustable models). Makes for easy final adjustment of valve seating or damper linkage travel.
- Improved control of dampers and valves — long life, direct drive feedback potentiometer mounted concentric with the output shaft. Increased number of balance positions and lower hysteresis for improved resolution.
- Accepts inputs from 135 ohm to 1000 ohm potentiometer controllers or V. D.C. inputs from Penn electronic controllers with no readjustment required.
- All Series M80J actuators accept in-head controller modules. See Bulletin for Series A82 1000 ohm temperature controller, Series R82 D.C. to D.C. interface and Series R93 electronic temperature controller.
- Up to three Series M80J motor actuators may be operated in parallel from one potentiometer controller. No retransmitting "slave" potentiometers required.

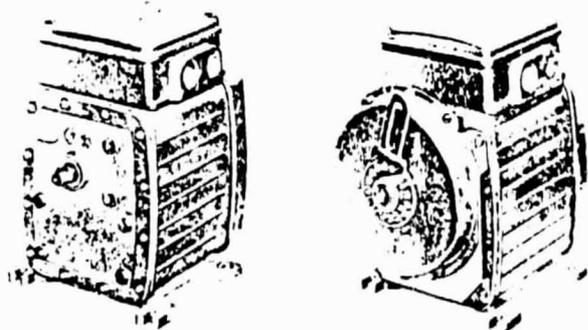


Fig. 2 — Load end view of non-spring return motor actuator (left) and spring return damper motor actuator (right).

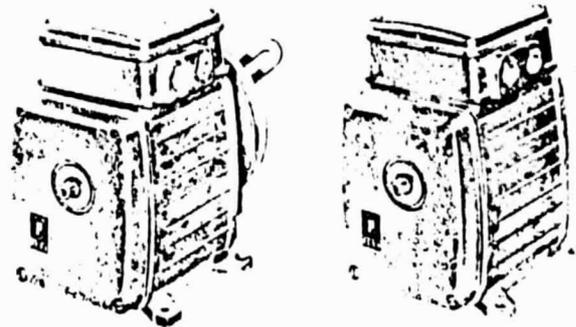


Fig. 1 — Back view of motor actuator. Spring return damper (left) and non-spring return (right).

ed. No separate master and/or slave model required. Field wiring between motors is reduced. No lag between master and slave position.

- All motor actuators have weather-resistant enclosure as standard.
- Models available with internal, adjustable differential auxiliary switches.

GENERAL DESCRIPTION

These actuators have solid state drive and limits that prevent erratic control performance often caused by excessive vibrations. A standard potentiometer type pressure, temperature or humidity controller may be used to operate the actuator. The actuator will accurately position its output shaft in direct proportion to the control signal.

The capacitor-run motor rotates an output shaft through a reduction of precision gears. There are three basic Series M80J motor actuators; standard proportional, proportional spring return damper and proportional spring return valve.

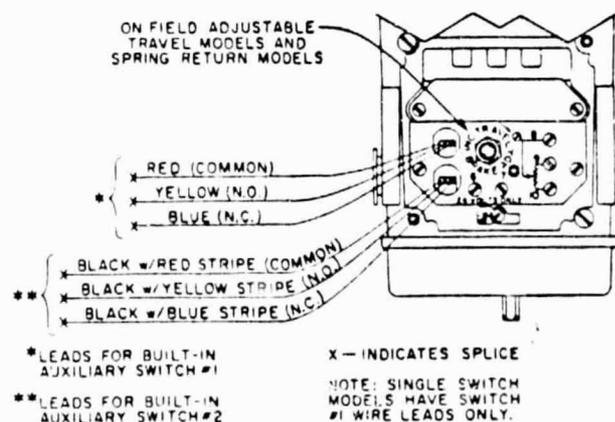


Fig. 3 — View of wiring compartment showing terminals and both travel and resistor brake adjustment.

PENN SERIES M80J PROPORTIONAL MOTOR ACTUATORS

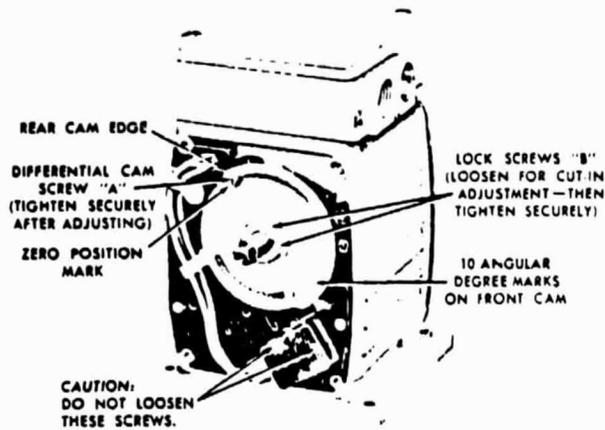


Fig. 4 — Interior view of motor actuator with auxiliary switch.

Series M80J motor actuators are available with fixed or field adjustable travel for proportional control of dampers and valves. (90 to 240° non-spring return, 90 to 180° spring return.) See Figure 3.

The spring return damper model has a heavy gauge built-in spring mechanism to return the motor shaft to its full CCW limit on power failure or interruption. An electrical resistor brake circuit prevents the return spring from driving the motor actuator towards its normal position unless the power is interrupted. The external spring housing and optional internal auxiliary switch are installed on opposite sides of the motor actuator. At no time is it necessary to disconnect the damper or remove

the spring housing for access to the auxiliary switch.

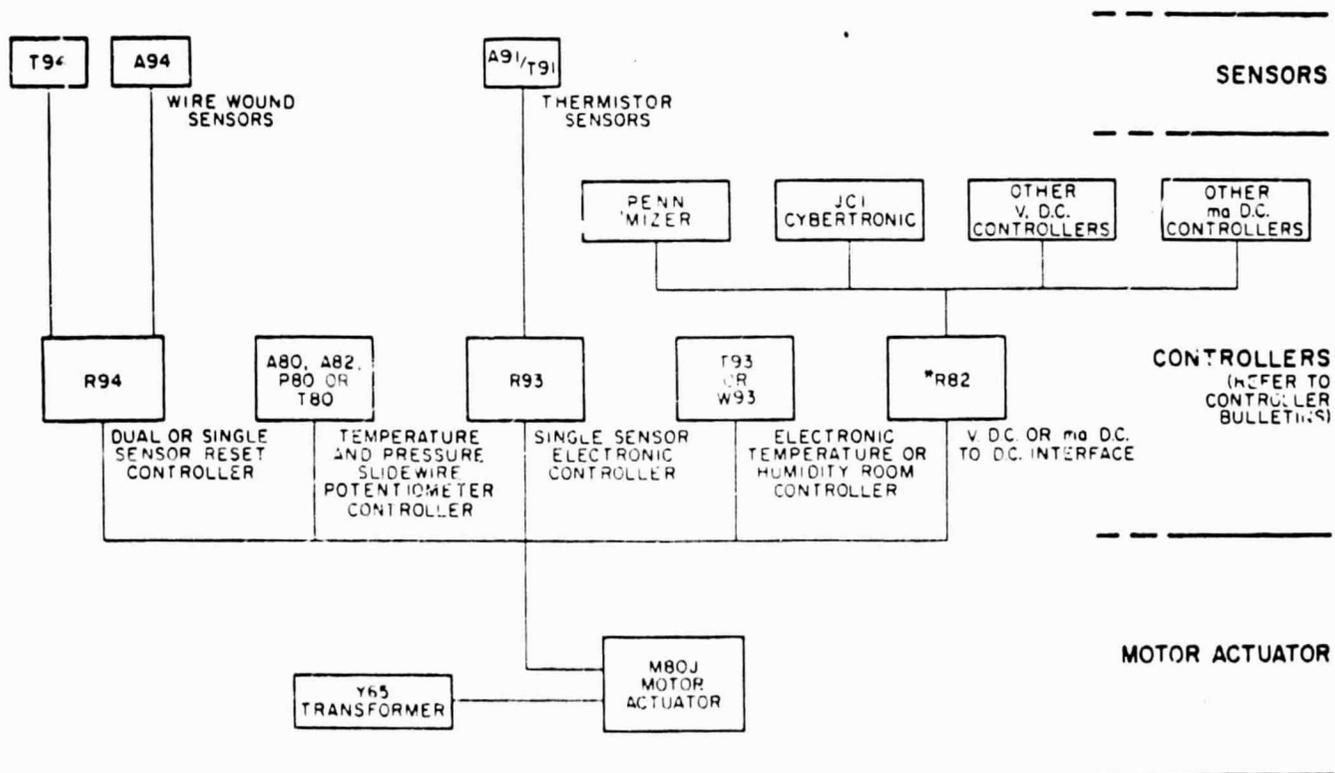
An adjustable crank arm on the output shaft for easy connection is standard on the spring return damper motor. It is slotted to allow an adjustable radius from 1-11/16" to 2 7/8". The crank arm may be secured to the motor actuator shaft in position increments of 22 1/2 angular degrees.

The proportional spring return valve model has a heavy gauge built-in spring mechanism to return the valve to its normal position on power failure or interruption. It has the same resistor brake circuit as the spring return damper motor actuator. Adjustment of this resistor brake is readily accessible within the wiring compartment as shown in Figure 3.

The spring return valve motor actuator is available for normally open (N.O.) and normally closed (N.C.) valve operation. Each type has field adjustable travel from 3/8" to 1.3" valve stem movement.

The motor actuator can be mounted in any position except upside down. However, mounting with the output shaft horizontal is recommended, and upright mounting is preferred. Spring return actuators must be mounted within 30° of upright.

The motor should travel through its full stroke (determined by its limit switches) while performing its function, even through the motor's full range may not be employed. Motor may be *damaged* if it is not free to complete its full stroke. The motor should be stopped at the end of its stroke by the limit switch, *not* stalled by the damper or valve.



*CONTROLLERS SUPPLYING INPUT TO SERIES R82 MUST NOT BE POWERED BY THE SAME TRANSFORMER SUPPLYING THE SERIES M80J POWER.

PENN SERIES M80J PROPORTIONAL MOTOR ACTUATORS

Control Signal Input: 3 lead potentiometer; 135 ohms up to 1000 ohms, 1/2 watt minimum or 0 to -2 V. D.C. ramp as provided by compatible electronic controllers.

Input Impedance: 10 kilohms (across terminals 8 and 10).

Power Requirement: 20 VA., 24 Volts A.C., 50/60 Hz. Spring return damper models with internal heater require 50 VA.

Shaft Specifications: Double ended, 3/8" square.

AMBIENT TEMPERATURE

Type Number	Minimum		Maximum	
	*F	*C	*F	*C
M80JAA, M80JAB, M80JAC, M80JFA*	-40	-40	+125	+52
M80JCA, M80JCB, M80JDA, M80JEA	+10	-12	+125	+52

* Includes internal heater.

OPTIONAL CONSTRUCTIONS

Travel Limit Settings: Standard factory setting is 90 angular degrees. Adjustable (90 to 240° non-spring return, 90 to 180° spring return) travel is standard option.

MISCELLANEOUS SPECIFICATIONS

Enclosure: Die cast natural aluminum provides a light and rugged case.

Built-In Auxiliary Switch: SPDT, adjustable range from 0 to 160°, adjustable differential from 5 to 90°.

Built-In Auxiliary Switch Electrical Rating At 125° F.

Volts A.C.	120 V.	240 V.	277 V.
Full Load Amps.	5.8	2.9	2.6
Locked Rotor Amps.	34.8	17.4	15.6
Non-Inductive Amps.	10.0	8.3	7.2
Pilot Duty - 125 VA. at 24 to 300 V. A.C.			
Maximum Connected Load 2000 VA.			

Internal Heater (Type M80JFA Spring Return Damper Motor): The thermostat control closes circuit to heater when ambient temperature drops below 20° F (-7° C) and opens circuit when temperature rises above 50° F (10° C). It cannot be field installed.

Conduit Openings: Two threaded openings for 1/2" conduit.

ACCESSORIES

Transformers: A transformer is required to provide motor actuators with the necessary 24 volt A.C. power supply.

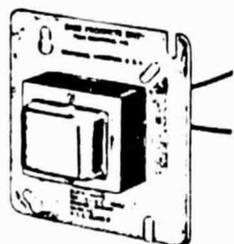
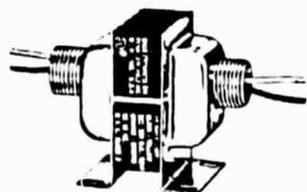


Plate mounted transformer.

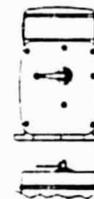


Foot mounted 40 VA transformer.

ply. Plate mounted transformers mount on a 4" electrical box. Transformers No. Y65AS-1 and Y65BS-1 have a 1/2" conduit fitting on the primary and secondary to permit direct mounting into the conduit opening in the motor wiring compartment. See Penn Series Y63, Y64 and Y65 Bulletin No. 3742 for additional information.

Transformer Capacity	Type Mounting	Primary Power Supply (V. A.C.)	Transformer Part No.
40 VA.	Plate	120	Y65AJ-1
		240	Y65BJ-1
	Foot	120	Y65AS-1
		240	Y65BS-1
50 VA.	Plate	120	Y63AJB-1
		480	Y63KJB-1
		208/240	Y635JB-1
	Foot	120	Y63ALB-2
		208/240	Y635LB-2
		208/240	Y635LB-2
100 VA.	Plate	120	Y64AJ-1
		208/240	Y645J-1
	Foot	120	Y64AL-2
		208/240	Y645L-1

Position Indicator: Kit No. PTR11A-600 is available, if required. It contains an indicator pointer and two pressure sensitive mylar decals. For field installation only.



Valves: Penn Division provides a complete line of two-way single seat and double seat, three-way diverting and mixing valves to meet your control application.

Refer to the following bulletins to select the valve and linkage required:

Valve Number	Description	Bulletin Number
V90AA	2-way, single seat globe	3624
V90BA	2-way, double seat	3625
V90CA	3-way, diverting	3627
V90DB	3-way, mixing	3626
V905A	Butterfly	3428

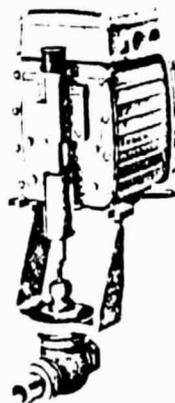


Fig. 6 - Motor actuator mounted on a two-way valve.



Fig. 7 - Spring return motor actuated three-way valve.

PENN SERIES M80J PROPORTIONAL MOTOR ACTUATORS

Damper Linkage Components: A variety of crank arms, ball joint connectors, push rods and a right angle mounting bracket provide easy connection of the motor actuator to a damper. Two complete sets are offered to simplify selection of proper components.



RIGHT ANGLE BRACKET
BKT22A-602



CRANK ARM ASSEMBLY
LVR27A-602

Description	Part Number	Application or Construction
Damper Linkage Sets	Y20DAA-2	For mounting of actuator to top of duct or any flat surface. Contains LVR27A-602, LVR27A-600, SWL10A-601 (2 ea.), and ROD16-3.
	Y20DAB-2	For mounting of actuator to side of duct or wall. Contains LVR27A-602, LVR27A-600, SWL10A-601 (2 ea.), ROD16-3, and BKT22A-602.
Crank Arms	LVR27A-600	For use on 1/2" or 7/16" diameter damper shafts. Adjustable radius from 3/4" to 4 1/2".
	LVR27A-602	For use on motor actuator. Adjustable radius from 1 1/16" to 2 7/8".
	BKT19A-600	Damper angle bracket to connect linkage to damper blade.
Ball Joint Connector	SWL10A-601	With 1/4"-28 diameter stud—use with LVR27A-602, LVR27A-600, and BKT19A-600 crank arms.
Push Rods	ROD16-2	5/8" diameter x 48" long plated steel shaft
	ROD16-3	5/8" diameter x 24" long plated steel shaft
Mounting Bracket	BKT22A-602	Right angle mounting bracket

Externally Mounted Auxiliary Switch Kits: Use Penn Series S91 switch kit. These kits are available with one, two or four SPDT snap acting switches. They can be mounted on either shaft end of the motor actuator and incorporate the time proven, reliable, Pennswitch construction.

Contacts are rated at 9.8 amps at 120 V. A.C. and 8.0 amps at 240 V. A.C. at 125° F (52° C) ambient.

For complete information, refer to Penn Series S91 Bulletin No. 3650.

SHIPPING WEIGHTS (Approx.)

Type Number	Individual Pack	
	lbs.	kg
M80JAA, M80JAB, M80JAC	11	5
M80JCA, M80JCB, M80JFA, M80JDA, M80JEA	15	6.8



DAMPER BRACKET
BKT19A-600



BALL-JOINT CONNECTOR
SWL10A-601



CRANK ARM
LVR27A-600

ORDERING INFORMATION

To order specify:

1. Complete Product Number, if available.

PRODUCT NUMBER SELECTION

Product Number	Timing (1) Secs./160°	Travel			Auxiliary Switches	Internal Heater	Application
		Fixed	Adjustable	Factory Setting			
M80JAA-1	60	X		90°	None	No	Valve or damper
*M80JAA-2	60		X	90°	None	No	Valve or damper
*M80JAB-1	60		X	90°	1	No	Valve or damper
*M80JAC-1	60		X	90°	2	No	Valve or damper
*M80JCA-2	60		X	90°	None	No	Spring return damper CCW
*M80JCB-1	60		X	90°	1	No	Spring return damper CCW
*M80JDA-1	60		X	1/2" lift	None	No	Valve stem normally down Spring return valve
*M80JEA-1	60		X	1/2" lift	None	No	Valve stem normally up Spring return valve
*M80JFA-1	60		X	90°	None	Yes	Spring return damper CCW

(1) See Specification Table for additional timing information.

* Wholesaler model available from stock.

SPECIFICATIONS

Type Number	Timing in Seconds (Nominal) Angular Travel 160° (2.8 rad)	Torque(1) lb.-inches Newton Meters ()	Damper Rating - Sq. ft. Sq. Meters in ()	Rotational Travel	
				Fixed	Field Adjustable
M80JAA, M80JAB, M80JAC	15	40 (4.5)	17.5 (1.6)	90° or 160° (1.6 or 2.8 rad)	90° to 240° (1.6 to 4.2 rad)
	30	80 (9)	35 (3)		
	60	150 (17)	70 (6.5)		
M80JCA, M80JCB, M80JFA	60	50 (5.6)	35 (3)	—	90° to 180° (1.6 to 3.2 rad)
M80JDA, M80JEA	60 sec for 1" valve lift	75 lb valve stem thrust	—	—	1/2" to 1.3" (2)

(1) Torque ratings are for load end of shaft (load end)

(2) Includes 1/8" overtravel for seating of 2 way valves, 1/4" overtravel for 3 way valves

Auxiliary output shaft is limited to a maximum dead weight of 25 lbs

B-33



type V90AA TWO-WAY, SINGLE-SEAT GLOBE VALVES

APPLICATION

These two-way valves are for two position (on/off) or proportional control of steam, water or air in air conditioning systems or commercial industrial applications.

GENERAL DESCRIPTION

Motor Actuators and Linkage

These valves are positioned by Penn Series M40, M80, M81 or M82 electric and electronic motor actuators. Clockwise motor rotation drives valve stem down to close off flow.

The actuators are adapted to the valve bodies by a linkage which not only fastens the valve body and actuator together, but also transforms the angular movement of the actuator output shaft to the straight-line motion required to position the inner valve plug of the valve body. A pinion gear on the actuator output shaft drives a gear rack that is connected to the valve stem. This construction maintains the designed flow characteristics of the valve body.

SPECIFICATIONS

These two-way, single seat valves provide 100% tight shutoff.

Sizes 1/2" through 2" have 150 lb. bronze bodies with bronze trim and 316 stainless steel stem. The inner valve (plug) provides equal percentage flow characteristics. The EPT valve packing limits the temperature of the media (hot/cold water, steam, air) to 281° F.

Valves 1/2" through 1 1/4" have one union type connector and one screwed end connector.

Valves 1 1/2" through 2" have screwed end connectors.

Sizes 2 1/2" through 4" have 150 lb. ASA flanged iron bodies with bronze trim and 316 stainless steel stem. A post guided plug provides equal percentage flow characteristics. Neoprene packing permits media temperatures to 281° F.

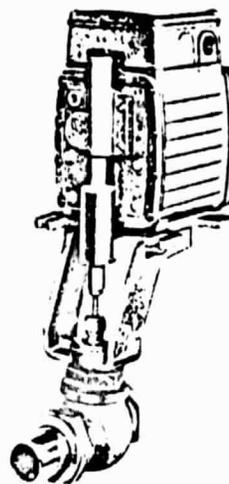


Fig. 1 - Motor Actuated Valve

ORDERING INFORMATION

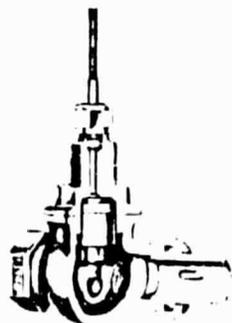
To order, specify:

1. Valve Body Product Number.
2. Valve Linkage Product Number.
3. Motor Actuator Product Number.
4. Factory assemble, if required.
5. Service.

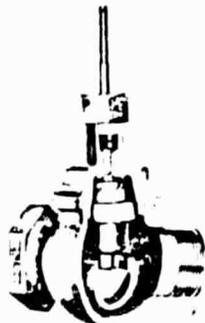
Example: One V90AA-12 Valve Body, one Y20AAA-2 Valve Linkage and one M80FAA-2 Motor Actuator with 60 sec. timing completely factory assembled; for 5 psi steam service.

VALVE SIZING

For steam applications, see Bulletin 3335. For liquid applications, see Bulletin 3334.

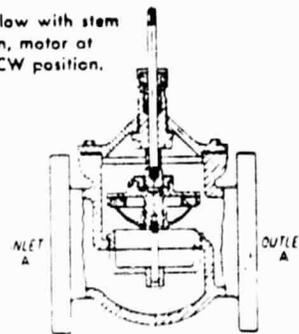


Cut-away view of Two-Way Valve in sizes 1/2" to 1 1/4"



Cut-away view of Two-Way Valve in sizes 1 1/2" to 2"

No flow with stem down, motor at full CW position.



Cross section view of Two-Way Valve in sizes 2 1/2" to 4". Valve shown with stem up (open).

PENN SERIES V90AA TWO-WAY SINGLE SEAT GLOBE VALVES

SPECIFICATION TABLE

Product Number	Valve Size (Inches)	Cv	Linkage Required (Order separately to match valve and motor selected)			Max. Close-Off Press. (psi)				Maximum Pressure Drop* (psi)	Valve Lift (Inches)	Shipping Wt. - Lbs. (Valve only)
			Standard Series M80, M81, M82	Spring Return Series M80, M81, M82	All Series M40	Standard M80, M81, M82		M40 and Spring Return M80, M81, M82				
						Steam	Water	Steam	Water			
V90AA-10	1/2	2.3	Y20AAA-2	Y20ABA-2	Y20EAA-1	40	150	35	130	35	1/2	3.3
V90AA-11	3/4	3.8	Y20AAA-2	Y20ABA-2	Y20EAA-1	40	150	35	150	30	3/4	4.0
V90AA-12	1	7.0	Y20AAA-2	Y20ABA-2	Y20EAA-1	40	150	35	100	25	3/4	4.0
V90AA-13	1 1/4	12.0	Y20AAA-2	Y20ABA-2	Y20EAA-1	40	150	35	40	25	3/4	6.5
**V90AA-14	1 1/2	20.0	Y20AAA-2	None	None	40	120	28	28	20	1	6.5
**V90AA-15	2	35.0	Y20AAA-2	None	None	40	65	16	16	20	1	8.3
V90AA-7	2 1/2	51.0	Y20AAB-1	Y20ABB-2	None	40	40	10	10	18	3/4	30.8
**V90AA-8	3	83.0	Y20AAB-1	None	None	28	28	None	None	17	1 1/2	45.0
**V90AA-9	4	150.0	Y20AAB-1	None	None	14	14	None	None	14	1 1/2	80.0

* Pressure drops for valve sizing in excess of those listed in the Specification Table can cause a reduction in the normal life expectancy of the valve.

** Cannot be used with spring return motors.

INSTALLATION

Upright mounting is recommended but valve assemblies can be mounted in other positions provided the output shaft is horizontal.

Ambient temperature plus heat transferred from the valve through the linkage must not cause the motor temperature to exceed its limit of 135° F.

Motor-actuated valves are available either completely factory assembled and tested or as individual components; valve body, valve linkage, and motor actuator.

CHECKOUT PROCEDURE

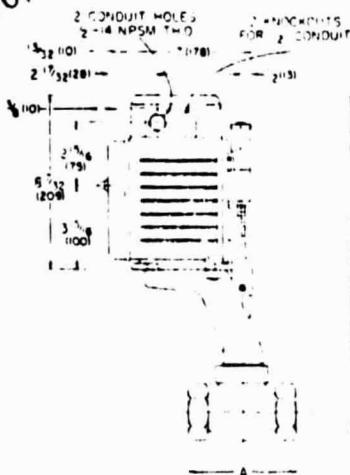
Make sure valve stem moves freely after valve is installed. The valve joints and seals should be checked to be sure there are no leaks.

After linkage and motor actuator are assembled to the valve, a complete operating cycle should be observed to be sure all components are functioning properly.

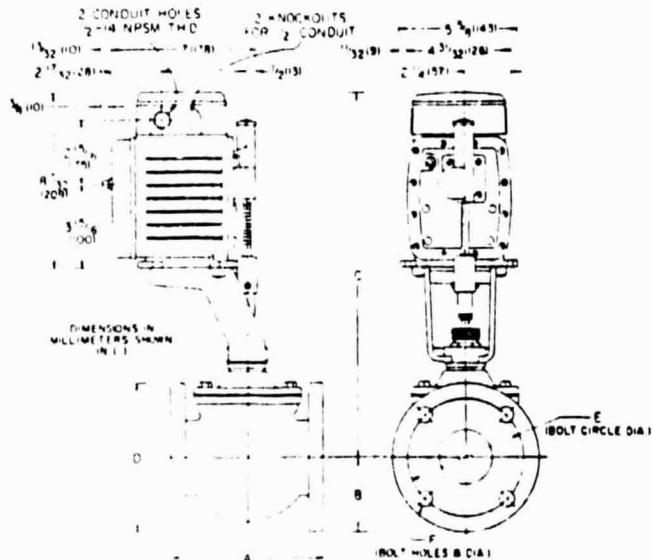
REPAIRS AND REPLACEMENT

Replacement of valve stem, valve plug and packing may be made in the field. When ordering replacement parts, give Valve Body Number and complete description of the part required.

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DIMENSIONS



Valve Size	A	B	C
1/2"	4 7/8" (124)	2" (51)	14 5/8" (371)
3/4"	5 1/4" (133)	2 3/8" (56)	14 11/16" (376)
1"	5 7/8" (149)	2 3/4" (59)	14 13/16" (379)
1 1/4"	6 11/16" (170)	2 5/8" (67)	15 1/4" (387)
1 1/2"	7 3/8" (187)	2 7/8" (73)	15 5/8" (395)
2"	8 3/8" (213)	3 3/8" (81)	15 3/4" (400)

Valve Size	A	B	C	D	E	F
2 1/2"	7 1/4" (184)	3 1/2" (89)	17 1/4" (440)	7" (178)	5 1/2" (140)	4-Holes 3/4" (19) Dia.
3"	8 5/8" (219)	3 1/2" (89)	17 13/16" (456)	7 1/2" (191)	6" (152)	4-Holes 3/4" (19) Dia.
4"	10 1/2" (267)	4 5/8" (117)	18 13/16" (481)	9" (229)	7 1/2" (191)	4-Holes 3/4" (19) Dia.

Performance specifications appearing herein are nominal and are subject to accepted manufacturing tolerances and application variables.

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Johnson VA-3200 Electro-Hydraulic Valve Actuator

The Johnson VA-3200 Electro-Hydraulic Valve Actuator provides control of fluid flows in heating, ventilating and air conditioning systems. Normally the actuator is used in association with a Cybertronic electronic controller and an appropriate Johnson valve body to regulate the flow of fluid, such as steam and water.

The VA-3200 is available for proportional action. For two-position action a PZ-4000 two-position power supply is required. The unit is a sealed electro-hydraulic system acting against a spring-loaded piston and shaft. Fail-safe operation is provided by the spring, which retracts the actuator shaft in the event of power failure.

A position feedback potentiometer connected to the actuator shaft may be ordered for applications requiring indication of relative shaft position. The potentiometer is used with the position meter on a GQ-4100 indication system.

Also available are two auxiliary switches independently wired for N.O. or N.C. operation. The "on" and "off" operating points



Actuator with
Feedback and
Auxiliary Switches

of each switch may be set at any percentage of actuator shaft travel. These switches return to the normal position when the actuator shaft is retracted.

Actuators without feedback and auxiliary switches are supplied with 8" pigtail leads and a standard handi-box for electrical connections. Those actuators with feedback and/or auxiliary switches have 42" pigtail leads and a large wiring box; one pre-drilled hole is provided for the pigtail leads.

Specifications

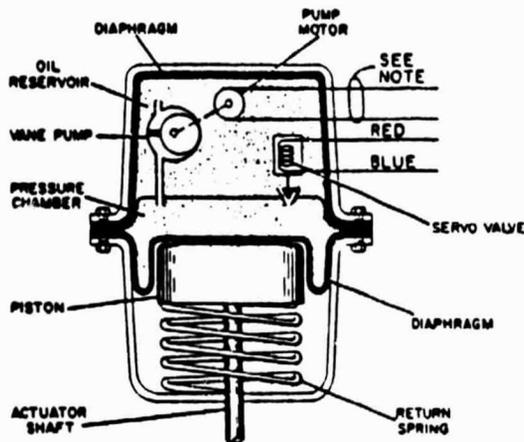
MODEL	VA-3200 ELECTRO-HYDRAULIC VALVE ACTUATOR
CONTROL MODE	PROPORTIONAL
SUPPLY VOLTAGE	120 OR 24 VOLTS A.C., 60 Hz (75 VA)
CONTROL SIGNAL VOLTAGE	0 TO 16 VOLTS D.C. ACROSS SERVO VALVE (APPROXIMATE RESISTANCE 1000 OHMS) NOMINAL OPERATING RANGE 8 TO 12 VOLTS D.C.
POWER	CAN OPPOSE 100 LBS. EXTENDED AND RETRACTED
STROKE	1/2" OR 1 1/2" INCHES
OPERATING TIME	APPROX. 20 SECONDS FOR 1/2" INCH STROKE APPROX. 60 SECONDS FOR 1 1/2" INCH STROKE
AMBIENT TEMPERATURE LIMITS	-25 TO 135F (-30C TO 55C)
ACCESSORIES	POSITION FEEDBACK POTENTIOMETER (APPROXIMATELY 110 OHMS CHANGE FOR 1 1/2" INCH STROKE)
	TWO AUXILIARY SWITCHES (SPDT) RATED AT 1/4 HORSEPOWER (5.8A AT 120 VOLTS A.C., OR 2.9A AT 240 VOLTS A.C.); AVAILABLE FOR EITHER N.O. OR N.C. OPERATION.
	TWO-POSITION POWER SUPPLY: PZ-4000-1 FOR 24V A.C. AND PZ-4000-2 FOR 120V A.C.

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NOTE: POWER WIRES FOR 120V UNIT ARE BLACK AND BLACK/RED; WIRES FOR 24 V UNIT ARE YELLOW AND WHITE.

Operation

In a typical application, a proportional action actuator is connected to a power source and to an electronic temperature controller. If the controller senses a change in temperature from the set point, it transmits a proportional control signal to the servo valve in the actuator. The servo valve modulates the hydraulic

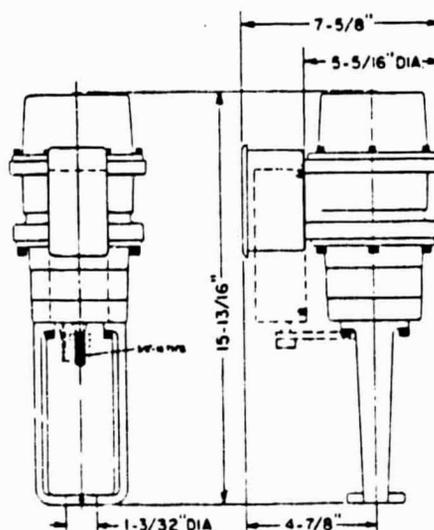
pressure in proportion to the signal; this causes the hydraulic fluid to move the piston and actuator shaft, to position the valve in response to the control signal.

For two-position action, the servo valve of the actuator is connected to the output of a PZ-4000 two-position power supply which is controlled by a two-position thermostat. The controller opens and closes the circuit to the actuator servo valve causing the two-position action of the actuator.

Mounting

The valve body should be installed in the line before the actuator is mounted, leaving a minimum clearance of the length of the actuator plus three inches. The actuator must always be mounted above the valve on horizontal steam or water lines to avoid damaging the unit in case of valve leakage.

Wiring connections are made to color coded pigtail leads. All wiring must conform with applicable electrical code requirements.



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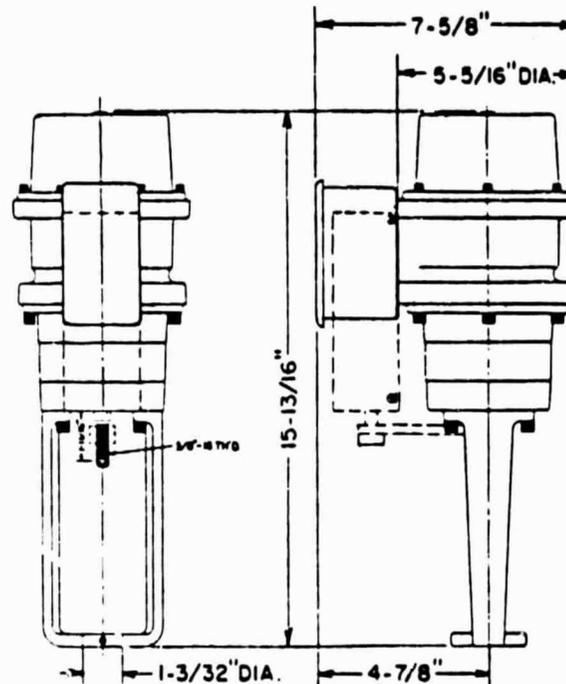
Johnson VA-3200 Electro-Hydraulic Valve Actuator

The Johnson VA-3200 Electro-Hydraulic Valve Actuator provides control of valves in heating, ventilating, and air conditioning systems. The actuator may be used with any controller or auxiliary device that produces a 0 to 16 volt D.C. output.

Installation:

The valve should be installed in the line before the actuator is mounted. A minimum clearance is required, equal to the length of the actuator plus an additional 3 inches, to permit the actuator to clear the valve stem during installation or removal. The actuator must always be mounted above the valve on horizontal steam or water lines to avoid damaging the unit in case of valve leakage.

NOTE: If necessary, the yoke may be detached from the actuator body and mounted to the valve body before the actuator is installed.



Mount the actuator as follows:

1. Remove the gland nut from the valve centerpiece. **CAUTION:** Normally closed, three-way, and 2-1/2" to 4" normally open valves must not have internal pressure. 1/2" to 2" normally open valve bodies with internal pressure may leak until the plug and stem seal against an internal O-ring.
2. Screw the 3/8" locknut and coupler onto the actuator shaft. The coupler should cover at least two threads above the hole in the shaft. **NOTE:** Valve coupling hardware is supplied as a VZ-1000 series Valve Coupling Hardware Kit.
3. Slip the actuator and yoke, the hold-down nut, and the gland nut over the valve stem and centerpiece.
4. Screw the (1/4" or 5/16", depending on type of valve) locknut and coupler onto the valve stem.
5. If A.C. power and control input signal are not available at actuator, using a 9/16" wrench, tighten the 3/8" locknut against the coupler, using it as a jam nut. **CAUTION:** On actuators having auxiliary switches and/or feedback, do not disturb the locknut which holds the feedback arm to the actuator shaft. The feedback arm must be free to slightly shift and move on the actuator shaft; otherwise, binding between the actuator and feedback or switch assembly may result.
6. Screw the valve stem into the coupler until the plug assembly just contacts the centerpiece. Do not force, as damage to the plug assembly may result.
7. While holding the valve stem with one hand to prevent it from rotating, use the 9/16" wrench on the 3/8" locknut to further adjust the actuator preload as noted in Table I. Do not rotate actuator or valve stem. Proceed to step 12, skipping steps 8 thru 10.
8. As an alternate procedure, if A.C. power and a control input signal are available at the actuator (assuming all wiring has been installed and checked out), adjust

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the control input signal to position the actuator shaft to the desired preload position as noted in Table I. Preload can be measured by placing a ruler parallel to the actuator shaft on the bottom of the actuator housing.

9. Screw the valve stem into the coupler until the plug assembly just contacts the centerpiece. Do not force, as this can damage the plug assembly.
10. Return the actuator shaft to the retracted position.
11. Tighten the locknuts on the actuator shaft and valve stem against the coupler.
12. Tighten the packing and hold-down nut on the centerpiece, being careful not to shift natural alignment between actuator and valve.

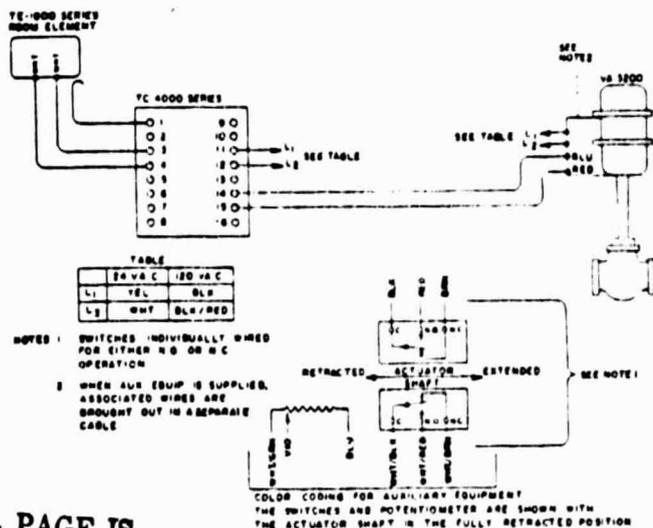
TABLE I. ACTUATOR PRELOAD

VALVE TYPE	PRELOAD
NORMALLY OPEN VB-3752	0-1/32"
NORMALLY CLOSED VB-3970	1/32" - 1/8"
THREE-WAY VB-4140 & VB-4322	1-32" - 1/16"

Wiring

All wiring must conform with applicable electrical code requirements.

The actuator with feedback is equipped with a 42" cable of color coded leads for system



Wiring for Proportional Operation

wiring. If a position potentiometer or switches are part of the assembly, a separate cable is used for the switch and potentiometer wires. Actuators without feedback are supplied with 8" pigtail leads.

Wiring connections should be made with wire nuts in the junction box.

The two-position actuator requires a PZ-4000 two-position power supply. A.C. power must be supplied to both the actuator and the separate power supply. The output of the power supply is connected to the actuator servo valve as shown in the wiring diagram. Do not mount the PZ-4000 in the actuator junction box. The heat generated to the actuator will cause the PZ-4000 to fail.

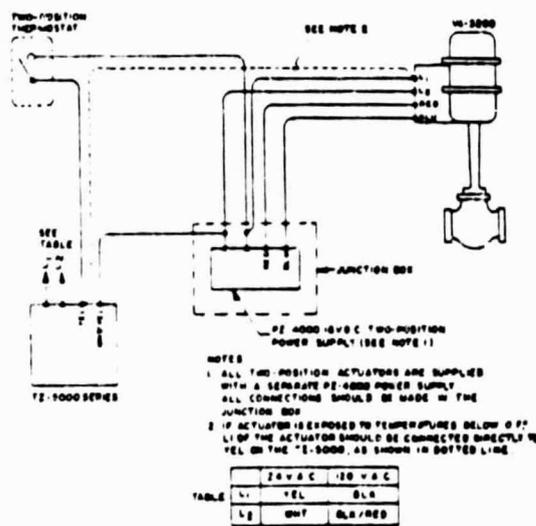
Lubrication

The actuator shaft and linkage should be lubricated periodically with Dow-Corning DC-44, or equivalent. No additional maintenance is required.

Operational Checkout

After the actuator has been installed in accordance with the previous instructions, an operational checkout should be performed, using the following procedure.

To check actuator operation, 120V A.C. or 24V A.C. (depending on the model) must be used. A variable D.C. source of 0 to 16V at 20 ma is also needed for the proportional actuators. This may be either a power supply or an appropriate Cybertronic controller.



Wiring for Two-Position Operation

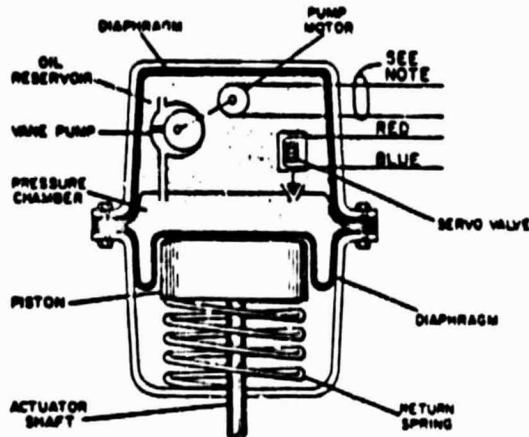
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NOTE: POWER WIRES FOR 120V UNIT ARE BLACK AND BLACK/RED; WIRES FOR 24 V UNIT ARE YELLOW AND WHITE.

If a controller is used, the voltage should be monitored at test points described in the operational checkout bulletin covering the controller, and the set point control varied to obtain the voltages required for the following procedure. Be sure power wiring and applied voltages are correct before testing.

Proportional Action:

1. Apply A.C. power to the actuator pump (black and black/red leads on a 120 volt unit, yellow and white leads on a 24 volt unit.)

NOTE: On early 120 volt models, two black wires are the A.C. power leads. On early 24 volt models, the A.C. power leads are green and white.

2. Connect the D.C. power supply to the servo valve (red and blue leads).
3. Observe the operation of the actuator. At 0 volts the shaft should be fully retracted.
4. Apply 16 volts to the servo valve.
5. Observe the operation of the actuator. The shaft should move to the fully-extended position, operating smoothly throughout the stroke.

6. Check the operation of the actuator with 9 volts D.C. applied to the servo valve. The actuator shaft should come to rest at a point between 25% and 75% of the stroke.

Two-Position Action:

1. Apply A.C. power to the actuator and to the PZ-400 power supply (black and black/red leads on a 120 volt unit, yellow and white leads on a 24 volt unit). The actuator shaft should move smoothly out to the fully-extended position.

NOTE: On early 120 volt models, A.C. power leads are two black wires. On early 24 volt models, the A.C. power leads are green and white.

2. Remove the A.C. power; the actuator shaft should return to the full-retracted position.

If the actuator does not operate properly, check the system for possible wiring errors. If necessary, check the servo valve resistance and the resistance to the pump motor against the values listed in Table II. If the resistance differs from the listed values, or the actuator still fails to function, replace it and return the defective unit to the factory. Do not attempt to repair the actuator in the field.

Adjustments

The following procedures apply to models equipped with auxiliary switches and/or feedback potentiometers.

Position Feedback Potentiometer Adjustments:

If the potentiometer is used in a GQ-4100 indication system, refer to the operational checkout procedures and adjustments for the indication system.

TABLE II. RESISTANCE VALUES

FUNCTION	RESISTANCE VALUES
PUMP MOTOR	120 VOLT UNIT, BLACK TO BLACK/RED. $11 \Omega \pm 1 \Omega$
	24 VOLT UNIT, YELLOW TO WHITE, APPROX. 0.5Ω
SERVO VALVE	RED TO BLUE, APPROXIMATELY 1200Ω
POSITION FEEDBACK POTENTIOMETER	BLUE TO WHITE GREEN, $135 \Omega \pm 15 \Omega$ (VIOLET LEAD IS CONNECTED TO WIPER ARM OF POTENTIOMETER)

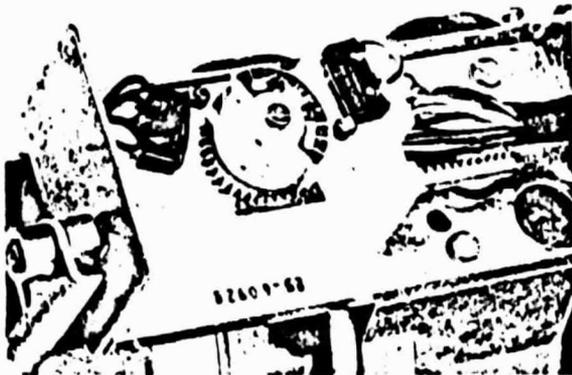
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Auxiliary Switch Adjustments:

The actuator may be supplied with two auxiliary switches. Each switch can be adjusted independently to open or close at any desired shaft position. The differential travel is also adjustable down to a minimum stroke of 1/32". This is the difference in shaft position between the point where the switch operates on a shaft extension and the point where the switch operates on a shaft retraction.

To set up the operating points on each switch, the proper A.C. voltage and a variable control signal of 0 to 16 volts D.C. must be connected to the actuator. However, if possible, do not connect power to the switches themselves until switch adjustment is completed.

1. Loosen the set screw that holds the upper cam to the shaft and remove the cam.
2. Apply A.C. power to the actuator and adjust the control voltage until the actuator shaft is at the position selected for operating the lower switch when the shaft is extending.
3. Loosen the set screw that holds the lower cam to the shaft. Rotate the cam clock-

wise to actuate the switch and tighten the set screw with the cam in this position.

NOTE: The point of operation can be determined by listening for an audible "click" or by connecting an ohmmeter across the switch leads. If an ohmmeter is used, there must be no external power applied to the switch.

4. Adjust the control voltage until the actuator shaft is at the position selected for operating the lower switch when the shaft is retracting.
5. Loosen the screws holding the differential cam segment. It may be necessary to move these screws to different holes in the bolt circle to achieve proper adjustment. Rotate the cam segment until the switch roller rests on the segment. Lift the switch roller off the cam to be sure the switch is in the proper operating position.
6. Rotate the cam segment counterclockwise until the roller drops and the switch operates. Tighten the cam segment mounting screws.
7. Check this adjustment by operating the actuator through its full travel and observing the positions at which the switch operates.
8. Replace the upper cam on the shaft and perform adjustments described in steps 2 through 7.

NOTE: Switch positions have been set at the factory and normally should not be changed. However, if a switch has been shifted and fails to operate properly, loosen the mounting screws and move the switch toward or away from the cam as required.

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Johnson VA-3400 Electro-Hydraulic Valve Actuator

Proportional or Two-Position Action

The Johnson VA-3400 Electro-Hydraulic Valve Actuator provides either proportional or two-position control of large valves in central heating and air conditioning systems. The actuator is especially designed for use with a CYBERTRONIC® electronic controller and an appropriate Johnson valve body in systems controlling the flow of extremely large volumes of fluid.

The VA-3400 is a completely self-contained unit consisting of an actuator shaft and a sealed electro-hydraulic system. The electro-hydraulic system is composed of an electrically driven pump, a servo valve, and a piston. These components are arranged so that the VA-3400 is fail-safe in operation: the actuator shaft returns to the retracted position in the event of power failure. The actuator may be connected to the controller for either direct or reverse acting control.

Operation

In operation, the actuator is connected to a power source and to an appropriate CYBERTRONIC controller, such as the TEC-4000 temperature controller.



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On a change in temperature, a control signal proportional to the temperature change is transmitted to the servo valve in the actuator. The servo valve operates, causing the hydraulic fluid to move the piston and actuator shaft. The actuator shaft positions the valve in response to the control signal.

Specifications

MODEL	VA 3400 ELECTRO-HYDRAULIC VALVE ACTUATOR
CONTROL MODE	PROPORTIONAL OR TWO-POSITION
SUPPLY POWER VOLTAGE	OPTIONAL, 115 VOLTS OR 24 VOLTS A.C., 60 CPS (45 WATTS)
CONTROL SIGNAL	0-16 VOLTS D.C. ACROSS SERVO VALVE (APPROXIMATE RESISTANCE 1000 OHMS)
STROKE	2½ INCHES
POWER	CAN OPPOSE 1000 POUNDS EXTENDED, 500 POUNDS RETRACTED
OPERATING TIME	SIX MINUTES FOR FULL STROKE
AMBIENT TEMPERATURE	125 F MAXIMUM

JOHNSON CONTROL

DESIGN • MANUFACTURE • INSTALLATION



JOHNSON SERVICE COMPANY
MILWAUKEE, WISCONSIN AND PRINCIPAL CITIES

As the temperature changes, the magnitude of the control signal changes proportionally. As the magnitude of the control signal changes, the actuator repositions the valve accordingly.

Mounting

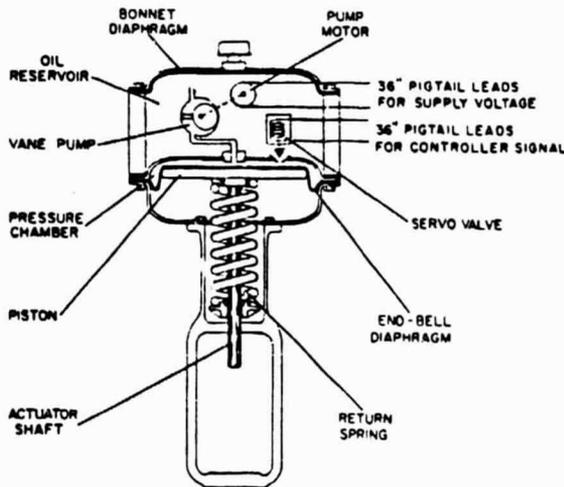
The exact method for installing the actuator depends on the type of valve body used and the requirements of the individual system.

The actuator should be mounted vertically. However, mounting in any other position is possible if a hanger or brace is provided to support the actuator body.

Wiring connections are made to 36" pigtail leads on the actuator. Applicable local and national electrical codes must be followed.

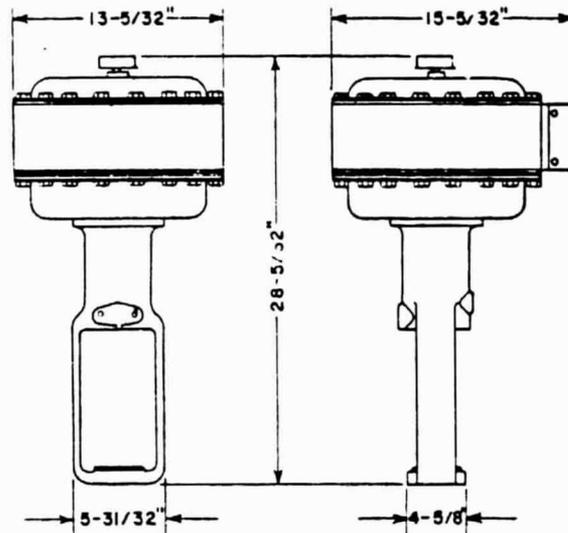
Ordering Instructions

When ordering, specify a complete model number from the Product Specification sheet for the VA-3400.



NOTE: 36" PIGTAIL LEADS COLOR-CODED AS FOLLOWS:

LEADS	115V UNIT	24V UNIT
PUMP MOTOR	BLK	GREEN
SERVO VALVE	BLK	WHITE
	RED	RED
	BLUE	BLUE



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Johnson VA-3400 Electro-Hydraulic Valve Actuator

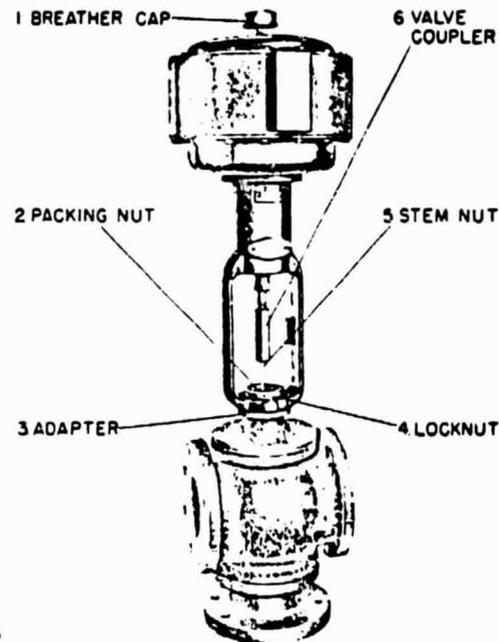
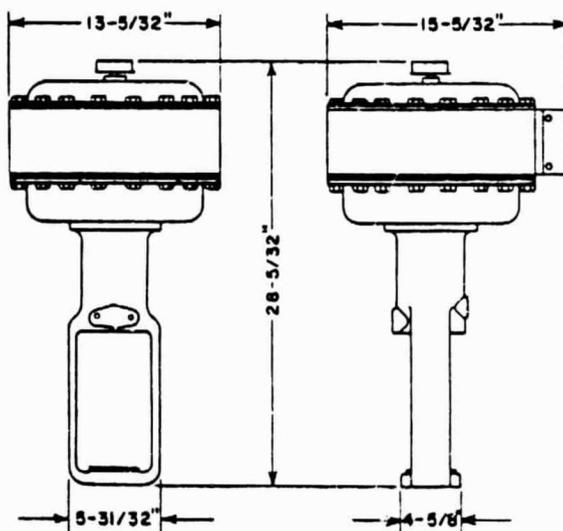
Proportional or Two-Position Action

The Johnson VA-3400 Electro-Hydraulic Valve Actuator provides proportional or two-position control for valves in central heating and air conditioning systems using extremely large volumes of fluid. The actuator is designed for use with a CYBERTRONIC electronic controller and an appropriate Johnson valve body. The actuator may be connected to the controller for either direct or reverse acting control.

Installation

If possible, the actuator should be mounted in a vertical position. However, mounting in any other position may be accomplished if a hanger or brace is provided to support the actuator body.

The exact method used to install the VA-3400 depends on the type of valve body used and on the requirements and limitations of the individual system. However, the following procedure for mounting the valve body to the actuator may be used in all installations.



1. Remove locknut (4) and (if necessary) packing nut (2) from the valve stem.
2. Place adaptor (3) over the valve center-piece.
3. Center the actuator over the adaptor and fit the yoke locknut (4) over the valve center-piece.
4. Replace the locknut and packing nut. Check the actuator for correct centering.
5. With the valve stem all the way up, hold valve coupler (6) alongside the actuator shaft so that the top of the coupler extends to the end of the threaded portion of the actuator shaft.
6. With the coupler in this position, thread stem nut (5) on the valve stem until it clears the coupler by one-eighth of an inch.
7. Hold the stem nut in this position and tighten the coupler against the nut, pushing the stem into the valve as required.



8. With the coupler securely locked on the valve stem, thread the coupler on the actuator all the way to the end of the threaded portion of the shaft. The valve stem should turn with the nut and coupler as the coupler is threaded on the shaft. The resistance encountered during the last few turns of the coupler is the valve preload.
9. Check the actuator for correct centering, then tighten the locknut securely.

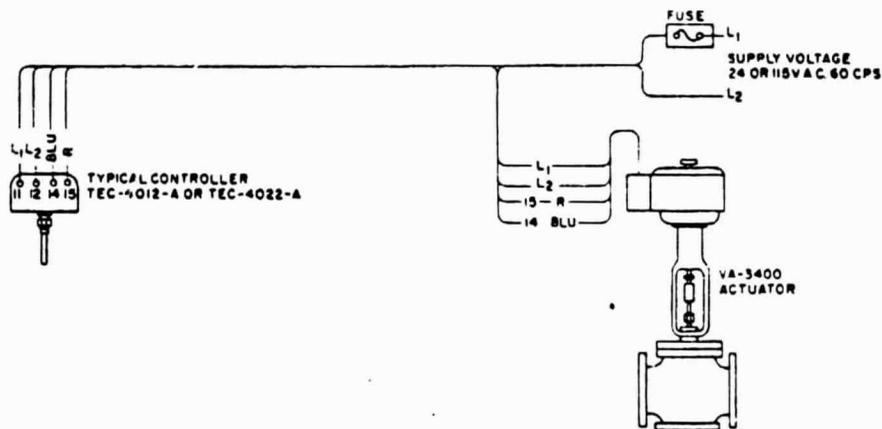
Wiring

The VA-3400 has a power consumption rating of 100 VA. This figure must be taken into consideration when sizing transformers.

The actuator is supplied with a 36" pigtail cable of color coded 18 gage stranded wire. Use wire nuts to connect the actuator to system wiring.

All wiring must be in accordance with applicable national and local electrical codes.

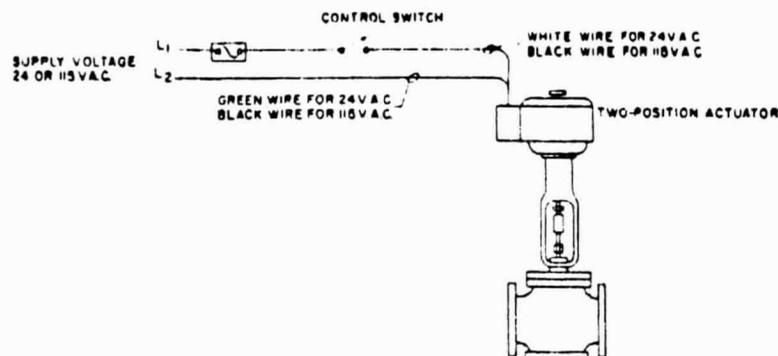
WIRING DIAGRAM FOR DIRECT ACTING CONTROL



NOTE
 COLOR CODE FOR POWER WIRING IS AS FOLLOWS

	24V	115V
L1	W	BLK
L2	GRN	BLK

WIRING DIAGRAM FOR TWO-POSITION CONTROL





II. VALVES

JOHNSON SERVICE COMPANY

507 EAST MICHIGAN STREET • MILWAUKEE, WISCONSIN 53201

PRODUCT
DATA

VB-3752

JOHNSON VB-3752

N.O. STEAM OR WATER VALVE

1/2" thru 2" Cast Brass 2-1/2" thru 8" Cast Iron

150 psi Body Rating

The Johnson VB-3752 Normally Open Valve is designed to regulate the flow of steam or water through coils or heat exchangers of all types. This valve is accurately controlled by a VA-3200, VA-3400 or VA-5000 actuator.

The VB-3752 valve body is constructed of cast red brass in sizes 1/2" through 2", and cast iron in sizes 2-1/2" through 8". A modulating valve plug, with a replaceable composition disc especially compounded for steam and water service, provides an equal percentage relationship between valve lift and flow at constant pressure drop.



VB-3752 N.O.
Valve with
VA-3200
Actuator

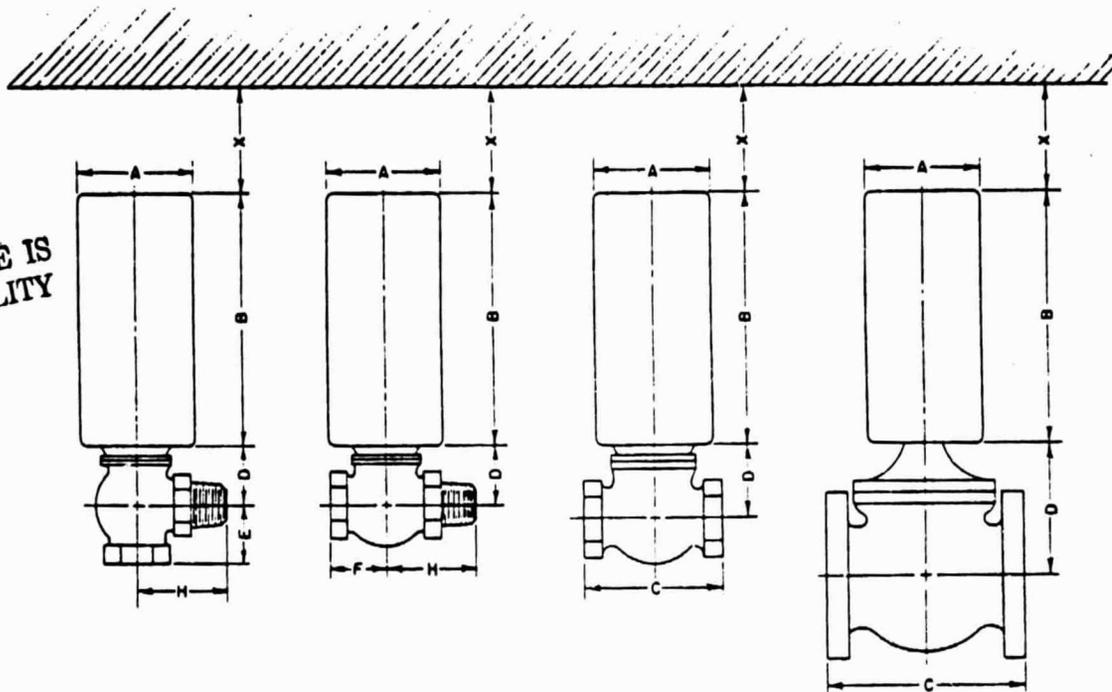
Specifications

MODEL		VB-3752 NORMALLY OPEN VALVE		
SERVICE		STEAM OR WATER, HOT OR COLD		
SERVICE CONNECTIONS/ BODY PATTERNS SIZES	UNION ANGLE	1/2" THROUGH 2"		
	UNION GLOBE	1/2" THROUGH 1-1/4"		
	SCREWED GLOBE	1-1/2" THROUGH 2"		
	FLANGED GLOBE 125 psi	2-1/2" THROUGH 8"		
INNER VALVE		EQUAL PERCENTAGE MODULATING PLUG		
BODY RATING		150 psi (10.5 kp/cm ²)		
MAXIMUM OPERATING PRESSURE	STEAM	35 psi (2.5 kp/cm ²)		
	WATER	150 psi (10.5 kp/cm ²)		
MAXIMUM OPERATING TEMPERATURE	STEAM	281F (138C)		
	WATER	281F (138C)		
MATERIALS	BODY	1/2" - 2"	HIGH GRADE CAST RED BRASS, NATURAL FINISH	
		2-1/2" - 8"	HIGH TENSILE CAST IRON, BLACK LACQUER FINISH	
	TRIM	1/2" - 2"	BRASS	
		2-1/2" - 8"	BRASS, WITH REPLACEABLE SCREWED-IN SEAT	
	DISC	REPLACEABLE COMPOSITION		
	STEM PACKING	1/2" - 2"	U-CUP, SYNTHETIC ELASTOMER (STEAM AND WATER)	
		2-1/2" - 4"	MOLDED RING, TEFLON (STEAM)	
2-1/2" - 4"		U-CUP, BUNA-N (WATER)		
2-1/2" - 8"		ROPE, GRAPHITED ASBESTOS (VA-3400 ONLY)		
ACTUATOR	1/2" - 2"	VA-5000 THERMAL OR VA-3200 ELECTRO-HYDRAULIC		
	2-1/2" - 4"	VA-3400 OR VA-3200 ELECTRO-HYDRAULIC		
	5" - 8"	VA-3400 ELECTRO-HYDRAULIC		

PRODUCT
DATA
VB-3752



JOHNSON SERVICE COMPANY
507 EAST MICHIGAN STREET • MILWAUKEE, WISCONSIN 53201



Dimensions

Actuator

ACTUATOR	A	B	X*
VA-5000	3-1/4	9-1/4	4-3/4
VA-3200	7-3/4	15-7/8	4-3/4
VA-3400	15-1/4	28-1/4	5-1/2

* X is the minimum clearance required to remove the actuator.

Installation

It is recommended that the VB-3752 valve be mounted in an upright position. It must be piped so that the valve seats against the flow and arranged so that the actuator can be easily removed and replaced.

Valve Body

VALVE SIZE (in.)	DIMENSIONS (in.)					
	C	D		E	F	H
		Angle	Globe			
1/2		1-3/8	1-5/8	1-3/8	1-3/8	2-11/16
3/4		1-13/16	1-15/16	1-5/8	1-5/8	3-1/16
1		2	2-5/16	1-7/8	1-7/8	3-5/16
1-1/4		2-1/4	2-7/16	2-3/16	2-1/3	4-1/16
1-1/2	4-7/8	2-5/8	2-3/4	2-1/4		4-1/4
2	5-1/8	3	3-1/4	2-5/8		5-3/4
2-1/2	7-1/4		4-11/16			
3	8-5/8		5-5/16			
4	10-1/2		6-5/16			
5	12-1/2		6-7/8			
6	14-1/2		8-3/16			
8	17-1/2		11-15/16			

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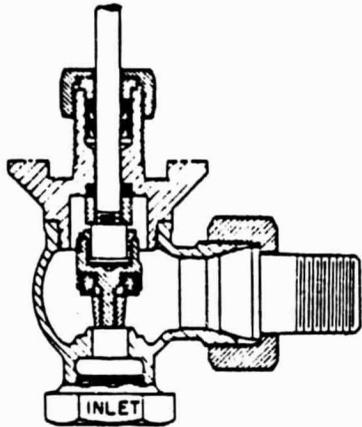


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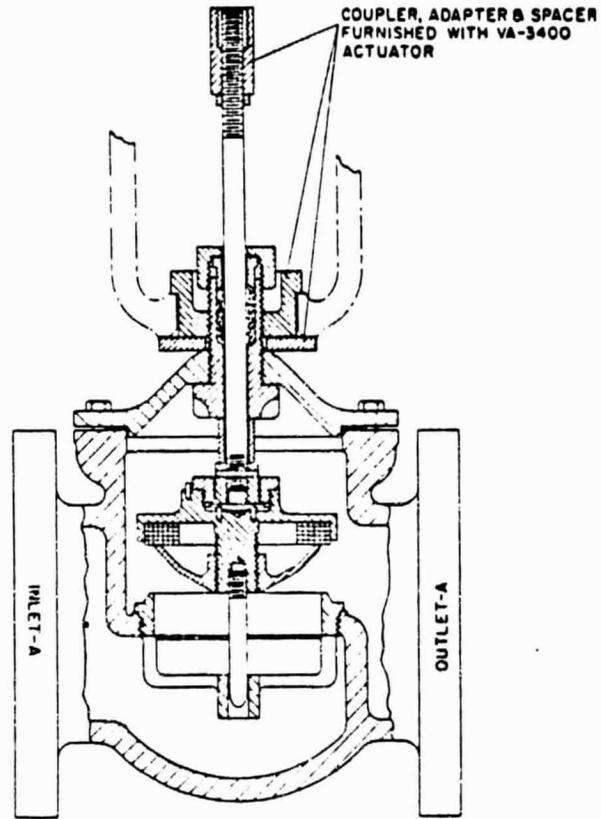
**PRODUCT
 DATA**
VB-3752

Capacities

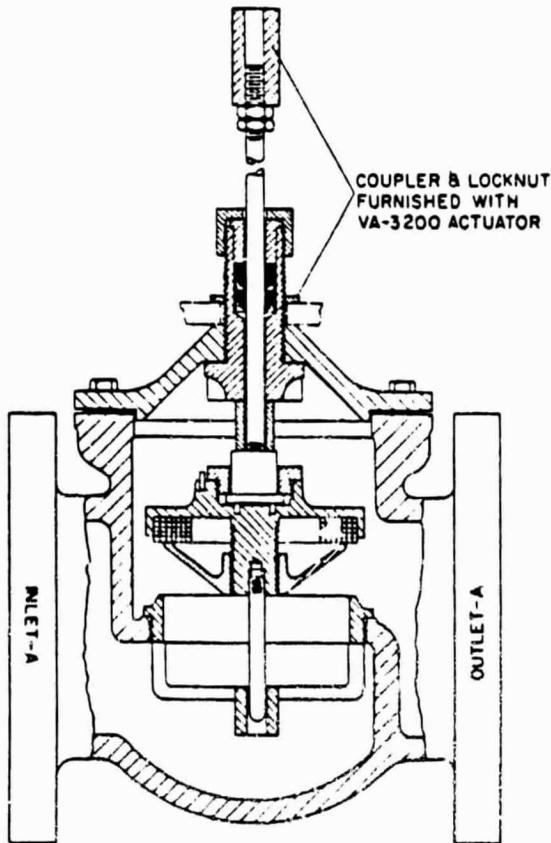
Valve Size (in.)		1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	5	6	8	
C _v Factor	Angle	1.1	1.5	2.5	3.7	6.7	12.0	20.0	35.0					
	Globe	0.9	1.5	2.3	3.6	7.0	12.0	20.0	35.0	51.0	83.0	150.0	240.0	350.0



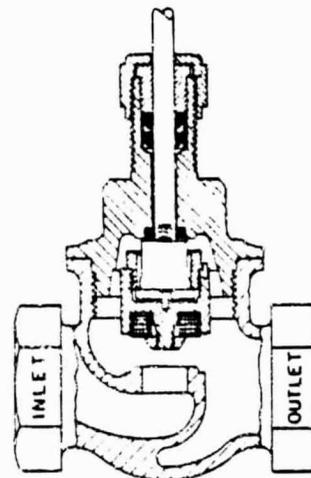
Angle Valve with Male Union Outlet



Globe Valve with Flanged Ends



Globe Valve with Flanged Ends



Globe Valve with Screwed Ends



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507 EAST MICHIGAN STREET • MILWAUKEE, WISCONSIN 53201

**PRODUCT
DATA
VB-3970**

JOHNSON VB-3970 N.C. STEAM OR WATER VALVE

1/2" thru 2" Cast Brass 2-1/2" thru 8" Cast Iron
150 psi Body Rating

The Johnson VB-3970 Normally Closed Valve is designed to regulate the flow of steam or water through coils or heat exchangers of all types. This valve is accurately controlled by a VA-3200, VA-3400 or VA-5000 actuator.

The VB-3970 valve body is constructed of cast red brass in sizes 1/2" through 2", and cast iron in sizes 2-1/2" through 8". A modulating valve plug, with a replaceable composition disc especially compounded for steam and water service, provides an equal percentage relationship between valve lift and flow at constant pressure drop.



**VB-3970 N.C.
Valve with
VA-3200
Actuator**

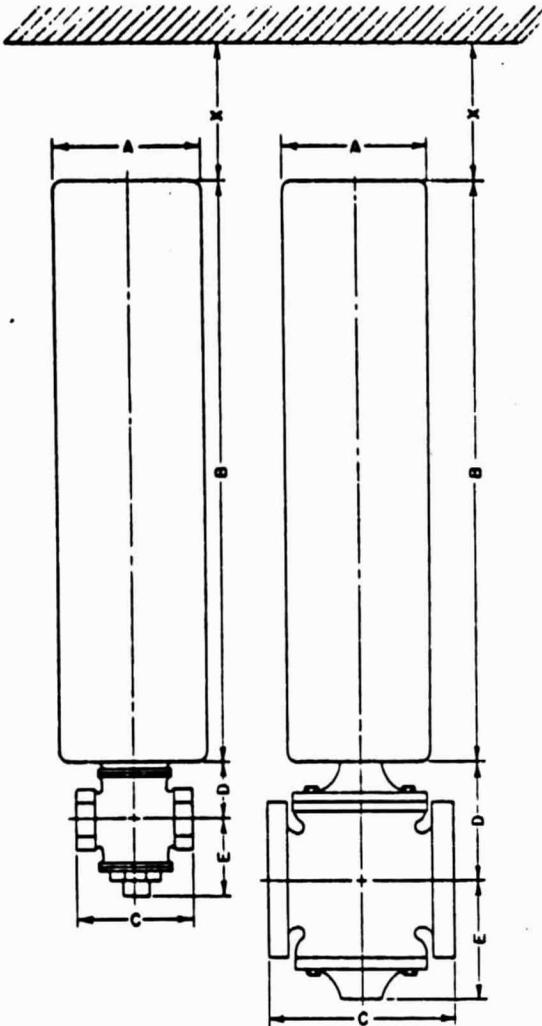
Specifications

MODEL		VB-3970 NORMALLY CLOSED VALVE		
SERVICE CONNECTIONS/ BODY PATTERNS/ SIZES	SCREWED GLOBE	1/2" THROUGH 2"		
	FLANGED GLOBE 125 psi	2-1/2" THROUGH 8"		
INNER VALVE		EQUAL PERCENTAGE MODULATING PLUG		
BODY RATING		150 psi (10.5 kp/cm ²)		
MAXIMUM OPERATING PRESSURE	STEAM	35 psi (2.5 kp/cm ²)		
	WATER	150 psi (10.5 kp/cm ²)		
MAXIMUM OPERATING TEMPERATURE	STEAM	281F (138C)		
	WATER	281F (138C)		
MATERIALS	BODY	1/2" - 2"	HIGH GRADE CAST RED BRASS, NATURAL FINISH	
		2-1/2" - 8"	HIGH TENSILE CAST IRON, BLACK LACQUER FINISH	
	TRIM	1/2" - 2"	BRASS	
		2-1/2" - 8"	BRASS, WITH REPLACEABLE SCREWED-IN SEAT	
	DISC	REPLACEABLE COMPOSITION		
	STEM PACKING	1/2" - 2"	U-CUP, SYNTHETIC ELASTOMER (STEAM AND WATER)	
		2-1/2" - 4"	MOLDED RING, TEFLON (STEAM)	
2-1/2" - 4"		U-CUP, BUNA-N (WATER)		
2-1/2" - 8"		ROPE, GRAPHITED ASBESTOS (VA-3400 ONLY)		
ACTUATOR	1/2" - 2"	VA-5000 THERMAL OR VA-3200 ELECTRO-HYDRAULIC		
	2-1/2" - 4"	VA-3200 OR VA-3400 ELECTRO-HYDRAULIC		
	5" - 8"	VA-3400 ELECTRO-HYDRAULIC		

**PRODUCT
DATA
VB-3970**



JOHNSON SERVICE COMPANY
507 EAST MICHIGAN STREET • MILWAUKEE, WISCONSIN 53201



Dimensions

Installation

It is recommended that the VB-3970 valve be mounted in an upright position. It must be piped so that the valve seats against the flow and arranged so that the actuator can be easily removed and replaced.

Actuator

ACTUATOR	A	B	X*
VA-5000	3-1/4	9-1/4	4-3/4
VA-3200	7-3/4	15-7/8	5-3/4
VA-3400	15-1/4	28-1/4	5-1/2

* X is the minimum clearance required to remove the actuator.

Valve Body

VALVE SIZE (in.)	DIMENSIONS (in.)		
	C	D	E
1/2	2-3/4	1-5/8	1-9/16
3/4	3-1/4	1-15/16	1-15/16
1	3-3/4	2-1/4	2-9/16
1-1/4	4-1/4	2-3/8	2-5/8
1-1/2	4-7/8	2-3/4	3
2	5-1/8	3-1/8	3-1/16
2-1/2	7-1/4	4-11/16	5-1/16
3	8-5/8	5-5/16	5-5/16
4	10-1/2	6-5/16	6-5/16
5	12-1/2	6-7/8	6-7/8
6	14-1/2	8-3/16	8-3/16
8	17-1/2	11-15/16	11-15/16

Capacities

Valve Size (in.)	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	5	6	8		
C _v Factor	0.9	1.7	2.2	3.8	6.9	11	20	35	54	83	150	237	344	576

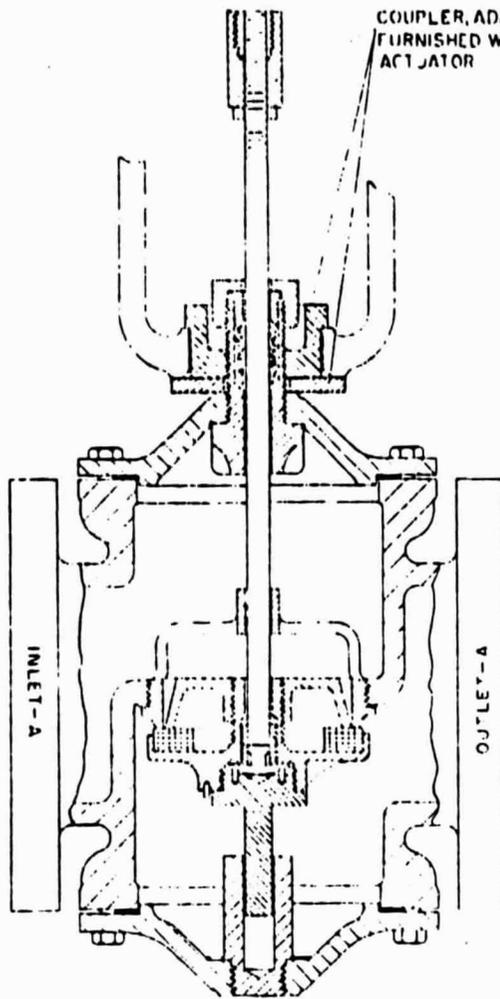
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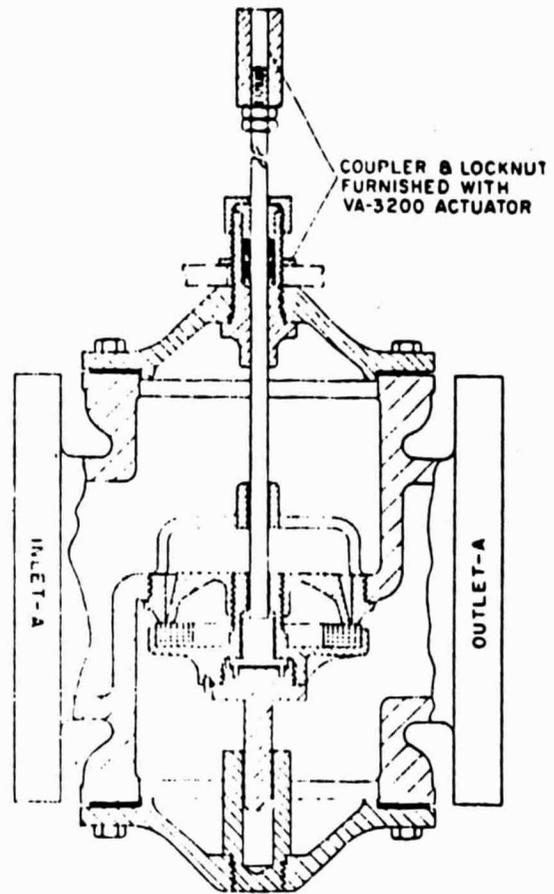
JOHNSON SERVICE COMPANY

207 EAST MICHIGAN STREET • MILWAUKEE, WISCONSIN 53201

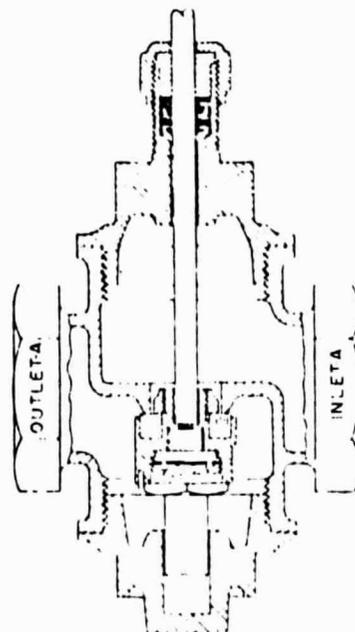
PRODUCT
DATA
VB-3970



Globe Valve with Flanged Ends



Globe Valve with Flanged Ends



Globe Valve with Screwed Ends

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IRON GATE

125 lb. SWP-200 lb. WOG† • OS&Y
Solid Wedge Disc • Bolted Bonnet • Gland Packed



MILWAUKEE 2884 • SE • BM
MILWAUKEE 2885 • FE • BM
MILWAUKEE 2889 • FE • BM*
MILWAUKEE 2891 • FE • AI

†Non-Shock

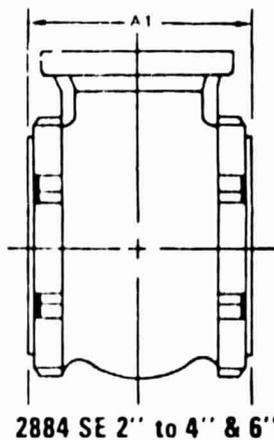
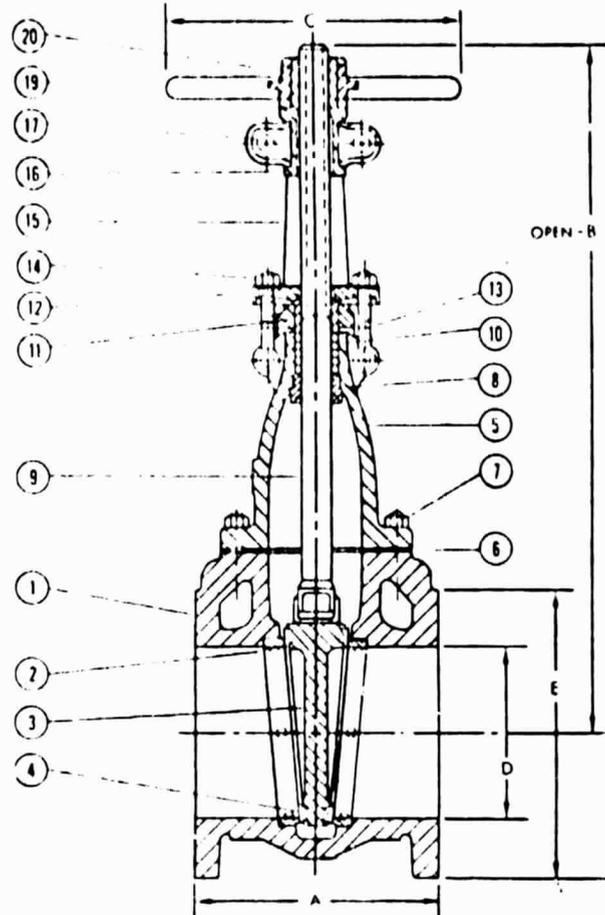
MATERIAL LIST

NO.	DESCRIPTION	MATERIAL & SPECIFICATION
1	Body	Semi Steel • ASTM A 126 Cl B
2	Seat Ring BM Seat Ring AI	Bronze • ASTM B 61 Semi Steel • ASTM A 126 Cl B
3	Wedge 2" 2½" BM Wedge 3" 12" BM Wedge AI	Bronze • ASTM B 61 Semi Steel • ASTM A 126 Cl B Semi Steel • ASTM A 126 Cl B
4	Wedge Ring 3" 12" BM	Bronze • ASTM B 61
5	Bonnet	Semi Steel • ASTM A 126 Cl B
6	Gasket	Asbestos • Compressed
7	Bonnet Bolt & Nut	Steel • ASTM A 307 Gr B
8	Backseat Bushing BM Backseat Bushing AI	Bronze • ASTM B 62 Semi Steel • ASTM A 126 Cl B
	Stem 2" 2½" BM Stem 3" 12" BM Stem 2891 & 2899	Mang Bronze • ASTM B 147 Al 7A Mang Bronze • ASTM B 119 Al A Nickel Pltd Steel • ASTM A 108 Gr B 1112
10	Packing	Graphited Asbestos • Formed
11	Gland BM Gland 2" 4" AI Gland 5" 12" AI	Bronze • ASTM B 62 Steel • ASTM A 108 Gr B 1112 Semi Steel • ASTM A 126 Cl B
12	Gland Flange	Semi Steel • ASTM A 126 Cl B
13	Gland Eyebolt	Steel • Mild Carbon
14	Eyebolt Nut BM Eyebolt Nut AI	Brass • ASTM B 16 Steel • ASTM A 307 Gr B
15	Yoke Arms 5" & 8" 12"	Semi Steel • ASTM A 126 Cl B
16	Yoke Nut	Mang Bronze • ASTM B 147 Al 7A
17	YA Bolt & Nut 5" & 8" 12"	Steel • ASTM A 307 Gr B
18	Yoke Retaining Nut 2" 4" • YA Cap Screw 5" & 8" 12" •	Semi Steel • ASTM A 126 Cl B Steel • ASTM A 108 Gr 1018
19	Handwheel	Mall Iron • ASTM A 47 Gr 32510
20	Wheel Nut	Mall Iron • ASTM A 47 Gr 32510

*Not Shown

DIMENSIONS

SIZE	2"	2½"	3"	4"	5"	6"	8"	10"	12"
A	7	7½	8	9	10	10½	11½	13	14
A 1	6½	6½	6½	7½		8½			
B	15½	16½	18½	23½	27½	32½	40½	49½	57½
C	8	8	9	10	12	12	14	18	20
D	7	2½	3	4	5	6	8	10	12
E	6	7	7½	9	10	11	13½	16	19



Flange Shape and Drilling to Spec USAS B 16.1 (125 lb)

*MILWAUKEE 2889 • FE • BM

Same as 2885 except Steel Stem

B-52

2884 meets or exceeds the requirements of Federal Specification No. WW V 58 for Type I (OS) Class A Valves 2889 meets or exceeds the requirements of Federal Specification No. WW V 58 for Type I (OF) Class A Valves

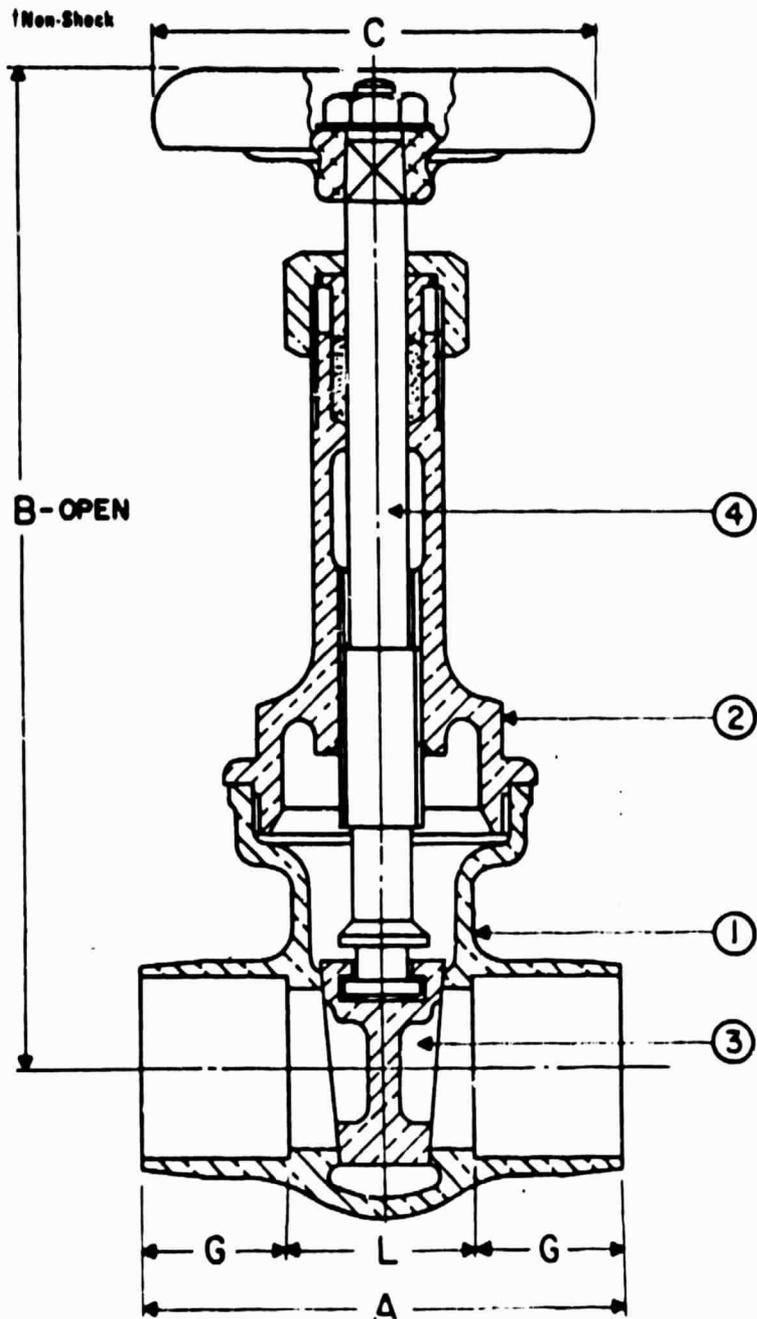
BRONZE GATE

125 lb. SWP-200 lb. WOG† • General Service
 Rising Stem • Solid Wedge Disc
 Screwed Bonnet • Sweat Ends • Gland Packed



MILWAUKEE
 MILWAUKEE
 MILWAUKEE

1149
 1149M*
 1119*



NOTE: 4" size has split wedge and bolted bonnet. It is not covered in Fed. Spec. WW-V-54.

NOTE: Dimensions shown are for solder ends. Brazed end preparation also available.

TEST PRESSURE

250 psi Shell

125 psi Seat

MATERIAL LIST

NO.	PART	MATERIAL	SPECIFICATION
1	Body	Bronze	ASTM B 62
2	Bonnet	Bronze	ASTM B 62
3	Wedge Disc	Bronze	ASTM B 62
4	Stem	Bronze	ASTM B 62
	Packing	Teflon/ Imp./Asb.	Commercial
	Gland	Bronze	ASTM B 16
	Packing Nut	Bronze	Commercial
	Handwheel	Aluminum	Commercial
	Identification Plate	Aluminum	Commercial
	Handwheel Nut	Bronze	Commercial

DIMENSIONS—INCHES

SIZE	DIM. A	DIM. B	DIM. C	DIM. G	DIM. L
3/8	1 1/16	5/8	2 1/8	3/8	1 1/16
1/2	2	5 1/8	2 1/8	1/2	1
3/4	2 1/2	6 1/8	2 3/8	3/4	1
1	3	7 1/8	2 3/8	7/16	1 1/8
1 1/4	3 3/4	8 1/8	3	1 1/16	1 1/8
1 1/2	3 3/8	9 1/8	3 1/8	1 1/16	1 1/8
2	4 1/8	11 1/8	4	1 1/16	1 1/8
2 1/2	5	14 1/8	4 1/2	1 1/16	2 1/8
3	5 1/2	16 1/2	5	1 1/16	2 3/8
4	7 1/4	15 1/2	5	2 1/16	2 1/4

*MILWAUKEE 1149M

Same but with malleable
 iron handwheel

MILWAUKEE 1119*

Same but with drain

B-53

These valves meet or exceed the requirements of Federal Specification No. WW-V-54 for Type II, Class A Valves.

MILWAUKEE VALVE COMPANY, INC.
 2375 South Burrell Street • Milwaukee, Wisconsin 53207



BRONZE GATE

125 lb. SWP-200 lb. WOG† • Industrial Service
 Rising Stem • Solid Wedge Disc
 Union Bonnet • Screwed Ends • Gland Packed

MILWAUKEE 1152

TEST PRESSURE

250 psi Shell 125 psi Seat

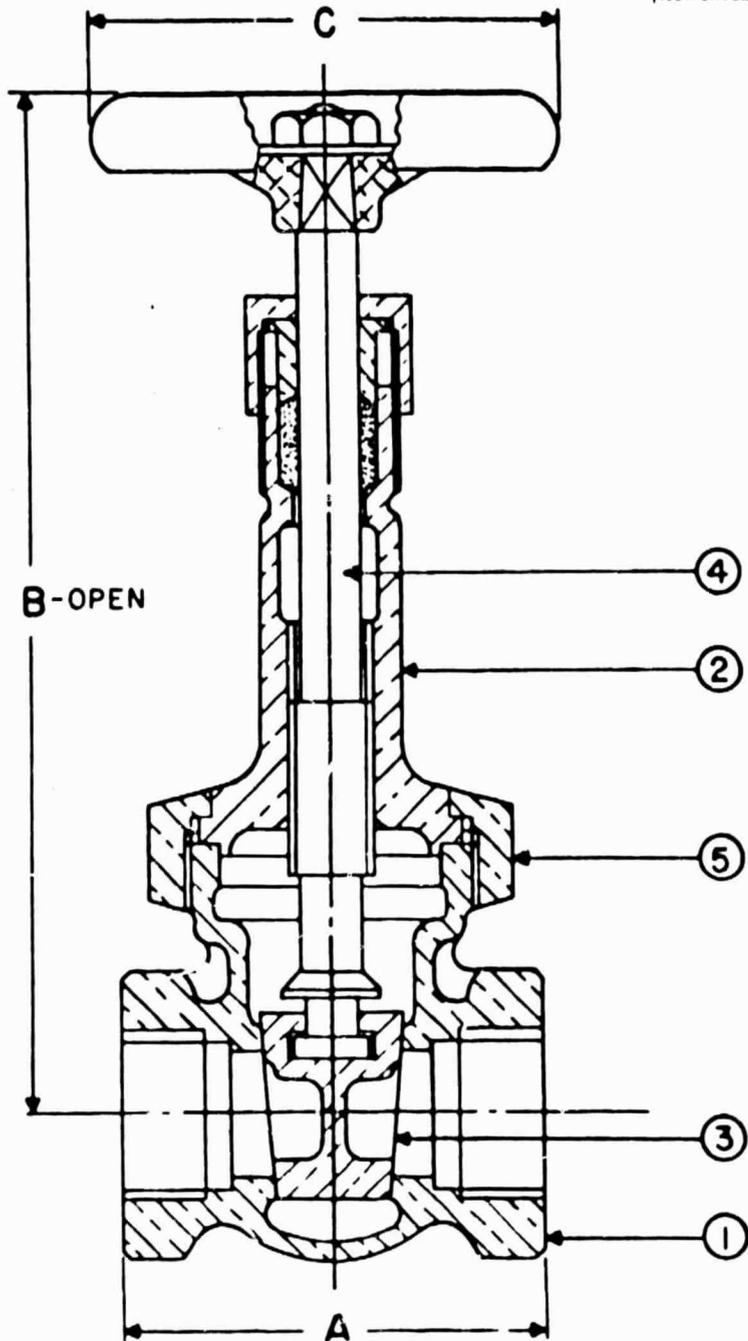
MATERIAL LIST

NO.	PART	MATERIAL	SPECIFICATION
1	Body	Bronze	ASTM B 62
2	Bonnet	Bronze	ASTM B 62
3	Wedge Disc	Bronze	ASTM B 62
4	Stem	Bronze	ASTM B 62
5	Union Bonnet Nut	Bronze	ASTM B 62
	Packing	Teflon/Imp./Asb.	Commercial
	Gland	Bronze	ASTM B 16
	Packing Nut	Bronze	Commercial
	Handwheel	Aluminum	Commercial
	Identification Plate	Aluminum	Commercial
	Handwheel Nut	Bronze	Commercial

DIMENSIONS—INCHES

SIZE	DIM. A	DIM. B	DIM. C
¼	1¾	5¾	2¾
⅜	1¾	5¾	2¾
½	2¾	6¾	2¾
¾	2¾	6¾	2¾
1	2¾	7¾	2¾
1¼	3¾	8¾	3
1½	3¾	9¾	3¾
2	3¾	11¾	4
2½	4¾	14¾	5
3	5	16¾	5

† Non-Stock



These valves meet or exceed the requirements of Federal Specification No. WW V-1-1 for Type II, Class A Valves

MILWAUKEE VALVE COMPANY, INC.
 2375 South Burrell Street • Milwaukee, Wisconsin 53207

MILWAUKEE VALVE

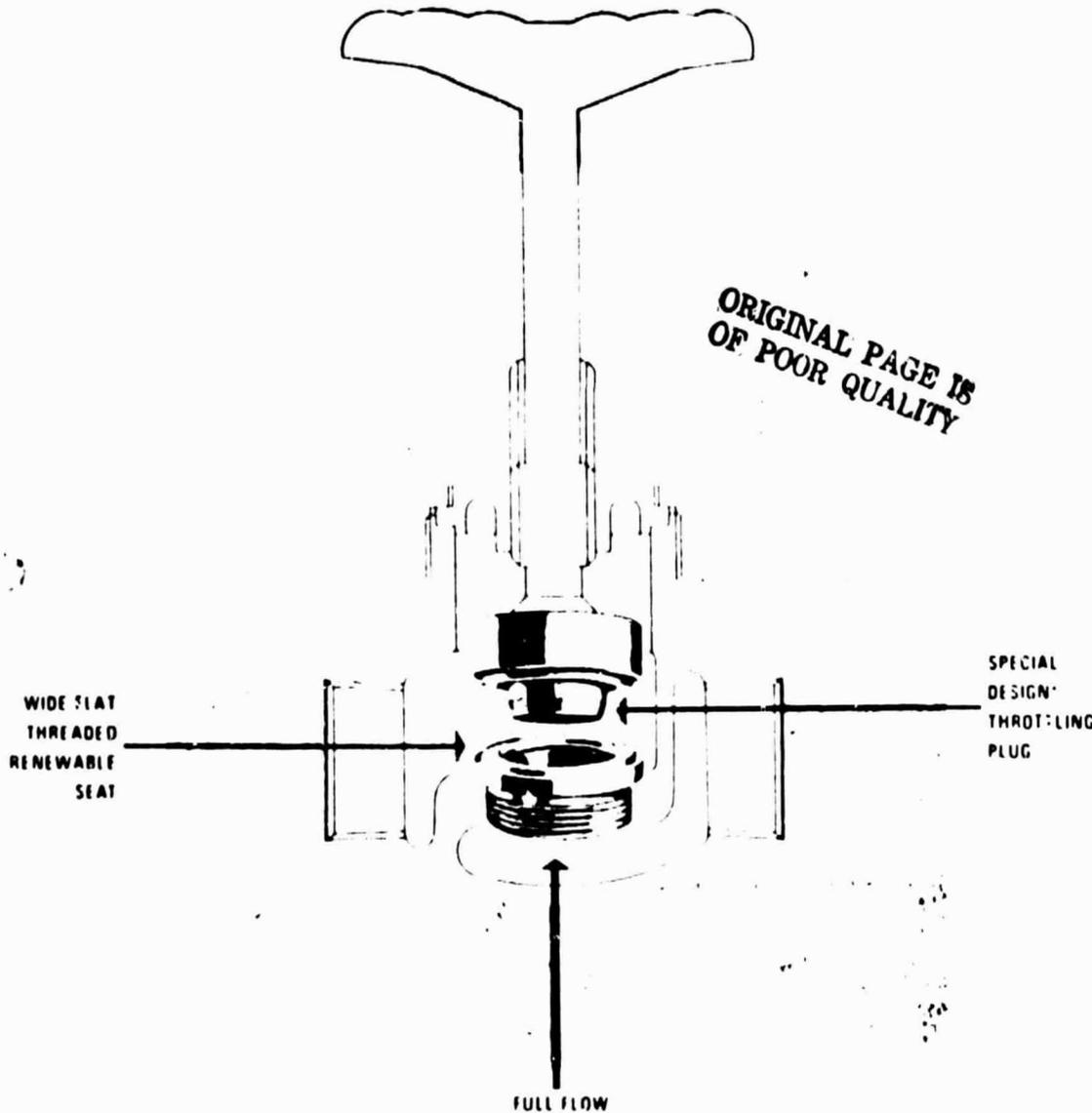
NEW from Milwaukee . . . globe valve for severe critical service . . . special design stainless steel renewable "600 Brinell" seat and disc . . . FULL FLOW



VALVES
BUILT
TO
TAKE
IT

NEW "600 BRINELL" GLOBE VALVES

FOR SEVERE CRITICAL SERVICE — 600 BRINELL SEAT RING AND DISC



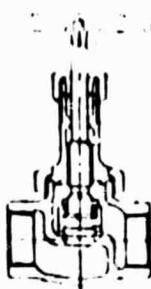
591
150 Lb.
300 WOG
Union Bonnet
Screwed Ends
Gland Packed
Sizes: 1/4" thru 2"

592
200 Lb. SWP-500
F 400 WOG
Union Bonnet
Screwed Ends
Gland Packed
Sizes: 1/4" thru 2"

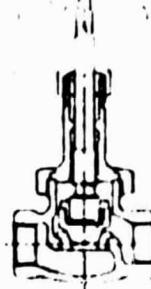
593
300 Lb. SWP-800
F 600 WOG
Union Bonnet
Screwed Ends
Gland Packed
Sizes: 1/4" thru 2"

593 1/2
350 Lb. SWP-500
F 1000 WOG
Union Bonnet
Screwed Ends
Gland Packed
Size: 1/4" thru 2"

This unique new MILWAUKEE globe valve makes two most popular designs obsolete!



This globe valve provides positive shut-off and allows no leakage surface for erosion.



B-55

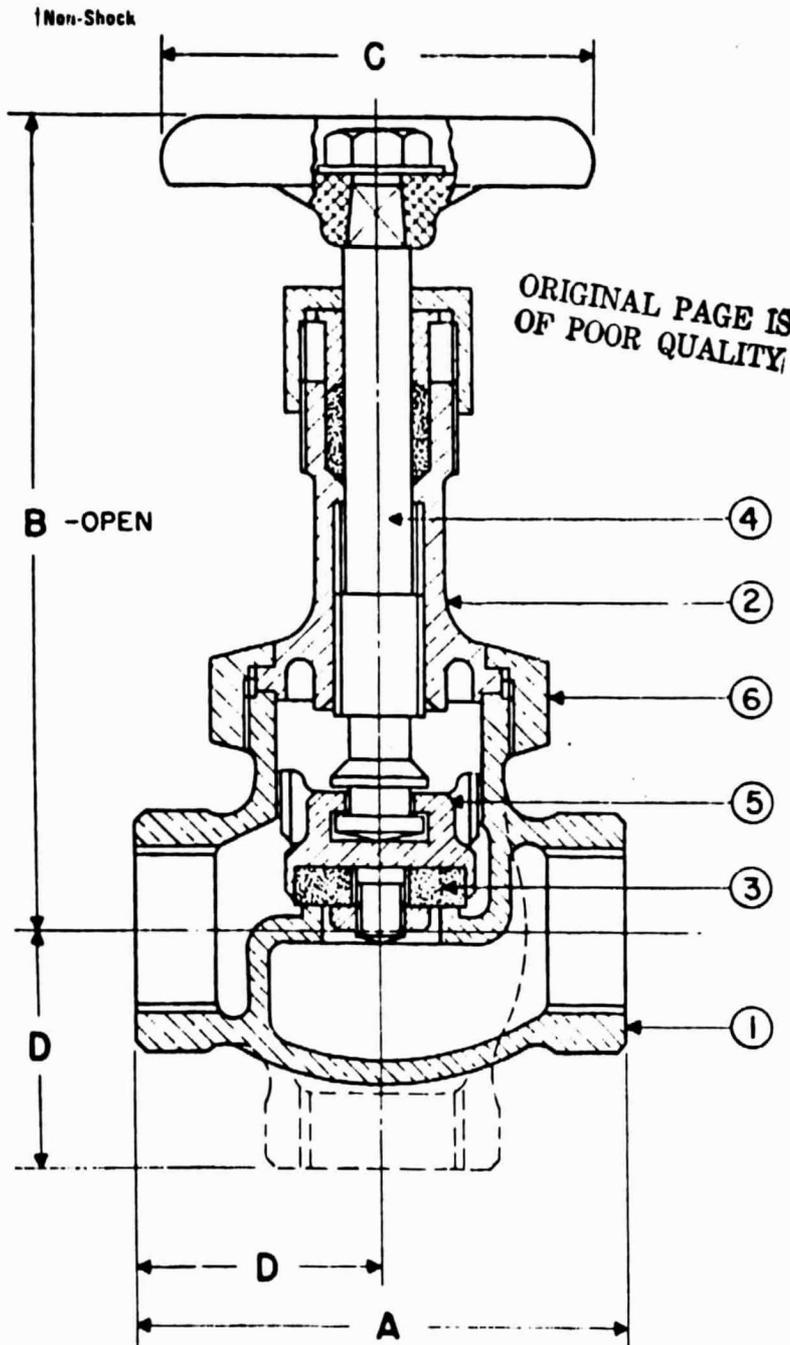
Wear in the throttling surface of this common plug-type globe valve reduces ability to

BRONZE GLOBE AND ANGLE

150 lb. SWP-300 lb. WOG† • Heavy Duty Service
Composition Steam Disc
Union Bonnet • Screwed Ends • Gland Packed



MILWAUKEE ⁵⁹¹590 GLOBE
MILWAUKEE 590S* GLOBE
MILWAUKEE 595 ANGLE
MILWAUKEE 595S* ANGLE



NOTE Teflon Disc available for 590 and 595.

TEST PRESSURES

300 psi Shell

150 psi Seat

MATERIAL LIST

NO.	PART	MATERIAL	SPECIFICATION
1	Body	Bronze	ASTM B 62
2	Bonnet	Bronze	ASTM B 62
3	Disc	Composition	
4	Stem	Bronze	ASTM B 62
5	Disc Holder	Bronze	ASTM B 16 ¼" & ⅜" ASTM B 62 ½" to 3" Incl.
6	Union Bonnet Nut	Bronze	ASTM B 62
	Packing	Teflon/ Imp./Asb.	Commercial
	Gland	Bronze	ASTM B 16
	Packing Nut	Bronze	Commercial
	Disc Nut	Bronze	Commercial
	Handwheel	Aluminum	Commercial
	Identification Plate	Aluminum	Commercial
	Handwheel Nut	Bronze	Commercial

DIMENSIONS—INCHES

SIZE	DIM. A	DIM. B	DIM. C	DIM. D
½	2 ½	4 ½	1 ¾	1 ½
¾	2 ½	4 ½	1 ¾	1 ½
1	2 ¾	4 ½	2 ¾	1 ¾
1 ¼	2 ¾	5 ½	2 ¾	1 ¾
1 ½	3 ¾	5 ½	2 ¾	1 ½
2	3 ¾	6 ¾	3	1 ¾
2 ½	4 ¾	7 ¾	3 ¾	2 ½
3	4 ¾	7 ¾	4	2 ¾
4	5 ¾	9	4 ½	2 ¾
5	6 ¾	10 ¾	5	3 ¾
6	8	12 ¾	6	3 ¾

*MILWAUKEE 590S

*MILWAUKEE 595S

300 lb. WOG†

Buna N Disc

590 and 590S meet or exceed the requirements of Federal Specification No. WW-V-51 for Type I, Class B Valves. 595 and 595S meet or exceed the requirements of Federal Specification No. WW-V-51 for Type II, Class B Valves.

IRON CHECK HORIZONTAL SWING

125 lb. SWP-200 lb. WOG • Bolted Cap



MILWAUKEE 2973 • SE • BM
MILWAUKEE 2972 • SE • AI
MILWAUKEE 2974 • FE • BM
MILWAUKEE 2971 • FE • AI

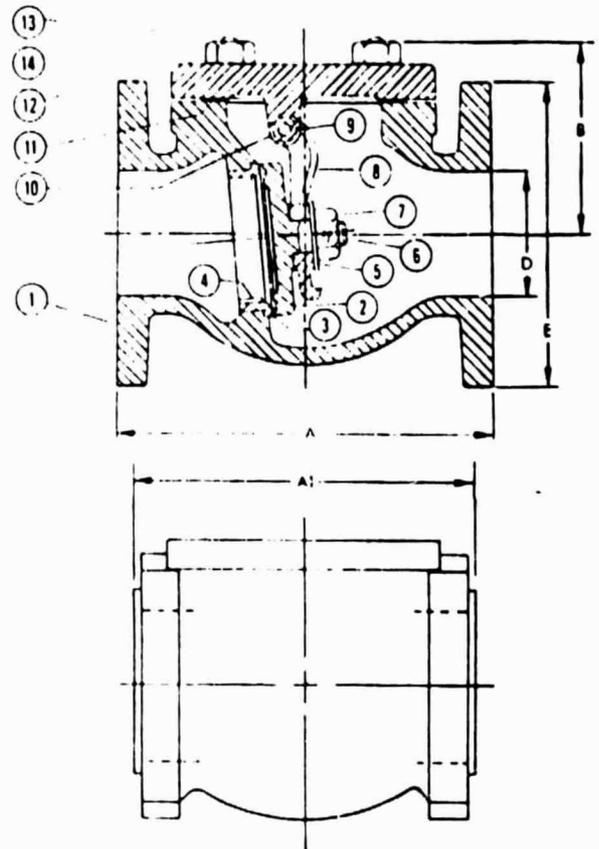
MATERIAL LIST

NO	DESCRIPTION	MATERIAL & SPECIFICATION
1	Body	Semi Steel • ASTM A 126 Cl B
2	Disc 2" 4" - BM Disc 5" 12" - BM Disc - AI	Bronze • ASTM B 61 Semi Steel • ASTM A 126 Cl B Semi Steel • ASTM A 126 Cl B
3	Disc Ring 5" 12" BM	Bronze • ASTM B 61
4	Seat Ring - BM Seat Ring - AI	Bronze • ASTM B 61 Semi Steel • ASTM A 126 Cl B
5	Disc Washer 2" 6" Disc Washer 8" Disc Washer 10" 12"	Steel • Mild Carbon Steel • ASTM A 107 Gr 1020 1022 Steel • ASTM A 7
6	Disc Stud 5" 12"	Steel • ASTM A 107 Gr 1015 1022
7	Disc Stud Nut	Steel • ASTM A 307 Gr B
8	Strap - BM Strap - AI	Bronze • ASTM A 61 Steel • ASTM A 216 Gr WCB
9	Strap Pin - BM Strap Pin - AI	Alum/Bronze • ASTM B 150 Al 1 Steel • ASTM A 108 Gr 1018 1020
10	Set Screw	Steel • Mild Carbon
11	Gasket	Asbestos • Compressed
12	Cap	Semi Steel • ASTM A 126 Cl B
13	Body Stud	Steel • ASTM A 107 Gr 1015-1022
14	Body Stud Nut	Steel • ASTM A 307 Gr B

DIMENSIONS

SIZE	2"	2½"	3"	3½"	4"	5"	6"	8"	10"	12"
A	8	8½	9½	10½	11½	13	14	19½	24½	27½
A1	6½	7	8		10					
B	3½	4½	4½	5½	5½	6½	7½	8½	10½	12½
D	2½	2½	3½	3½	4½	5½	6½	8½	10½	12½
E	6	7	7½	8½	9	10	11	13½	16	19

† Non-Stock



2972/2973 SE 2"-2½"-3"-4"

Flange Shape and Drilling to Spec. USAS B 16.1 (125 lb.)

MILWAUKEE VALVE COMPANY, INC.
2375 South Burrell Street • Milwaukee, Wisconsin 53207

CODE: SE - Screwed Ends, FE - Flanged Ends, BM - Bronze Mounted, AI - All Iron Construction.

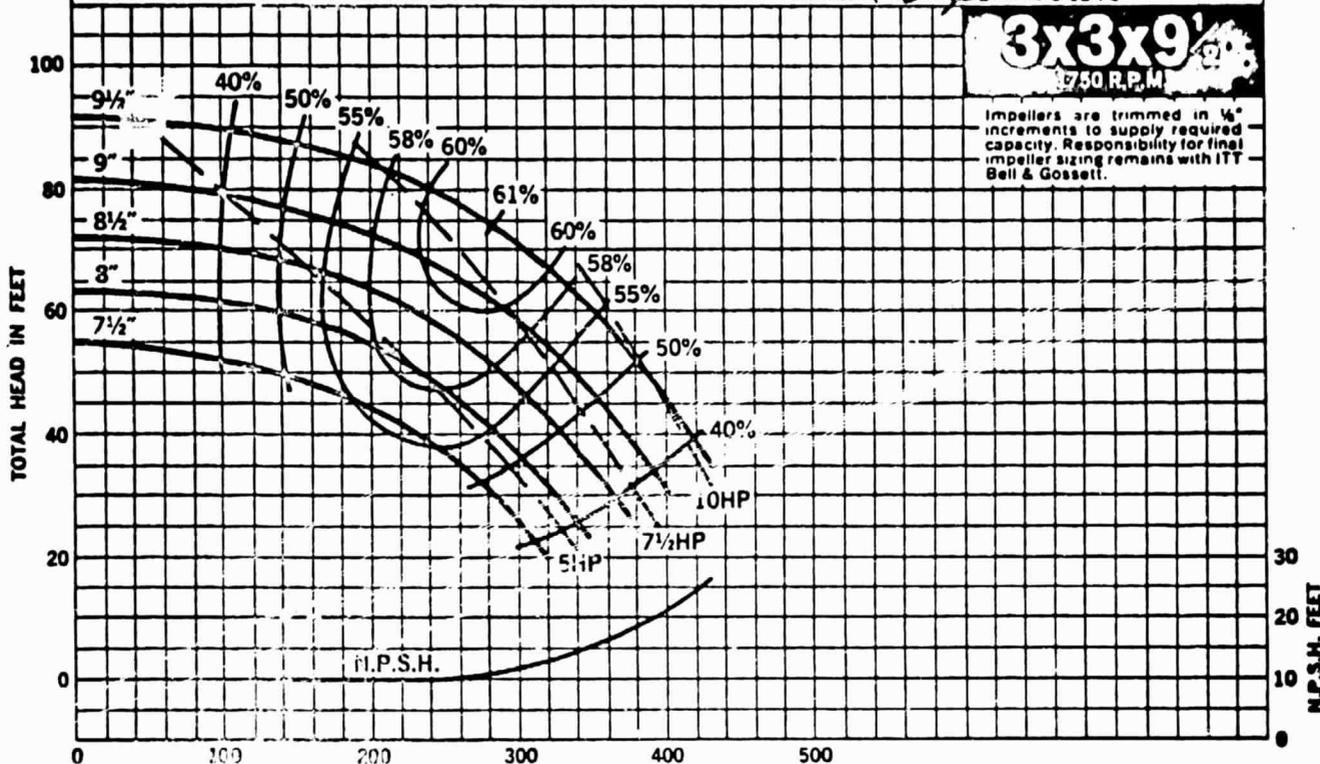
III. PUMPS

SERIES 80 PERFORMANCE CURVES

PERFORMANCE CHARACTERISTIC CURVE FOR 3x3x9½ CENTRIFUGAL PUMP FIG. NO. SERIES 80 SPEED 1750 R.P.M.

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

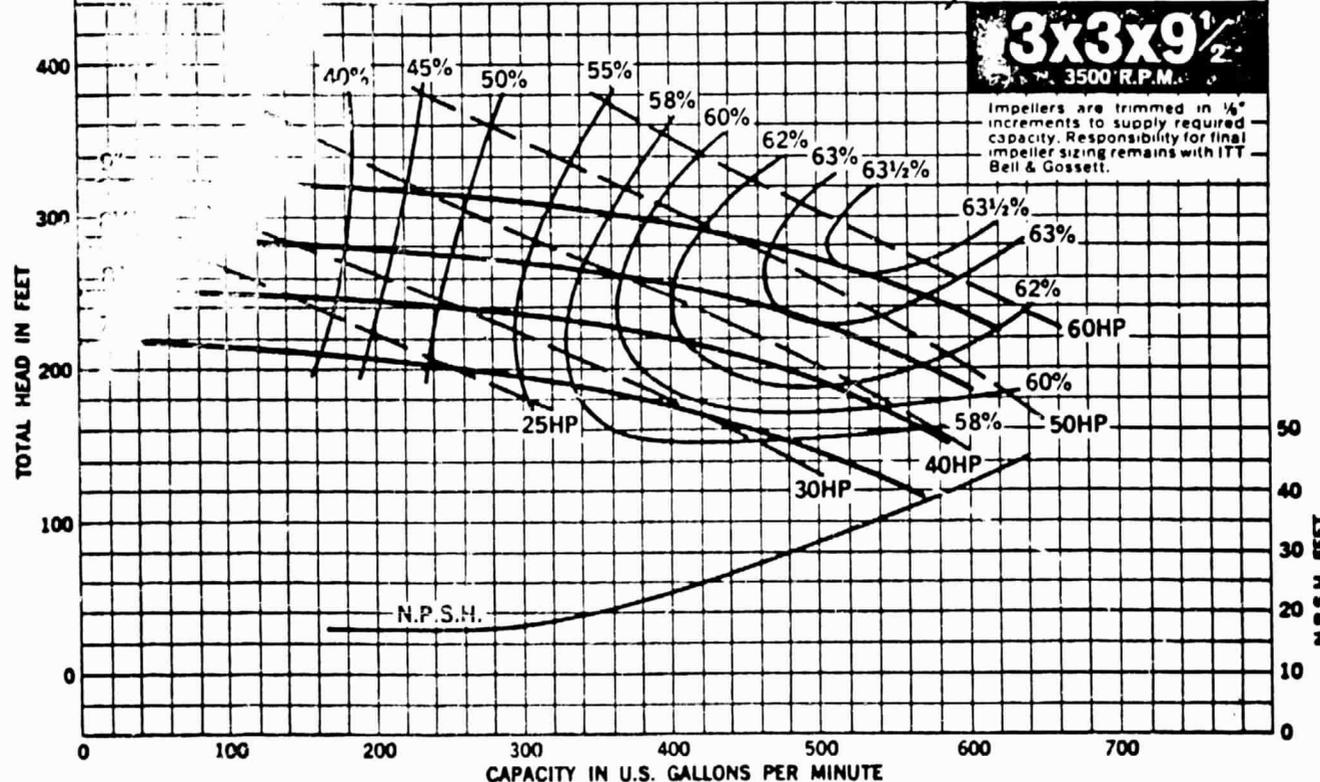
APPROVED *R. Boyer* DATE 3-18-70



PERFORMANCE CHARACTERISTIC CURVE FOR 3x3x9½ CENTRIFUGAL PUMP FIG. NO. SERIES 80 SPEED 3500 R.P.M.

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

APPROVED *R. Boyer* DATE 3-18-70

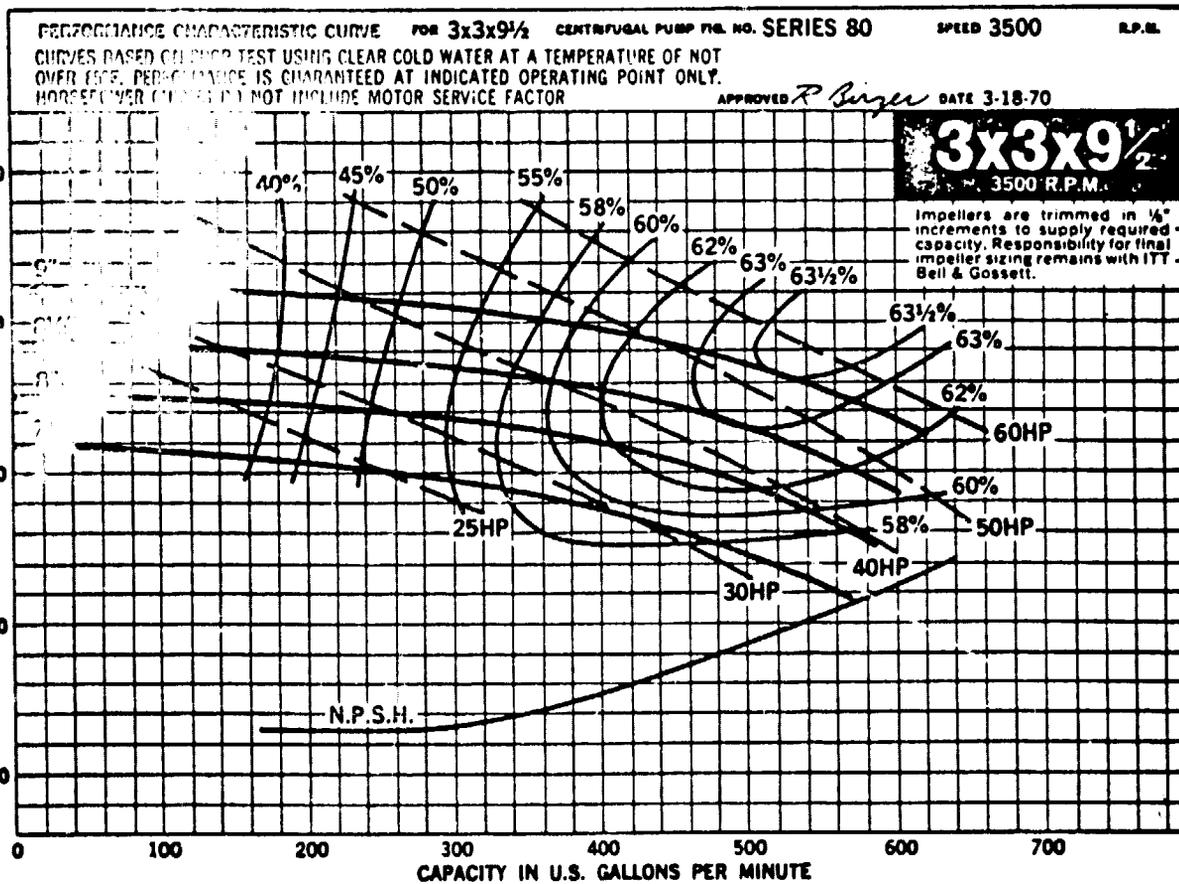
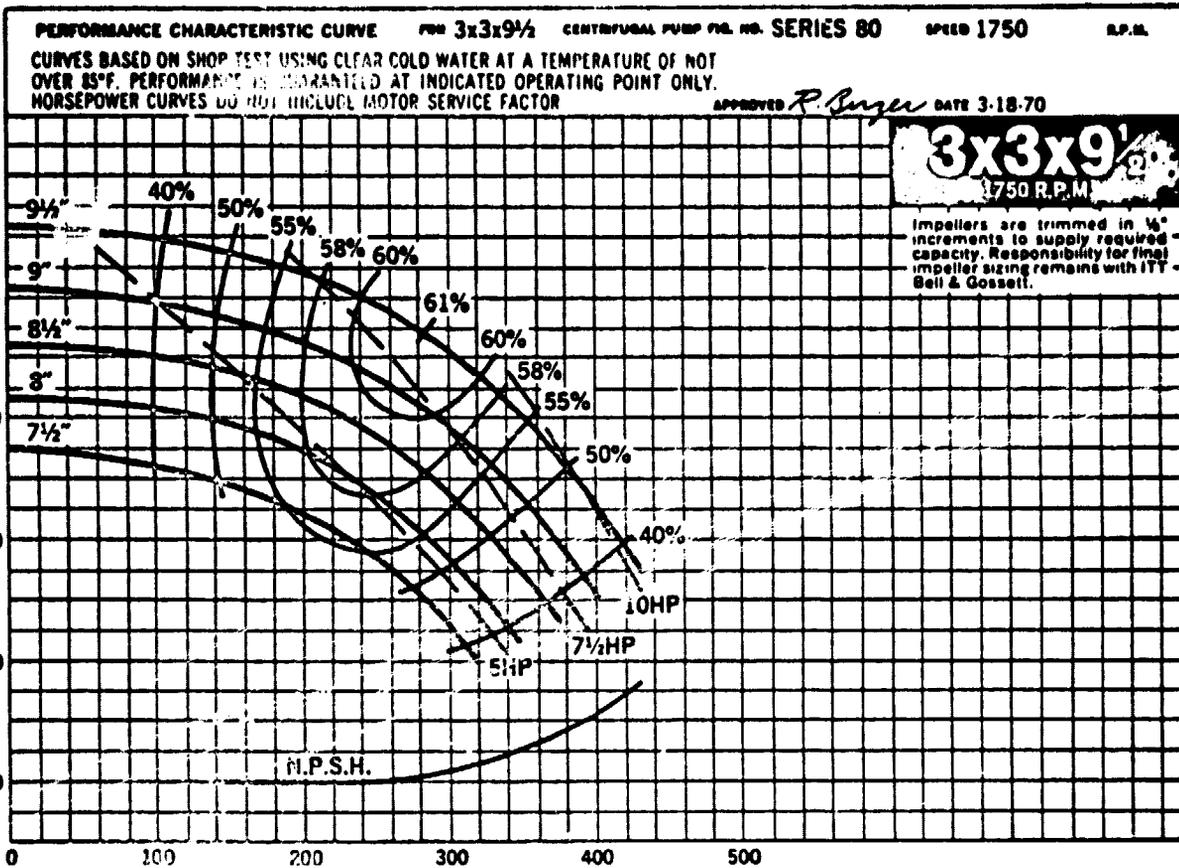


BELL & GOSSETT MORTON GROVE, ILL. 60053
Fluid Handling Division, International Telephone and Telegraph Corporation



III. PUMPS

SERIES 80 PERFORMANCE CURVES



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

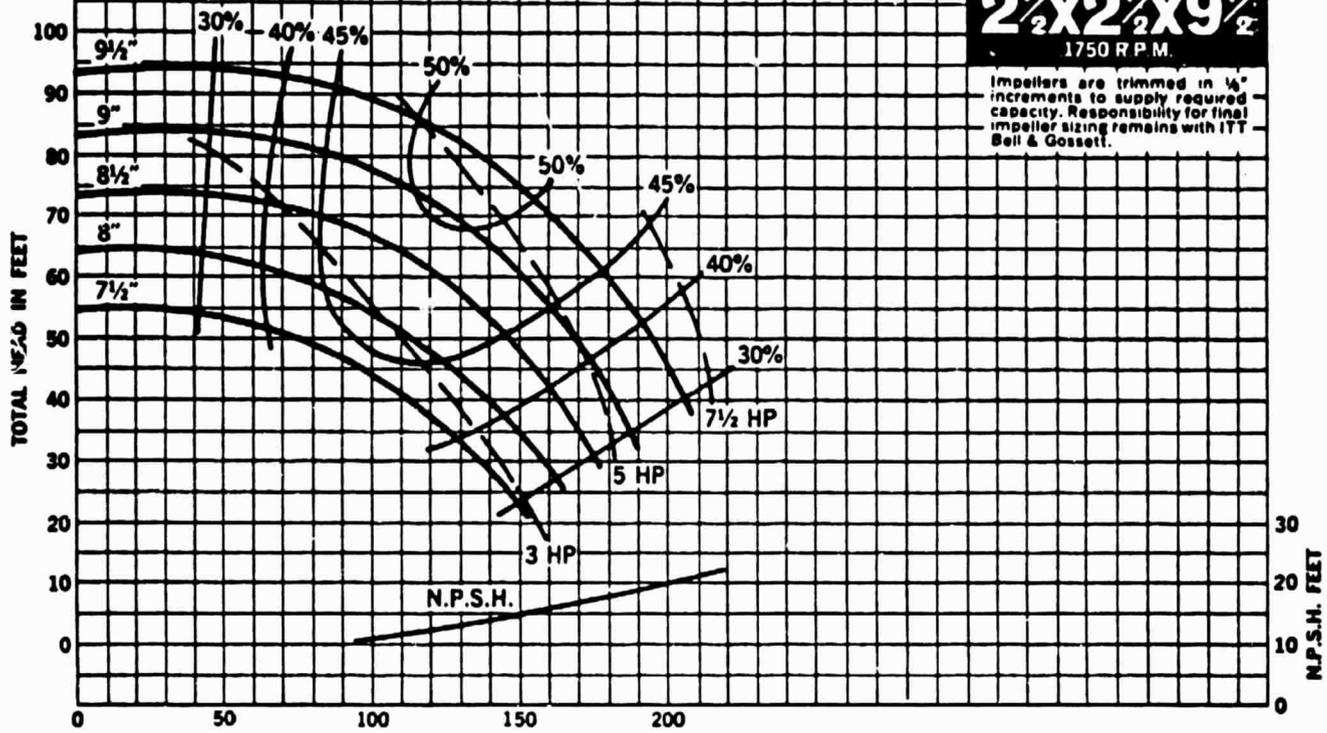
SERIES 80 PERFORMANCE CURVES

PERFORMANCE CHARACTERISTIC CURVE FOR 2½x2½x9½ CENTRIFUGAL PUMP FIG. NO. SERIES 80 SPEED 1750 R.P.M.
 CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY. HORSEPOWER CURVES DO NOT INCLUDE MOTOR SERVICE FACTOR.

APPROVED *R. Berger* DATE 3-18-70

2½x2½x9½
1750 R.P.M.

Impellers are trimmed in ¼ increments to supply required capacity. Responsibility for final impeller sizing remains with ITT Bell & Gossett.

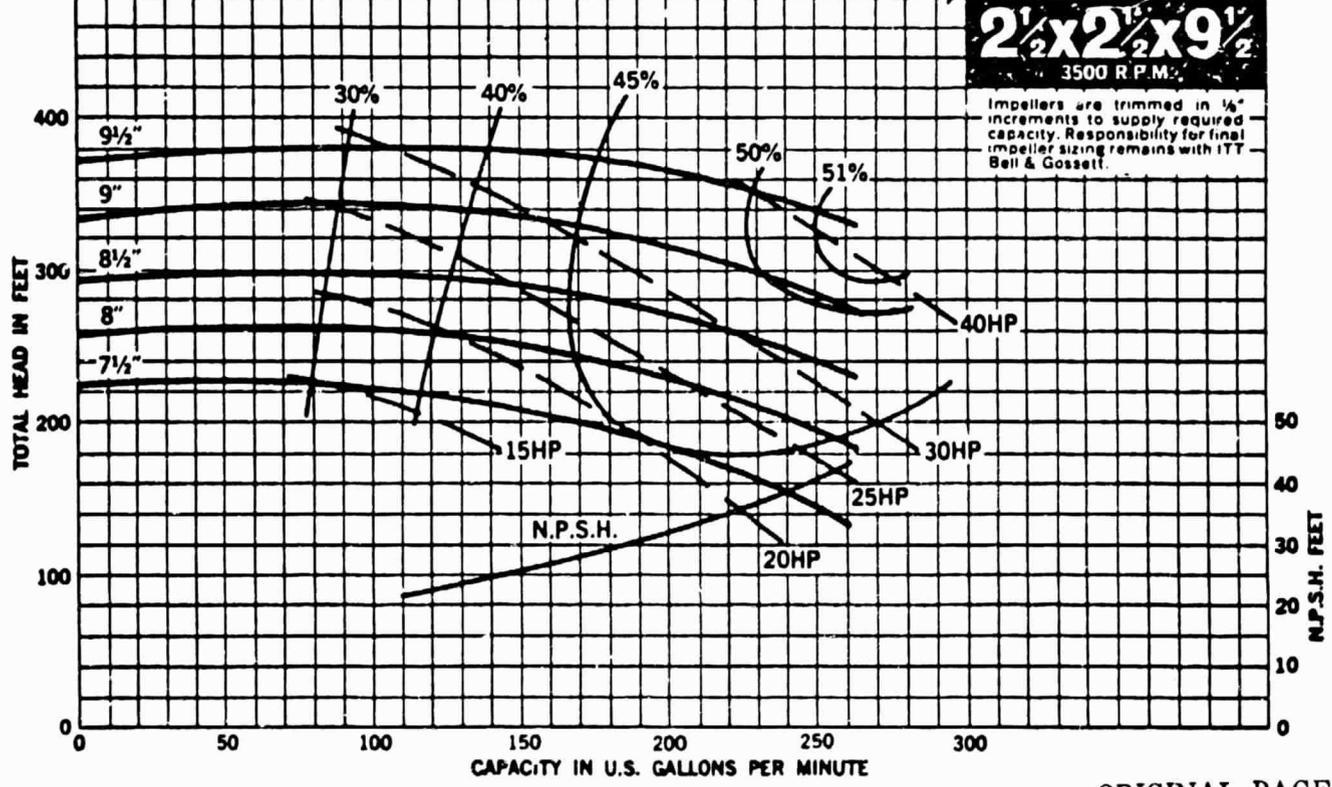


PERFORMANCE CHARACTERISTIC CURVE FOR 2½x2½x9½ CENTRIFUGAL PUMP FIG. NO. SERIES 80 SPEED 3500 R.P.M.
 CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY. HORSEPOWER CURVES DO NOT INCLUDE MOTOR SERVICE FACTOR.

APPROVED *R. Berger* DATE 3-18-70

2½x2½x9½
3500 R.P.M.

Impellers are trimmed in ¼ increments to supply required capacity. Responsibility for final impeller sizing remains with ITT Bell & Gossett.



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



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AURORA PUMP

A UNIT OF GENERAL SIGNAL

800 AIRPORT ROAD - NORTH AURORA, ILLINOIS - 60542

NO. OF PRINTS	
8	FOR APPROVAL
	FINAL

SALES OFFICE: W.W. GOETSH ASSOCIATES PO # 9829

FACTORY ORDER NUMBER: 9C7-9539

JOB: TELEX - BLUE EARTH MINNESOTA

SERVICE: _____

ENGINEER: _____

CONTRACTOR: MANKATO PLUMBING AND HEATING COMPANY

SOLD TO: MANKATO PLUMBING AND HEATING COMPANY PO # _____

REFERENCE: PUMP No. 1

PUMP

ONE NUMBER OF UNITS 4V9K7A SIZE 531 MODEL 11'-0" PIT DEPTH
290 GPM 20' HEAD 1750 RPM DUPLEX SIMPLEX

STUFFING BOX:

- SLINGER
- PACKING
- LANTERN RING

PUMP BEARING:

- STANDARD
- CUTLESS RUBBER
- RELIEF
- GRAPHITAR
- GLASS/TEFLON

INTERMEDIATE BEARING:

- STANDARD
- CUTLESS RUBBER
- RELIEF
- GRAPHITAR
- GLASS/TEFLON

LUBRICATION:

- GREASE
- FLUSH
- PRESSURIZED

CONSTRUCTION:

- STANDARD FITTED
- _____

COUPLING:

- STANDARD
- GUARD
- _____

BASE PLATE:

- 40" DIA
- 20x24 OVAL
- 22x28 OVAL

CONTROLS:

- SG-D9036-A65-S4 FLOAT SWITCH
- _____ ALTERNATOR
- _____ HIGH WATER ALARM

MOTOR

2 HP. 3 PHASE 60 HERTZ 230/460 VOLTS 1760 RPM 195HP FRAML

BY: AURORA
 OTHERS

- ODP
- TEFC
- XPROOF

VERTICAL

FACTORY CHOICE
MANUFACTURER

NOTE: MOTOR NOT MOUNTED AT FACTORY ON VERTICAL UNITS.

SPECIAL REQUIREMENTS

PUMP: S.S. SHAFT

DRIVE: _____

ELECTRICAL: _____

CERTIFIED PRINT: SECTION: 530 PAGE: 253 CURVE NUMBER: 3PC-116306
SPECIAL: _____ MAINTENANCE: _____
BY: M DW DATE: 8/3/77 OFFICE: AURORA

THIS ORDER WILL NOT BE PROCESSED FOR MANUFACTURING UNTIL APPROVAL IS RECEIVED.
PRINTS ARE NOT TO SCALE AND ARE CERTIFIED CORRECT ONLY FOR THIS ORDER. ALL
ORDERS SUBJECT TO ACCEPTANCE AT AURORA PUMP, NORTH AURORA, ILLINOIS.

THIS ORDER CAN BE RELEASED FOR MANUFACTURING AS SHOWN: []

RELEASE FOR MANUFACTURING PER ATTACHED CHANGE ORDER: []

AUTHORITY: _____

OFFICE: _____

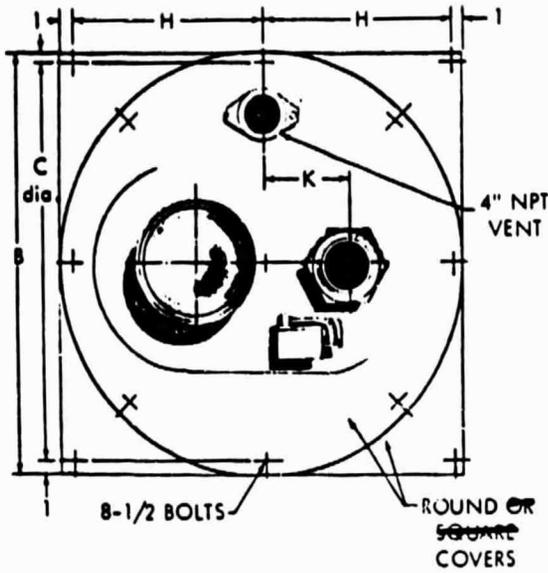
DATE: _____

AURORA MODEL 531 PUMP ON SIMPLEX PLATE WITH OVAL

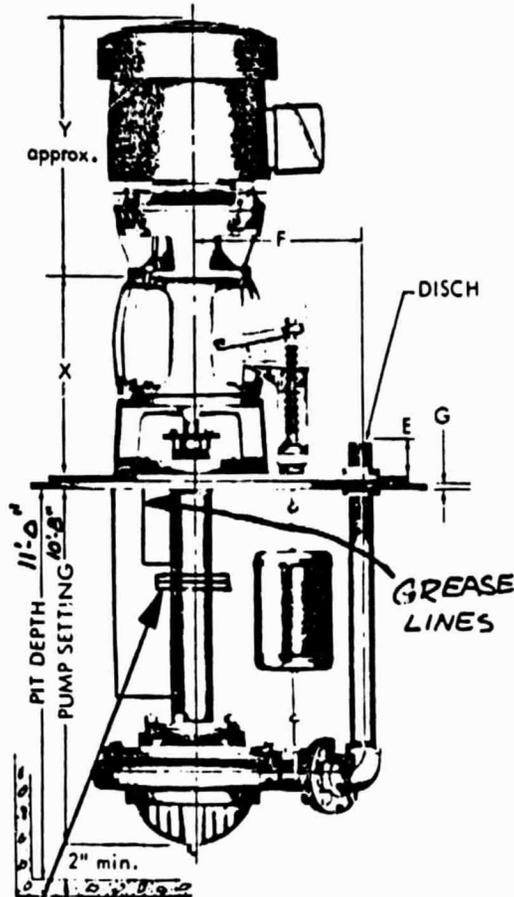
SECTION 530 PAGE 253

DATED MARCH 1975

SUPERSEDES PAGE 253
DATED AUGUST 1973



PUMP SIZE			E	F	K	MIN. COVER SIZE
DISCH	SUCTION	CASE BORE				
1 1/2	1 1/2	7	3 1/2	8 1/8	5 1/8	34
1 1/2	1 1/2	9	3 1/2	9 1/8	7 1/8	34
1 1/2	2	7	3 1/8	8 1/2	6	34
1 1/2	2	9	3 1/8	10 1/4	7 1/4	34
1 1/2	2	12	3 1/8	12 1/8	9 1/8	36
2	2 1/2	7	4 1/8	10 1/8	7 1/8	34
2	2 1/2	9	4 1/2	12	9	36
2	2 1/2	12	3 11/16	13 11/16	10 11/16	36
2 1/2	3	7	4 1/8	11 1/4	8 1/4	36
2 1/2	3	9	4 1/8	12 11/16	9 11/16	36
2 1/2	3	12	3 11/16	14 1/2	9	36
3	4	9	4 1/8	13 11/16	8 1/8	36
3	4	12	4 1/8	15 1/8	9 11/16	36
4	4	7	4 1/8	13 3/8	8 3/8	36
4	5	9A	4 1/8	14 1/4	8 3/8	36
4	5	9B	4 1/8	15 1/2	9 1/2	36
6	6	9	5 1/8	14 1/4	8 1/2	36



OVAL SIZE	
20 X 24	
22 X 28	X

COVER SIZE B	C	H	G
			STEEL
34	32	16	1/2
40	38	19	1/2
46	44	22	1/2
53	51	25 1/2	1/2
60	58	29	1/2
66	64	32	1/2
78	76	38	1/2

FRAME	X	Y
143HP	13 1/8	11
145HP	13 1/8	12
182HP	13 1/8	13
184HP	13 1/8	14
213HP	13 1/8	16
215HP	13 1/8	17
254HP	13 1/8	19
256HP	13 1/8	21
284HPH	15 1/2	21
286HPH	15 1/2	23
324HP	15 1/2	24
326HP	15 1/2	25
364HP	15 1/2	29
365HP	15 1/2	30

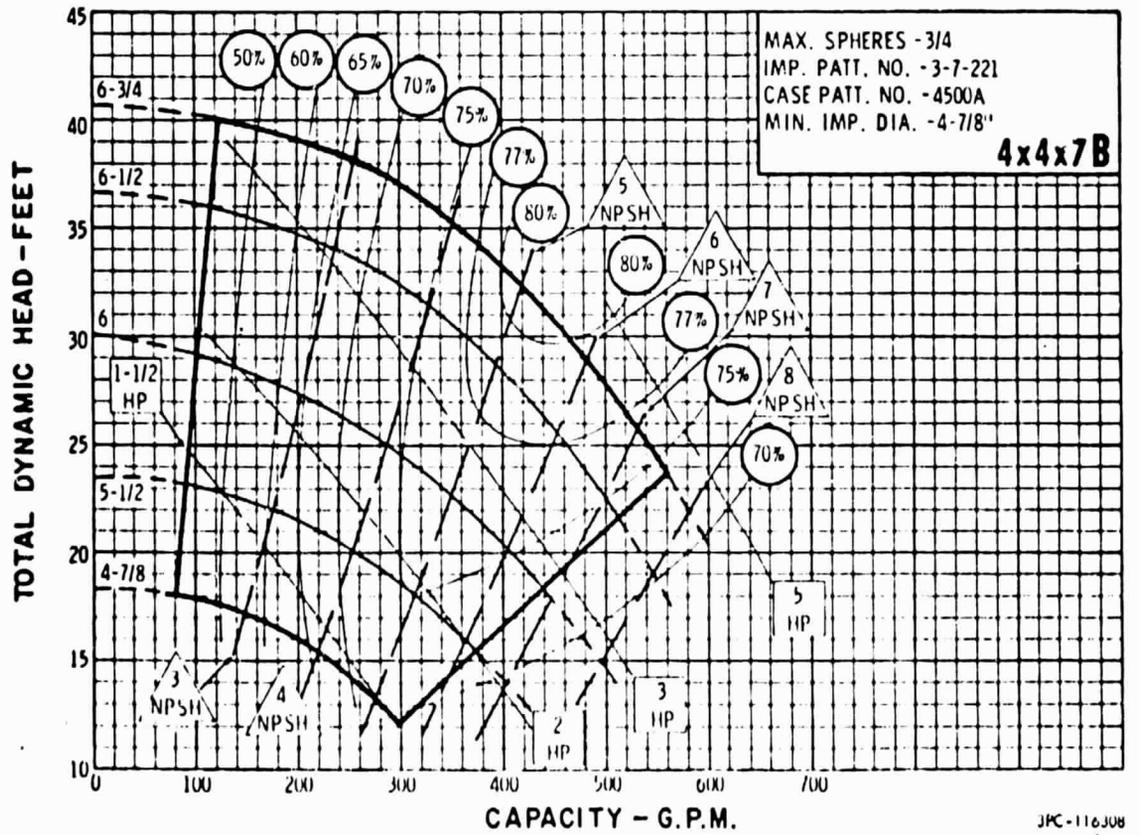
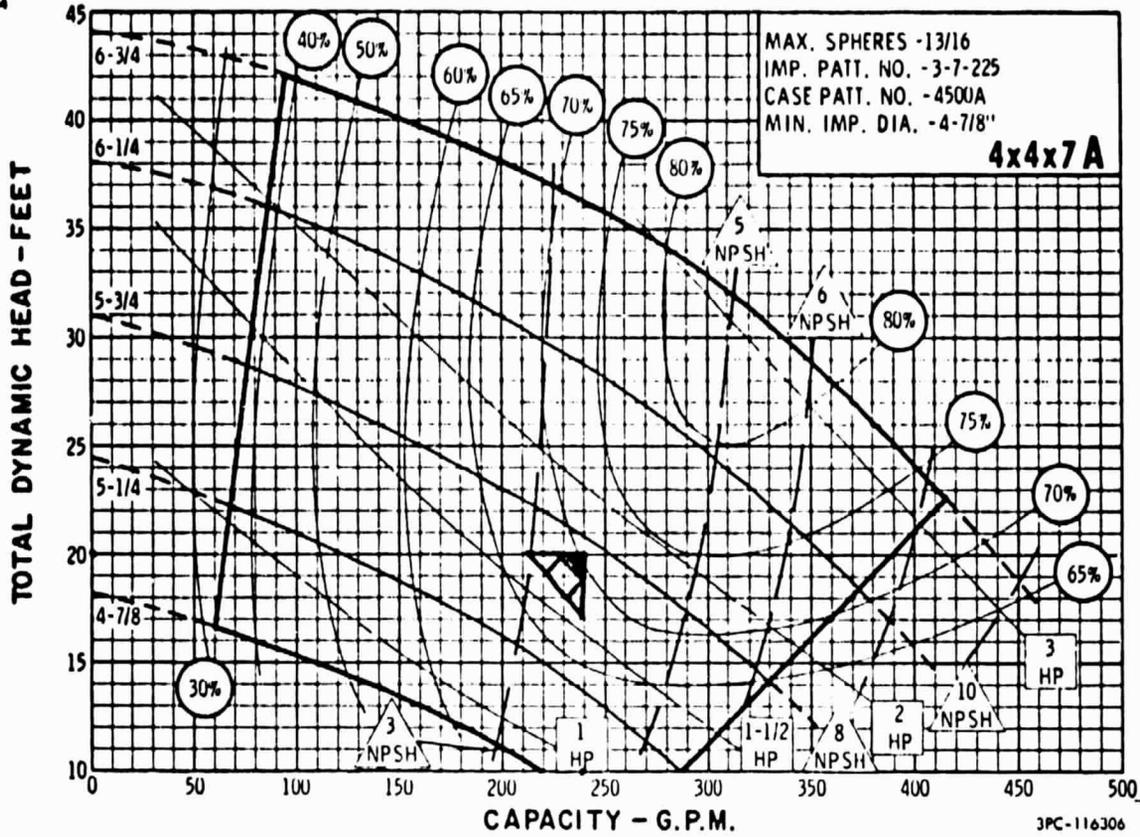
- NOTES: 1. ALL DIMENSIONS IN INCHES.
2. DIMENSIONS MAY VARY ±1/8.
3. NOT FOR CONSTRUCTION PURPOSES UNLESS CERTIFIED.
4. FLOAT SWITCH FURNISHED ONLY WHEN SPECIFIED.
5. LINE SHAFT BEARING FURNISHED ON 6' 2" PUMP SETTINGS AND LONGER.
6. PUMPS WITH 36" COVER AND LARGER ARE SUPPLIED WITH 22 X 28 OVAL AS STANDARD.



AURORA PUMP
A UNIT OF GENERAL SIGNAL

(103 AIRPORT ROAD - NORTH AURORA, IL; INQUIRY - (312) 642-1000

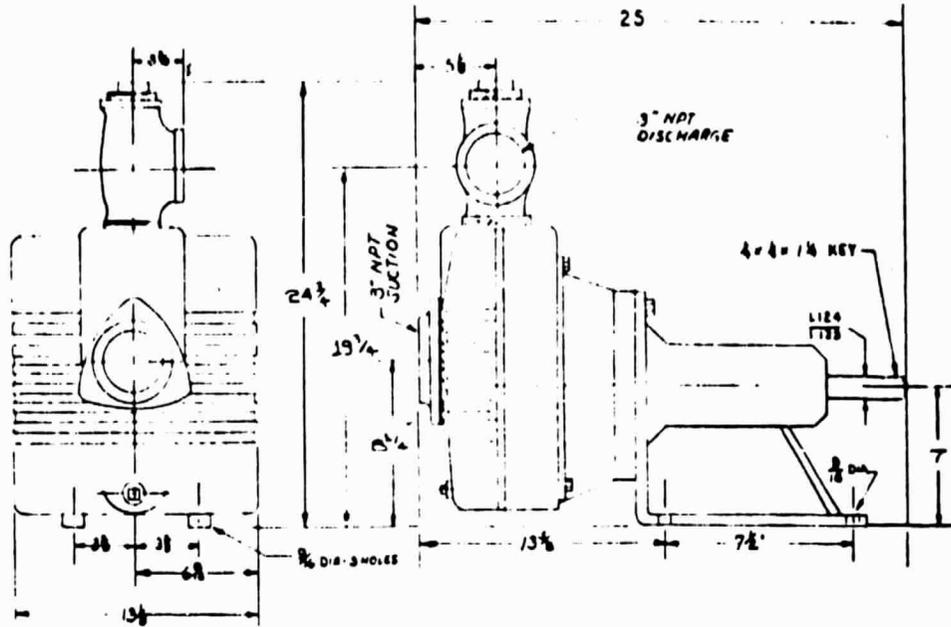
4 x 4 x 7 SERIES 530
ENCLOSED IMPELLER



AURORA PUMP
 A UNIT OF GENERAL SIGNAL CORPORATION

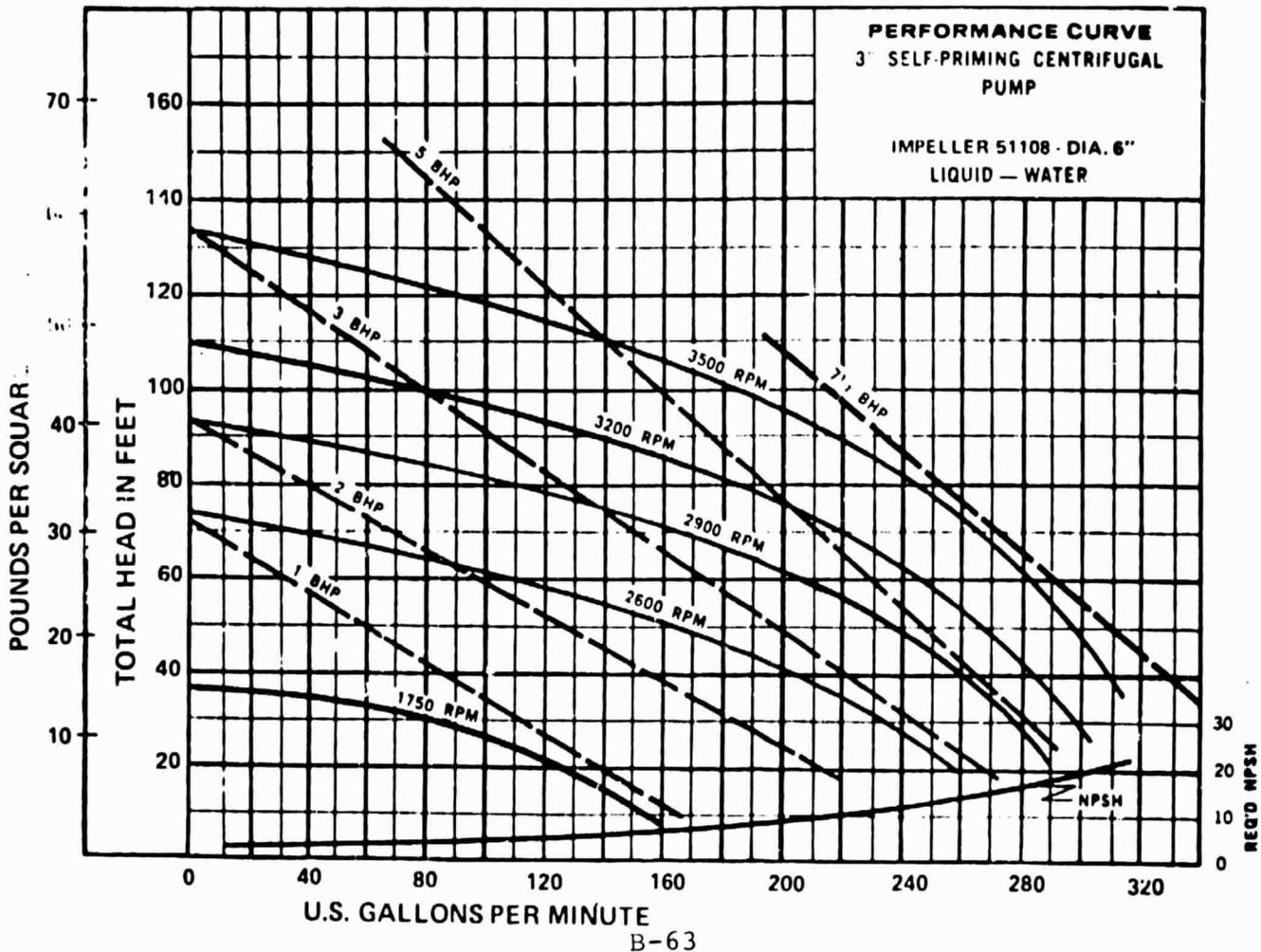
AURORA - ILLINOIS

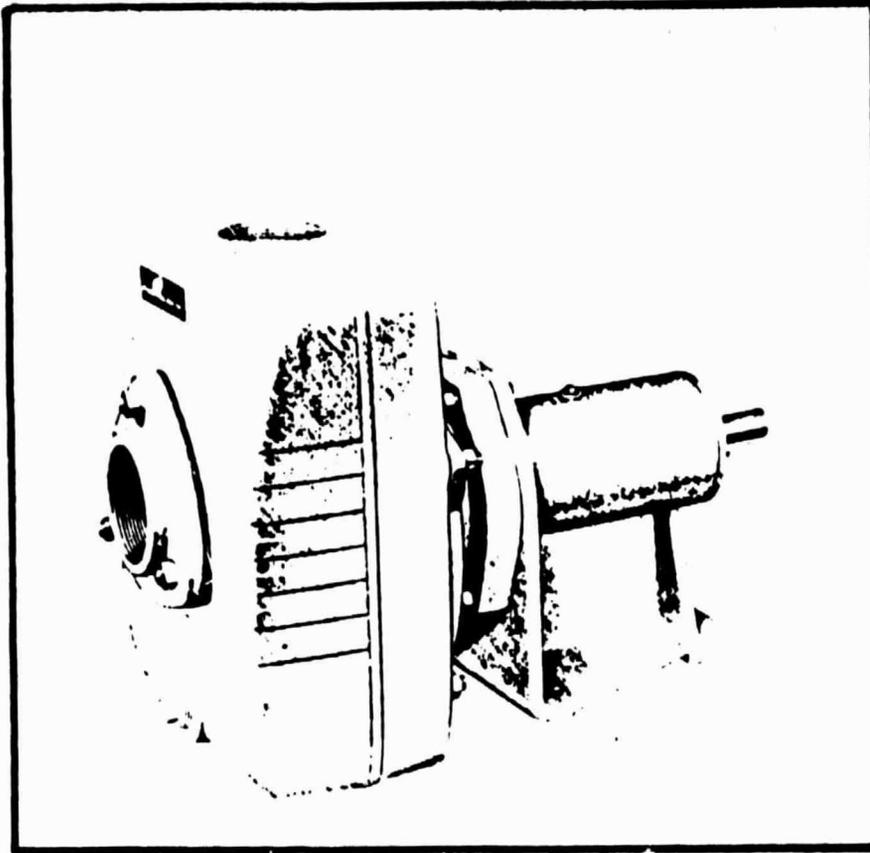
Model 151CU-1



Peabody Barnes
 MANSFIELD, OHIO

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Model 151CU-1

Size 3" x 3"

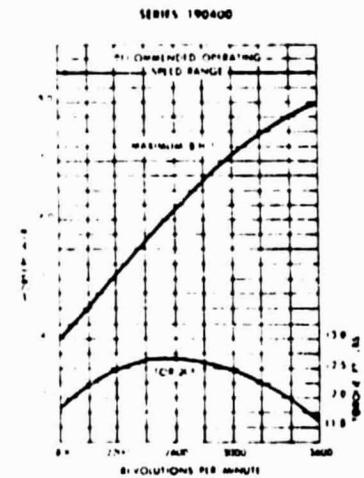
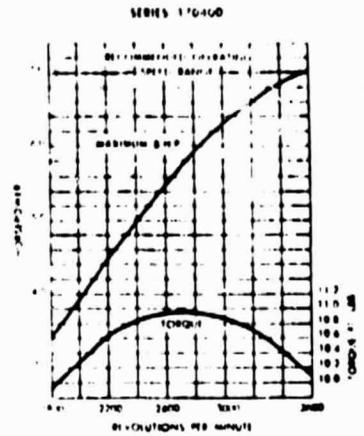
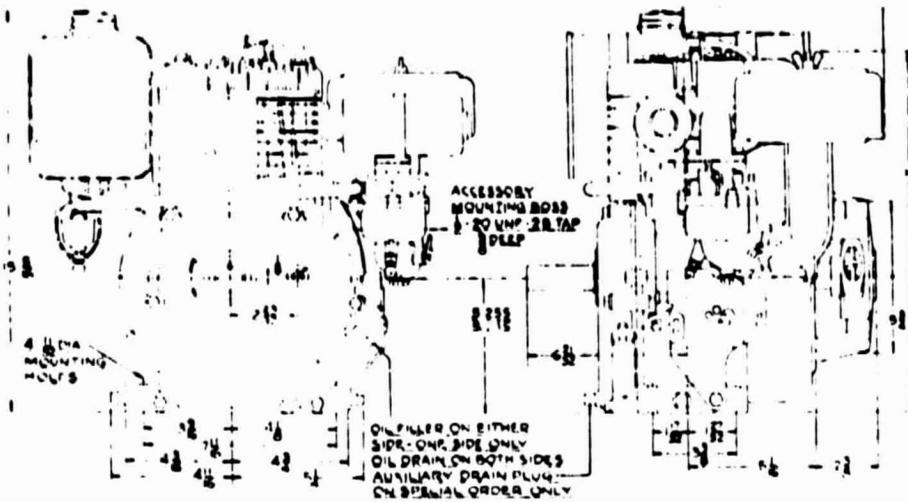
- **UNIVERSAL DRIVE—
ADAPTS TO ANY
POWER SOURCE**

SELF PRIMING CENTRIFUGAL PUMP

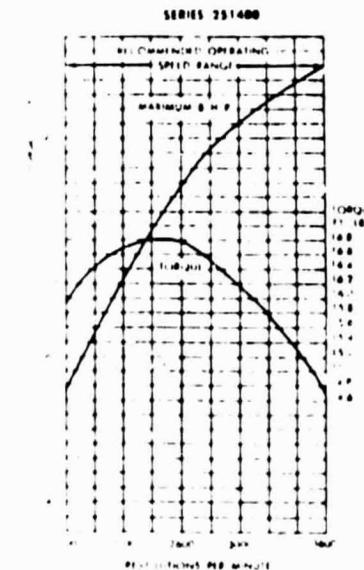
PUMP SPECIFICATIONS

- Size Suction & Discharge:** 3" x 3"
Body Material: Cast Iron
Volute Material: Cast Iron
Impeller Material: Cast Iron
Impeller: Open Type, Cast Iron
Seal: Double Oil Lubricated Mechanical
Face and Lip Type, Stainless Steel
Metal Parts, Carbon and Ceramic Faces
Pedestal Material: Cast Iron
Bearings: 2 Radial Ball Bearings
Shaft: Steel with Stainless Steel
Standard Equipment: Discharge Priming Tee,
Suction Flange, Suction Check Valve
- Note:** Available with Base, Flexible Coupling,
Electric Motor and Special Seals—
Consult Factory

ENGINES 7 H.P. to 10 H.P.

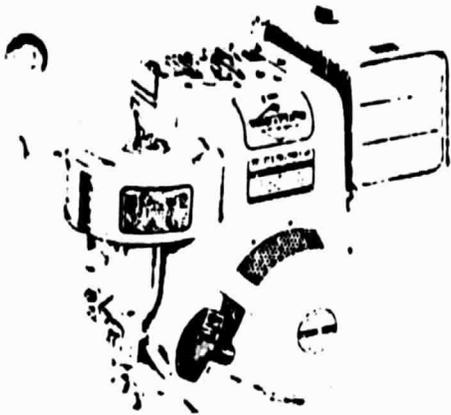


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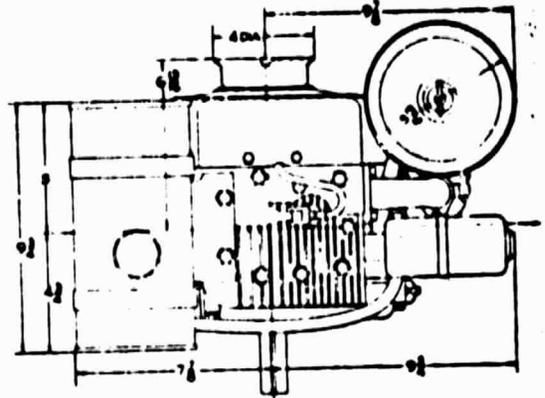
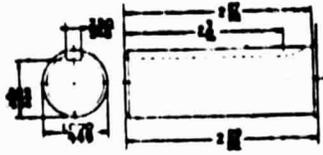


HORIZONTAL CRANKSHAFT

SERIES 170400

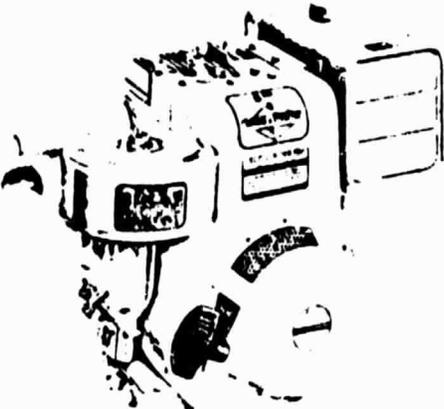


Series	Bore	Stroke	Displ	H.P.	Net Wt.
170400	3	2 1/4	16.7	7.0	44 1/2

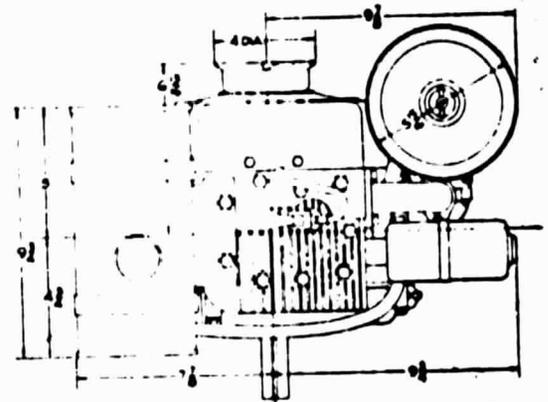


SERIES 190400

SERIES 190400

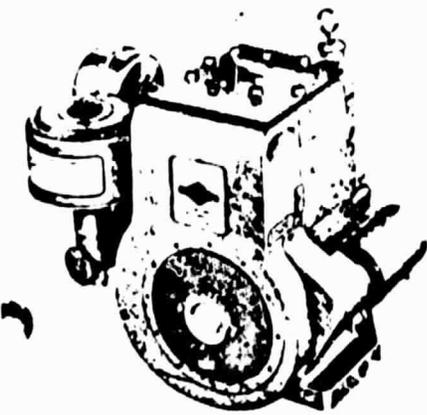


Series	Bore	Stroke	Displ	H.P.	Net Wt.
190400	3	2 1/4	19.44	8.0	45

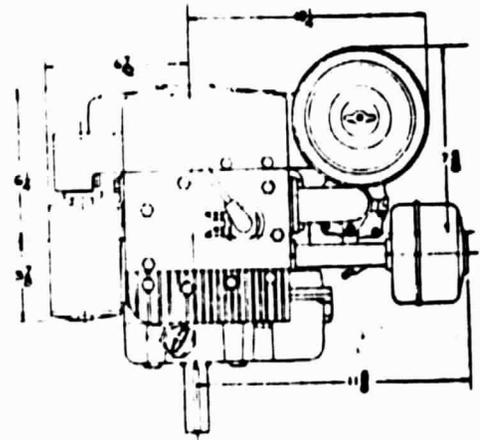


SERIES 251400

SERIES 251400



Series	Bore	Stroke	Displ	H.P.	Net Wt.
251400	3 1/4	2 1/4	24.36	10.0	67





AML

IV. PIPING

SUBMITTAL DATA

DATE: July 7, 1977

JOB: Solar System Underground Pre-Insulated Piping

LOCATION: Telex Corporation

CONTRACTOR: Mankato Plumbing & Heating
Mankato, MN

ENGINEER: I T C (Intertechnology Corp.)
Warrenton, VA

SYSTEM: Rovanco's Insul-8 Copper "0" Ring Coupled

Carrier Pipe:
(Inner Pipe)

Tubing, Copper, Type L, conforming to ASTM B88, "0" Ring Coupled

Insulation:

Polyurethane foam conforming to MIL-I-24172 with the following minimum characteristics: Thickness-1", Density-2pcf, Closed Cell Content-90-95%, K Factor-.13 at 65°F

Jacketing Material:

Seamless polyvinylchloride (PVC) Class 12454 compound conforming to ASTM 1784, Type 1, Grade 1

Joining Method of System:

An integral part of each 20' length of pipe includes a machined bronze coupling containing one "0" Ring Seal with operating temperature and pressure limits of 250°F and 250 psi as rated by independent testing laboratories

Fittings:

Wrought copper compatible with pipe

End Seals:

End seal protection of exposed insulation according to Rovanco Corp's most recent data

Expansion/Contraction:

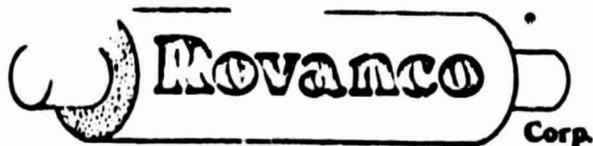
Taken up in coupling mechanism which allows 3/4" expansion or contraction every 20 feet

Insulation of Coupling Joints:

Couplings are insulated with flexible polyurethane disk and sleeved with PVC with seams sealed with a heat shrinkable tape to complete vapor barrier

Insulation of Fittings:

Fittings are left uninsulated but are thrust blocked in poured concrete to provide anchors and to insure movement is taken up in coupling mechanisms



210 SO CENTER STREET
JOLIET, ILLINOIS 60438

PHONE: 815-726-0640

Insul-8

Manufacturers of Pre-Insulated Piping System.

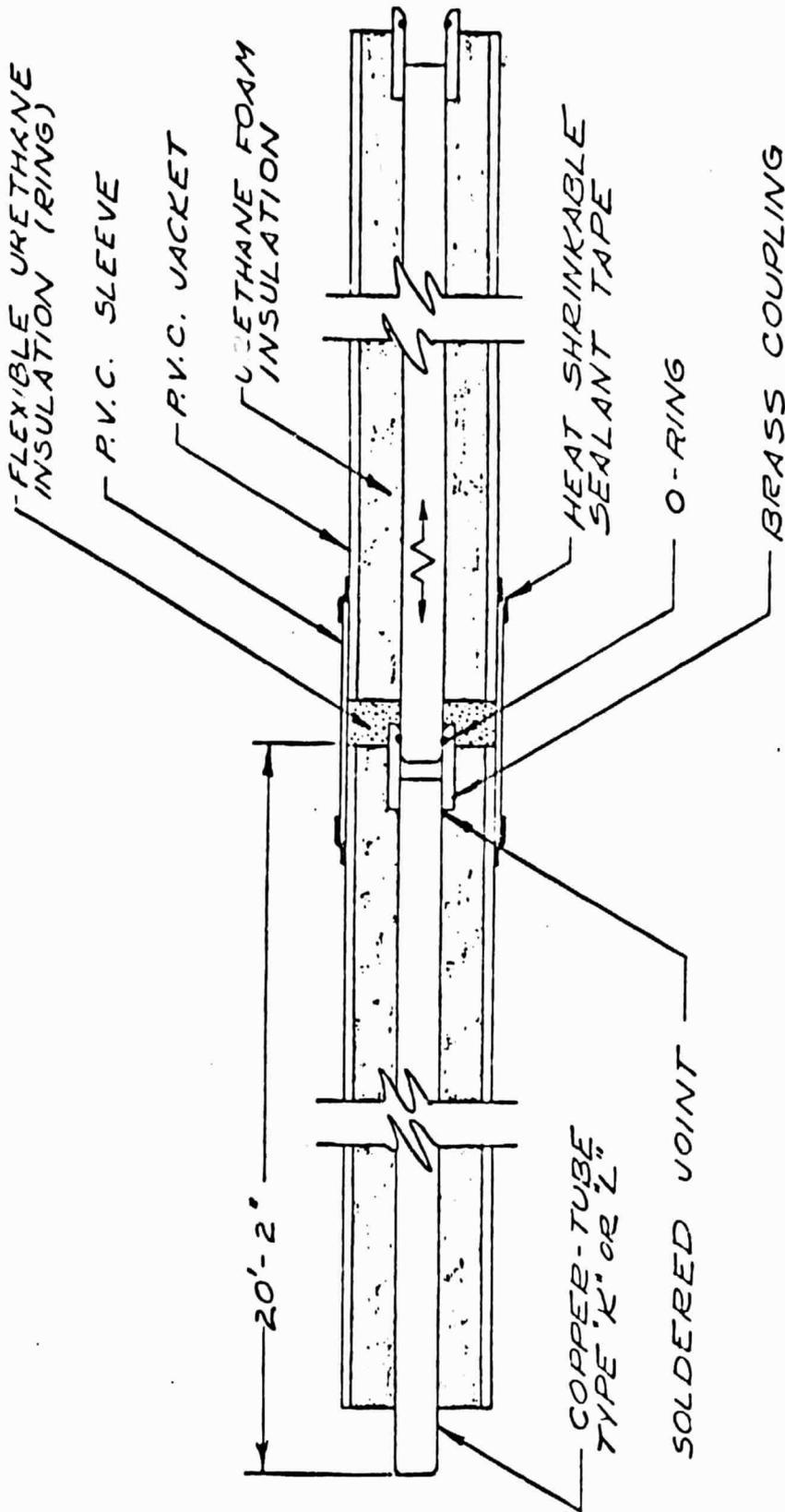
ROVANCO INSUL-8 "0" RING COUPLING

Drawing Description and Assembly Instructions

The O-Ring Coupling System shown in Rovanco Drawing #75 has been designed to allow for expansion and contraction of underground insulated piping systems. This O-Ring Coupling follows all basic design and engineering principles and meets all federal specifications for these type systems. Other competitors have similar systems which are patented. Rovanco's patents do not infringe others in any way, and you will be indemnified in this matter.

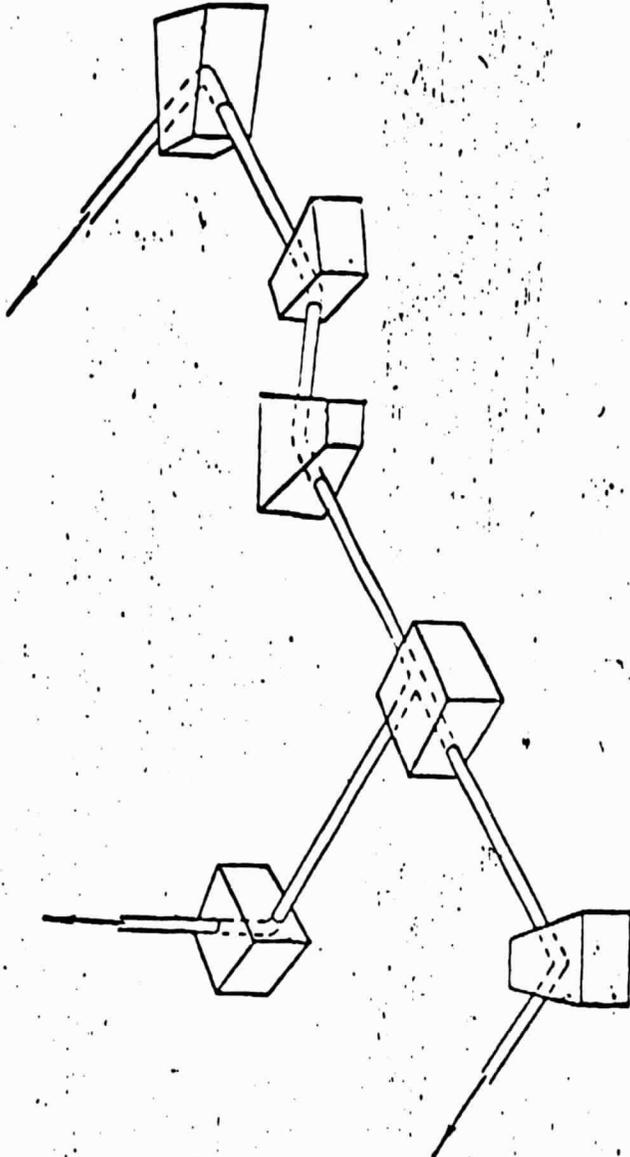
Our system comes to you complete and ready to install with the expansion coupling attached to one end of the pipe, and the other pre-sized and dressed to insert into the coupling.

1. Place P.V.C. Sleeve on one end of the pipe. Slide it back so it will be out of the way for joint assembly.
2. Clean off any dirt or oil from the coupling (female end) and the spigot end (male end).
3. Place flexible urethane ring around the coupling and insert spigot end into coupling until there is no gap between the sections.
4. Slide P.V.C. Sleeve over the joint centering it.
5. Elbows are soldered to a spigot end of pipe and the foam is sealed against moisture with an end seal.
6. If necessary to cut full lengths in the field, this is easily done by following the instructions in Exhibit B.
7. Concrete thrust blocks are poured as anchors at all changes of directions, 90° Els, 45° Els, Tees.
8. After the system has been installed and pressure tested, the sleeves that were slid over the couplings are sealed with tapecoat to prevent any ground water from entering the system.



ORIGINAL PAGE IS OF POOR QUALITY

Insul-8 SYSTEMS BY ROVANCO CORP.		DRAWN BY	M.E.
		APPROVED BY:	<i>A.S.</i>
SCALE:		DATE:	3/16/76
Copper Expansion Coupling		DRAWING NUMBER	75



Insul-8		SYSTEMS BY ROVANO CORP.	
SCALE: _____	APPROVED BY: <i>AD!</i>	DRAWN BY <i>MB</i>	
DATE: <i>3.11.76</i>		R. VISED	
THRUST BLOCKS			
			DRAWING NUMBER 45

McQuay DIVISION, McQUAY-PERFEX INC.
P.O. BOX 1551, MINNIAPOLIS, MINNESOTA 55440

**SERPENTINE
WATER COIL**

FOR.4 2329308

HI-E4
HI-E5

CERTIFIED DRAWING V. HEAT EXCHANGERS

JOB: Telex Corporation - Blue Earth, Minn.

DATE 6/30/77 DR. TMC
CH. APP.

G.O.

PURCHASER:
Mankato Plumbing & Heating

PURCHASERS P.O. 100
REP. Schwab-Vollhaber, Inc.

CONS. ENG'R:
International Design, Inc.

REP. P.O. PAGE 1 OF 1
10 PRINTS FOR APPR'L. FOR RECORD

REVISION	NO.	DATE	BY	WAS

PHYSICAL AND PERFORMANCE DATA

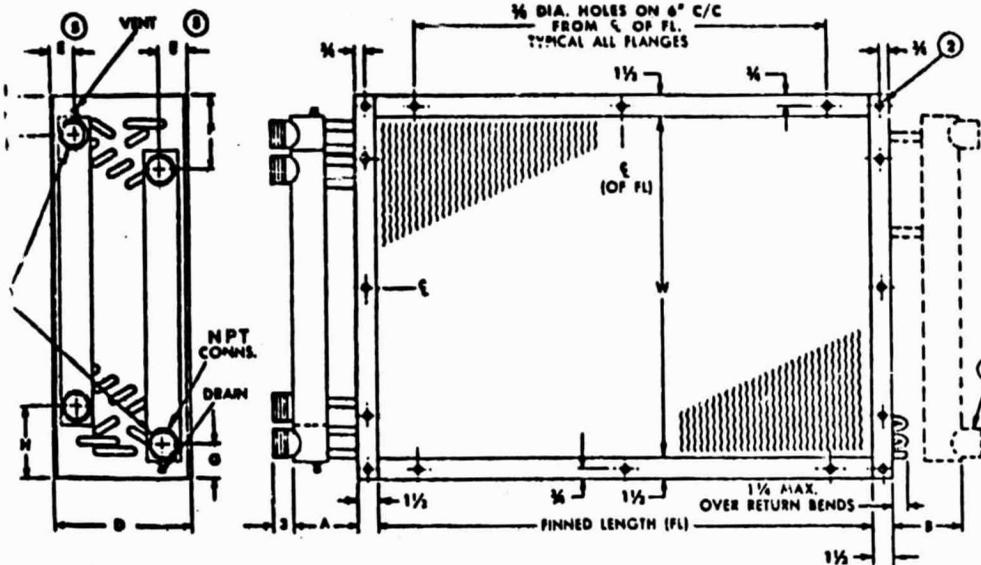
ITEM	QTY.	COIL MODEL NUMBER			FACE DIMENSIONS			AIR FLOW (H, V)	CONN. NPT	TAG, MARK OR NOTES	
		TYPE	FIN SERIES	ROWS	FIN GEOM.	W (IN.)	F.L. (IN.)				AREA (SQ. FT.)
010	1	5WS	10	03	C	21	84	12.25	H	1 1/2	Unit #1
020	2	5WS	12	03	C	21	84	12.25	H	1 1/2	Unit #2 and #3
030	1	5WH	08	03	C	18	60	7.5	H	1 1/2	Unit #4
040	2	5WH	12	03	C	12	24	2.0	H	1 1/2	Unit #5 and #6
050	1	5WH	10	03	C	15	30	3.125	H	1 1/2	Unit #7
060	2	5WS	06	03	C	21	84	12.25	H	1 1/2	Unit #8 and #9

ITEM	AIR CONDITIONS						CAPACITY		WATER CONDITIONS				
	CFM (STD. AIR)	FACE VEL. (FPM)	ENTERING		LEAVING		AIR P.D. IN. H ₂ O	SENSIBLE BTUH	TOTAL BTUH	GPM	ENT. (°F)	LVG. (°F)	P.D. FT. H ₂ O
			DB (°F)	WB (°F)	DB (°F)	WB (°F)							
010	8000	653	50		80		.70	262,400		35	105	90	1.7
020	9200	734	50		80		.75	300,000		40	105	90	2.0
030	3800	506	50		80		.40	124,000		16	105	90	2.5
040	1200	600	50		80		.65	39,000		5	105	90	0.5
050	2000	640	50		80		.64	65,100		9	105	90	0.8
060	10500	860	50		70		.75	228,000		30	105	90	1.2

BILL OF MATERIAL

NO.	DESCRIPTION	MATERIAL	NO.	DESCRIPTION	MATERIAL
1	CASING	GALV. STEEL	5	CASING BOLTS	PLATED STEEL
2	FINS - HI-F	ALUMINUM	6	CONNECTIONS	STEEL
3	TUBES	COPPER	7	VENT	1/8 N.P.T. BRASS
4	HEADERS	COPPER			

REV. 1-73



GENERAL NOTES

1. VERTICAL OR HORIZONTAL AIR FLOW MUST BE SPECIFIED.
2. 3/8 DIAMETER HOLES IN CORNERS. ALL COILS DRAINABLE.
3. 1 SERPENTINE 3 & 5 ROW COILS AND 2 SERPENTINE 6 AND 10 ROW COILS HAVE SUPPLY AND RETURN CONN. ON OPPOSITE ENDS OF COIL. 1-1/2 3/4 & 1-1/2 SERPENTINE SUPPLY AND RETURN CONNS. ALWAYS ON SAME END.
4. 1-1/2 AND 2 SERPENTINE 4 ROW COILS SUPPLIED WITH ONLY TWO CONNS. AS SHOWN. FOR E DIM., SEE BELOW.
5. CONNECT COILS FOR COUNTERFLOW I.E. ENTERING WATER CONN. ON LEAVING AIR SIDE OF COIL.
6. 7. ALL DIMENSIONS ARE IN INCHES.

	Rows	3	4	5	6	8	10
CIRCUITING	D	6	7 1/2	8 1/2	10	12 1/2	15
-WH, -WL, -WS	E	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2
-WM	E	-	-	2 1/4	2'	2 1/2	2 1/2
-WD	E	-	-	-	2 1/4	2 1/2	2 1/2

WH
WH } 1/2 SERPENTINE

FOR W = 12.36, 1 1/2 NPT CONN

HORIZ. AIR FLOW	Rows	3	4	5	6	8	10
A	3 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
F	5 1/2	6	6 1/2	6	7 1/2	7 1/2	
G	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	
H	6	6	6	6	7 1/2	7 1/2	
K	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	

VERT. AIR FLOW	Rows	3	4	5	6	8	10
A	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
F	5 1/2	6	3 1/2	3	3	3	
G	3	2 1/4	3	3 1/2	3 1/2	3 1/2	
H	6	6	4 1/2	4 1/2	4 1/2	4 1/2	
K	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	

FOR W = 39.42, 2 NPT CONN

HORIZ. AIR FLOW	Rows	3	4	5	6	8	10
A	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2
F	5 1/2	6 1/2	7	6 1/2	7 1/2	7 1/2	
G	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	
H	6 1/2	6 1/2	6 1/2	6 1/2	7 1/2	7 1/2	
K	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	

VERT. AIR FLOW	Rows	3	4	5	6	8	10
A	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2
F	5 1/2	6 1/2	4	4	4	4	
G	3 1/2	2 1/2	3 1/4	4	4	4	
H	6 1/2	6 1/2	4 1/2	4 1/2	4 1/2	4 1/2	
K	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	

WL
WL } 3/4 SERPENTINE

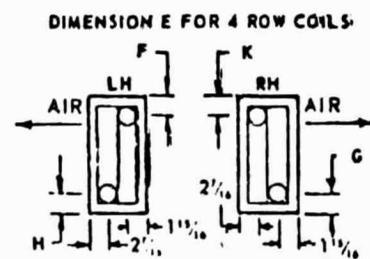
HORIZ. AND VERT. AIR FLOW	ROWS	FOR W = 12.36	FOR W = 39.42	FOR W = 12.18				FOR W = 19 1/2 - 30				FOR W = 31 1/2 - 42					
		1 1/2 NPT CONN	2 NPT CONN	1 1/2 NPT CONN				2 NPT CONN				2 1/2 NPT CONN					
A	2 1/2	3 1/2	2 1/2	3 1/2	2 1/2	2 1/2	2 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	4 1/2	3 1/2	3 1/2	3 1/2
F	3 1/2	4	4 1/2	3 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4	4 1/2	4 1/2	4 1/2	5	4 1/2	5	5	5
G	2 1/4	2 1/2	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
H	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	5	5	5	5
K	2 1/4	2 1/2	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2

WS
WS } 1 SERPENTINE

HORIZ. AND VERT. AIR FLOW	Rows	FOR W = 12-18						FOR W = 19 1/2 - 30						FOR W = 31 1/2 - 42					
		1 1/2 NPT CONN						2 NPT CONN						2 1/2 NPT CONN					
A	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	
B	2 1/2	-	2 1/2	-	-	-	-	3 1/2	-	3 1/2	-	-	-	3 1/2	-	3 1/2	-	-	
F	3 1/2	4 1/2	5 1/2	4 1/2	4 1/2	4 1/2	4	4 1/2	5 1/2	4 1/2	4 1/2	4 1/2	4 1/2	5	5 1/2	5	5	5	
G	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	
H	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	5	5	5	5	5	
K	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	

WM
WM } 1 1/2 SERPENTINE
WD
WD } 2 SERPENTINE

HORIZ. AND VERT. AIR FLOW	-WM					-WD				
	ALL 2 1/2 NPT CONN					ALL 2 1/2 NPT CONN				
Rows	4	5	6	8	10	Rows	4	6	8	10
A	6 1/2	4 1/2	4 1/2	3 1/2	4 1/2	A	6 1/2	5 1/2	3 1/2	3 1/2
F	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	B	-	3 1/2	-	3 1/2
G	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	F	2 1/2	2 1/2	2 1/2	2 1/2
H	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	G	2 1/2	2 1/2	2 1/2	2 1/2
K	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	H	2 1/2	2 1/2	2 1/2	2 1/2
						K	2 1/2	2 1/2	2 1/2	2 1/2



RH STANDARD UNLESS OTHERWISE SPECIFIED



McQuay GROUP McQuay-Parsons Inc.
P.O. Box 1341, Minneapolis, Mn. 55440

**UNIT HEATERS
DOWNFLOW**

FORM 102200A

TYPE UDH

CERTIFIED DRAWING

JOB: Telex Corporation - Blue Earth, Minn.

DATE 6/30/77 DR. TMC
P.O.

G.O.

PURCHASER: Mankato Plumbing & Heating

REP. Schwab-Vollhaber

REP. P.O.

ACCESSORIES

10

PRINTS DATE

FOR APPL

FOR RECORD

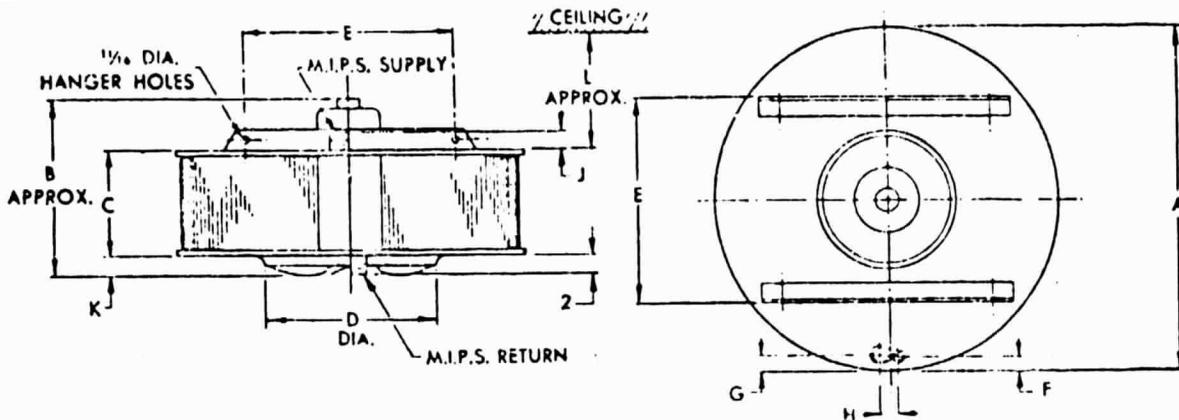
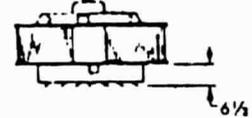
NO. 1 - FAN GUARD

NO. 2 - RADIAL DEFLECTOR

NO. 3 - CONE DEFLECTOR

NO. 4 - ANEMOSTAT

NO. 5 - LOUVER DEFLECTOR



ITEM	QTY.	ACCES. NO.	UHM UNIT SIZE	TAG	A	B	C	D	E	F	G	H	J	K	L	M	N		M.I.P.S. CONNS.	
																	HUJ	HIA	SUPPLY	RETURN
			040		25 3/8	9	3 3/8	14 1/2	16	1 1/4	1 1/4	1 3/8	2	1 3/8	8	5 1/8	10 3/8	10 3/8	1 1/4	1 1/4
			060		25 3/8	8 1/4	4 1/8	14 1/2	16	1 1/4	1 1/4	1 3/8	2	1 3/8	8	5 1/8	10 3/8	10 3/8	1 1/4	1 1/4
			080		25 3/8	10 3/8	6 1/8	16 1/2	16	1 1/4	1 1/4	1 3/8	2	2 1/4	8	5 1/8	11 3/4	11 3/4	1 1/4	1 1/4
			100		25 3/8	12	7 3/8	14 1/2	16	1 1/4	1 1/4	1 3/8	2	2 1/4	8	5 1/8	10 3/8	10 3/8	1 1/4	1 1/4
			120		33 3/8	15 3/8	6 1/8	18 1/2	21 1/2	1 1/4	1 1/4	2	2	2	10	6	11 3/4	11 3/4	2	1 1/4
			144		33 3/8	12 3/8	6 1/8	18 1/2	21 1/2	1 1/4	1 3/8	2	2	2 1/8	10	6	11 3/4	11 3/4	2	1 1/4
			160		33 3/8	15 3/8	7 3/8	18 1/2	21 1/2	1 1/4	1 3/8	2	2	2 3/8	10	6	11 3/4	11 3/4	2	1 1/4
			200		33 3/8	14 3/8	9 3/8	18 1/2	21 1/2	1 1/4	1 3/8	2	2	2 3/8	10	6	11 3/4	11 3/4	2	1 1/4
			240		33 3/8	16 3/8	12 3/8	24 3/4	21 1/2	1 1/4	1 3/8	2	2	2	10	7	15	15 3/4	2	1 1/4
			270		33 3/8	18 3/8	12 3/8	24 3/4	21 1/2	1 1/4	1 3/8	2	2	2 3/8	10	7	15	15 3/4	2	1 1/4
070	3	2	330		42 3/8	18 3/8	13 3/8	24 3/4	27 1/2	1 3/8	1 3/8	2 3/8	2 3/8	2 3/8	12	7	15	15 3/4	2 1/2	1 1/2
			384		42 3/8	19	13 3/8	26 3/4	27 1/2	1 3/8	1 3/8	2 3/8	2 3/8	2 3/8	12	7 1/4	17 1/4	16 1/2	2 1/2	1 1/2
			434		42 3/8	20 3/8	15 3/8	26 3/4	27 1/2	1 3/8	1 3/8	2 3/8	2 3/8	2 3/8	12	7 1/4	17 1/4	16 1/2	2 1/2	1 1/2
			494		42 3/8	23 3/8	18 3/8	30 3/4	27 1/2	1 3/8	1 3/8	2 3/8	2 3/8	2 3/8	12	7 1/4	17 1/4	16 1/2	2 1/2	1 1/2
			560		42 3/8	26 3/8	21 3/8	30 3/4	27 1/2	1 3/8	1 3/8	2 3/8	2 3/8	2 3/8	12	7 1/4	17 1/4	16 1/2	2 1/2	1 1/2
			610		42 3/8	26 3/8	21 3/8	30 3/4	27 1/2	1 3/8	1 3/8	2 3/8	2 3/8	2 3/8	12	7 1/4	17 1/4	16 1/2	2 1/2	1 1/2

CAPACITIES

ITEM	QTY.	MODEL NO.	MOTOR DATA			cfm @ FT	STEAM 105 ENT. H ₂ O 00 ENT AIR					
			hp	rpm	volt, cy & ph		Bluh	EDR	lbs of cond./hr	final air temp °F	gpm	
010	3	330	1/2	1140	120/60/1	5600	77,625				73.0	12

VI. WATER CONDITIONER

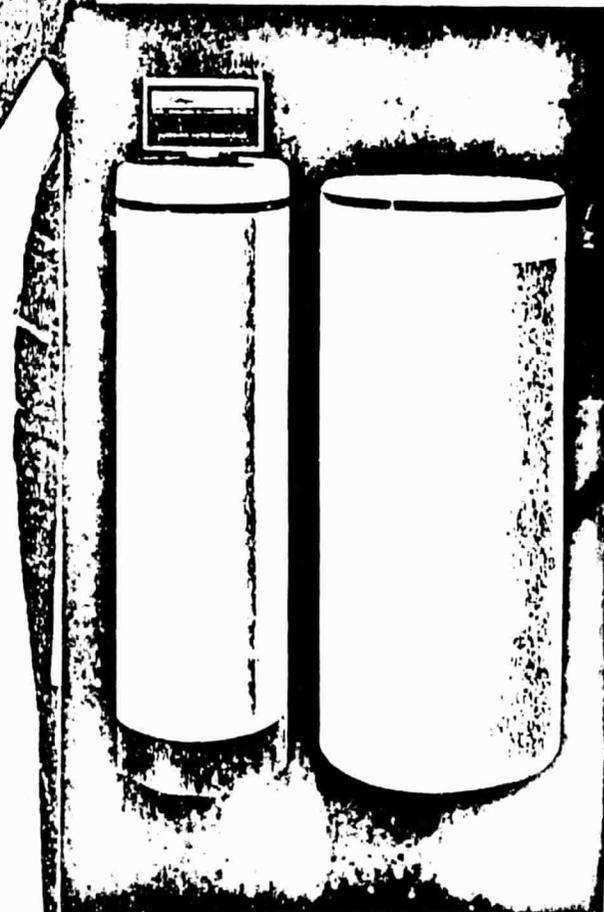


ORIGINAL PAGE IS
OF POOR QUALITY



Culligan[®]
Mark 512
Automatic
Water
Conditioner

The big family,
big-water-use way
to benefit from an
unlimited supply
of soft water for
homemaking needs.

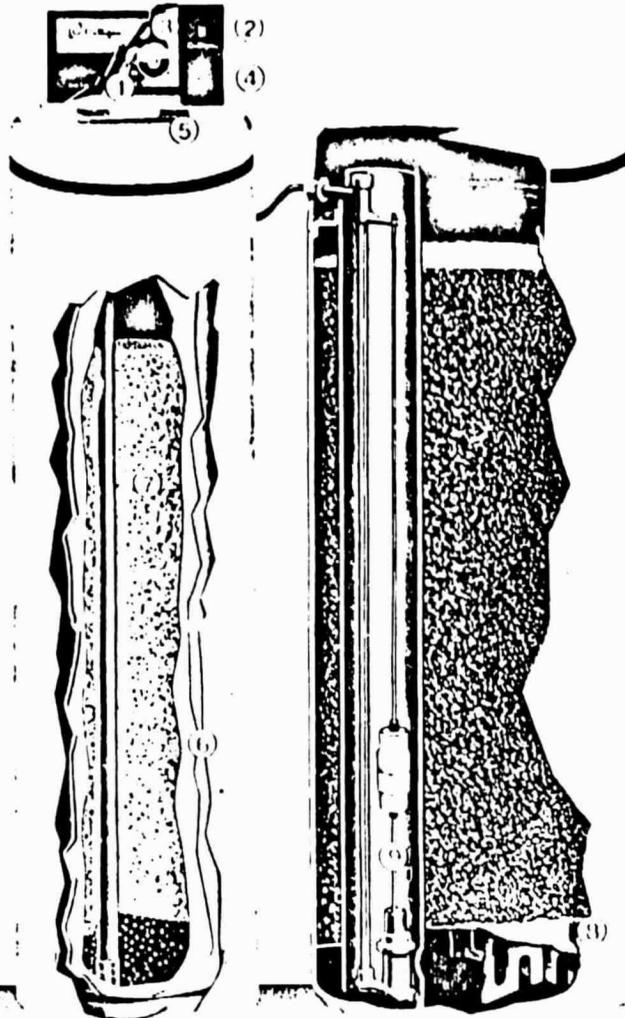
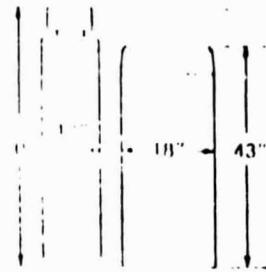




Culligan Mark 512 AUTOMATIC WATER CONDITIONER

This heavy-duty, giant-capacity model features our exclusive "Electro-Brain" for peak performance

Ideal where large volume of conditioned water is required. Capacity for extra hard water, controls high iron and manganese content. Anti-Corrosion Construction throughout. Distinctive Culligan styling, with scuff-resistant Dusk Grey and Platinum Beige exterior with Black trim. Salt Economizer automatically meters exact amount of brine for recharging.



ELECTRO-BRAIN

Our exclusive custom pre-set electronically operated timer automatically regulates recharge time and frequency of recharge.

HYDRO-ELECTRIC VALVE

Reliable 5-cycle operation efficiently directs water flow during recharge. Adapts to water pressures from 20 to 120 PSI.

GUEST CYCLE

Permits you to provide an extra supply of soft water when there are temporarily more people in the household.

DUAL BY-PASS

Automatically furnishes unconditioned water during recharge cycle. Optional push-button Cul-Flo-Valv* by-pass distributes unconditioned water for non-household uses.

STAINLESS STEEL BRACKETS

Rugged, non-corroding mounting brackets relieve Control Center from stress at plumbing connections.

TRIPL-HULL TANK

Corrosion-proof inner shell is enclosed in heavy steel, and covered with a sweat-free foam insulated styrene jacket.

CULLEX RESIN

Culligan-quality super-durable softening resin is stable and uniform to assure greatest water conditioning capacity.

SALT STORAGE CONTAINER

Extra-rigid construction; in 250-lb. or 375-lb. capacities. Protective Horizontal Salt Dissolver for added efficiency.

DUBL-SAFE REFILL

Electrical valve, combined with a positive mechanical float shut-off, prevents water overflow into salt container.

We Treat Water Seriously..

CULLIGAN SERVICE—ALWAYS AVAILABLE. It's the same prompt, expert, factory-trained service system Culligan originated in the U.S. and now provides in 91 countries world wide. Ask about our Culligan Warranty. Salt Delivery service is offered for your convenience.



Simply call and say... **"KEY CULLIGAN MAN!"**



Culligan



Before calling for service . . . refer to the instructions furnished with your Culligan water conditioner and review those items you can check yourself.

If you need service . . . call your Culligan Man with product model and installation date. He will make arrangements for prompt local service.

Culligan equipment is serviced by over 1000 dealers and distributors throughout the world. Consult your telephone directory, or write Culligan USA for warranty and service information.

Culligan



LIMITED

WARRANTY

LIMITED WARRANTY

You have just purchased one of the finest water conditioners made. As an expression of our confidence in Culligan products, your water conditioner is warranted to the original consumer purchaser against defects in material and workmanship from the date of the original installation as follows:

For a period of ONE YEAR

The entire conditioner

For a period of FIVE YEARS

The control valve body, but
excluding its internal parts,
and

The salt storage container,
and

The brine valve and all its
component parts.

For a period of FIFTEEN YEARS,
including a warranty against corrosion
originating inside the conditioner tank

The conditioner tank if it
contains a plastic inner liner.

If a part described above becomes defective within the specified period, you should notify your Culligan dealer and arrange a time during normal business hours for the dealer to inspect the water conditioner on your premises.

Any part found defective by the dealer within the terms of this warranty will be repaired or replaced by him. You pay only freight from our factory and local labor charges.

Naturally, damage caused by accident, fire, flood, Act of God, misuse, misapplication, neglect, alteration, modification or operation contrary to our printed instructions, is not covered by this warranty.

Our product performance specifications are furnished with each water conditioning unit. ALL IMPLIED WARRANTIES INCLUDING, WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE PERIODS SPECIFIED ABOVE FOR THE PARTS DESCRIBED IN THIS LIMITED WARRANTY. As manufacturer, we do not know the characteristics of your water supply or the purpose for which you are purchasing this water conditioner. Please understand that the quality of water supplies may vary seasonally or over a period of time, and that your water usage rate may vary as well, while water characteristics can change considerably if your water conditioner is moved to a new location. For these reasons, we assume no liability for the determination of the proper equipment necessary to meet your requirements, and we do not authorize others to assume such obligations for us. OUR OBLIGATIONS UNDER THIS WARRANTY ARE LIMITED TO THE REPAIR OR REPLACEMENT OF THE DEFECTIVE PARTS OF THE WATER CONDITIONER, AND WE ASSUME NO LIABILITY WHATSOEVER FOR INCIDENTAL AND CONSEQUENTIAL DAMAGES, WHETHER FROM CORROSION OR OTHER CAUSES.

Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you. Similarly, some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Culligan, the world-wide water conditioning people . . . We treat water seriously. . .

The Culligan logo features a stylized 'C' with a dot above it, followed by the word 'Culligan' in a cursive script.

CULLIGAN USA, DIVISION OF
CULLIGAN INTERNATIONAL COMPANY
One Culligan Parkway
Northbrook, Illinois 60062

Culligan® Technical Applications Bulletin

DATE March 1977

NUMBER _____

REFERENCE INFORMATION Boiler/Tower Treatment

CHEMICAL TREATMENT C-70

DESCRIPTION

Chemical Treatment C-70 is a blend of corrosion inhibitors, and alkalinity builders for complete treatment of closed water systems. C-70 is composed mostly of nitrite, borate, and MBT. The nitrite is an excellent corrosion inhibitor for ferrous metals and is very good for many other types of metals. Nitrite helps form a thin protective film on the metal surfaces. The MBT is a specific corrosion inhibitor for copper and copper alloys.

C-70 contains no chromates or phosphates and is a relatively mild non-polluting chemical. C-70 is blended for the use in closed heating and cooling systems. Typical uses are for chilled water systems, hot water systems, radiators, furnace cooling coils and any system where water loss is very low. It can be used in open recirculating systems; however, the cost usually makes it uneconomical to use. It can be used in a wide range of water supplies up to 150 psi or 370° F and ethylene glycol protected refrigeration systems at -10° F.

C-70 should not be used with chromate solutions, in potable water, or any domestic water supplies that may come in contact with people or animals, as nitrites are toxic particles in the concentrated form.

DOSAGE

A normal dosage of 2,000 - 2,500 ppm of C-70 will usually provide an excellent corrosion protection. This dosage will raise the pH of the water supply to 8 - 10.

An initial dosage of one pound per 50 gallons of water in the closed system will provide the initial dosage of 2,000 ppm. As water leaks from the system, the residual will drop. More chemical should be added before the residual reaches 1,000 ppm C-70 (500 ppm nitrite). When the residual C-70 drops below 1,000 ppm, sufficient chemical must be added to the closed system to reach the initial dosage of 2,000 - 2,500 ppm of C-70.

CONTROL LIMITS

A test for C-70 is the nitrite test. A nitrite residual of 1,000 ppm indicates approximately 2,000 ppm of Culligan C-70. Therefore, a residual of the closed system of at least 1,000 ppm of nitrite should be maintained.

FEEDING

A pot feeder is used when the chemical needs to be added only a few times a year. This is a very convenient method of getting this chemical into a closed water system.

An automatic feed system should be used when there is sufficient water loss to warrant additional chemical several times per month. An automatic feed system will assure that C-70 is kept at prescribed levels when the operating personnel are too busy to use a pot feeder regularly.

HANDLING

Culligan C-70 is slightly toxic, especially in the concentrated form. It should be handled with normal precaution and not allowed to come in contact with food, food products or eyes. It should be stored in a dry place away from heat; and it will become hard if left open to atmosphere as it absorbs moisture from the air.

Culligan[®] Technical Applications Bulletin

DATE 6/76

NUMBER _____

REFERENCE
INFORMATION

MICROBIOCIDE

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CHEMICAL TREATMENT M-25

DESCRIPTION

Chemical Treatment M-25 is a combination of two organo sulfur compounds for use in commercial and industrial cooling water. It is especially effective in controlling algae, bacteria, and fungi, which contribute to biological fouling.

M-25 can be used in any cooling water system that does not come in direct contact with food. M-25 does not foam; M-25 also is not volatile and therefore is not lost by evaporation.

DOSAGE

An initial dosage of 60-120 ppm, which is 6.9 to 13.8 fluid ounces per 1,000 gallons of recirculating water, is recommended. It is also recommended that an initial general physical clean-up of the cooling water system be made to remove excess slime and algae deposits.

Subsequent slug additions of 20 to 120 ppm or 2.3 to 13.8 fluid ounces per 1,000 gallons are recommended. The frequency of additions of M-25 depends on the amount of bleed-off and severity of microbiological fouling, typically once a week.

CONTROL LIMITS

Visual inspection is the only convenient method of determining if additional M-25 is required. If a visual inspection indicates the presence of algae, obviously additional M-25 is required. If the additional M-25 does not remove the algae, switching to M-23 may be required as it is possible that the algae has built up an immunity to M-25.

HANDLING

IMPORTANT: M-25 is an EPA approved microbiocide which is permitted to be sold at the concentration specified on the label. M-25 is registered under EPA No. 2938-8. Therefore M-25 can not be diluted and resold without violating EPA regulations.

DANGER: Keep out of the reach of children. As with most microbiocides, the concentrated solution is a toxic material. M-25 causes eye damage and skin irritation. Wear goggles and rubber gloves when handling. Harmful or fatal if swallowed, avoid contamination of food.

In case of contact, flush with plenty of water for at least 15 minutes. If eye irritation persists, get medical attention.

Do not reuse empty containers, destroy container by perforating or crushing and burying in safe place.

This product is toxic to fish, do not discharge into effluent where it will drain into lakes, streams or ponds.

**WITH CULLIGAN,
YOU GET MORE THAN A
QUALITY PRODUCT**

**You get local Culligan
care and service**

Our reputation—that of the Culligan Man and the Culligan Gal—is based on prompt, courteous attention to your needs. Selling and servicing water conditioners here is our full-time business and satisfied customers are our greatest assets.

**And you get the security of dealing
with an organization
that's trusted in 91 countries**

The Culligan System sells and services more water conditioners than does any other brand in the world. This position of leadership is not awarded, it is earned. It means that a Culligan product will never be an "orphan" because we will always stand behind our guarantees. It means that we will always strive to deserve your confidence.



Simply call and say ...
"HEY CULLIGAN MAN!"

**How to get the most
enjoyment, economy
and efficiency
from your new
Culligan Water**



**USE and
CARE
GUIDE**

Culligan. MARK SERIES
Automatic Water Conditioners

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Thank you...

**AND WELCOME TO YOUR NEW WORLD OF
BETTER LIVING WITH CULLIGAN WATER.**

If this is your first experience having soft, conditioned water in your home, you'll be amazed at the marvelous difference it makes. We promise that you'll never want to be without it again.

Congratulations, too, on selecting one of the "first family" of water conditioners in the prestigious Culligan Mark Series. With Culligan's many years of knowledge and experience in water treatment, you can be confident that the model you selected has been designed and engineered to provide years of service with a minimum of care and attention.

We hope you will become familiar with this Guide so that you will better understand how your new appliance works and how you can help it give you the many benefits of softened, filtered, conditioned water.



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IT'S ALL SO EASY, SO ECONOMICAL,

SO EFFICIENT, SO ENJOY-ABLE!

KIND TO SKIN AND COMPLEXION

Soft water will help prevent red, itchy or dry skin because there are no hardness impurities to cause soreness, no soap curd to coat the skin. Shaving is easier, smoother—either with blade or electric shaver.



BATHING AND SHOWERING M-m-m!

You'll use far less soap with conditioned water. Use your soap very sparingly—not as you did before soft water. Just a quick rinse removes all lather, leaving your skin pleasantly smooth and silky—because now it's free of sticky soap curd and film.



SAVES WASHING COSTS, HELPS CONTROL ENVIRONMENTAL POLLUTION

Soft water washes whiter and cleaner with a lot less soap or detergent. Because the hardness impurities are removed, your detergents can concentrate solely on washing. You'll have to reduce the amount of detergent you use substantially if you normally used a cup per wash load with hard water. Use only 1/2 cup depending on the size of your wash load and the degree of soil. Different amounts are required, but you can always use much less with softened water. An added bonus is the fact that your washable fabrics will last longer.

Soft water not only saves soaps, detergents and cleaning products used in the home, but also plays an active role in controlling environmental pollution since it provides for a very substantial reduction in the amount of cleaning wastes which enter our lakes and streams.



DISHES ARE A DELIGHT!

Washed by hand or in a dishwasher, glassware, dishes and silver wash cleaner, easier. Follow your dishwasher manufacturer's instructions. Soft water promotes sanitation because no greasy hard water film can form to collect soil or harbor bacteria.



EASIER HOUSEKEEPING, GLEAMING FIXTURES

You'll be amazed at the marvelous difference. Just a wash of the cloth and the bathtub or shower and fixtures are clean and sparkling. Imagine no scouring! No hard water scum to cause rings, streaks, spots and stains. To keep their gleaming luster, simply wipe fixtures with a towel after use. Formica, tile walls, floors, woodwork surfaces clean easier, stay clean longer. You'll save on cleaning aids and save on time!



SAVES WATER HEATING ENERGY, HELPS WATER HEATING APPLIANCES

Soft water prevents the formation of rock-like hard water scale which encrusts water heaters, hot water pipes, shower heads, and water-heating appliances and this scale can cause premature maintenance and failure.

Elimination of hard water scale also produces tremendous energy savings because scale acts as an insulator, wasting electricity or gas used to heat water. As little as a 1/8 inch of scale can boost water heating bills as much as 16¢ for each dollar of fuel costs.



SAVINGS GALORE

A water conditioner is frequently referred to as "the appliance that pays for itself." You'll find that your savings on soaps, detergents, cleaning aids, and personal care products will help your family's household budget. And if you place a price on your time, you'll be most happy with the time saved by your new family servant.



WATER FOR LAWNS AND HOUSEHOLD PLANTS

Soft water for lawns and household plants should be supplied with hard water primarily because it is uneconomical to soften so much water. Household plants are much more sensitive than lawns with respect to the kind of water which is best. First, because they receive no rainfall and, second, there is little drainage of the soil. Preferably they should be watered with rainwater or water which is low in mineral content such as distilled or demineralized water. Additional information may be obtained from your Culligan dealer.

SUPER HAIR CONDITIONING

Soft water is great for scalp and hair care. No insoluble deposits are formed. Hair is shinier, softer, more manageable. Reduce the amount of shampoo you have normally used.

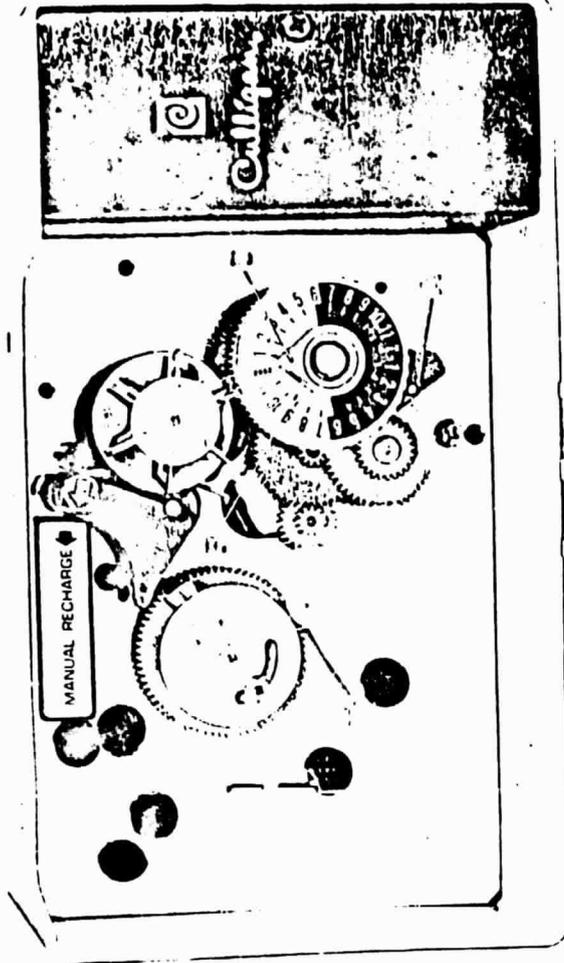
HOW TO MAKE ADJUSTMENTS TO THE ELECTRO-BRAIN™ CONTROLLER

An Adjustment Is Needed When:

you must reset the clocks around your home due to a power failure, time change, or other reason. Remember also to reset the time-of-day on your water conditioner.

you want recharge to occur at a different time than was set at installation. Note: recharge should be set for a time when water use is at a minimum. Usually this is in the wee hours of the morning, such as 2:00 a.m.

more softening capacity is needed on a continuous basis than was originally set, either because of increased use or change in water characteristics. (If a tempo ary increase in water use is anticipated or has occurred, an immediate recharge can be initiated without interfering with the automatic settings. Use the "Manual Recharge.")



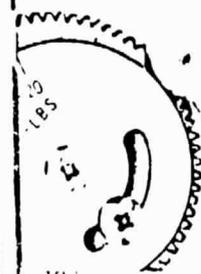
ACCESS TO TIMER ADJUSTMENTS

Grasp tab at bottom front of timer cover. Pull forward and lift up. Cover is hinged and will swing back to give access to adjustments. Don't force cover back too far. Note that provision has been made for you to secure the cover to prevent tampering with controls.



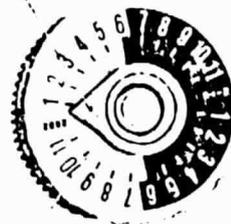
SERVICE (SOFT WATER) POSITION

The timer is in the "service" position supplying conditioned water to the house lines when the toothless section of the blue gear (T) is over the small white gear.



TIME-OF-DAY

The stationary blue pointer (D) tells the time of day on the moving 24-hour dial (B). If the blue pointer is not pointing to the correct time-of-day, according to your watch, you can reset this by pulling out the orange gear, clockwise until the correct time-of-day is opposite the blue pointer. Note: the dark half of the time dial represents nighttime hours.

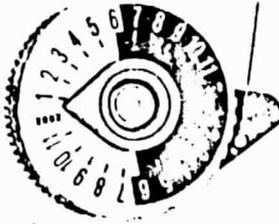


TIME OF RECHARGE

During recharge, hard water is automatically by-passed into the house lines. Recharge time is factory set to start at about 2:00 a.m. when water is not being used by most families. However, if you desire to have your unit charge at a time other than 2:00 a.m., this can be accomplished with a simple adjustment.

The position of the tiny round dot or pin on the orange tab (A) is opposite the time on the 24-hour dial when the unit will begin to recharge. To change the time of recharge, grasp the white outer 24-hour dial (B) and rotate until the desired recharge time on the dial is opposite the orange dot (A).

Note: Whenever the time of recharge is changed, the time-of-day setting must also be changed following above instructions. (When you reset time-of-day, double check to be sure that the time of recharge is not accidentally changed in the process.)



CONTINUED NEXT PAGE

ADJUSTMENTS
CONTINUED



FREQUENCY OF RECHARGE

The frequency of recharge was pre-set for your expected family needs when the water conditioner was installed. There are six stainless steel tabs on a numbered wheel (F) which program recharge. When all six tabs are pushed in, the unit will recharge every day; if every other tab is in, recharge will occur every other day; if two opposite tabs are in, recharge will be every third day; and if only one tab is in, recharge occurs every sixth day.

REMEMBER

Push IN to recharge, pull OUT to skip.

AQUA-SENSOR® MODELS

push all tabs in so that the water conditioner can recharge every day, if the sensor calls for it.

SALT ECONOMIZER

has a white dial (S) which controls the pounds of salt used per recharge. This was set at time of installation. Before making any change, phone your Culligan dealer for advice on the proper setting, then make these adjustments:

Loosen screw in slot of white dial (S). While holding blue gear stationary, rotate the white dial until desired salt dosage in pounds is aligned with blue marker. Then tighten screw in slot.

If salt dosage is changed, the float on the brine valve in the salt storage container must also be repositioned. See Installation Manual or call your dealer.

MANUAL RECHARGE FOR MORE SOFTENING CAPACITY

When you expect guests or feel that your use of soft water will temporarily increase, you can get more softening capacity with a manual recharge.

This can be initiated by moving the orange lever (E) at the top of the timer all the way to the left in the direction of the arrow. (On Aqua-Sensor models, a red button on the bottom of the Electro-Brain housing must also be pushed in.)

After the orange lever is released, it will return to its original position. Recharge will begin within a few minutes. After manual recharge, the unit will resume its automatic, programmed cycle.

If you have an Aqua-Sensor model and expect to use a lot of water the next day—rather than starting an immediate recharge—push in the Red Button underneath the Electro-Brain housing only, not the orange lever. This will cause the

Aqua-Sensor to delay recharge until the next pre-set time.

TIP

If you have an Aqua-Sensor model and expect to use a lot of water the next day—rather than starting an immediate recharge—push in the Red Button underneath the Electro-Brain housing only, not the orange lever. This will cause the Aqua-Sensor to delay recharge until the next pre-set time.

SALT SUPPLY, USAGE AND SERVICE

Salt is the mineral used to "recharge" your water conditioner. A brine solution is automatically made up in the bottom of the salt storage container and, as explained on page 7, the Culllex resin beads in the tall, thin tank are flushed with the brine solution as a step in the recharging process.

Your Culligan water conditioner has been carefully designed to get the greatest amount of softening capacity from the salt it uses. Here is some pertinent information about salt usage, types and service.

SALT ECONOMIZER

This control is set at the time of installation, and determines salt usage according to the water hardness, number of persons in the household, and water usage. See page 10 for instructions on adjusting setting.

Aqua-Sensor models maintain a constant salt usage which is pre-set at the factory. By recharging only when required, these models use only a minimum amount of salt. They are second to none for salt economy.

WHAT KIND OF SALT IS BEST

The tank-in-tank cabinet models all feature Culligan's exclusive Vertical Salt Plate which permits the use of any water conditioner salt of good quality, including "rock," "pellet," "solar," "evaporated," or "granulated" types. If purified salt products are used, the salt storage compartment on these models will not require the normal periodic clean-out.

All other Culligan Water Conditioners are designed to use quality grades of "rock" salt. And all "rock" salt, regardless of source, contains insoluble material which collects on the Horizontal Salt Plate in the salt storage tank—and does require periodic clean-out.

Regardless of what type of salt is used, we recommend Culligan Brand Salt as suggested by your Culligan Dealer. He is the expert and can provide you with the best product for your Culligan Water Conditioner.

AUTOMATIC SALT DELIVERY SERVICE

Ask your Culligan Man for details about his salt delivery service. You can have your salt supply replenished on a regular basis. Whether you can automatic delivery service or pick up salt from your Culligan Man, you will be getting quality salt packaged according to rigid Culligan specifications. Using Culligan Brand Salt will help assure continued efficiency and trouble-free operation of your water conditioner.

CAUTION:

Do not use salt products containing iron-removal additives as products of this type can be harmful to plastic valve parts.

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WHEN AND HOW TO BY-PASS YOUR WATER CONDITIONER

Normally, all water except to outside lines passes through the water conditioner. There are times when the water conditioner should be by-passed, using the push-button "Cul-Flo-Valv", or a 3-way by-pass valve. You should by-pass:

If lines to outside faucets do not by-pass the water conditioner, and you do not want to waste soft water on lawn sprinkling or other outside uses.

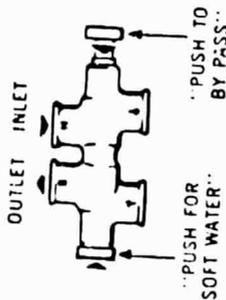
If you are going away on vacation and want to save salt by not having the unit recharge while you're away.

If you wish to inspect and clean the valves or salt storage container.

If a water leak from the conditioner is evident.

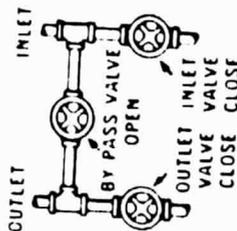
PUSH-BUTTON BY-PASS

In the back of most Culligan water conditioners is a push-button "Cul-Flo-Valv". To by-pass unit, simply push the Red knob (marked "Push to By-Pass") all the way to your left. To return to soft water service, reverse the procedure—push the Blue knob (marked "Soft Water") all the way to your right.



HAND VALVE BY-PASS

If hand valves are used, close both the inlet and outlet valves and open the center by-pass valve. To get soft water, reverse the process by closing the center by-pass valve and opening the inlet and outlet valves.



NOTE:

When the conditioner is by-passed, all water used is hard. For example, your water heater may fill with hard water. And the conditioner cannot recharge. Remember to place the push-button Cul-Flo-Valv or hand valves back to the "Soft Water" position as soon as possible.

CARE AND CLEANING OF YOUR CULLIGAN WATER CONDITIONER

Following these simple precautions, will help assure continued trouble-free service, and keep your Culligan Water Conditioner looking like new for years.

- 1 Do not place heavy objects on top of the salt storage tank or cabinet covers.
- 2 Use only mild soap and warm water when cleaning the exterior of the conditioner. Never use harsh, abrasive cleaning compounds or similar products which contain acid such as vinegar, bleach and
- 3 Protect your water conditioner and the entire drainline from freezing temperatures.
- 4 The timer is very accurate. Keep time-of-day setting correct to assure recharging at the proper time.
- 5 Should service, adjustment or trouble-shooting information be needed which is not covered in this Use and Care Guide, refer to Supplement #6602-15 Culligan Mark Series Maintenance Supplement, and the appropriate installation manual for your model. If you do not have this material, it may be obtained free from your Culligan dealer or by writing:

Director of Consumer Affairs
Culligan USA
One Culligan Parkway
Northbrook, Illinois 60062

When writing, be sure to include identification information shown on page 19.



If further service is required, please call your local Culligan Man. He will be glad to be of assistance to you.

THINGS TO CHECK BEFORE YOU CALL FOR SERVICE

If you unexpectedly experience hard water, make these simple checks before calling your Culligan Man. One of the following conditions may be the reason for your interruption of service.

IMPORTANT:

If any of the following conditions are found, the water conditioner should be manually recharged according to instructions on page 10 after you have corrected the condition.



POWER SUPPLY

Check your power supply cord. Is it plugged fully into the electric outlet? Be certain that the outlet does not have a wall switch which has been turned off. Reset conditioner to proper time of day and then plug in.

LOW FUSE

Check the house fuse or circuit breaker panel. Replace a blown-out fuse or reset an open circuit breaker.



POWER FAILURE

Any interruption in your power supply, or time changes—such as daylight savings—will disrupt your conditioner's recharge schedule by causing the timer to run off-schedule. Reset timer to proper time of day.

SALT SUPPLY

Check it. Refill if necessary and wait approximately four hours for the salt to dissolve before initiating a recharge cycle.



BY-PASS VALVES

Check to see if they are in the proper position. Cui-Flo-Valv, if used, should be in the "Push for Soft Water" position. If hand valves are used, see that inlet and outlet valves are opened and that the by-pass valve is closed.

INCREASED USAGE

Guests, family additions, new water-using appliances, etc. all will result in more water usage and will require more capacity from your conditioner. You can re-program your recharging schedule by following the directions on adjustments on pages 8, 9 and 10. Call your Culligan Man for advice and save a service call.

RECORDS AND DATA

Important Data on Your Water Conditioner

It is advisable to have the salesman or installer fill in the information below for your future reference. If this has not been done, please ask for it, as it is necessary if you contact the factory.

IDENTIFICATION

Model Name _____ Catalog No. _____

Control Model No. _____ Control Serial No. _____

Date of Installation _____ Tank Serial No. _____

SETTINGS

Frequency of recharge: _____ lbs.

Every Day Every other Day Salt Setting _____

Every 3rd Day Every 6th Day Time of Recharge: _____

Upon Demand _____ a.m. _____ p.m.

(Aqua-Sensor models)

Number of people in household _____

WATER ANALYSIS

Total Hardness _____ (gpg) Total Iron _____ (ppm) ph (acidity) _____

Other _____

SHOULD YOU NOTICE ANY NEW PROBLEMS WITH YOUR WATER, CULLIGAN HAS THE CAPABILITIES TO SOLVE THEM.

Today we have the technology to control or remove all of the impurities listed as undesirable by the U.S. Public Health Service in its Drinking Water Standards. Culligan products and systems remove both natural and man-made water pollutants—provide the best water for each specific use and application.

Your new Culligan Water Conditioner can be adjusted to handle a wide range of water problems, but it does have limitations. It has been specified on the basis of your water conditions at the time of sale. It is possible for the chemical makeup of your water to change in time, and such changes cannot be predicted. Your needs and uses may also change. Your Culligan Man is ready to help you if any problem should arise.

APPENDIX C

**THE ITC/SOLAR FLAT-PLATE COLLECTOR:
PARTS, REPAIR, INSTALLATION AND MAINTENANCE**

October 1978
Norman Barbera
ITC/Solar Staff Engineer

THE ITC/SOLAR FLAT-PLATE COLLECTOR: PARTS, REPAIR, INSTALLATION, AND MAINTENANCE

INTRODUCTION

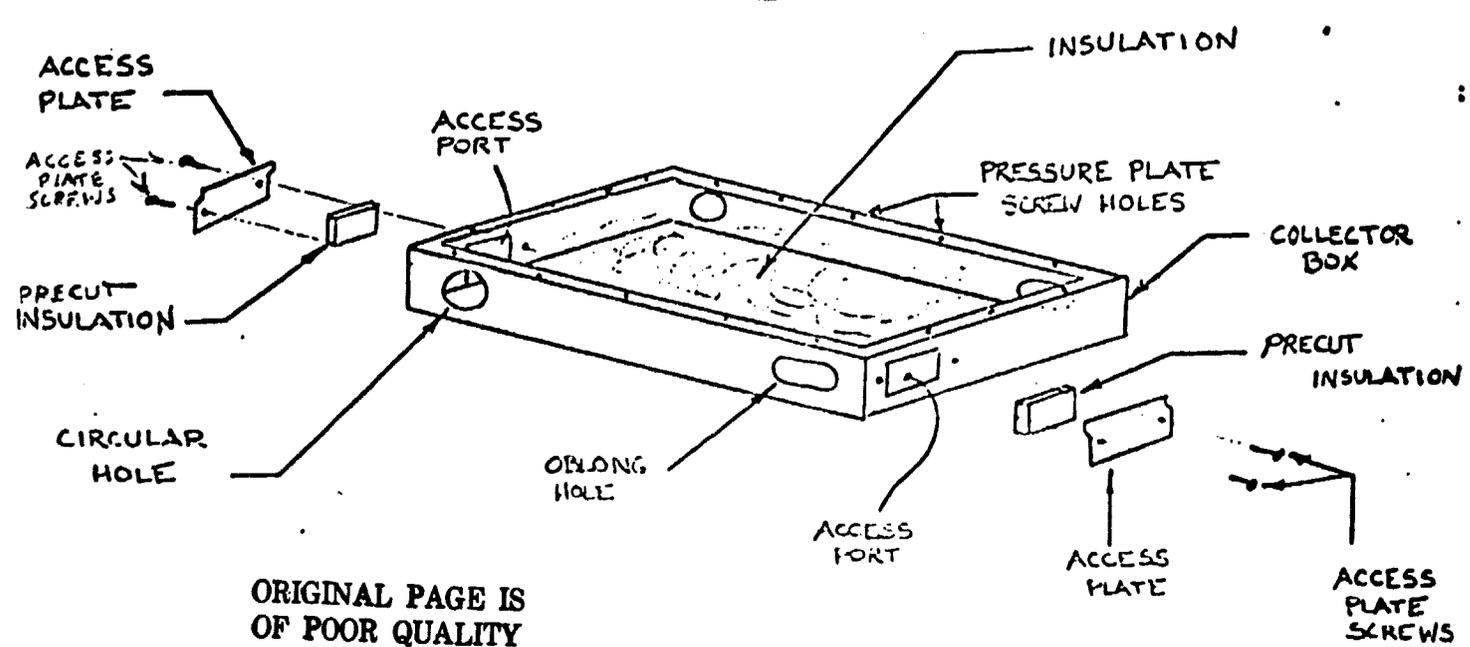
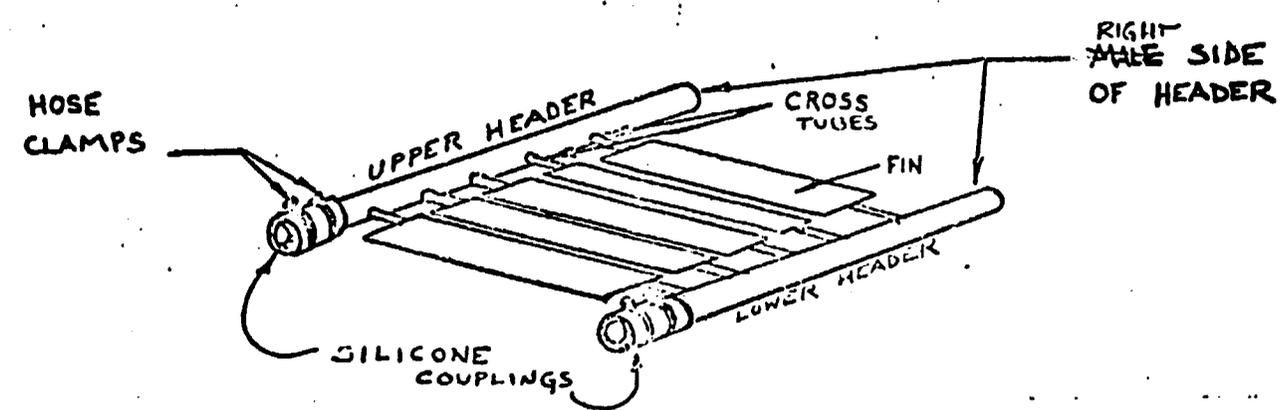
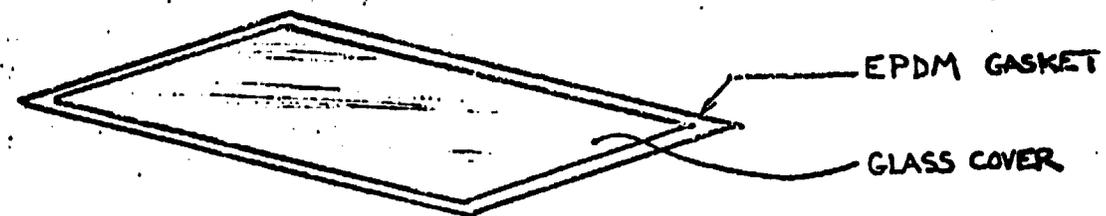
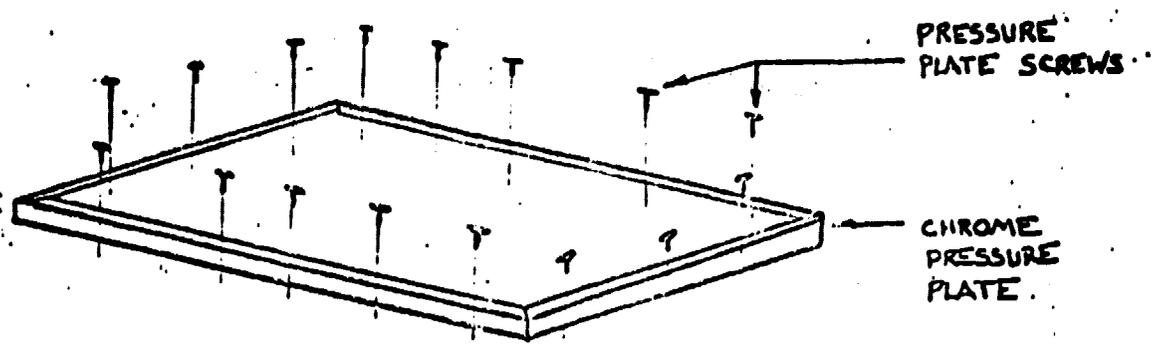
The intent of this information is fourfold:

1. To describe the various parts contained in the ITC/Solar Flat-plate collector,
2. To describe the steps necessary to replace any of these parts,
3. To list guidelines to follow when connecting collectors together, and
4. To briefly discuss maintenance.

PARTS & REPLACEMENTS

This section contains a description of the various parts of the ITC/Solar collector. At times one or more of these parts may be damaged, preventing proper operation of the collector. The collectors are made to allow removal and replacement of any part in the box, hence, a discussion of removal and replacement of parts is also included herein. Figures 1 and 2 can be used as a guide for this section.

To establish conventions, the front of the collector will be considered the glass side of the collector. The side with the protruding manifolds will be designated as the right side. The side with the tube couplings and recessed manifolds will be designated as the left side. The bottom of the collector will always be the end with the oblong openings around the header. Mark V collectors are nominal 3' x 6-1/2' with a 1" or 2-1/2" header. Mark III collectors are nominal 4' x 8' with a 2-1/2" header. With the exception of end boxes, all collectors will have protruding manifolds on one side and recessed manifolds on the other side. (See section on end boxes.)



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FIGURE 1 - EXPLODED VIEW OF COLLECTOR (NOT TO SCALE)

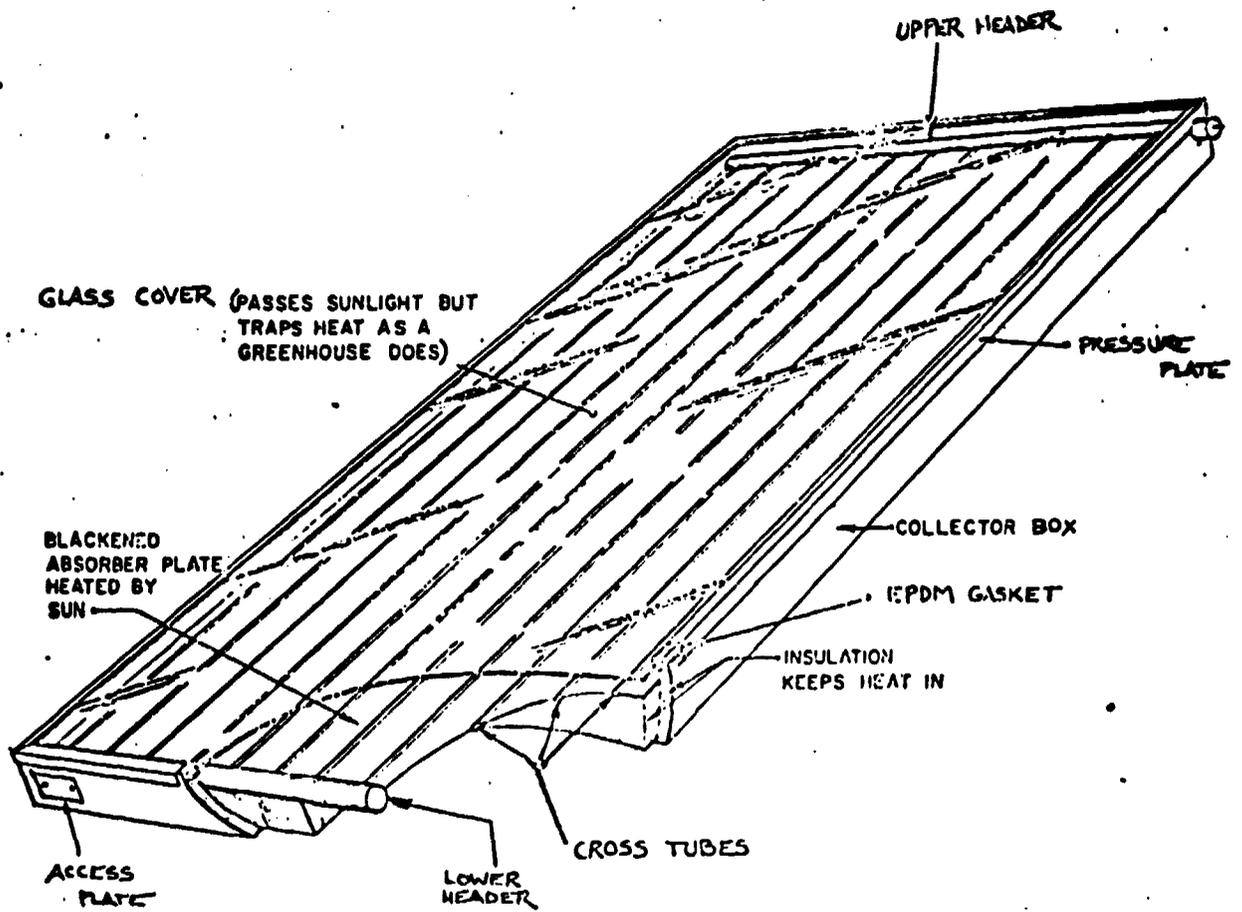


FIGURE 2 - ASSEMBLED COLLECTOR

Glass Covers

The chrome piece around the perimeter of the collector is the pressure plate. The pressure plate holds the glass cover (sometimes referred to as glazing) in place and can be freed by removing all the pressure plate screws holding it down. There is an EPDM, black rubber gasket that fits securely around the glass. This gasket reduces heat loss through the top of the collector, provides a water-proof seal, cushions the glass, and helps hold the glass in place. The gasket should lift out of place when the glass is removed. If the gasket or the glass does not come loose the gasket may be stuck to the box. Passing a knife between the gasket and box should eliminate this difficulty.

The glass cover may be lifted by hand or special vacuum cup handles may be used (Figure 3). The special handles are made specifically to handle glass and have one or two suction cups per handle that grip the glass. If the collectors are mounted on a slant and the glass must be removed, the use of these handles is recommended.

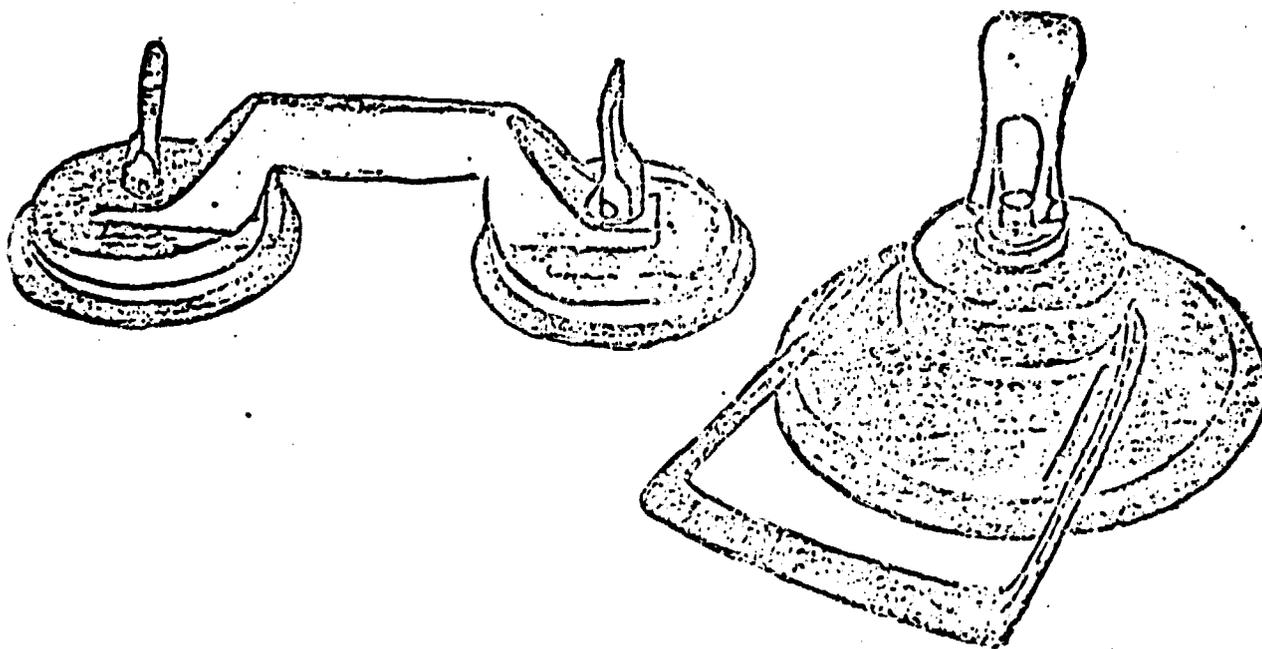


FIGURE 3: VACUUM CUP HANDLES

If the glass cover has broken, remove the pressure plate and clean all the broken glass from the gasket and the collector box. Wipe the gasket clean with a damp rag. Do not use soap. Fit the gasket around the perimeter of a new glass cover. Place the glass and gasket back on the lip around the interior edge of the box. When replacing the cover make sure the glass does not cover the pressure plate screw holes. When the collector is mounted and on a slant it may be necessary to place a shim on the lip of the collector box below the bottom edge of the gasket and glass cover. This will stop the glass from sliding down and covering the pressure plate screw holes. The pressure plate will fit over the gasket and around the outside of the box. Tighten down the pressure plate by replacing the pressure plate screws.

If the glass cover slides out from under the pressure plate, the gasket may not be gripping as it was designed to do. Remove the gasket and wipe it with a clean, damp rag. Do not use soap as that will leave a thin film which contributes to slippage.

Access Ports

The small covers on the top and bottom of the collector in the corner near the female side are the access plates. These cover a piece of insulation which in turn plugs an access port. The access port provides access to the left side of the header. The access plates can be removed by removing the small hex-head screws on either side of the plate. This requires a 5/16" wrench. A speed wrench is ideal for this and may also be used on the hose clamps mentioned later.

Headers & Collector Connections

The headers (sometimes referred to as manifolds) are nominal 1" (Mark V) or 2-1/2" (Mark III and some Mark V) copper tubes at the top and bottom of the collector. The short lengths of hose on the header are the silicone connectors or couplings.

Removal & Replacement of Connections

Occasionally it becomes necessary to remove a connector. If the connector is to be removed, the two hose clamps that hold the connector to the header must be loosened. Access to the hose and clamps is available through the access ports.

After the clamps have been loosened reach in with a sharp knife, slice the coupling along its length, and remove it from the box through the access port.

Replacement of connectors on single uninstalled collectors differs from replacement of connectors on collectors already installed in a row of collectors. With collectors not yet installed in a row, it may be possible to slide the connector through the opening on the side of the box and guide it onto the header by reaching in through the access ports. Where the connector does not fit through the opening or when the collector is already installed in a row, it may be possible to push the coupling in through the access port and slide it onto the collectors.

To replace connectors on installed collectors that do not have adequate room between the two adjacent headers to slide the coupling on, the collector plates (see next paragraph) may require shifting. Loosen the coupling directly below the coupling that is being worked on (or above if the coupling to be replaced is at the bottom of a box) and the two couplings on the collectors to either side. (That's five couplings.) Now reach in through the appropriate access port and push apart the headers where the new coupling is to be installed. It may be necessary to push on both the top and bottom headers in order to separate the two adjacent headers at that connection. If the hose coupling cannot be replaced in either of these ways, that side of the collector plate will have to be lifted out of the box.

Collector Plates

The collector (or absorber) plate is the subassembly that consists of upper and lower headers, cross tubes, fins, silicone couplings, and hose clamps. The collector box is the housing for the collector plate. The cross tubes are the small copper tubes running the length of the box. Should the tubes be broken or badly crimped, return the collector to ITC/Solar. The fins are pressed on the cross tubes and have, on occasion, pulled away from the tubes. If this occurs, consult the collector dealer or ITC/Solar.

The glass cover and pressure plate must be removed in order to provide access to the collector plate. Once these are removed, shift the plate to the right (as you face the collectors), as far as possible, and lift up on the left side of the plate. The hose connections can then be removed and/or replaced.

END BOXES

Included with most 2-1/2" header collector orders are special end boxes for each row of the collector array. The end boxes will have headers protruding from both sides of the box. These collectors should be the first collector mounted in each row and should be mounted on the west end of the row. (Remember, the collectors are facing south so the west end is to the left as you face the array.) When end boxes are not included with an order, whether it be Mark V or Mark III collectors, it will be necessary to construct an end box by modifying any one of the existing boxes. Modifications can be made as follows.

Remove both access plates and pull out the small piece of precut insulation to expose the silicone couplings. Tighten the clamp that holds the coupling to the header and loosen the second clamp. Insert a short

piece of 1" or 2-1/2" (which ever matches the header size) copper pipe (supplied) into each of the couplings. Push the pipe as far as possible into the coupling and secure it in place by tightening the previously loose clamp around the coupling and pipe. Since this is an end box the space between the header and the piece of pipe is not critical. When two collectors are being connected, a 3/4" space between the two headers at the connection will be necessary (see step #9, page C-14).

SUPPORT STRUCTURES

When connecting collectors, it is necessary to move the free collector left or right, while keeping it at the same height as the attached collector. The support structure should be designed to prevent up and down slippage and allow movement left or right during installation. This can be done with a temporary horizontal lip running a short distance either way from the collector being worked on, or with a permanent horizontal lip running the entire length of the support. Should the latter be used, provisions for self-draining of the lip must be included, otherwise water may collect on the lip and cause collector corrosion.

INSTALLATION

1. Cover the collectors with an opaque material (paper or plastic) to prevent the collector boxes from getting too hot to handle.
2. Mount the special end collector so that it is the west end collector of the row to be installed. Attach this end collector to the support structure. Subsequent collectors will be added to the east of those already installed. Remember the oblong holes in the collector box should be at the bottom of the collector. The right side of the collector will be pointing east.

3. Expose the access ports on the next collector to be hung by removing the access plates and precut pieces of insulation. As this collector is not yet connected to the support structure it will be designated the free collector. The collector to the west to which the free collector connects, and which has already been connected to the support frame, will be designated as the attached collector.
4. Lift the free box into place along side the attached box.
5. The clamps on both silicone couplings of the free collector should all be loosened and the hose coupling pushed to the edge of the header

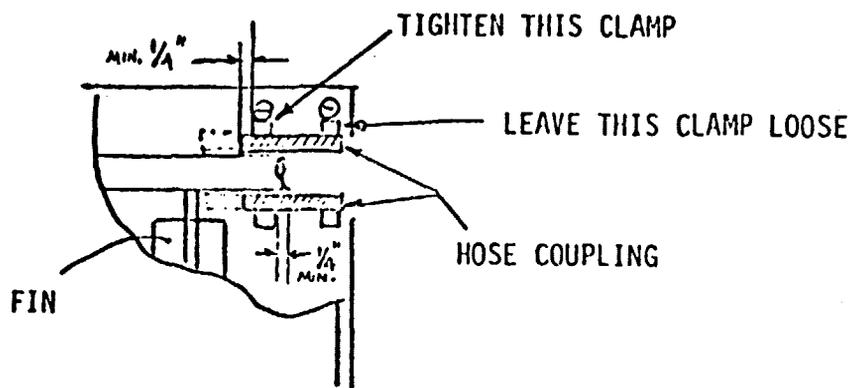


FIGURE 4: CLAMP MOVED TO THE EDGE OF THE HEADER

they are mounted on. (See Figure 4 above.) Tighten one clamp around the header leaving 1/4" or more of hose coupling on either side of the clamp. Leave the other clamp loose. In some cases the hose coupling may have to be pushed closer than 1/4" from the edge of the header to make the connection to the adjacent box possible. If at all possible, maintain the 1/4" clearings on both sides of the clamp.

On collectors with 1" headers the hose coupling can be pushed over with a screwdriver. The collectors with 2-1/2" headers have the larger hose couplings and are more difficult to handle.

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Two hooks similar to the one shown in Figure Five can aid considerably in installation. The hooks can be used to reach around the headers and manipulate the hose couplings. The hook shown in the figure is available from the collector manufacturer.

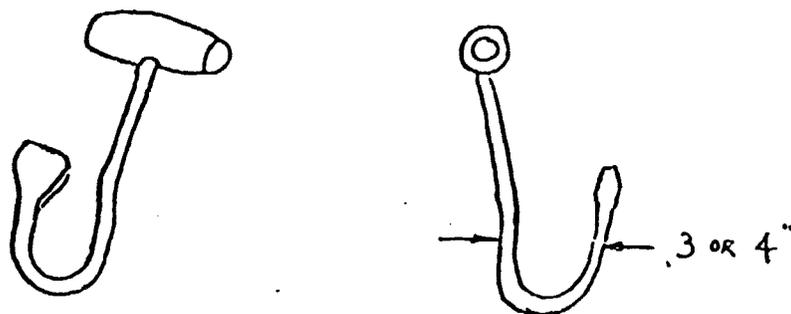


FIGURE 5 : HOOKS AVAILABLE FROM ITC/SOLAR

6. Position one person so they can work with the top coupling and a second person so they can work with the bottom coupling. Slide the free box toward the attached box to a point where the headers on the attached box, are just touching the hose connections.

7. Now align the hose couplings on the free box to the headers on the attached box.

8. Finally, complete the connections by pushing both headers on the right side of the free box, at the same time, hard and deliberate, toward the attached box. This will cause the hose couplings on the free box to slide onto the headers of the attached box.

With the 2-1/2" header collectors it may be necessary to have 3 or 4 people helping with installation. One person aligning each of the hose couplings with the headers, and one or two people pushing the free box toward the attached box.

Hose Coupling - Header Alignment Problems

When aligning the hose couplings to the headers only one of the two (top or bottom) connections may line up. The following suggestions will aid with the alignment of the hose coupling to the header and the completion of the connection.

Having both connections aligned at the same time makes installation easier and an attempt should be made to do so. If both cannot be aligned or completed at the same time, complete one connection at a time. In this case, rather than pushing on both headers on the right side of the free box, push only that header corresponding to the header to be connected on the left side. Once one connection is made, the second connection can be worked on. When working on the second connection, push against the appropriate header on the right side of the free box to prevent the first connection from coming apart.

Figure 6 shows the bottom connection already made and the top connection being worked on.

HOSE PREVIOUSLY MISALIGNED IS NOW ALIGNED

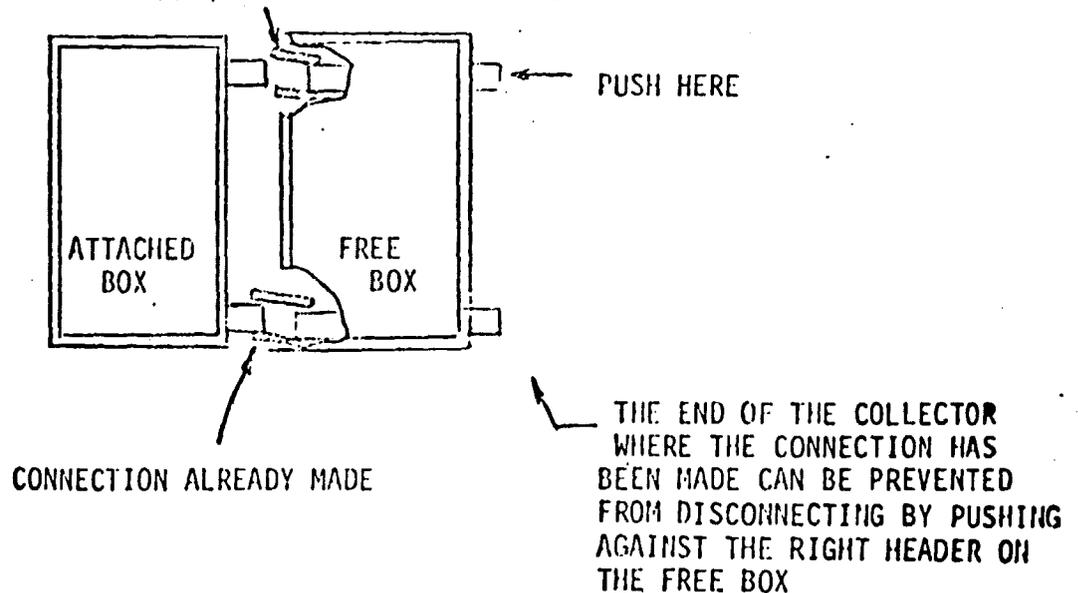


FIGURE 6: ALIGNING THE SECOND COUPLING AFTER ONE HAS BEEN CONNECTED

If the hose coupling is badly buckled and will not slide around the header, pull the collectors apart and realign the hose to the headers.
(See Figure 7 below.)

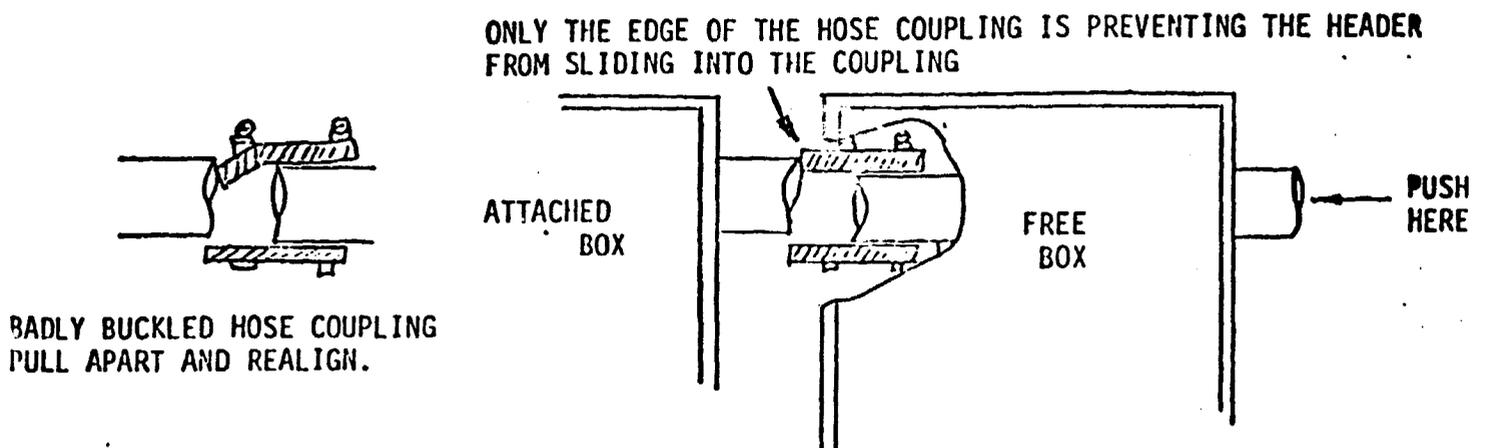


FIGURE 7: BUCKLED HOSE AND HOSE WITH CAUGHT EDGE

The header and hose coupling can be adjusted for alignment as shown in Figures 8 & 9.

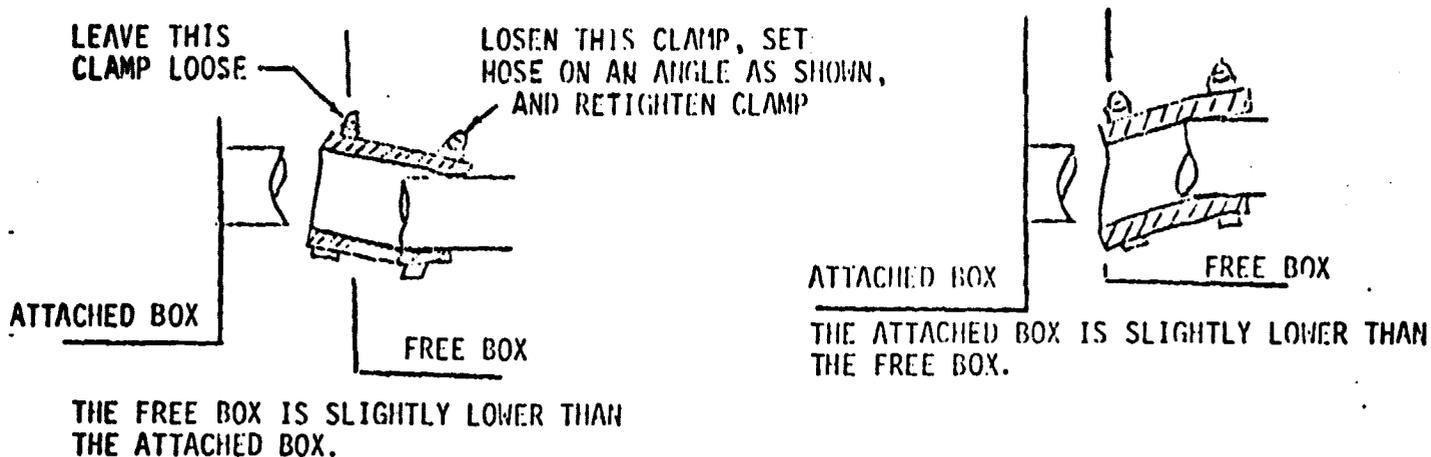


FIGURE 8: COUPLINGS SET ON AN ANGLE CAN AID IN HEADER-COUPLING ALIGNMENT

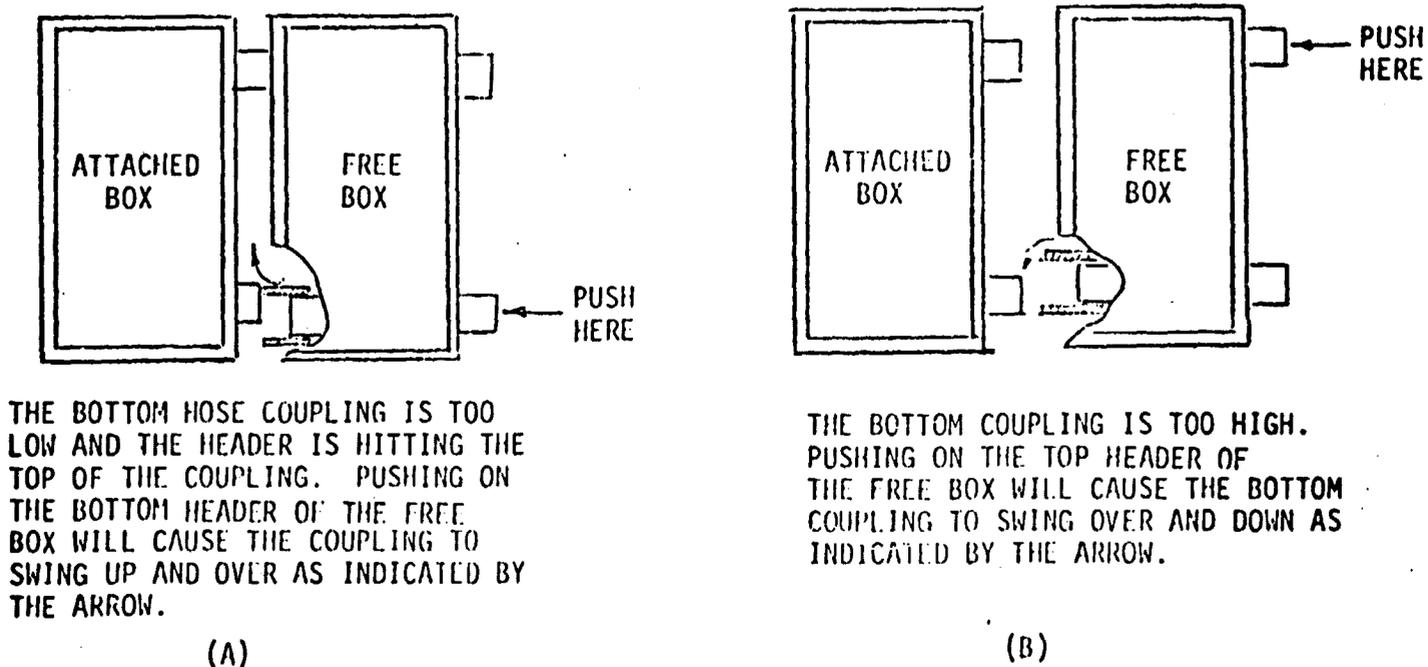


FIGURE 9: SHIFTING OF THE COLLECTOR PLATE AIDS IN HEADER-COUPLING ALIGNMENT

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9. Slide the two collectors together to a point at which the two headers are approximately $\frac{3}{4}$ " from each other inside the coupling as shown in Figure 10.

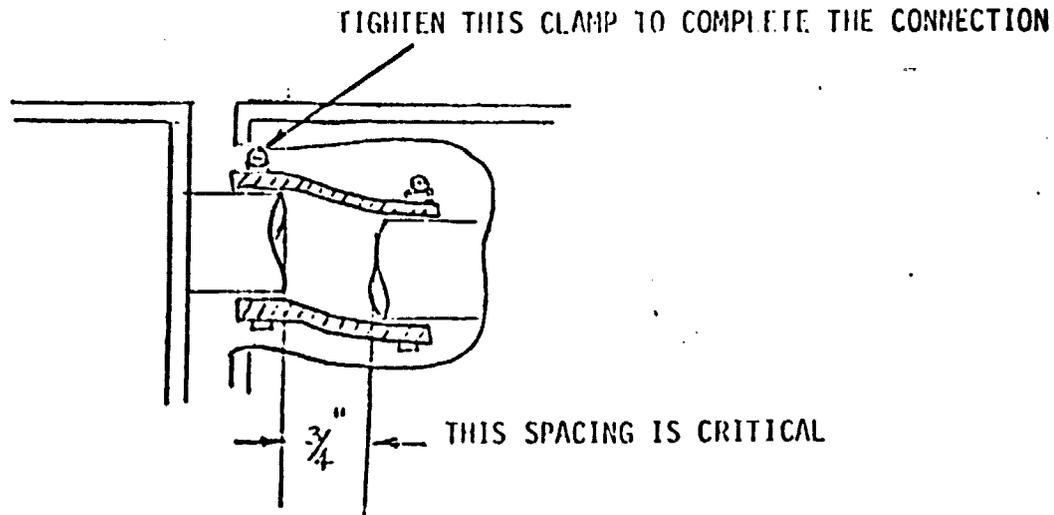


FIGURE 10: COMPLETED CONNECTION BETWEEN COLLECTORS AND THE CORRECT SPACING BETWEEN MALE AND FEMALE HEADERS

The $\frac{3}{4}$ " spacing between headers is important as it allows for thermal expansion. While the $\frac{3}{4}$ " space is not visible it can be felt through the rubber. Secure the hose coupling to the header with the hose clamp.

10. Attach the free box to the support structure. Do not replace the access plates until the system has been checked for leaks.

11. Repeat steps 1 and 3-10 with remaining collectors to complete the array.

IMPORTANT NOTE:

Keep in mind that the first row of collectors must be sloped $\frac{1}{4}$ " per collector toward the inlet of the array. The inlet on additional rows may be from another row, a separate inlet pipe, or the same inlet as the initial row. Each row should be sloped toward its own inlet.

MAINTENANCE

For normal drain-down systems deionized or distilled water is suggested for the heating fluid that travels through the collectors. Normal tap water can be used but may cause mineral buildup in the collectors. If a drain-down system cannot be used, consult ITC/Solar for other suggested fluids.

The first few times the system is started, it will be necessary to check for leaks at the silicone couplings. After the first few minutes of operation, a visual check will turn up any leaks. Use tap water when testing for leaks. Color dye in that water will allow leaks to be spotted easier. Condensation will build up on most of the collector cover on any collector that leaks. There may also be a noticeable flow of heating fluid from the leaky collector. Most leaks are due to loose hose clamps on the couplings and can be stopped by tightening the clamps on the hose that leaks. Occasionally, a coupling will slide completely off the headers and must be reinstalled. After the first 4 or 5 leak-free runs, a quick check of the collectors every month or so is advisable.

The monthly check need only be a visual inspection for broken glass, leaks, or excess dirt on the collector covers. With normal precipitation, any dirt or film that may prevent sun rays from passing through the glass cover will be rinsed away. To prevent a build-up of film, washing once or twice a year is recommended. A strong spray from a garden hose will be adequate. Long dry periods or blowing, dusty periods increase film build-up and more frequent washing may be required.

If the insulation on the inside of any collector gets wet, remove the access plates for a day or so. This will allow the insulation to dry out. Since running the collector with wet insulation will not harm the collector, the plates need not be removed until there is sunny weather.

APPENDIX D

As-Built Drawings



ISSUE INDEX
A. SUBMITTALS
B. AS BUILT 4/24/78

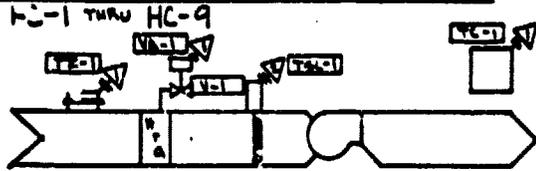
DRA
 1 CO
 2 M
 3 S
 4 W
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 6

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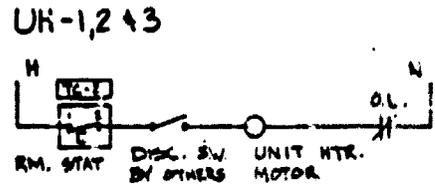
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LEGEND			COLOR ABBREVIATIONS										
S P	MAIN AIR SUPPLY TUBE AT 20 PSIG	7	PNEUMATIC TUBE TERMINAL WITH APPROPRIATE NUMBER	W	BUILD TYPE TEMPERATURE SENSING ELEMENT	ABB	Abbr.	BTU	British Thermal Unit	BR	Brass	AB	Abb.
D P	DUAL AIR SUPPLY TUBE AT 10-20 PSIG	17	ELECTRICAL WIRE TERMINAL WITH APPROPRIATE NUMBER	Z	AVERAGING TYPE TEMPERATURE SENSING ELEMENT	AC	Air Conditioning	BTU	British Thermal Unit	BR	Brass	AB	Abb.
H P	HIGH PRESSURE AIR SUPPLY TUBE AT 100 PSIG	2	SPECIAL TERMINALS WITH APPROPRIATE NUMBER (MUST BE IDENTIFIED ON DRAWINGS)	V	VAPOR TENSION TEMPERATURE SENSING ELEMENT	AC	Air Conditioning	BTU	British Thermal Unit	BR	Brass	AB	Abb.
S	AIR LINE OR ELECTRICAL WIRE	4	ITEM LOCATED IN CONTROL PANEL	O	BUILD TYPE TEMPERATURE SENSING ELEMENT LOCATED UNDER SHEATH IN OUTDOOR AIR	AC	Air Conditioning	BTU	British Thermal Unit	BR	Brass	AB	Abb.
D	CONNECTED LINE OR WIRE	5	ITEM LOCATED IN MOTOR STARTER	I	BUILD TYPE TEMPERATURE SENSING ELEMENT LOCATED INSIDE SHEATHS IN DOCK # 1 ALL	AC	Air Conditioning	BTU	British Thermal Unit	BR	Brass	AB	Abb.
D C	CROSSING LINE OR WIRE, NOT CONNECTED	6	ITEM LOCATED AT A/C UNIT	7	AIR PRESSURE GAGE	AC	Air Conditioning	BTU	British Thermal Unit	BR	Brass	AB	Abb.
D C E	ELECTRIC WIRE IN FRONT OF SHEATH INDICATE NO. OF WIRES	8	ITEM LOCATED ON PANEL FACE	9	FINISHING SYMBOLS WITH APPROPRIATE NUMBER	AC	Air Conditioning	BTU	British Thermal Unit	BR	Brass	AB	Abb.
10	INSTRUMENT IDENTIFICATION NUMBER	9	IN LINE RESTRICTOR			AC	Air Conditioning	BTU	British Thermal Unit	BR	Brass	AB	Abb.

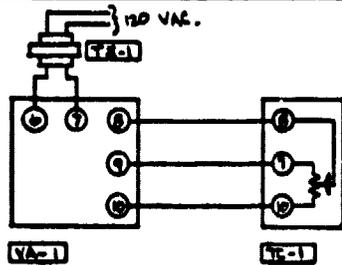
EXIST. AIR HANDELING UNITS



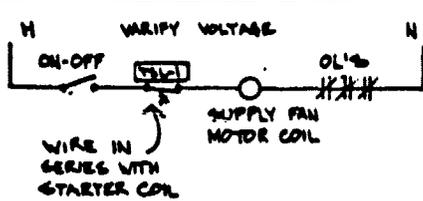
UNIT HEATER OPERATION



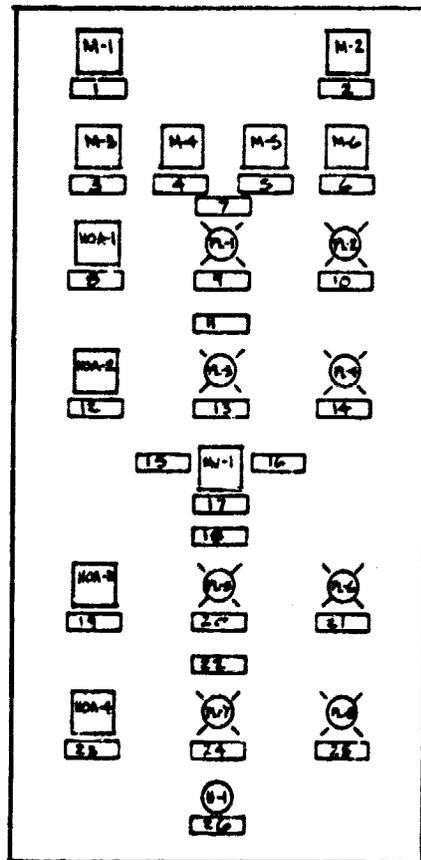
WIRING DIAGRAM #1



WIRING DIAGRAM #2



PANEL P-1 FACE



NAME PLATE

ITEM	NAME PLATE
1	HTG. SUP. W
2	HTG. RET. W
3	OUTSIDE TEM
4	INSIDE TEM
5	WATER TEM
6	WATER TEM
7	COLLECTOR P
8	HOA
9	POWER ON
10	PUMP ON
11	HOT WTR
12	HOA
13	POWER ON
14	PUMP ON
15	P-2 LEAD
16	P-2 LEAD
17	P-2, P-3 LE
18	HOT WTR
19	HOA
20	POWER ON
21	PUMP ON
22	SUMP PUMP
23	HOA
24	POWER ON
25	PUMP ON
26	SUMP HIGH L

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BILL OF MATERIAL	LEGEND	CONTROL
J= WIRING BY JCI		SET
O= WIRING BY OTHERS		WIT
F= OUTSIDE PURCHASED MATERIAL		ON
P= FURNISHED BY JCI PANEL DIV.		FIELD
B= FURNISHED BY JCI BRAND-OFF.		FIELD

NAME PLATE SCHEDULE

ITEM	NAME PLATE
1	HTG. SUP. WATER TEMP.
2	HTG. RET. WATER TEMP.
3	OUTSIDE TEMP.
4	INSIDE TEMP.
5	WATER TEMP. ENT. BLDG.
6	WATER TEMP. LVG. BLDG.
7	COLLECTOR PUMP P-1
8	H/A
9	POWER ON
10	PUMP ON
11	HOT WTR. SUPPLY PUMP P-2
12	H/A
13	POWER ON
14	PUMP ON
15	P-2 LEAD
16	P-3 LEAD
17	P-2, P-3 LEAD - LAG
18	HOT WTR. SUPPLY PUMP P-3
19	H/A
20	POWER ON
21	PUMP ON
22	SUMP PUMP P-4
23	H/A
24	POWER ON
25	PUMP ON
26	SUMP HIGH LEVEL ALARM

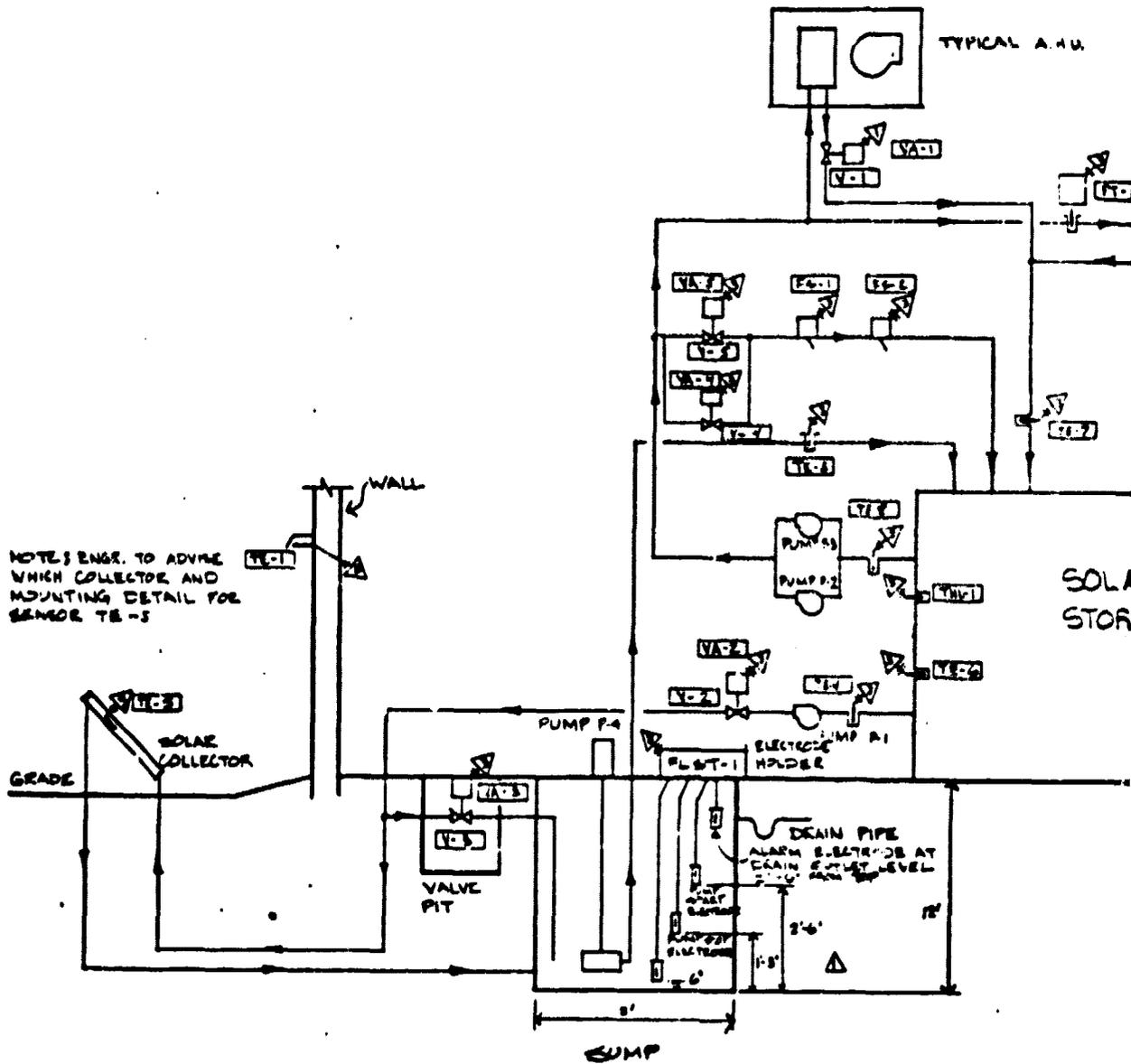
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LEGEND CONTROL DIAGRAM SYMBOLS SEE WIRING DETAIL NUMBER WITHIN TRIANGLE DEVICE FLUSH MOUNTED ON PANEL FACE FIELD WIRING CONNECTION FIELD PNEUMATIC CONNECTION	MISC.	REFERENCE SYMBOLS SALES ENGINEER APPLICATION ENGINEER	PROJECT TELEX. BLUE EARTH MN.	JOHNSON CONTROLS Systems & Services Dept.	1801 67th AVE N MPLS. MN. 55430	2050 100th 2066
	D-2	2	1			

SOLAR HEATING SYSTEM SCHEMATIC

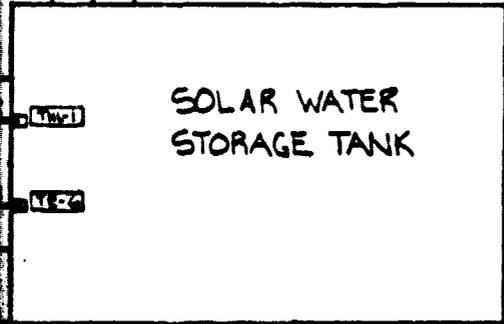
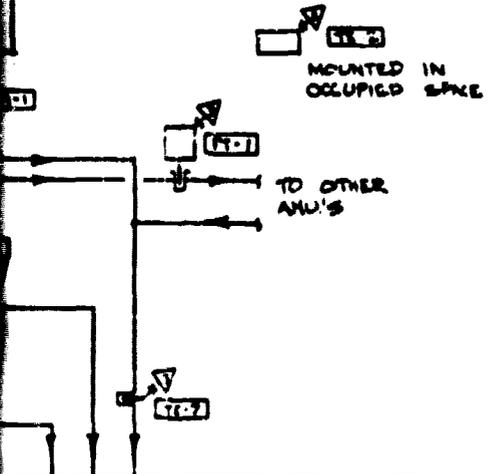


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O= WIRING BY OTHERS	CS
F= OUTSIDE PURCHASED MATERIAL	CD
P= FURNISHED BY JCI PANEL DIV.	CC
B= FURNISHED BY JCI BRANCH OFF.	CB

TYPICAL A.H.U.



ITEM NO.	QTY	UNIT	EDGE NO.	DESCRIPTION	RANGE SETTING	REMARKS
FIELD EQUIPMENT						
PT-1	1	B	BY OTHERS	R/W CONTROL	SEE SHEET 3	
PT-2	2	B	BY OTHERS	McDONALD MILLER P20-3	ONE 8 1/2" DIA ONE 8 1/4" DIA	
PT-3	1	B	PC00DA-3	Pressure Control	20 PSI	
TC-1	3	B	TC00DA-3		77° F	
TC-2	3	B	TC01-3		72° F	
TE-1	1	B	TE-1300-1			
TE-2	1	B	TE-1300-2			
TE-3,4,7,8	4	B	TE-1100-5			W/2-1000-4 WLL
TE-5	1	B	A-410-3			
TE-6	1	B	A-410-3			W/2-1000-4 WLL
TML-1	1	B	A-1200-12		100° F	
TSL-1	9	B	A11A-1		40° F	
TV-1	9	B	VC00A-1	40 VAC	FOOT	120V/24VAC
VA-1	9	B	VE00A-1	SPE VALVE SCHEDULE		
VA-2	1	B	VE-3200-12	24 VAC		
VA-3	1	B	VE-3200-12	4"		
VA-4	1	B	VE-3200-12	120 VAC		
VA-5	1	B	VE-3200-12	4"		
VA-6	1	B	VE-3200-12	120 VAC		
VA-7	1	B	VE-3200-12	1 1/2"		
VA-8	1	B	VE-3200-12	24 VAC		
VA-9	1	B	VE-3200-12	2 1/2"		
VA-10	1	B	VE-3200-12	24 VAC		
X-2	1	B	PE-5000-10	120V/24V		
X-3,4	2	B	PZ-4000-1	120 VAC		

FOR DESCRIPTION OF OPERATION SEE PAGE 6 OF 6

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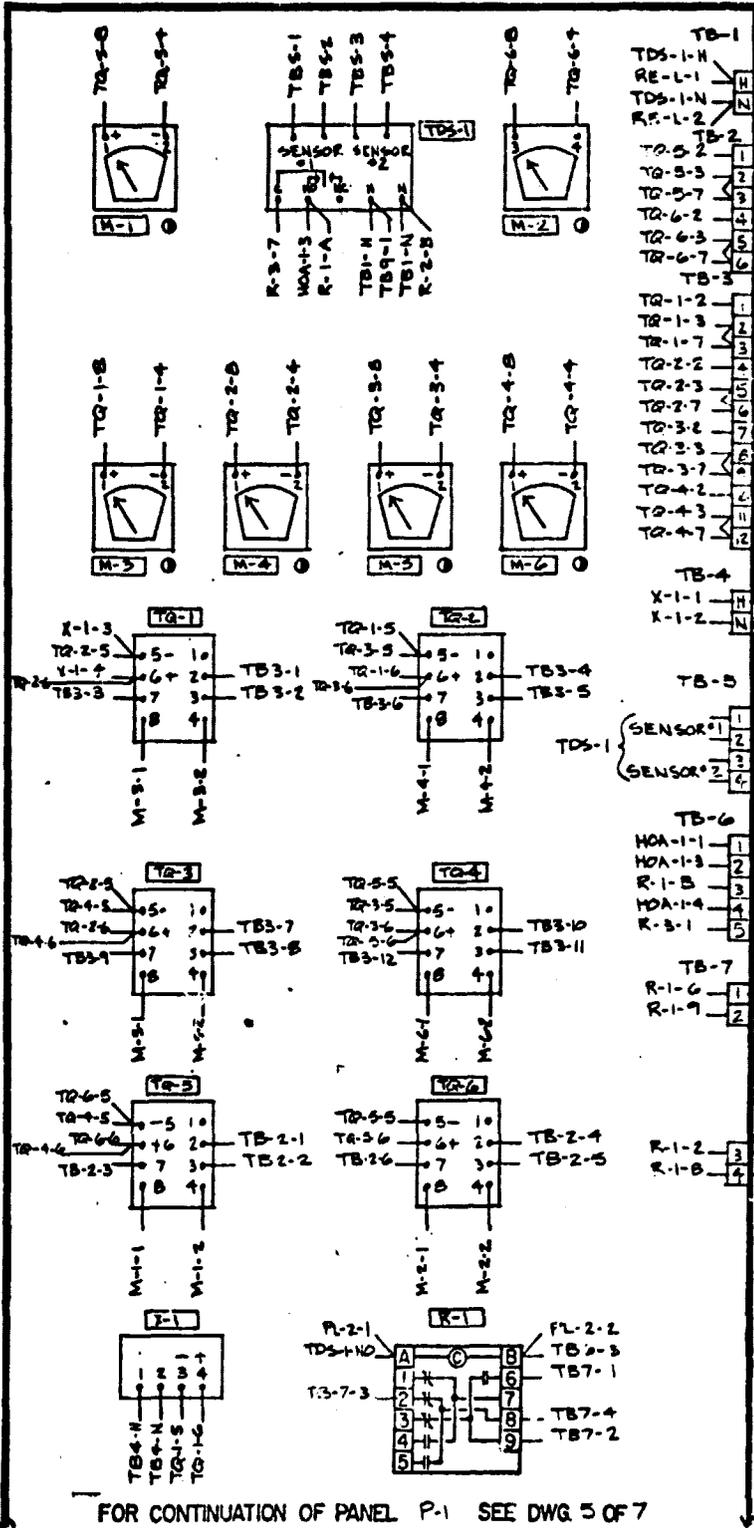
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JCI	SEE WIRING DETAIL NUMBER WITHIN TRIANGLE	
OTHERS	DEVICE FLUSH MOUNTED ON PANEL FACE	
PURCHASED MATERIAL BY JCI PANEL DIV.	FIELD WIRING CONNECTION	
BY JCI BRANCH OFF.	FIELD PNEUMATIC CONNECTION	

SYSTEM SCHEMATIC	AS BUILT
TELEX BLUE EARTH MIN.	JOHNSON CONTROLS Systems & Services Division
	301 07th AVE N. MPLS. MN. 55409
	DATE: 10/20/82 BY: [Signature]

D-3

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WIRING DIAGRAM #3



NOTES SEE LADD ON SHT. 7

FOR CONTINUATION OF PANEL P-1 SEE DWG 5 OF 7

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J	WIRING BY J.C.I.	△	CONTROL
O	WIRING BY OTHERS	⊗	SET
F	OUTSIDE PURCHASED MATERIAL	⊙	WIT
P	FURNISHED BY JCI PANEL DIV.	⊕	DEV
B	FURNISHED BY JCI BRANCH OFF.	⊖	ON
		◇	FEL
		○	FIE

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BILL OF MATERIAL

ITEM NO.	QTY	DIV	CODE NO.	DESCRIPTION	RANGE SETTINGS	REMARKS
PANEL EQUIPMENT						
ES-1	1	P	SQ-3001-2	SEQUENCING NETWORK	SEE SHT. 4	
H-1	1	P	PD-111-5	MALLOY SC-110	120V	SIGNALERT
HDA-1,2,3,4	4	P	PD-106-11	A/B SOFT-J2A	1 H.O.-3 N.C.	
M-1	1	P	M2-2006-5	3" - 2000 OHM	-30 TO 120°F	
M-2	1	P	M2-2006-7	3" - 2000 OHM	40 TO 90°F	
M-3,4,5,6	4	P	M2-2006-10	3" - 2000 OHM	0 TO 200°F	
P-1	1	P	M-8160-14	24 x 24 x 9		
PL-1,3,5,7	4	P	PD-102-3	SYLVANIA 120 PSB GREEN	120V	W/PD-103-35
PL-2,4,6,8	4	P	PD-102-3	SYLVANIA 30099 RED	120V	W/PD-103-55
TD-1	1			ON DELAY RELAY	L2-1 PD SECONDS	
R-1,2,3	3	P	PD-100-20	3 PCT P & B KUP14A15	120V	W/PD-101-35
RE-1	1	P	RH-3100-3	135 OHM INPUT		
SM-1	1	P	PD-100-5	2 PCS. DPDT TOGGLE		
TDS-1	1	P	R3400A-1	120V	PUMP ON 8 & T250P	
TR-1	1	P	GO-4100-2	24 VDC	PUMP ON 8 & T250P -30 TO 120°F	
TO-2	1	P	GO-4100-4	24 VDC	40 TO 90°F	
TO-3,4,5,6	4	P	GO-4100-7	24 VDC	0 TO 200°F	
X-1	1	P	VG-4100-1		SET 24 VDC	24 VAC INPUT

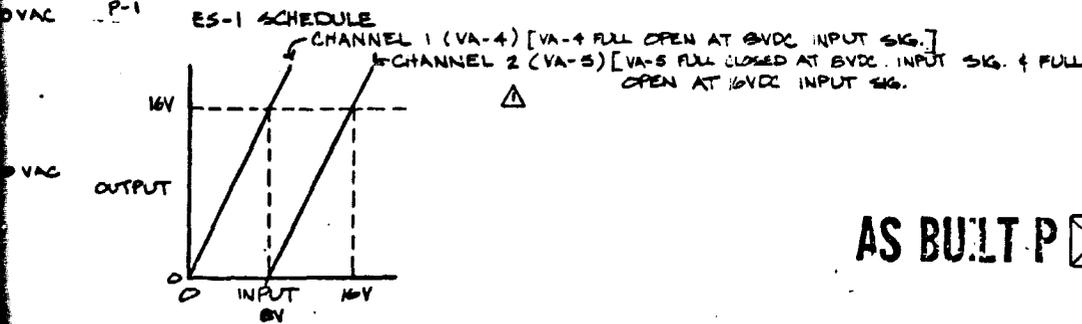
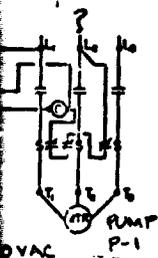
NOTES SEE LADDER DIAGRAMS ON SHT. 7 OF 7

FOR DESCRIPTION OF OPERATION SEE PAGE 6 OF 6

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LEGEND

CONTROL DIAGRAM SYMBOLS

SEE WIRING DETAIL NUMBER WITHIN TRIANGLE

DEVICE FLUSH MOUNTED ON PANEL FACE

FIELD WIRING CONNECTION

FIELD PNEUMATIC CONNECTION

DRAWING TITLE

WIRING DIAGRAM #3

PROJECT

TELEX BLUE EARTH MN.

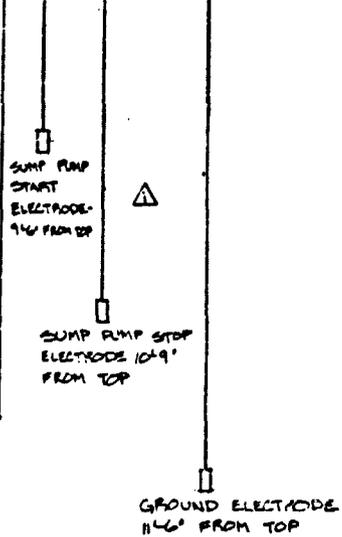
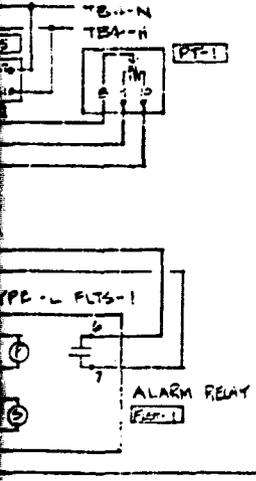
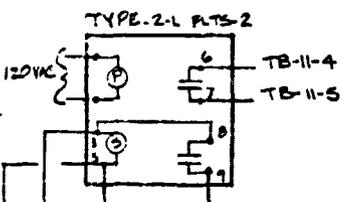
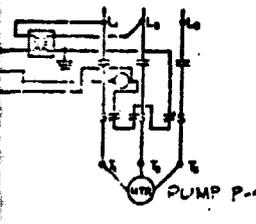
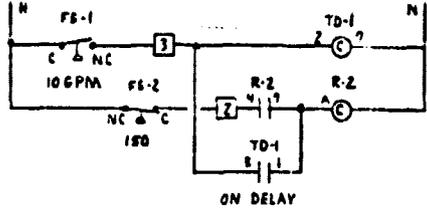
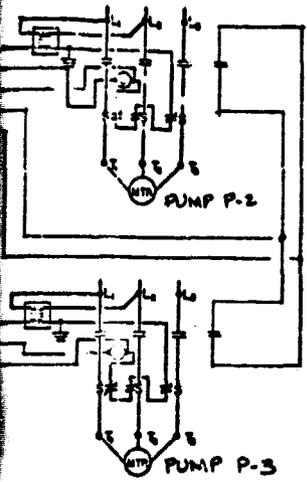
JOHNSON CONTROLS

1801 67th AVE N. MPLS. MN. 55430

Systems & Services Division

CONTRACT NUMBER 7327-0046

DRAWING NUMBER 200



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LEGEND	
OF MATERIAL	CONTROL DIAGRAM SYMBOLS
BY JCI	SEE WIRING DETAIL NUMBER WITHIN TRIANGLE
BY OTHERS	⊕ DEVICE FLUSH MOUNTED ON PANEL FACE
PURCHASED MATERIAL	◇ FIELD WIRING CONNECTION
BY JCI PANEL DIV.	○ FIELD PNEUMATIC CONNECTION
BY JCI BRANCH OFF.	

DRAWING TITLE	WIRING DIAGRAM #3 CONT'D
PROJECT	TELEX BLUE EARTH MIN.
COMPANY	JOHNSON CONTROLS Systems & Services Division
ADDRESS	100 17th Ave N. Mpls, MN. 55450
DATE	
SCALE	

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OF POOR QUALITY

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2

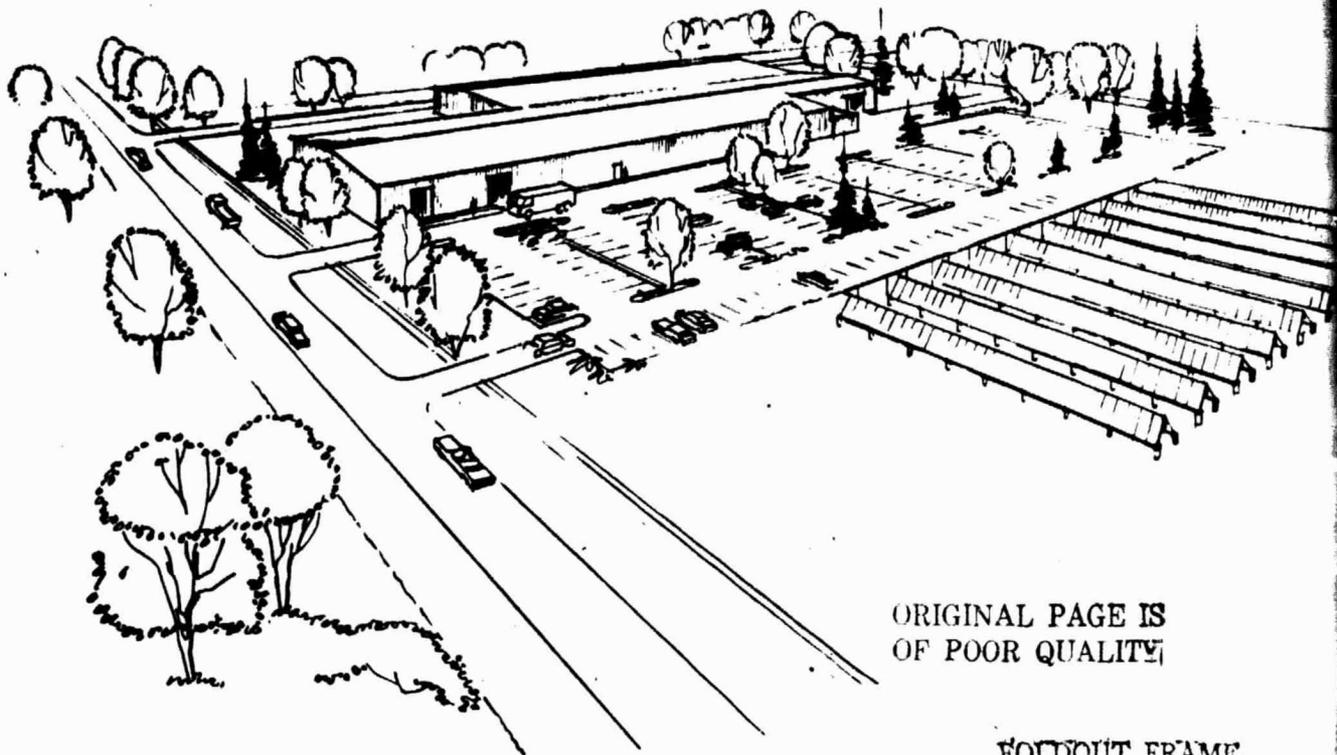
AS BUILT P E

FIELD READOUT
 INDOOR AIR TEMPERATURE
 METER M-3 THROUGH TO #1
 AVERAGE INDOOR SPACE TEMPERATURE
 METER M-4 THROUGH TO #3
 HEATING BUILDING TEMPERATURE
 METER M-5 THROUGH TO #3
 COOLING BUILDING TEMPERATURE
 METER M-6 THROUGH TO #4
 COLLECTOR TEMPERATURE
 STORAGE TANK TEMPERATURE
 BOILER SYSTEM SUPPLY TEMPERATURE
 METER M-1 THROUGH TO #5
 BOILER SYSTEM RETURN TEMPERATURE
 METER M-2 THROUGH TO #6
 BOILER SYSTEM IS POWERED BY X-1 (VO-4100-1)
PILOT LIGHT OPERATION
 PUMP P-1
 LIGHT (PL-1) "POWER ON" GREEN LENS
 LIGHT (PL-2) "PUMP RUN" RED LENS
 PUMP SUPPLY PUMP #1 (P-2)
 LIGHT (PL-3) "POWER ON" GREEN LENS
 LIGHT (PL-4) "PUMP RUN" RED LENS
 PUMP SUPPLY PUMP #2 (P-3)
 LIGHT (PL-5) "POWER ON" GREEN LENS
 LIGHT (PL-6) "PUMP RUN" RED LENS
 PUMP #1 P-4
 LIGHT (PL-7) "POWER ON" GREEN LENS

LEGEND	
CONTROL DIAGRAM SYMBOLS	SEE WRITING DETAIL NUMBER WITHIN TRIANGLE
DEVICES FLUSH MOUNTED ON PANEL FACE	FIELD WIRING CONNECTION
FIELD WIRING CONNECTION	FIELD PNEUMATIC CONNECTION

DRAWING TITLE		VALVE SCHEDULE + LADDER DIAGRAMS	
PROJECT	JOHNSON CONTROLS	1601 67TH AVE. N.	MPLS. MN. 55430
Systems & Services Division		DRAWING NUMBER 6076	

TELEX COMMUNIC



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BLUE EARTH, MINNESOTA

GENERAL NOTES

1. General:

- A. Do not scale drawings. All indicated dimension shall govern.
- B. Engineer's approval must be secured for all substitutions.

2. Site:

- A. Precautions shall be taken to prevent erosion as required by local Soil Conservation District and Codes.
- B. All elevations on the drawings are based on a survey performed by Bolton and Hank, Inc., Engineers, Farmouth, Minnesota.
- C. Datum point to be used for all site layout work and elevations will be that used by Bolton and Hank, Inc., Engineers, Farmouth, Minnesota for survey performed by them; filed January 25, 1968 No. 1258.
- D. Contractor shall be thoroughly familiar with the soil report and take all necessary precautions in order to assure that drilled-in-place concrete piers are installed properly with minimal hazard to laborers. Care should be exercised in excavating for piers. Excavation wall stability and ground water could be a problem. Place concrete as soon as possible after excavating. See soil report for amplification. Consultation with soil Engineer may be desired.

3. Design:

- A. Wind load = 20 PSF
- B. Head load = 10 PSF
- C. Allowable soil stresses and densities per Soil Exploration Company report. For complete details see report.
 1. Allowable bearing @ piers = 2000 PSF
 2. Allowable bearing @ tank = 2000 PSF

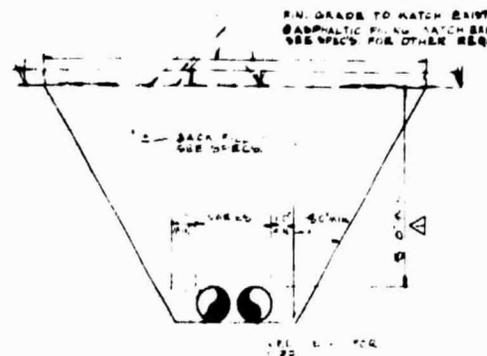
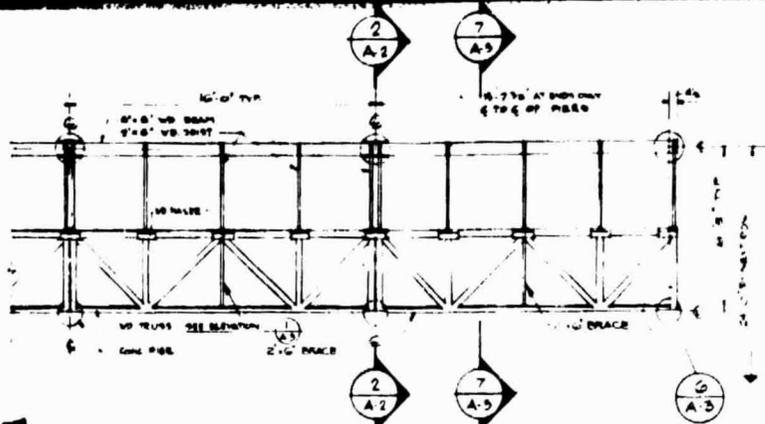
- 3. Passive pressure = overburden pressure + 2x cohesion (1000 PSF)

4. Materials:

- A. For complete details see specifications.
- B. Concrete: f'_c = 3000 psi compressive strength at 28 days.
- C. Reinforcing bars: ASTM Grade 40
 1. All bar lengths are not drawn to scale. No splices of reinforcement shall be made except as detailed or authorized by the Engineer.
 2. Detail bars in accordance with A.C.I. Manual of Standard Practice for Detailing Reinforced Concrete Structures (ACI 318) and A.C.I. Building Code Requirements for Reinforced Concrete (ACI 318), latest editions.
 3. Provide all accessories necessary to support reinforcing at positions shown on the drawings.
- D. Lumber:
 1. Unless otherwise noted lumber to be Douglas Fir Larch, studs-grade, preservative treatment per specifications.
 2. Metal hardware, nails and anchor bolts to be galvanized steel.
 3. 6 x 8 wood beam to be cut to and length to have bolt and nail holes prebored prior to pressure treatment per specification.

5. Construction:

- A. All dimensions and conditions shown on drawings shall be verified by the contractor and any discrepancy shall be reported to the Engineer prior to proceeding with fabrication or construction.
- B. All concrete shall be thoroughly vibrated to prevent honeycombing.
- C. Cast-in-Place Concrete Piers:
 1. For complete details see specifications.
 2. Concrete piers to be drilled in place, true in diameter, depth with no caving in of soil or ground water present. Steel caps and concrete to be placed as soon after drilling as possible to prevent disturbance to soil. In all cases piers shall have full bearing at tip elevation. Remove all loose soil at bottom of pier shaft. Dewatering of soil will be required if excessive water is present. Engineer should be consulted if excessive ground water present.
 3. Forms shall not be removed until 7th day after placement of concrete. Solar structure shall not be placed on concrete piers until 14th day after placement of concrete.
- D. Cast-in-Place Concrete Storage Tank Slabs
 1. Concrete slabs for water tank shall have been in place 5 days prior to installing tank. Do not fill tank with water until 14th day after concrete has been placed.
 2. Verify all dimensions through floor and walls with mechanical and electrical requirements.
 3. Compaction of backfill where required shall be 95% of Proctor maximum dry density.

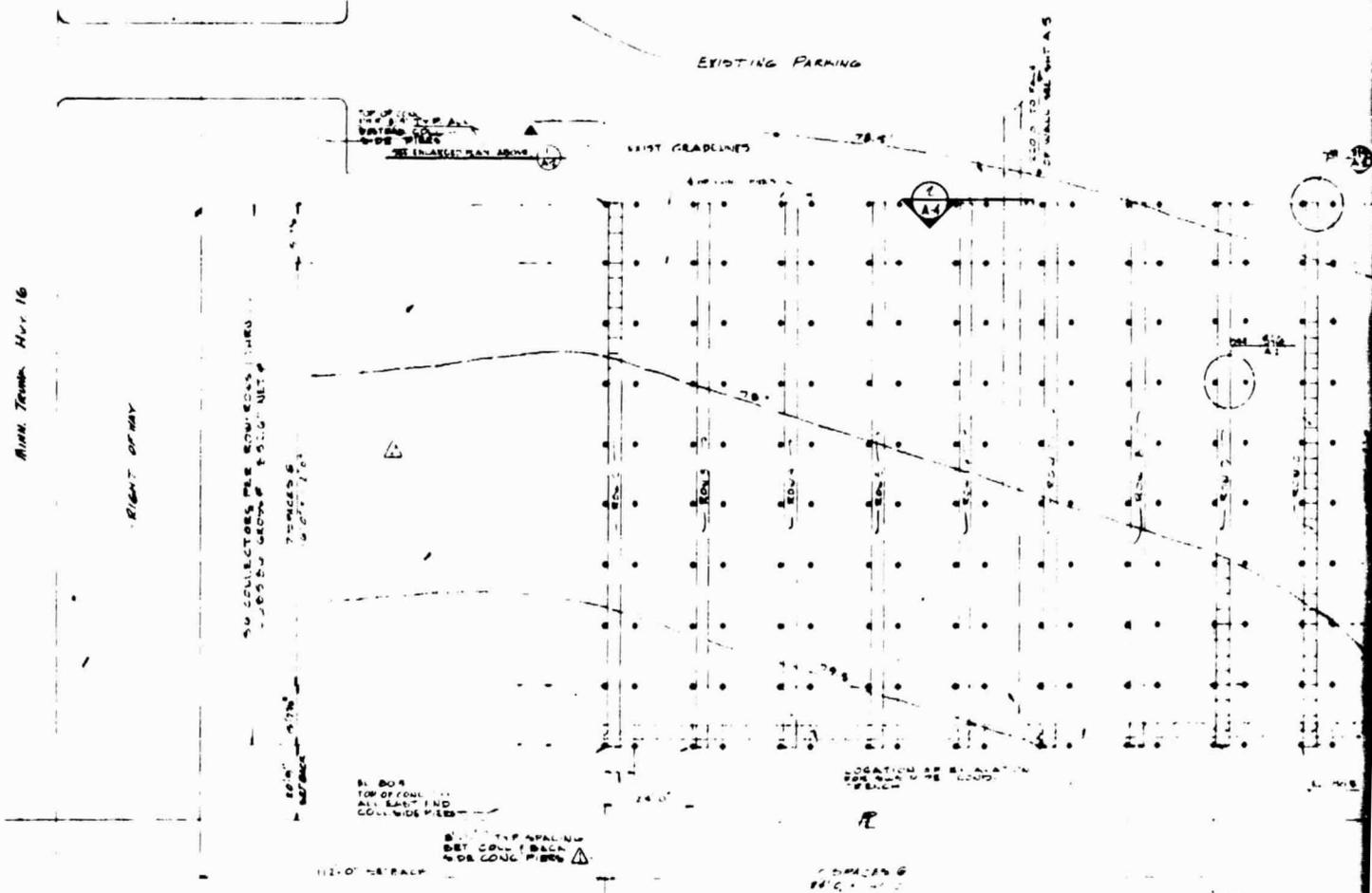


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PARTIAL WOOD FRAMING PLAN
SCALE 1/8" = 1'-0"

PIPE TRENCH DETAIL
SCALE 1/8" = 1'-0"

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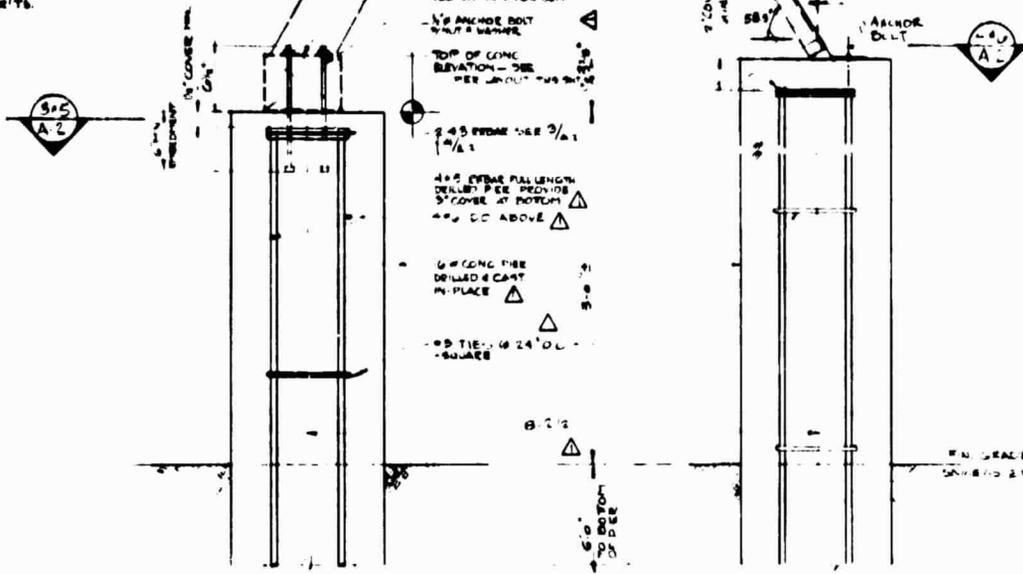
PIER LAYOUT
SCALE 1/8" = 1'-0"

NAME OF PROJECT SC AIR HEATING SYSTEM TELEX COMMUNICATIONS, INC. BLUE EARTH, MINNESOTA	REV NONE	DESCRIPTION ISSUED FOR REVIEW	DATE 4/2/77	SHEET TITLE PIER LAYOUT, FRAMING P & DETAILS
	REV A	DESCRIPTION PER OWNER REQUEST	DATE 4/2/77	
	REV B	DESCRIPTION PER OWNER REQUEST	DATE 4/2/77	

FIN. GRADE TO MATCH BRIST'S
 CATHOLIC FIN. NO. MATCH BRIST'S
 SEE SPEC. FOR OTHER REQUIRETS.

SEE DET. A-3 FOR DET.

SIMPSON DA-18 OR EQUAL
 FLANGE BOLT MUST PROTRUDE ON
 THE SIDE FACING EXTERIOR.

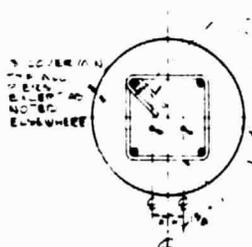


CONC. PIERS -
 VERT. SECTION

SCALE 1/2" = 1'-0"

2
 A-2

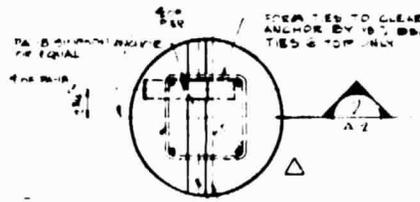
DETAIL
 A
 A-2



HORIZONTAL SECTION
 END PIER, COLLAR SIDE

SCALE 1/2" = 1'-0"

3
 A-2

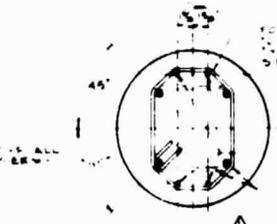


PLAN VIEW
 END PIER, BACK SIDE

SCALE 1/2" = 1'-0"

4
 A-2

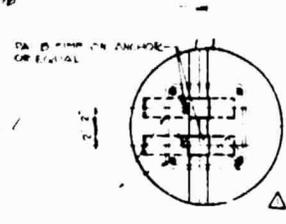
NOTE: ALL PIERS TO BE 16" DIA.



HORIZONTAL SECTION

SCALE 1/2" = 1'-0"

5
 A-2



PLAN VIEW

SCALE 1/2" = 1'-0"

6
 A-2

FOLDOUT FRAME
 2

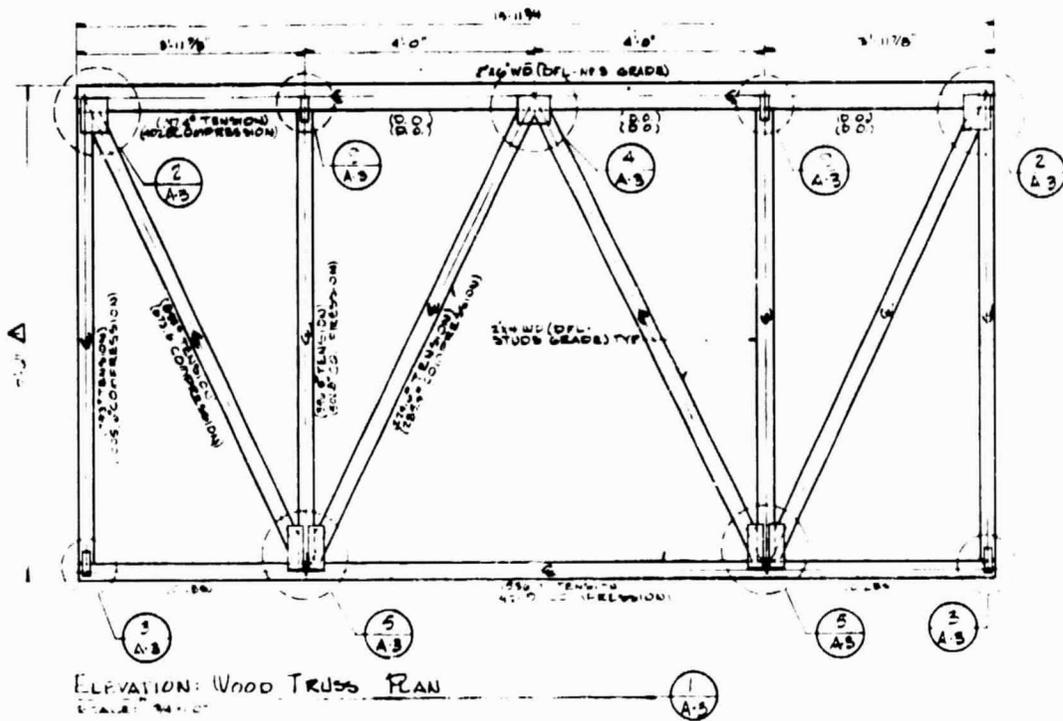
NOTE: ELEVATIONS ON SIDE OF COLLECTOR ARE
 THE FINISH ELEVATION OF COLLECTOR
 SIDE OF END PIER. THE EXTERIOR
 SIDE OF PIER BETWEEN END AND PIER
 SHALL BE STEPPED DOWN TO PIER
 LEVEL. THE EAST BACKSIDE PIER SHALL
 BE 5" HIGHER THAN RELATED
 COLLECTOR SIDE PIER SEE DET. A-3

A-2
 1/2" = 1'-0"

OUT, FRAMING PLAN,	JOB NUMBER	SCALE	ITC	INTERTECHNOLOGY CORPORATION	SHEET NO
	00040	AS NOTED			
	DATE	DRAWN BY			A-2
		APPROVED BY			

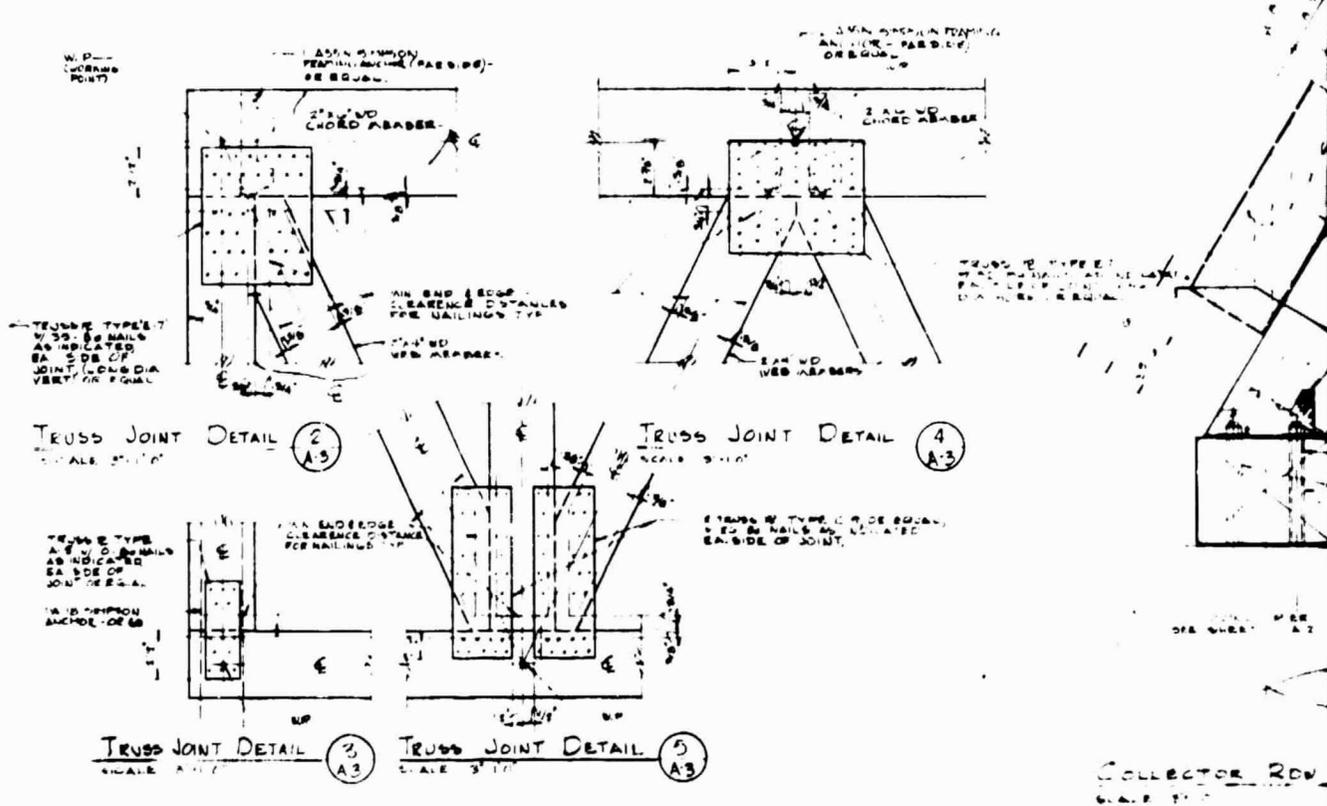
111 MAIN STREET
 WARRENTON, OREGON 97146 USA

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WOOD BEAM & COLLECTOR
CONNECTION DETAILS
ROW ENDS
SCALE: 3/4" = 1'-0"

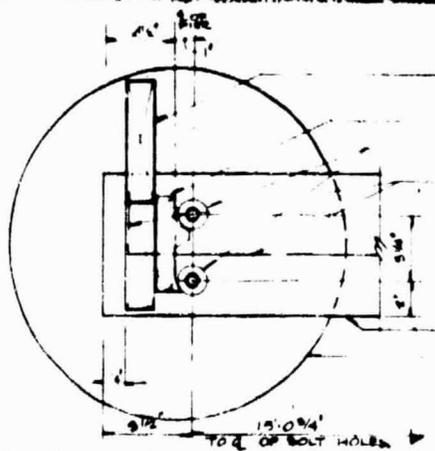
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REV	DESCRIPTION	DATE	SHEET TITLE
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2	PER NASA 20% REVIEW COMMENTS	5/5	
3	AS BUILT CORRECTIONS	9/11/77	

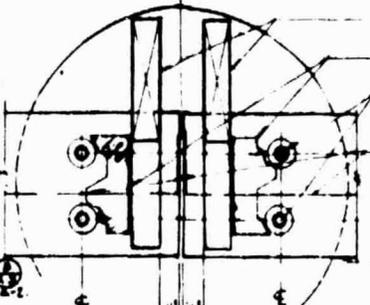
NAME OF PROJECT
SOLAR HEATING SYSTEM
 TELEX COMMUNICATIONS, INC.
 BLUE EARTH, MINNESOTA



1/2" ANCHOR BOLTS WITH
FLAT WASHERS SEE
SOLAR COLLECTOR
LOCATION

1/2" ANCHOR BOLTS WITH
FLAT WASHERS SEE
SOLAR COLLECTOR
LOCATION

1/2" ANCHOR BOLTS WITH
FLAT WASHERS SEE
SOLAR COLLECTOR
LOCATION



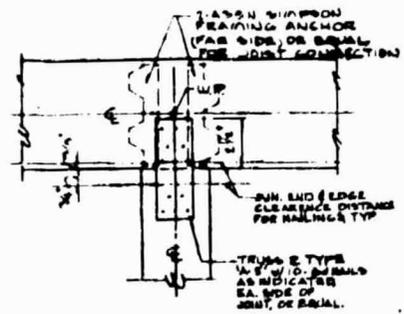
1/2" ANCHOR BOLTS WITH
FLAT WASHERS SEE
SOLAR COLLECTOR
LOCATION

1/2" ANCHOR BOLTS WITH
FLAT WASHERS SEE
SOLAR COLLECTOR
LOCATION

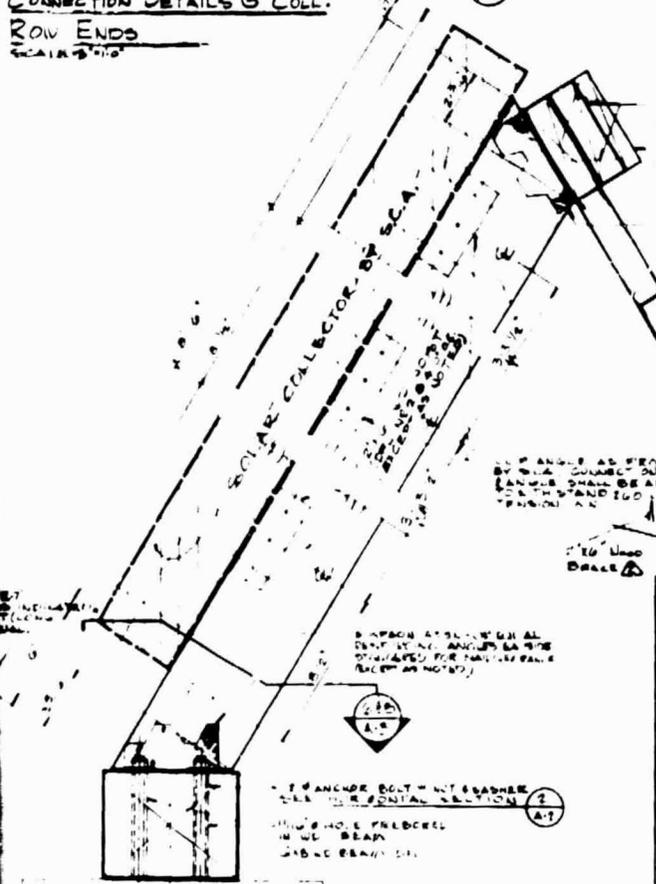
1/2" ANCHOR BOLTS WITH
FLAT WASHERS SEE
SOLAR COLLECTOR
LOCATION

WOOD BEAM & COLLECTOR JOIST
CONNECTION DETAILS @ COLL.
ROW ENDS
SCALE 3"=10"

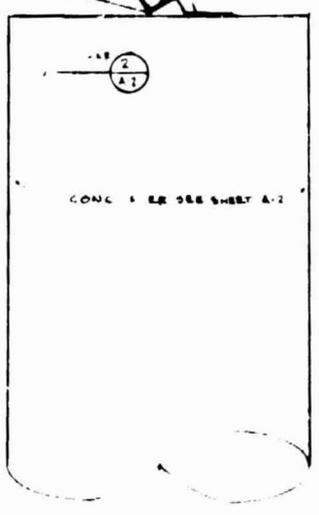
WOOD BEAM & COLLECTOR JOIST
CONNECTION DETAIL TYPICAL
SCALE 3"=10"



TRUSS JOINT DETAIL
SCALE 3"=10"



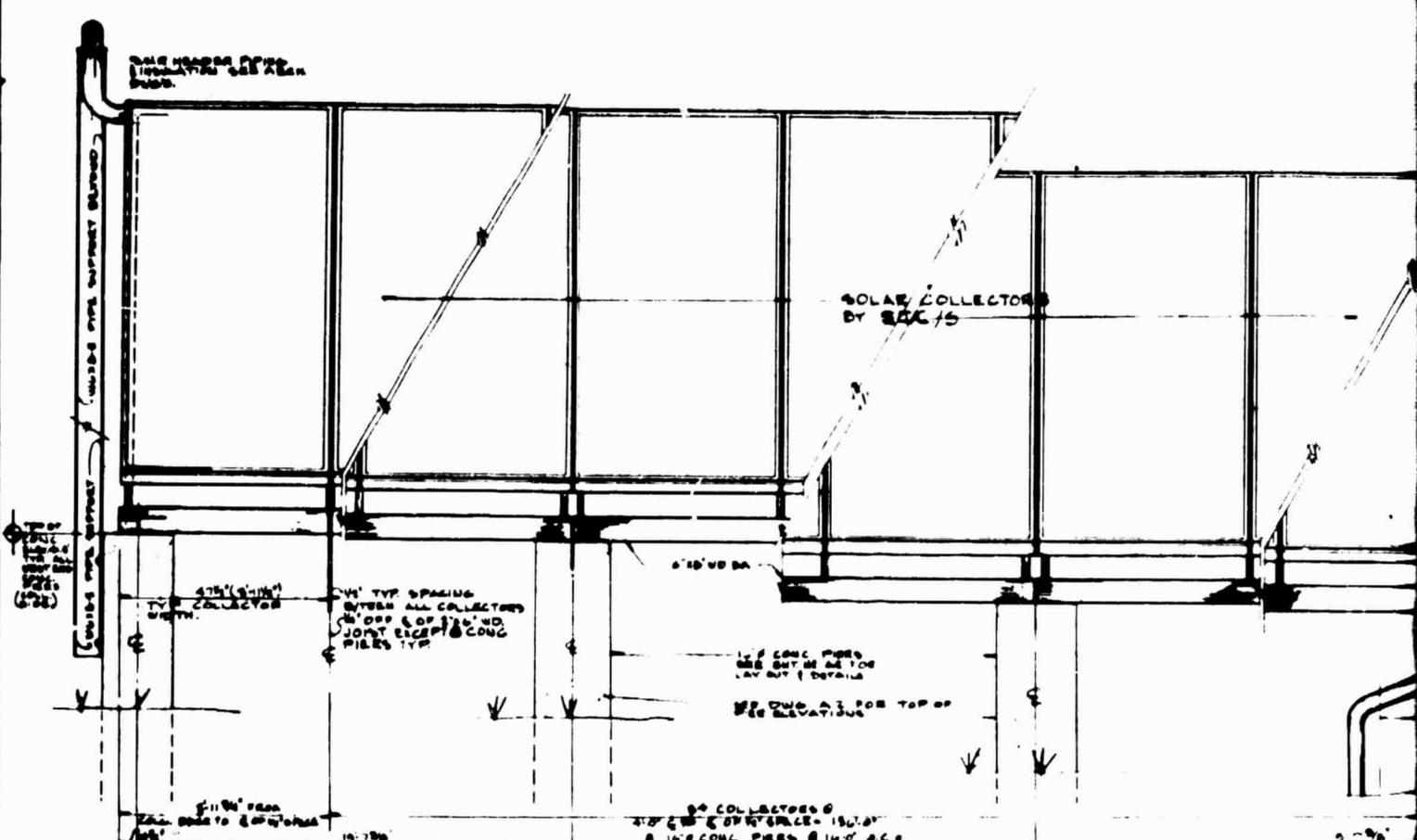
COLLECTOR ROW CROSS SECTION
SCALE 3"=10"



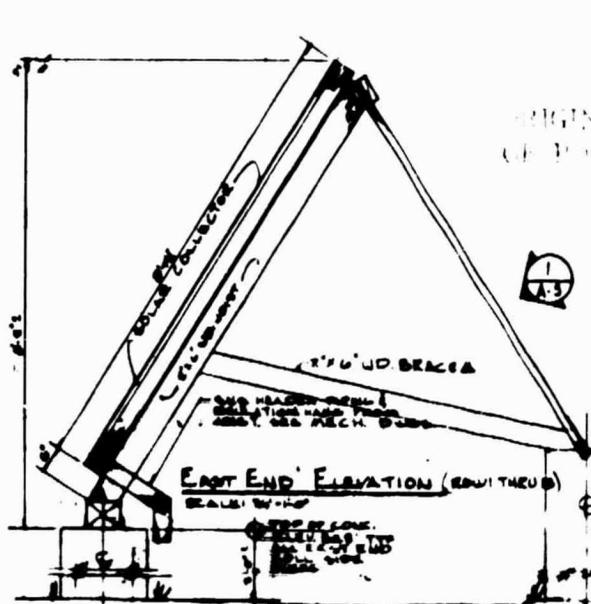
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FILE COLLECTOR SUPPORT DETAILS	JOB NUMBER 00040	SCALE AS SHOWN	ITC INTERTECHNOLOGY CORPORATION 100 MAIN STREET WARRENTON, VIRGINIA 27060 U.S.A.	SHEET NO A-3
	DATE 27 Oct 76	DRAWN BY M.W. J.C.		



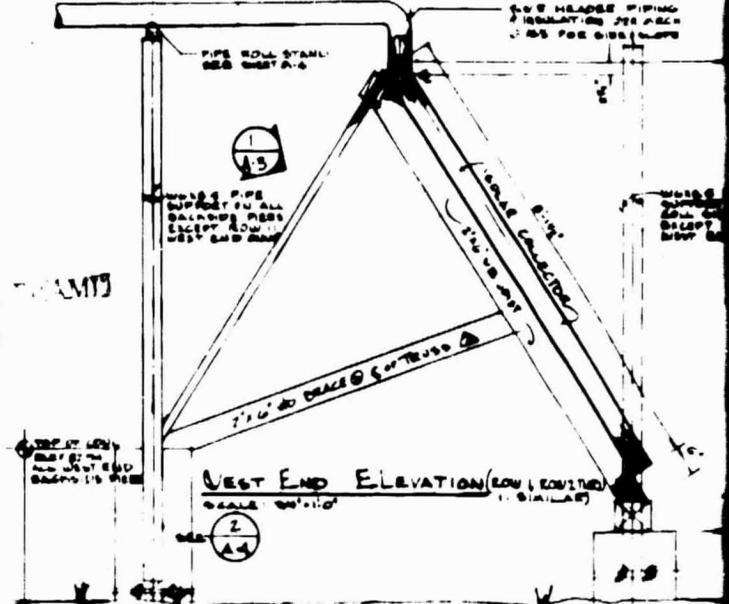
ROW 1: SOUTH ELEVATION (ALL OTHER ROWS SIMILAR) 1
 SCALE: 3/4"=1'-0"



EAST END ELEVATION (EQUILIBRIUM)
 SCALE: 3/4"=1'-0"

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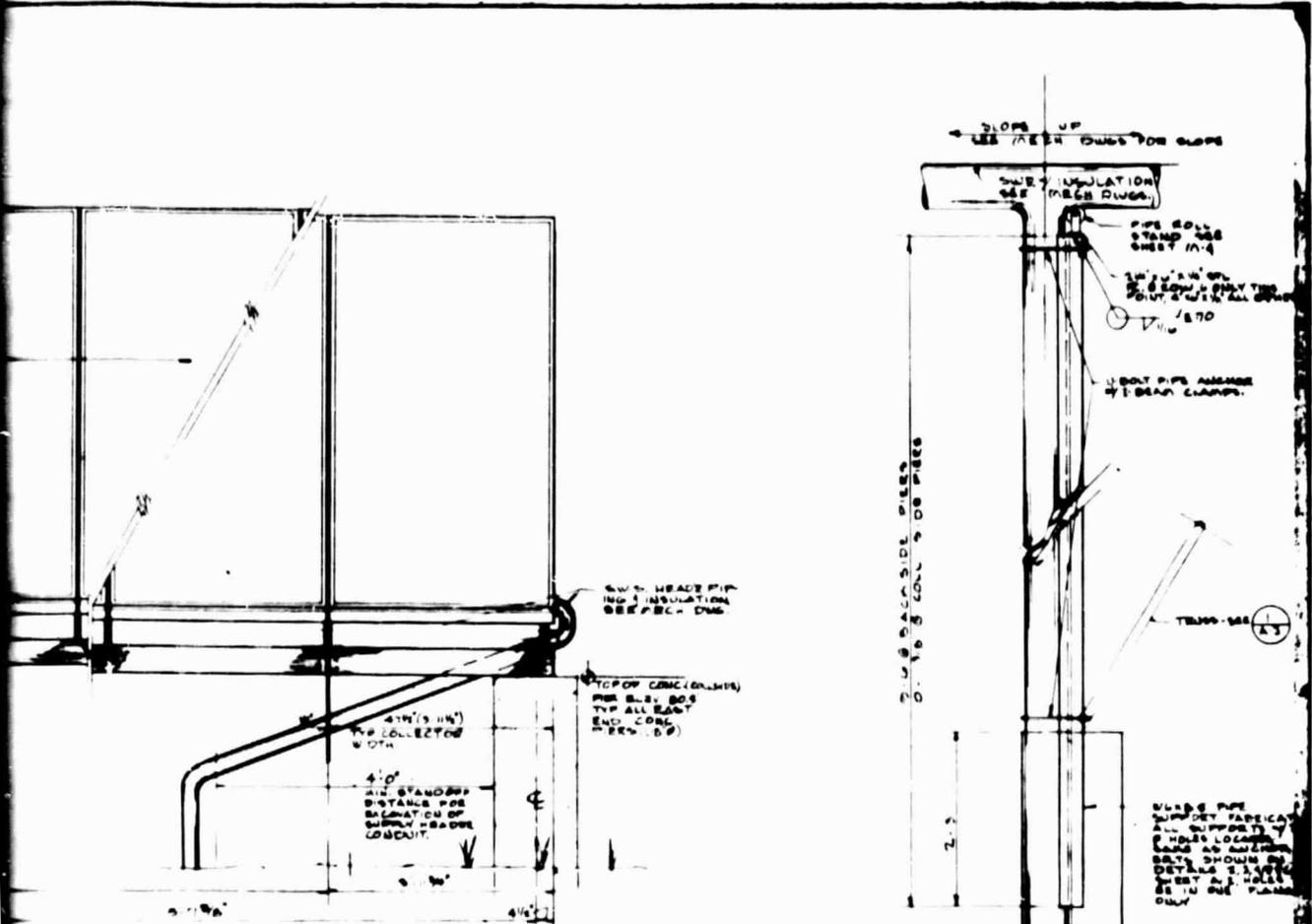


WEST END ELEVATION (EQUILIBRIUM)
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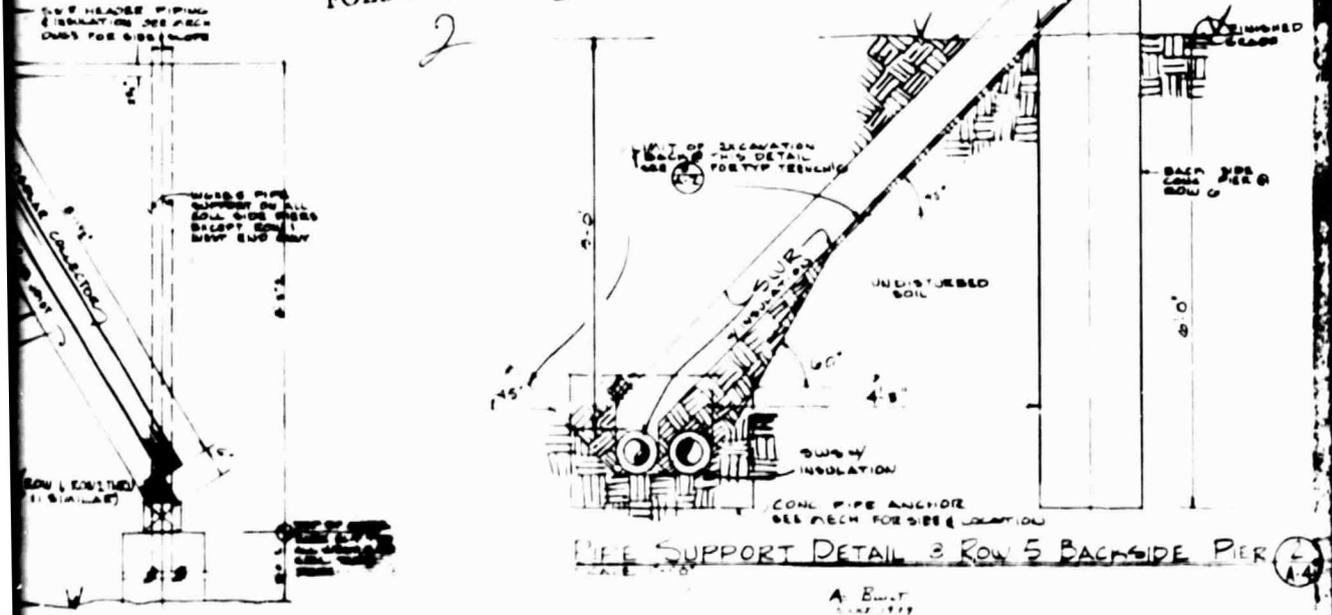
SOLAR HEATING SYSTEM
 TELEX COMMUNICATIONS
 BLUE EARTH, MINNESOTA

REV	DESCRIPTION	DATE
1	ISSUED FOR CONSTRUCTION	1987
2	FOR OWNER'S REQUEST	1987
3	FOR ARCHITECT'S COMMENTS	1987

SHEET TITLE
 TYPICAL ROW ELEVATION
 DETAILS

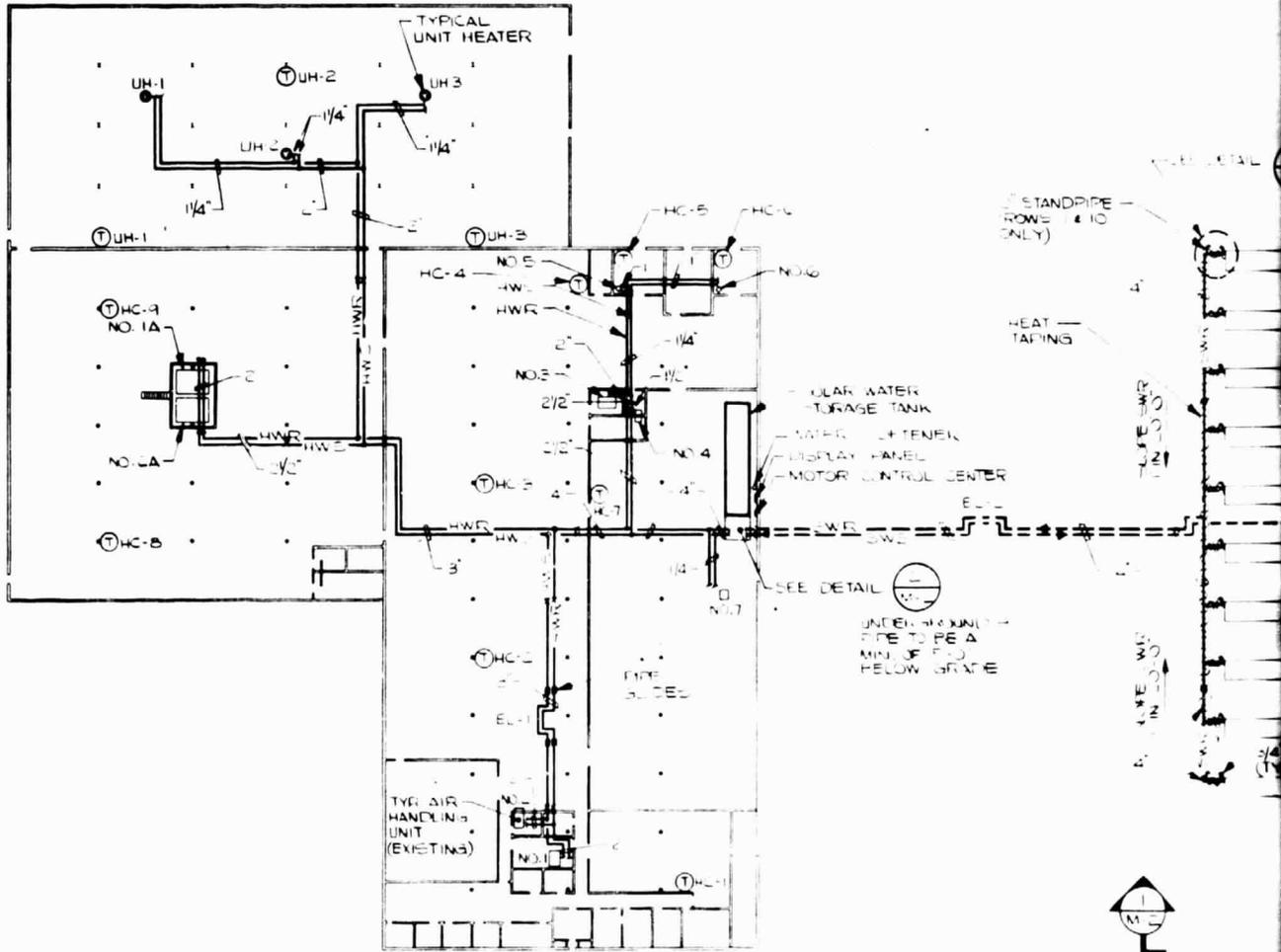


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 2
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FOOTPRINT FRAME



FLOOR PLAN
SCALE: 1/32" = 1'-0"



NAME OF PROJECT	REV	DESCRIPTION	DATE	SHEET TITLE
SOLAR HEATING SYSTEM TELEX COMMUNICATIONS, INC. <small>10000 W. 10th Ave., Denver, CO 80202</small>				FLOOR PLAN, GENERAL NOTES AND SYMBOL LIST

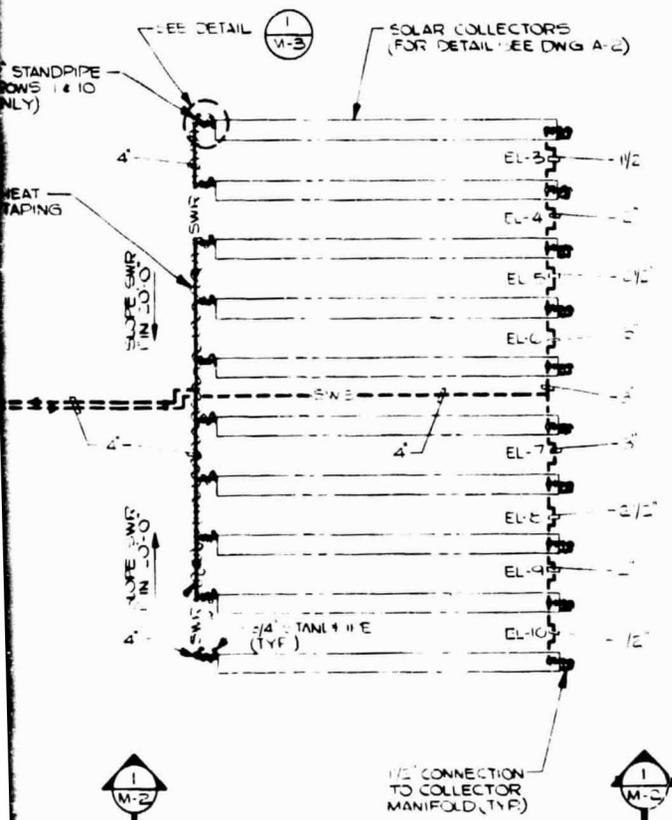
D12

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SYMBOL LIST

	Gate Valve
	Globe Valve
	Motorized Valve
	Balancing Valve
	Check Valve
	Butterfly Valve
	Union
	Automatic Air Vent
	Combination Automatic Air Vent/Vacuum Breaker
	Strainer
	Pipe Anchor
	Pipe Up
	Pipe Down
	End Cap for Pipe
	Direction of Flow
	Thermostat
S-S	Solar Meter Supply
SMR	Solar Meter Return
HMS	Hot Water Supply
HMR	Hot Water Return
HC	Heating Coil
UH	Unit Heater
GPM	Gallons Per Minute
FPM	Feet Per Minute
RP	Revolutions Per Minute
CFM	Cubic Feet Per Minute
TDH	Total Dynamic Head
EAT	Entering Air Temperature
LAT	Leaving Air Temperature
EMT	Entering Water Temperature
LWT	Leaving Water Temperature
WG	Water Gauge
PDV	Pressure Differential Valve
PD	Pressure Drop
EL	Expansion Loop
AAF	American Air Filter
NO	NORMALLY OPEN
NC	NORMALLY CLOSED



GENERAL NOTES

1. ALL THERMOSTAT LOCATIONS SHALL BE COORDINATED WITH EXISTING THERMOSTATS AND WITH THE PLANT MANAGER BEFORE INSTALLATION.
2. MAKE-UP WATER SUPPLY CONNECTION SHALL BE MADE IN STRICT ACCORDANCE WITH LOCAL CODES WITH A BACKFLOW PREVENTER AND PRESSURE REDUCING VALVE.
3. ONLY LONG RADIUS ELBOWS SHALL BE USED ON ALL PIPES.
4. BOTH SUPPLY AND RETURN WATER MAINS TO COLLECTOR SHALL ALWAYS SLOPE TOWARDS THE PIT.
5. ALL VALVES, AIRVENTS AND VACUUM BREAKERS OUTSIDE THE BUILDING SHALL BE HEAT TRACED TO PREVENT FREEZING.
6. ANCHOR UNDERGROUND PIPE AT ALL CHANGES IN DIRECTION AND AS RECOMMENDED BY THE PIPE MANUFACTURER. ANCHOR COLLECTOR SUPPLY PIPE AT ALL VERTICAL CONNECTIONS.

AS BUILT
15 OCT 1979
2661

FOR PLAN,
GENERAL NOTES
SYMBOL LIST

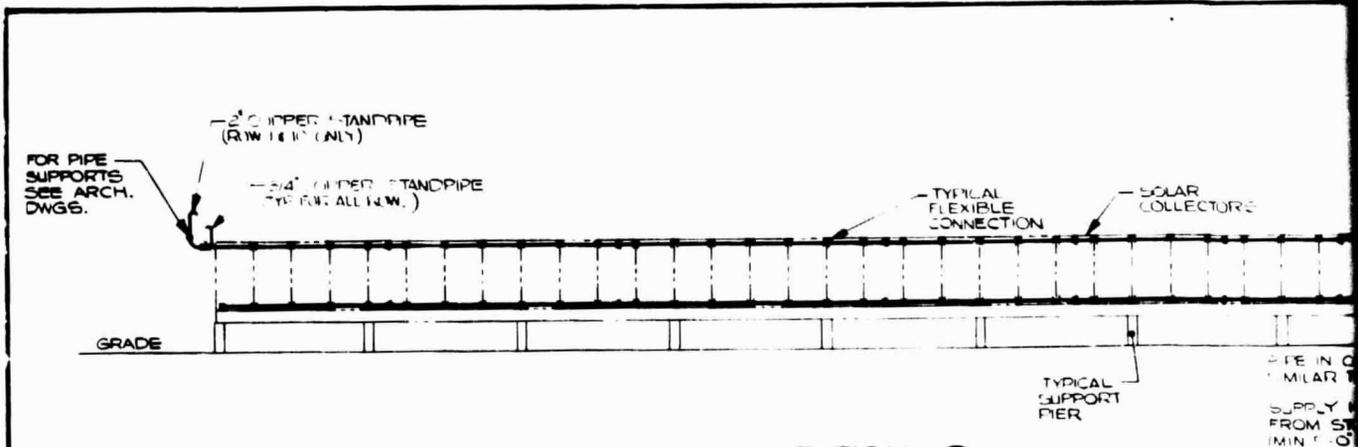
JOB NUMBER	SCALE AS SHOWN
00040	DRAWN BY T.W.A.
DATE	APPROVED BY
APRIL 20, 1977	



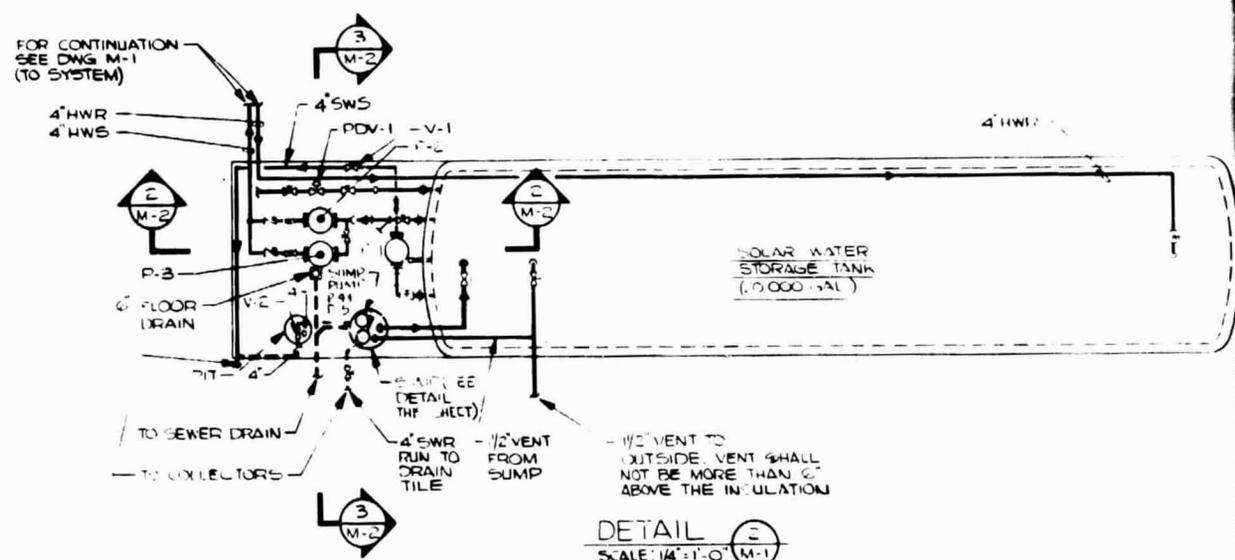
INTERTECHNOLOGY CORPORATION

SHEET NO
M-1

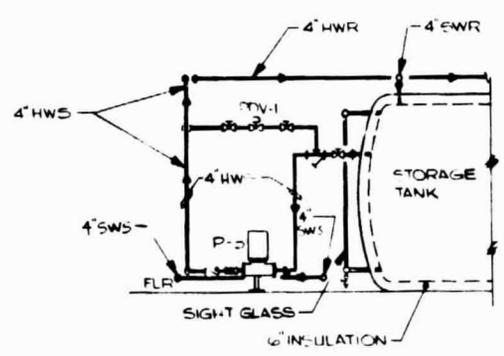
100 MAIN STREET
WARRENTON, VIRGINIA 22606, U.S.A.



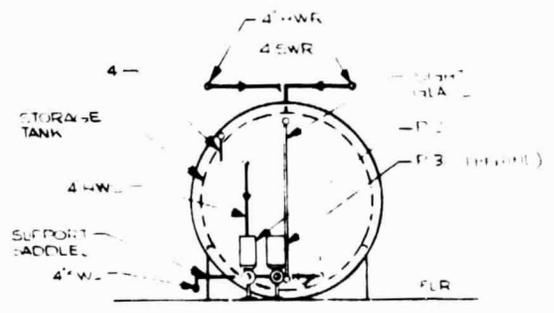
SECTION 1
SCALE: 1/8" = 1'-0" (M-1)



DETAIL 2
SCALE: 1/4" = 1'-0" (M-1)



SECTION 2
SCALE: 1/4" = 1'-0" (M-2)

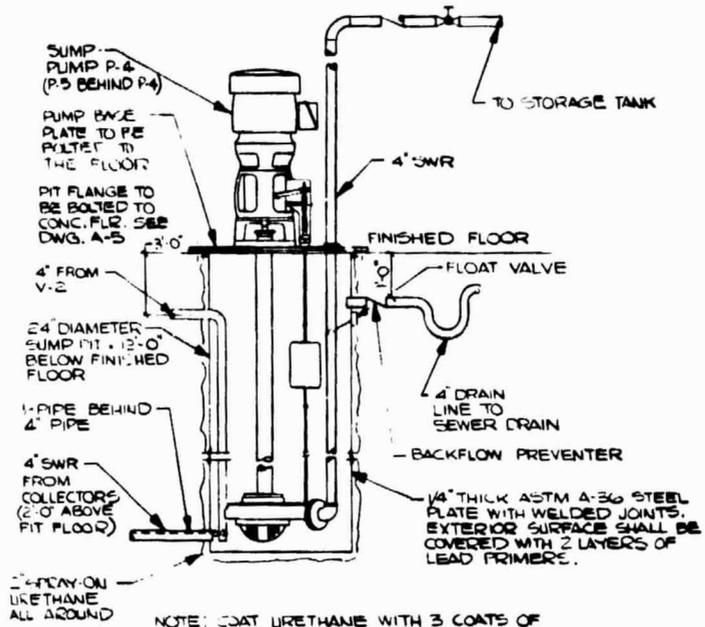
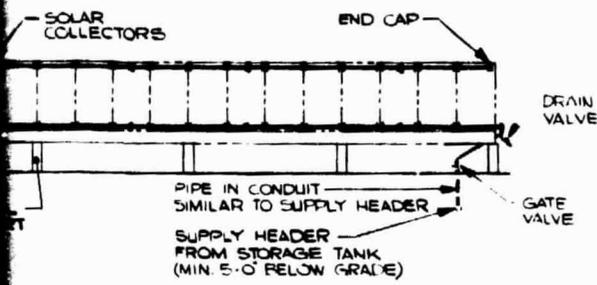


SECTION 3
SCALE: 1/4" = 1'-0" (M-2)

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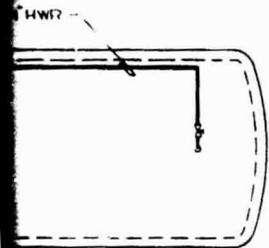
CONCRETE FRAME

NAME OF PROJECT SOLAR HEATING SYSTEM TELEX COMMUNICATIONS, INC.	REV	DESCRIPTION	DATE	SHEET TITLE SECTIONS FLOW DIAG D/3



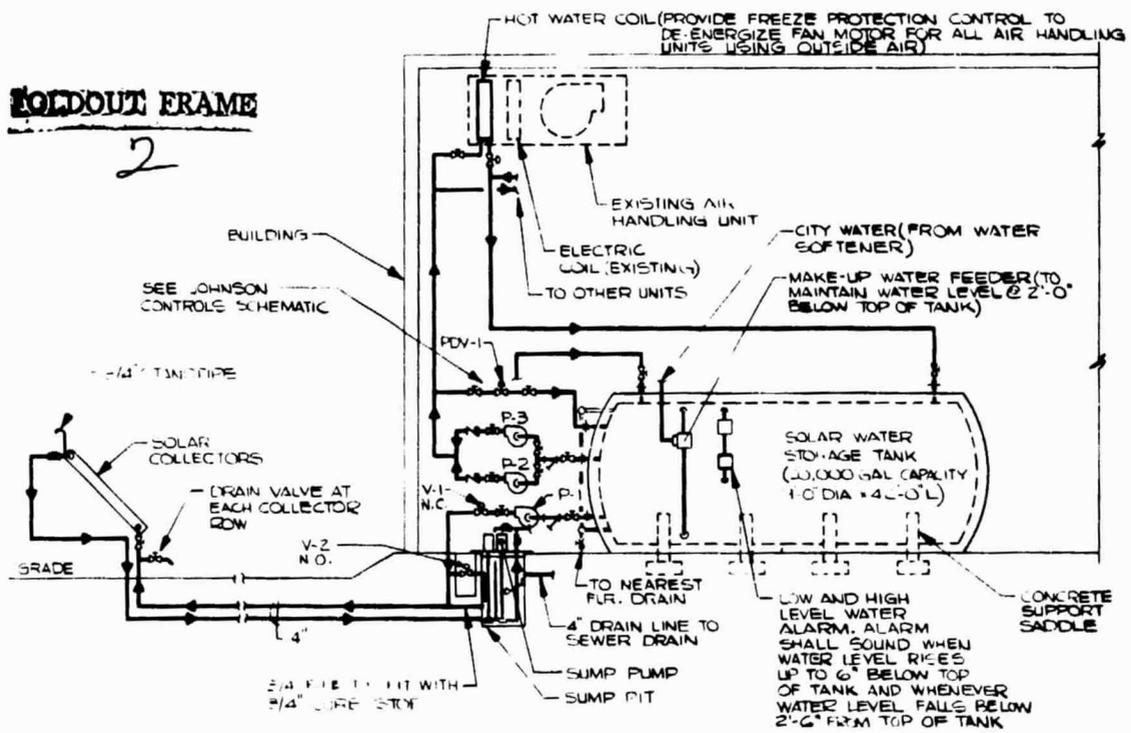
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NOTE: COAT URETHANE WITH 3 COATS OF WATER BASE PAINT AND WRAP IN POLYETHYLENE BEFORE INSTALLING IN GROUND.
SUMP PUMP DETAIL
 SCALE: NONE



FOLDOUT FRAME

2



FLOW DIAGRAM
 SCALE: NONE

As Built
 15 OCT 1977
 TWP

TITLE SECTIONS AND FLOW DIAGRAM D-13	JOB NUMBER 00040	SCALE AS SHOWN DRAWN BY T.W.A.		INTERTECHNOLOGY CORPORATION 100 MAIN STREET D-13	SHEET NO. M-2
	DATE APRIL 20, 1977	APPROVED BY			

PUMP SCHEDULE

PUMP NO.	SERVICE	PERFORMANCE DATA				CONSTRUCTION DATA		NPSH AVAIL.	NPSH REQD.	MANUFACTURER
		GPM	TDH FT.	RPM	MOTOR H.P.	TYPE	PUMP			
1	SOLAR COLLECTORS	240	55	1750	7/2	CENTRIFUGAL IN-LINE		8'	4'	BEG SERIES 80
2	HEATING COILS	125	60	1750	5	CENTRIFUGAL IN-LINE		8'	3'	" " "
3	HEATING COILS	125	60	1750	5	CENTRIFUGAL IN-LINE		8'	3'	" " "
4	SUMP PIT	240	20	1750	2	SUMP PUMP		6'	4'	AURORA SERIES 530
5	SUMP PIT	240	20	3600	1/2	SUMP PUMP		6'	4'	" " 530

HEATING COIL SCHEDULE

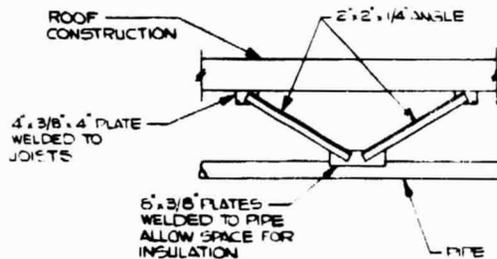
COIL NO.	LOCATION	CAP CFM	AIR			WATER				MAX FACE VELOCITY IN FPM
			EAT °F	LAT °F	P.D. IN. WG	GPM	EWT °F	LWT °F	P.D. FT. WG	
HC-1	UNIT-1	8000	50	80	.5	35	105	90	2	600
HC-2	UNIT-2	9200	50	80	.5	40			2	600
HC-3	UNIT-3	9200	50	80	.5	40			2	600
HC-4	UNIT-4	3800	50	80	.5	16			2	600
HC-5	UNIT-5	1200	50	80	.5	5			2	600
HC-6	UNIT-6	1200	50	80	.5	5			2	600
HC-7	UNIT-7	2000	50	80	.5	9			2	600
HC-8	UNIT 1A	10500	50	70	.5	30			-	600
HC-9	UNIT-2A	10500	50	70	.5	30			2	600

UNIT HEATER SCHEDULE

UNIT NO.	SERVICE	CAP MBH	CFM	GPM	EWT °F	LWT °F	MOT. DATA		ELECTRICAL DATA			REMARKS
							MHP	RPM	VOLTS	HZ	PHASE	
1	STORAGE	78	5430	12	105	90	1/2	1140	120	60	1	SIMILAR TO A.A.F. NO. YU-2620
2	STORAGE	78	5430	12	105	90	1/2	1140	120	60	1	SIMILAR TO A.A.F. NO. YU-2620
3	STORAGE	78	5430	12	105	90	1/2	1140	120	60	1	SIMILAR TO A.A.F. NO. YU-2620

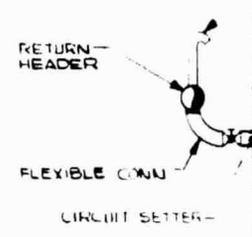
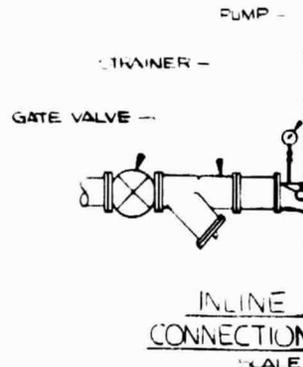
FOLLOW UP FRAME

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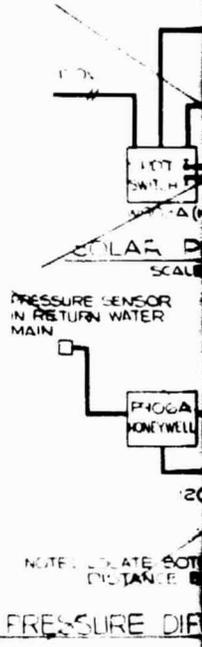


PIPE ANCHOR DETAIL

SCALE: NONE



DETAIL 1
SCALE: NONE



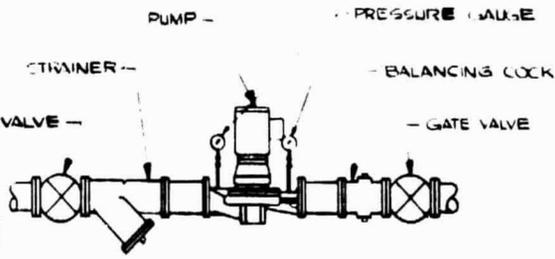
PRESSURE DIFFERENCE

NAME OF PROJECT

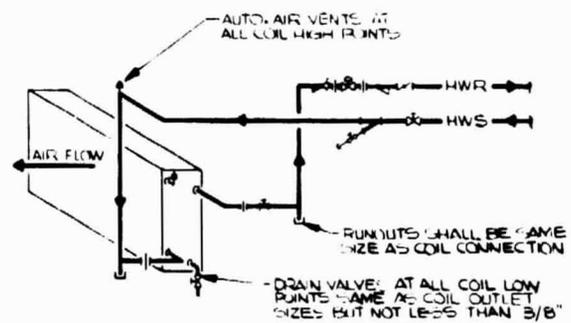
SOLAR HEATING SYSTEM
TELEX COMMUNICATIONS, INC.
DULUTH, MINNESOTA

REV	DESCRIPTION	DATE	SHEET TITLE

DETAILS AND SCHEDULES

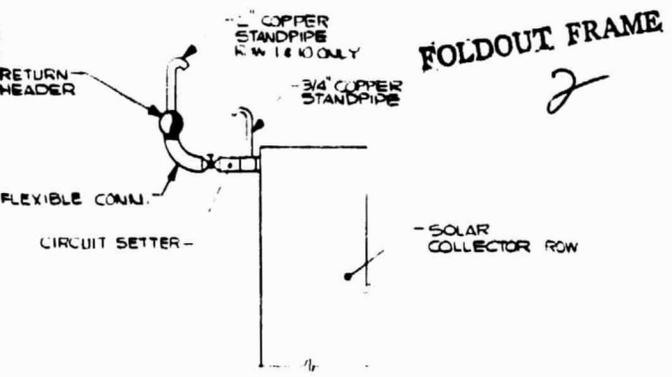


INLINE PUMP CONNECTION DETAIL
SCALE: NONE



NOTES: LOCATE PIPE UNIONS AND ARRANGE PIPING TO FACILITATE COIL REMOVAL.

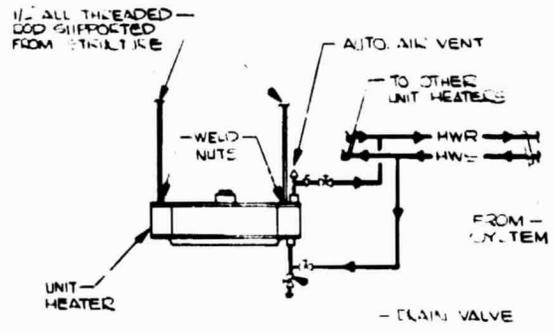
TYPICAL HOT WATER COIL PIPING CONNECTIONS
SCALE: NONE



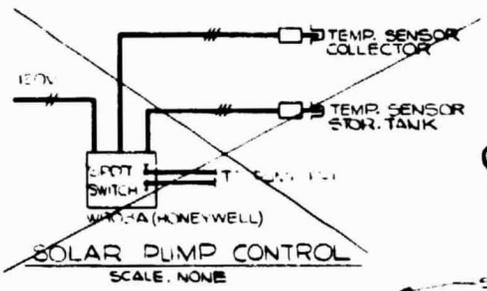
FOLDOUT FRAME

DETAIL 1
SCALE: NONE (1:1)

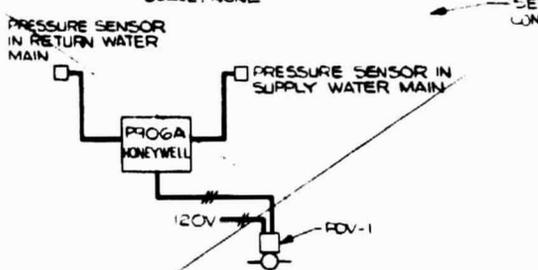
NOTE: ALL VENTS SUBJECT TO FREEZING SHALL BE INSULATED AND HEAT TAPE'D.



UNIT HEATER PIPING DETAIL
SCALE: NONE

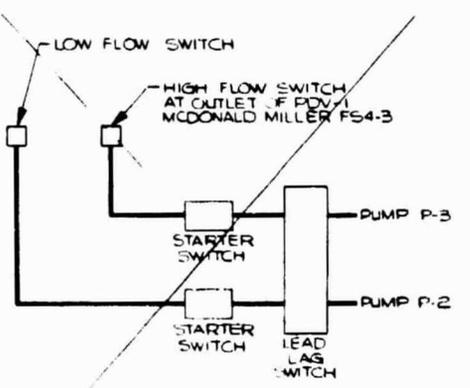


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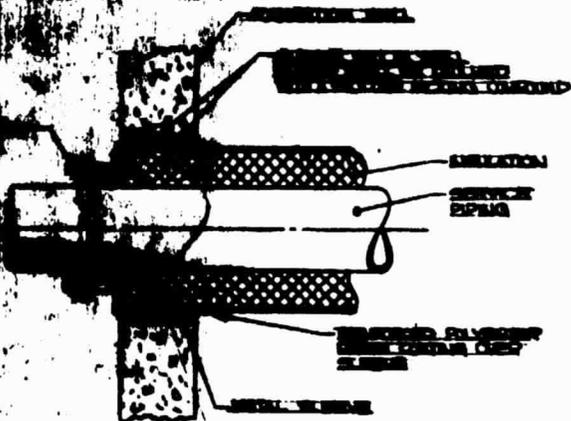
NOTE: LOCATE BOTH SENSORS APPROX. 3/4 OF THE DISTANCE BETWEEN FARTHEST COIL AND PUMP

PRESSURE DIFFERENTIAL VALVE CONTROL
SCALE: NONE

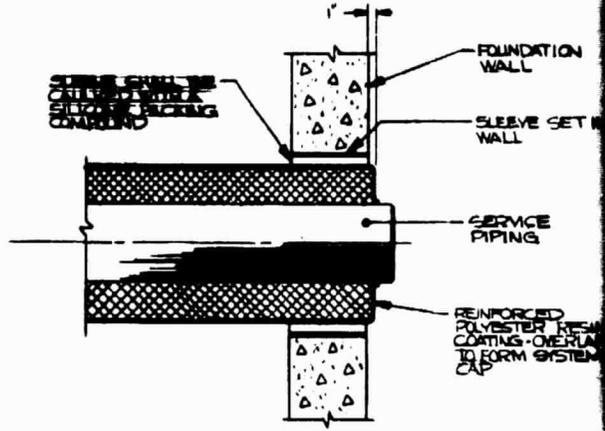


PUMP P-2 AND P-3 CONTROL
SCALE: NONE

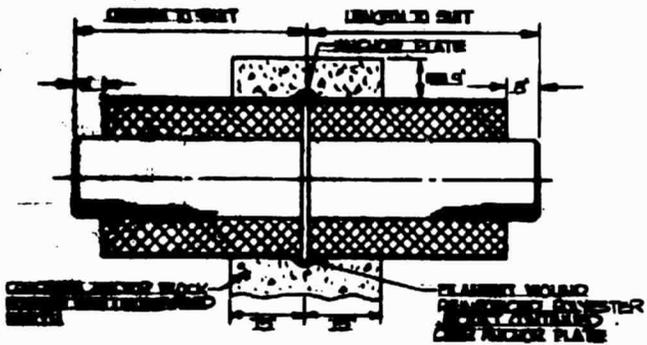
ND SCHEDULES	JOB NUMBER	SCALE AS SHOWN	ITC	INTERTECHNOLOGY CORPORATION	SHEET NO		
	00040	DRAWN BY T.W.A.				100 MAIN STREET WARRENTON VIRGINIA 27186 U.S.A.	M-3
	DATE	APPROVED BY					
	APRIL 20, 1977						



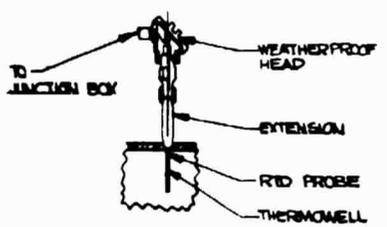
END SEAL FOR PIPE ENTERING PIT
SCALE: NONE



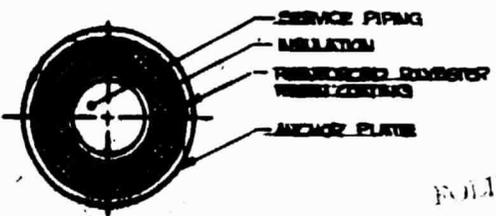
END SEAL FOR UNDERGROUND PIPE ENTERING
SCALE: NONE



UNDERGROUND PIPE ANCHOR
SCALE: NONE

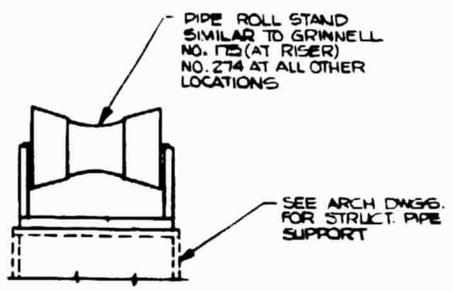


TEMP SENSOR MOUNTING DETAIL FOR 4" PIPE AND STORAGE TANK
SCALE: NONE



UNDERGROUND PIPE ANCHOR
SCALE: NONE

FOLDOUT FRAME



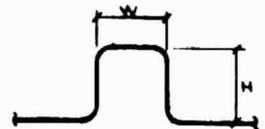
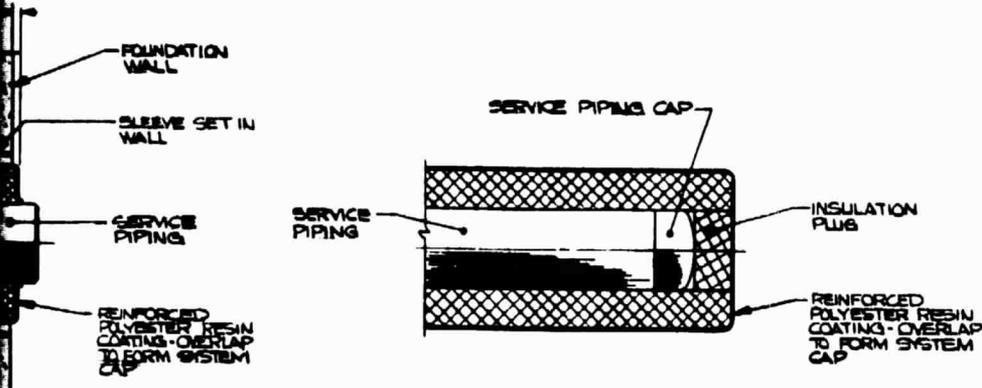
COLLECTOR PIPE SUPPORT DETAIL
SCALE: NONE

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DATE	SHEET TITLE

DETAILS

EXP. LOOP SCHEDULE			
LOOP NO.	PIPE SIZE IN.	W FEET	H FEET
1	3	5	6
2	4	5	8
B-11	1/2, 2, 2 1/2	1	2



ALL ELBOWS TO BE LONG RADIUS

PIPE ENTERING BLDG.

PIPE CAP FOR UNDERGROUND PIPE

SCALE: NONE

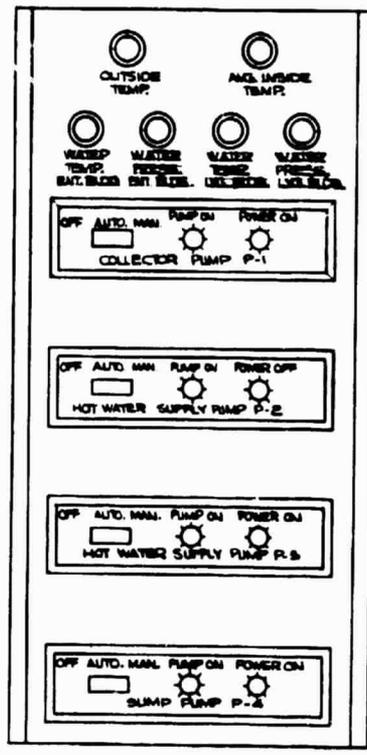
- WEATHERPROOF HEAD
- EXTENSION
- RED PROBE
- THERMOWELL

MOUNTING DETAIL STORAGE TANK

ROLL STAND LAD TO GRINNELL (AT RISER) 1/4" AT ALL OTHER POSITIONS

SEE ARCH DWGS. FOR STRUCT. PIPE SUPPORT

SUPPORT DETAIL



57" HIGH x 24" WIDE x 9" DEEP PANEL SIMILAR TO HONEYWELL NO. 1575-3275-001

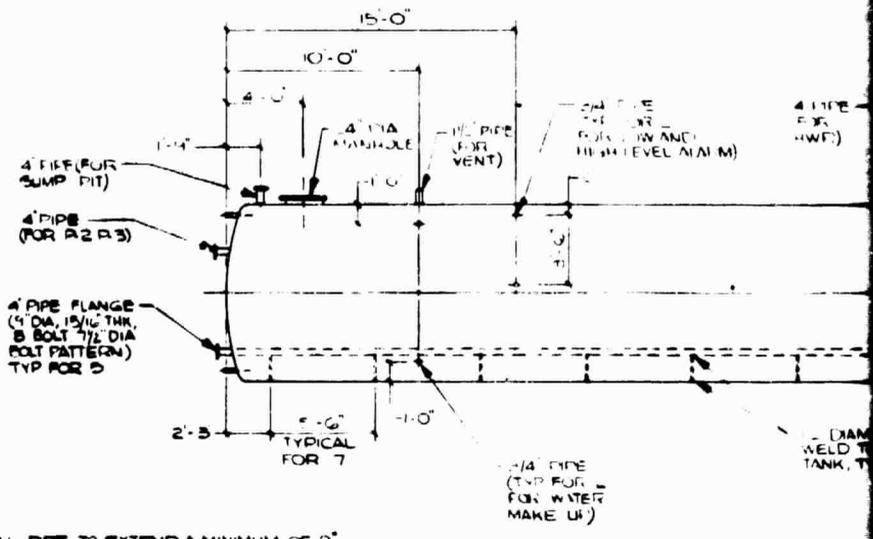
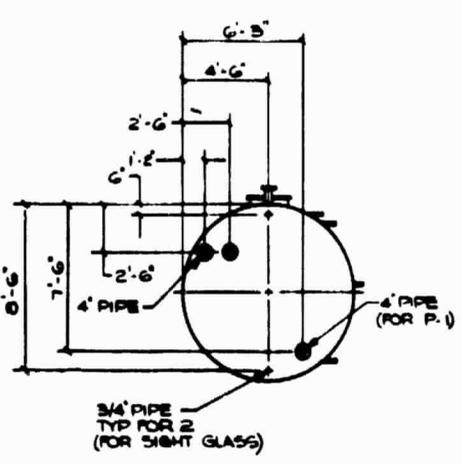
FOLDOUT FRAME

2
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DISPLAY PANEL

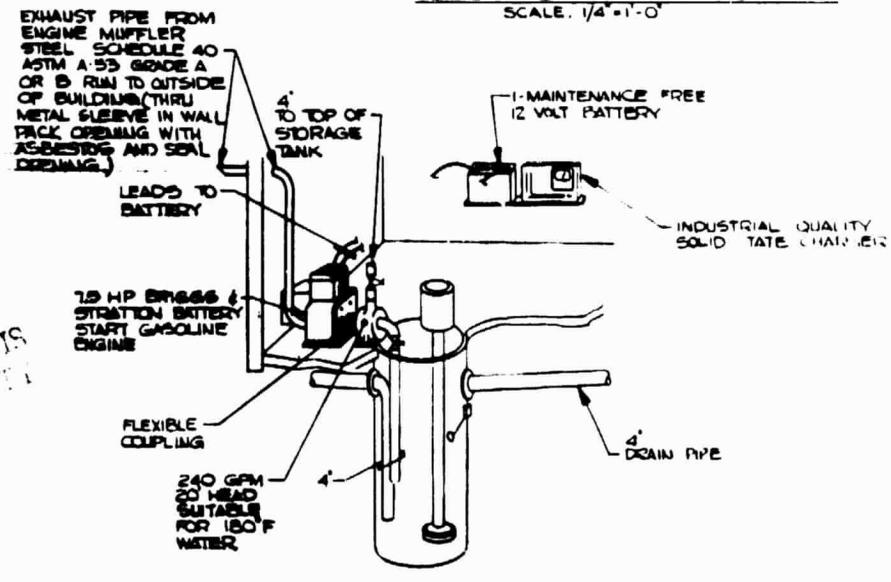
SCALE: NONE

As Built
15 OCT 1979
LWAL



NOTE: 1. ALL PIPE TO EXTEND A MINIMUM OF 9" BEYOND THE SURFACE OF THE TANK.
 2. ALL PIPE SMALLER THAN 2 1/2" SHALL BE THREADED PIPE.

STORAGE TANK DETAIL
 SCALE: 1/4"=1'-0"



NOTE: THE UNIT SHALL AUTOMATICALLY TURN ON WHENEVER THE WATER LEVEL IN THE PIT RISES TO 6" BELOW DRAIN PIPE AND SHUT OFF WHENEVER THE WATER LEVEL DROPS 2" BELOW DRAIN PIPE.

EMERGENCY SUMP PUMP DETAIL
 SCALE: NONE

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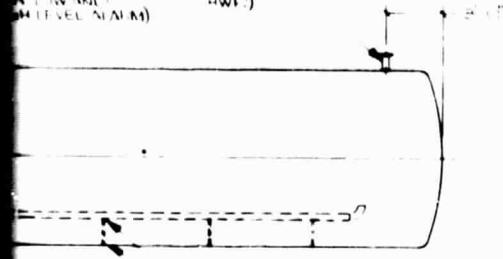
WOODRUM FRAME

REV.	DESCRIPTION	DATE	SHEET TITLE

DE TAILS

TYPE
PIPE
FOR
LOW AND
MEDIUM ALUM

4 INCH -
FOR
HWF



1/2" DIAMETER PIPE
WELD TO 4" PIPE AND
TANK, TYP FOR 7

HOLDOUT FRAME
2

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OF POOR QUALITY

As Shown
12-21-1977
TWA

DETAILS	JOB NUMBER	SCALE		INTERTECHNOLOGY CORPORATION <small>100 MAIN STREET WARRINGTON, VIRGINIA 22090 USA</small>	SHEET NO M-5
	00040	AS SHOWN			
	DRAWN BY	TWA			
	DATE	APRIL 20, 1977	APPROVED BY		