DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-161586

SOLAR HEATING SYSTEM INSTALLED AT JACKSON, TENNESSEE - FINAL REPORT

Prepared from documents furnished by

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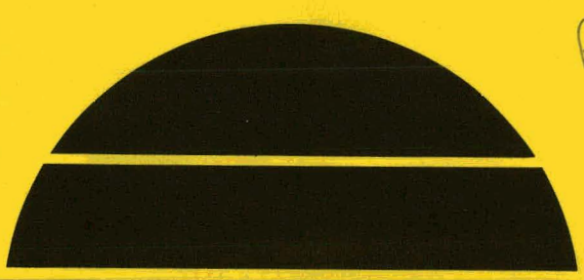
5575 Poplar Avenue, Suite 612
Memphis, Tennessee 38117

Under DOE Contract EG-77-A-01-4092

Monitored by

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

For the U. S. Department of Energy



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Solar Energy

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TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
DOE/NASA CR-161586		

4. TITLE AND SUBTITLE	5. REPORT DATE
Solar Heating System Installed at Jackson, Tennessee Final Report	October 1980 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT #
9. PERFORMING ORGANIZATION NAME AND ADDRESS Coca-Cola Bottling Works of Jackson, TN P. O. Box 1804 Jackson, Tennessee 38301	10. WORK UNIT NO. 11. CONTRACT OR GRANT NO. EG-77-A-01-4092
12. SPONSORING AGENCY NAME AND ADDRESS National Aeronautics and Space Administration George C. Marshall Space Flight Center	13. TYPE OF REPORT & PERIOD COVERED Contractor Report Final 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

This work was done under the technical supervision of Mr. Douglas Westrope, George C. Marshall Space Flight Center, Alabama

16. ABSTRACT

This final report describes the solar energy heating system installed at the Coca-Cola Bottling Works, in Jackson, Tennessee. The solar components were partly funded by the Department of Energy under Grant EG-77-A-01-4092, and the technical management was done by NASA/George C. Marshall Space Flight Center, Alabama.

The system consists of 9480 square feet of Owens Illinois evacuated tubular solar collectors with attached specular cylindrical reflectors and will provide space heating for the 70,000 square foot production building in the winter, and hot water for the bottle washing equipment the remainder of the year.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
	UC-59a Unclassified-Unlimited William A. Brooksbank Jr. WILLIAM A. BROOKSBANK JR. Mgr., Solar Energy Applications Project

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassified	143	N. TIS

MSFC - Form 3292 (Rev. December 1972)

For sale by National Technical Information Service, Springfield, Virginia 22151

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TABLE OF CONTENTS

SOLAR HEATING SYSTEM FOR THE COCA-COLA BOTTLING WORKS OF JACKSON, TENNESSEE

KEY WORD ABSTRACT

Application	-	space and water heating
System Type	-	active
Collector Type	-	hydronic evacuated tube
Collector Manufacturer	-	Owens-Illinois
Collector Area	-	9480 sq. ft. net
Storage Capacity	-	24,000 gallons
Building Load	-	5001 x 10^6 BTU/YR
BTU's Produced	-	2765 x 10^6 BTU/YR
Building Owner	-	Coca-Cola Bottling Works
	-	of Jackson, Inc.
Designer	-	Energy Solutions Inc.
Contractor	-	Morgan & Turner, Inc.

INTRODUCTION

A retrofit solar heating system has been designed and installed at the Coca-Cola Bottling Works in Jackson, Tennessee. The system consists of 9480 square feet (net) of Owens-Illinois evacuated tubular solar collectors with attached specular cylindrical reflectors and will provide space heating for the 70,000 square foot production building in the winter and hot water for the bottle washing equipment the remainder of the year.

It is anticipated that the solar heating system will supply an estimated 55% of the present total thermal load at the bottling plant.

DESIGN PHILOSOPHY

It was originally envisioned that flat plate collectors would be used for the system, but the evacuated tubular collector was ultimately chosen because it offered greater potential for possible higher temperature applications at the plant (e.g. process cooling and air conditioning) in the future.

Figure 1 presents a schematic of the final system design. A total of 346 collector modules comprise the solar collector array which faces virtually due south and is tilted 50^{o} from the horizontal. The steep tilt angle for this year-round system is due to the high space heating load in the winter months (900×10^{6}BTU/MO) compared to the much lower process hot water load in the summer (200×10^{6}BTU/MO).

Storage is provided via two (2) 12,000 gallon steel tanks located within the bottling plant's production building. The somewhat higher than normal storage volume-to-collector area ratio (2.5 GAL/FT^2) is required because of the four-day work week employed at the plant. Thus, energy is collected seven days a week but is used primarily only four days a week.

Space heating from storage occurs via sixteen (16) hydronic unit heaters located throughout the production building. Four shell-and-tube heat exchangers transfer stored heat from the tanks to the bottle washer.

The collector pump is activated whenever a pyranometer in the plane of the collectors measures a solar insolation above some threshold (e.g. 50 BTUH/FT^2). To minimize pump cycling, a time-delay arrangement keeps the pump on a minimum of 30 minutes (adjustable) once it is activated. Over-temperature protection is provided via the purge coil through which collector return water is diverted whenever the return temperature exceeds 235^{o} F. The heat from the purge unit is directed to the outdoors in the summer and to the indoors during the heating season. The collector pump is activated for 30 minutes every four hours to supply freeze protection whenever the outdoor temperature is below 35^{o} F.

Because the existing roof structure was unable to support the collector array with an acceptable margin of safety, a super-structure tied to the vertical columns of the building was designed and installed above the roof using standard steel structural members.

Figure 2 presents the predicted thermal performance of the system along with the combined space and water heating loads of the bottling works. As can be seen, with the exception of a couple of summer months, virtu-

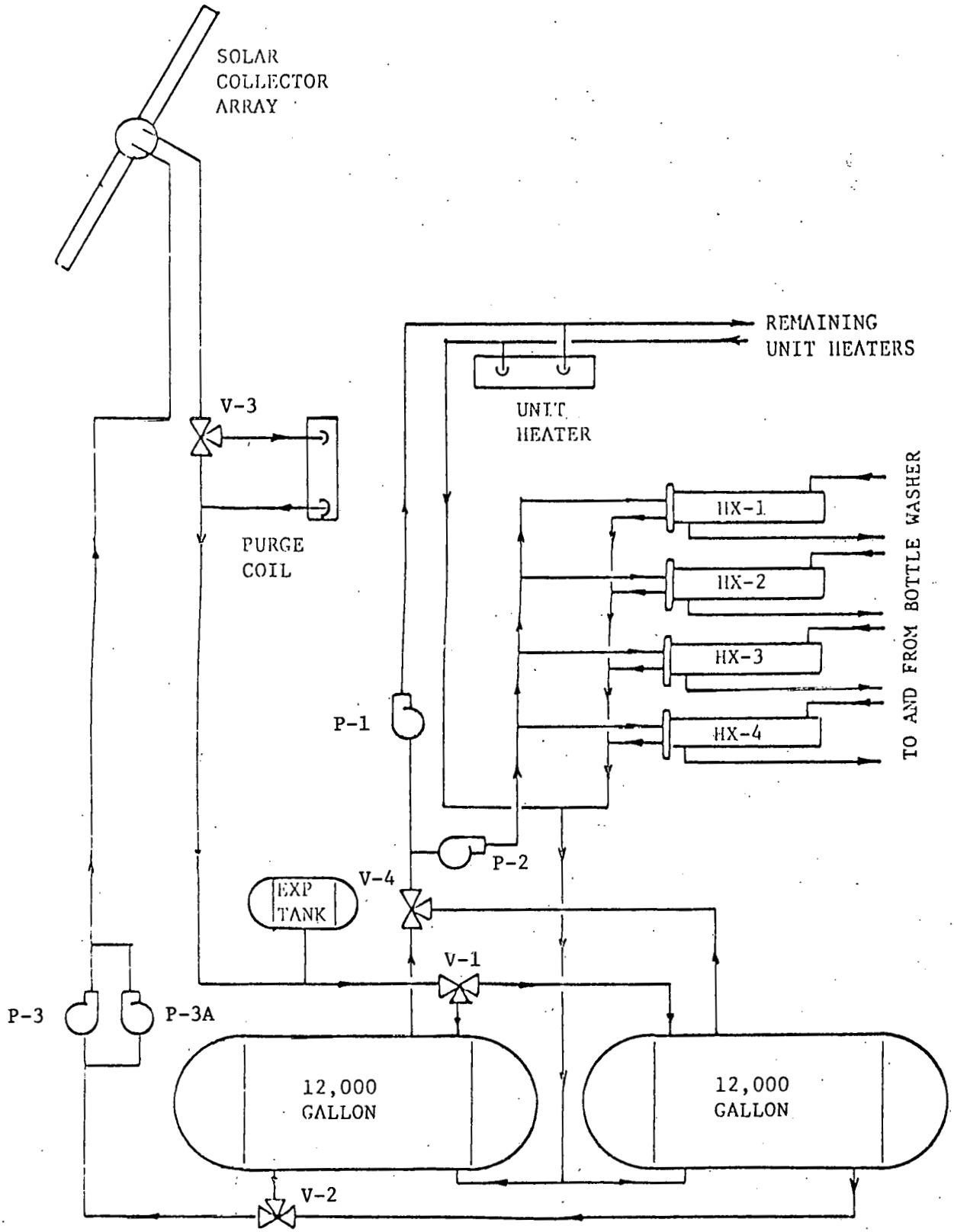


FIGURE 1. SCHEMATIC OF SYSTEM

ally all of the collected energy can be used by the plant.

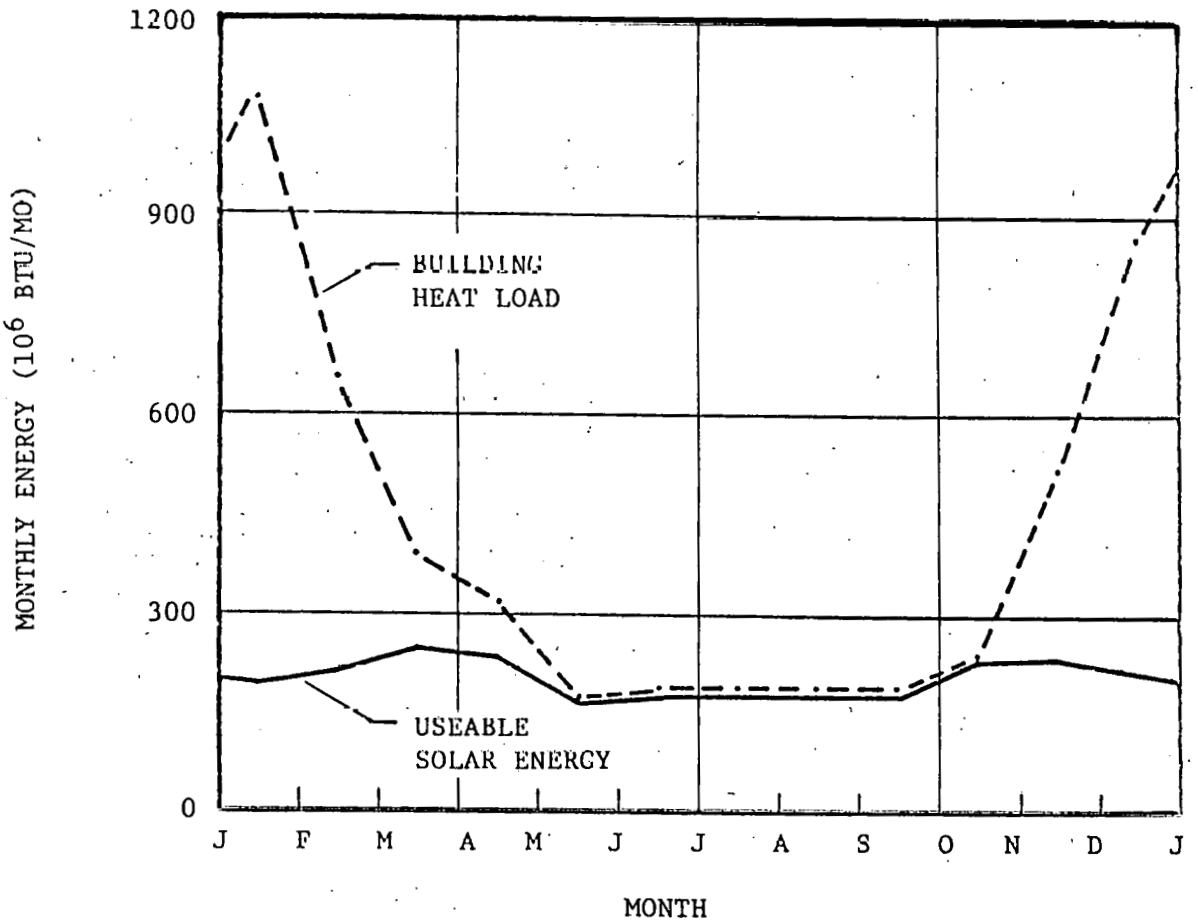


FIGURE 2. SYSTEM PERFORMANCE PREDICTION

PROBLEMS ENCOUNTERED AND SOLUTIONS

The two major problems that led to project delays both concerned changes in solar collectors. The first concerned the request to change from the originally proposed flat plate collector to the evacuated tubular collector. Approximately three months elapsed before approval of this request was given.

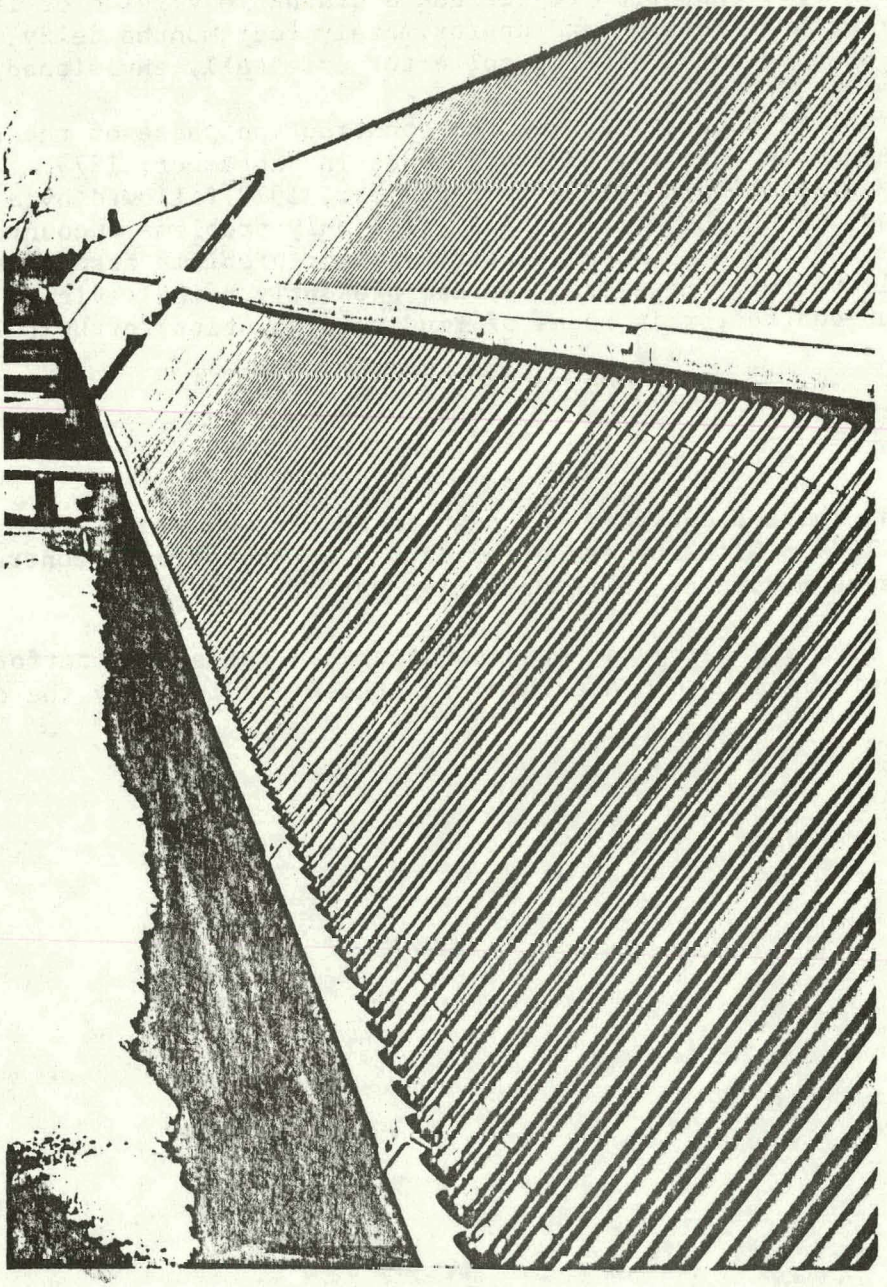
The second delay occurred after the final design review when the collector manufacturer urged that the project use a drainable version of its collector. After much discussion and approximately four months delay, it was decided to use the non-drainable collector originally envisioned.

No major problems occurred during the construction phase of the project which commenced in January, 1979 and ended in September, 1979. A virtually flawless start-up occurred in September, 1979 followed by a "shake-down" period during the ensuing fall. The only problems encountered during this last phase have been relatively minor problems associated with the control system. These problems are presently being reviewed by the controls sub-contractor in hopes of finding a solution forthwith.

PROJECT STATUS

As discussed above the system has been in continuous operation since early September, 1979. With the exception of the aforementioned controls problem, the system appears to be operating satisfactorily.

At present data are being gathered to ascertain the system performance characteristics and to compare them with those predicted by the design analysis.



TYPICAL COLLECTOR ROW

APPENDIX A

ACCEPTANCE TEST PLAN

ACCEPTANCE TEST PLAN

PROJECT NAME: Coca-Cola Bottling Works of Jackson, Inc.

PROJECT LOCATION: Jackson, Tennessee

DATE OF TEST: September 20, 1979

INSPECTOR: _____

I. COLLECTION SUB-SYSTEM

A. Verify that solar collectors are those called for and that the number of collectors is that called for in the plans and specifications.

COMMENTS: Owens-Illinois Tubular Collectors installed

B. Verify that collector orientation is that called for in the plans.

COMMENTS: Collectors are slightly off due south 4^{o} west of south

C. Verify that collector-loop pump is that called for in plans.

COMMENTS: Verified

D. Verify that pressure relief valves of the rating called for in the plans are installed at each collector array between any shut-off valves.

COMMENTS: Verified

E. Verify that collector fluid is a water/ethylene glycol mixture with a freezing point below -20^{o} F.

COMMENTS: The system is using water with a pump mode for freeze protection.

F. Verify that collector loop can maintain a pressure of 30 psig for 15 minutes with no leaks occuring. If relief valves are removed, care should be taken to insure that solar collectors do not overheat.

COMMENTS: System was pressure tested to 100 PSIG hydrostatic pressure for 24 hours and no leaks were found.

G. With collector pump operating, adjust "circuit-setter" valves at each collector array to provide schedule flow rate through each array.

COMMENTS: Circuits were balanced

H. With collector pump operating and with clear skies prevailing, record the system performance via the below table. Fluid temperatures shall be taken with thermometers mounted in the collector supply and return lines as near the collector array as possible. Insolation measurements shall be made with a solar pyranometer in the plane of collector Array #1.

TIME	AMBIENT TEMP. (F)	COLLECTOR SUPPLY TEMP. (F)	COLLECTOR RETURN TEMP. (F)	SOLAR INSOLATION (BTUH/FT^2)
9:24 am	50°F	140°F	152°F	150
10:50 am		148°F	166°F	225

COMMENTS: Data taken on November 7, 1979

II. HEAT DISSIPATION SUB-SYSTEM

A. Verify that purge unit is that called for in the plans or note any exceptions. Verify that unit is installed as shown in the plans.

COMMENTS: Purge air unit measured amp 25 - 24 - 25

B. Verify that whenever storage tank temperature exceeds a given (adjustable) set-point that flow returning from the collector array is diverted through purge unit.

COMMENTS: Verified

C. With storage tank temperature above 180° F and with a solar insolation level above 200 BTUH/FT^2 in the collector plane, verify that flow returning to tank heat exchanger via the purge coil is at a lower temperature than flow leaving the tank heat exchanger.

COMMENTS: Purge unit operation was simulated and found to operate properly

III. STORAGE SUB-SYSTEM

A. Verify that main storage tank and all related hardware are as specified in the plans. Verify that tank carries an ASME seal.

COMMENTS: Verified

IV. PROCESS HEATING SUB-SYSTEM

A. Verify that the pump, piping, valves, heat exchangers, insulation and related components are in accordance with the plans or note any exceptions.

COMMENTS: Verified

B. Verify that solar collector pump starts whenever the collector temperature exceeds the main storage temperature by 20°F and remains on until this temperature difference falls to less than 3°F.

COMMENTS: Solar pump is started by pyronometer

C. Verify that whenever main storage tank temperature exceeds a given set point (nominally 240°F) and collector pump is on, the flow returning from the collectors is diverted through the purge coil via the two-position motirized valve and that purge coil fan is simultaneously activated. Verify that this condition prevails until tank temperature drops to at least 2° below the given set point.

COMMENTS: Condition was simulated and verified

D. Verify that whenever the building's thermostat calls for space heat and the main storage tank temperature is above a given set point (nominally 100°F) the space heating pump is activated and that the air-handling unit is activated simultaneously.

COMMENTS: Simulated

B. Verify that tank drain valve and sight gage are operative.

COMMENTS: Tank drain valve is operational. There is a sight gage on expansion tanks

C. Verify that tank is equipped with a pressure relief valve as shown in the plans.

COMMENTS: Verified

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APPENDIX B

MAINTENANCE AND OPERATING PROCEDURES

EQUIPMENT FUNCTIONS
SOLAR HEATING PROJECT
COCA-COLA BOTTLING WORKS OF JACKSON, INC.
JACKSON, TENNESSEE

1. Solar Collectors

A total of 346 Owens-Illinois solar collectors are installed on the roof of the building. These collectors are of glass construction and must be protected against freezing and from excessive pressure. Water must be circulated thru the collectors or they must be drained whenever solar heat from the sun is available or in the event the outdoor temperature is below 35^{o}. It is very important that water be circulated when solar heat is available as the heat build-up can occur very quickly, thereby generating steam and pressures which will cause the tubes to explode. Individual relief valves have been installed at each array of collectors to protect against high pressure. These valves should not be depended upon for protection of the collectors except in the case of an emergency. In the event maintenance is required on a collector, the work should preferably be done on a cloudy day so as to minimize the chance of pressure build-up.

In the event it is necessary to drain the water from the collectors, they must be vented as they are filled to purge all air out of the tubes and assure a filled condition. The circulation tubes within the collectors are quite small and the least amount of air can be trapped in the tubes and block the water flow. This blockage of water flow would then result in a high pressure as soon as sunlight was available and possibly cause damage to the collectors. Venting may be accomplished thru the individual tubes and also thru a manual air vent located at the pipe connection to each array.

It will be necessary to periodically clean the collector tubes and particularly the reflectors. We do not have a recommended schedule for this, the surfaces should be checked and maintained in a clean condition.

2. Hot Water Unit Heaters

A total of 16 McQuay downflow hot water unit heaters have been installed for building heat. These units are controlled by wall mounted electric thermostats and manual starters. Each thermostat is equipped with a manual "Fan-On" switch which permits operation of the fan for air circulation.

3. Hot Water Circulating Pumps

A total of 4 centrifugal pumps provide all water circulation for the system. These pumps are automatically controlled so long as the starter selector switch is in the "AUTO" position. The function of each pump is as listed below:

P-1 Circulation of hot water thru the McQuay unit heaters.

P-2 Circulation of hot water thru the 4 heat exchangers which serve the bottle washer.

P-3 Circulation of water thru the solar collectors.

P-3A Circulation of water thru the solar collectors, this is the same function and pumping circuit as P-3. NOTE: There is located at the bottom of the control panel a switch marked "P-3/P-3A", the purpose of this switch is to alternate the use of these two pumps. This switch should be re-positioned on a monthly basis so as to evenly distribute the running time between the two pumps.

4. Water to Water Heat Exchangers

These units are located on the floor near the bottle washer. Hot water circulated from Pump P-2 flows thru the tubes within these heat exchangers and provides a source of heat for the caustic solution used in the bottle washer. The caustic solution is circulated thru the shell of these heat exchangers and is heated by the hot water being circulated thru the tubes. Temperature control of the caustic solution is achieved by varying the water flow thru the tubes. This is accomplished by the Honeywell valves located at each

heat exchanger. Control of these valves is discussed in the control sequence portion of this manual.

5. Watts Backflow Preventer

A series 900 Watts backflow preventer is installed in the fresh water fill connection serving the solar system. The purpose of this device is to prevent a backflow of water from the solar system into the domestic system serving the plant.

6. Nitrogen Compressors

Two Ingersall-Rand nitrogen compressors are located adjacent to the control panel and under the storage tank. These compressors control the system pressure so as to maintain the minimum pressure necessary for circulation thru the collectors and to prevent an excessive build-up of pressure as the heated water expands. A supply of nitrogen must be maintained in the 3 storage cylinders located to the left of the control panel as this nitrogen provides the cushion in the compression tanks. The purpose of the nitrogen is to provide a gas which will prevent oxidation within the piping system. Pressure control switches are located adjacent to the compressors and their function is described on sheet 10 of the control diagrams.

7. Purge Air Handling Unit

A McQuay air handling unit with a capacity of 18000 cfm is located on a platform above the storage tanks. The purpose of this unit is to exhaust excessive heat to the atmosphere. There is no way to prevent the collectors from absorbing heat whenever solar energy is available;therefore, whenever the control system senses an excessive build-up of heat, the Purge unit fan runs and hot water is diverted thru the coil of the unit. Dampers are available in the discharge duct to direct the heated air either thru the roof or back into the building. It is very unlikely that excessive heat

would ever be available when heat would be desired within the building; therefore, the dampers should always be positioned for exhaust thru the roof. A chain operator has been provided to facilitate the positioning of these dampers. The selector switch on the face of the starter cover serving this unit should always be left in the "AUTO" position.

8. Control Panel

This panel houses the various control relays and instruments for the operation of the system. Pilot lights are provided which indicate equipment operation and in some cases alarm conditions. A description of the various lights and switches is as follows:

System Alarm - 4 lights are provided at the top of the panel and indicate high temperature alarm, outside air temperature below 35^{o}, low nitrogen pressure in the storage system and low water level in the expansion tanks. In addition to the alarm lights, an audible alarm will sound in the event of an alarm condition.

Display Thermometer located in the center of the panel can be used to obtain the temperature at any of the 16 points indicated by the push buttons below the thermometer. These points are as follows:

"Heating supply and return" indicates the hot water temperature being circulated by pump P-1 thru the hot water unit heaters.

"Process supply and return" indicates the temperature of the hot water being circulated by pump P-2 thru the heat exchangers.

"HX supply and return" for each of the 4 heat exchangers indicates the temperature of glycol solution entering and leaving the heat exchanger.

"Compartment supply" provides an indication of the temperature of the glycol being supplied to the individual wash compartment. This may be higher than the temperature leaving the heat exchanger, indicating that the gas burner is supplementing the heat to the washer.

In addition to the single multiple use thermometer in the center of the panel, 4 indicating thermometers are located on each side of the panel. Temperature in each storage tank is indicated by "Tank #1" and "Tank #2". Temperature of the water being circulated to the solar collectors on the roof is indicated by "Solar Supply" while "Solar Return" indicates the temperature of the water returning to the tank from the solar panels. On the right hand side of the panel, 4 thermometers indicate the temperature in each compartment of the bottle washer.

Eight pilot lights located near the bottom of the panel indicate the operation of the system. Four lights to the left indicate which storage tank is filling, that is obtaining heat from the solar loop and which tank is in use, that is providing heat to the process pump or the building heating system. The four lights to the right are an indication as to whether or not the automatic control system would permit the individual burners to be used. This is not an indication that the burners are in operation only that they can operate automatically if required to maintain the desired compartment temperature.

At the bottom of the panel, selector switches are provided for Pumps P-1, P-2, P-3 and P-3A. These switches should be left in the automatic position during normal operation. The selector switch between P-3 and P-3A should be re-positioned on some regular schedule, preferably monthly, so as to utilize each pump on an equal basis.

The sequence of control operation is shown on sheet #1 of the attached control diagrams.

9. Manual Control of Evans Heaters

Occasionally it may be desirable to operate the gas fired Evans heaters separately from the solar installation. The original sensing elements have

been left at the side of the bottle washer and must be inserted in one of the temperature wells at that point. A selector switch in front of each Evans heater should then be placed in the "MANUAL" position. Under this condition temperature of the caustic solution being circulated to the washer will be controlled directly by the gas heaters. As soon as possible, the system should be returned to a normal and automatic condition.

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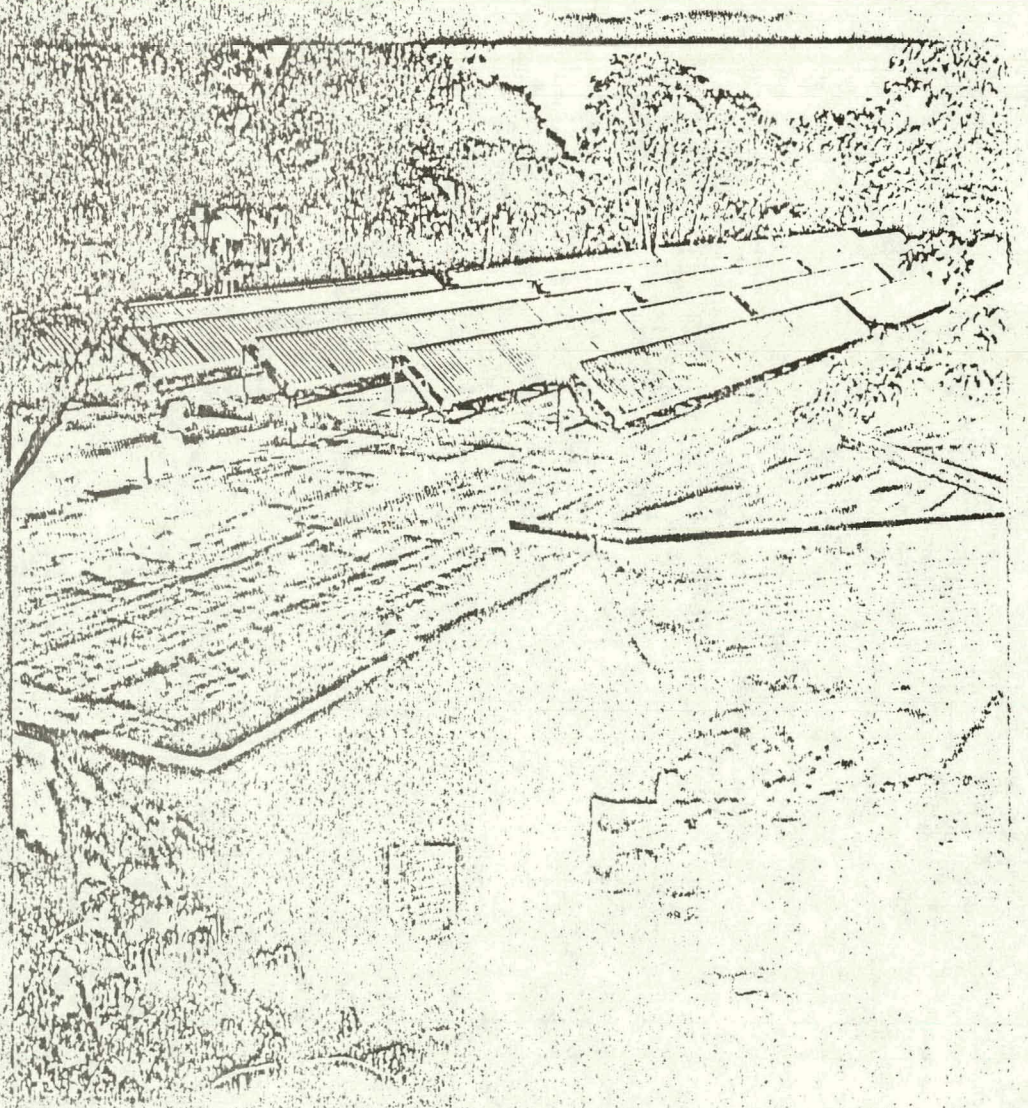
APPENDIX C

EQUIPMENT DESCRIPTIONS

A PIPELINE TO THE SUN FROM OWENS-ILLINOIS

SUNPAK

Energy Products and Ventures Group of Owens-Illinois



SUNPAK™
Energy Products and Ventures Group of Owens-Illinois

The SUNPAK collectors described in this catalog are the most efficient solar collectors offered in the marketplace today. The following graphs show comparative test data for SUNPAK vs. flat-plate and other vacuum tube collectors based on actual independent laboratory test data.*

Fig. 1: ASHRAE 93-77 test data at normal incidence for SUNPAK collectors, measured by independent test laboratories—and shown on an aperture area basis.

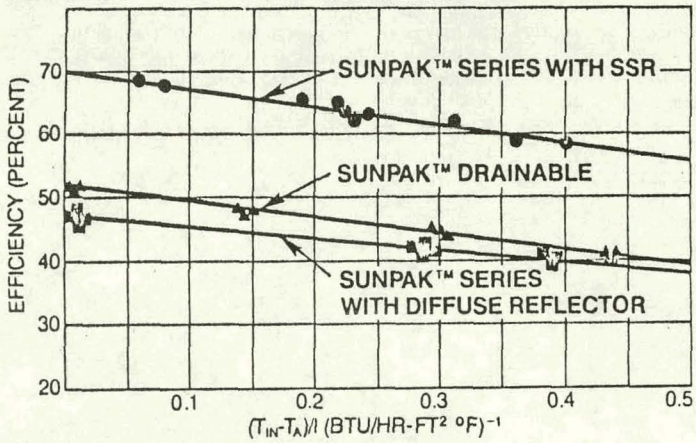
Fig. 2: Incidence angle modifiers for SUNPAK collectors, measured according to ASHRAE 93-77 standards by independent test laboratories. For comparison, similar data is shown for both the GE evacuated tube collector and a typical flat-plate collector.

Fig. 3: All-day efficiencies of the SUNPAK collectors, measured on an aperture area basis, by independent test laboratories at the indicated inlet temperatures. I_{AVE} is equal to daily insolation—divided by the number of hours between sunrise and sunset. Solid lines indicate effective daily efficiency curves derived from ASHRAE 93-77 instantaneous test data.**

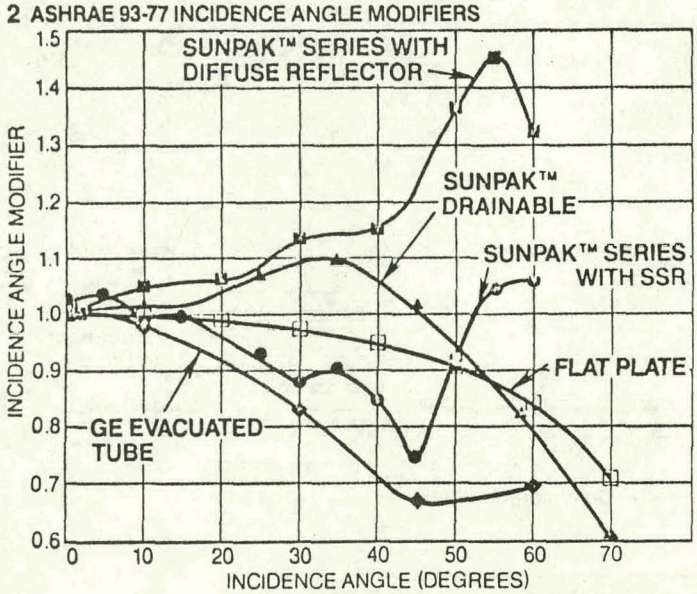
Fig. 4: Comparison of ASHRAE 93-77 normal incidence efficiency curves for SUNPAK collectors, two flat-plate collectors, and the GE evacuated tube collector, all on an aperture area basis.

Fig. 5: Comparison of effective all-day efficiency curves for SUNPAK collectors, two flat-plate collectors, and the GE evacuated tube collector (see Fig. 4). Colored regions indicate typical operating ranges for swimming pool heating, space and water heating, and air conditioning.

1 ASHRAE 93-77 TEST DATA AT NORMAL INCIDENCE



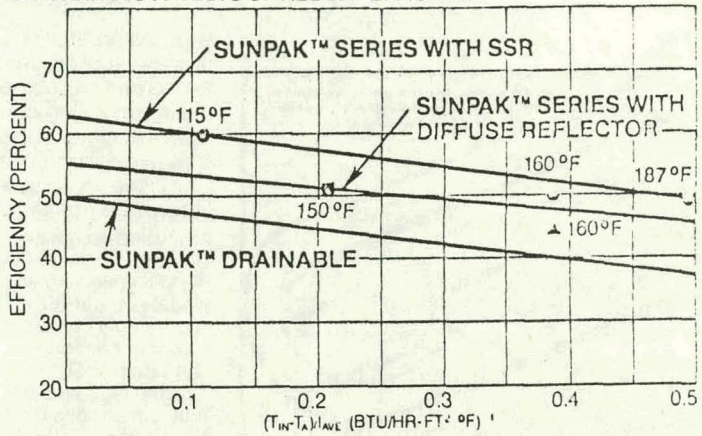
2 ASHRAE 93-77 INCIDENCE ANGLE MODIFIERS



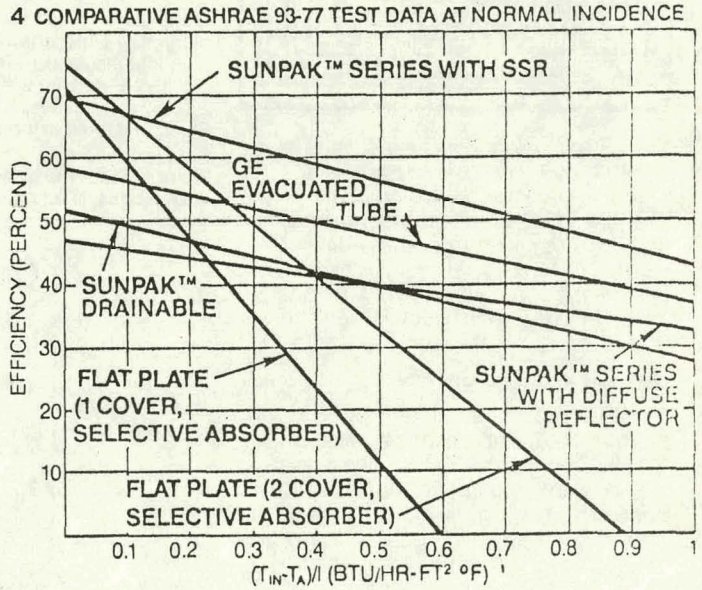
*Florida Solar Energy Center and Desert Sunshine Exposure Test, Inc.

**Multiply the normal incidence intercepts in Fig. 1 by weighted daily averages of the incidence angle modifier data in Fig. 2. Slopes of curves are the same as in Fig. 1.

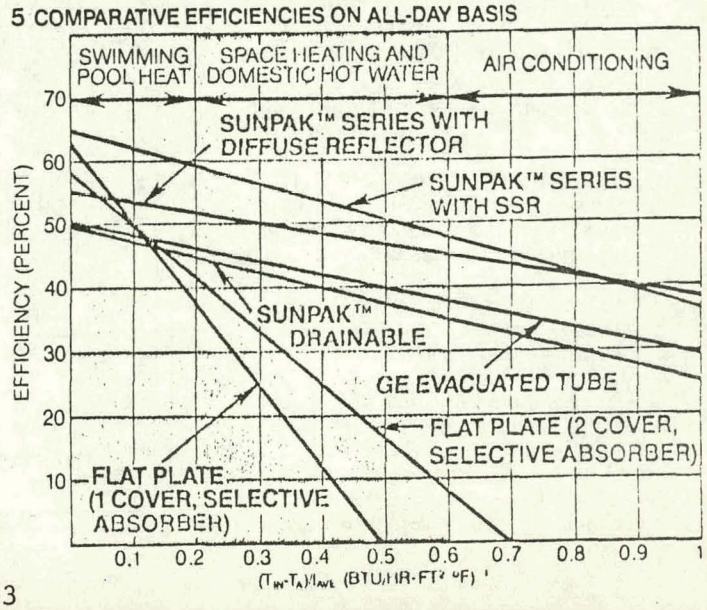
3 ASHRAE 93-77 TESTS OF ALL-DAY EFFICIENCY



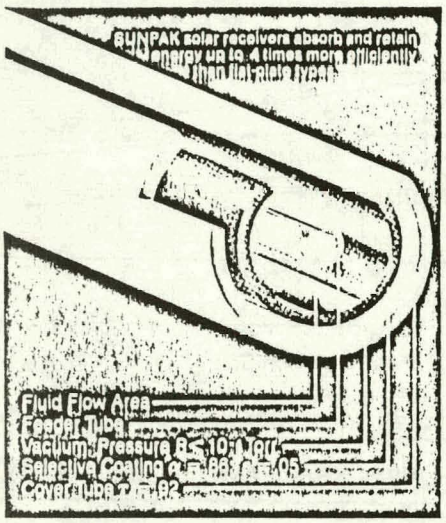
4 COMPARATIVE ASHRAE 93-77 TEST DATA AT NORMAL INCIDENCE



5 COMPARATIVE EFFICIENCIES ON ALL-DAY BASIS



Sunpak Evacuated Tubes



The basic component of the Owens-Illinois SUNPAK solar collector system is a hermetic package consisting of an absorber glass tube and a cover tube. The absorber tube accommodates differential thermal expansion, while a third tube permits the reverse flow path for the heat transfer fluid. Nominal tube dimension is 2" in diameter by 44" long.

Durability and Weatherability

SUNPAK tubes are made of low iron, low thermal expansion chemically resistant, weatherable Kimble KG-33 borosilicate glass – with a high-performance selective coating applied on the outside surface of the absorber tube. This coating is a semiconductor type providing absorptance of $\alpha = 0.86$, $\epsilon = 0.05$.

Vacuum protects the coating from environmental effects, while the vacuum itself is protected by a barium getter.

Extensive life testing shows our tubes can indefinitely withstand the dry temperatures that can accompany bright sunlight (650°F). Field experience and tests conducted at the Institute for Disaster Research at Texas Tech University, also demonstrate that the tubes can withstand 1.25" diameter hail stones without breaking.

Sunpak Series Collector

A SUNPAK series solar collector consists of 24 evacuated tubes in a series flow arrangement: 12 tubes above, and 12 tubes below a centrally located manifold. A module consisting of tubes, manifold and hardware occupies an area of approximately 4' x 8' (or 32 ft²). The series module is a hydronically filled non-drainable solar unit ideal for those large commercial buildings or industrial process applications where there's a need for maximum solar collection area with minimum piping connections. Once the hydronic circuit is filled, minimum power is required to circulate the solar circuit. Comes ready-to-assemble, or pre-assembled (for large installations).

Physical Description

Module installation area – 32 ft² (4 ft. x 8 ft.).
Module collecting aperture = 27.4 ft²
Module weight-185 lbs. water filled, 110 lbs. dry.
Intermodule connections made by integral copper headers.
(1.125 in. O.D. 1 in. I.D.) and mechanical clamp type phenolic activated seal.
Tube dimensions (nominal): 2 in. diameter x 44 in. long.
Recommended heat transfer fluid = water.

Materials

Manifold—Hard drawn type M copper tube.
Manifold insulation—Polyurethane foam, 2 lbs./ft³ density, k = 0.012 Btu/hr ft. °F, average thickness of 2 inches.
Fluid Seals—High temperature silicone rubber.

Freeze Protection

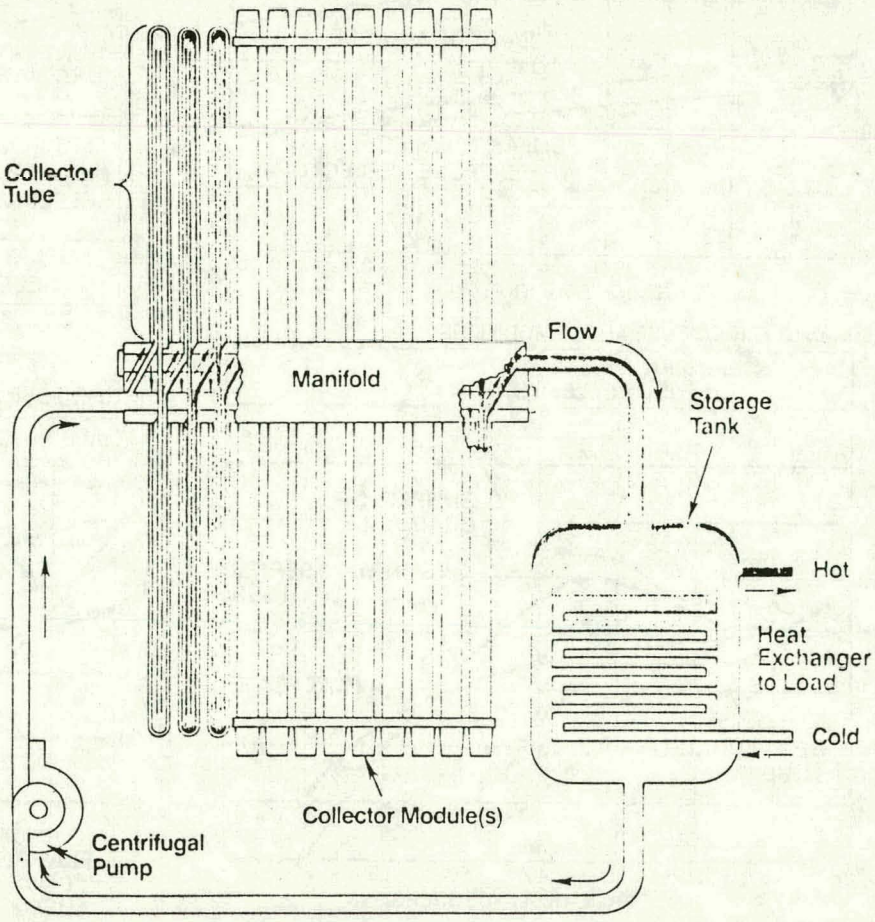
Water, without the addition of freeze depressants, is recommended as the heat transfer fluid in most geographical locations in the U.S. Resistance to freezing results from the very low thermal losses and high thermal mass of the SUNPAK tube, whose temperature-decay time constant is greater than 20 hours. Periodic fluid flow for brief periods is recommended to protect inlet/outlet pipes and connections under nighttime or other no-flow conditions.

Operating Conditions

Temperature Range—minus 40°F 210°F
Maximum outlet pressure—30 psig.
Minimum pressure drop—5 psi.
Tilt Angle—optimized for best performance

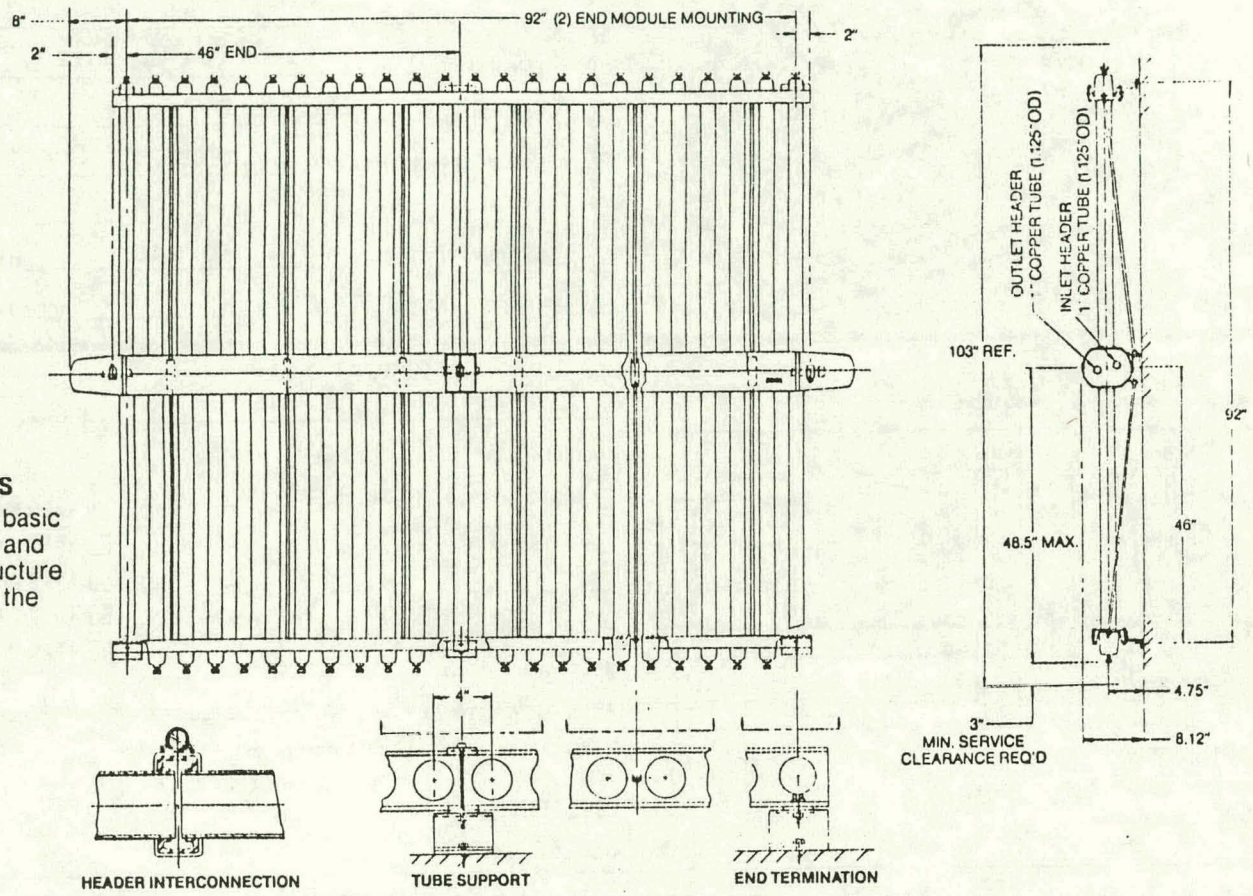
Thermal Performance

Testing at the National Bureau of Standards and at Desert Sunshine Exposure Test, Inc., in addition to extensive in-house performance tests, verifies the high-performance features of the SUNPAK collector. In particular, SUNPAK's ability to deliver useful energy throughout an entire day has been demonstrated for both high temperatures ($T_{IN} \geq 200°F$) and cold, cloudy weather conditions. Since performance testing is always performed on one or more complete SUNPAK modules, the effects of manifold and miscellaneous heat losses are automatically included in the test data.



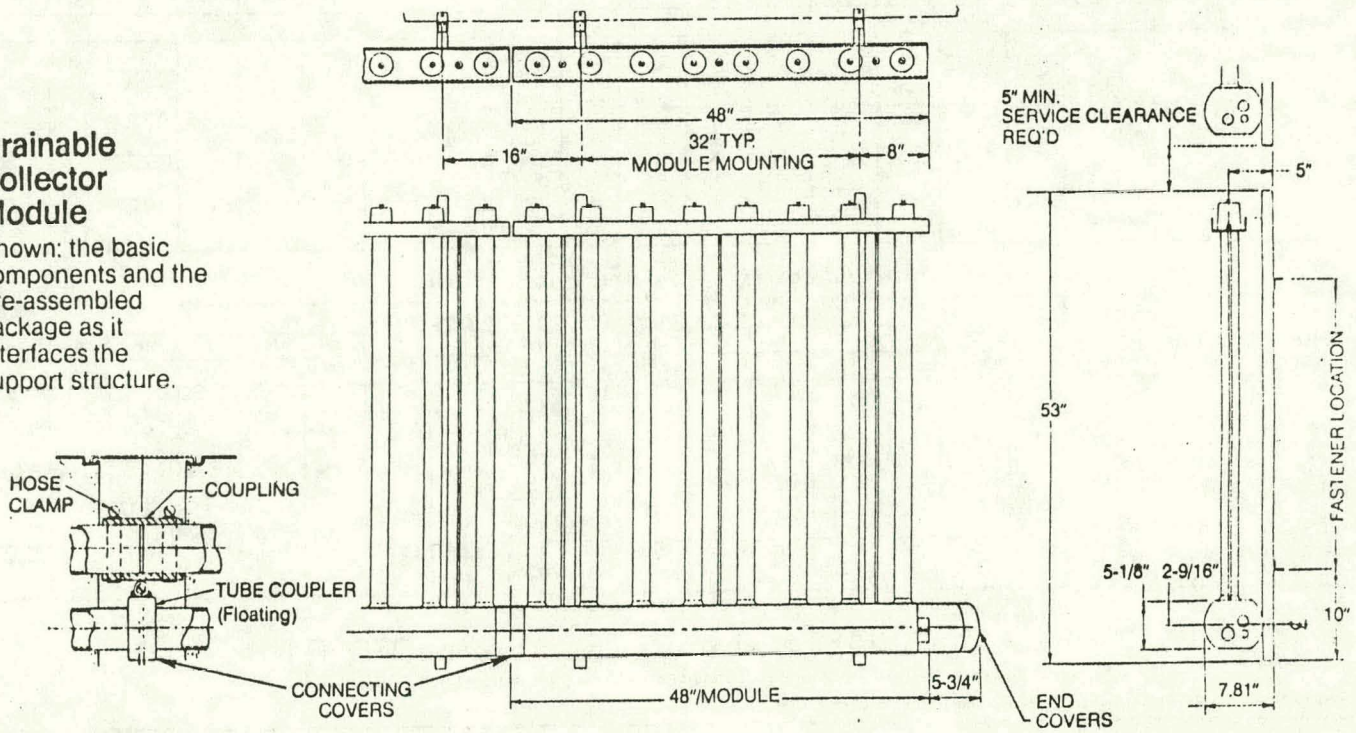
Series Collectors

Shown: the basic dimensions and support structure interface of the module.



Drainable Collector Module

Shown: the basic components and the pre-assembled package as it interfaces the support structure.



BELL & GOSSETT PRODUCTS

CENTRIFUGAL PUMPS

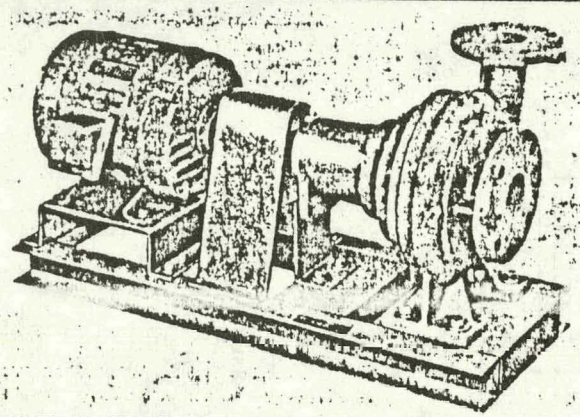
SUBMITTAL B-224.2

REVISION 5

Centrifugal Pumps—Base Mounted

SERIES 1510

2AB



JOB Coca-Cola Jackson, TN

UNIT TAG NO. P-1

ENGINEER Griffith C. Burr

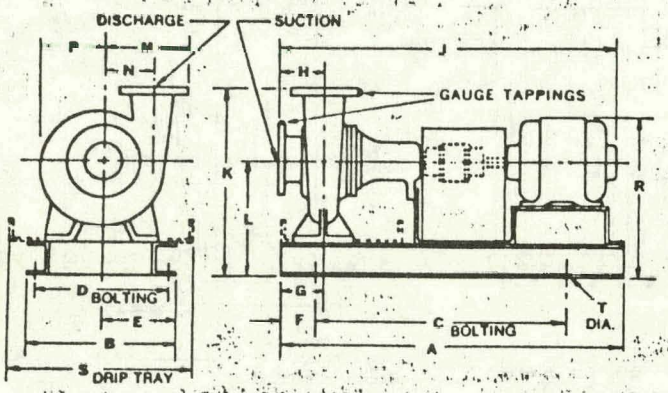
CONTRACTOR Morgan & Turner

B & G REPRESENTATIVE Johnson & Scott

ORDER NO. 1252

SUBMITTED BY Gene Mankowski DATE 12-6-78

APPROVED BY _____ DATE _____



SPECIFICATIONS

95 GPM 45 FT.

MATERIALS OF CONSTRUCTION.

☒ BRONZE FITTED ☐ ALL IRON ☐ ALL BRONZE

ELECTRICAL DATA: 3 HP

240 VOLTS 60 CY. 3 PH.

MOTOR ENCL. OPDP

SPEC. CONSTR. _____

APPROXIMATE WEIGHT 206 LBS.

MAXIMUM WORKING PRESSURE 175 PSI

FLANGES ARE 125# A.S.A.

☒ 1510 (Standard Seal)
☐ 1510-P (Packed)
☐ 1510-PF (Packed—Flush)
☐ 1510-S (Single Seal)
☐ 1510-D (Double Seal)

DIMENSIONS

STANDARD SEAL 1510

PUMP SIZE	SUCTION SIZE	MOTOR FRAME	PUMP DIMENSIONS (INCHES) A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
			"S" FRAME																
2AB	2½	56									25⅞						13		
		143T	28¾	12	22½	10¼	6		3¼		27⅞						13⅜		
		145T									28⅞								
		182T	31		25						29¾						14¼		
		184T				12⅞	7¼	3	4¼	3	30¾	16¼	9¾	7¾	4¾	5⅛		11⅛	¾
		213T	34⅝	14⅛	28⅝						32⅞						14¹³⁄₁₆		
		215T									33¹⁄₁₆								
		254T	39⅜		33⅜						37¼	17¼	10¾				17¼		
		256T									39¼								

STUFFING BOX 1510-P, 1510-PF, 1510-S, 1510-D

PUMP SIZE	SUCTION SIZE	MOTOR FRAME	PUMP DIMENSIONS (INCHES) A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
			"S" FRAME																
2AB	2½"	56									29⅛						13		
		143T									31⅛						13⅜		
		145T	34⅝	14⅛	28⅝						32⅛								
		182T				12⅞	7¼	3	4¼	3	33¼	16¼	9¾	7¾	4¾	5⅛	14¼	11⅛	¾
		184T									34¼								
		213T	39⅜		33⅜						35¾						14¹³⁄₁₆		
		215T									37¼								
		254T	46½	16	36½	14	8	5	5¼	3	40⅞	18½	12				18¼		⅞
		256T									42⅝								

BELL & GOSSETT MORTON GROVE, ILL. 60053 ITT

Fluid Handling Division, International Telephone and Telegraph Corporation

1510 PERFORMANCE CURVES

PERFORMANCE CHARACTERISTIC CURVE

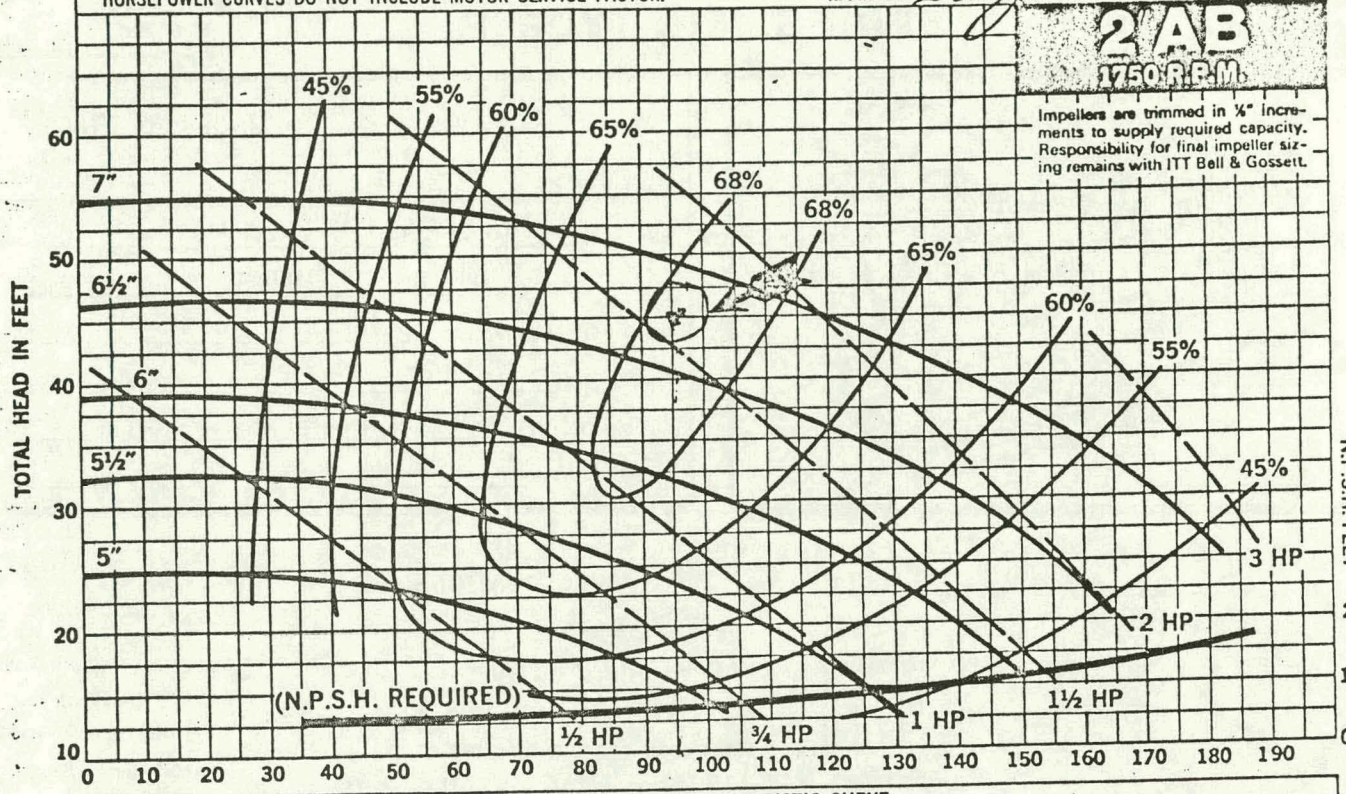
FOR 2"AB CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1750 R.P.M.

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.W.J. DATE 10-9-67 Rev.

2 AB
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

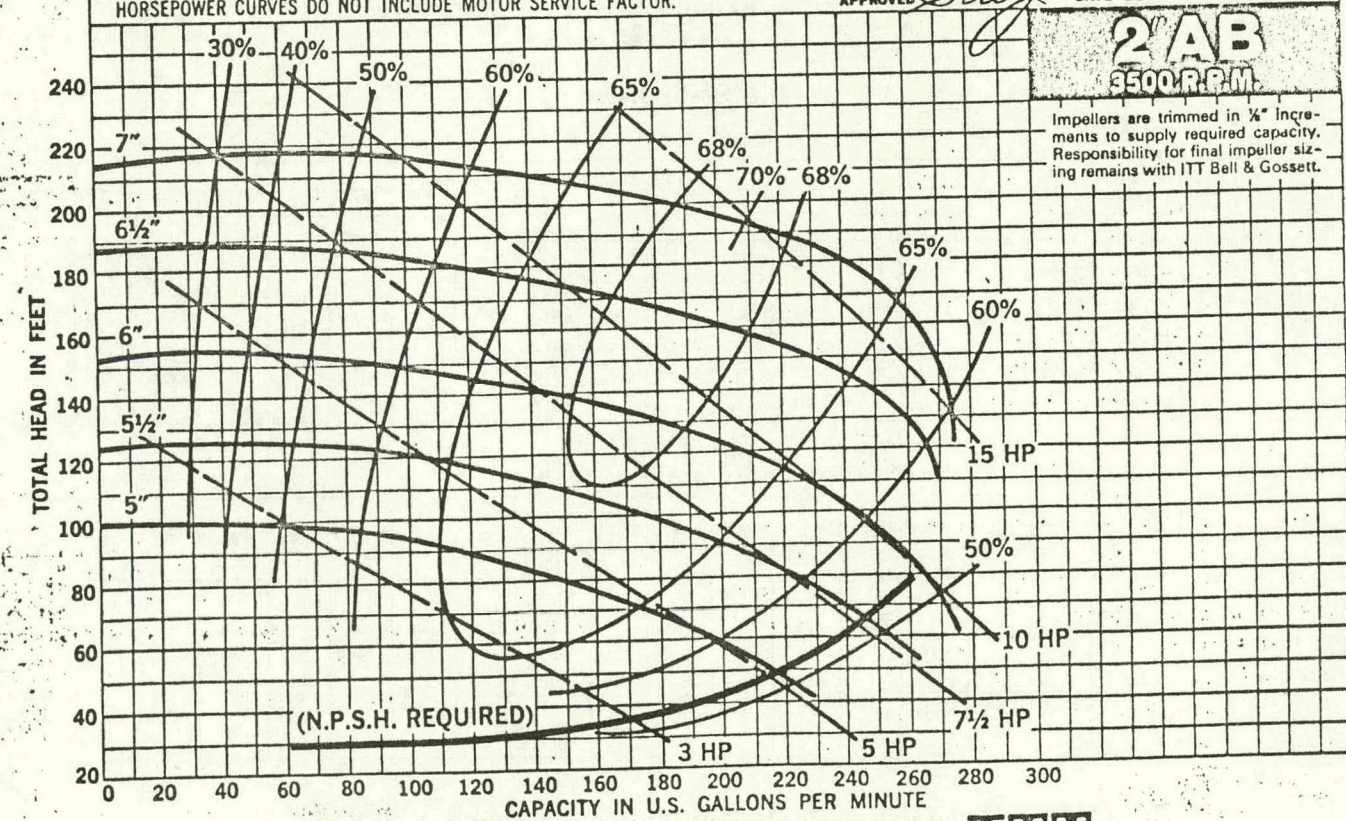
FOR 2"AB CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 3500 R.P.M.

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.W.J. DATE 10-9-67 Rev.

2"AB
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 ITT

Fluid Handling Division, International Telephone and Telegraph Corporation

PRINTED IN U.S.A. 8-73

BELL & GOSSETT PRODUCTS

CENTRIFUGAL PUMPS

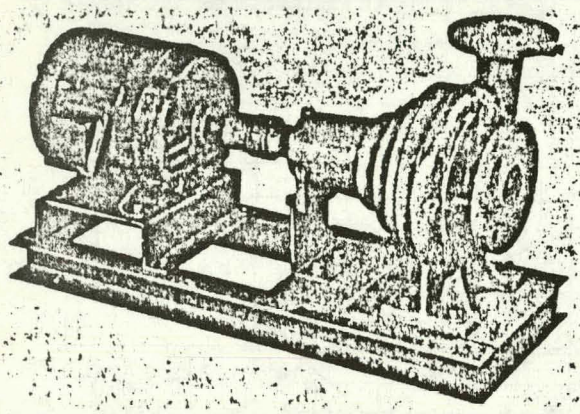
SUBMITTAL B-224.9

REVISION 3

Centrifugal Pumps—Base Mounted

SERIES 1510 TYPE B

2½ B



JOB Coca-Cola Jackson, TN

UNIT TAG NO. P-2

ENGINEER Griffith C. Burr

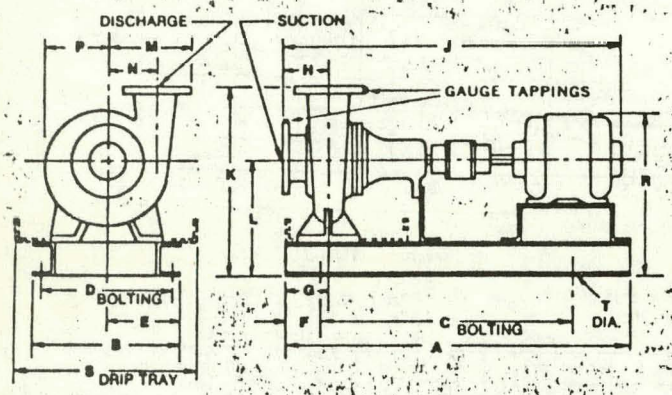
CONTRACTOR Morgan & Turner

B & G REPRESENTATIVE Johnson & Scott

ORDER NO. 1252 DATE

SUBMITTED BY Gene Mankowski DATE 12-6-78

APPROVED BY DATE



SPECIFICATIONS

194 GPM 50 FT.

MATERIALS OF CONSTRUCTION:

☒ BRONZE FITTED ☐ ALL IRON ☐ ALL BRONZE

ELECTRICAL DATA: 5 HP

240 VOLTS 60 CY. 3 PH.

MOTOR ENCL. OPDP

SPEC. CONSTR.

MAXIMUM WORKING PRESSURE 175 PSI

FLANGES ARE 125# A.S.A.

☒ 1510 (Standard Seal)
☐ 1510-P (Packed)
☐ 1510-PF (Packed—Flush)
☐ 1510-S (Single Seal)
☐ 1510-D (Double Seal)

DIMENSIONS

STANDARD SEAL 1510

PUMP SIZE	SUCTION SIZE	MOTOR FRAME	PUMP DIMENSIONS (INCHES) A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
		"S" FRAME																	
2½B	3"	182T	31	14⅛	25	12⅞	7¼	3	4¼	3½	30⅜	17½	10¾	9½	6	6¼	15¼	13¾	¾
		184T									31⅜								
		213T	34⅜		28⅜						33¼						15¹¼		
		215T									34¹¼								
		254T	39⅜		33⅜						37¹¼						17¼		
		256T									39¹¼								

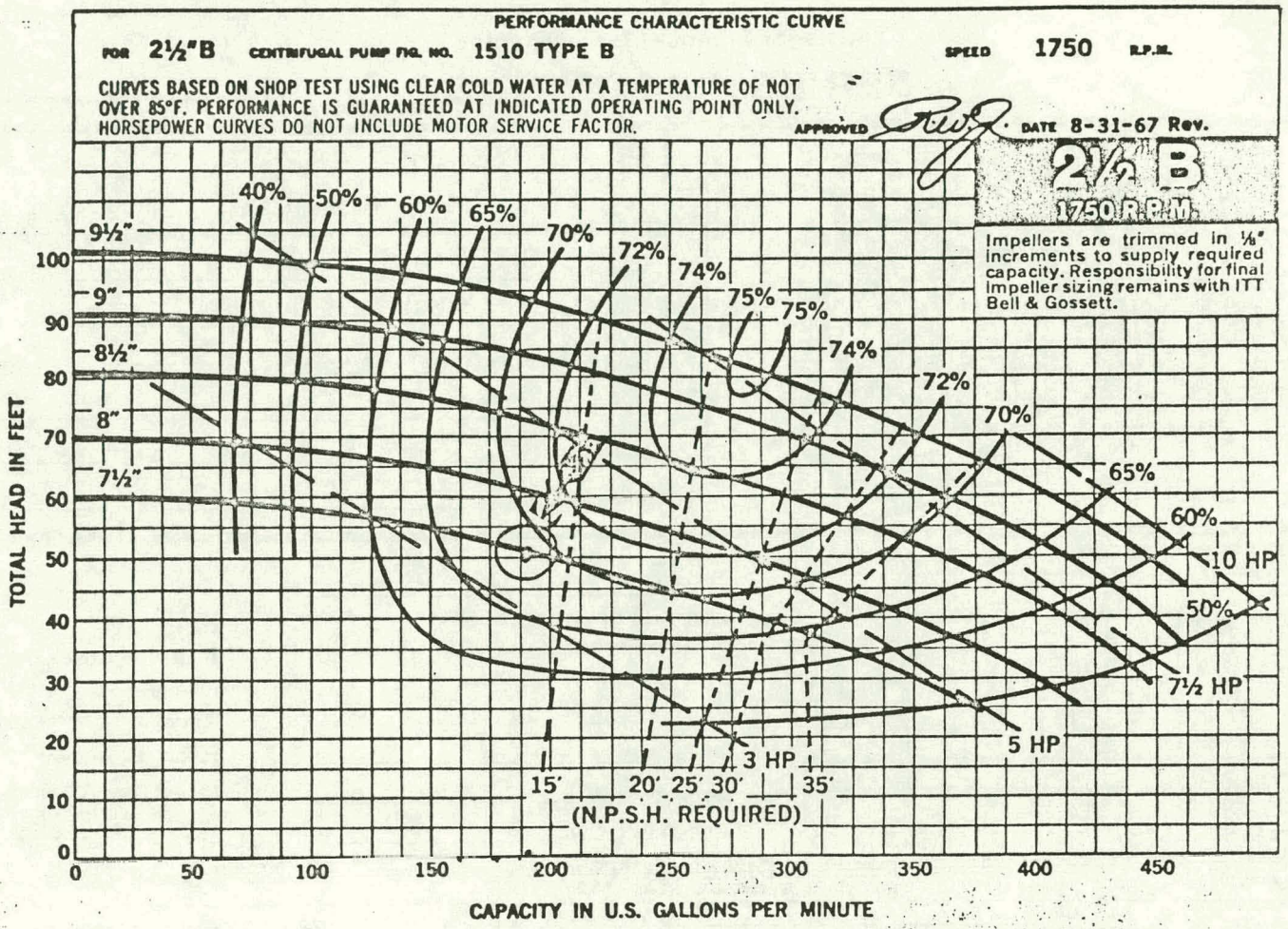
STUFFING BOX 1510-P, 1510-PF, 1510-S, 1510-D

PUMP SIZE	SUCTION SIZE	MOTOR FRAME	PUMP DIMENSIONS (INCHES) A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
		"S" FRAME																	
2½B	3"	182T	34⅜	14⅛	28⅜	12⅞	7¼	3	4¼	3½	33¹¼	17½	10¾	9½	6	6¼	15¼	13¾	¾
		184T									34¹¼								
		213T	39⅜		33⅜						36⅞						15¹¼		
		215T									38⅜								
		254T	46½	16	36½	14	8	5	5¼		41½	18¾	12				18¼		⅞
		256T									43¼								

BELL & GOSSETT MORTON GROVE, ILL. 60053

Fluid Handling Division, International Telephone and Telegraph Corporation ITT

1510 PERFORMANCE CURVES



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PRINTED IN U.S.A. 2-70

BELL & GOSSETT PRODUCTS

CENTRIFUGAL PUMPS

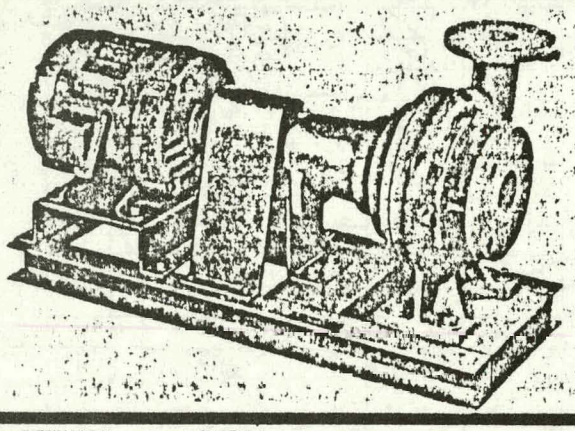
SUBMITTAL B-224.6

REVISION 4

2BB

Centrifugal Pumps—Base Mounted

SERIES 1510 TYPE B



JOB Coca-Cola Jackson, TN

UNIT TAG NO. P-3, P-3A

ENGINEER Griffith C. Burr

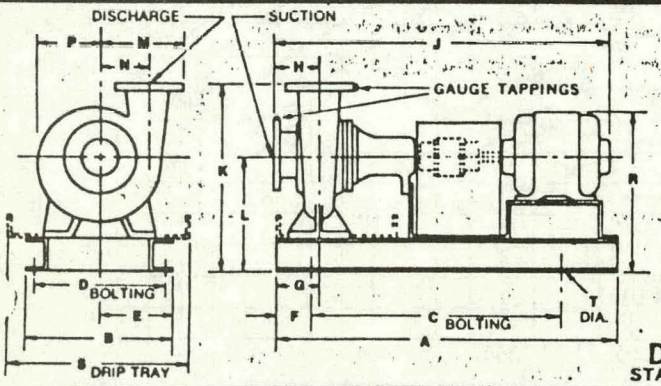
CONTRACTOR Morgan & Turner

B & G REPRESENTATIVE Johnson & Scott

ORDER NO. 1252 DATE

SUBMITTED BY Gene Mankowski DATE 12--6-7

APPROVED BY DATE



SPECIFICATIONS

173 GPM 55 FT

MATERIALS OF CONSTRUCTION:

☒ BRONZE FITTED ☐ ALL IRON ☐ ALL BRONZE

ELECTRICAL DATA: 5 HP

240 VOLTS 60 CY 3 PH.

MOTOR ENCL. OPDP

SPEC. CONSTR.

APPROXIMATE WEIGHT 260 LBS.

☒ 1510 (Standard Seal)

☐ 1510-PF (Packing—Flushed)

☐ 1510-S (Single Seal)

☐ 1510-D (Double Seal)

FLANGES ARE 125# A.S.A.

MAXIMUM WORKING PRESSURE 175 PSI

DIMENSIONS

STANDARD SEAL 1510

PUMP SIZE	SUCTION SIZE	MOTOR FRAME	PUMP DIMENSIONS (INCHES) A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
		"S" FRAME																	
2BB	2½"	143T	31	14⅜	25	12⅞	7¼	3	4¼	3¼	28¾	17¾	10¾	8⅞	5⅞	6½	14⅜	13¾	¾
		145T									29¾								
		182T									30⅜						15¼		
		184T									31⅜								
		213T	34⅜		28⅜						33¼						16¼		
		215T									34¹³⁄₁₆								
		"L" FRAME																	
		215T	39⅜	14⅜	33⅜	12⅞	7¼	3	4¼		39¼	17¾	10¾				16¼		¾
		254T	46½	16	36½	14	8	5	5¼	3¼	42¾	19	12	8⅞	5⅞	6½	18¼	13¾	⅞
		256T									44¼								
		284TS									43½	20	13				20		
		286TS									45¼								
		324TS									46¼	19	12						
		326TS									47¾								

STUFFING BOX 1510-P, 1510-PF, 1510-S, 1510-D

PUMP SIZE	SUCTION SIZE	MOTOR FRAME	PUMP DIMENSIONS (INCHES) A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
		"S" FRAME																	
2BB	2½"	143T	34⅜	14⅜	28⅜	12⅞	7¼	3	4¼	3¼	31¾	17¾	10¾	8⅞	5⅞	6½	14⅜	13¾	¾
		145T									32¾								
		182T									33¹³⁄₁₆						15¼		
		184T									34¹³⁄₁₆								
		213T	39⅜		33⅜						36⅞						16¼		
		215T									38⅜								
		"L" FRAME																	
		215T	46½		36½						41¼						17¼		
		254T									44¹¹⁄₁₆	19	12				18¼		
		256T									46¾								
		284TS	51¼	16	41¼	14	8	5	5¼	3¼	45⅞	20	13	8⅞	5⅞	6½	20	13¾	⅞
		286TS									47⅝								
		324TS									48⅝	19	12						
		326TS									50⅛								

BELL & GOSSETT MORTON GROVE, ILL. 60053 ITT

Fluid Handling Division, International Telephone and Telegraph Corporation

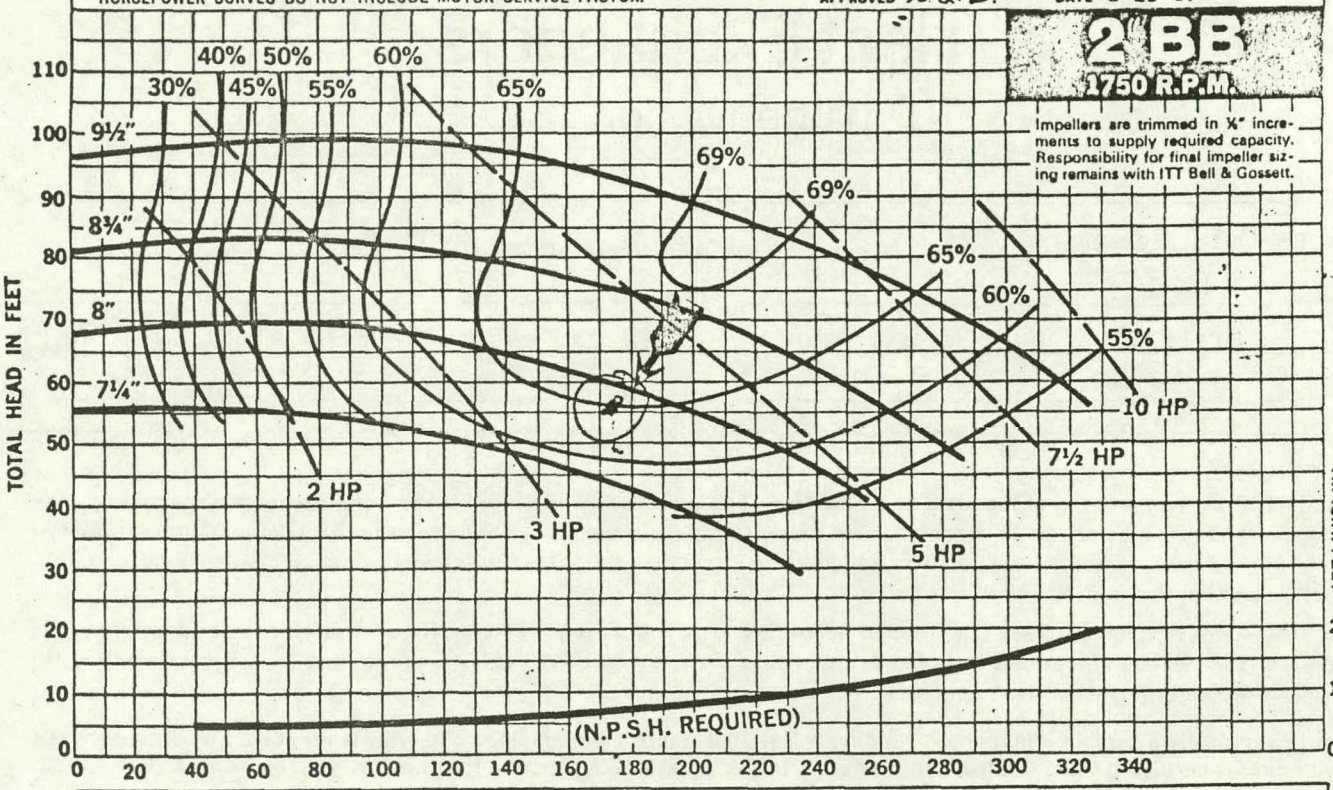
1510 PERFORMANCE CURVES

PERFORMANCE CHARACTERISTIC CURVE

FOR 2"BB CENTRIFUGAL PUMP FIG. NO. 1510 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 H.L.D. DATE 8-25-67

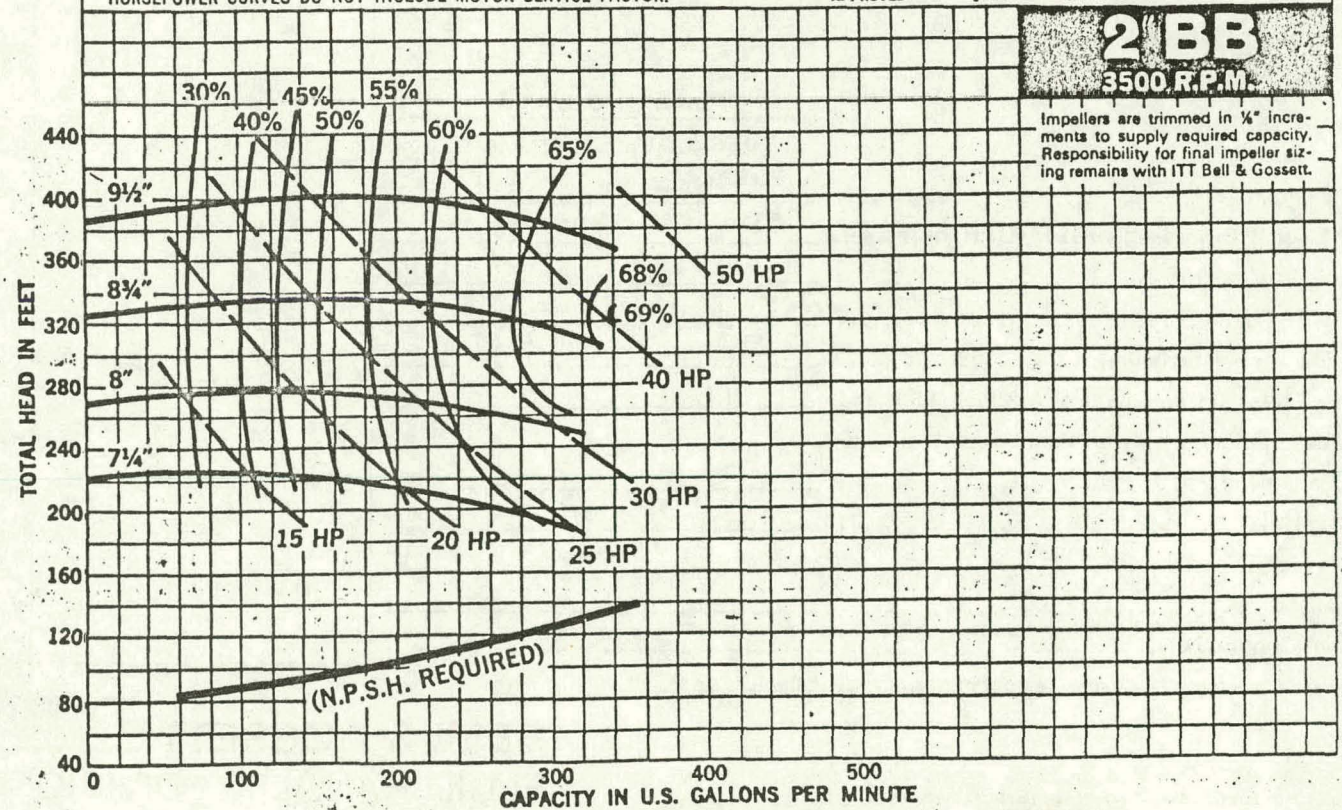


PERFORMANCE CHARACTERISTIC CURVE

FOR 2"BB CENTRIFUGAL PUMP FIG. NO. 1510 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 H.L.D. DATE 8-29-67



CAPACITY IN U.S. GALLONS PER MINUTE

BELL & GOSSETT MORTON GROVE, ILL. 60053 ITT

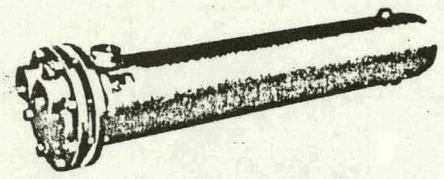
Fluid Handling Division, International Telephone and Telegraph Corporation

PRINTED IN U.S.A. 6-73

BELL & GOSSETT

SUBMITTAL

C-131.3
REVISION 3



10" Series Type "WU" Heat Exchangers

"U" Tube Design

JOB Coca-Cola Jackson, TN
B & G REPRESENTATIVE Johnson & Scott
UNIT TAG NO. HX-1
ORDER NO. 1252
DATE
ENGINEER Griffith C. Burr
SUBMITTED BY Gene Mankowski
DATE 12-6-78
CONTRACTOR Morgan & Turner
APPROVED BY
DATE

DESCRIPTION

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

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

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

RECOMMENDED "WU" HEAT EXCHANGER
MODEL NO. 109-45
HEATING SURFACE (SQ. FT.) 125

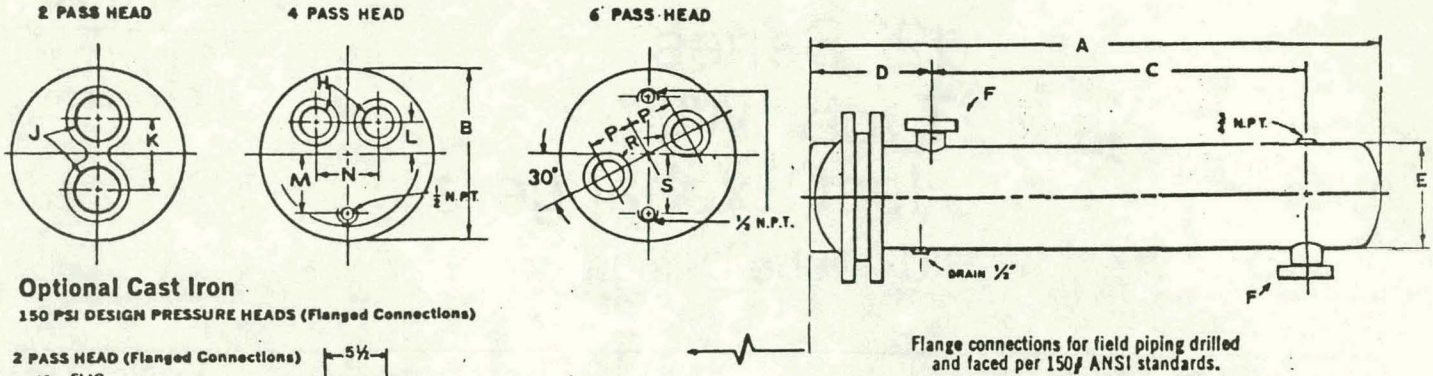
APPROVALS

OPERATING DATA	TUBE SIDE	SHELL SIDE
1. Fluid Circulated	Water	Water
2. Total Flow* (*Expressed in GPM, GPH, or lbs./hr.)	63	63
3. Temperature In/Out	160 / 140	120 / 140
4. Transfer BTU/hr.	622,000	622,000
5. Pressure Drop (Maximum)	2.5FT	1.5 FT
6. Fouling Factor or Percentage of Additional Surface	.001	
Note: Following applies only for fluids other than water.		
7. Specific Gravity		
8. Specific Heat		
9. Latent Heat		
10. Viscosity**		
11. Thermal Conductivity		

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

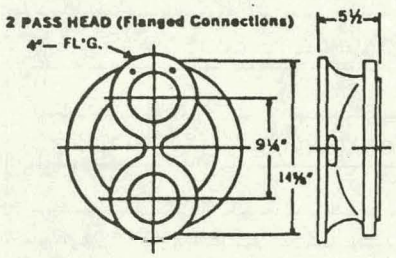
BELL & GOSSETT ITT
FLUID HANDLING DIVISION

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



Optional Cast Iron

150 PSI DESIGN PRESSURE HEADS (Flanged Connections)



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

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

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

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

Complete sales number consists of example: WU106-45

DIMENSIONS

UNIT NUMBER			DIMENSIONS IN INCHES															HEATING SURFACE (SQ. FT.)			APPROX. SHIPPING WT. (LBS.)
			2 PASS		4 PASS				6 PASS			2, 4 AND 6 PASS									
2 PASS	4 PASS	6 PASS	J	K	H	L	M	N	P	R	S	A	B	C	D	E	F	2 Pass	4 Pass	6 Pass	
WU104-25	WU104-45	WU104-65	4 NPT	5⅛	3 NPT	2⅜	4⅛	4¾	3 13/16	2½ NPT	4⅛	53	14⅜	37¼	8½	10¾	4 FLG	58	55	46	324
WU105-25	WU105-45	WU105-64	4 NPT	5⅛	3 NPT	2⅜	4⅛	4¾	3 13/16	2½ NPT	4⅛	65	14⅜	49¼	8½	10¾	4 FLG	73	69	58	379
WU106-25	WU106-45	WU106-65	4 NPT	5⅛	3 NPT	2⅜	4⅛	4¾	3 13/16	2½ NPT	4⅛	77	14⅜	61¼	8½	10¾	4 FLG	88	83	69	434
WU107-25	WU107-45	WU107-65	4 NPT	5⅛	3 NPT	2⅜	4⅛	4¾	3 13/16	2½ NPT	4⅛	89	14⅜	73¼	8½	10¾	4 FLG	102	97	81	489
WU108-25	WU108-45	WU108-65	4 NPT	5⅛	3 NPT	2⅜	4⅛	4¾	3 13/16	2½ NPT	4⅛	101	14⅜	85¼	8½	10¾	4 FLG	117	111	93	544
WU109-25	WU109-45	WU109-65	4 NPT	5⅛	3 NPT	2⅜	4⅛	4¾	3 13/16	2½ NPT	4⅛	113	14⅜	97¼	8½	10¾	4 FLG	132	125	104	599
WU1010-25	WU1010-45	WU1010-65	4 NPT	5⅛	3 NPT	2⅜	4⅛	4¾	3 13/16	2½ NPT	4⅛	125	14⅜	109¼	8½	10¾	4 FLG	147	139	116	654

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

DESIGN PRESSURES*				DESIGN TEMPERATURES* TUBE & SHELL SIDE	
TUBE SIDE		SHELL SIDE			
DESIGN	TEST	DESIGN	TEST	CAST IRON	BRASS
4 & 6 Pass					
150 psi	300 psi	150 psi	300 psi	375 F	300 F
2 Pass					
125 psi	250 psi	150 psi	300 psi	375 F	300 F
2 Pass Head (Flanged Connections) Cast Iron only					
150 psi	300 psi	150 psi	300 psi	375 F	—

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

MATERIALS

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

Caution:

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

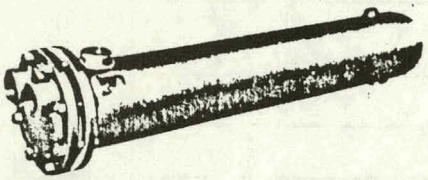
PRINTED IN U.S.A. 8-76

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

BELL & GOSSETT

SUBMITTAL

C-131.4
REVISION 5



12" Series Type "WU" Heat Exchangers

"U" Tube Design

JOB: Coca-Cola Jackson, TN	B & G REPRESENTATIVE: Johnson & Scott
UNIT TAG NO.: HX-2	ORDER NO.: 1252 DATE:
ENGINEER: Griffith C. Burr	SUBMITTED BY: Gene Mankowski DATE: 12-6-78
CONTRACTOR: Morgan & Turner	APPROVED BY: DATE:

DESCRIPTION

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

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

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

RECOMMENDED "WU" HEAT EXCHANGER

MODEL NO. 128-46

HEATING SURFACE (SQ. FT.) 160

APPROVALS

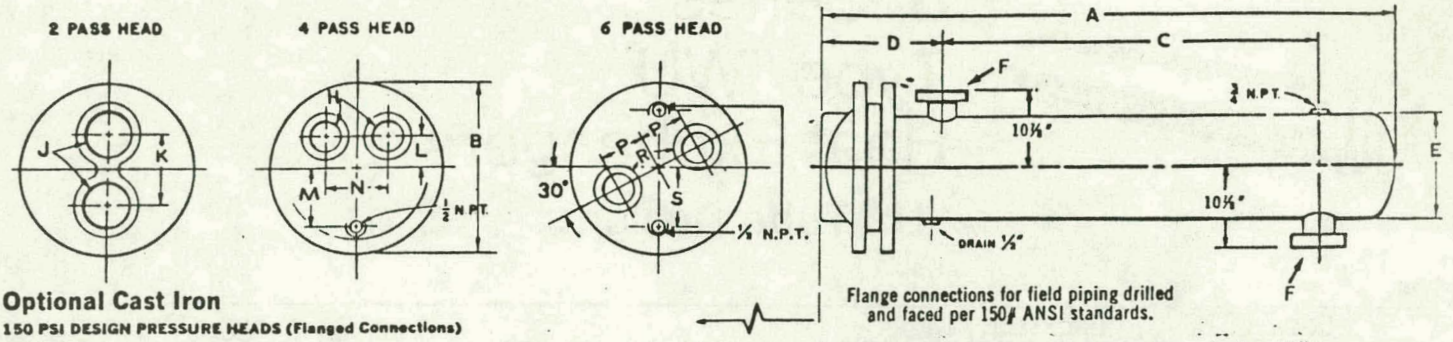
OPERATING DATA

	TUBE SIDE	SHELL SIDE
1. Fluid Circulated	Water	Water
2. Total Flow* (*Expressed in (GPM), GPH, or lbs./hr.)	90	
3. Temperature In/Out	190 / 179	160/178
4. Transfer BTU/hr	567,000	567,000
5. Pressure Drop (Maximum)	4.1	1.1
6. Fouling Factor or Percentage of Additional Surface	.001	
Note: Following applies only for fluids other than water.		
7. Specific Gravity		
8. Specific Heat		
9. Latent Heat		
10. Viscosity**		
11. Thermal Conductivity		

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

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

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



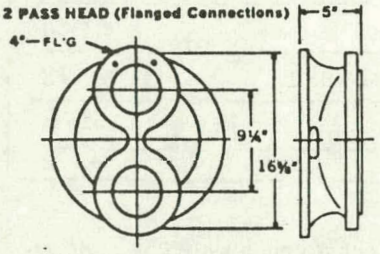
Flange connections for field piping drilled and faced per 150# ANSI standards.

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

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

Optional Cast Iron

150 PSI DESIGN PRESSURE HEADS (Flanged Connections)



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

Complete sales number consists of example: WU126-26

DIMENSIONS

UNIT NUMBER			DIMENSIONS IN INCHES														HEATING SURFACE (SQ. FT.)			APPROX. SHIPPING WT. (LBS.)
			2 PASS		4 PASS				6 PASS			2, 4 AND 6 PASS								
2 PASS	4 PASS	6 PASS	J	K	H	L	M	N	P	R	S	A	B	C	D	E	FLG F	2 Pass	4 Pass	6 Pass	
WU124-26	WU124-46	WU124-66	4 NPT	7¼	4 NPT	2⅝	5⅛	5⅛	4½	3 NPT	5¹³⁄₁₆	56½	16⅝	37¼	10¼	12¼	5	83	78	68	456
WU125-26	WU125-46	WU125-66	4 NPT	7¼	4 NPT	2⅝	5⅛	5⅛	4½	3 NPT	5¹³⁄₁₆	68½	16⅝	49¼	10¼	12¼	5	104	98	85	525
WU126-26	WU126-46	WU126-66	4 NPT	7¼	4 NPT	2⅝	5⅛	5⅛	4½	3 NPT	5¹³⁄₁₆	80½	16⅝	61¼	10¼	12¼	5	126	119	103	594
WU127-26	WU127-46	WU127-66	4 NPT	7¼	4 NPT	2⅝	5⅛	5⅛	4½	3 NPT	5¹³⁄₁₆	92½	16⅝	73¼	10¼	12¼	5	148	139	121	663
WU128-26	WU128-46	WU128-66	4 NPT	7¼	4 NPT	2⅝	5⅛	5⅛	4½	3 NPT	5¹³⁄₁₆	104½	16⅝	85¼	10¼	12¼	5	169	160	139	732
WU129-26	WU129-46	WU129-66	4 NPT	7¼	4 NPT	2⅝	5⅛	5⅛	4½	3 NPT	5¹³⁄₁₆	116½	16⅝	97¼	10¼	12¼	5	191	180	156	801

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

DESIGN PRESSURES*				DESIGN TEMPERATURES* TUBE & SHELL SIDE	
TUBE SIDE		SHELL SIDE			
DESIGN	TEST	DESIGN	TEST	CAST IRON	BRASS
6 Pass					
150 psi	300 psi	150 psi	300 psi	375 F	—
2 & 4 Pass					
125 psi	250 psi	150 psi	300 psi	375 F	300 F
2 Pass Head (Flanged Connections) Cast Iron only					
150 psi	300 psi	150 psi	300 psi	375 F	—

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

MATERIALS

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

Caution:

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

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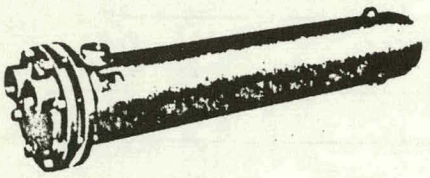
REVISION 5



8" Series Type "WU" Heat Exchangers

"U" Tube Design

JOB: Coca-Cola Jackson, TN	B & G REPRESENTATIVE: Johnson & Scott
UNIT TAG NO.: HX-3	ORDER NO.: 1252 DATE:
ENGINEER: Griffith C. Burr	SUBMITTED BY: Gene Mankowski DATE: 12-6-78
CONTRACTOR: Morgan & Turner	APPROVED BY: DATE:

DESCRIPTION

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

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

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

RECOMMENDED "WU" HEAT EXCHANGER

MODEL NO. 89-43

HEATING SURFACE (SQ. FT.) 75

APPROVALS

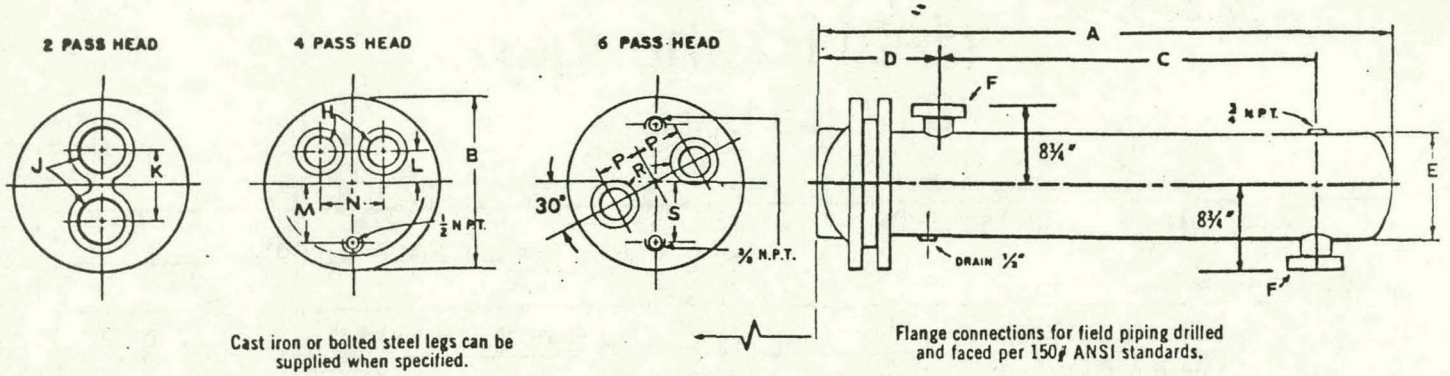
OPERATING DATA

	TUBE SIDE	SHELL SIDE
1. Fluid Circulated	Water	Water
2. Total Flow* (*Expressed in (GPM), GPH, or lbs./hr.)	56	42
3. Temperature In/Out	160 / 175	160 / 177
4. Transfer BTU/hr	349,000	349,000
5. Pressure Drop (Maximum)	4.5'	5.0'
6. Fouling Factor or Percentage of Additional Surface	.001	
Note: Following applies only for fluids other than water.		
7. Specific Gravity		
8. Specific Heat		
9. Latent Heat		
10. Viscosity**		
11. Thermal Conductivity		

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

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

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



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

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

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

DIMENSIONS

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

Complete sales number consists of example: WU86-44

UNIT NUMBER			DIMENSIONS IN INCHES															HEATING SURFACE (SQ. FT.)			APPROX. SHIPPING WT. (LBS.)
			2 PASS		4 PASS				6 PASS			2, 4 AND 6 PASS									
2 PASS	4 PASS	6 PASS	J	K	H	L	M	N	P	R	S	A	B	C	D	E	FLG. F	2 Pass	4 Pass	6 Pass	
WU84-24	WU84-44	WU84-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	53	12½	37	8½	8⅝	4	32		26	222
WU85-24	WU85-44	WU85-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	65	12½	49	8½	8⅝	4	41		33	258
WU86-24	WU86-44	WU86-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	77	12½	61	8½	8⅝	4	49		41	294
WU87-24	WU87-44	WU87-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	89	12½	73	8½	8⅝	4	58		48	330
WU88-24	WU88-44	WU88-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	101	12½	85	8½	8⅝	4	67		55	366
WU89-24	WU89-44	WU89-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	113	12½	97	8½	8⅝	4	75		62	402

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

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

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

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

MATERIALS

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

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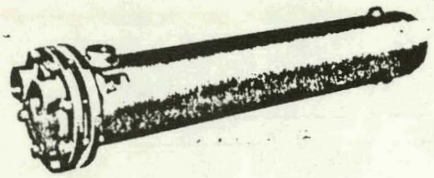
SUBMITTAL

C-131.2
REVISION 5



8" Series Type "WU" Heat Exchangers

"U" Tube Design

JOB: Coca-Cola Jackson, TN	B & G REPRESENTATIVE: Johnson & Scott
UNIT TAG NO.: HX-4	ORDER NO.: 1252 DATE:
ENGINEER: Griffith C. Burr	SUBMITTED BY: Gene Mankowski DATE: 12-6-78
CONTRACTOR: Morgan & Turner	APPROVED BY: DATE:

DESCRIPTION

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

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

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

RECOMMENDED "WU" HEAT EXCHANGER

MODEL NO. 89-44

HEATING SURFACE (SQ. FT.) 75

APPROVALS

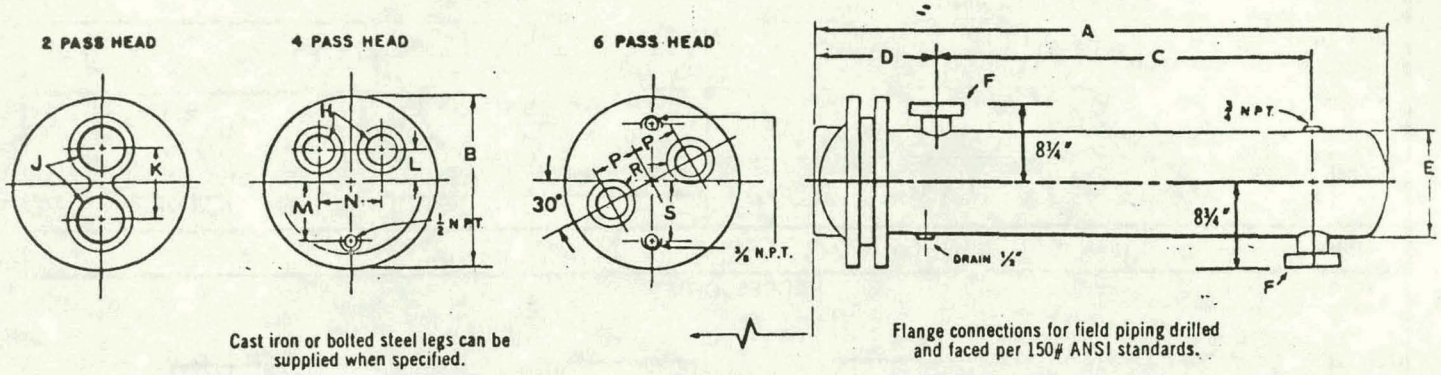
OPERATING DATA

	TUBE SIDE	SHELL SIDE
1. Fluid Circulated	Water	Water
2. Total Flow* (*Expressed in (GPM), GPH, or lbs./hr.)	35	35
3. Temperature In/Out	190 /179	120/ 140
4. Transfer BTU/hr.	345,200	345,200
5. Pressure Drop (Maximum)	2.0'	2.5'
6. Fouling Factor or Percentage of Additional Surface	.001	
Note: Following applies only for fluids other than water.		
7. Specific Gravity		
8. Specific Heat		
9. Latent Heat		
10. Viscosity**		
11. Thermal Conductivity		

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

BELL & GOSSETT ITT
FLUID HANDLING DIVISION

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



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

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

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

DIMENSIONS

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

Complete sales number consists of example: WU86-44

UNIT NUMBER			DIMENSIONS IN INCHES															HEATING SURFACE (SQ. FT.)			APPROX. SHIPPING
			2 PASS		4 PASS				6 PASS			2, 4 AND 6 PASS									
2 PASS	4 PASS	6 PASS	J	K	H	L	M	N	P	R	S	A	B	C	D	E	FLG. F	2 Pass	4 Pass	6 Pass	WT. (LBS.)
WU84-24	WU84-44	WU84-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	53	12½	37	8½	8⅝	4	32		26	222
WU85-24	WU85-44	WU85-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	65	12½	49	8½	8⅝	4	41		33	258
WU86-24	WU86-44	WU86-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	77	12½	61	8½	8⅝	4	49		41	294
WU87-24	WU87-44	WU87-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	89	12½	73	8½	8⅝	4	58		48	330
WU88-24	WU88-44	WU88-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	101	12½	85	8½	8⅝	4	67		55	366
WU89-24	WU89-44	WU89-64	3 NPT	5	2 NPT	2	3½	4	3	2 NPT	3¼	113	12½	97	8½	8⅝	4	75		62	402

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

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

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

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

MATERIALS

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

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INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

McQUAY GROUP McQuay-Perfex Inc.
P.O. Box 1551, Minneapolis, Mn. 55440
CERTIFIED DRAWING

UNIT HEATERS
DOWNFLOW

TYPE UDH

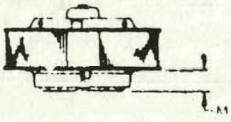
JOB: Coca-Cola Bottling Co
DATE 1-2-78 DR.
CH. APP.
G.O. 670630
PURCHASER Jackson, Tennessee
PURCHASERS P.O. 10857 REP. P.O. 3342
REP. D.M. Mills and Assoc.
CONS. ENG'R: Office of Griffith C. Burr
ITEM OF ITEMS QTY.
12 PRINTS ☐ FOR APPR'L. ☒ FOR RECORD

REVISIONS	No 1	DATE 1-3-78	BY CKB	WAS A Vintage

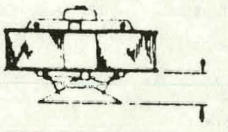
ACCESSORIES

NO 1 FAN GUARD

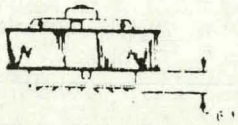
NO 2 RADIAL DEFLECTOR

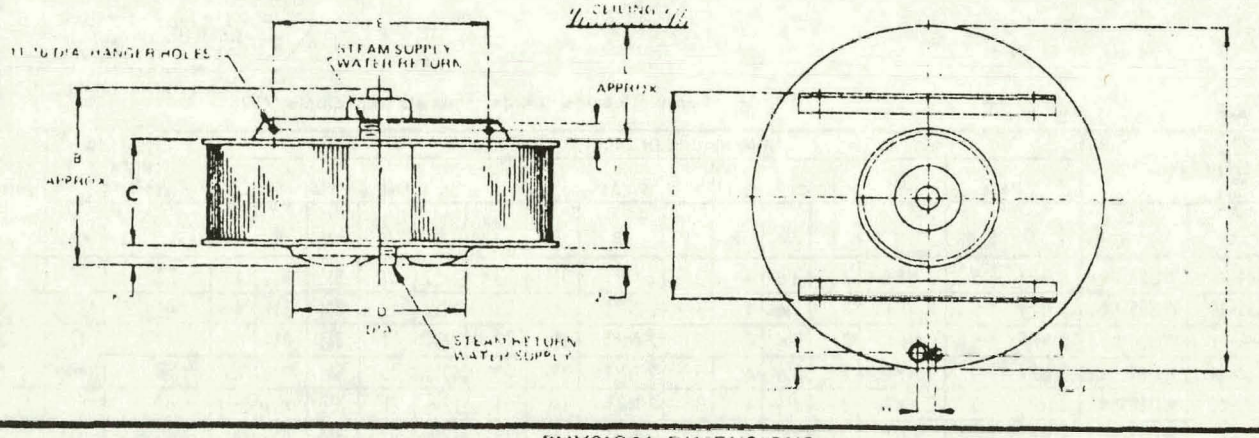


NO 3 DISC DEFLECTOR



NO 4 LOUVER DEFLECTOR





PHYSICAL DIMENSIONS

ITEM	ACCES. NO.	MODEL NUMBER	A	B	C	D	E	F	G	H	J	K	L	M	M.I.P.S. CONNS. SUPPLY	M.I.P.S. CONNS. RETURN
		UDH-040B	25.62	12.41	3.12	12.38	16.00	1.25	1.25	1.62	2.00	1.42	15.87	5.62	1 1/4"	1 1/4"
		UDH-060B	25.62	13.28	4.62	14.50	16.00	1.25	1.25	1.62	2.00	1.53	15.13	5.62	1 1/4	1 1/4"
		UDH-080B	25.62	16.58	6.12	16.50	16.00	1.25	1.25	1.62	2.00	2.07	16.38	5.62	1 1/4"	1 1/4"
		UDH-100B	25.62	17.74	7.62	14.50	16.00	1.25	1.25	1.62	2.00	2.03	16.09	5.62	1 1/4"	1 1/4"
		UDH-120B	33.62	18.47	6.12	18.50	21.50	1.25	1.62	2.00	2.00	2.03	18.32	6.00	2"	1 1/4"
		UDH-144B	33.62	17.94	6.12	18.50	21.50	1.25	1.62	2.00	2.00	2.03	17.79	6.00	2"	1 1/4"
		UDH-160B	33.62	18.72	7.62	18.50	21.50	1.25	1.62	2.00	2.00	2.37	16.73	6.00	2"	1 1/4"
		UDH-200B	33.62	19.85	9.12	24.75	21.50	1.25	1.62	2.00	2.00	2.14	16.59	6.00	2"	1 1/4"
010	2	UDH-240B	33.62	19.82	12.12	24.75	21.50	1.25	1.62	2.00	2.00	2.14	13.56	7.00	2"	1 1/4"
		UDH-270B	33.62	17.32	12.12	24.75	21.50	1.25	1.62	2.00	2.00	1.63	11.57	7.00	2"	1 1/4"
		UDH-330B	42.62	17.62	13.62	24.75	27.50	1.38	1.88	2.38	2.75	1.63	10.75	7.00	2 1/2"	1 1/2"
		UDH-384B	42.62	19.35	13.62	26.75	27.50	1.38	1.88	2.38	2.75	1.72	12.00	7.25	2 1/2"	1 1/2"
		UDH-434B	42.62	19.61	15.12	26.75	27.50	1.38	1.88	2.38	2.75	1.72	10.75	7.25	2 1/2"	1 1/2"
		UDH-494B	42.62	21.72	18.12	30.75	27.50	1.38	1.88	2.38	2.75	1.58	10.75	7.25	2 1/2"	1 1/2"
		UDH-560B	42.62	24.72	21.12	30.75	27.50	1.38	1.88	2.38	2.75	1.58	10.75	7.25	2 1/2"	1 1/2"
		UDH-610B	42.62	24.72	21.12	30.75	27.50	1.38	1.88	2.38	2.75	1.58	10.75	7.25	2 1/2"	1 1/2"

CAPACITIES

STEAM 180 ENT H2O 60 ENT AIR

ITEM	QTY	TAG	MOTOR DATA HP	RPM	VOLTS CY & PH	CFM @ .10"	BTUH	EDR	LBS OF COND. HR	FINAL AIR TEMP °F	GPM
010	16	UDH240B	1/3	1050 PSC	115/60/1	3900	118,000			85	5.9

BULLETIN NO. IM 215
OCTOBER 1978
INSTALLATION &
MAINTENANCE DATA

UNIT HEATERS

Downflow and Horizontal

For Steam & Hot Water Heating Systems

CONTENTS

INSPECTION

When the equipment is received all items must be carefully checked against the bill of lading to be sure all cartons have been received. Visible or concealed damage should be reported immediately to the carrier and a claim filed with him for damage. The electrical nameplate should be checked to be sure it agrees with the power supply available.

INSTALLATION

Installation and maintenance are to be performed only by qualified personnel who are familiar with local codes and regulations, and experienced with this type of equipment.

CAUTION: Sharp edges and coil surfaces are a potential injury hazard. Avoid contact.

UNIT MOUNTING

Use care in handling the units to avoid damage to the coil fins. Hang units with supporting rods; do not hang units from piping. When handling the downflow unit heaters do not set the unit down on its fan blades as the fan blades may be damaged. The unit should be hung level and located with sufficient space around it for maintenance. It is suggested that 8 inches of space be left between the highest point on the downflow units and the ceiling.

The downflow unit heaters have four 11/16-inch diameter hanger holes on the top of the unit. The horizontal unit heaters have two 1/2-13 weld nuts on top of the unit for threaded hanger rods.

OSHA regulations, as recorded in Federal Register Vol. 37, No. 202 in October 1972, require the use of a fan guard when the periphery of the fan blades is less than 7 feet above the floor or working surface. The customer must evaluate the location of the unit to determine if the guidelines set up by OSHA provide adequate protection against personal injury and provide protection if required. A fan guard designed to comply with OSHA requirements is available from the unit manufacturer.

PIPING

Typical piping diagrams are illustrated in Figures 1 through 4. All piping should be in conformance with good standard practice and local codes. Pipe size is based on the type of heating system, pressure and flow rate. Consult the ASHRAE guide for complete data. The selection of proper steam traps and air vents is very important. Steam traps must be properly sized and orificed for the pressure involved and should be sized for a minimum of two times the maximum condensing rate of the unit heater. In case of doubt, consult the steam trap manufacturer. Branch piping must allow for expansion and contraction without placing a strain on the unit heater. Piping should be independently supported, not supported by the unit.

Do not exceed 150 PSIG or 375°F temperature on standard coils, 350 PSIG or 450°F temperature on high pressure coils, or 300°F temperature on horizontal unit optional low flow water coils. The unit nameplate designates coil pressure.

PIPING DIAGRAMS

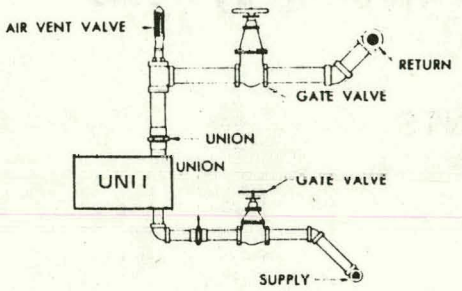


Fig. 1 HOT WATER SYSTEM

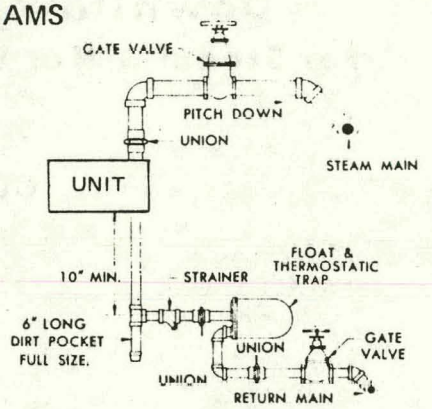


Fig. 2 VAPOR AND VACUUM STEAM SYSTEM

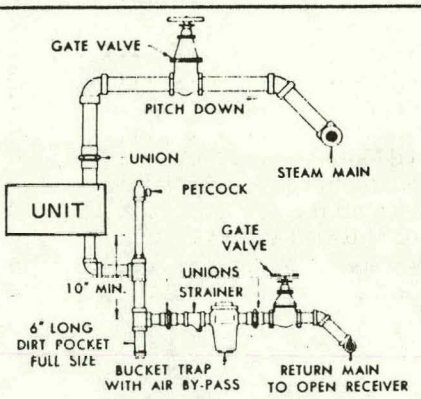


Fig. 3 HIGH PRESSURE STEAM SYSTEM

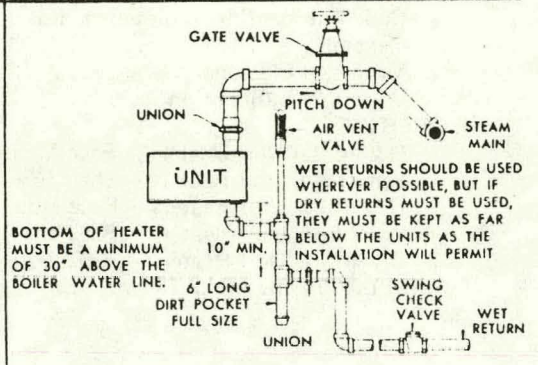


Fig. 4 LOW PRESSURE STEAM GRAVITY SYSTEM

WIRING

Wire in accordance with local codes or the National Electric Code, whichever is applicable. The installer shall provide wiring to the motor, branch circuit overcurrent protection, and disconnect means. All standard units, except the UHH-094 and UDH-270 and 330 with 3-phase motors and all UDH-384 through 610, are provided with motors which have internal thermal overloads. The installer must provide overload protection for those units. Typical wiring diagrams are shown in Diagrams 1 through 6. Wiring instruction for the optional speed controller are included with the speed controller.

Diagram 1 and 4. Although unit heaters are usually thermostatically controlled, there are some installations where manual "on-off" control is sufficient. These diagrams show this type of control. The single phase manual starter shown in Diagram 1 may be of the single pole or double pole type.

Diagram 2 and 5. These diagrams show the most common method of controlling unit heaters. Each unit is controlled by a space thermostat and, in addition, a limit control (temperature or pressure type) is connected in the circuit so that the unit cannot operate when the temperature of the steam or water is too low.

Diagram 3 and 6. These diagrams show the most flexible method of control providing both automatic and manual operation. The automatic operation will be the same as in Diagram 2 and 5. However, an additional provision is made for operating the unit manually. This permits the unit being used as an air circulator during the non-heating season.

Although Diagram 6 shows a multiple application, this same type of control may be applied to individual units by substituting a magnetic starter for the magnetic relay and omitting the manual starter.

TYPICAL WIRING DIAGRAMS

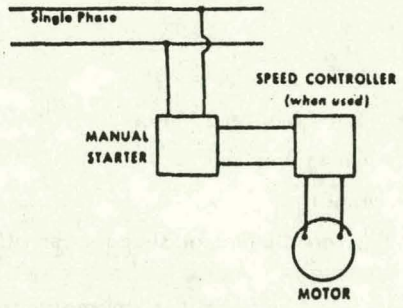


Diagram 1 – Single Phase Power
MANUAL CONTROL

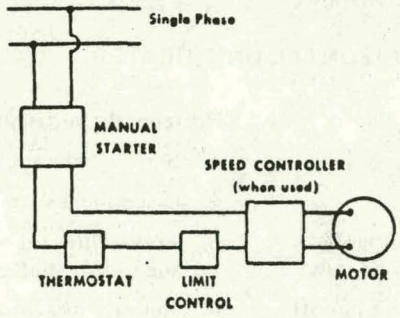


Diagram 2 – Single Phase Power
AUTOMATIC CONTROL

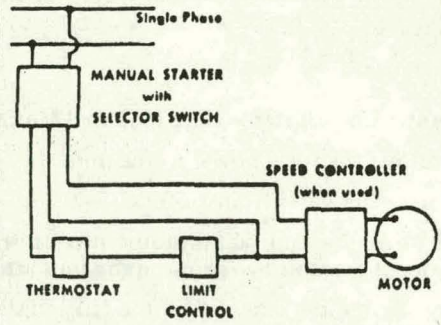


Diagram 3 – Single Phase Power
MANUAL OR AUTOMATIC CONTROL

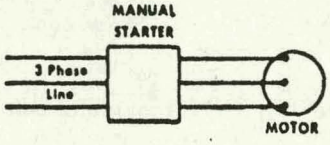


Diagram 4 – 3-Phase Power
MANUAL CONTROL

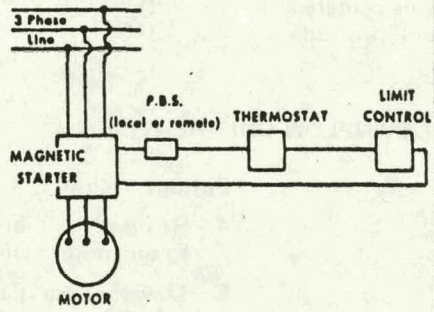


Diagram 5 – 3-Phase Power
AUTOMATIC CONTROL

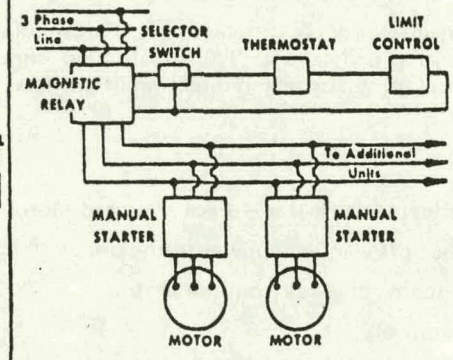


Diagram 6 – 3-Phase Power
MANUAL OR AUTOMATIC CONTROL

START-UP

Inspect the unit heater carefully before starting. Tighten any loose nuts, bolts or screws. Examine the propeller fan to see that it has not been damaged during installation, that it is tight on the shaft, and that it rotates freely and in the correct direction. The fan should be centered in the orifice (equal gap between fan and orifice on each side of fan), and the fan should protrude through the orifice (in direction of air flow) approximately 1/3 of the blade depth. Make sure that the line voltage at the unit is within 10% of the motor nameplate voltage. Vent the lines on hot water systems. Discharge dampers should not be closed more than 75% or motor overheating may occur.

MAINTENANCE

WARNING – Before performing any maintenance, disconnect the electrical power to avoid electrical shock or injury from rotating parts.

COIL CLEANING

All unit heater coils should be cleaned at least once a year and more often under unfavorable conditions. Build-up of dirt, grease and lint will reduce original heating capacity and may overload motor. The following are suggested cleaning methods.

1. Disconnect the electrical power before servicing to avoid electrical shock or injury from rotating parts.
2. Use a brush to loosen dirt on side where air enters the coil and then turn fan on to blow the dirt from the unit.
3. Use compressed air to loosen dirt by blowing from leaving airside of unit.
4. For a more thorough cleaning of coil, remove the fan and motor and spray a mild alkaline solution over the coil. This must be followed by a very thorough hot water rinse.

INTERNAL CORROSION SAFEGUARDS

1. Provide controlled water treatment – but do not use an excess of boiler compounds.
2. De-aerate boiler feed water.
3. Insure rapid and continous condensate drainage by proper sizing and installation of steam traps and piping.
4. Clean strainers and check steam traps for proper operation.
5. Provide proper vents for each unit. Verify annually that automatic vents are operating properly.
6. Use low pressure steam whenever possible.

GENERAL

Casings should be periodically cheaned to remove dirt, grease and corrosive substances which might injure the finish. Any rusted or corroded spots should be cleaned and repainted. Check accessories and motor mount. Also, check fan for tight connection to shaft, free rotation and proper clearance.

MOTOR

Cleaning – Disconnect the electrical power before cleaning to avoid electrical shock or injury from rotating parts. During each inspection, remove all grease and dirt from the outside of the motor. This is important as grease and dirt act as insulation and thereby prevent heat dissipation, causing overheating of the motor.

Lubrication – Sleeve bearing motors with oilers should be relubricated at the end of the first year and after each 2000 hours of operation thereafter. Use one teaspoon or 5cc of SAE No. 20 non-detergent oil per bearing. Where motors are operated in high ambient temperatures and/or under severe conditions, they must be serviced more frequently. DO NOT OVER-LUBRICATE.

SERVICE

This equipment should be serviced only by qualified, experienced technicians. Always disconnect the electrical power before servicing to avoid electrical shock or injury from rotating parts. If motor service is required, the motor can be removed as follows:

HORIZONTAL UNIT HEATER

Horizontal Unit Heater – Face Mounted Motor

1. Shut off electrical power to the unit.
2. Disconnect wires from motor.
3. Remove the fan guard/motor mount from the back panel of the unit by removing the four attaching screws.
4. Loosen the set screw(s) on the fan and slide the fan off the motor shaft.
5. Remove four nuts holding the motor to the fan guard/motor mount.
6. Reverse process to reassemble. Fan should be centered in the orifice and 1/3 of the fan should protrude through the orifice in direction of air flow.

Horizontal Unit Heater – Shelf Mounted Motor

1. Shut off electrical power to unit.
2. Disconnect wires from motor.
3. Loosen the set screw(s) on the fan and slide the fan off the motor shaft.
4. Remove the four nuts and bolts holding the motor to the motor shelf and lift the motor off the unit.
5. Reverse process to reassemble. Fan should be centered in the orifice and 1/3 of the fan should protrude through the orifice in direction of air flow.

DOWNFLOW UNIT HEATER

Downflow Unit Heater – Face Mounted Motor

1. Shut off electrical power to the unit.
2. Disconnect wires from the motor.

Top removal

3. Loosen the set screw(s) on the fan and slide the fan off the motor shaft.
4. Remove the four nuts holding the motor to the bottom motor pan.
5. Lift motor out of the top of unit. Proceed to Step 6.

Bottom removal

3. Remove four screws holding bottom motor pan to motor cylinder. Lower fan motor and motor pan assembly out the bottom of the unit.
4. Loosen the set screw(s) on the fan and slide the fan off the motor shaft.
5. Remove the four nuts holding the motor to the bottom motor pan. Proceed to Step 6.
6. Reverse process to reassemble. Fan should be centered in the orifice and 1/3 of the fan should protrude through the orifice in direction of air flow.

Downflow Unit Heater – Resilient Ring Mounted Motor

1. Shut off electrical power to the unit.
2. Disconnect wires from the motor.
3. Loosen the set screw(s) on the fan and slide the fan off the motor shaft.

Top removal

4. Disconnect the bracket at the top of the motor.
5. Lift the motor out of the top of the unit. Proceed to Step 6.

Bottom removal

4. Remove the four screws holding the bottom motor pan to the motor cylinder.
5. Lower motor pan and motor out the bottom of the unit. Proceed to Step 6.
6. Reverse process to reassemble. Fan should be centered in the orifice and 1/3 of the fan should protrude through the orifice in direction of air flow.

Downflow Unit Heater – Rigid Base Motor

1. Shut off electrical power to the unit.
2. Disconnect wires from the motor.
3. Loosen the set screw(s) on the fan and slide the fan off the motor shaft.

Top removal

4. From top of unit, reach down and remove the four bolts that attach the motor to the plate in the motor cylinder.
5. Lift the motor out the top of the unit. Proceed to Step 6.

Bottom removal

4. From bottom of unit, remove the screws holding the bottom motor pan to the motor cylinder.
5. Remove the four bolts that attach the motor to the plate in the cylinder and lower the motor out the bottom of the unit. Proceed to Step 6.
6. Reverse process to reassemble. Fan should be centered in the orifice and 1/3 of the fan should protrude through the orifice in direction of air flow.

REPLACEMENT PARTS

When writing for service or replacement parts always provide a complete description of the service part, part number (if known), plus complete serial and model number of unit involved.

McQuay GROUP , McQUAY-PERFEX INC.
P.O. BOX 1551, MINNEAPOLIS, MINNESOTA 55440

SEASONMASTER
CENTRAL STATION AIR CONDITIONER
LOW AND MEDIUM PRESSURE
HORIZONTAL DRAW THRU

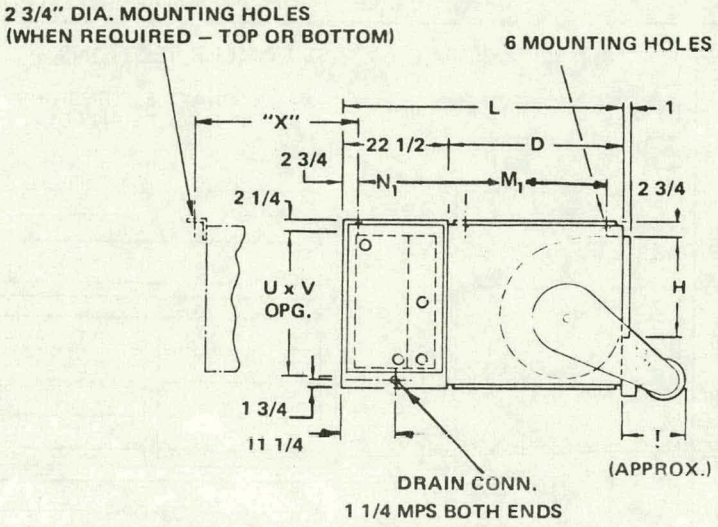
265538Y

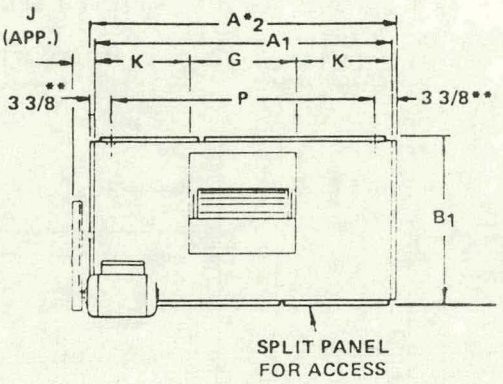
TYPES LSL AND MSL

McQuay certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval of this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by McQuay at its home office.

GENERAL SPECIFICATIONS

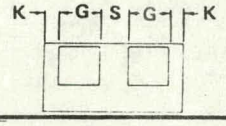
CABINET – GALVANIZED STEEL STRUCTURAL FRAME AND PANELS. ACCESS DOORS AND REMOVABLE PANELS PROVIDE COMPLETE ACCESSIBILITY TO INTERIOR.
FANS – GALVANIZED STEEL DYNAMICALLY BALANCED. BLADES RIVETED TO RIMS AND CENTER PLATE. CAST IRON HUBS.
HOUSINGS – GALVANIZED STEEL, DIE FORMED WITH SPOT WELDED SEAMS.
SHAFTS – SOLID HIGH CARBON STEEL SIZED SO THAT THE OPERATING SPEED IS WELL BELOW THE FIRST CRITICAL SPEED.
SHEAVES – MACHINED CAST IRON, "V" GROOVE TYPE, KEY SEATED TO SHAFT.
MOTOR MOUNT – ADJUSTABLE FOR VARYING BELT TENSION.
BEARINGS – SELF ALIGNING, BALL TYPE WITH GREASE FITTINGS AND EXTENDED LUBE LINES.
BELT GUARDS – GALVANIZED STEEL WITH FAN SHAFT TACHOMETER OPENING.
INSULATION – NEOPRENE COATED 1" GLASS FIBER. MEETS NBFU 90A STANDARDS.
DRAINPAN – GALVANIZED STEEL, INNER PAN COVERED WITH PROTECTIVE MASTIC COATING AND THERMALLY ISOLATED FROM BOTTOM PAN WITH 1" GLASS FIBER INSULATION.



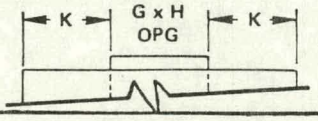


NOTES:
1. A_1 & B_1 DIMENSIONS FOR BLOWER SECTION
   A_2 & B_1 DIMENSIONS FOR COIL SECTION
2. "X" DIMENSION FOUND BY ADDING DIMENSION OF THE OPTIONAL SECTIONS USED PLUS 3 5/8 IN. INCLUDE 1/8" FOR GASKETING WHERE SECTIONS BOLT TOGETHER

CABINETS WITH F.C. FAN WHEELS
UNIT SIZES 214, 217, 222 & 228



CABINETS WITH OPTIONAL A.F. FAN WHEELS
UNIT SIZES 214, 217, 222 & 228



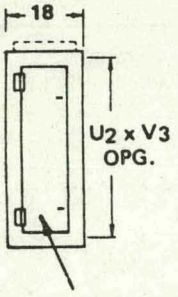
	214	217	222	228
G	29 3/8	29 3/8	35 5/8	35 5/8
H	23 1/4	23 1/4	28 5/8	28 5/8
K	24 3/8	31 7/8	30 1/2	42 1/4

TAG	UNIT SIZE	DIMENSIONS (Inches)																
		A_1	A_2*	B_1	D	G	H	J	K	L	M_1	N_1	P	S	T	U	V	X
	103	34	35 1/8	22 3/4	21 3/4	11 3/4	10 1/4	6 1/2	11 1/8	44 3/8	16 1/8	22 5/8	28 1/2	—	15	18 1/4	29 7/8	
	104	40	41 1/8	25 3/4	24 3/4	12 1/4	13 1/2	6 1/2	13 3/8	47 3/8	19 1/8	22 5/8	34 1/2	—	15	21 1/4	35 7/8	
	106	50	51 1/8	29	28	17 1/4	15 3/8	6 1/2	16 3/8	50 5/8	22 3/8	22 5/8	44 1/2	—	16	24 1/2	45 7/8	
	108	48	49 1/8	37 3/4	36 3/4	21 1/8	19 3/8	8	13 7/16	59 3/8	31 1/8	22 5/8	42 1/2	—	18	33 1/4	43 7/8	
	111	63	64 1/8	37 3/4	36 3/4	23 1/4	21 3/8	8	19 3/8	59 3/8	31 1/8	22 5/8	57 1/2		18	33 1/4	58 7/8	
	214	78	79 1/8	37 3/4	36 3/4	19	17 7/8	8	10	59 3/8	31 1/8	22 5/8	72 1/2	20	21	33 1/4	73 7/8	
	217	93	94 1/8	37 3/4	36 3/4	21 1/8	19 3/8	8	12 11/16	59 3/8	31 1/8	22 5/8	87 1/2	25 3/8	21	33 1/4	88 7/8	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	228	120	121 1/8	44 3/4	43 3/4	28 1/4	26 1/2	9	15 1/8	66 3/8	38 1/8	22 5/8	114 1/2	31 1/4	23	40 1/4	115 1/8	

*Add 5 inches with extra large face area coils. **Add 2½ inches with extra large face area coils.

☐ ACCESS BY-PASS SPACER SECTION

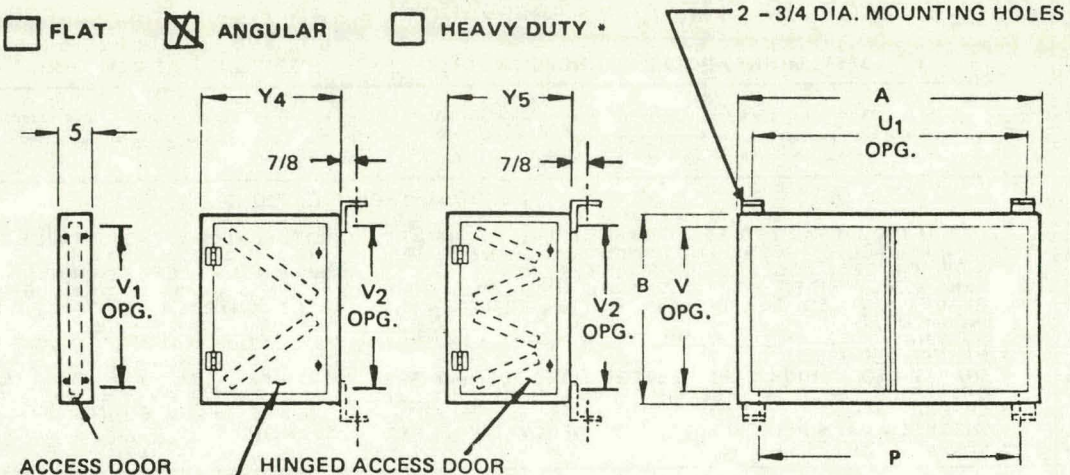
OPENING PROVIDED WHEN USED AS BY-PASS SPACER SECTION



HINGED ACCESS DOOR BOTH ENDS

FILTER SECTIONS

☐ FLAT ☒ ANGULAR ☐ HEAVY DUTY *

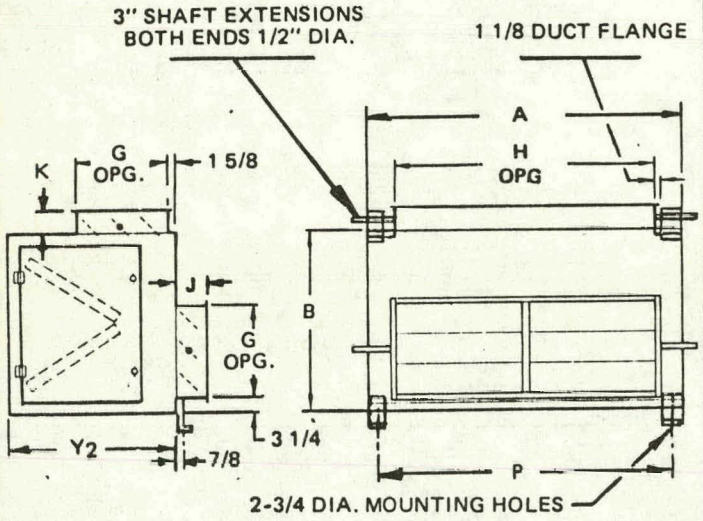


ACCESS DOOR BOTH ENDS

HINGED ACCESS DOOR BOTH ENDS

*AVAILABLE IN UNIT SIZES 111 THRU 228 ONLY

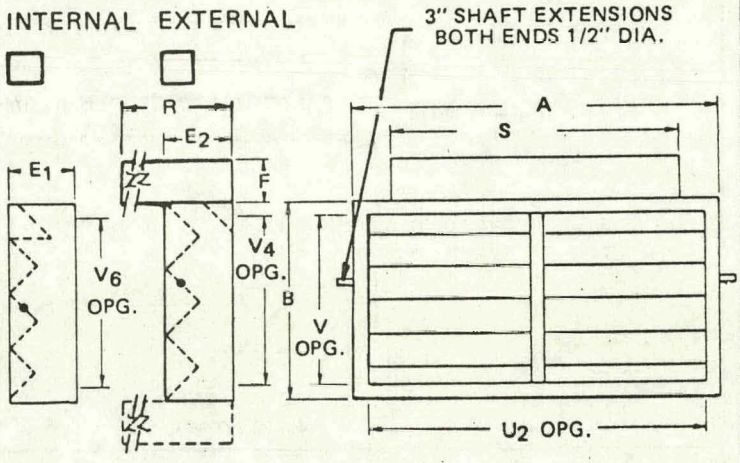
☐ COMBINATION MIXING BOX AND ANGULAR FILTER SECTION



NOTE: WHEN BACK AND BOTTOM OPENINGS ARE REQUIRED, MIXING BOX IS INVERTED. (TOP AND BOTTOM OPENINGS ALSO AVAILABLE.)

☐ FACE AND BYPASS DAMPER SECTIONS

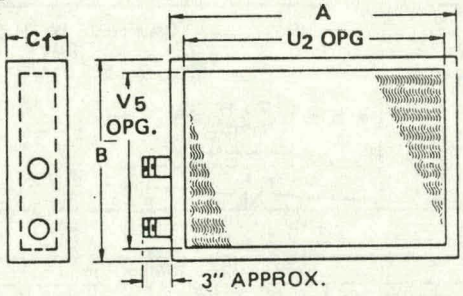
INTERNAL ☐ EXTERNAL ☐



NOTES:

1. WHEN TOP BYPASS IS REQUIRED, UNIT MUST BE FLOOR MOUNTED.
2. WHEN BOTTOM BYPASS IS REQUIRED, FACE AND BYPASS SECTION IS INVERTED, AND UNIT MUST BE CEILING HUNG.

☐ HEATING COIL SECTION (1 & 2 ROW ONLY)*



*SMALL & LARGE FACE AREA COILS ONLY

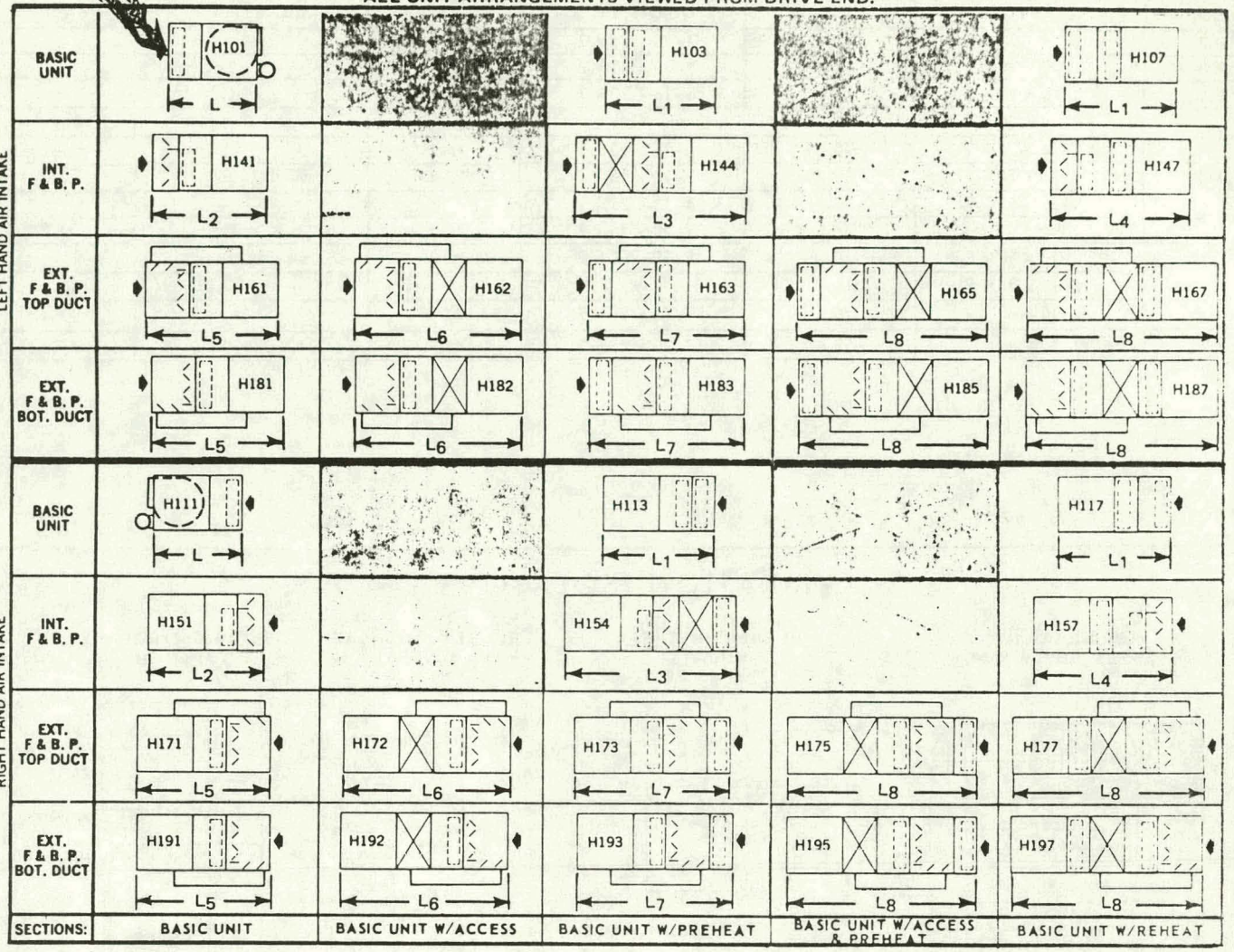
NOTE: WHEN SECTIONS ARE BOLTED TOGETHER, ADD 1/8" FOR GASKETING.

UNIT SIZE	DIMENSIONS (Inches)																								
	A	B	C1	E1	E2	F	G	H	J	K	P	R	S	T	U1	U2	V1	V2	V3	V4	V5	V6	Y2	Y4	Y5
103	34	21⅛	6½	6¼	7⅛	6	12⅛	25⅛	6¼	4⅝	28½	36⅛	33⅛	25½	30⅝	29⅛	17⅝	18¼	17½	17⅝	17½	18¼	22½	19½	N.A.
104	40	24⅛	6½	8	8⅛	6⅛	12⅛	31⅛	6¼	4⅝	34½	37¼	39⅛	20½	36⅝	35⅛	20	21¼	20½	20⅜	20½	21¼	23	19	N.A.
106	50	27⅛	6½	9	9⅛	7⅛	12⅛	41⅛	6¼	4⅝	44½	39⅛	49⅛	22	46⅝	45⅛	23⅛	24½	23¼	23	23¼	24½	27¼	22¼	N.A.
108	48	36⅛	6½	9	11	9⅛	18⅛	39⅛	6¼	4⅝	42½	43⅛	47⅛	25½	44⅝	43⅛	32½	33¼	32½	30⅜	32½	33¼	33½	26	N.A.
111	63	36⅛	6½	9	11	9⅛	18⅛	54⅛	6¼	4⅝	57½	43⅛	62⅛	25½	59⅝	58⅛	32½	33¼	32½	30⅜	32½	33¼	33½	26	23¼
214	78	36⅛	6½	9	11	9⅛	18⅛	69⅛	6¼	4⅝	72½	43⅛	77⅛	25½	74⅝	73⅛	32½	33¼	32½	30⅜	32½	33¼	33½	26	23¼
217	93	36⅛	6½	9	11	9⅛	18⅛	84⅛	6¼	4⅝	87½	43⅛	92⅛	25½	89⅝	88⅛	32½	33¼	32½	30⅜	32½	33¼	33½	26	23¼
222	97	43⅛	7	8¼	13⅛	11¼	24⅛	88⅛	7¼	5⅛	91½	47⅛	96⅛	23	93⅝	92⅛	40⅛	40¼	39½	37¼	39½	33¼	32½	23	23⅛
228	120	43⅛	7	8¼	13⅛	11¼	24⅛	111⅛	7¼	5⅛	114½	47⅛	119⅛	23	116⅝	115⅛	40⅛	40¼	39½	37¼	39½	40¼	32½	23	23⅛

N.A.—Not Available. *"T"= Maximum Clearance required for filter removal.

UNIT ARRANGEMENTS

ALL UNIT ARRANGEMENTS VIEWED FROM DRIVE END.

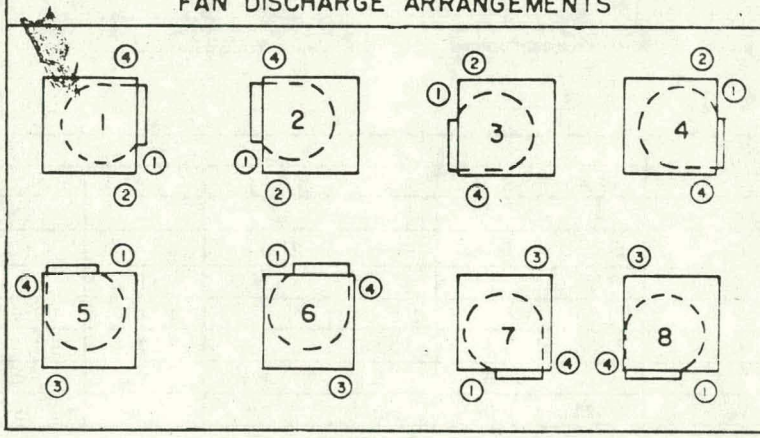


UNIT SIZE	DIMENSIONS (Inches)								
	L	L1*	L2	L3*	L4*	L5	L6	L7*	L8*
103	44⅛	51	51¼	76	57⅞	52⅛	70½	59	77⅛
104	47⅛	54	55½	80¼	62⅛	55⅛	73¼	62¼	80⅛
106	50⅛	57¼	59¾	84½	66⅛	59⅛	78	66½	84⅛
108	59⅛	66	68½	93¼	75⅛	70½	88⅛	77⅛	95¼
111	59⅛	66	68½	93¼	75⅛	70½	88⅛	77⅛	95¼
214	59⅛	66	68½	93¼	75⅛	70½	88⅛	77⅛	95¼
217	59⅛	66	68½	93¼	75⅛	70½	88⅛	77⅛	95¼
222	66⅛	73½	74¾	100	81⅛	79⅛	98	87	105⅛
228	66⅛	73½	74¾	100	81⅛	79⅛	98	87	105⅛

NOTE:

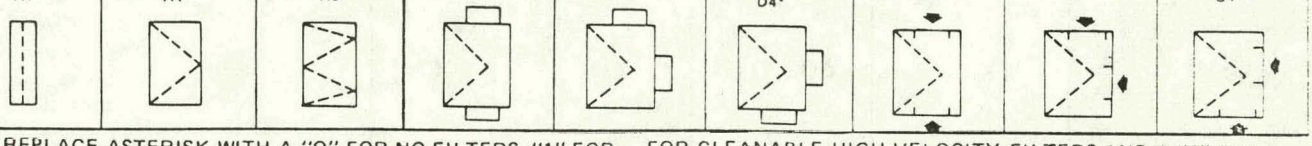
FOR OVERALL UNIT LENGTH ADD DIMENSIONS OF ACCESSORIES NOT INCLUDED IN ABOVE "L" DIMENSION

FAN DISCHARGE ARRANGEMENTS



ACCESSORY ARRANGEMENTS

FLAT FILTER	ANGULAR FILTER	HEAVY DUTY FILTER	COMB. ANGULAR FILTER AND MIXING BOX					
			WITH DAMPERS			WITHOUT DAMPERS		
A1*	A4*	A5*	B4*	C4*	D4*	E4*	F4*	G4*

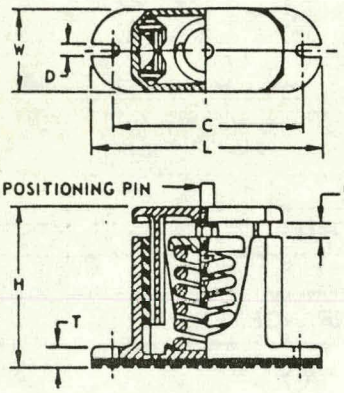


REPLACE ASTERISK WITH A "0" FOR NO FILTERS, "1" FOR THROWAWAY FILTERS, "2" FOR CLEANABLE FILTERS, "3" FOR CLEANABLE HIGH VELOCITY FILTERS AND A "4" FOR THROWAWAY HIGH PERFORMANCE FILTERS.

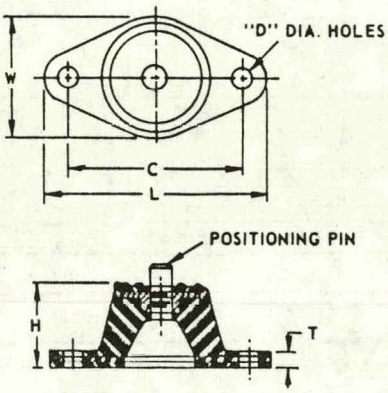
UNIT SIZE	FLAT		ANGULAR		HEAVY DUTY	
	QUANTITY	AREA	QUANTITY	AREA	QUANTITY	AREA
103	2–16 x 20 x 2	4.4	2–16 x 25 x 2	5.6	–	–
104	2–20 x 20 x 2	5.6	4–16 x 20 x 2	8.9	–	–
106	3–16 x 25 x 2	8.4	6–16 x 20 x 2	13.3	–	–
108	2–16 x 20 x 2	–	–	–	–	–
	2–16 x 25 x 2	10.0	6–16 x 25 x 2	16.7	–	–
111	6–16 x 20 x 2	13.3	6–20 x 25 x 2	20.8	9–20 x 20 x 2	25.0
214	6–16 x 25 x 2	16.7	4–16 x 25 x 2	–	–	–
	–	–	4–20 x 25 x 2	24.9	9–20 x 25 x 2	31.2
217	4–16 x 20 x 2	20.0	8–20 x 25 x 2	27.8	9–20 x 20 x 2	
	4–16 x 25 x 2	–	–	–	6–16 x 20 x 2	38.3
222	12–16 x 20 x 2	26.7	12–16 x 25 x 2	33.4	24–16 x 20 x 2	53.3
228	12–20 x 20 x 2	33.4	12–20 x 25 x 2	41.8	24–20 x 20 x 2	66.6

VIBRATION ISOLATORS

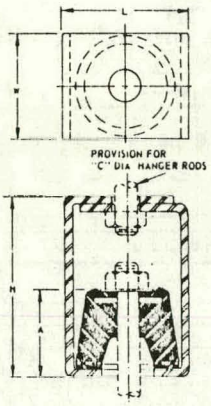
SPRING MOUNTS TYPES "BP" & "CP"



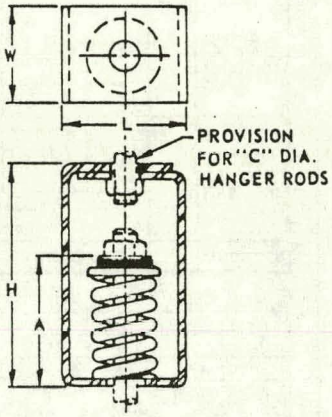
RUBBER-IN-SHEAR MOUNTS TYPE "RP"



RUBBER-IN-SHEAR HANGER TYPE "RH"



SPRING HANGER TYPE "SH"

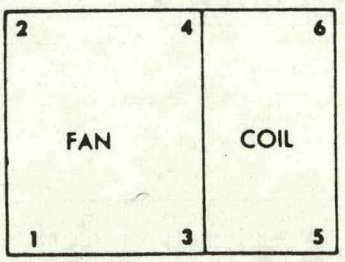


DIMENSIONS	ISOLATORS											
	BP	CP1	CP2	RP1	RP2	RP3	RP4	RH2	RH3	RH4	SH	SH5
A	–	–	–	–	–	–	–	1 3/8	2	2	4 3/8	3 1/8
C	5	6 1/2	9 1/4	2 3/8	3	4 1/2	5	5/8	3/4	1	3/4	1/2
D	7/16	5/8	5/8	11/32	11/32	9/16	9/16	–	–	–	–	–
*H	3 7/8	5	5 1/4	1	1 1/4	1 3/4	1 3/4	4 1/2	5 3/4	8	7	4 1/2
L	5 5/8	7 1/2	10 1/4	3	3 7/8	5 1/2	6 1/2	3	3 3/4	4 3/4	3 3/4	3 3/4
T	1/2	5/8	5/8	1/4	1/4	1/4	1/4	–	–	–	–	–
W	2 1/8	2 3/4	2 3/4	1 5/8	2 3/8	3 3/8	4 1/4	2 1/4	3 1/4	4	3	2 1/4

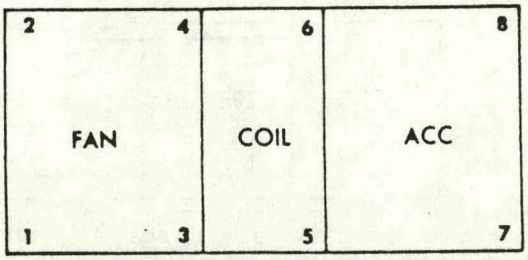
*Operating Height

*OPERATING HEIGHT.

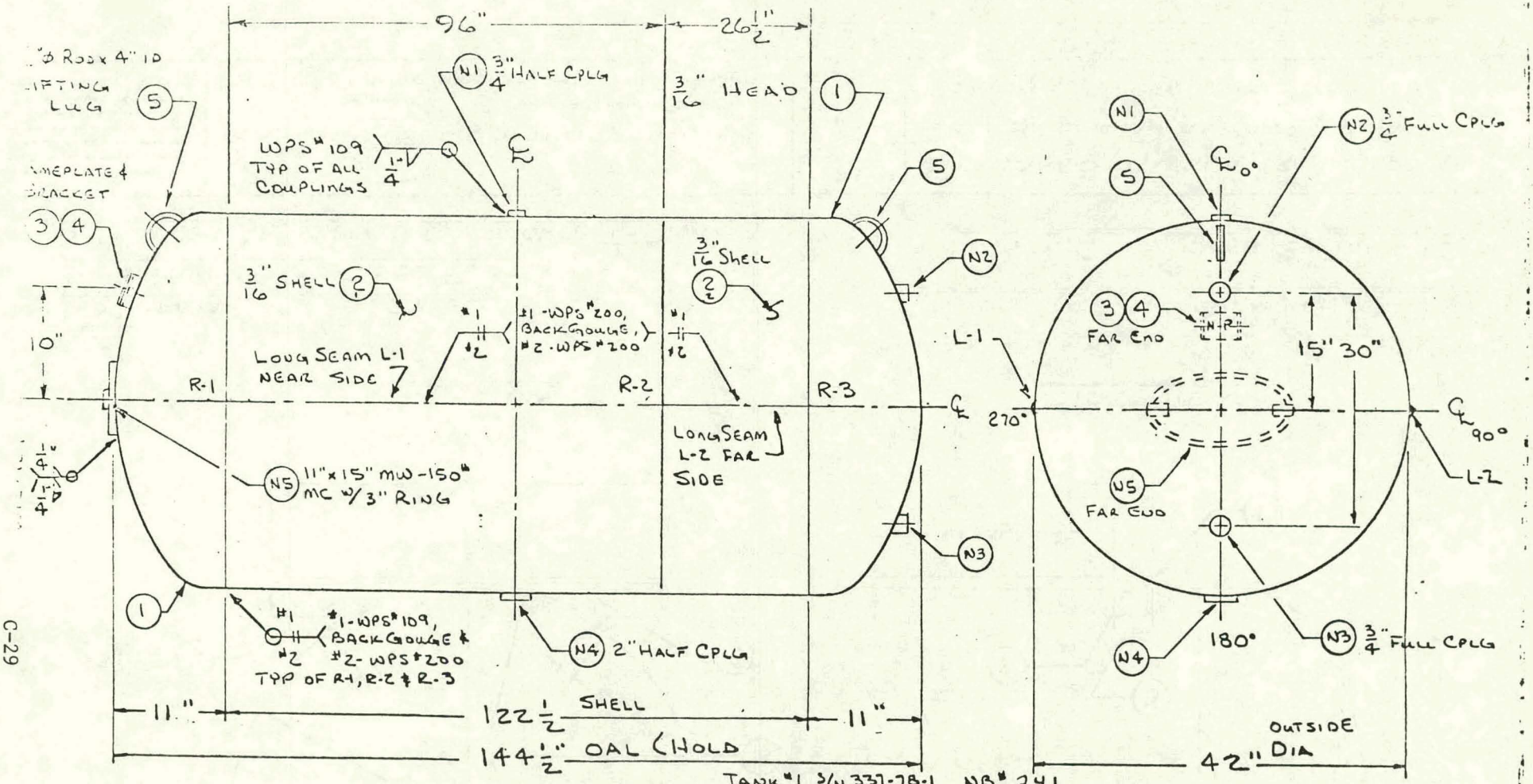
ISOLATOR LOCATIONS



WITHOUT ACCESSORIES



WITH ACCESSORIES



SIDE ELEVATION

END VIEW

TANK #1	S/N 337-78-1	NB# 241
TANK #2	S/N 337-78-2	NB# 242
TANK #3	S/N 337-78-3	NB# 243
TANK #4	S/N 337-78-4	NB# 244

4 - TANKS REQ'D

NOTES:

1- ASME & NATIONAL BOARD STAMPED
2- 50 PSI DESIGN PRESSURE @ 500°F
3- 75 PSI HYDRO TEST PRESS.
4- NO RADIOGRAPH EXAM.
5- 144 SQ.FT. SURFACE AREA
6- 750 WATER GALLONS
7- .1875" HEADS - SA285C F&D-HC
8- .1875" SHELL - SA516-70
9- EXTERIOR - S/B AND RED OXIDE PRIMER
10- INTERIOR - S/B AND CHARGE WITH 2PSI NITROGEN BEFORE SHIPMENT
11- FURNISH 4 SADDLES PER DWG# AS337-78-2, 2 REQUIRED PER TANK

C-29

the GASKELL company Incorporated
INDUSTRIAL CONSTRUCTION
1886 HARBOR AVE. • P.O. BOX 13225 • MEMPHIS, TENN. 38113

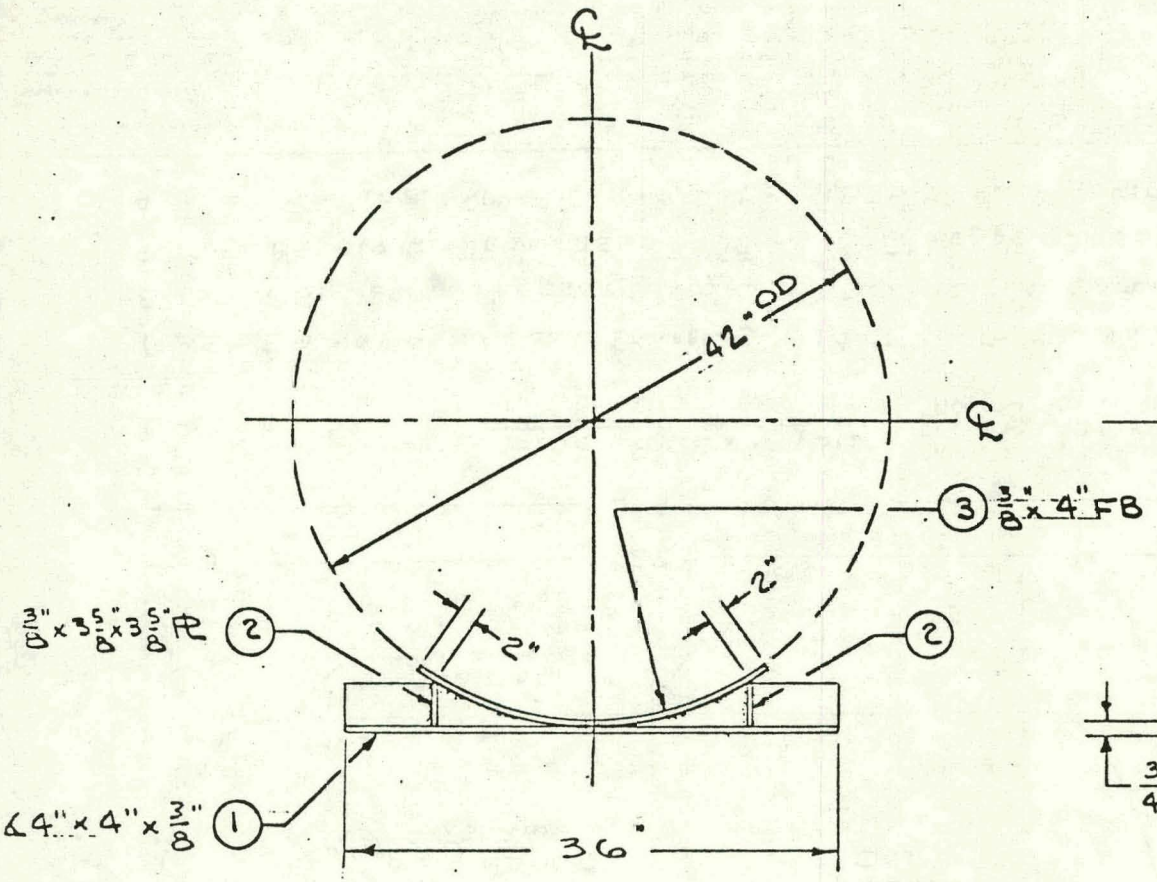
DATE	12-27-78
DRAWN	DALLMUS
APPROVED	QCM - MD
SCALE	NONE

750 GALLON EXPANSION TANKS

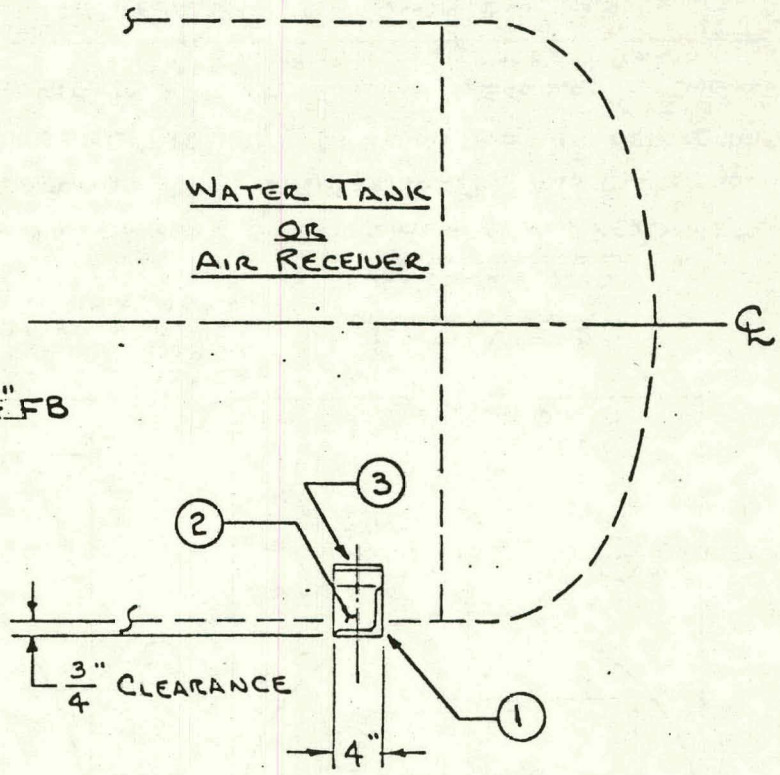
42" OD x 144 1/2" OAL - ASME & NB - 50PSI D/WP
FOR
MORGAN & TURNER, INC. P.O.# 1255

JOB NO	5337-78
QNT. REQ.	1
QP	1
DRAWING NO	AS337-78-1

JOB: COCA COLA BOTTLING CO. JACKSON, TENN. P.O.# 4007



FRONT VIEW



SIDE VIEW

NOTES:

1- MATERIAL - SA36 STEEL

2- PAINT W/1 CT. RED OXIDE PRIMER

3- SADDLES ARE SHIPPED UNATTACHED TO TANK

4 TANKS REQ'D 8 SADDLES REQ'D

TANK SIZE - 42" OD x 144½" OAL

NUMBER OF SADDLES PER TANK - 2

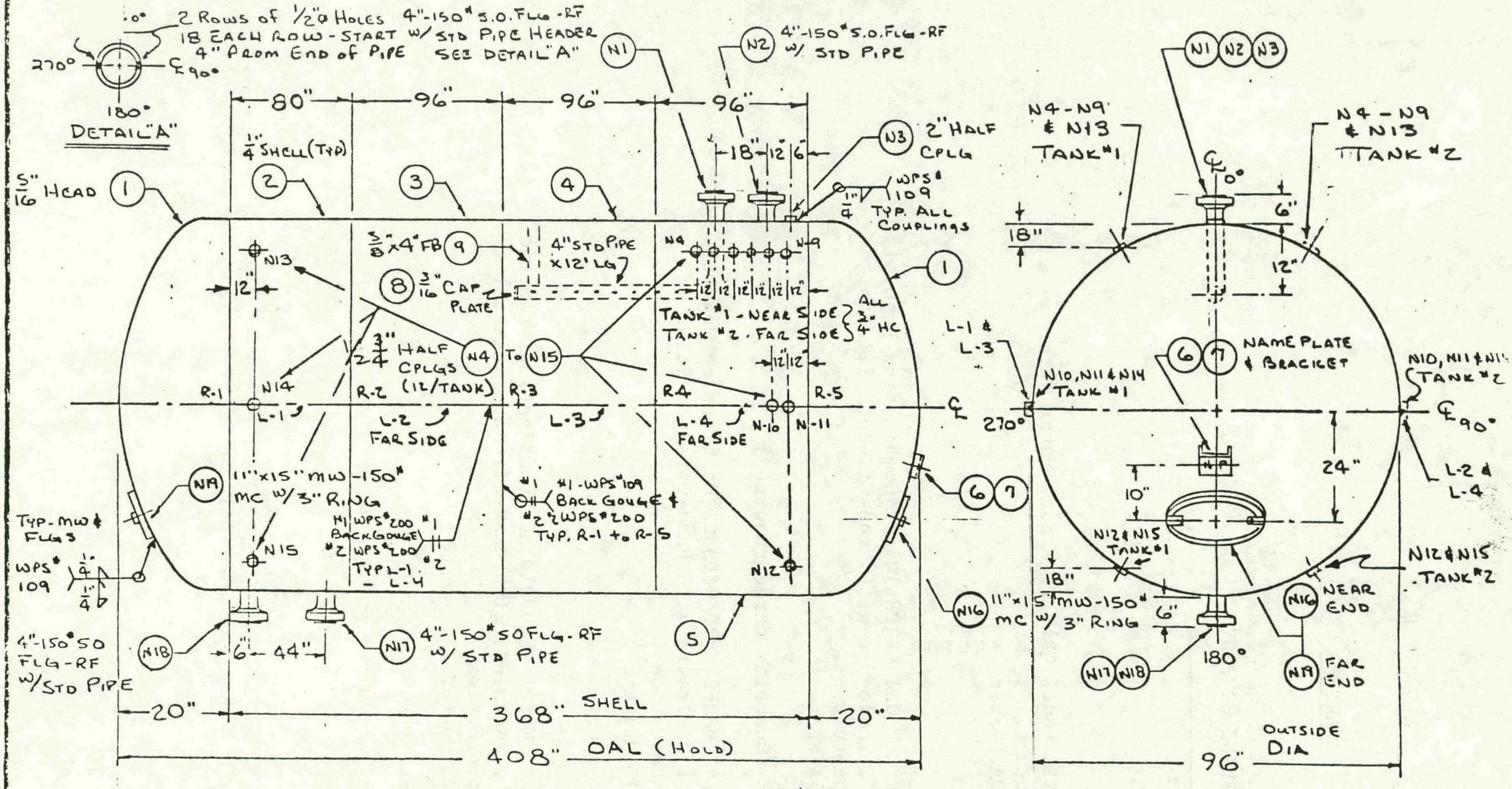
the GASKELL company Incorporated
INDUSTRIAL CONSTRUCTION
1555 HARBOR AVE. • P.O. BOX 13325 • MEMPHIS, TENN. 38113

DATE	10-21-78
DRAWN	DALLMUS
APPROVED	BFD
REVISED	NONE

STANDARD ANGLE IRON SADDLES
FOR: 750 GALLON EXPANSION TANKS
FOR
MORGAN & TURNER, INC P.O.# 125

JOB NO.	5337-7
SHT. NO.	1
DRAWING NO.	AS337-

JOB: SOLAR HEATING PROJECT - COCA COLA BOTTLING CO. JACKSON, TENN.



C-31

Side Elevation

Tank #5 S/N 337-78-5 NB# 245
Tank #6 S/N 337-78-6 NB# 246

End View

2 Tanks Req'd

Notes:

1- ASME & National Board Stamped
2- 50 PSI Design Pressure @ 500°F
3- 75 PSI Hydro Test Press.
4- No Radiograph Exam.
5- 915 Sq. Ft. Surface Area
6- 12,000 Water Gallons
7- .3125" Heads - SA516-70 F&D
8- .250" Shell - SA516-70
9- Exterior - S/B And Red Oxide Prime
10- Interior - S/B And Charge With
1 2 PSI Nitrogen Before Shipment
11- Flange Bolt Holes To Straddle Center Lines

the GASKELL company Incorporated
INDUSTRIAL CONSTRUCTION
1825 Harbor Ave. • P.O. Box 13225 • Memphis, Tenn. 38113

Date	12-27-78
Drawn	Dallmus
Approved	GCM-MD
Scale	None

12,000 Gallon Horizontal Water Tanks
96" OD x 408" OAL - ASME & NB - 50 PSI D/WP
For
Morgan & Turner, Inc P.O.# 1255

S337-7
Sheet No. 1 1
Drawing No. AS337-7

Job: Coca Cola Bottling Co. Jackson, Tenn. P.O.#
Solar Heating Project

S C H E D U L E

STARTERS

PROJECT: COCA COLA BOTTLING COMPANY
JACKSON, TN

UNIT HEATERS

GENERAL ELECTRIC Model CR101Y1 Manual Motor Watchman in surface mounted enclosure.
1 - CR123H6.80A Heater

PUMP P-1

GENERAL ELECTRIC Model CR208B103ACA Combination Magnetic Starter, size 0 in NEMA 1 enclosure with Hand-Off-Auto Selector, and three-leg overload protection.
3 - CR123C6.95A Heaters

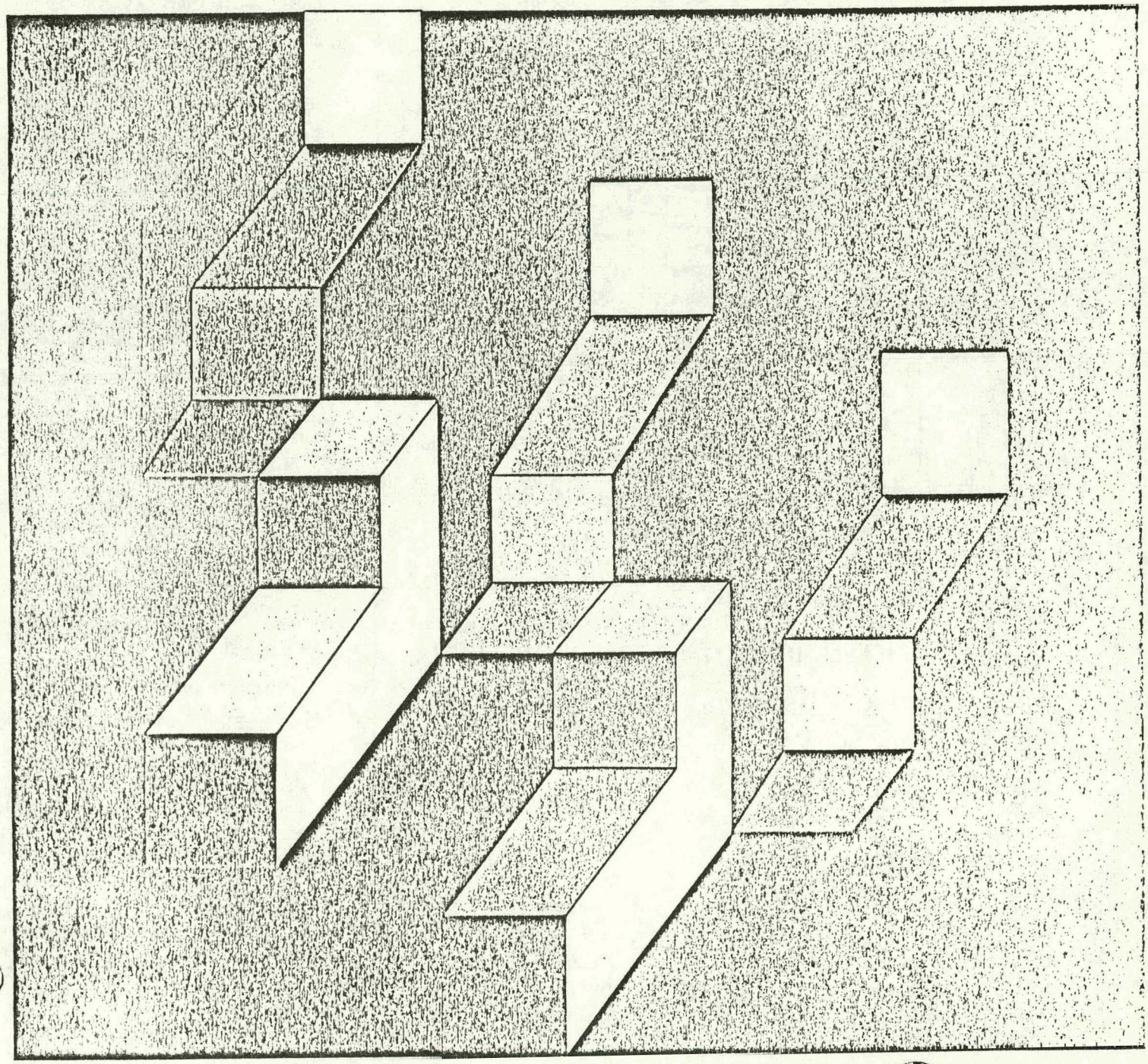
PUMPS P-2, P-3 and P-3A (Quantity three required)

GENERAL ELECTRIC Model CR208C103ACA Combination Magnetic Starter, Size 1 in NEMA 1 enclosure with Hand-Off-Auto Selector and three-leg overload protection.
3 - CR123C16.3B Heaters

PURGE FAN

GENERAL ELECTRIC Model CR208D103ACA Combination Magnetic Starter, Size 2 in NEMA 1 enclosure with Hand-Off-Auto Selector and three-leg overload protection.
3 - CR123C44.0B Heaters

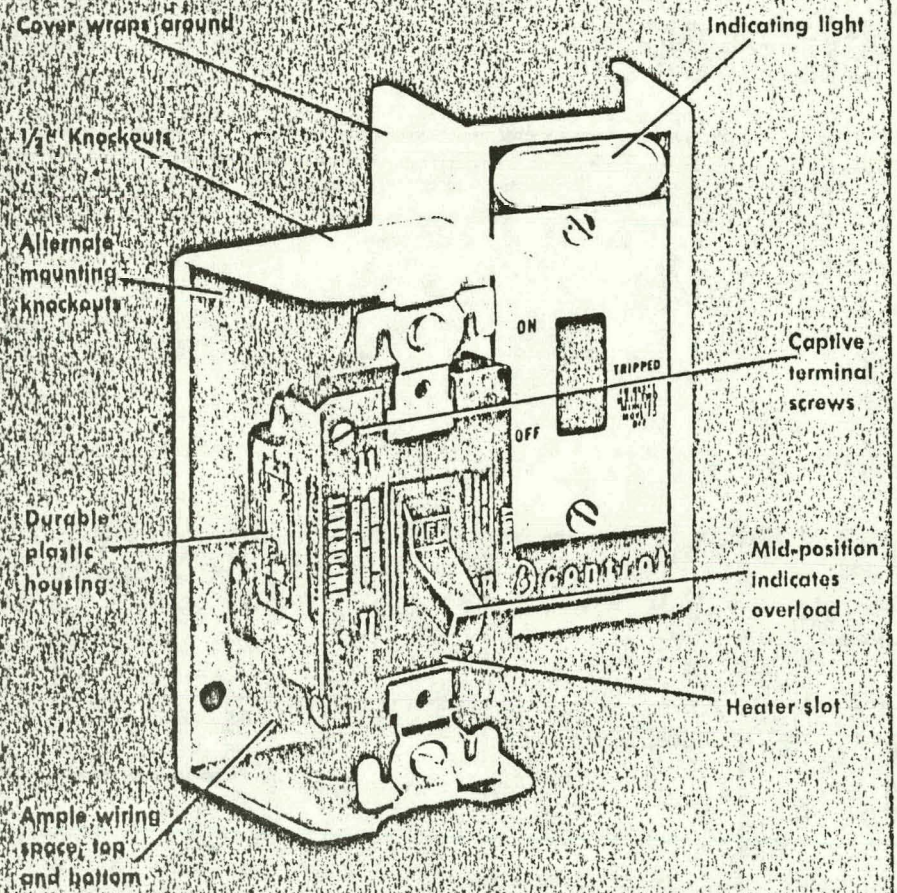
manual motor starters



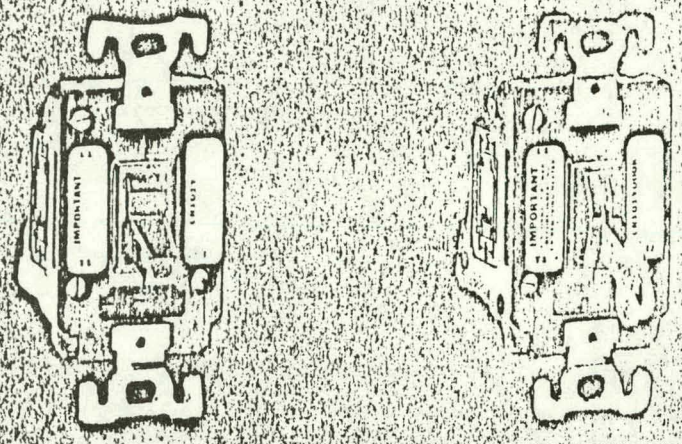
GENERAL ELECTRIC

CR101 manual starters FOR FRACTIONAL HORSEPOWER MOTORS

115 to 230 volts, single-or double-pole, 60 to 25 hertz, 1 horsepower maximum



AVAILABLE IN TWO BASIC FORMS



General Electric's CR101 manual starter is designed for use on single-phase fractional-horsepower motors. It provides dependable overload protection for general purpose motors and it is the most economical starter choice for applications requiring no undervoltage protection. Typical applications include grinders, conveyors, hydraulic presses, blowers and mixers.

The CR101 manual starter offers many measurable advantages — distinct and valuable advantages over other makes of starters — which can save time and money in your operation. The chief measurable advantages are illustrated at the right.

DEPENDABLE OVERLOAD PROTECTION

Positive bimetallic overload protection is provided by the thermal protective device which automatically opens the contacts when an overload occurs, and removes the motor from the line. The thermal overload device includes a heater (a coil of resistance wire) which simulates the motor temperature.

The heater is designed to follow the heating curve of the motor. If the motor is overloaded, the excess current passing through the heater radiates additional heat, which causes a bimetallic strip to bend. Bending the strip causes the starter contacts to open. This bimetallic strip will not trip on momentary overloads such as starting currents, but will guard the motor against even small persistent overloads.

Under overload conditions, the switch handle moves to the mid-position, giving a positive indication that an overload has occurred. The bimetallic mechanism is completely trip-free, so that contacts cannot be reclosed until the bimetallic strip cools. To restart after overload, turn starter to OFF and then to ON.

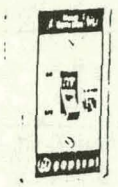
A COMPLETE LINE

General Electric's CR101 manual starter is available in two basic forms; toggle or key-operated. Each form is offered as either single- or double-pole. In addition, this starter may be ordered in open or general-purpose, dust- and watertight and hazardous-location enclosures. Two-speed and combination forms are also available.

General Electric offers the widest variety of cover plates, flush plates, and accessory kits in the industry. As a result, you can select or assemble the exact starter you need to meet any fhp motor application.

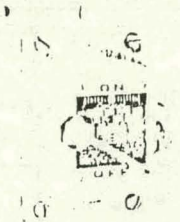
enclosures and components

Open starter (toggle operated)

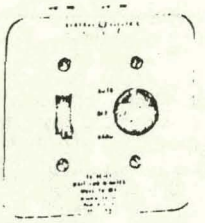


General-purpose starter

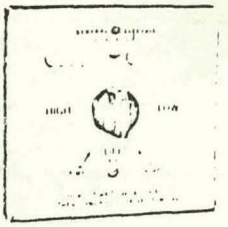
Water- and dust-tight starter



Hazardous location starter



Combination starter



Two-speed starter with indicating lights

Single-phase Fractional Horsepower — 1 HP Maximum on 115 or 230 Volts, 60 to 25 Hertz

STANDARD FORMS

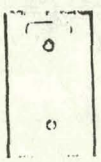
No. of Poles	Open	General-purpose, NEMA Type 1		Water- and Dust-tight, NEMA Type 4	Hazardous-location-NEMA Types 7 and 9, (Class I, groups C and D, Class II, groups E, F and G)
	For Flush or Outlet Box Mtg.	Surface-mtg.	Surface-mtg. W/Ind. Light		
TOGGLE-OPERATED				LEVER-OPERATED—¾" hub on one end	
1	CR101 Y	CR101 Y1	CR101 Y11	CR101 Y400H	CR101 Y700H
2	CR101 H	CR101 H1	CR101 H11	CR101 H400H	CR101 H700H
KEY-OPERATED				LEVER-OPERATED—¾" hub on both ends	
1	CR101 Y000K	CR101 Y100K	CR101 Y110K	CR101 Y400J	CR101 Y700J
2	CR101 H000K	CR101 H100K	CR101 H110K	CR101 H400J	CR101 H700J

TWO-SPEED FORMS

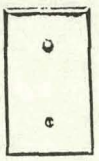
No. of Poles	Indicating Lights	General Purpose, NEMA Type 1	General-purpose, Flush-mounting	
		Surface-mounting	Gray Flush-plate	Stainless-steel Flush-plate
1	None	CR101 Y600B	CR101 Y600A	CR101 Y606A
1	Two	CR101 Y610B	CR101 Y610A	CR101 Y616A
2	None	CR101 H600B	CR101 H600A	CR101 H606A
2	Two	CR101 H610B	CR101 H610A	CR101 H616A

COMBINATION FORMS

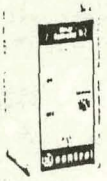
No. of Poles	Catalog Number
	Note: Do not use Selector Switch to interrupt motor power.
2	CR101 H12 (CR101 H+HOA Sel. Sw.)
2	CR101 H13 (Two CR101 H)



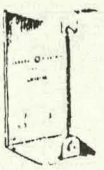
Standard flush plate with indicating light, machine gray finish (CR101 X1)



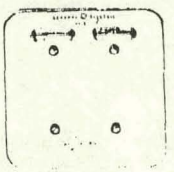
Stainless steel flush plate (CR101 X8)



Standard front cover for surface mounting (CR101 X5)



Back box for surface mounting (CR101 X6)



Combination flush plate with indicating lights for flush or surface mounting (CR101 X13)

Back box for combination forms (CR101 X14)

Locking attachment for standard starters (CR101 X3)

ORDERING INFORMATION

Catalog Number Component Only	STARTER COMPONENTS	Toggle Operated		Key Operated	
		1 Pole Switch	2 Pole Switch	1 Pole Switch	2 Pole Switch
	Description	Catalog Number—includes complete switch plus component			
CR101 X1	Flush plate with 115/230 volt indicating light and screws	CR101 Y31	CR101 H31	CR101 Y310K	CR101 H310K
CR101 X2	Standard flush plate with screws	CR101 Y3	CR101 H3	CR101 Y300K	CR101 H300K
CR101 X3	Locking attachment (lock not included)	.....	.....	.....	.....
CR101 X4	Cover (front) with 115/230 volt neon indicating light and screws	.....	.....	.....	.....
CR101 X5	Standard cover (front) with screws	.....	.....	.....	.....
CR101 X6	Enclosure (back) with screws (surface mounting)	.....	.....	.....	.....
CR101 X7	Stainless-steel flush plate with 115/230 volt indicating light and screws	CR101 Y51	CR101 H51	CR101 Y510K	CR101 H510K
CR101 X8	Stainless-steel flush plate with screws	CR101 Y5	CR101 H5	CR101 Y500K	CR101 H500K
CR101 X10	Combination flush plate with HOA selector switch	CR101 Y32	CR101 H32	CR101 Y320K	CR101 H320K
CR101 X11	Combination flush plate with HOA selector switch and 115/230 volt neon indicating light	CR101 Y35	CH101 H35	CR101 Y350K	CR101 H350K
CR101 X12	Combination flush plate for 2—CR101 open starters	CR101 Y33	CR101 H33	CR101 Y330K	CR101 H330K
CR101 X13	Combination flush plate for 2—CR101 open starters with 2—115/230 volt neon indicating lights	CR101 Y36	CR101 H36	CR101 Y360K	CR101 H360K
CR101 X14	Box (back) for combination forms	.....	.....	.....	.....
CR101 X1&X3	Flush plate with 115/230 volt indicating light, screws and locking attachment (lock not included)	CR101 Y38	CR101 H38	.....	.....
CR101 X2&X3	Standard flush plate with screws and locking attachment (lock not included)	CR101 Y37	CR101 H37	.....	.....

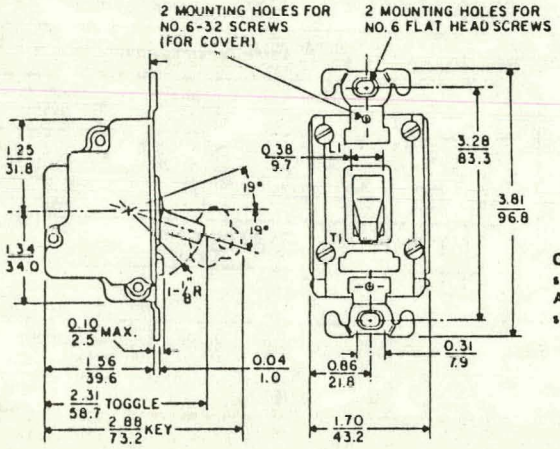
ORDERING INFORMATION — Components (Cont'd)

FIELD ASSEMBLY

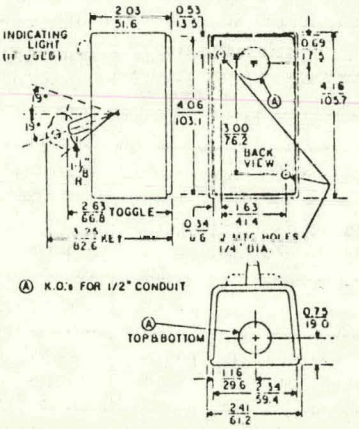
Customer assembly of components/open starters can be accomplished by using the table at right as a guide. The assembled units are Type 1 enclosed forms and listed by Underwriters' Laboratories.

COMPONENTS		ADD	ASSEMBLED UNIT
Component Kit			
Encl. Cover Catalog No.	Encl. Back Box Catalog No.	Open Starter Catalog No.	NEMA 1 Enclosed Starter Catalog No.
CR101 X5	CR101 X6	CR101 Y	CR101 Y1
CR101 X4	CR101 X6	CR101 Y	CR101 Y11
CR101 X5	CR101 X6	CR101 H	CR101 H1
CR101 X4	CR101 X6	CR101 H	CR101 H11

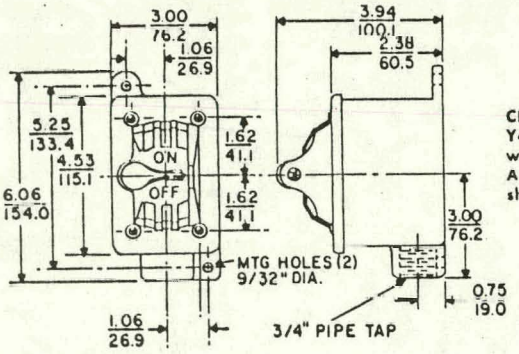
DUAL DIMENSIONS—INCHES / MILLIMETERS—AND WEIGHTS (For Estimating Only)



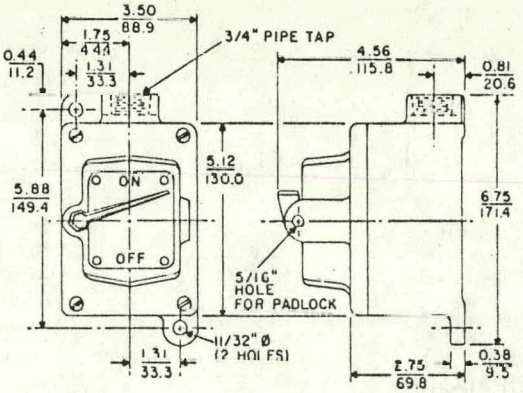
CR101H or Y open starter
Approx. shipping wt, 1 lb



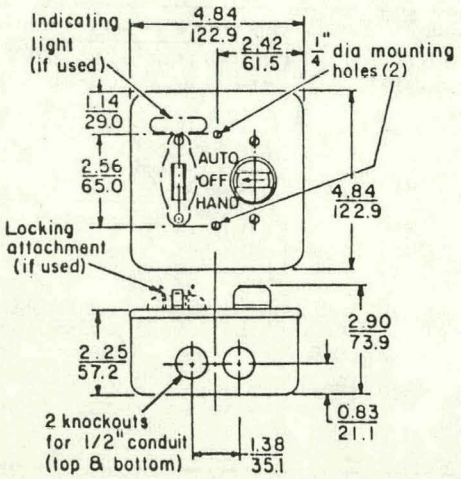
CR101H1, H11 or Y1
general purpose enclosed starter
Approx. shipping wt, 2 lb



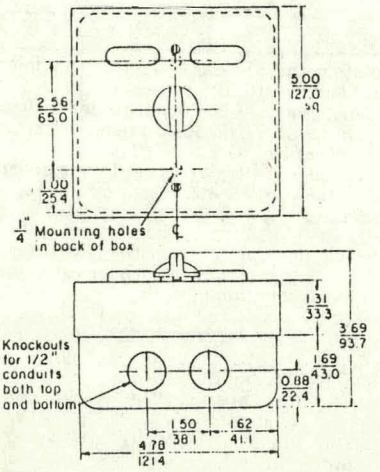
CR101H400H or Y400H dust-tight and watertight starter
Approx. shipping wt, 4 lb



CR101H700H or Y700H hazardous location starter
Approx. shipping wt, 3½ lb



CR101H12 or H13 combination device
Approx. shipping wt, 4 lb



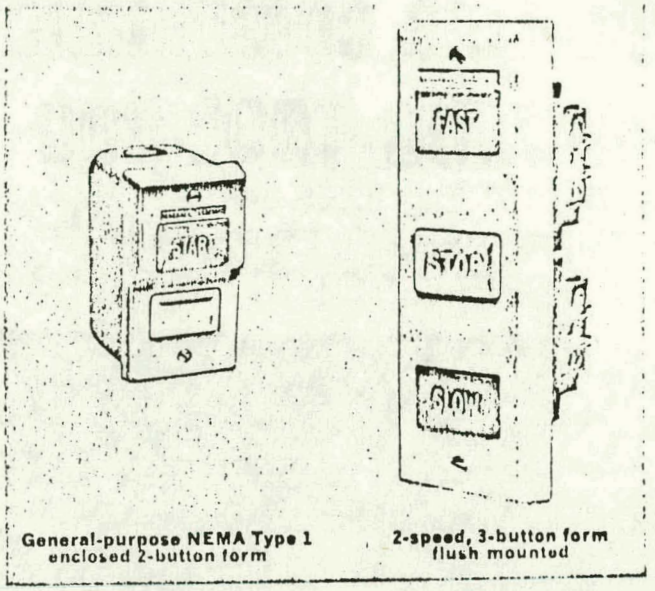
CR101H or CR101Y two-speed, NEMA Type 1 enclosed starter
Approx. shipping wt, 3 lb

CR101 manual motor starting switch

The CR101 Types B and J manual motor-starting switches are designed for use with self-protected single and polyphase motors, dc motors, and on-off applications where overload protection is not required.

Typical applications include light machine tools, home workshop equipment, fan motors, pumps or light commercial use.

- **Durable Construction** — heavy phenolic housing protects switch mechanism
- **Long life** — contacts of low-resistance silver
- **Convenient Mounting** — mounting screws have same spacing as wall boxes
- **Mechanical Interlock**—on three-button reversing and 2-speed forms, prevents two buttons from operating simultaneously
- **Flush START and extended STOP button** helps prevent accidental start and permits quick stop in an emergency



General-purpose NEMA Type 1 enclosed 2-button form

2-speed, 3-button form flush mounted

SINGLE-SPEED FORMS

ORDERING INFORMATION: (Device Catalog Number)			
Two-Pole	**Three-Pole**	**Enclosure**	**Push Button Markings**
CR101 JA0A	CR101 BA0A	Open with flush plate	START-STOP
CR101 JA1A	CR101 BA1A	NEMA Type 1	START-STOP
CR101 JA0B	CR101 BA0B	Open with flush plate	ON-OFF
CR101 JA1B	CR101 BA1B	NEMA Type 1	ON-OFF

RATINGS

Ac Max.

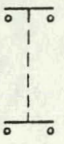
Continuous Carry — 16 Amps

Single phase
115 volts 1 hp
230 volts 1½ hp

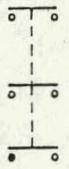
Three phase
115 volts 1½ hp
200 volts 2 hp
230 volts 2 hp

Dc Max.
125-250 volts ¼ hp

CONNECTION DIAGRAMS



CR101J Single phase



CR101B Three phase

2-SPEED AND REVERSING FORMS

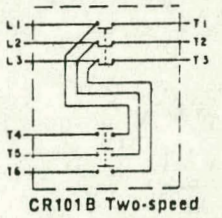
ORDERING INFORMATION: (Device Catalog Number)		
Three-Pole	**Enclosure**	**Push Button Markings**
CR101 BB0B	Open with flush plate	FAST-STOP-SLOW
CR101 BB1B	NEMA Type 1	FAST-STOP-SLOW
CR101 BE0A	Open with flush plate	FORWARD-OFF-REVERSE
CR101 BE1A	NEMA Type 1	FORWARD-OFF-REVERSE
CR101 BE0B	Open with flush plate	FORWARD-STOP-REVERSE
CR101 BE1B	NEMA Type 1	FORWARD-STOP-REVERSE
CR101 BE0C	Open with flush plate	UP-STOP-DOWN
CR101 BE1C	NEMA Type 1	UP-STOP-DOWN

RATINGS

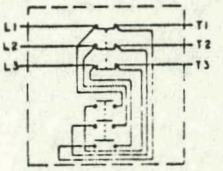
Ac Max.

Three phase
115 volts 1½ hp
200 volts 2 hp
230 volts 2 hp

WIRING DIAGRAMS



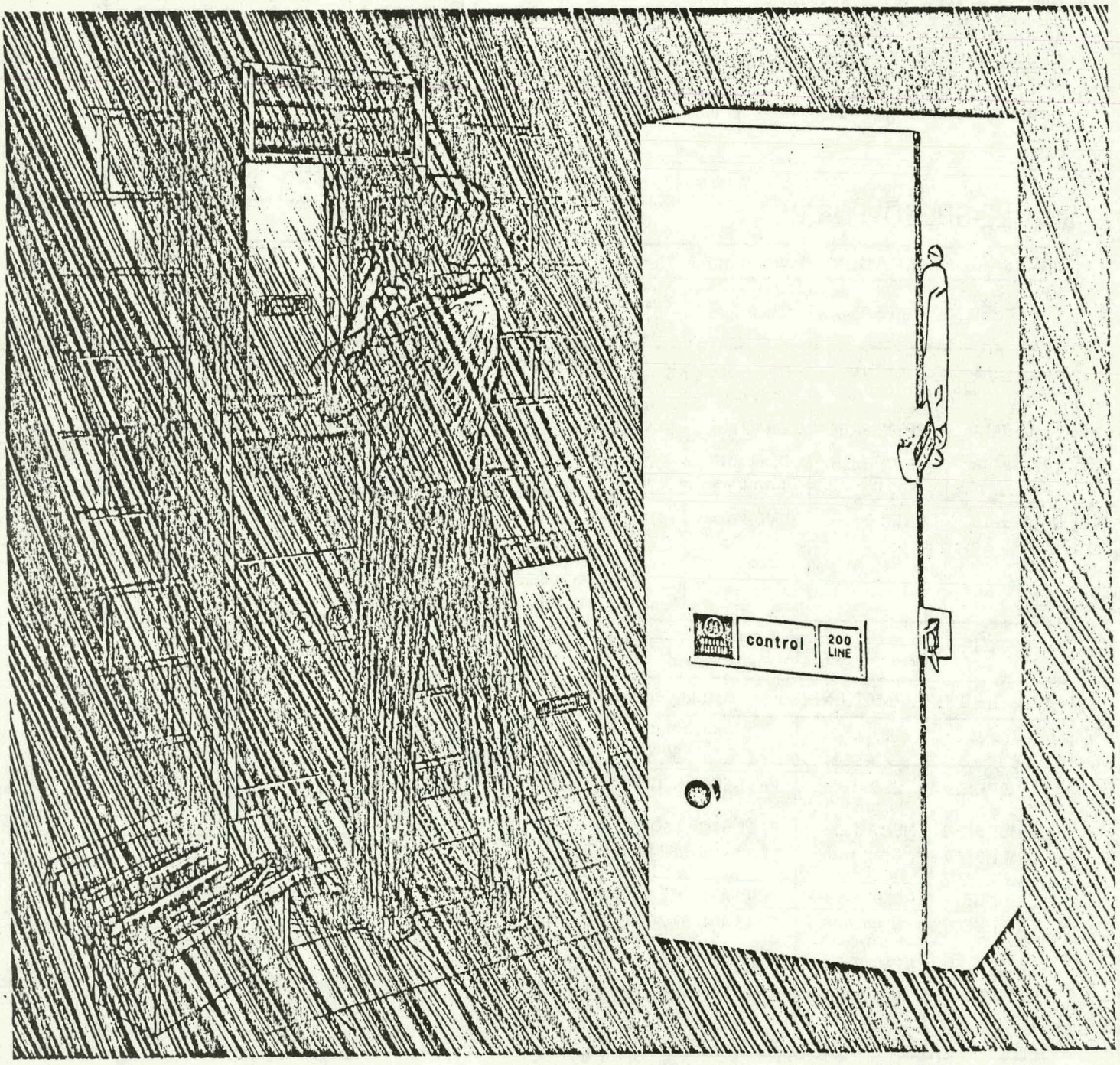
CR101B Two-speed



CR101B Reverser

200-Line combination magnetic starters and MOD-TROL 200

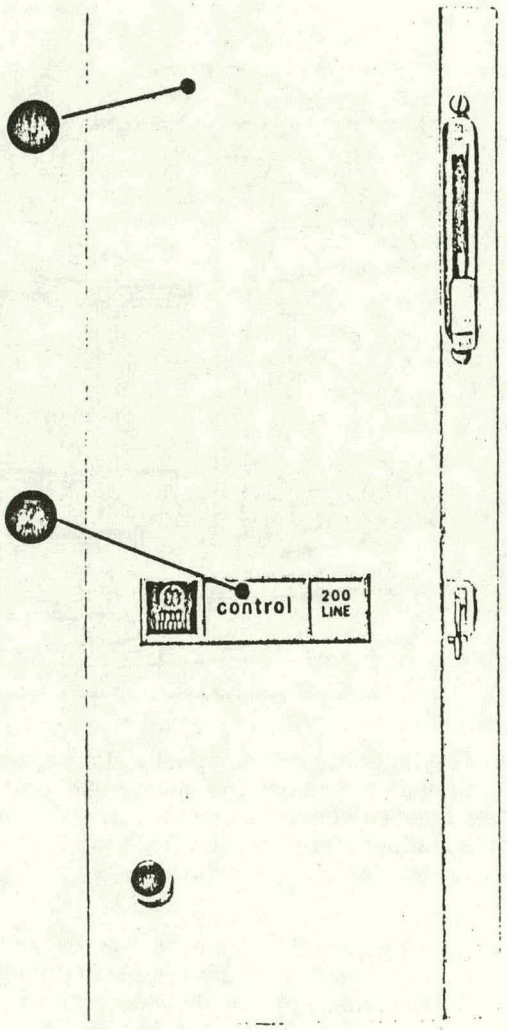
- NEMA TYPE 1 SIZES 0-5
- NEMA TYPE 12 SIZES 0-5
- MAG BREAK MOTOR STARTERS



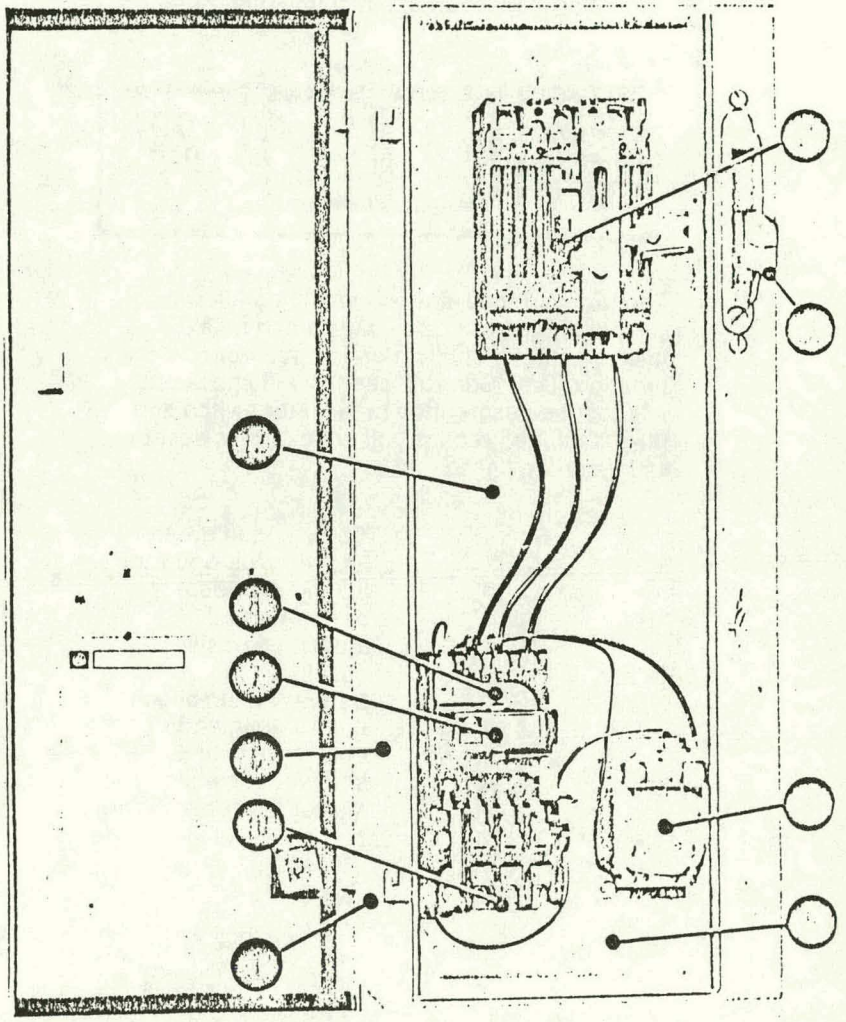
GENERAL ELECTRIC

200-Line combination magnetic starters ... SECOND GE

CR207—DOOR CLOSED



CR207—INSIDE OF DOOR



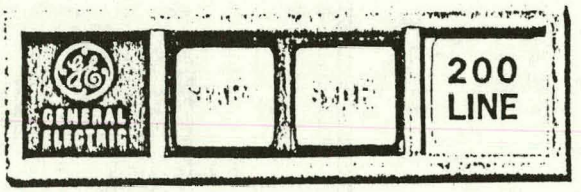
CR207—COMPONENT PARTS

The 200-Line combination magnetic starter, like each of the members of General Electric's smart looking 200-Line family, was designed with features that make it the industry's most contemporary starter package. The 200-Line—GE's "second generation" of magnetic motor starters—consolidates the time proved dependability of the 100-Line with the most recent developments in control technology. Yet, basic renewal parts and overload relay heaters are completely interchangeable from line to line.

Both inside and out the combination magnetic starter is every inch a member of the 200-Line family. Its **modern design** makes it easy to install and wire. The starter's vertical contact design makes possible **convenient inspection and maintenance.** All mechanical parts are built to perform with greater motor protection and **assured safety.** And this quality apparatus provides the utmost in **combination starter flexibility.**

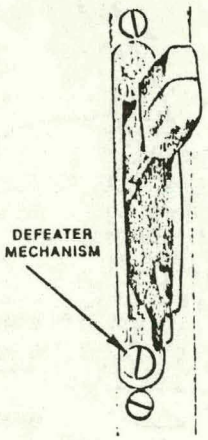
1. Removable hinged enclosure cover allows for optional side-by-side butt mounting and simplifies inspection and maintenance.

2.



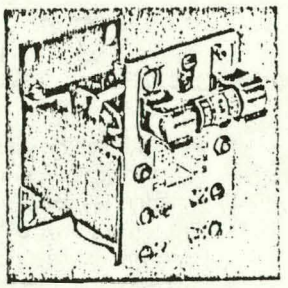
The dual purpose slotted nameplate allows for installation of custom labels in the field, giving instant identification to circuit or control function. The "Control" section will knock out to accept a push button or selector switch and the "200-Line" section will knock out to accept an indicating light.

3.



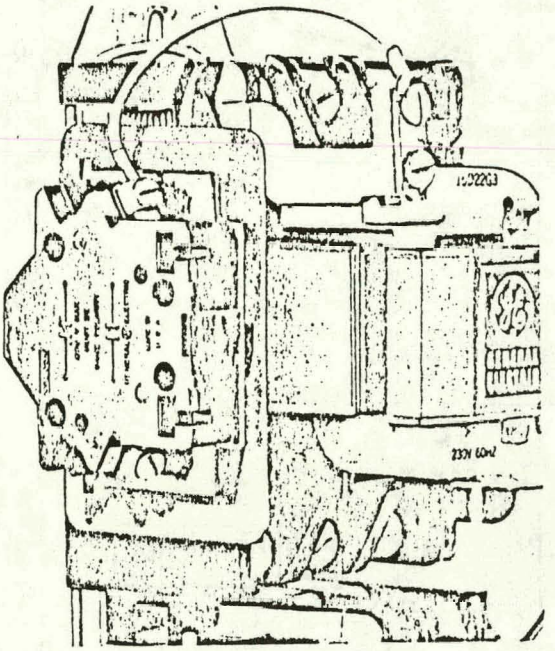
Color-coded green and red side-operator handle provides positive visual indication of switch position.
Defeater mechanism allows opening the enclosure with a screwdriver while starter is in operation.

4. Control power transformer is available either factory installed or as a kit for field installation. Short-circuit protection in low-voltage side is standard. Transformer is also available with both primary and secondary fused.



5. Up to 14 knockouts for ample conduit access.

6.

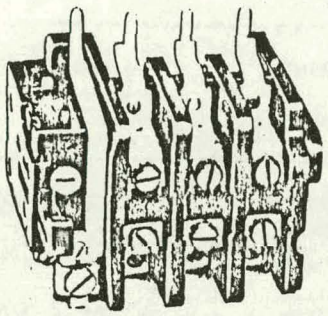


Auxiliary interlocks fit compactly along side the contactor. Straight line plunger motion gives positive contact action. NO or NC contact adder blocks are available for greater application versatility.

7. Specially treated "E" magnet resists rust and corrosion. Magnet faces are protected during idle periods, ready to operate when needed.

8. Encapsulated coil is impervious to molsture . . . resists high humidity failure and mechanical damage.

9. Enclosure dimensions are identical for Sizes 0, 1, and 2.

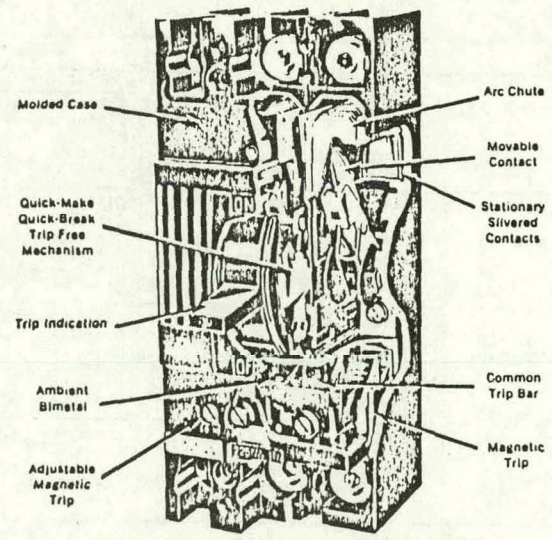
10. 

The three-leg block overload relay offers dual bimetal current monitoring . . . an additional bimetal strip anticipates the rate of temperature rise in the heater, effectively reducing trip time in locked rotor conditions. The manual weld check operator permits you to check for welded contacts—in the field, and the overload relay is convertible from manual to automatic reset. Relay trip is adjustable ± 10% of rated value, and a single reset arm resets all three legs at once.

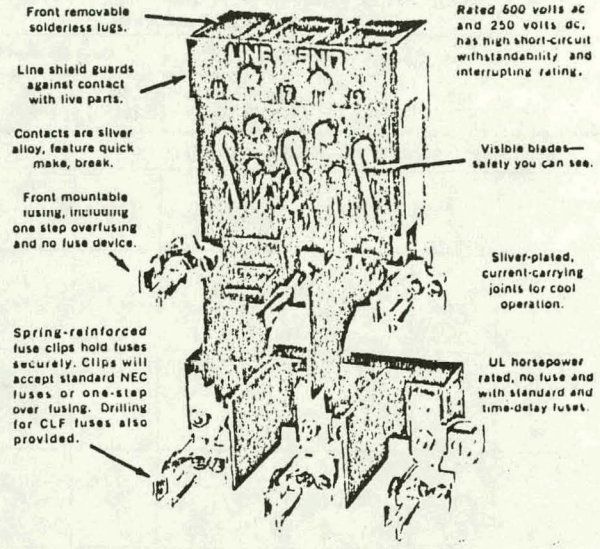
11. Choose from either molded case circuit breaker or fusible QMR disconnect switch.

12. Pre-drilled and tapped holes for field conversion of non-fused and fused forms.

13. Combination starters are designed to mount on General Electric's MOD-TROL 200 framework.



MOLDED CASE CIRCUIT BREAKER



QMR DISCONNECT SWITCH

SHORT-CIRCUIT PROTECTION

Fusible-type combination magnetic starters, sizes 0 through 5, when equipped with UL labeled, nonrenewable NEC-type fuses having an interrupting rating not less than the available short-circuit current, are adequate for installation on motor branch circuits where the available short-circuit current at the incoming line terminals of the starter does not exceed 22,000 rms symmetrical amperes. These combination starters can be furnished with noninterchangeable fuse clips for current-limiting fuses and when so equipped may be specified for up to 100,000 rms symmetrical amperes available short circuit current.

Circuit breaker-type combination magnetic starters equipped with the circuit breakers listed in the table below are adequate for installation on motor branch circuits where the available short-circuit current at the incoming line terminals of the starter does not exceed the value shown.

For either type, it is recognized that maintenance of some components may be required after a branch-circuit fault and in some cases a device may require replacement.

NEMA Size Starter	Circuit Breaker Type	Circuit Breaker Max Amp.	Max System Voltage	Available Short-Circuit Current AC RMS Amperes—Symmetrical 115, 200, & 230 Volts	Available Short-Circuit Current AC RMS Amperes—Symmetrical 460 to 600 Volts
0,1,2,3	TEB	100	240	10,000	.....
	TED		(240 or) 600	14,000	14,000
3	TED	125	600	.....	14,000
4	TFJ	225	600	14,000	14,000
5	TJJ	400	600	22,000	22,000
	TJK4	400	600	22,000	22,000
5	TJK6	600	600	22,000	22,000

ordering information

GENERAL PURPOSE & INDUSTRIAL USE—REVERSING & NON-REVERSING STARTERS

NEMA Size	Maximum Horsepowers — Single Element Fuses: 200/208V	220–240V	440–480V	550–600V	Dual Element Fuses: 200/208V	220–240V	440–600V	Fuse Clip Size Amps	NON-REVERSING FORMS: NEMA Type 1	NEMA Type 12	S.U.†	REVERSING FORMS: NEMA Type 1	NEMA Type 12
WITH DISCONNECT SWITCH (Power fuses not included)									CR208 FORMS			CR211 FORMS	
0	3	3	5	5	....	....	....	NON-F	B1**AAA	B2**AAA	1	B1**AAA	B2**AAA
	3	3	....	....	3	3	....	30	B1**BAA	B2**BAA	1	B1**BAA	B2**BAA
	....	....	5	5	....	....	5	30	B1**DAA	B2**DAA	1	B1**DAA	B2**DAA
1	7½	7½	10	10	....	....	....	NON-F	C1**AAA	C2**AAA	1	C1**AAA	C2**AAA
	....	....	....	....	7½	7½	....	30	C1**BAA	C2**BAA	1	C1**BAA	C2**BAA
	7½	7½	....	....	....	....	....	60	C1**CAA	C2**CAA	1	C1**CAA	C2**CAA
	....	....	7½	7½	....	....	10	30	C1**DAA	C2**DAA	1	C1**DAA	C2**DAA
	....	....	10	10	....	....	....	60	C1**EAA	C2**EAA	1	C1**EAA	C2**EAA
2	10	15	25	25	....	....	....	NON-F	D1**AAA	D2**AAA	1	D1**AAA	D2**AAA
	....	....	....	....	10	15	....	60	D1**BAA	D2**BAA	1	D1**BAA	D2**BAA
	10	15△	....	....	....	15	....	100	D1**CAA	D2**CAA	1	D1**CAA	D2**CAA
	.....	....	15	20	....	....	25	60	D1**EAA	D2**EAA	1	D1**EAA	D2**EAA
	....	....	25‡	25‡	....	....	....	100	D1**FAA	D2**FAA	2	D1**FAA	D2**FAA
3	25	30	50	50	....	....	....	NON-F	E1**AAA	E2**AAA	2	E1**AAA	E2**AAA
	....	....	....	....	25△	30△	....	100	E1**BAA	E2**BAA	2	E1**BAA	E2**BAA
	25△	30△	....	....	25	30	....	200	E1**CAA	E2**CAA	2	E1**CAA	E2**CAA
	....	....	30△	30	....	....	50	100	E1**EAA	E2**EAA	2	E1**EAA	E2**EAA
	....	....	50	50	....	....	....	200	E1**FAA	E2**FAA	2	E1**FAA	E2**FAA
4	40	50	100	100	....	....	....	NON-F	F1**AAA	F2**AAA	4	F1**AAA	F2**AAA
	....	....	....	....	40	50	....	200	F1**BAA	F2**BAA	4	F1**BAA	F2**BAA
	40	50	....	....	....	....	....	400	F1**CAA	F2**CAA	4	F1**CAA	F2**CAA
	....	....	60△	60	....	....	100	200	F1**DAA	F2**DAA	4	F1**DAA	F2**DAA
	....	....	100	100	....	....	....	400	F1**EAA	F2**EAA	4	F1**EAA	F2**EAA
5§	75	100	200	200	....	....	....	NON-F	G1**AAA	G2**AAA	4	.....	.....
	....	....	....	....	75	....	....	400	G1**BAA	G2**BAA	4	.....	.....
	75	100	....	....	....	....	....	600	G1**CAA	G2**CAA	4	.....	.....
	....	....	125△	125	....	100	200	400	G1**FAA	G2**FAA	4	.....	.....
	....	....	200	200	....	....	....	600	G1**GAA	G2**GAA	4	.....	.....

**Coil Suffix Table

(use where ** appears in nomenclature).

Frequency (Hertz)	115V	200/208V	230V
60	02	23	03
	460V	575V	600V
	04	05	06
Frequency (Hertz)	110V	220V	380V
50	07	08	04
	440V	550V	600V
	09	10	11

Use 22 for dual rated 120V, 60 Hz/110V, 50 Hz coil.

† Space units for CR207 & CR208 when installed on MOD-TROL frame.

‡ Requires oversize enclosure. See Fig. 2 on Page 10.

△ For ordinary starting duty only. Dual element, next larger size fuses or breaker with higher trip rating is recommended for frequent starts or long accelerating time.

§ Size 5 nomenclature listing applies to 60 or 50 hertz forms only.

NOTE: Packages of 100 plastic insert cards are available for use in the enclosure cover identification panel. Order CR205X147A.

NEMA Size	Maximum Horsepowers: 200/208V	220–240V	440–480V	550–600V	Circuit Breaker Rating Amps	NON-REVERSING FORMS: NEMA Type 1	NEMA Type 12	S.U.†	REVERSING FORMS: NEMA Type 1	NEMA Type 12
WITH THERMAL MAGNETIC TRIP BREAKERS						CR207 FORMS			CR210 FORMS	
0	2	2	...	...	15	B1**AAA	B2**AAA	1	B1**AAA	B2**AAA
	3	3	...	...	20	B1**BAA	B2**BAA	1	B1**BAA	B2**BAA
	....	.....	3	...	15	B1**FAA	B2**FAA	1	B1**FAA	B2**FAA
	....	.....	5	...	20	B1**GAA	B2**GAA	1	B1**GAA	B2**GAA
	....	.....	...	5	15	B1**WAA	B2**WAA	1	B1**WAA	B2**WAA
1	5	5	...	...	40	C1**DAA	C2**DAA	1	C1**DAA	C2**DAA
	7½	7½	...	...	50	C1**EAA	C2**EAA	1	C1**EAA	C2**EAA
	....	.....	...	7½	20	C1**XAA	C2**XAA	1	C1**XAA	C2**XAA
	....	.....	7½	...	30	C1**HAA	C2**HAA	1	C1**HAA	C2**HAA
	....	.....	10	...	35	C1**JAA	C2**JAA	1	C1**JAA	C2**JAA
	....	.....	.....	10	30	C1**YAA	C2**YAA	1	C1**YAA	C2**YAA
2	10	15△	...	...	50	D1**EAA	D2**EAA	1	D1**EAA	D2**EAA
	....	15	...	...	100	D1**GAA	D2**GAA	1	D1**GAA	D2**GAA
	....	.....	...	15	40	D1**YAA	D2**YAA	1	D1**YAA	D2**YAA
	....	.....	25△	...	50	D1**MAA	D2**MAA	1	D1**MAA	D2**MAA
	....	.....	25	...	70	D1**NAA	D2**NAA	1	D1**NAA	D2**NAA
	....	.....	...	25	50	D1**ZAA	D2**ZAA	1	D1**ZAA	D2**ZAA
3	....	30△	...	...	100	E1**CAA	E2**CAA	2	E1**CAA	E2**CAA
	25	30	...	...	125	E1**TAA	E2**TAA	2	F1**BBA	E2**BBA
	....	...	...	30	70	E1**RAA	E2**RAA	2	E1**RAA	E2**RAA
	....	...	50	...	100	E1**FAA	E2**FAA	2	E1**FAA	E2**FAA
	....	...	...	50	100	E1**SAA	E2**SAA	2	E1**SAA	E2**SAA
4	....	...	60	75	125	F1**BAA	F2**BAA	2	F1**BAA	F2**BAA
	....	40△	75	100	150	F1**CAA	F2**CAA	2	F1**CAA	F2**CAA
	40	50	100	...	200	F1**EAA	F2**EAA	2	F1**EAA	F2**EAA
5‡	....	60	125△	150	250	G1**AAA	G2**AAA	4	.....	.....
	....	75	150	200	300	G1**BAA	G2**BAA	4	.....	.....
	75	100	200	...	400	G1**CAA	G2**CAA	4	.....	.....

Data subject to change without notice

INDUSTRIAL JIC SAFETY STARTERS—REVERSING & NON-REVERSING FORMS

Complies with most automotive industry standards and electrical standards for Mass Production Equipment EMP-1-1967

SAFETY STARTER WITH FUSIBLE DISCONNECT SWITCH

NEMA Size	Maximum Horsepower							Fuse Clip Size Amps	Nomenclature (Includes Standard Rated Control Circuit Transformer)	
	Single Element Fuses				Dual Element Fuses					
	200/208V	220-240V	440-480V	550-600V	200/208V	220-240V	440-600V		Non-Reversing Form CR208	Reversing Forms CR211
1	7½	7½	10	10	...	...	...	NON-F	C2**AYA253	C2**AYA56
	...	...	...	...	7½	7½	...	30	C2**BYA253	C2**BYA56
	7½	7½	...	...			...	60	C2**CYA253	C2**CYA56
	...	...	7½	7½	...	...	10	30	C2**DYA253	C2**DYA56
	...	...	10	10	...	...	...	60	C2**EYA253	C2**EYA56
2	10	15	25	25	...	...	...	NON-F	D2**AYA105	D2**AYA7
	...	...	...	...	10	15△	...	60	D2**BYA105	D2**BYA7
	10	15△	...	...	...	15	...	100	D2**CYA105	D2**CYA7
	...	...	15	20	...	...	25	60	D2**EYA105	D2**EYA7
	...	...	25‡	25‡	...	...	...	100	D2**FYA105	D2**FYA7
3	25	30	50	50	...	...	...	NON-F	E2**AYA56	E2**AYA2
	25△	30△	...	...	25	30	...	200	E2**CYA56	E2**CYA2
	...	...	...	30	...	...	50	100	E2**EYA56	E2**EYA2
	...	...	50	50	...	...	...	200	E2**FYA56	E2**FYA2
4	40	50	100	100	...	...	...	NON-F	F2**AYA35	F2**AYA2
	...	...	...	...	40	50	...	200	F2**BYA56	F2**BYA2
	40	50	...	...	...	...	...	400	F2**CYA35	F2**CYA3
	...	...	60△	60	...	...	100	200	F2**DYA35	F2**DYA2
	...	...	100	100	...	...	...	400	F2**FYA35	F2**EYA2

REVERSING & NON-REVERSING TYPE 12 STARTERS—JIC

Complies with electrical standards for General Purpose Machine Tools, EGP-1-1967

TYPE 12 STARTER—JIC WITH DISCONNECT SWITCH

NEMA Size	Max. Horsepower							Fuse Clip Size Amps	With control transformer 230/460-volt supply, 115-volt control, 60 Hz	
	Single Element Fuses				Dual Element Fuses					
	200/208V	220-240V	440-480V	550-600V	200/208V	220-240V	440-600V		Non-Reversing CR208 Forms	Reversing CR211 Forms
0	3	3	5	5	...	...	...	NON-F	Use NEMA Size 1	
	3	3	...	...	3	3	...	30		
	...	...	5	5	...	...	5	30		
1	7½	7½	10	10	...	...	...	NON-F	C204AGA	C204AGA
	...	...	...	...	7½	7½	...	30	C203BGA	C203BGA
	7½	7½	...	...	...	...	...	60	C203CGA	C203CGA
	...	...	7½	7½	...	...	10	30	C204DGA	C204DGA
	...	...	10	10	...	...	...	60	C204EGA	C204EGA
2	10	15	25	25	...	...	...	NON-F	D204AGA	D204AGA
	...	...	...	...	10	15△	...	60	D203BGA	D203BGA
	10	15△	...	...	...	15	...	100	D203CGA	D203CGA
	...	...	15	20	...	...	25	60	D204EGA	D204EGA
	...	...	25‡	25‡	...	...	...	100	D204FGA	D204FGA
3	25	30	50	50	...	...	...	NON-F	E204AGA	E204AGA
	25△	30△	...	...	25	30	50	200	E203CGA	E203CGA
	...	...	30△	30	...	...	...	100	E204EGA	E204EGA
	...	...	50	50	...	...	...	200	E204FGA	E204FGA
4	40	50	00	100	...	...	...	NON-F	F204AGA	F204AGA
	40	50	...	...	...	50	...	400	F203CGA	F203CGA
	...	...	60△	60	...	...	100	200	F204DGA	F204DGA
	...	...	100	100	...	...	...	400	F204EGA	F204EGA
5§	75	100	200	200	...	...	...	NON-F	G204AGA	...
	75	100	...	...	...	...	...	600	G203CGA	...
	...	...	125△	125	...	...	200	400	G204FGA	...
	...	...	200	200	...	...	...	600	G204GGA	...

△ For ordinary starting duty only. Dual element, next larger size fuse or breaker with higher trip rating is recommended for frequent starts or long accelerating time.
§ Size 5 nomenclature shown applies to 60- and 50-Hertz forms only. The transformer is supplied as a control relay and transformer for the relay.
‡ Requires oversize enclosure. See Fig. 8, page 11.

SAFETY STARTER WITH CIRCUIT BREAKER

NEMA Size	Max. Horsepower				Circ. Brkr. Rating Amps	Non-Reversing Forms CR207	Reversing Forms CR210
	200/208V	220-240V	440-480V	550-600V			
1	5	5	...	...	40	C2**DYA185	C2**DYA54
	7½	7½	...	...	50	C2**EYA185	C2**EYA54
	...	...	...	7½	20	C2**XYA185	C2**XYA54
	...	...	7½	...	30	C2**HYA185	C2**HYA54
	...	...	...	10	30	C2**YYA185	C2**YYA54
	...	...	10	...	35	C2**JYA185	C2**JYA54
2	10	15△	...	...	50	D2**EYA89	D2**EYA3
	...	15	...	...	100	D2**GYA89	D2**GYA3
	...	...	...	15	40	D2**YYA89	D2**YYA3
	...	...	25△	...	50	D2**MYA89	D2**MYA3
	...	...	...	25	50	D2**ZYA89	D2**ZYA3
	...	...	25	...	70	D2**NYA89	D2**NYA3
3	25△	30△	...	...	100	E2**CYA71	E2**CYA6
	...	...	...	30	70	E2**RYA71	E2**RYA6
	...	...	...	50	100	E2**PYA71	E2**PYA6
	...	...	50	...	100	E2**FYA71	E2**FYA6
4	...	...	60	75	125	F2**BYA43	F2**BYA2
	...	40△	75	100	150	F2**CYA43	F2**CYA2
	40	50	100	...	200	F2**EYA43	F2**EYA2
5	...	60	125△	150	250	G2**AYA53	...
	...	75	150	200	300	G2**BYA53	...
	75	100	200	...	400	G2**CYA53	...

TRANSFORMER/COIL-SUFFIX TABLES

**(Use where double asterisk appears in nomenclature)

Voltages, Supply-control	NEMA SIZE				
	1*	2*	3*	4*	5*
230-115	03	03	03	03	03
240-120	58	44	31	37	29
460-115	04	04	04	04	04
480-120	57	45	32	36	12
575-115	05	05	05	05	05
600-120	13	13	13	13	38

*For extra capacity transformer, refer to nearest GE Sales Office.

TYPE 12 STARTER—JIC WITH THERMAL MAGNETIC TRIP BREAKER & CONTROL TRANSFORMER

NEMA Size	Max. Horsepower				Circ. Brkr. Rating Amps	With control transformer, 230/460 volt supply, 115 volt control, 60 Hz	
	200/208	220-240	440-480	550-600		Non-Reversing Forms CR207	Reversing Forms CR210
0	2	2	...	...	15	Use NEMA Size 1	
	3	3	...	...	20		
	...	...	3	...	15		
	...	...	5	...	20		
1	5	5	...	...	40	C2**DGA	C2**DGA
	7½	7½	...	...	50	C2**EGA	C2**EGA
	...	...	...	7½	20	C2**XGA	C2**XGA
	...	...	7½	...	30	C2**HGA	C2**HGA
	...	...	10	...	35	C2**JGA	C2**JGA
	...	...	...	10	30	C2**YGA	C2**YGA
2	10	15△	...	...	50	D2**EGA	D2**EGA
	...	15	...	...	100	D2**GGA	D2**GGA
	...	...	...	15	40	D2**YGA	D2**YGA
	...	...	25△	...	50	D2**MGA	D2**MGA
	...	...	...	25	50	D2**ZGA	D2**ZGA
	...	...	25	...	70	D2**NGA	D2**NGA
3	...	30△	...	...	100	E2**CGA	E2**CGA
	...	...	...	30	70	E2**RGA	E2**RGA
	...	...	...	50	100	E2**PGA	E2**PGA
	...	...	50	...	100	E2**FGA	E2**FGA
4	...	...	60	75	125	F2**BGA	F2**BGA
	...	40△	75	100	150	F2**CGA	F2**CGA
	40	50	100	...	200	F2**EGA	F2**EGA
5	...	60	125△	150	250	G2**AGA	...
	...	75	150	200	300	G2**BGA	...
	75	100	200	...	400	G2**CGA	...

NOTE: For NEMA Type 12 Multispeed Forms refer to nearest General Electric Sales Office.

DUAL DIMENSIONS $\frac{\text{INCHES}}{\text{MILLIMETERS}}$ (For estimating only)

CR207 and CR208 Combination Starters in NEMA Type 1 enclosures

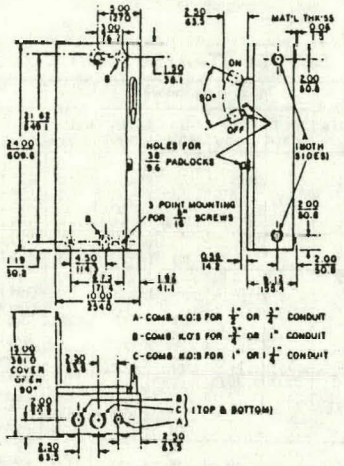


Fig. 1

CR207-208 Combination Starter, NEMA Sizes 0-2

(Except Size 2 with 100 Amp, 600V Fuse Clips)

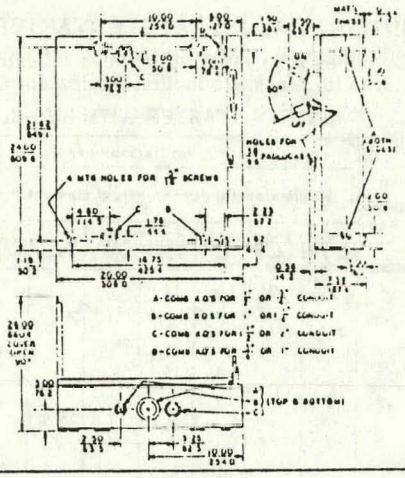


Fig. 2

CR208 NEMA Size 2 With 100 Ampere, 600 Volt Fuse Clips and CR208 NEMA Size 3 Combination Starter

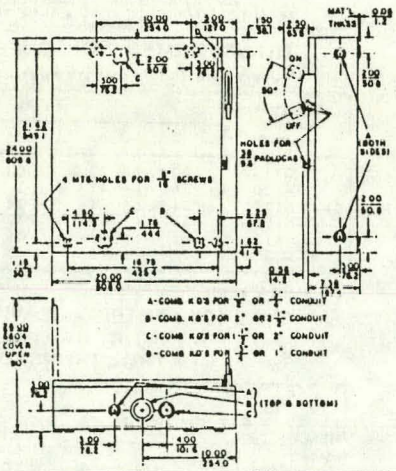


Fig. 3

CR207 NEMA Sizes 3 and 4 Combination Circuit Breaker Type Starter

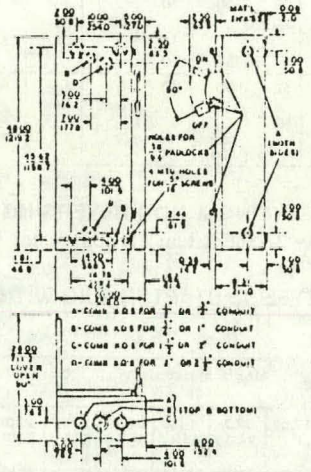


Fig. 4

CR208 NEMA Size 4 Combination Disconnect Type Starter

CR207 and CR208 JIC Safety Starters In NEMA Type 12 enclosures

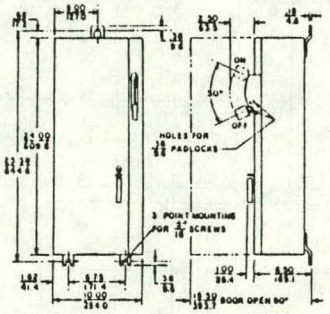


Fig. 5

CR207-208 Safety Starter, NEMA Sizes 0-2

(Except Size 2 with 100 Amp, 600V Fuse Clips)

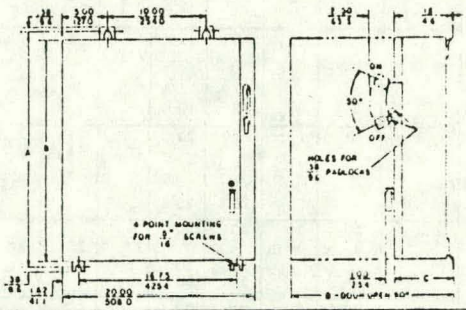


Fig. 6

CR207-208 Safety Starter, NEMA Sizes 3-5

NEMA Size	Form CR207	Form CR208	A		B		C		D	
			In.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.
2	....	D2 (with 100A, 600V fuse clips)	25.38	644.6	24.00	609.6	8.50	215.9	27.00	685.8
3	E2	E2	25.38	644.6	24.00	609.6	8.50	215.9	27.00	685.8
4	F2	....	25.38	644.6	24.00	609.6	8.50	215.9	27.00	685.8
4	....	F2	49.38	1254.2	48.00	1219.2	9.12	231.6	28.00	711.2
5	G2	G2	57.38	1457.4	56.00	1422.4	11.25	285.8	30.00	762.0

Data subject to change without notice

CR207 — CR208 JIC and Standard Starters in NEMA Type 12 enclosures

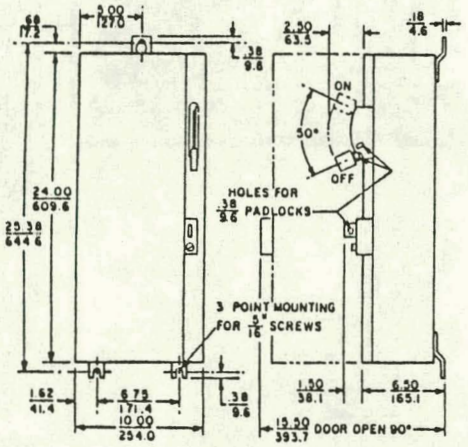


Fig. 7

CR207-208 JIC and Standard Type 12 Starter, NEMA Sizes 0-2 (Except Size 2 with 100 Amp, 600V Fuse Clips)

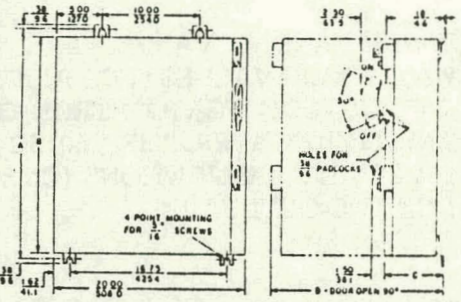


Fig. 8

CR207-208 JIC and Standard Type 12 Starters, NEMA Size 2 with 100 amp circuit breaker or 100 amp 600 volt fuse clip and NEMA Sizes 3-5.

NEMA Size	Form CR207	Form CR208	A In.	A Mm.	B In.	B Mm.	C In.	C Mm.	D In.	D Mm.
2	D2	D2	25.38	644.6	24.00	609.6	8.50	215.9	27.00	685.8
3	E2	E2	25.38	644.6	24.00	609.6	8.50	215.9	27.00	685.8
4	F2	....	25.38	644.6	24.00	609.6	8.50	215.9	27.00	685.8
4	....	F2	49.38	1254.2	48.00	1219.2	9.12	231.6	28.00	711.2
5	G2	G2	57.38	1457.4	56.00	1422.4	11.25	285.8	30.00	762.0

CR210 and CR211 Combination Reversing or Multispeed Starters in NEMA Type 12 enclosures

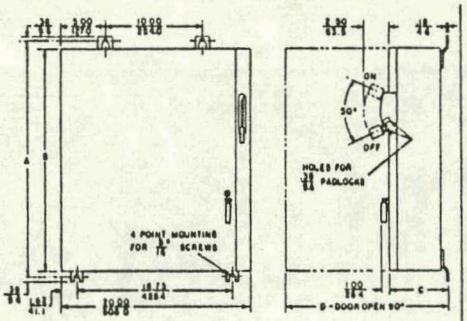


Fig. 9

CR210-211 Reversing or Multispeed Safety Starters

NEMA Size	A In.	A Mm.	B In.	B Mm.	C In.	C Mm.	D In.	D Mm.
0-2	25.38	644.6	24.00	609.6	8.50	215.9	27.00	685.8
3, 4	49.38	1254.2	48.00	1219.2	9.12	231.6	28.00	711.2

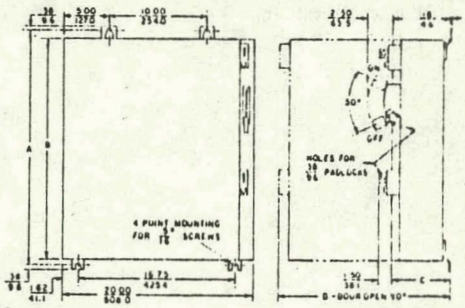


Fig. 10

CR210-211 Type 12 and JIC Reversing or Multispeed Starter

NEMA Size	A In.	A Mm.	B In.	B Mm.	C In.	C Mm.	D In.	D Mm.
0-2	25.38	644.6	24.00	609.6	8.50	215.9	27.00	685.8
3, 4	49.38	1254.2	48.00	1219.2	9.12	231.6	28.00	711.2

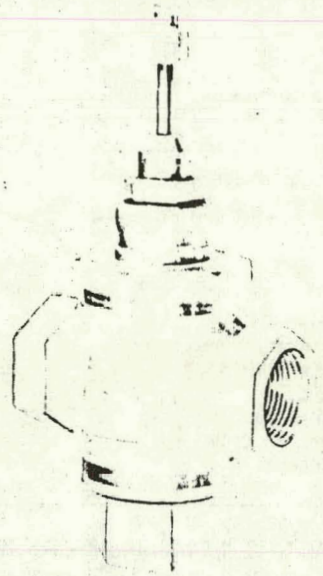
H eywe

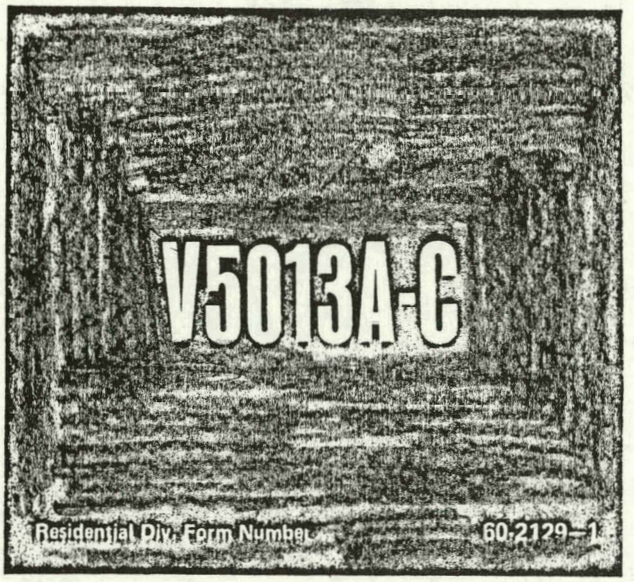
THREE-WAY VALVES

V5013A AND B VALVES ARE THREE-WAY MIXING VALVES (TWO INLETS AND ONE OUTLET) FOR CONTROL OF HOT AND COLD WATER. THE V5013C IS FOR DIVERTING APPLICATIONS (ONE INLET AND TWO OUTLETS).

- Valves require a Q618 or Q601 Linkage and control motor to position the valve.
- Constant total flow through full plug travel.
- Spring-loaded, self-adjusting, Teflon cone packing provides seal-off for all common agents.
- Stainless steel stem prevents corrosion.

NOTE: Mixing and diverting valves are not interchangeable.





H.A.
REV. 8-75 (.034)

SPECIFICATIONS

MODELS:

V5013A–Three-Way Mixing Valve with screwed valve end connections.

V5013B–Three-Way Mixing Valve with flanged valve end connections.

V5013C–Three-Way Diverting Valve with flanged valve end connections.

MODEL NO.	SERVICE	PIPE SIZE (IN.)	CAPACITY INDEX (CV)	CLOSE-OFF RATINGS[a] WHEN USED WITH LINKAGES			VALVE DIMENSIONS				VALVE END CONNECTIONS
							FACE-TO-FACE		CENTER LINE TO BOTTOM		
				Q618A 80 LB LINKAGE	Q618A 160 LB LINKAGE	Q601E	IN.	MM	IN.	MM	
V5013A	Mixing[c]	1/2	2.5	140 psig	150 psig	–	3-1/8	79.5	2- 3/4	70	Screwed
		1/2	4.0	130 psig	150 psig	–	3-1/8	79.5	2- 3/4	70	
		3/4	6.3	120 psig	150 psig	–	3-3/8	85.5	2-19/32	66	
		1	10.0	70 psig	150 psig	–	3-7/8	98.5	2-27/32	72	
		1-1/4	16.0	–	146 psig	–	4-1/4	108	2-23/32	69	
		1-1/2	25.0	35 psig	98 psig	–	4-3/4	120.5	2- 7/8	73	
		2	40.0	20 psig	67 psig	–	5-7/8	149	3- 1/4	82.5	
V5013B	Mixing[c]	2-1/2	63.0	–	32 psig	–	9-1/2	241.5	6- 7/16	163.5	Flanged[b]
		3	100.0	–	22 psig	–	11	279.5	6- 5/8	168.5	
		4	160.0	–	–	9 psig	13	330	8-11/16	220.5	
		5	250.0	Not recommended for tight close-off			15	381	9- 5/8	244.5	
		6	360.0	Not recommended for tight close-off.			16-1/2	419	10-11/16	271.5	
		8[e]	600.0	Not recommended for tight close-off			21-3/8	543	14	355.5	
V5013C	Diverting[d]	2-1/2	63.0	–	32 psig	–	9-1/2	241.5	6- 7/16	163.5	Flanged[b]
		3	100.0	–	22 psig	–	11	279.5	6- 5/8	168.5	
		4	160.0	–	–	9 psig	13	330	8-11/16	220.5	
		5	250.0	Not recommended for tight close-off.			15	381	9- 5/8	244.5	
		6	360.0	Not recommended for tight close-off.			16-1/2	419	10-11/16	271.5	
		8[e]	600.0	Not recommended for tight close-off.			21-3/8	543	14	355.5	

[a] Represents maximum pressure difference between the outlet and either of the two inlets (or between the inlet and either of the two outlets).

[b] Flanged bodies conform to A.S.A. specifications for cast-iron pipe flanges and flanged fittings. Valve flanges are flat faced with a smooth finish.

[c] For mixing service only.

[d] For diverting service only.

[e] Use industrial type of O1 operator.

(continued on page 3)

ORDERING INFORMATION

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

SPECIFY–

1. MODEL NUMBER.
2. VALVE SIZE IN INCHES.
3. CAPACITY INDEX (CV) FOR 1/2 INCH V5013A.
4. ACCESSORIES OR REPLACEMENTS, IF DESIRED.

ORDER FROM–

1. YOUR USUAL SOURCE, OR
2. HONEYWELL
   1885 DOUGLAS DRIVE NORTH
   MINNEAPOLIS, MINNESOTA 55422
   (IN CANADA–HONEYWELL CONTROLS LIMITED
   740 ELLESMERE ROAD
   SCARBOROUGH, ONTARIO)
   INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

VALVE LIFT: 3/4 in. [19 mm] for models up to 3 inches; 1-1/2 in. [38 mm] for 4 to 6 inch models; 2 in. [51 mm] for 8 inch models.

PACKING LIMITATIONS:

Water–150 psig maximum pressure; 40 F [4 C] minimum temperature, 240 F [116 C] maximum temperature.

For alternative hot and cold water–140 F [60 C] maximum differential temperature.

V5013B,C hot water service–100 psig maximum pressure.

MATERIALS:

COMPONENTS	BODY TYPE	
	V5013A	V5013B,C
Valve Body[a]	Cast-bronze	Cast-iron
Stem	Stainless Steel	Stainless Steel
Plug	Brass	Bronze
Seat	Integral Brass	Bronze, Removable
Packing	Teflon Cone	Teflon Cone

[a]Body material should be similar to that of the system in which the valve is installed.

MAXIMUM PRESSURE:

Bronze Body–150 psig at 366 F [186 C] max.

Iron Body–125 psig at 353 F [178 C] max.

For quiet water service–20 psig maximum differential at any position.

MOUNTING MEANS: Valve mounts directly in pipe line. Must be mounted so that control motor shaft is horizontal.

ACCESSORIES AND REPLACEMENTS:

1. Lubricant for the stem and packing (Plasti-Lube No. 2)–1/2 oz. can, Part No. 311193, 2 oz. can, Part No. 311057.
2. Teflon cone packing
   - –V5013A screw body; order 3 packings, Part No. 310623, for 1/2, 3/4, 1, or 1-1/4 inch valves; order 4 packings, Part No. 311432, for 1-1/2 or 2 inch valves.
   - –V5013B or C flanged body; order 4 packings, Part No. 41035, for 2-1/2 or 3 inch valves; order 5 packings, Part No. 41036, for 4, 5, and 6 inch valves. For 8 inch V5013B, order Part No. 65401; for 8 inch V5013C, order Part No. 37243.
3. Q601, Q618 linkages–see Table I.
4. See Honeywell Commercial Division publication, form 77-5613, for V5013 replacement parts list.

INSTALLATION

CAUTION

a. Installer must be a trained, experienced serviceman.
b. Before wiring the actuator motor, disconnect power supply to prevent electrical shock and equipment damage.
c. Mixing valves are designed for mixing applications and diverting valves for diverting applications; they are not interchangeable.
d. Install the valve so the fluid flows in the direction of the arrow cast on the body. The valve should be mounted with the operator motor shaft horizontal.
e. Always conduct a thorough checkout when installation is complete.

LOCATION

In selecting a location, the following must be considered.

1. Make sure sufficient space has been provided for the complete valve assembly. The valve linkage and motor fit over the valve stem. For installation and service, they require 4 inches [101.5 millimeters] minimum clearance to the length required for the motor and linkage.
2. The Modutrol motor must be mounted with the shaft horizontal.
3. The linkage should not be mounted below the valve where moisture or dirt may accumulate.

The ambient temperature must not exceed the maximum limits for the valve or motor. Controlled liquid-pressure must not exceed the maximum pressure limits of the valve.

PIPING HOOKUPS

All piping must comply with local codes and ordinances. Refer to Figs. 1-5 for typical piping hookups.

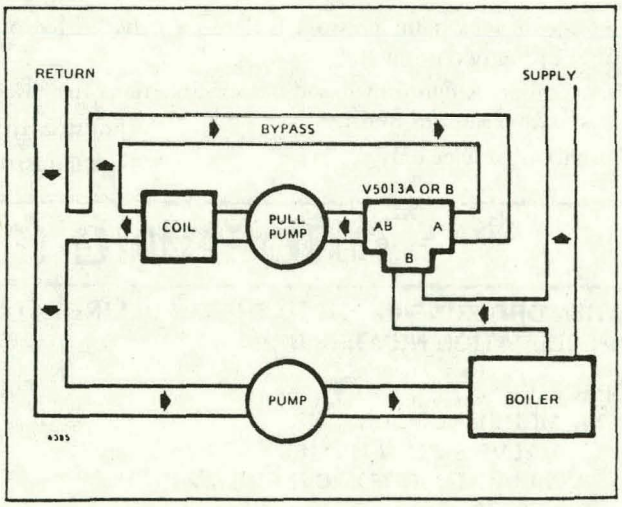


FIG. 1–TYPICAL V5013A OR B MIXING VALVE WITH CONSTANT VOLUME THROUGH COIL. FOR TYPICAL MOTOR-CONTROLLER WIRING, SEE FIG. 8.

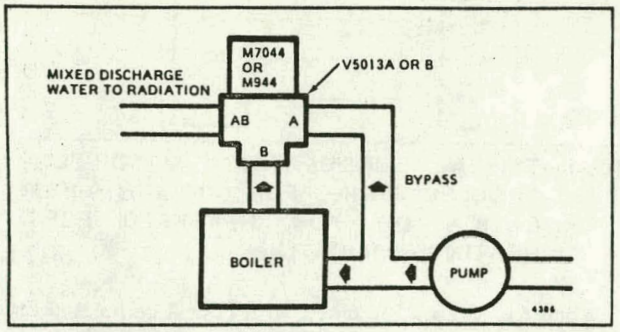


FIG. 2–SINGLE ZONE BYPASS FOR RESET CONTROL. FOR TYPICAL MOTOR-CONTROLLER WIRING, SEE FIG. 8.

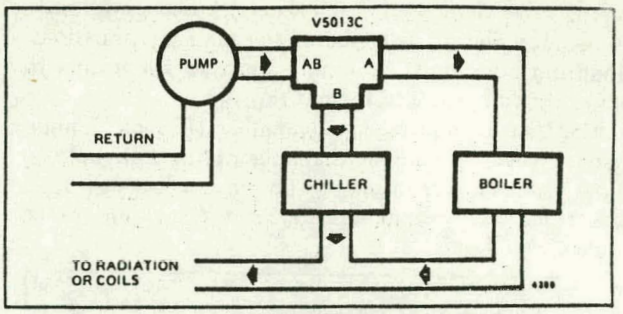


FIG. 4–V5013C DIVERTING VALVE USED TO CHANGEOVER COMPLETE SYSTEM. FOR TYPICAL MOTOR-CONTROLLER WIRING, SEE FIG. 8.

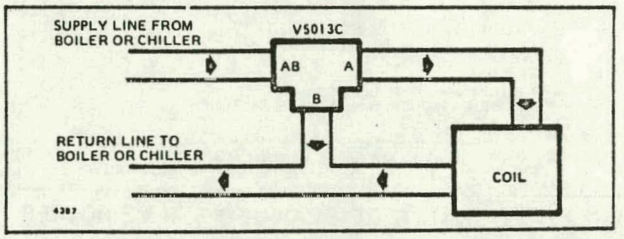


FIG. 5–TYPICAL ZONE HOOKUP OF V5013C USED TO CONTROL FLOW THROUGH COIL. FOR TYPICAL MOTOR-CONTROLLER WIRING, SEE FIG. 8 FOR HEATING APPLICATION OR FIG. 9 FOR COOLING APPLICATION.

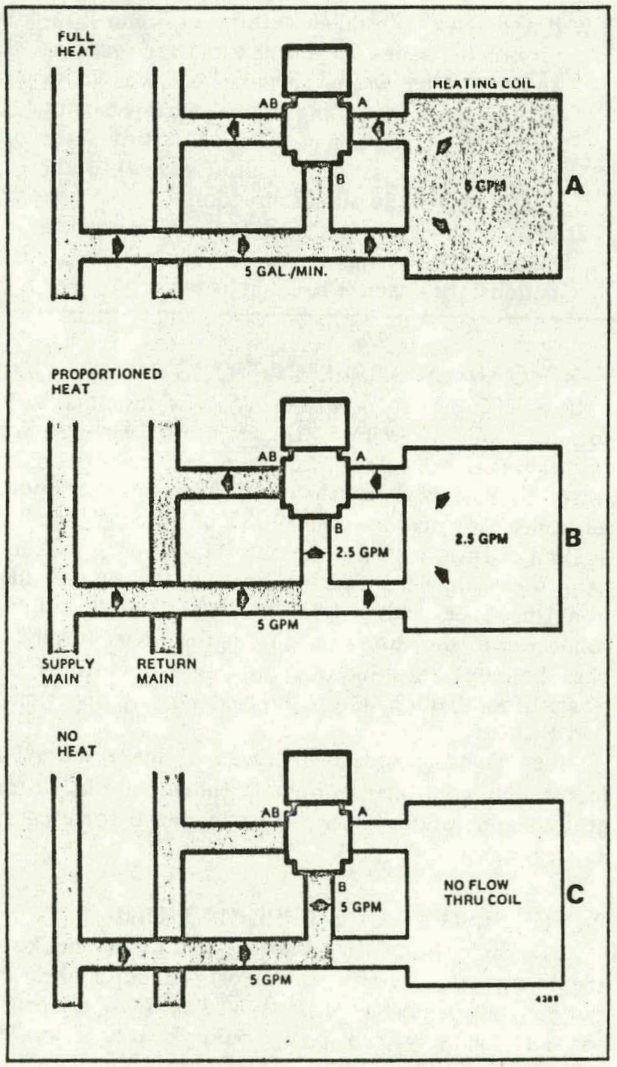


FIG. 3–THREE-WAY VALVE OPERATION–COIL BYPASS. THREE-WAY VALVES MAINTAIN CONSTANT FLOW IN THE PIPING. AS THE TEMPERATURE REQUIREMENTS CHANGE, THE VOLUME OF THE FLUID IN THE COIL VARIES. FOR TYPICAL MOTOR-CONTROLLER WIRING HOOKUP, SEE FIG. 9.

VALVE INSTALLATION

SCREWED VALVE BODIES

Line up the pipes squarely with the valve at each end. If the pipes are forced into the valve, the body may become twisted and improper seating will result. Prevent pipe chips, scale, and dirt from entering the piping since they may lodge in the seat and prevent proper closing. Apply a vise or wrench to the valve only as shown in the following figure.

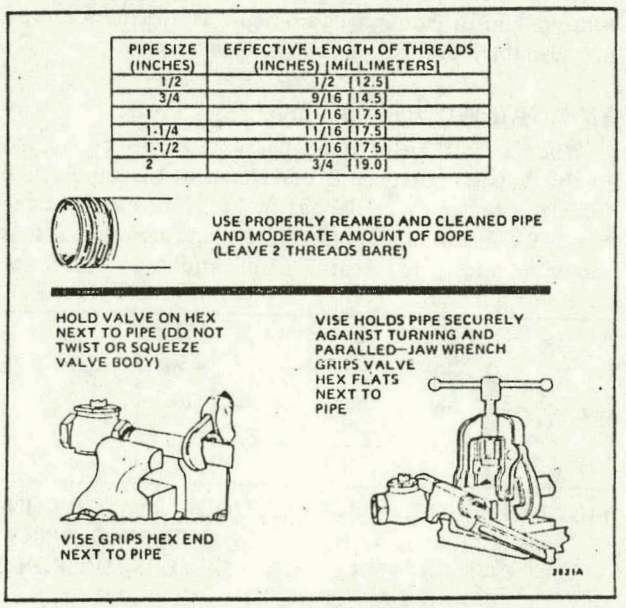


FIG. 6–MOUNTING OF SCREWED VALVE BODIES.

FLANGED VALVE BODIES

The valve flanges are flat faced with a smooth finish. Companion flanges must be of the same specifications. Mounting bolts must be long enough to allow nuts to utilize the full length of the nut threads.

The bolts should be approximately 1/8 inch [3 millimeters] smaller than the diameter of the bolt hole to allow clearance for installing. To prevent leakage, use a gasket material recommended for the medium to be handled.

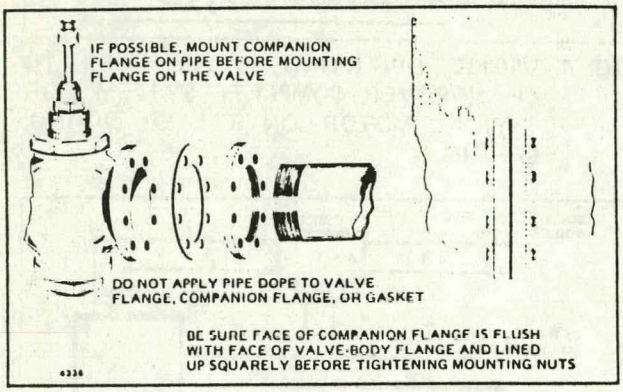


FIG. 7–MOUNTING OF FLANGED VALVE BODIES.

NOTE: For V5013A and B, if the pressures in the pipe lines at inlets A and B are unequal, a balancing cock may be installed in the line carrying the higher pressure. Best possible modulation will be obtained if this cock is adjusted under actual operating conditions so that pressures A and B are equal at midstroke.

MOTOR-CONTROLLER WIRING

CAUTION

Disconnect power supply to prevent electrical shock and equipment damage.

All wiring must comply with local codes and ordinances.

When wiring the modulating motor to the controller, refer to the instructions packed with the motor and heating and/or cooling equipment. If instructions are not available, refer to the following section.

TYPICAL WIRING HOOKUPS

When a V5013A or B is piped with Port A connected to the bypass and Port B connected in the supply line from the boiler or chiller, as in Fig. 1 or Fig. 2, make series 90 motor and controller wiring connections as shown in Fig. 8 for heating applications or Fig. 9 for cooling applications.

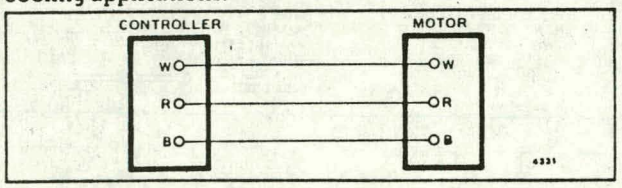


FIG. 8–TYPICAL MODULATING MOTOR-CONTROLLER WIRING FOR HEATING APPLICATION OR FOR REVERSED PORT COOLING APPLICATION.

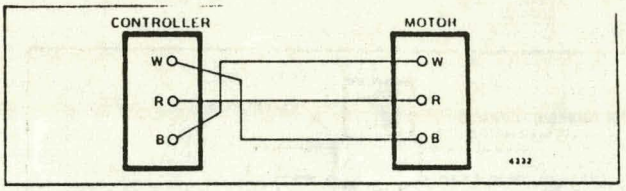


FIG. 9–TYPICAL MODULATING MOTOR-CONTROLLER WIRING FOR COOLING APPLICATION OR FOR REVERSED PORT HEATING APPLICATION.

When the V5013C is piped with Port A connected to the coil and Port B connected in the return line to the boiler or chiller, as in Fig. 5, make series 90 motor and controller wiring connections as shown in Fig. 8 for heating applications or Fig. 9 for cooling applications.

REVERSE PORT HOOKUP WIRING

CAUTION

1. If the valve is installed with ports A and B reversed, the series 90 motor (nonspring return) and controller wiring *must* be reversed. Series 70 and series 90 (spring return) motors cannot be reversed. See applicable specification sheet for series 70 or series 90 (spring return) motor which runs in the proper direction.
2. Mixing valves are designed for mixing applications and diverting valves for diverting applications; they cannot be interchanged.

MIXING VALVE APPLICATIONS

If a V5013A or B Mixing Valve is installed with Ports A and B reversed (i.e., the hot water enters Port A rather than Port B, and the coil bypass is connected to Port B rather than Port A), series 90 motor-controller wiring connections MUST be reversed (Fig. 3).

On a call for heat in a normal V5013A or B hookup, stem travels upward opening Port B, the supply line from the boiler. When Port A rather than Port B is connected in the supply line from the boiler (reversed port hookup), the motor-controller wiring must be reversed so that on a call for heat Port A opens and Port B closes.

When Ports A and B are reversed, make series 90 motor and controller wiring as shown in Fig. 9 for heating applications or as shown in Fig. 8 for cooling applications.

DIVERTING VALVE APPLICATIONS

On a call for heat with a V5013C, in a normal hookup, the stem travels upward opening Port A to supply heat to the coil. When Port B rather than Port A is connected to the coil (reversed port hookup), the series 90 motor-controller wiring must be reversed such that on a call for heat Port B opens and Port A closes.

When Ports A and B are reversed, make series 90 motor and controller wiring as shown in Fig. 9 for heating applications or as shown in Fig. 8 for cooling applications.

OPERATION

V5013A,B MIXING VALVES– HEATING APPLICATION

A three-way mixing valve should not be used in diverting service.

When the V5013A or B is used in a heating application Port B is connected in the supply line from the hot water boiler, Port A is connected to the bypass, and Port AB is connected to the load. A fall in temperature at the controller will partially open Port B and close Port A to increase the temperature of the water to the load. A rise in temperature at the controller will partially close Port B and open Port A to decrease the temperature of the water to the coil. See Figs. 1, 2, and 10A.

V5013C DIVERTING VALVE– HEATING APPLICATION

When the V5013C is used in a heating application, Port A is connected to the coil, Port B is connected to the coil bypass, and Port AB is connected in the supply line from the boiler. A fall in temperature at the controller will close Port B and open Port A to increase the flow of hot water through the coil. An increase in temperature at the controller will close Port A and open Port B to decrease the flow of hot water through the coil. See Figs. 5 and 10B.

V5013C USED AS AUTOMATIC CHANGEOVER

When the V5013C (Figs. 4 and 10C) is used as an automatic changeover, Port A is connected in the supply line to the boiler, Port B is connected in supply line to the chiller and Port AB is connected in the return line from the load. A fall in temperature at the controller will close Port B to isolate the cooling equipment and open Port A to increase the coil temperature. An increase in temperature at the controller will close Port A to isolate heating equipment and open Port B to decrease coil temperature.

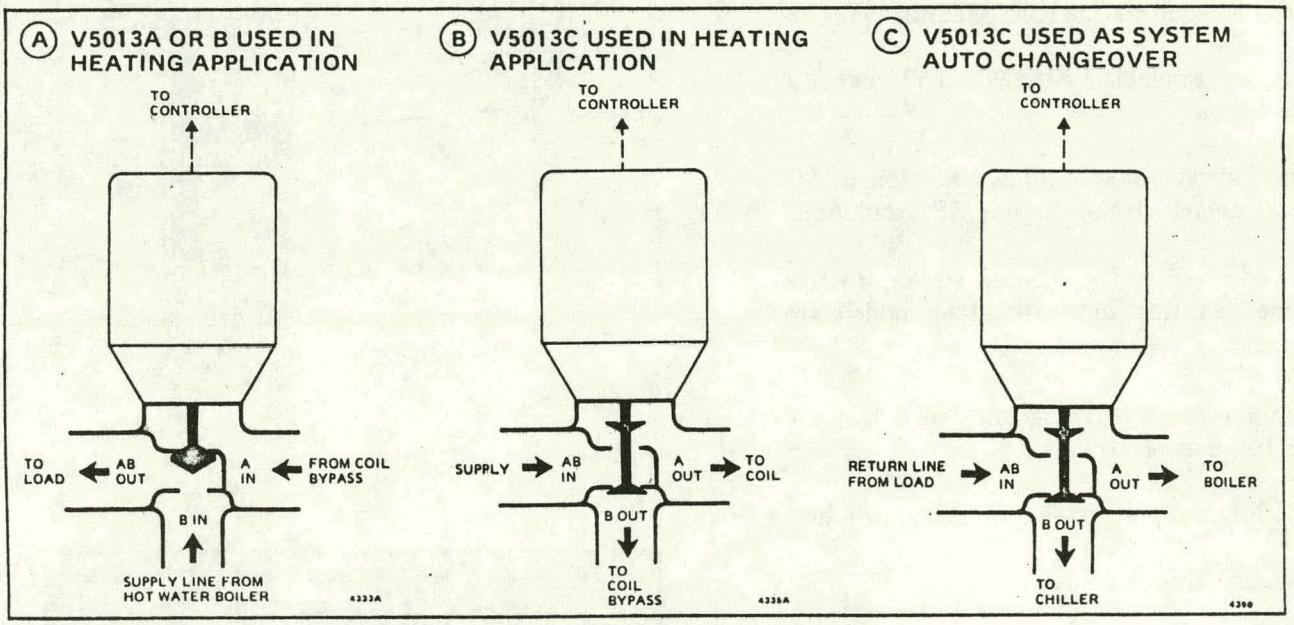


FIG. 10–V5013A-C VALVE HOOKUPS.

CHECKOUT

It is important to check the valve stem to see that it operates freely. Impaired valve stem operation may indicate that the body was twisted by faulty piping or the stem was bent by rough handling. Either of these conditions may warrant replacement of the valve body or other components.

The valve should be checked at regular intervals for leakage around the packing. The packing is spring-loaded and should seldom require attention. If leakage is discovered and inspection shows that the packing gland is screwed down tightly, the valve must be repacked.

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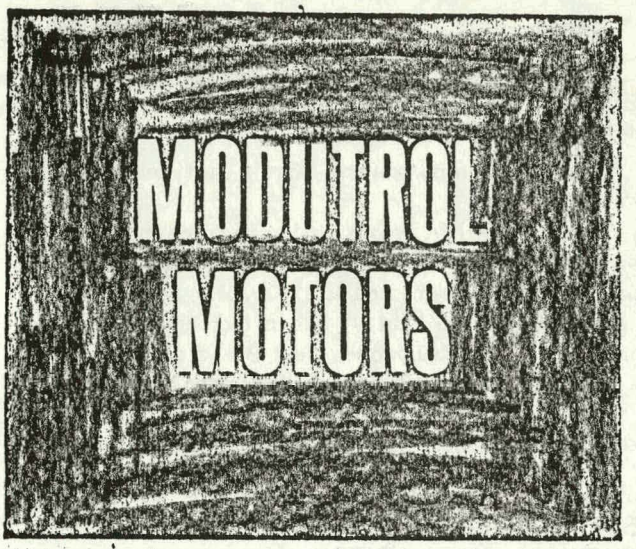
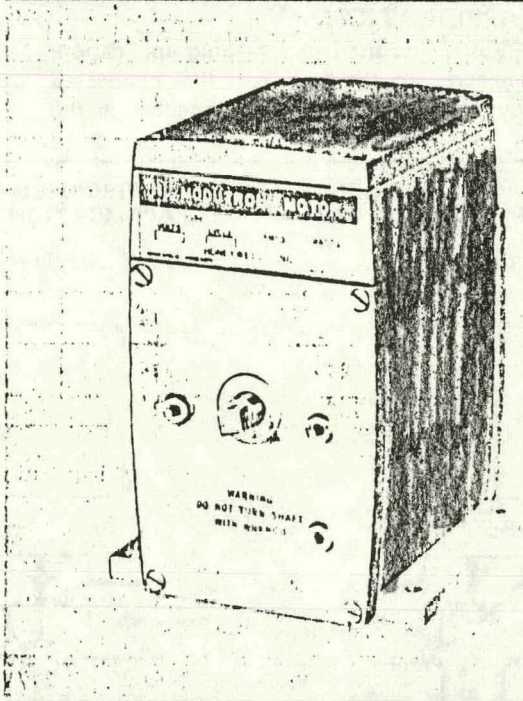
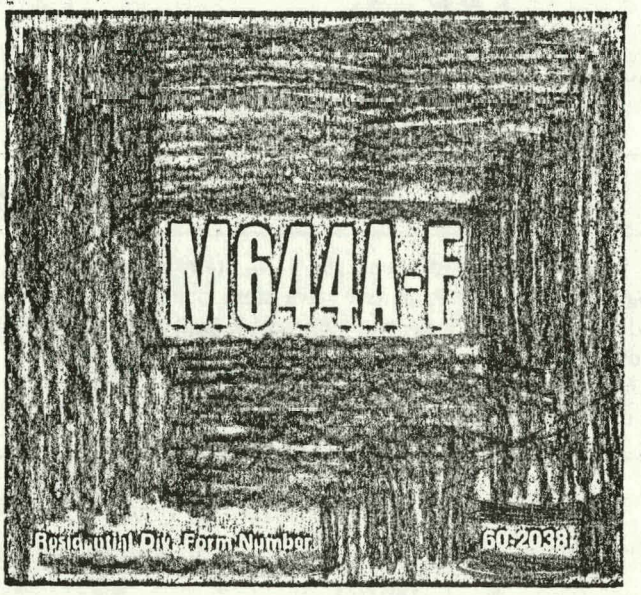


THE M644 TWO POSITION MODUTROL MOTORS OPEN AND CLOSE DAMPERS AND VALVES ACCORDING TO THE DEMANDS OF AN SPDT, SNAP-ACTING CONTROLLER.



- ☐ M644A,C,D,E require a 24V controller; M644B,F require a line voltage controller.
- ☐ Models available with 90, 160, or 180 degree stroke.
- ☐ Dual stroke models allow selection of 90 or 160 degree stroke at time of installation.
- ☐ M644F, with 180 degree stroke, rotates in one direction only. All other models are reversing.
- ☐ Timing range is 15 seconds to 4 minutes for a 160 degree stroke.
- ☐ M644D,E have built-in auxiliary switches.
- ☐ Die-cast aluminum case.
- ☐ Oil-immersed motor and gear train.
- ☐ Weatherproofing kit, explosion-proof housing, auxiliary switches, and linkages available as accessories.



J.A.
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SPECIFICATIONS

TRADELINE MODELS

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

TRADELINE MODEL AVAILABLE: M644A Modutrol Motor.

ELECTRICAL RATINGS:
Voltage—24V ac.
Frequency—50/60 Hz.
Power Consumption—14 watts, 17 VA.

STROKE: 160 degrees.

TIMING: 60 seconds.

ADDITIONAL FEATURES: Tradeline pack with cross reference label.

STANDARD MODELS

MODELS:

MODEL	VOLTAGE 50/60 HZ	POWER CONSUMPTION		TIMING	MAXIMUM OPERATING TORQUE (in lb.-in.)	STROKE (IN DEGREES)
		WATTS	VA			
M644A	24	14	17	15 sec.	37	160
				30 sec.	150	90
				1 min.	150	160
M644B	120	13	16	15 sec.	37	160
				30 sec.	75	
M644C	24	14	17	15 or 30 sec.	75	90 or 160[a]
				2 or 4 min.	150	
M644D[b]	24	14	17	30 or 60 sec.	150	90 or 160[a]
M644E[b]	24	14	17	30 or 60 sec.	150	90 or 160[a]
M644F[c]	120	13	16	30 sec.	75	180

[a]Stroke is field adjustable.
[b]M644D has 2 auxiliary switches; M644E has 1 auxiliary switch.
[c]Rotates in only one direction.

AUXILIARY SWITCH RATINGS (in amps):

M644D (2 spdt auxiliary switches)—

	120V	240V	277V
Full Load	5.8	2.9	—
Locked Rotor	34.8	17.4	—
Resistive	11.0	11.0	11.0

M644E (1 spdt auxiliary switch)—

	120V	240V
Full Load	7.2	3.6
Locked Rotor	43.2	21.6

(continued on page 3)

ORDERING INFORMATION

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

SPECIFY—
1. MODEL NUMBER.
2. VOLTAGE AND FREQUENCY.
3. STROKE.
4. TIMING.
5. ACCESSORIES, IF REQUIRED.

ORDER FROM—
1. YOUR USUAL SOURCE, OR
2. HONEYWELL
1885 DOUGLAS DRIVE NORTH
MINNEAPOLIS, MINNESOTA 55422
(IN CANADA—HONEYWELL CONTROLS LIMITED
740 ELLESMERE ROAD
SCARBOROUGH, ONTARIO)
INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

UNDERWRITERS' LABORATORIES, INC. LISTED (M644B,D,E only): File No. E4436, Guide No. XAPX.

NOTE: Only line voltage models and models with auxiliary switch are listed by Underwriters' Laboratories, Inc.

CANADIAN STANDARDS ASSOCIATION CERTIFIED: M644B,D,E,F. File LR1620, Guide No. 400-E-O.

DEAD WEIGHT LOAD ON SHAFT: Power end—200 pounds; auxiliary end—100 pounds.

TERMINAL CONNECTIONS: M644A-E—screw terminals; M644F—leadwires.

AMBIENT TEMPERATURE RATING: Maximum—125 F; minimum—minus 40 F.

STROKE: Fixed—90, 160, or 180 degrees; dual—90 or 160, field adjustable. See MODELS.

DIMENSIONS: See Fig. 1.

CRANK SHAFT: Double ended shaft, 3/8 inch square.

ACCESSORIES:

Q607 Auxiliary Switch—Controls auxiliary equipment as a function of motor position.

Q605 Damper Linkage—Connects motor to damper.

Cover-Transformer—Die-cast aluminum cover with built-in transformer.

130810A—120V, 60 Hz.
130810B—120/208/240V, 60 Hz.
130810C—220V, 50 Hz.
130810D—208/240V, 50/60 Hz.
130810E—208V, 60 Hz.
130810F—240V, 50/60 Hz.

Q601 Linkage—Connects Modutrol motor to water or steam valve.

Q100 Linkage—Connects Modutrol motor to butterfly valve.

Q455 Linkage—Connects Modutrol motor to water or steam valve.

Q618 Linkage—Connects Modutrol motor to water or steam valve.

Weatherproofing Kit (Part No. 7640JS)—Weatherproofs the M644 Modutrol motor.

Motor Crank Arm (Part No. 7616BR)—Included with the Q605 Linkage but not with the motor.

DHE94 Explosion-Proof Housing—Encloses Modutrol motor for use in explosive atmospheres. Not for use with Q601 and Q455 Linkage. Order from Crouse Hinds Co. Requires Honeywell 7617DM Coupling.

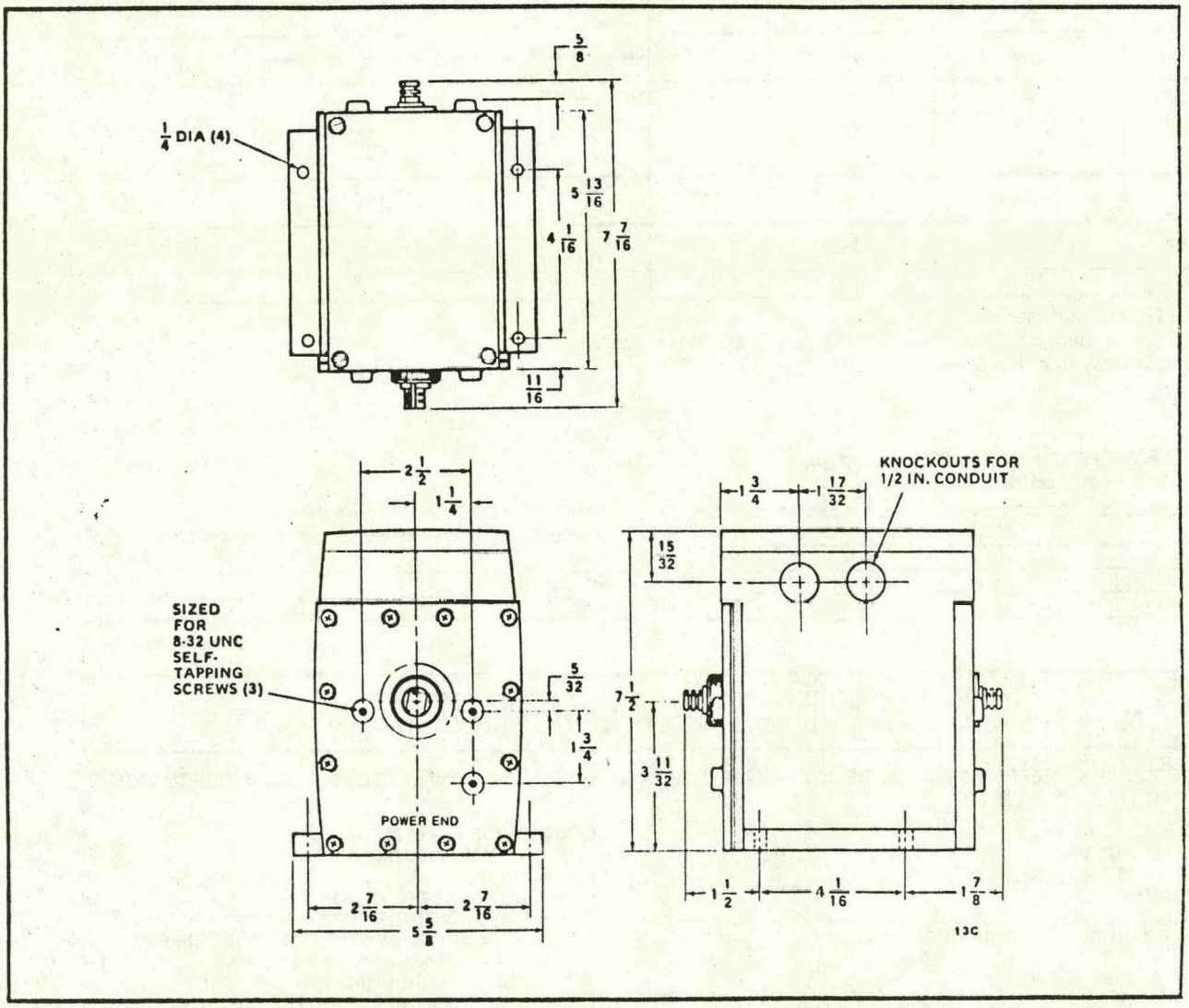


FIG. 1–APPROXIMATE DIMENSIONS OF THE M644 MODUTROL MOTOR IN INCHES.

60-2038—1

INSTALLATION

CAUTION

1. Installer must be a trained, experienced serviceman.
2. Disconnect power before beginning installation.
3. Do not turn the motor shaft manually or with a wrench as damage to the gear train may result.

LOCATION

Install the Modutrol motor in any location except where acid fumes or other deteriorating vapors might attack the exposed metal parts of the motor, or where escaping gases or other explosive mixtures might create a fire hazard.

When choosing a location for the motor, be sure to allow enough space for mounting auxiliary equipment and servicing the motor.

MOUNTING

The motor has a flange on the bottom for mounting. The mounting holes are sized for 1/4 inch machine screws or bolts. The motor may be mounted in any position as long as the shaft is horizontal.

All M644 Modutrol motors are shipped in the closed position. The closed position for the 160 degree motor is the limit of counterclockwise ↶ rotation as viewed from the power end of the motor, where the groove is on top of the shaft and the flat on the shaft is 10 degrees from horizontal.

The closed position for the 90 degree motor is the same as for the 160 degree motor except that the flat of the shaft is 45 degrees from the horizontal.

The closed position for the M644F (180 degree stroke) is with the groove in the power end of the shaft up and the flat nearly horizontal. The shaft rotates clockwise ↷ as viewed from the power end of the motor.

LINKAGES

The motor comes without a crank arm. The motor crank arm is included in the Q605 Linkage or may be ordered separately (Part No. 7616BR).

For detailed instructions on the assembly of specific linkages, refer to the instruction sheet packed with each individual linkage.

When planning for and installing a motor and linkage, check the following points of operation:

1. Attach the valve or damper linkage to the motor crankarm so that the motor crankarm travels through its full range while the drive mechanism moves through only its required maximum distance.

2. The motor shaft must travel through its full angular stroke while opening or closing a valve or damper. This holds true even though the full stroke is not required to drive the valve or damper through its required stroke.

3. The motor must be stopped at the end of its stroke by the limit switch and must not be stalled by the damper or valve.

WIRING

CAUTION

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

All wiring must comply with local codes and ordinances. See Figs. 2-6 for typical hookups.

When using a low voltage motor, make certain that the voltage and frequency stamped on the transformer correspond to the characteristics of the power supply.

NOTE: Blue (B_1) and white (W_1) connections at the motor may be interchanged if necessary to obtain proper motor action on a temperature (or pressure) change at the controller.

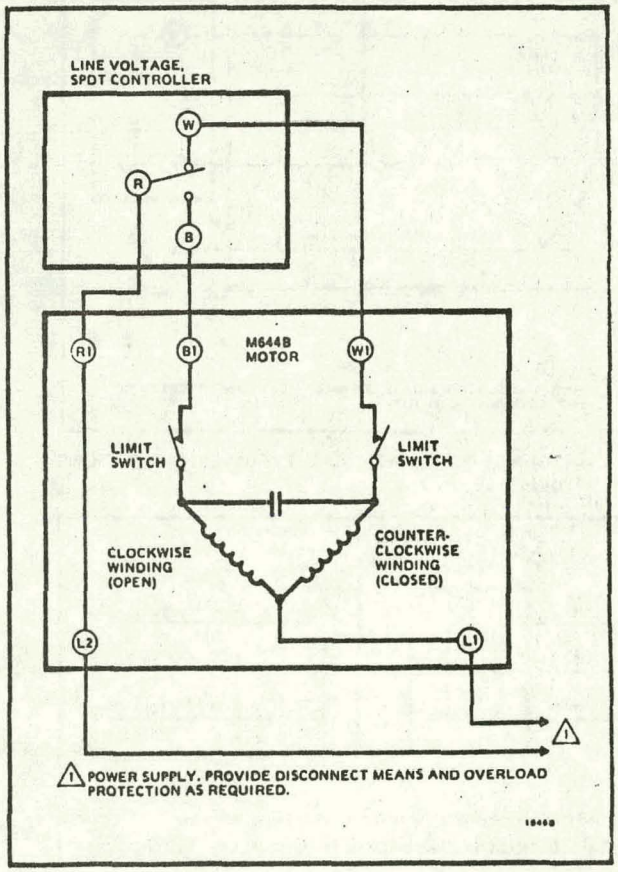


FIG. 2–INTERNAL SCHEMATIC AND TYPICAL CONNECTIONS FOR M644B.

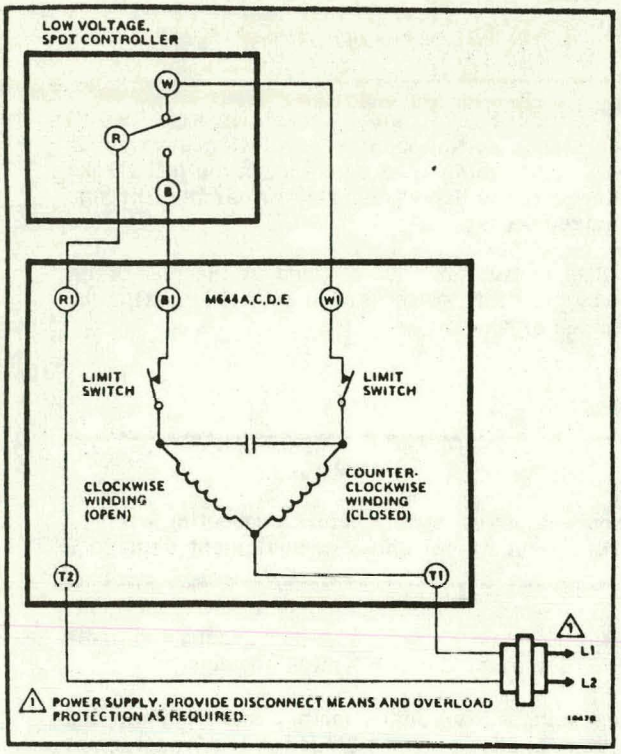


FIG. 3–INTERNAL SCHEMATIC AND TYPICAL CONNECTIONS FOR M644A,C,D,E.

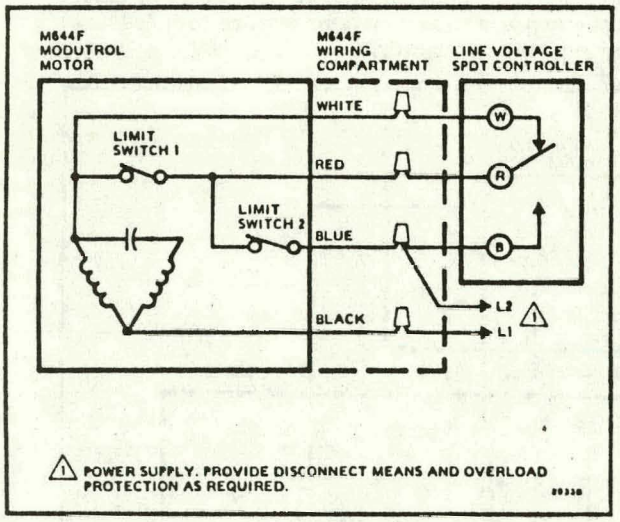


FIG. 4–INTERNAL SCHEMATIC AND TYPICAL CONNECTIONS FOR M644F.

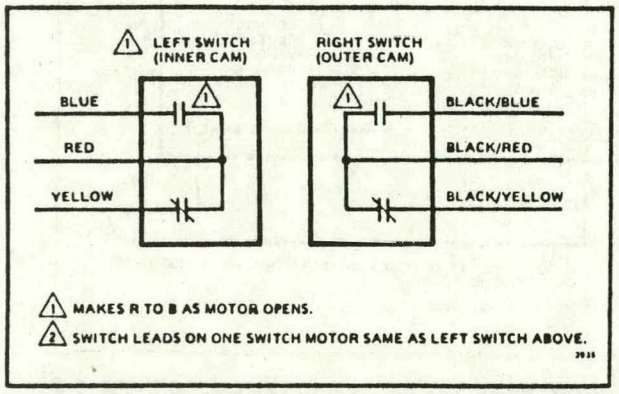


FIG. 5–COLOR CODING ON AUXILIARY SWITCH LEADS.

REPLACING A THERMOSTAT-CONTROLLED M204 MODUTROL MOTOR

When the M644 is used to replace a thermostat-controlled M204 Modutrol Motor, the thermostat must also be replaced to provide correct cycling rate.

Use a T87F or T882A with the low voltage M644. An initial heat anticipator setting of 0.7 amp is recommended. If this does not produce the desired cycling rate, adjust the thermostat heat anticipator as follows:

—Raise setting to decrease number of cycles.

—Lower setting to increase number of cycles.

Refer to Fig. 6 for the correct electrical hookup. Note that this is not a color-to-color connection.

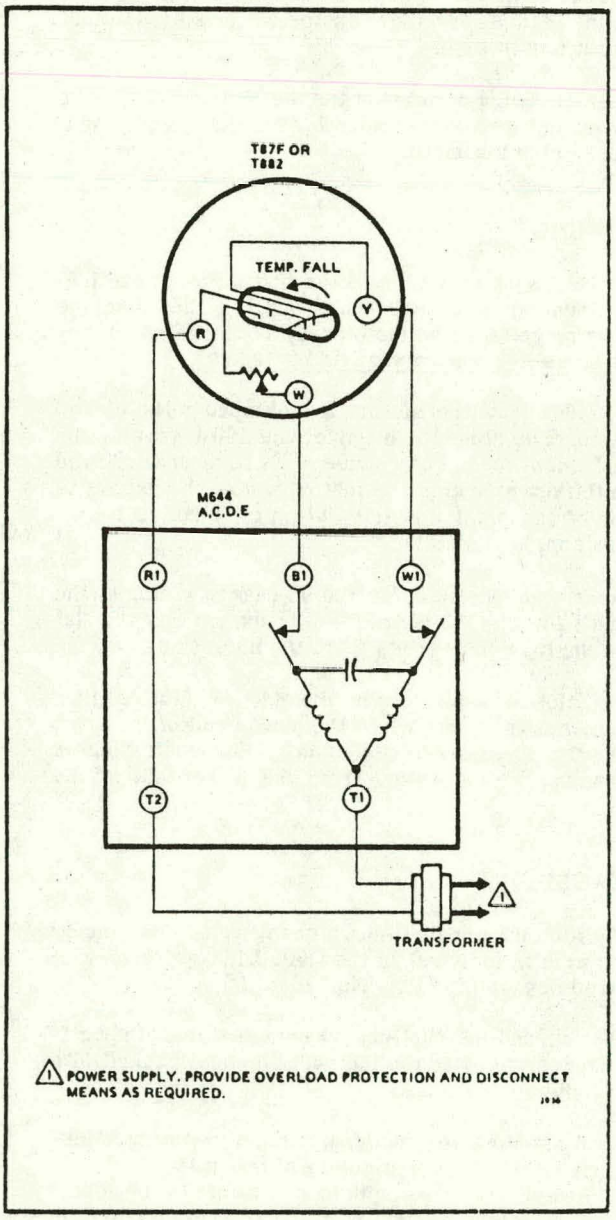


FIG. 6–HOOKUP FOR LOW VOLTAGE M644 MOTOR WHEN CONTROLLED BY A THERMOSTAT.

60-2038—1

CAUTION
Do not turn the motor shaft manually or with a wrench as damage to the gear train will result.

STROKE ADJUSTMENT (M644C, D, E)

The stroke is adjusted by changing the position of the limit arms that actuate the limit switches.

STEP 1

Short motor terminal R to B and run the motor to approximately midstroke. Stop the motor and remove power while adjustments are in progress. Remove the cover from the auxiliary end of the motor by taking out the four screws securing it.

NOTE: On M644D and E only—be careful not to lose the small spring and washers around the shaft. This spring holds the switch cams in contact with the driving dogs. Remove the switch cams by moving the switch actuating lever away from the cam and pulling the cam assembly straight out.

STEP 2

Loosen the two screws in the limit arm hub (see Fig. 7). Set the arms at either extreme of their travel. With both arms up, the stroke will be 160 degrees, and with both arms down, the stroke will be 90 degrees. Retighten the two screws.

STEP 3

(On M644D and E models only, replace the switch cams and spring. Make sure the driving dogs engage the switch cams.)

Replace the cover on the auxiliary end of the motor and fasten the four screws removed earlier.

AUXILIARY SWITCH OPERATION

The auxiliary switches in the M644 are operated by cams on the motor shaft. Each switch is operated by a separate set of cams; the left switch and cams are color-coded blue, and the right switch and cams are color-coded red. M644D has 2 switches, and M644E has 1 switch. The switch makes when its cam roller moves to the upper level of the operational cam and breaks when the cam roller moves to the lower level. The differential cam provides an intermediate level; it can be used to increase differential between switch make and break points. The differential is adjustable on M644D and fixed on M644E.

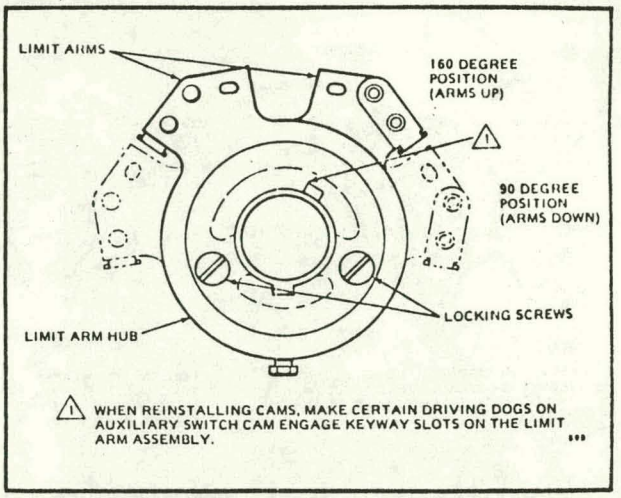


FIG. 7–ADJUSTING LIMIT ARM HUB ASSEMBLY TO CHANGE THE STROKE OF THE MOTOR.

APPROXIMATE SWITCH ADJUSTMENT—M644D

(Does not require running the motor.)

1. Make sure motor is in the full closed position.
2. Remove the cover from the auxiliary end of the motor by taking out the 4 screws securing it.
3. Remove spring on motor shaft.
4. Push back right cam roller and remove outer cam. Note color code dots.
5. Adjust left switch (inner cam) first. See Fig. 9.

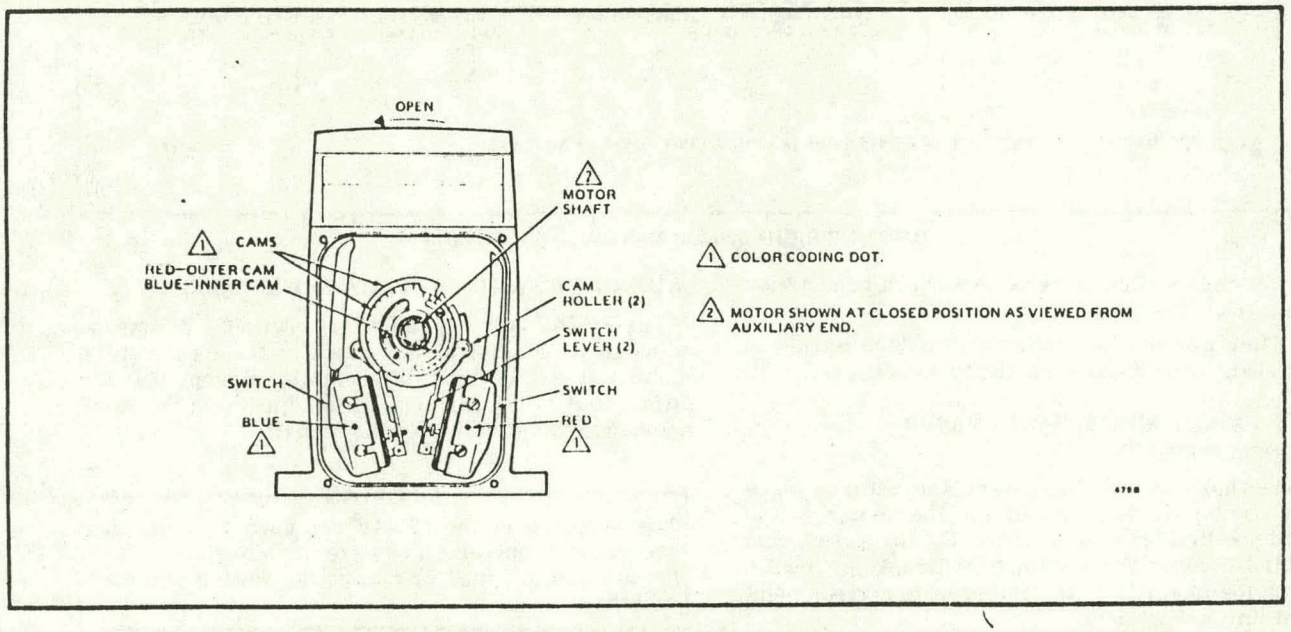


FIG. 8--LOCATION OF INTERNAL AUXILIARY SWITCHES AND SWITCH CAMS IN M644D MODUTROL MOTOR.

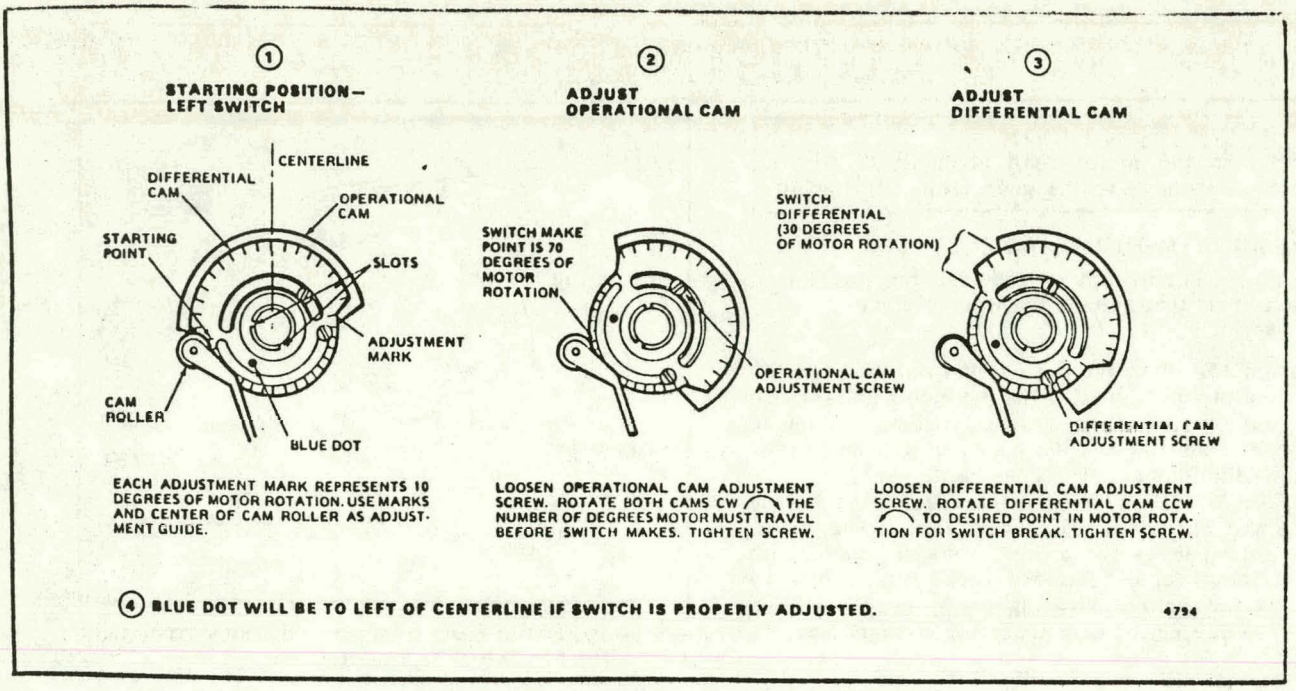


FIG. 9--ADJUSTING LEFT SWITCH MAKE AND BREAK POINTS.

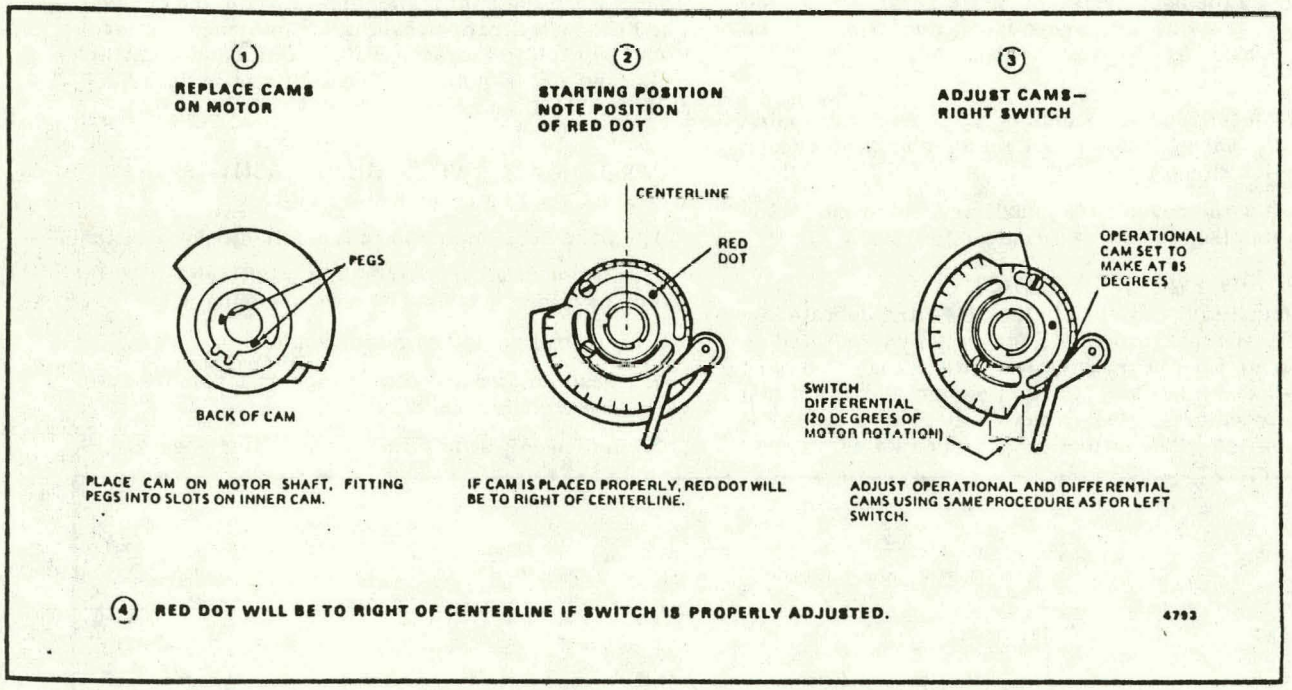


FIG. 10--ADJUSTING RIGHT SWITCH MAKE AND BREAK POINTS.

6. Put right switch cams on motor shaft and adjust right switch. See Fig. 10.

7. After switches are adjusted, replace spring on motor shaft, then replace auxiliary end cover.

EXACT SWITCH ADJUSTMENT—M644D
(Requires running the motor.)

Connect a manual potentiometer to the motor in place of the regular controller and run the motor to the desired position for switch make. Set the switch cam as described under "Approximate Switch Adjustment;" then run the motor back to desired switch break point and set differential cam.

AUXILIARY SWITCH ADJUSTMENT (M644E)

The M644E has one auxiliary switch. It may be adjusted to operate at any point in the stroke of the motor. It has a fixed differential. Except that the differential is not variable, it is adjusted in the same manner as the switches in the M644D.

IMPORTANT

The switches on the M644F are used to limit the stroke of the motor. They are not adjustable. Do not attempt to adjust or change the setting of these switches.

60-2038—1

CHECKOUT

After installation and linkage adjustment, check out the entire installation. A good checkout proves that:

a. the motor operates properly,

b. the motor responds to the controller properly,

c. the motor operates the valve or damper as it should.

Energize the motor by setting the controller so its contacts close R to B or by placing a jumper wire across terminals R and B. The motor should run smoothly and drive the valve or damper to the end of its stroke. If it does not, check the source of power to be sure there is voltage and that it is at least 85 percent of the rated voltage stamped on the nameplate of the motor.

OPERATION

ALL MODELS EXCEPT M644F

Whether the M644 is used with a line voltage or low voltage controller the operation is the same.

Refer to Figs. 2 and 3 for an internal schematic diagram of the M644.

When the controller makes in one direction, the motor will run in a corresponding direction. The motor will continue to run in that direction until the limit of rotation is reached and the limit switch opens, or until the controller makes in the opposite direction.

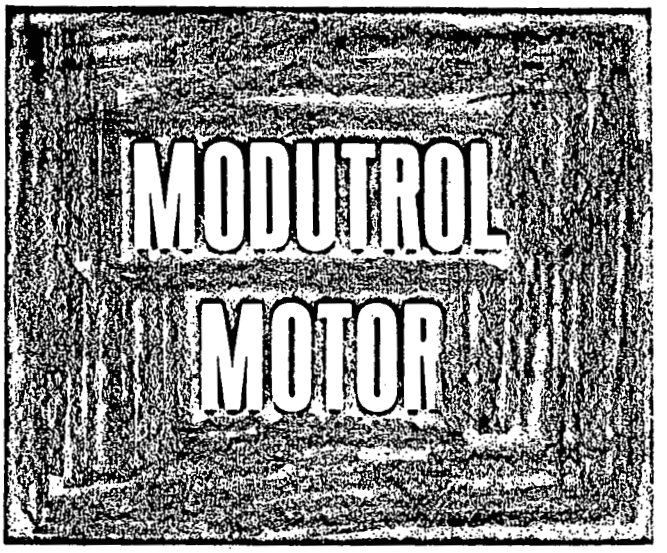
M644F

Refer to Fig. 4 for an internal schematic diagram of the M644F.

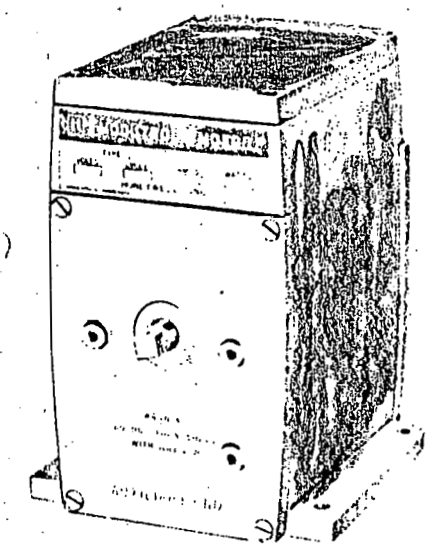
When controller makes R to B, with the motor in the closed position (limit switch in blue lead open), power is applied to motor windings through the controller and limit switch 1. When the motor reaches full open, limit switch 1 opens, stopping the motor.

When controller makes R to W the motor will be powered through limit switch 2, controller, and the white lead. When the motor reaches full closed, limit switch 2 will open, stopping the motor.

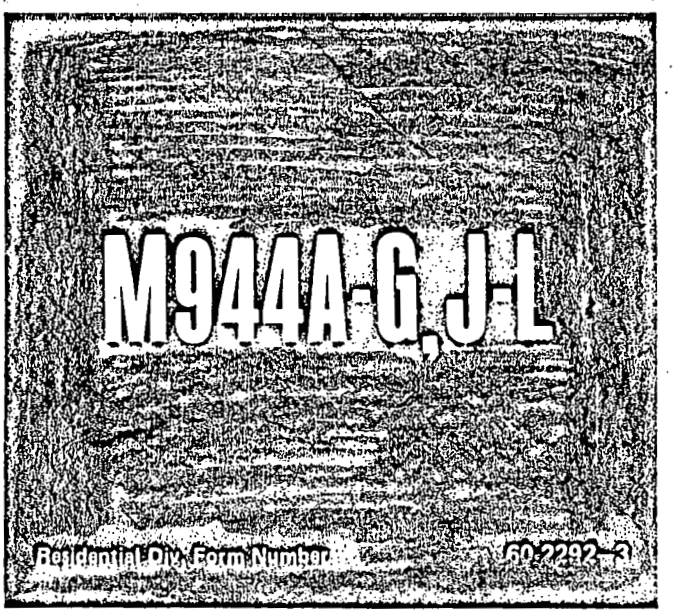
Honeywell



M944 MODUTROL MOTORS ARE REVERSING, PROPORTIONAL MOTORS USED TO OPERATE DAMPERS OR VALVES IN ELECTRONIC (SERIES 70) OR ELECTRIC (SERIES 90) MODULATING CIRCUITS.



- ☐ M944A-F,J are low voltage and M944G,K,L are line voltage motors.
- ☐ M944C-E,L stroke is field adjustable to 90 or 160 degrees; stroke is fixed at 90 or 160 degrees on other models.
- ☐ M944A,C,D,F have internal balance relay.
- ☐ M944B,E,G,J-L require external balance relay.
- ☐ Die-cast aluminum case.
- ☐ Direct drive feedback potentiometer.
- ☐ Rated for ambient temperatures of minus 40 to 125 F [minus 40 to 55 C].
- ☐ Interchangeable with other proportioning motors. Use existing accessories.
- ☐ Available with 2 internal, cam-adjusted auxiliary switches.
- ☐ Available accessories include weatherproofing kit and cover-mounted transformer.



V.J.
REV. 11-75 (.073)

SPECIFICATIONS

TRADELINE MODELS

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

MODELS: M944 Modutrol Motor. For additional model characteristics, refer to the table below.

MODEL	VOLTAGE 50/60 HZ	MOTOR TIMING	STROKE (DEGREES ROTATION)	AUXILIARY SWITCH
M944A	24V ac	60 seconds	Fixed, 160	–
M944B	24V ac	60 seconds	Fixed, 160	–
M944D	24V ac	30 or 60 seconds	Dual, 90 or 160	2
M944E	24V ac	30 or 60 seconds	Dual, 90 or 160	2

ADDITIONAL FEATURES: Tradeline pack with cross reference label and special instruction sheet.

STANDARD MODELS

MODELS: M944 Modutrol Motors.

MODEL	VOLTAGE (50/60 HZ)	BALANCE RELAY	STROKE (DEGREES ROTATION)	MOTOR TIMING	AUXILIARY FUNCTIONS	
					SWITCHES	POTENTIOMETER
M944A	24V	yes	90	30 sec.	–	–
			160	15 sec. or 60 sec.		
M944B	24V	no	160	15 sec., 1 min., or 4 min.	–	–
M944C	24V	yes	90 or 160[a]	15 sec. or 2 min.	–	–
M944D	24V	yes	90 or 160[a]	30 sec.	2	–
M944E	24V	no	90 or 160[a]	15 sec. or 2 min.	2	–
M944F	24V	Yes	160	1 min.	–	yes
M944G	120V	no	90	30 sec.	–	–
			160	1 min.		
M944J	24V	no	160	1 min.	–	yes
M944K	120V	no	160	1 min.	2[b]	–
M944L	120V	no	90 or 160[a]	2 min.	–	–

[a]Stroke is field adjustable. Motor timing shown applies when 90 degree stroke is used; timing doubles when 160 degree stroke is selected.

[b]Auxiliary switches are wired to provide stroke limit also. Auxiliary switches close when motor reaches full open position.

(continued on page 3)

ORDERING INFORMATION

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

SPECIFY–

1. MODEL NUMBER, TRADELINE IF DESIRED.
2. VOLTAGE AND FREQUENCY.
3. STROKE AND TIMING.
4. ACCESSORIES.

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

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

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

ELECTRICAL CONSUMPTION:

M944A,D,F–18 watts.

M944B,E,J,K–14 watts.

M944G,L–13 watts.

AUXILIARY SWITCH RATINGS (amps):

M944D,E,K (2 MICRO SWITCH snap-acting switches)–

	120V	240V	277V
Full Load	5.8	2.9	–
Locked Rotor	34.8	17.4	–
Resistive	11.0	11.0	11.0

TORQUE (in pound-inches):

TIMING		NORMAL RUNNING TORQUE	BREAKAWAY TORQUE[a]
90 DEGREE STROKE MOTORS	160 DEGREE STROKE MOTORS		
–	15 sec.	37	75
15 sec.	30 sec.	75	150
30 sec., 1,2 min.	1,2,4 min.	150	300

[a]Breakaway torque is the maximum torque available to overcome occasional large loads such as a seized damper or valve. MOTOR MUST NOT BE USED CONTINUOUSLY AT THIS RATING.

DEAD WEIGHT LOAD ON SHAFT:

Power End–200 pounds maximum.

Auxiliary End–100 pounds maximum.

AMBIENT TEMPERATURE RATINGS:

Maximum–125 F [55 C].

Minimum–minus 40 F [minus 40 C].

CRANKSHAFT: Double-ended, 3/8 inch square.

DIMENSIONS: See Fig. 1.

ACCESSORIES:

DHE-94 Explosion-proof Housing–encloses motor for use in explosive atmospheres. Not for use with Q601 and Q455 Linkages. Order separately from Crouse-Hinds Co. Requires Honeywell 7617DM Coupling.

Cover-transformers–die-cast aluminum cover with built-in transformer.

Part No. 130810A–120V ac; 60 Hz.

Part No. 130810B–120/208/240V ac; 60 Hz.

Part No. 130810C–220V ac; 50 Hz.

Part No. 130810D–208/240V ac; 60 Hz.

Part No. 130810E–208V ac; 60 Hz.

Part No. 130810F–240V ac; 60 Hz.

Q607 Auxiliary Switch–controls auxiliary equipment as a function of motor position.

Q605 Damper Linkage–connects motor to damper. INCLUDES MOTOR CRANK ARM.

Q618 Linkage–connects Modutrol motor to water or steam valve.

Q601 Linkage–connects Modutrol motor to water or steam valve.

Q100 Linkage–connects Modutrol motor to butterfly valve.

Q209 Potentiometer–limits minimum position of motor.

Q68 Dual Control Potentiometer–controls 1 through 9 additional motors.

W859 Economizer Control Package–provides controls needed for outdoor and return air damper system.

Q181 Auxiliary Potentiometer–controls 1 or 2 additional motors.

7640JS Weatherproofing Kit–weatherproofs the M944 Modutrol Motor.

7616BR Motor Crank Arm–included with Q605 but not with motor.

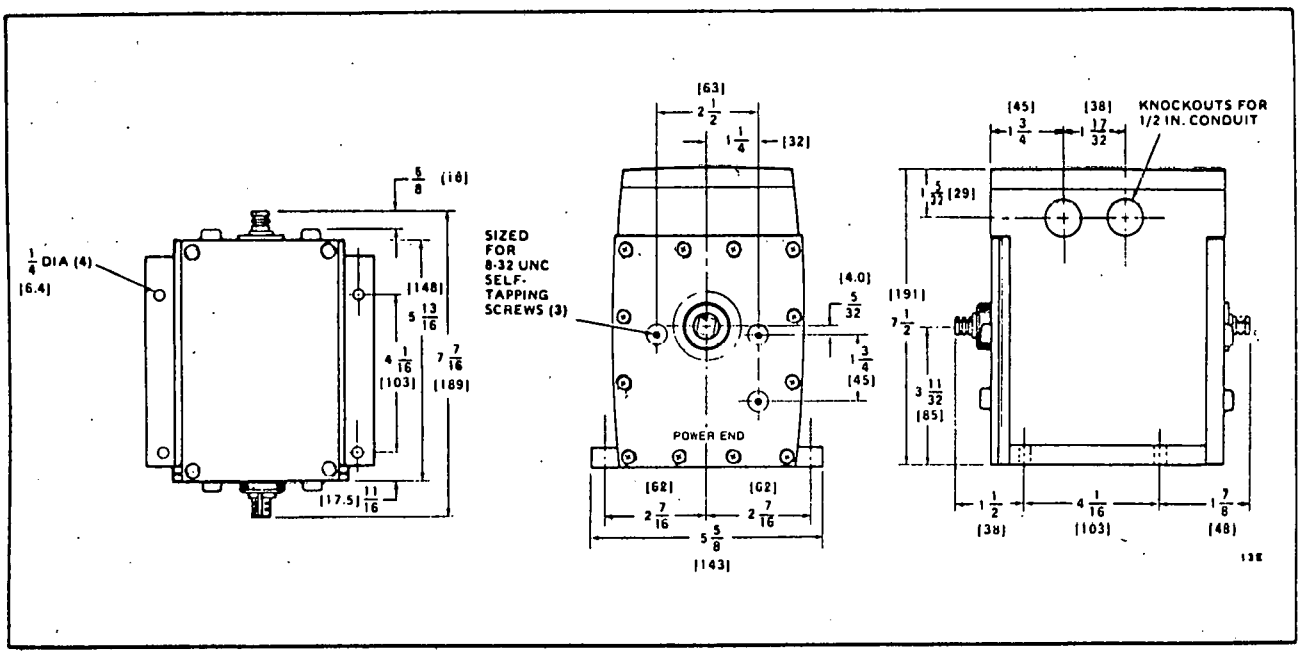


FIG. 1–DIMENSIONS, IN INCHES [IN MILLIMETRES], OF M944 MODUTROL MOTOR.

60-2292–3

INSTALLATION

CAUTION

1. Installer must be a trained, experienced serviceman.
2. Disconnect power supply before beginning installation.
3. Do not attempt to turn the motor shaft by hand or with a wrench. Damage to the gear train will result.
4. Always conduct a thorough checkout when installation is complete.

LOCATION

Install the Modutrol motor in any location except where acid fumes or other deteriorating vapors might attack the metal parts, or in atmospheres of escaping gas or other explosive vapors. Motors are rated for ambient temperatures between minus 40 and 125 F [minus 40 and 55 C]. If located outdoors, use weatherproofing kit; see Accessories section.

Allow enough clearance for installing accessories and servicing the motor when selecting a location. See Fig. 1.

MOUNTING

Always install the motor with the crankshaft horizontal. Mounting flanges extending from the bottom of the motor housing are drilled for 1/4 inch machine screws or bolts.

All M944 motors are shipped from the factory in closed position; i.e., at the limit of counterclockwise ↶ rotation as viewed from the power end of the motor, with the groove in the shaft on top. The flat of the shaft is 10 degrees from horizontal on 160 degree stroke models and 45 degrees from the horizontal on 90 degree stroke models.

INSTALLING LINKAGES

The motor comes without a crank arm. The motor arm is included in the Q605 Linkage or may be ordered separately (see Accessories).

For detailed instructions on the assembly of specific linkages, refer to the instruction sheet packed with each linkage.

In general, however, check the following points of operation when installing a motor and linkage.

1. Linkages for valves and louver type dampers should be adjusted so that the damper or valve moves through only the maximum required distance when the motor moves through its full stroke.
2. With modulating control, maximum damper opening should be no more than 60 degrees. Little additional airflow is provided beyond this point.
3. The motor must be stopped at the end of its stroke by the limit switch and must not be stalled by the damper or valve. The motor will be damaged if it is not permitted to complete its full stroke.
4. Do not exceed the motor ratings in any installation.

WIRING

CAUTION

Disconnect power supply before wiring to prevent electrical shock or equipment damage.

All wiring must agree with applicable codes, ordinances, and regulations.

Make sure that the voltage and frequency stamped on the motor correspond to the characteristics of the power supply.

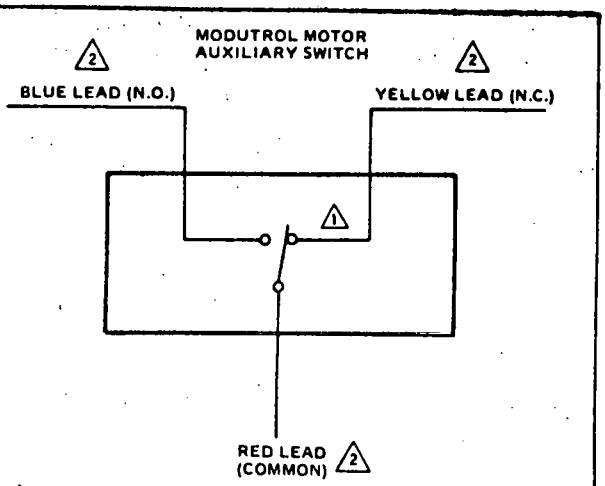
Figs. 2–5 show internal schematics for the M944 motors, and Figs. 6–12 show some typical system connections.

IMPORTANT

After the valve or damper linkage is connected to the motor, it may be necessary to interchange the blue and yellow connections at the motor terminals to obtain the proper action of the valve or damper on a temperature increase or decrease at the controller.

If a motor operates in a direction opposite of the rotation desired, the rotation can be reversed by switching wires at either the motor or the panel. With the M944A, C,D, and F motors, reverse wires at the B1 and W1 terminals. With M944B,E,G,J, and L motors, reverse the wires at the 1 and 2 terminals and the Y and G terminals. On the M944K motor, reverse the wires at the 1 and 3 terminals, and the 4 and 6 terminals.

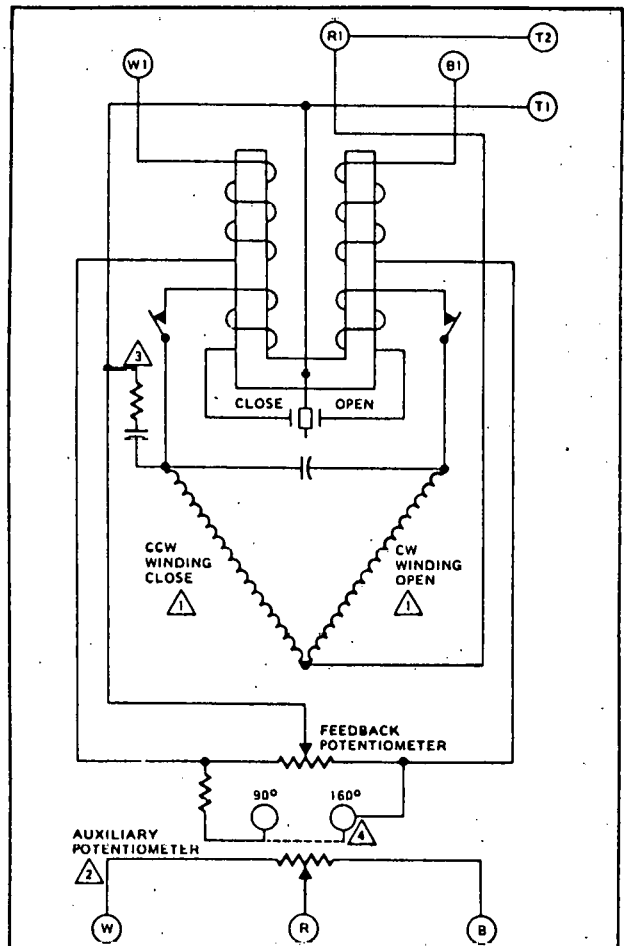
NOTE: In most applications a single 135 ohm potentiometer in the limit controller provides 50 percent operation of a valve or damper. For those applications where the limit controller must be able to operate the valve or damper to 100 percent of its capacity, it must have either one 270 ohm potentiometer or two series-connected potentiometers with combined total resistance up to 280 ohms. If a 2-potentiometer limit controller is used, it should be wired into the circuit so control varies over the entire resistance.



1. WIRING SHOULD BE NEC CLASS 1 UNLESS MAXIMUM CONTACT VOLTAGE IS LESS THAN 30 VOLTS; THEN USE CLASS 2. TAPE UNUSED LEADS. MAKE CERTAIN THE CURRENT DRAW OF THE EXTERNAL CIRCUIT IS LESS THAN CONTACT RATING OF SWITCH.
2. ON TWO-SWITCH MOTORS, RIGHT SWITCH (RED DOT) HAS BLACK LEADS WITH BLUE, YELLOW, AND RED TRACERS.

183m

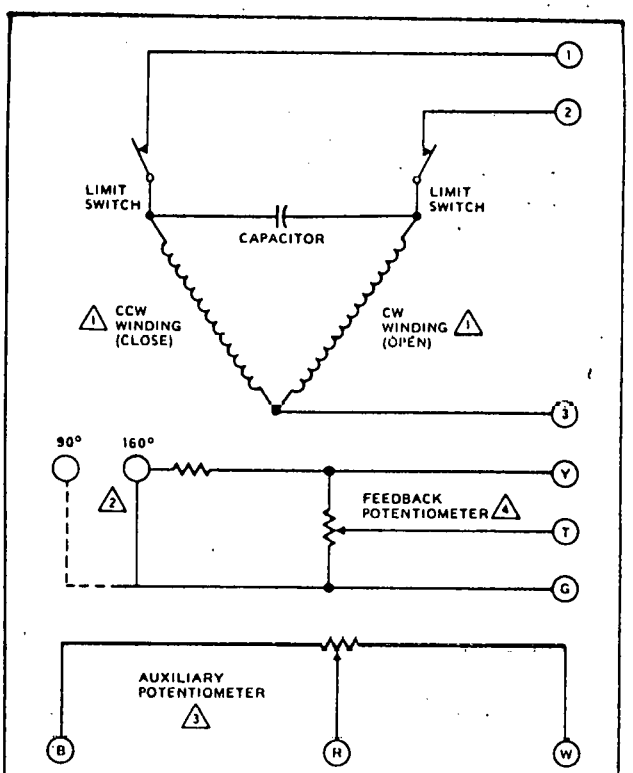
FIG. 2– AUXILIARY SWITCH SCHEMATIC.



1. DIRECTION OF MOTOR ROTATION AS VIEWED FROM POWER END.
2. M944F ONLY. MAKES R TO W IN FULL CLOSED POSITION, R TO B IN FULL OPEN POSITION.
3. RESISTOR AND CAPACITOR FOR ARC SUPPRESSION.
4. M944C,D ONLY. LEAD MUST BE FIELD CONNECTED TO CORRECT TERMINAL FOR DESIRED MOTOR STROKE.

6147

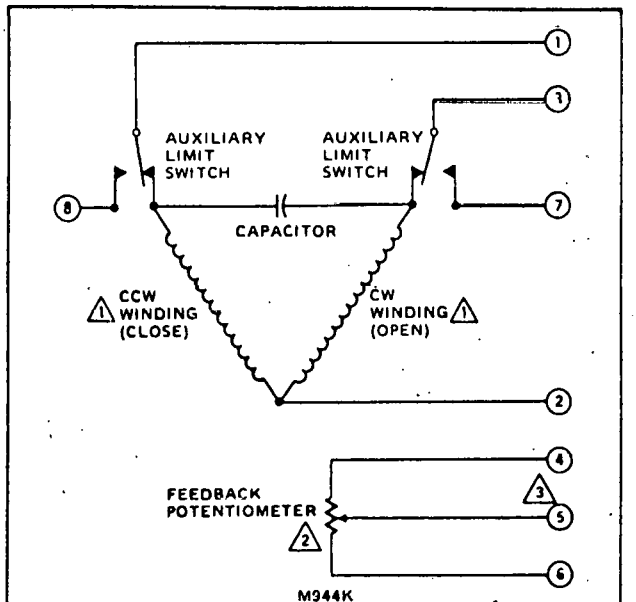
FIG. 3–M944A,C,D,F INTERNAL SCHEMATIC.



1. DIRECTION OF MOTOR ROTATION AS VIEWED FROM POWER END.
2. M944E ONLY. LEAD MUST BE FIELD-CONNECTED TO CORRECT TERMINAL FOR DESIRED MOTOR STROKE.
3. AUXILIARY POTENTIOMETER ON M944J ONLY; MAKES R TO W IN FULL CLOSED POSITION, R TO B IN FULL OPEN POSITION.
4. FEEDBACK POTENTIOMETER MAKES T TO G IN FULL CLOSED POSITION, T TO Y IN FULL OPEN POSITION.
5. TERMINALS 1, 2, AND 3 ARE LINE VOLTAGE ON M944G,L ONLY.

463C

FIG. 4– M944B,E,G,J,L INTERNAL SCHEMATIC.



1. DIRECTION OF MOTOR ROTATION AS VIEWED FROM POWER END.
2. FEEDBACK POTENTIOMETER MAKES 5 TO 6 IN FULL CLOSED POSITION; 5 TO 4 IN FULL OPEN POSITION.
3. TERMINAL 4, 5, AND 6 LOW VOLTAGE.

477A

FIG. 5– M944K INTERNAL SCHEMATIC.

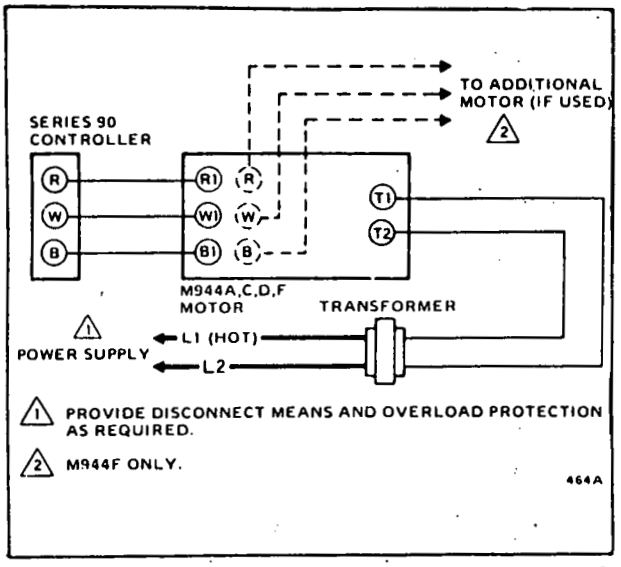


FIG. 6–M944A,C,D, OR F MODUTROL MOTOR USED WITH A SERIES 90 CONTROLLER. DOTTED LINES SHOW CONNECTIONS TO SECOND MOTOR (M944F ONLY).

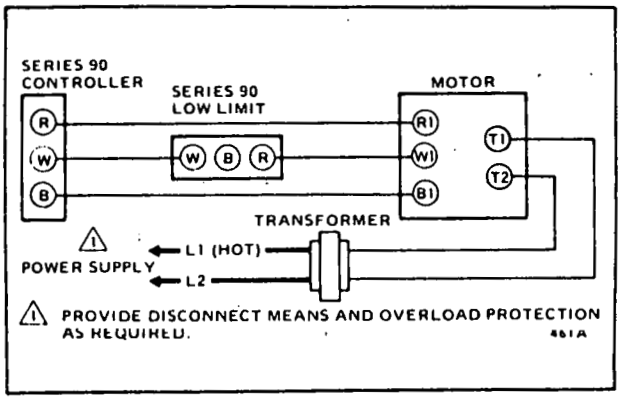


FIG. 7–M944A,C,D, OR F USED WITH MODULATING LOW LIMIT TO PREVENT DISCHARGE AIR FROM GOING BELOW DESIRED MINIMUM TEMPERATURE (MAXIMUM AUTHORITY–50 PERCENT WITH 135 OHM CONTROLLER OR 100 PERCENT WITH 270 OHM CONTROLLER).

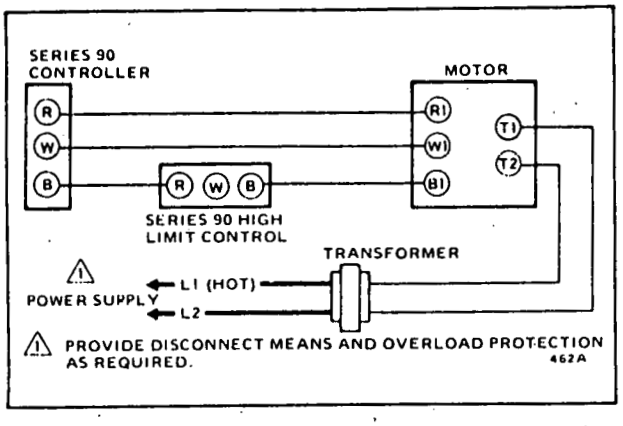


FIG. 8–M944A,C,D, OR F MOTOR USED WITH A SERIES 90 CONTROLLER AND A SERIES 90 HIGH LIMIT; OFTEN USED ON CENTRAL FAN HEATING SYSTEMS TO LIMIT THE DISCHARGE AIR TEMPERATURE.

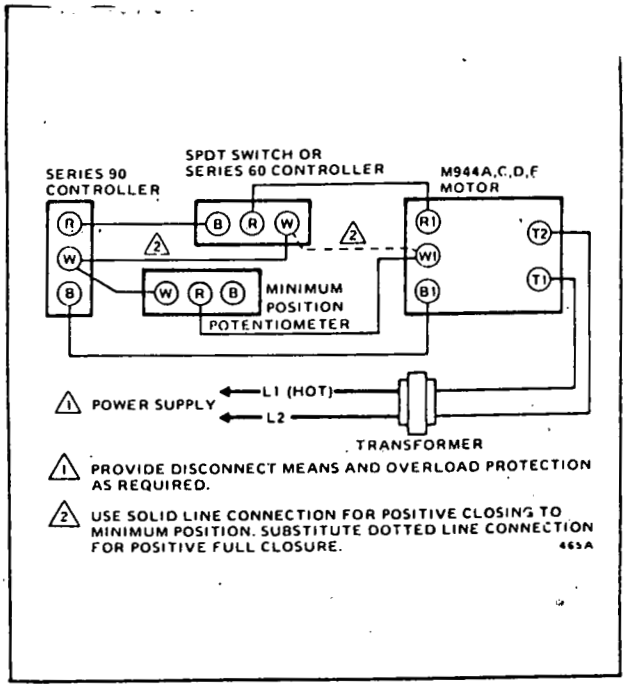


FIG. 9–M944A,C,D, OR F MOTOR USED WITH A SERIES 90 CONTROLLER, A MANUAL MINIMUM POSITION POTENTIOMETER, AND AN SPDT SWITCH FOR 2-POSITION HIGH LIMIT CONTROL.

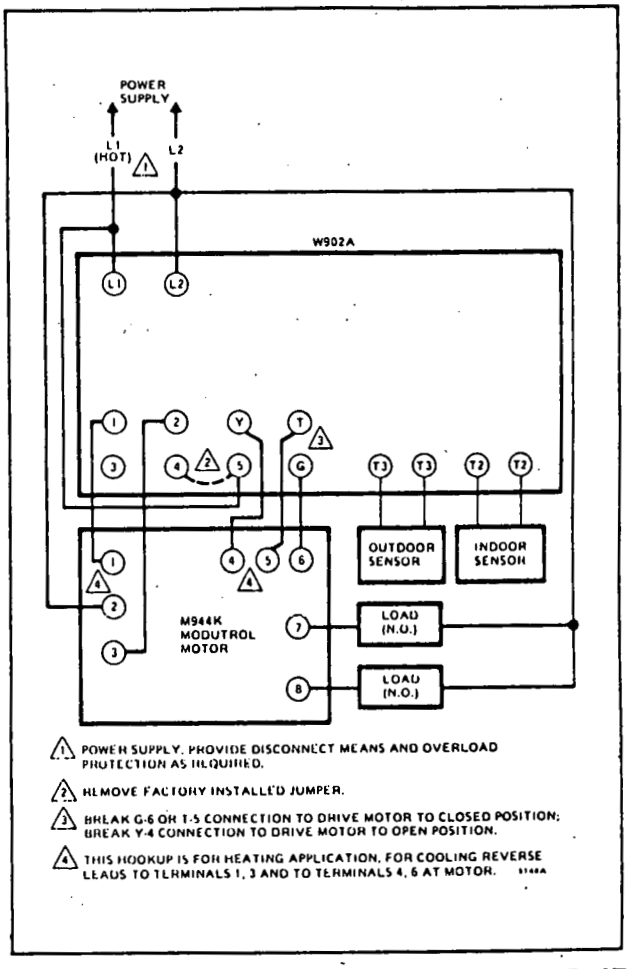


FIG. 10–CONNECTING M944K TO W902 RESET CONTROL.

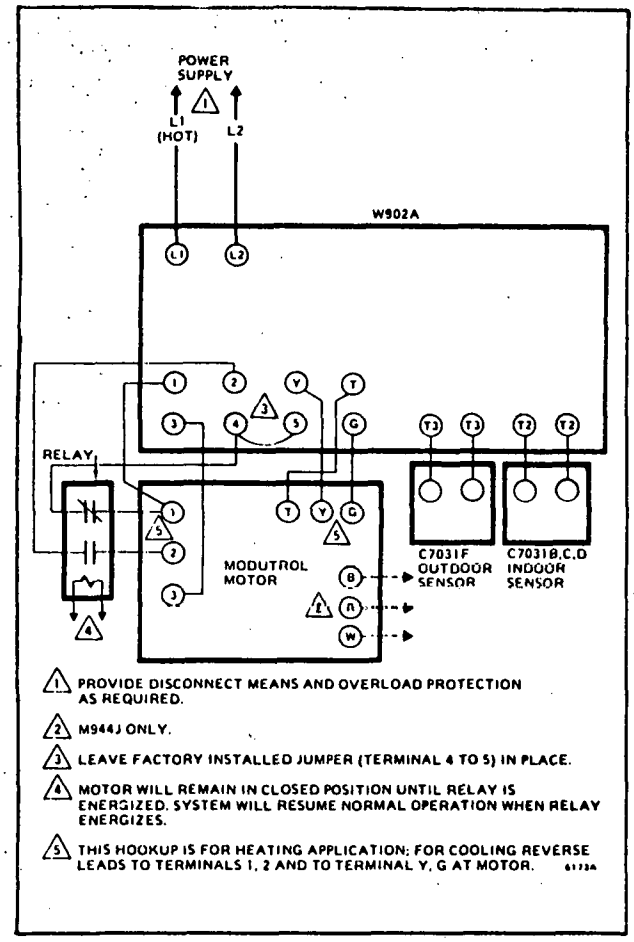


FIG. 11–M944B,E, OR J USED WITH W902 RESET CONTROL. DOTTED LINES SHOW CONNECTIONS TO SECOND MOTOR (M944J ONLY).

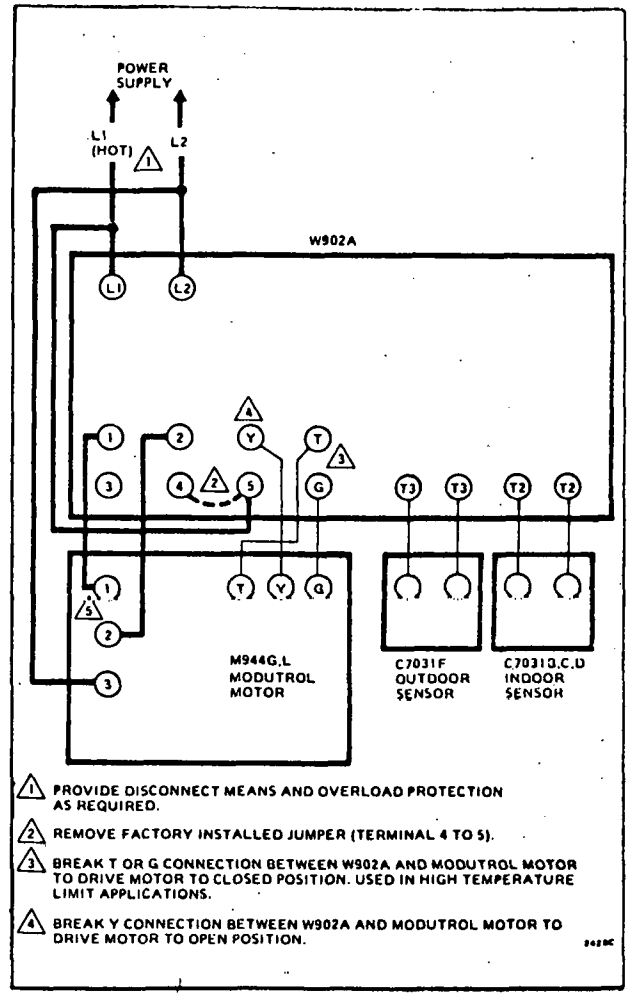


FIG. 12–CONNECTING M944G,L TO W902 RESET CONTROL.

SETTINGS AND ADJUSTMENTS

STROKE ADJUSTMENT

(DUAL STROKE MOTORS M944C,D,E, AND L)

Changing the position of the limit arms that actuate the limit switches adjusts the motor stroke. Use the following procedure to adjust the stroke to 90 or 160 degrees.

1. Run motor to approximately midstroke (motor must remain there while making adjustments). Remove the cover from the auxiliary end of the motor by taking out the 4 screws securing it. On the M944D and E, be careful not to lose the small spring and washers around the motor shaft. They hold the switch cams against the driving dogs. Remove the switch cams from the M944D and E.

NOTE (for motors with auxiliary switches): The switch cams are color-coded to insure they are driving the correct switch. The inner cam (color-coded blue) drives the left switch (also color-coded blue). The outer cam (color-coded red) drives the right switch. When replacing the cam in the motor, make certain the color code of the switch matches the color code of the driving cam.

2. Loosen the 2 screws in the limit arm hub (Fig. 13). Set the arms at either extreme of their travel. With both arms up, the stroke will be 160 degrees; with both arms down, the stroke will be 90 degrees. Retighten both screws.

3. Connect the terminal board lead to the proper terminal (160 or 90).

CAUTION

Both limit arms and lead must be set for the same stroke (90 or 160) or the motor will not control accurately.

4. Replace the switch cams and the spring and washers on M944D,E.

NOTE: When reinstalling cam, make certain the driving dogs engage the keyway slots on the limit arm assembly. Replace the motor cover and secure with 4 screws.

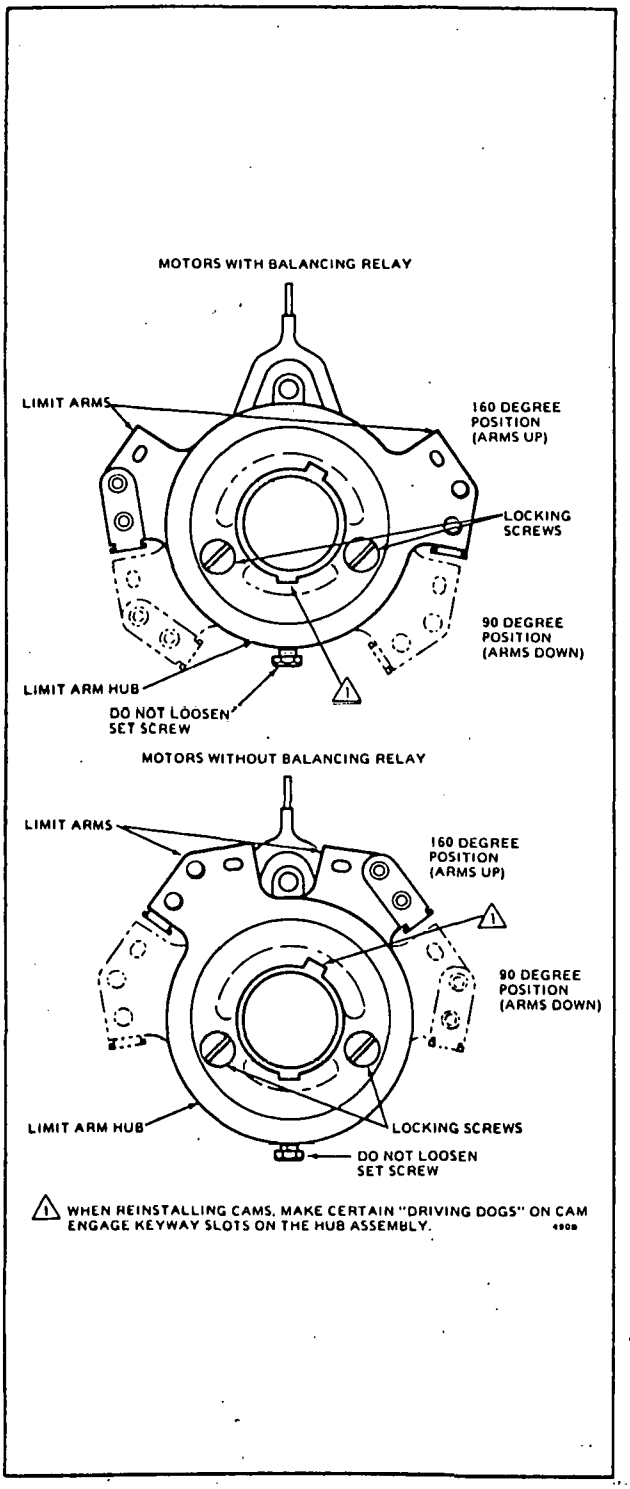


FIG. 13–CHANGE THE POSITIONS OF THE LIMIT ARMS TO ADJUST THE MOTOR STROKE.

AUXILIARY SWITCH ADJUSTMENT (M944D,E ONLY)

The auxiliary switches in the M944 are operated by cams on the motor shaft. Each switch is operated by a separate set of cams; the left switch and cams are color-coded blue, and the right switch and cams are color-coded red. The switch makes red to blue when its cam roller moves to the upper level of the operational cam and makes red to yellow when the cam roller moves to the lower level. The differential cam provides an intermediate level; it can be used to increase differential between the switch make and break points.

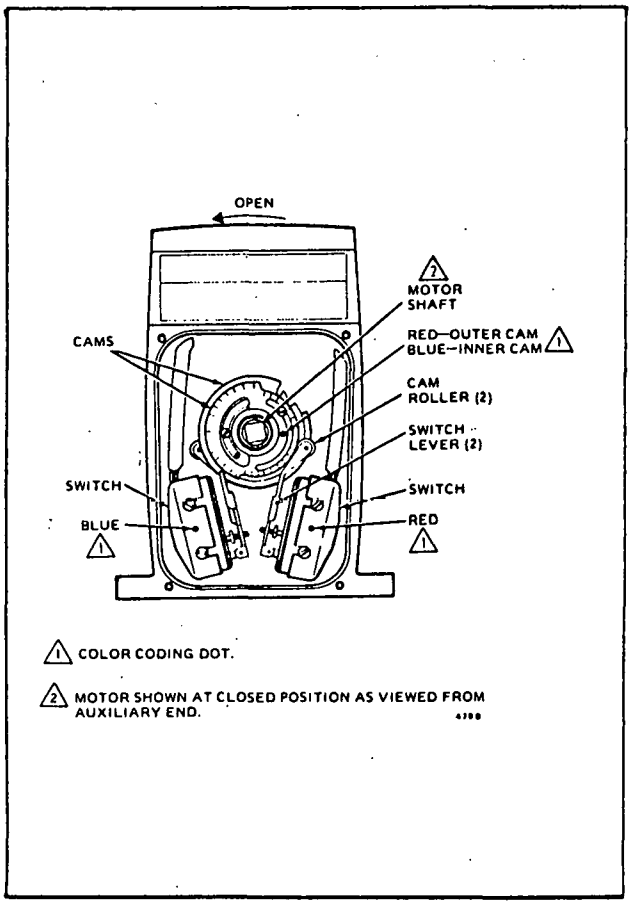


FIG. 14–LOCATION OF INTERNAL AUXILIARY SWITCHES AND SWITCH CAMS IN M944 MODUTROL MOTORS.

APPROXIMATE ADJUSTMENT

(Does not require running the motor.)

1. Motor must be in the full closed position.
2. Remove auxiliary end cover by removing the 4 screws securing it to the motor.
3. Remove spring and washers on motor shaft.
4. Push back right cam roller and remove outer cam. Note color coding dots.
5. Adjust left switch (inner cam) first (Fig. 15).

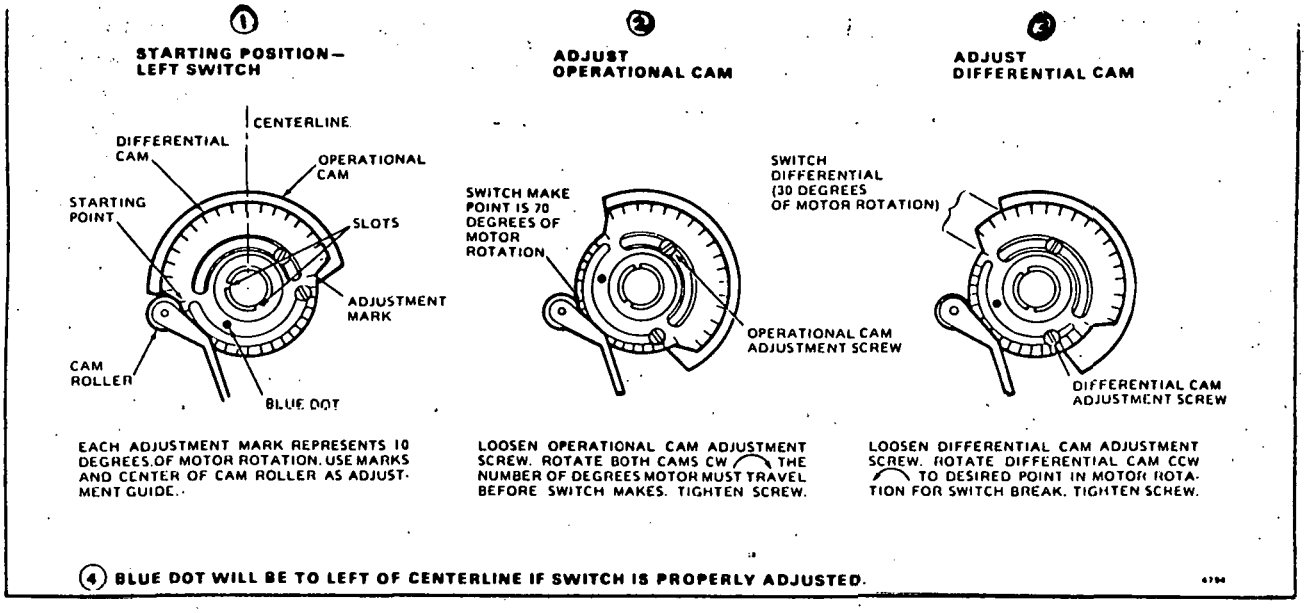


FIG. 15—ADJUST MAKE AND BREAK POINTS OF LEFT AUXILIARY SWITCH.

6. Put right switch cams on motor shaft and adjust right switch (Fig. 16).

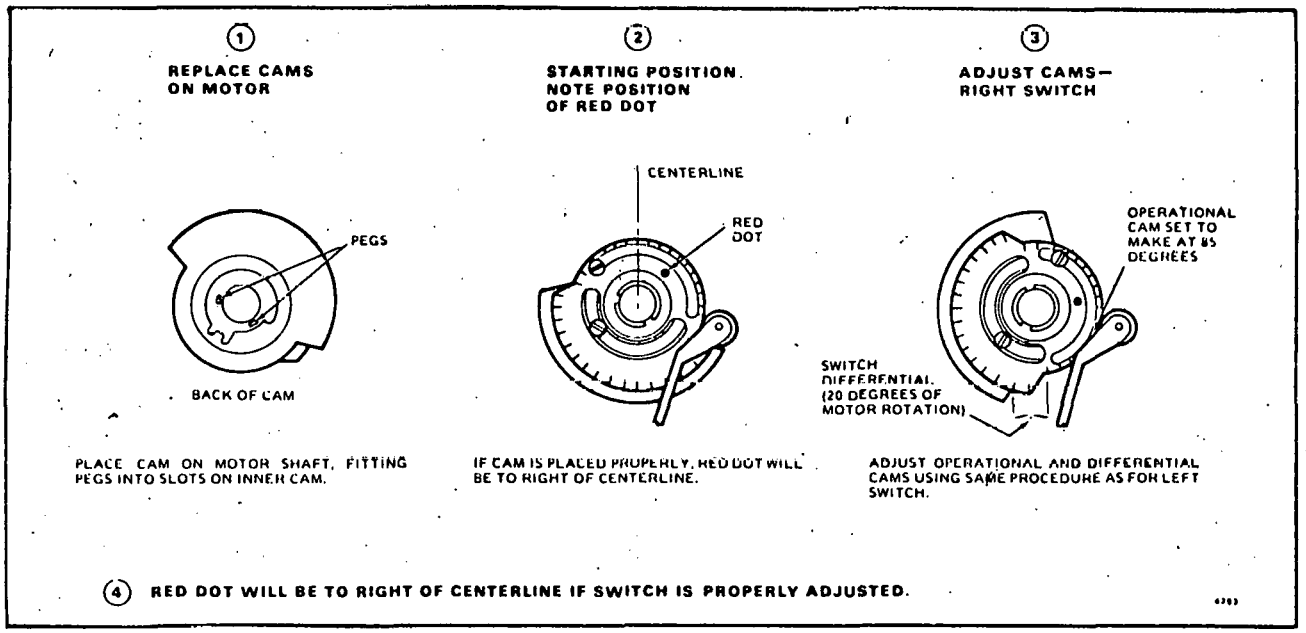


FIG. 16—ADJUST MAKE AND BREAK POINTS OF RIGHT AUXILIARY SWITCH.

7. After switches are adjusted, replace spring and washers on motor shaft and replace the auxiliary end cover.

EXACT ADJUSTMENT

(Requires running the motor.)

Connect a manual potentiometer to the motor in place of the regular controller and run the motor to the desired position for switch make. Set the switch cam and then run the motor back to desired switch break point and set differential cam.

CAUTION

Do not turn the motor shaft by hand or with a wrench as damage to the gear train will result.

M944K AUXILIARY SWITCHES

The auxiliary switches in the M944K are not adjustable. They are spdt switches which function both as auxiliary switches and as limits on motor rotation. When the motor reaches the full open position, the auxiliary side of the switches makes to power auxiliary equipment. When the motor begins to close, these switches break and the limit side of the switches remakes to supply power to the motor windings.

OPERATION

SERIES 90 CIRCUIT

The 2 potentiometers, one in the controller and one in the motor, along with the balancing relay form a bridge circuit. As long as the value of the controlled medium remains at the controller set point, the circuit is balanced (equal current flowing through each half of the balancing relay), and the motor does not run.

When the value of the controlled medium changes, the potentiometer wiper in the controller is moved. This unbalances the circuit and more current flows through one-half of the balancing relay. The relay closes and the motor runs in the direction necessary to correct the change in temperature or pressure. As the motor runs, the feedback potentiometer moves to rebalance the circuit and stop the motor.

SERIES 70 CIRCUIT

When the M944 is used with an electronic panel, the operation is similar to that described above. In this application, however, the temperature is sensed by a resistance element. With a change in temperature, the resistance of the element changes and unbalances a circuit that actuates the electronic relay. This, in turn, runs the motor, which moves the feedback potentiometer and rebalances the circuit.

CHECKOUT

After installation and linkage adjustment, check the entire motor and control hookup to prove that–

–the motor operates the damper or valve properly.

–the motor responds properly to the controller.

Inspect the motor, linkage and valve or damper to see that all mechanical connections are correct and secure. In damper installations, the pushrod should not extend more than a few inches past the ball joints. Check to see that there is adequate clearance for the linkage to move through its stroke without binding or striking other objects.

M944 motors are shipped in the fully closed position (the limit of counterclockwise rotation as viewed from the power end of the motor).

To check operation of motors with integral balance relay, jumper R1 to W1 to close, or R1 to B1 to open, the motor. Check operation of motors without integral balance relay by jumpering appropriate terminals on the remote balance relay. If the motor is used with an electronic relay, follow the instructions provided with the relay.

To reverse the direction of motor rotation, reverse the wires at terminals B1 and W1 on M944A,C,D, and F; terminals 1 and 2 and terminals Y and G on M944B,E, G,J, and L motors. On M944K motors, reverse the wires at terminals 1 and 3 and terminals 4 and 6. The wires may be reversed either at the motor or at the panel.

To check system operation, adjust the set point of the controller above and below the ambient value and make sure the motor and valve or damper operate as desired. Return controller to desired setting before leaving job.

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

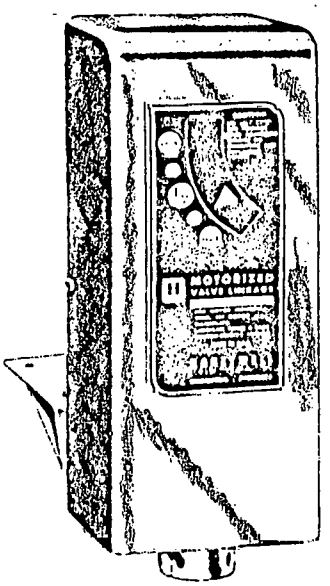
PRINTED IN U.S.A.

Honeywell

VALVE LINKAGE

THE Q601 VALVE LINKAGE IS USED TO CONNECT A MODUTROL MOTOR TO A WATER OR STEAM VALVE.

- ☐ It is applicable to either two or three way valves in modulating or two position service.
- ☐ The linkage mounts directly on the valve bonnet and the motor mounts on the linkage.
- ☐ Easy-to-read valve position indicator.
- ☐ Simple lift adjustment.
- ☐ Strain relief permits tightest possible close-off without excessive strain on the motor.
- ☐ Easy mounting and valve connection.
- ☐ Two bracket diameters make linkages adaptable to many valve bodies.



Q601E,F,J,K,L,M

Residential Div. Form Number 71-92136

H.A.
REV. 5-74 (.034)

SPECIFICATIONS

TRADELINE MODELS

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

TRADELINE MODELS AVAILABLE: Q601M non-adjustable valve linkage.

TRADELINE FEATURES: Special Tradeline pack with cross reference label and special Tradeline instructions.

STANDARD MODELS

TABLE I

MODEL	STRAIN RELIEF SPRING TENSION (LB)	LIFT SLOT ADJUSTMENT (IN)	BONNET CONNECTION	BONNET SIZE (IN)	STEM CONNECTION TYPE	ANTI-SPIN MECHANISM INCLUDED	LINKAGE REPLACED
Q601E	160	3/8 to 1-1/2	Setscrews	1-7/8	button & clamp	yes	—
Q601F	80	3/8 to 2-1/2	Setscrews	1-7/8	button & clamp	yes	Q601H
Q601J	160	3/4 fixed[a]	Setscrews	1-3/8	button & clamp	no	—
Q601K	160	3/8 to 1-1/2	Setscrews	1-3/8	button & clamp	yes	Q601D
Q601L	80	3/8 to 1-1/2	Setscrews	1-3/8	button & clamp	yes	Q601G
Q601M	80	3/4 fixed[a]	Setscrews	1-3/8	button & clamp	no	Q455G

[a]Heat-Cool sequenced linkage.

MODELS VALVE-LINKAGE-MOTOR COMBINATIONS

TABLE II—SPRING RETURN MOTORS: 2 POSITION-M445, M845; MODULATING-M945—

VALVE	TYPE	CONNECTIONS	PIPE SIZE (IN)	LINKAGE
V5011A	2 way	screwed	1/2, 3/4, 1, 1-1/4, 1-1/2, 2, 2-1/2, 3	Q601L
V5011A	2 way	flanged	2-1/2, 3	Q601L
V5047A	2 way	screwed	1, 1-1/4, 1-1/2, 2	Q601L
V5013A	3 way mixing	screwed	1/2, 3/4, 1, 1-1/4, 1-1/2, 2	Q601L

TABLE III—NON-SPRING RETURN MOTORS: 2 POSITION-M644; MODULATING-M944—

VALVE	TYPE	CONNECTIONS	PIPE SIZE (IN)	LINKAGE
V5011A, C	2 way	Screwed	1/2, 3/4, 1, 1-1/4, 1-1/2, 2, 2-1/2, 3	Q601K
V5011A	2 way	Flanged	2-1/2, 3	Q601K
V5011A, B	2 way	Flanged	4, 5, 6	Q601E
V5047A	2 way	Screwed	1, 1-1/4, 1-1/2, 2	Q601K
V5051A	2 way	Flanged	2-1/2, 3, 4, 5, 6	Q601K
V5013A	3 way, mixing	Screwed	1/2, 3/4, 1, 1-1/4, 1-1/2, 2	Q601K
V5013B	3 way, mixing	Flanged	2-1/2, 3	Q601K
V5013B	3 way, mixing	Flanged	4, 5, 6	Q601E
V5013C	3 way, diverting	Flanged	2-1/2, 3	Q601K
V5013C	3 way, diverting	Flanged	4, 5, 6	Q601E

(continued on page 3)

ORDERING INFORMATION

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

SPECIFY—
1. MODEL NUMBER (VALVE AND MOTOR MUST BE ORDERED SEPARATELY).
2. Q601M TRADELINE, IF DESIRED.

ORDER FROM—
1. YOUR USUAL SOURCE, OR
2. HONEYWELL
   1885 DOUGLAS DRIVE NORTH
   MINNEAPOLIS, MINNESOTA 55422
   (IN CANADA—HONEYWELL CONTROLS LIMITED
   740 ELLESMERE ROAD
   SCARBOROUGH, ONTARIO)
   INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

LISTS FOR COMMONLY USED VALVES (INCHES)

TABLE IV–

VALVE	VALVE SIZEa										
MODEL NO.	1/2 IN.	3/4 IN.	1 IN.	1-1/4 IN.	1-1/2 IN.	2 IN.	2-1/2 IN.	3 IN.	4 IN.	5 IN.	6 IN.
V5011A	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	1-1/2	1-1/2	1-1/2
V5013A	3/4	3/4	3/4	3/4	3/4	3/4	—	—	—	—	—
V5013B	—	—	—	—	—	—	3/4	3/4	1-1/2	1-1/2	1-1/2
V5013C	—	—	—	—	—	—	3/4	3/4	1-1/2	1-1/2	1-1/2
V5047A	—	—	9/16	9/16	9/16	3/4	—	—	—	—	—
V5051A	—	—	—	—	—	—	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2

aWhere no lift values are given, either the valve is unavailable in that size or using this valve size in motor-driven assembly is not recommended.

DIMENSIONS

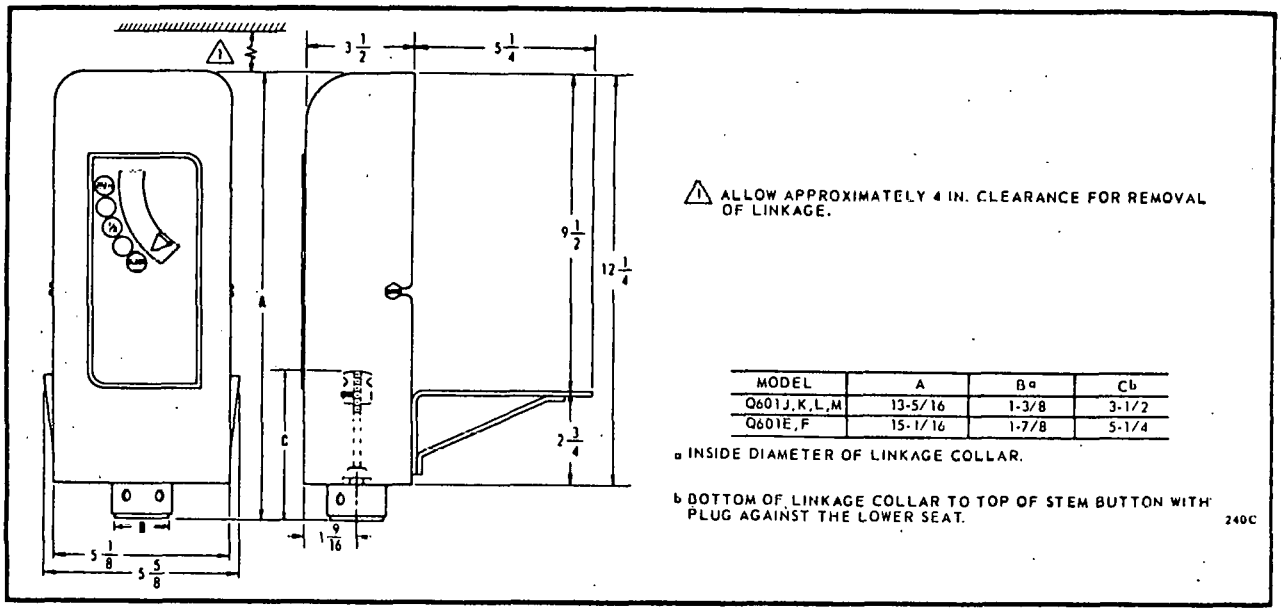


FIG. 1–Q601 LINKAGES INSTALLATION WITH DIMENSIONS IN INCHES.

INSTALLATION

IMPORTANT

1. Installer must be a trained and experienced serviceman.
2. Perform a complete checkout when installation is complete.

LOCATION

Select a location that allows ample clearance for adjustment and maintenance.

Mount the motor with the shaft horizontal to keep the gear train properly lubricated. Allow at least four inches above the linkage to remove the valve assembly for maintenance.

MOUNTING THE MOTOR

1. Hold the crank arm and connector link as shown in Fig. 2 (turn arm 160 degrees for normally open motors).
2. Slide the motor toward crank arm slot until motor shaft properly engages the crank arm. The key on the crank arm must fit in the keyway on the motor shaft.
3. Tighten the clamp screw.
4. Bolt motor to bracket with the four bolts provided.

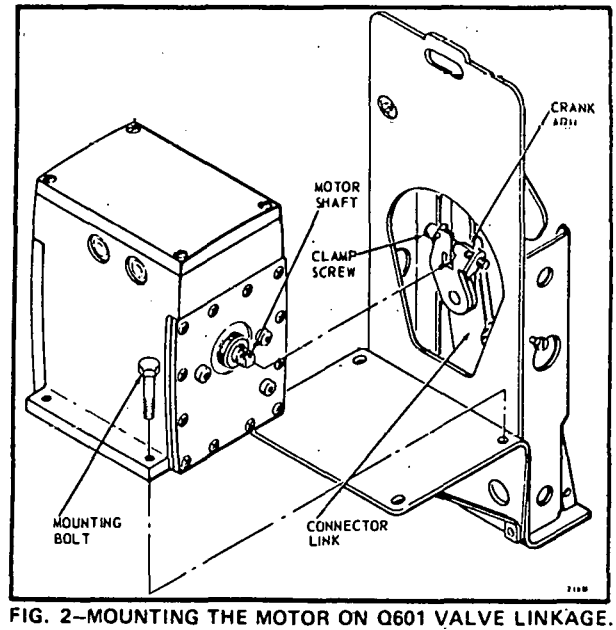


FIG. 2–MOUNTING THE MOTOR ON Q601 VALVE LINKAGE.

MOUNT MOTOR AND LINKAGE ON VALVE

SETSCREW BONNET CONNECTION

1. Remove the button clamp screw.

2. Loosen screws, fit collar over valve bonnet, and tighten screws.

3. Loosen adjustment screw locknut.

4. Push valve stem to bottom of stroke for normally closed installation (closed to port B on three-way valve).

Push valve stem to top of stroke for a normally open installation (open to port B on three-way valve).

5. Turn adjustment screw and align stem button clamp with groove in stem button.

6. Fit stem button into clamp, line up anti-spin device (when fitted), and replace and tighten the screw.

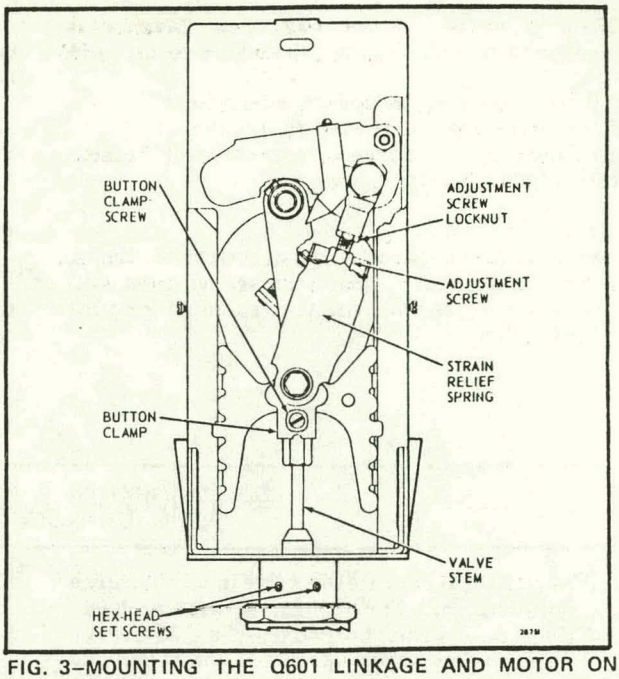


FIG. 3–MOUNTING THE Q601 LINKAGE AND MOTOR ON THE VALVE.

ADJUSTMENTS

TWO-WAY VALVES

1. On Q601E, F, K, L only, set the lift adjustment equal to the rated lift of the valve (Table IV).

2. For all models, with valve and motor closed, loosen the locknut and turn the adjusting screw down until top of washer is even with pointer. This puts tension on valve in closed position.

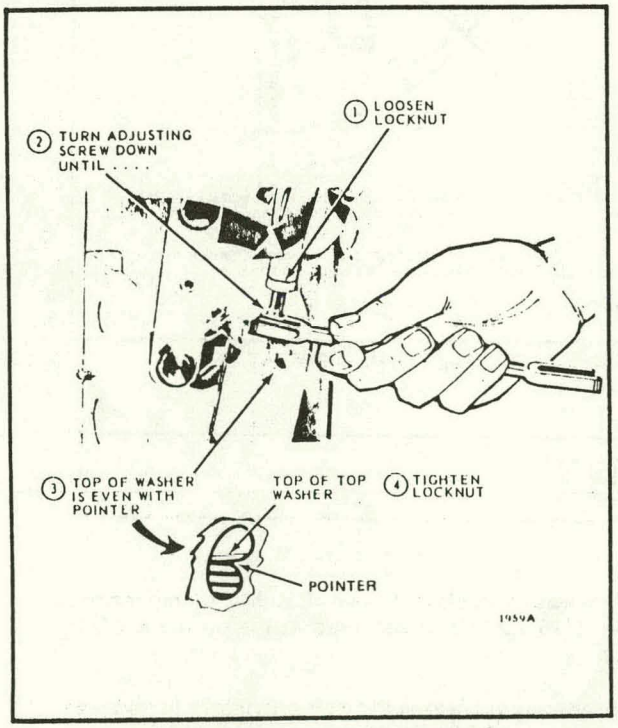


FIG. 4–TWO-WAY VALVE ADJUSTMENT.

THREE-WAY VALVES

Q601E, F, K, L

1. Set the lift adjustment 1/2 division above the rated valve lift (Table IV).

2. With motor closed and valve at bottom of stroke, loosen locknut and turn adjustment screw down until top of washer is even with pointer (same as for two-way valve).

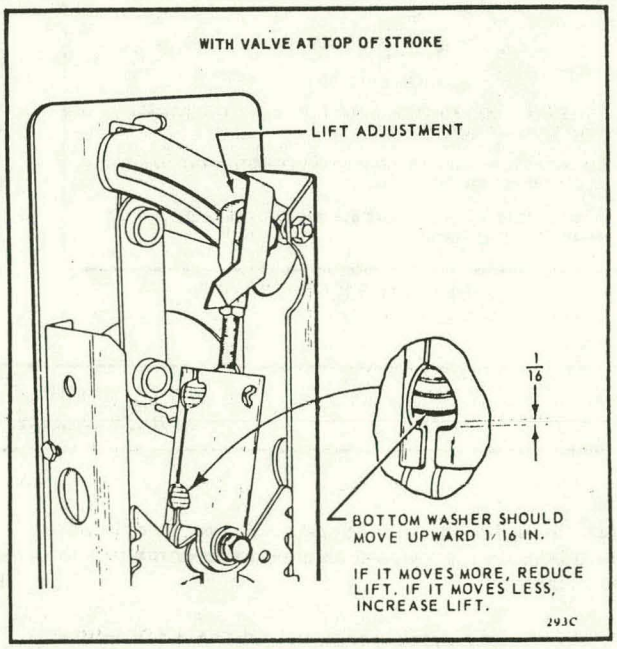


FIG. 5–THREE-WAY VALVE ADJUSTMENT.

3. Run the motor all the way open. Washer at bottom of strain relief spring should move up 1/16 inch—

—If it moves more, reduce lift adjustment.

—If it moves less, increase lift adjustment.

If lift adjustment is changed, reset close-off tension at bottom of stroke before going on.

Q601J, M

1. With motor closed and valve at bottom of stroke, loosen locknut and turn adjustment screw down until top of washer is even with pointer (same as for two-way valves).

2. Run the motor all the way open. Washer at bottom of strain relief spring should move up approximately the same distance as top washer moved down.

If bottom washer moves more—turn adjusting screw up (counterclockwise ↶).

If bottom washer moves less—turn adjusting screw down (clockwise ↷).

Adjust screw until washer movement is equal. If tension is incorrectly adjusted, valve may not close off tightly.

OPERATION

The Q601E, F, K, L operate the valve in a 160 degree stroke. See Fig. 6. The Q601J, M heat-cool sequenced linkages operate the valve in a 100 degree stroke. Auxiliary switches operate in the remaining 60 degrees to sequence the cooling equipment. See Fig. 7.

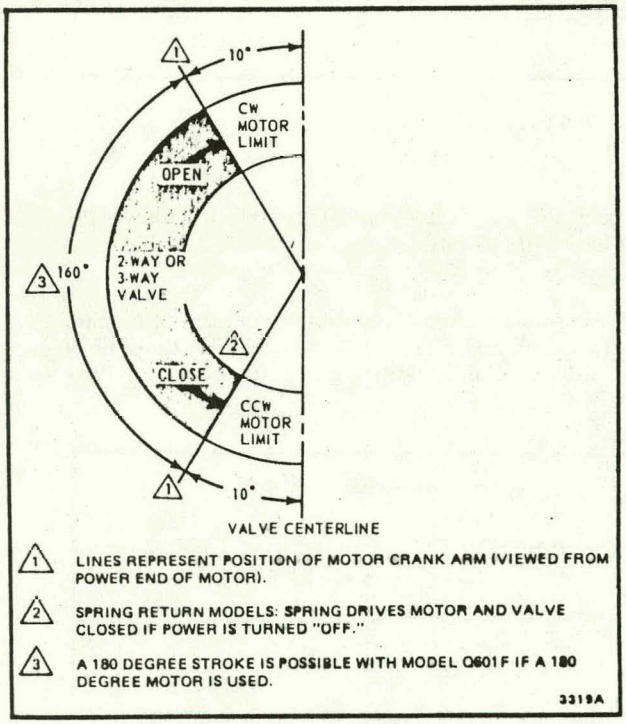


FIG. 6—OF Q601E,F,K,L OPERATION

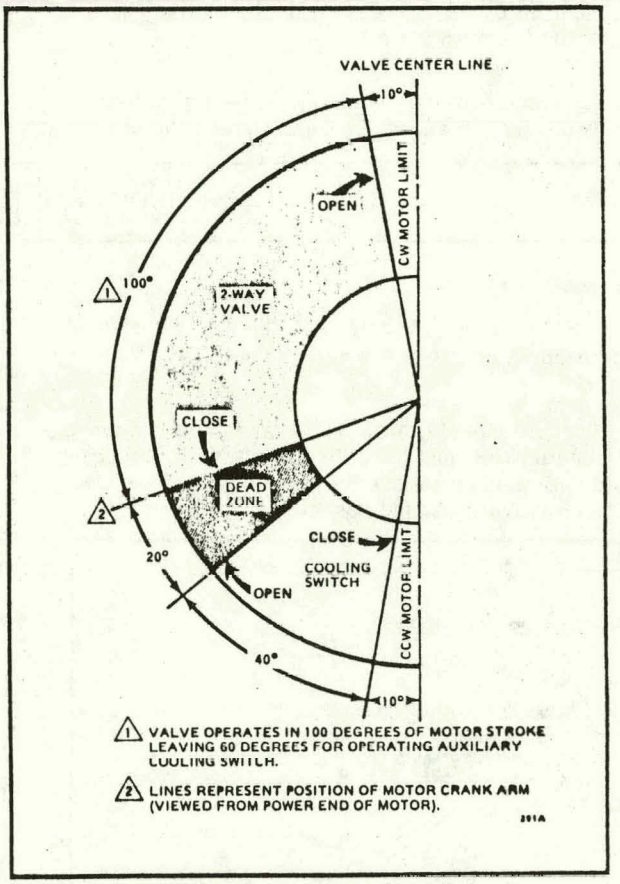


FIG. 7—OF Q601J,M OPERATION

CHECKOUT

After installation and adjustment are completed, check to be sure the valve-linkage-motor combination works properly.

Refer to the appropriate instruction sheet for information on running the motor during checkout.

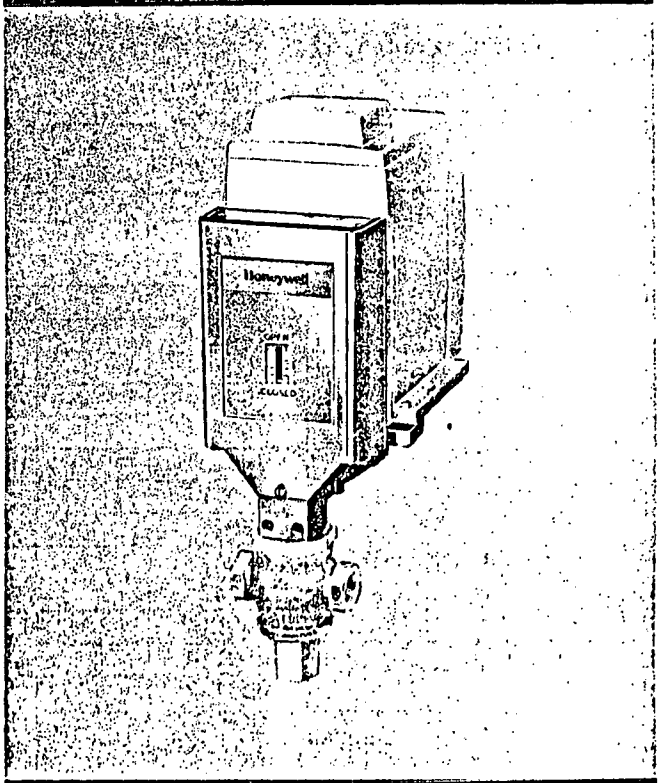
A two-way valve should close off tightly (compressing spring 1/16 inch) and not bind at the open end of its stroke.

A three-way valve should close off tightly (compressing spring 1/16 inch) at both ends of its stroke.

71-92136

Ho eywe

VALVE LINKAGE



Q618A

THE Q618 VALVE LINKAGE CONNECTS A MODUTROL MOTOR TO A 2- OR 3-WAY VALVE. IT IS USED ON HONEYWELL STEAM AND WATER VALVES HAVING A 3/4 INCH [19 MM] STROKE AND A 1-3/8 INCH [35 MM] BONNET, SUCH AS THE V5011 OR V5013.

- Linkage requires no adjustment for use on either 2- or 3-way valves.
- Linkage mounts easily on Modutrol motors and valves.
- Requires no adjustment, either at installation or later.
- Small, lightweight unit requires little space on the installation.
- Available with either 80 or 160 pound seal-off force.

S.K.
REV. 8-75 (.012)

SPECIFICATIONS

TRADELINE MODELS

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

TRADELINE MODELS:
Q618A Valve Linkage with 80 or 160 lb. seal-off force on valve stem.

ADDITIONAL FEATURES: Tradeline pack with cross reference label and special instruction sheet.

STANDARD MODELS

MODEL: Q618A Valve Linkage.
STROKE: 3/4 inch [19 mm], fixed.
SEAL-OFF FORCE ON VALVE STEM: 80 or 160 pounds.
VALVE BONNET SIZE: 1-3/8 inches [35 mm].
TEMPERATURE RATINGS: Limited only by temperature rating of valve and motor.
WEIGHT: 3-1/2 pounds.
MOTOR REQUIRED:
160 pound–M944, M644, M941.
80 pound–M945, M445, M845, M934, M634.
MOTOR STROKE: 160 degrees–normally open or normally closed.
DIMENSIONS: See Fig. 1.

LINKAGE REPLACEMENT INFORMATION:

OLD LINKAGES	TYPICALLY USED ON–		REPLACEMENT LINKAGES	
	VALVE	SIZE IN INCHES [MM]	STANDARD	TRADELINE
Q455C and Q601D	V5011	1/2–3 [12.5–76]	Q618A1008	Q618A1024
	V5013	1/2–3 [12.5–76]	Q618A1008	Q618A1024
	V5047[a]	1–1-1/2 [25.5–38]	Q601K1003	–
	V5047	2 [51]	Q618A1008	Q618A1024
	V5051[a]	2-1/2–6 [63.5–152.5]	Q601K1003	–
Q455D	V5011[a]	4–6 [101.5–152.5]	Q601E1000	–
	V5013[a]	4–6 [101.5–152.5]	Q601E1000	–
Q455E and Q601H	V5011[a]	4–6 [101.5–152.5]	Q601F1009	–
	V5013[a]	4–6 [101.5–152.5]	Q601F1009	–
Q445F and Q601G	V5011	1/2–3 [12.5–76]	Q618A1016	Q618A1032
	V5013	1/2–3 [12.5–76]	Q618A1016	Q618A1032
	V5047[a]	1–1-1/2 [25.5–38]	Q601L1002	–
	V5047	2 [51]	Q618A1016	Q618A1032
	V5051[a]	2-1/2–6 [63.5–152.5]	Q601L1002	–
Q455G	V5011[a]	1/2–3 [12.5–76]	Q601M1001	Q601M1019
	V5013[a]	1/2–3 [12.5–76]	Q601M1001	Q601M1019

[a]See Q601 Specification Sheet, 71-92136.

(continued on page 3)

ORDERING INFORMATION

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

SPECIFY–
1. MODEL NUMBER, SPECIFY TRADELINE, IF DESIRED.
2. SEAL-OFF FORCE.

ORDER FROM–
1. YOUR USUAL SOURCE, OR
2. HONEYWELL
1885 DOUGLAS DRIVE NORTH
MINNEAPOLIS, MINNESOTA 55422
(IN CANADA–HONEYWELL CONTROLS LIMITED
740 ELLESMERE ROAD
SCARBOROUGH, ONTARIO)
INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

INSTALLATION

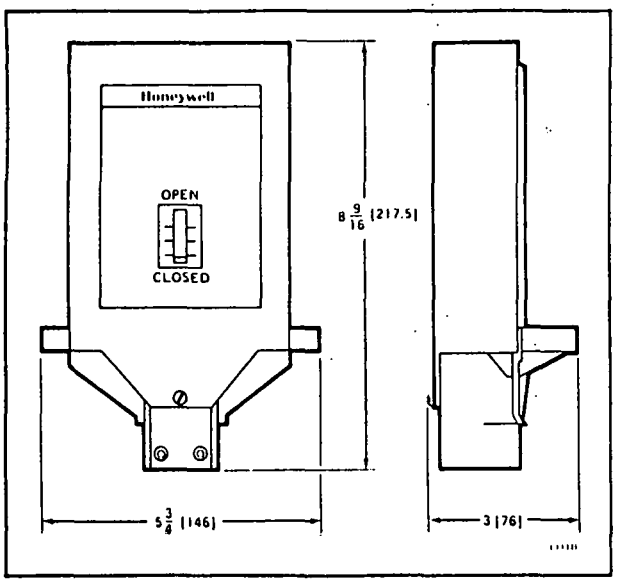


FIG. 1–Q618 INSTALLATION DIMENSIONS, IN INCHES [MILLIMETERS SHOWN IN BRACKETS].

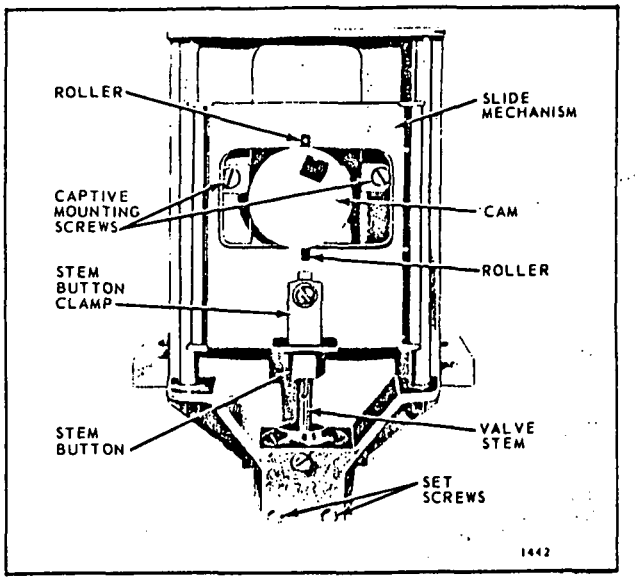


FIG. 2–INTERNAL PARTS OF THE Q618 VALVE LINKAGE.

CAUTION

1. Installer must be a trained, experienced serviceman.
2. Disconnect power supply before beginning installation.
3. Always conduct a thorough checkout when installation is complete.

The Q618A mounts on the power end of a Modutrol motor. The linkage and motor can be rotated 360 degrees around the valve stem. The motor, however, must be installed with the shaft in a horizontal position.

Refer to the instructions packed with the valve for information on valve installation.

Wiring diagrams and other motor installation information are found in the appropriate motor instruction sheet.

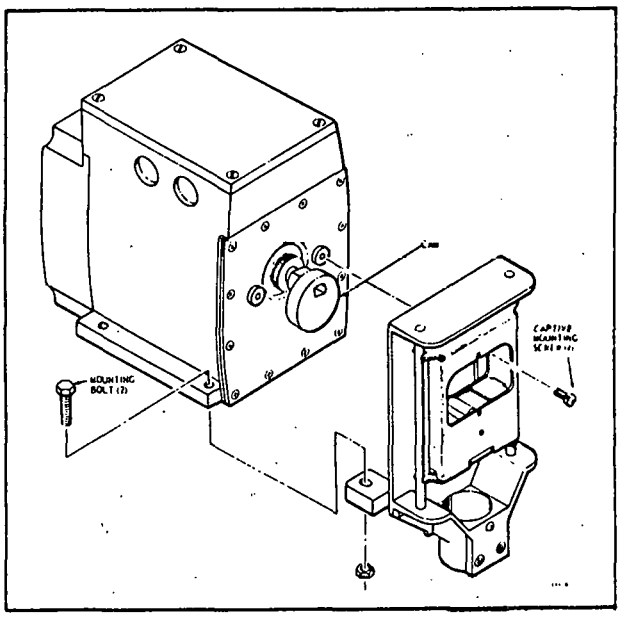


FIG. 3–ASSEMBLY OF THE Q618 VALVE LINKAGE TO A MODUTROL MOTOR.

MOUNT LINKAGE ON MOTOR

1. Remove the cover from the linkage.
2. Mount the cam on the shaft at the power end of the motor. Note that the key on the cam must fit into the keyway on the motor shaft.
3. Use the 2 bolts provided to fasten the linkage to the base of the motor. Note that the slide mechanism will have to be compressed slightly to fit over the cam. Put the nuts on these bolts, but leave them slightly loose (Figs. 2 and 3).
4. Fasten the linkage to the motor with the 2 captive self-tapping screws in the linkage.
5. Tighten the 2 machine bolts (step 3 above).

MOUNT LINKAGE AND MOTOR ON VALVE

CAUTION

Make sure nut on valve stem is tight.

1. Remove the stem button clamp.
2. Loosen, if necessary, the 2 setscrews and slide the linkage over the valve bonnet (Fig. 4).
3. Tighten the 2 setscrews to secure the linkage and motor to the valve.

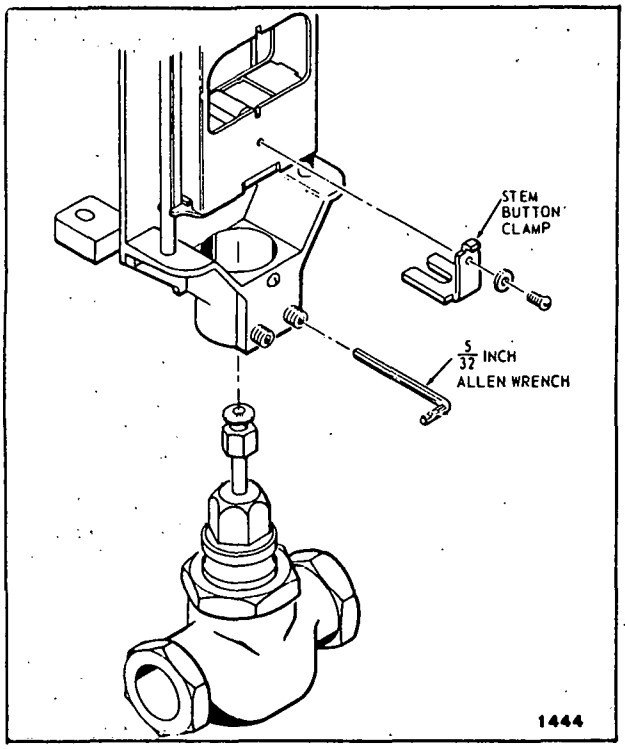


FIG. 4–ASSEMBLY OF THE LINKAGE TO THE VALVE.

CONNECT VALVE STEM TO LINKAGE

NORMALLY CLOSED MOTORS

1. Place a heavy duty screwdriver under the linkage slide and into the slot in the back of the linkage (Fig. 5).
2. Use the screwdriver as a lever to force the slide mechanism up (compressing the tension relief spring) until the stem button clamp can be fully inserted into its slot.
3. Replace and tighten the stem button clamp screw.
4. Replace the cover on the valve linkage.

NORMALLY OPEN MOTORS

1. Place a heavy duty screwdriver between the slide mechanism and the top of the linkage frame.
2. Use the screwdriver as a lever to force the slide mechanism down until the stem button clamp can be fully inserted into its slot.
3. Replace and tighten the stem button clamp screw.
4. Replace the cover on the valve linkage.

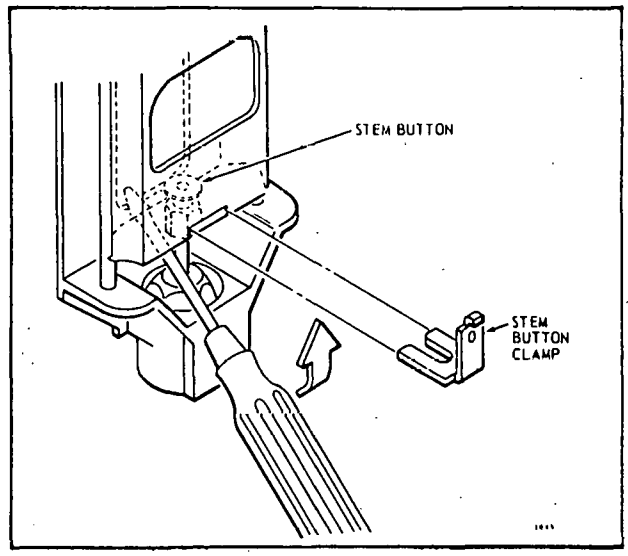


FIG. 5–THE STEM BUTTON CLAMP FASTENS THE VALVE STEM TO THE LINKAGE SLIDE MECHANISM.

CHECKOUT

After installation has been completed, the motor linkage, and valve should be checked for the following points of operation.

1. Motor should be free to run through its complete stroke.
2. The linkage should work freely without binding.
3. The valve must close off tightly at the bottom of its stroke (both ends of stroke for 3-way valve). Check for at least 1/32 [.8 mm] deflection of the roller bracket in closed position (Fig. 6).

Refer to the motor instructions for motor checkout procedure.

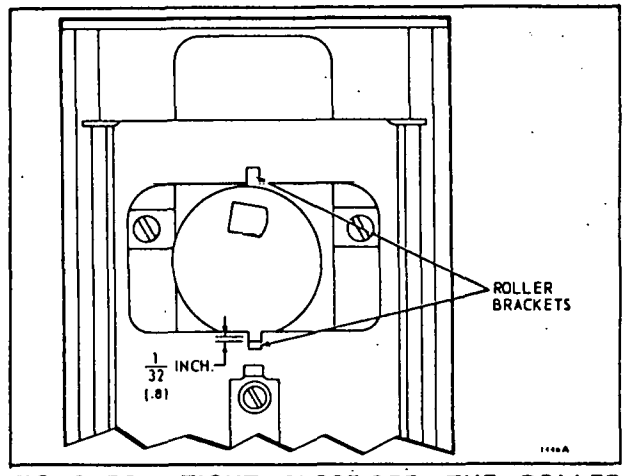


FIG. 6–FOR TIGHT CLOSE-OFF, THE ROLLER BRACKET ON THE LINKAGE MUST BE DEPRESSED AT LEAST 1/32 INCH [.8 MM] AT THE END OF THE MOTOR'S STROKE.

LUBRICATION

The Q618 Valve Linkage was lubricated at the factory and should require no additional lubrication at the time of installation. For optimum performance, the slide mechanism rollers may be lubricated yearly with a good grade of cup grease.

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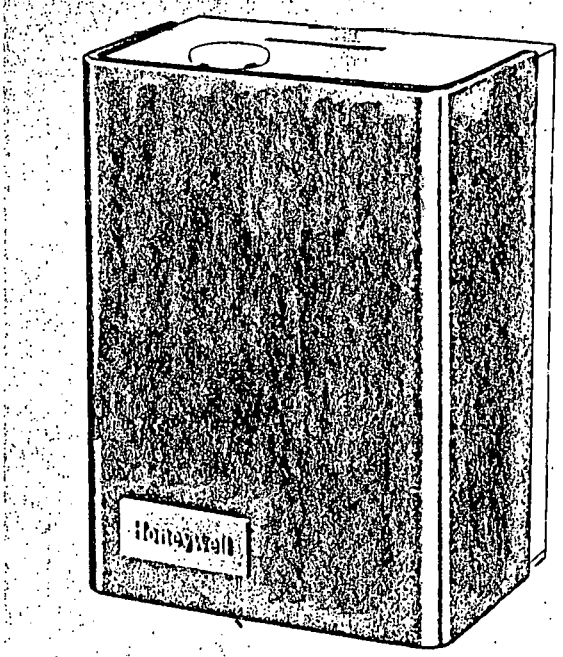
Honeywell

DIFFERENTIAL TEMPERATURE CONTROLLER

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

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



R7412A-F

Form Number 60-2305-2

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

SPECIFICATIONS

IMPORTANT

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

TRADELINE MODELS

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

TRADELINE MODEL AVAILABLE:

R7412F Differential Temperature Controller.

TRADELINE FEATURES:

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

STANDARD MODELS

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

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

TEMPERATURE SETTING RANGES:

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

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

Freeze Protection–

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

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

Freeze differential–3 F [1.7 C].

Overtemperature Protection–

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

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

Overtemperature differential–10 F [5.5 C].

(continued on page 3)

ORDERING INFORMATION

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

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

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

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

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

ELECTRICAL RATINGS:

Input Voltage–120V ac, 60 Hz.

Load Relay Contacts–

1 N.O. Pole–10 AFL/60 ALR at 120V ac.

1 N.C. Pole–125 VA at 120V ac.

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

Power Consumption–7 watts maximum.

AMBIENT TEMPERATURE RANGE:

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

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

MOUNTING:

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

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

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

DIMENSIONS: See Fig. 2.

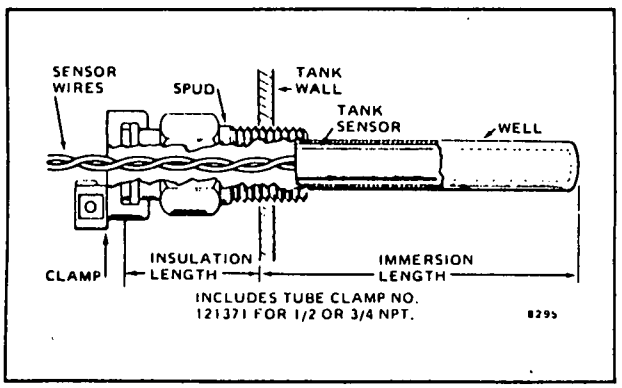


FIG. 1–TANK SENSOR INSERTED IN IMMERSION WELL.

AUXILIARY RELAYS:

R856A Fan Centers–

Line voltage spst and spdt switching.

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

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

R8225B Fan Relay–spst switching; normally open contacts.

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

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

OPTIONAL SPECIFICATIONS:

Indicator Light–indicates when pump or fan are operating.

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

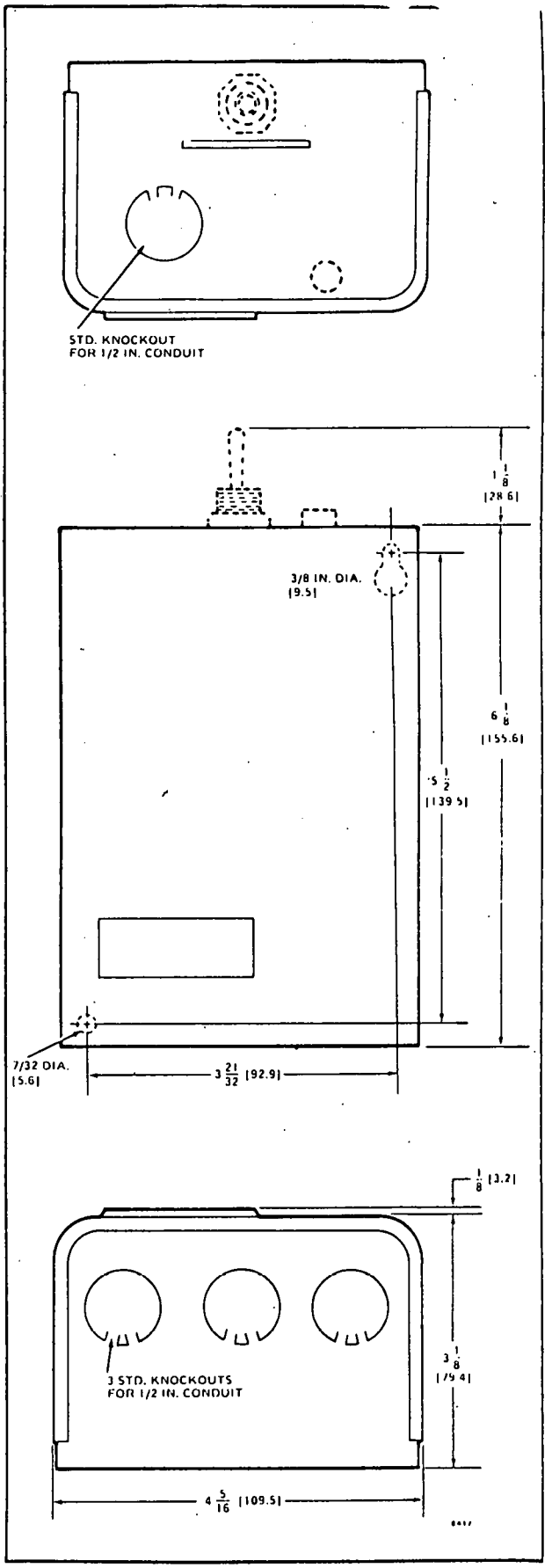


FIG. 2–R7412 MOUNTING DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

ACCESSORIES:

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

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

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

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

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

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

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

[a]Has plastic sleeve on insertion well.

INSTALLATION

CAUTION

1. Installer must be a trained, experienced service technician.
2. Disconnect power supply before connecting wiring.
3. Conduct thorough checkout when installation is complete.

IMPORTANT

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

MOUNTING CONTROLLER

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

MOUNTING TEMPERATURE SENSORS

Mount tank sensor and immersion well as follows:

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

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

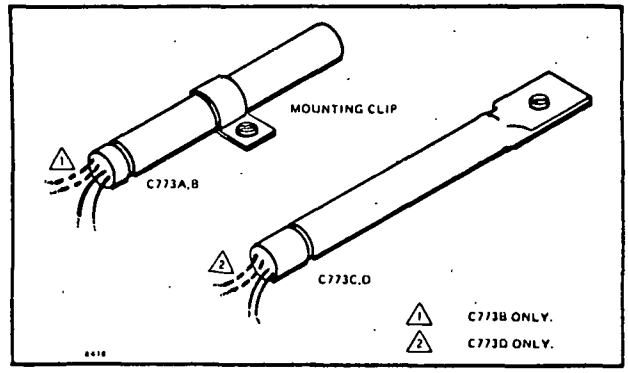


FIG. 3–MOUNTING THE C773 TEMPERATURE SENSOR.

WIRING

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

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

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

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

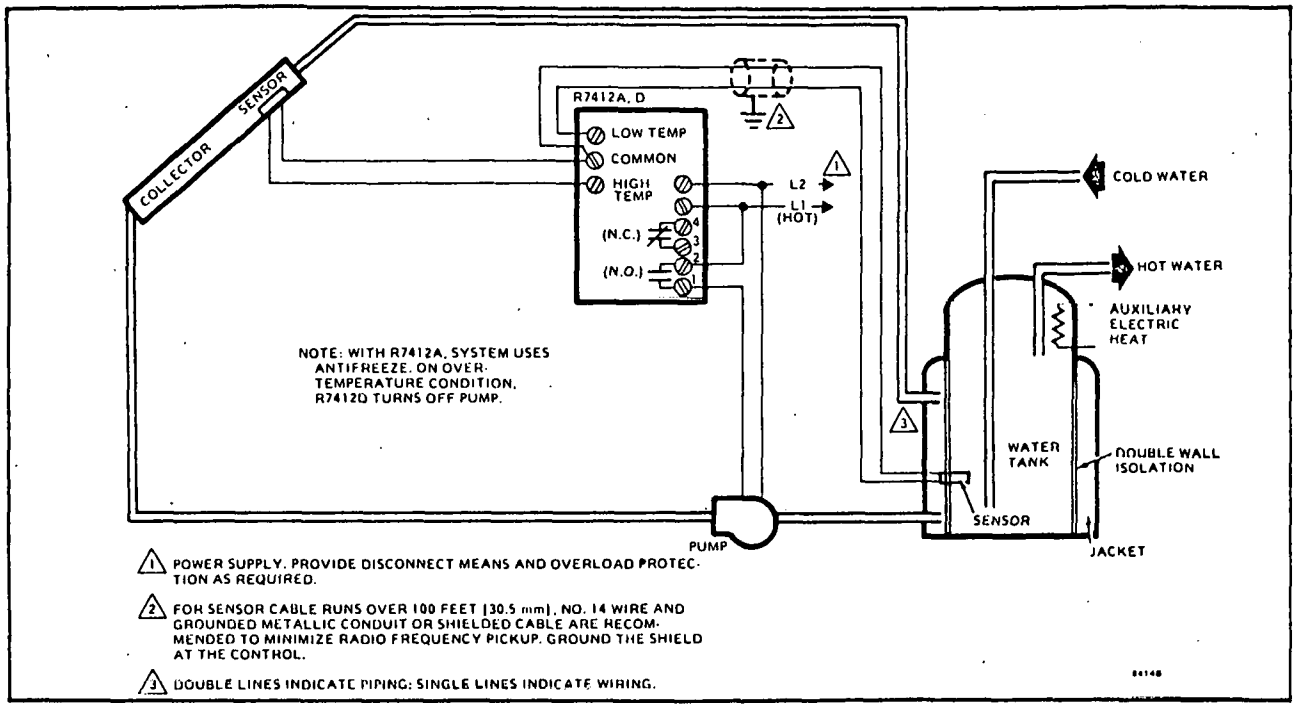


FIG. 4–USING THE R7412A,D WITH A SOLAR WATER HEATER.

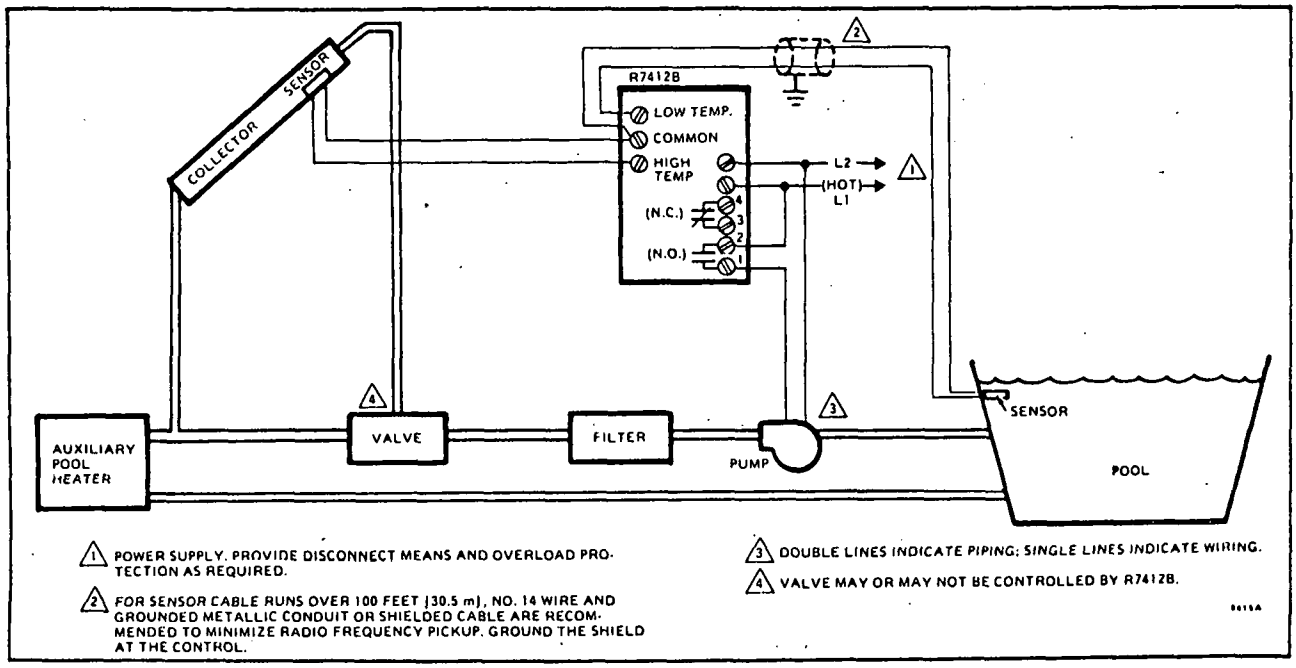


FIG. 5–USING THE R7412B WITH A SOLAR POOL HEATER. CONTROLLER ENERGIZES PUMP DURING FREEZE CONDITION.

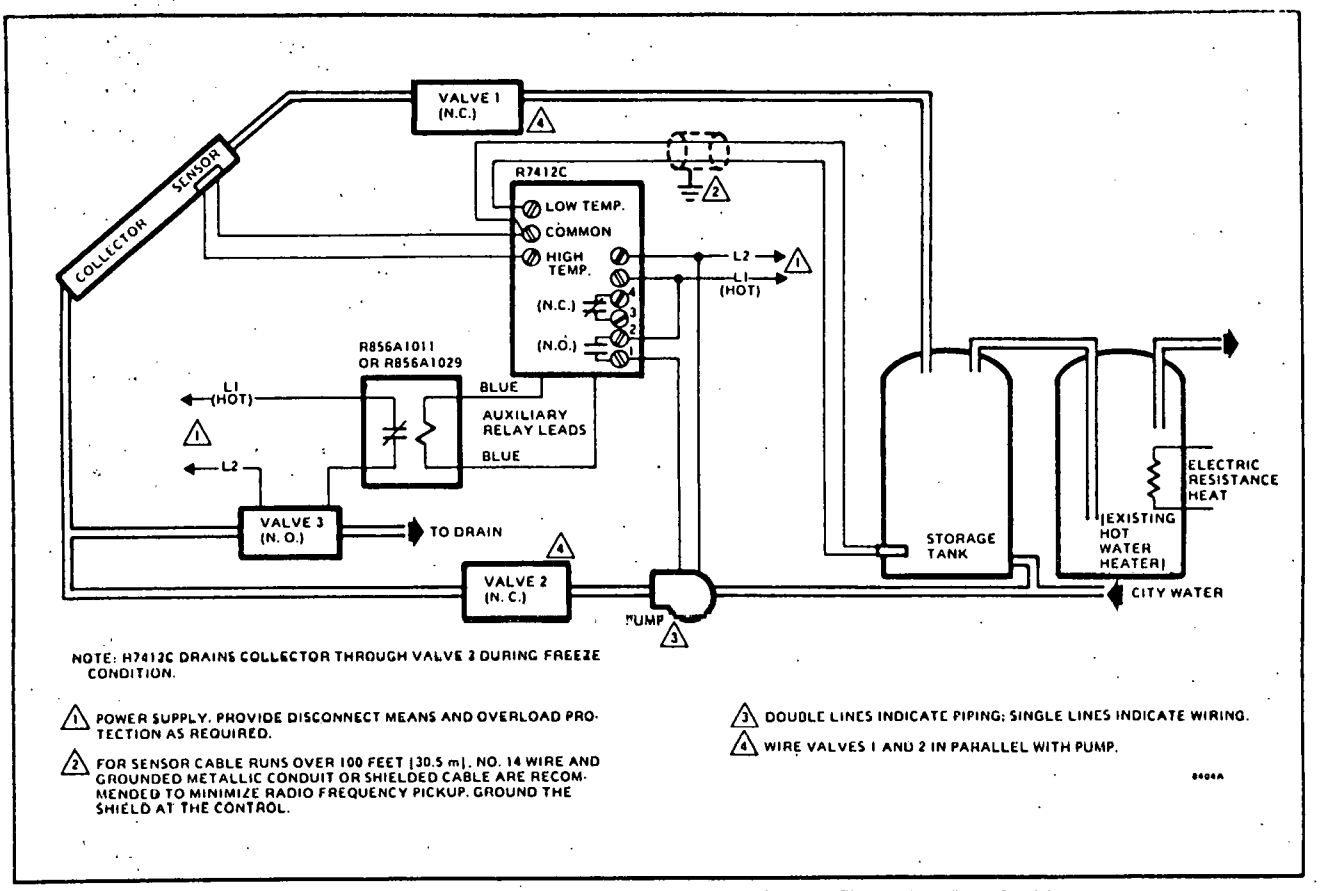


FIG. 6–INSTALLING THE R7412C IN A SOLAR HOT WATER HEATING SYSTEM.

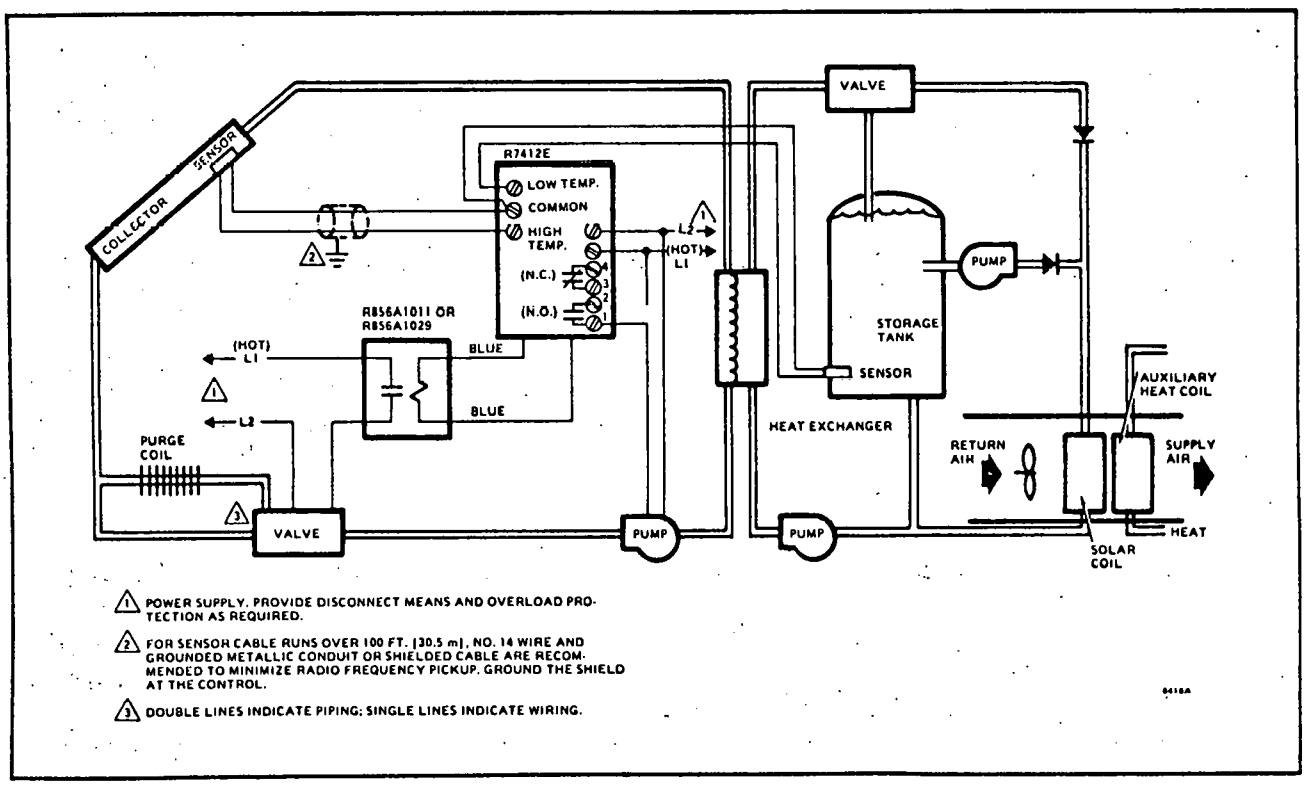


FIG. 7–TYPICAL INSTALLATION OF THE R7412E IN A SOLAR HOT WATER TO WARM AIR HEATING SYSTEM.

DIFFERENTIAL TEMPERATURE SELECTION

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

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

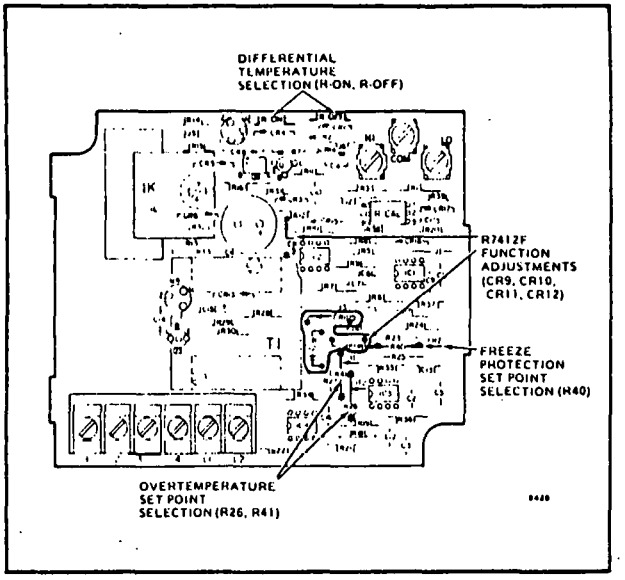


FIG. 8–ADJUSTMENT COMPONENTS OF THE R7412.

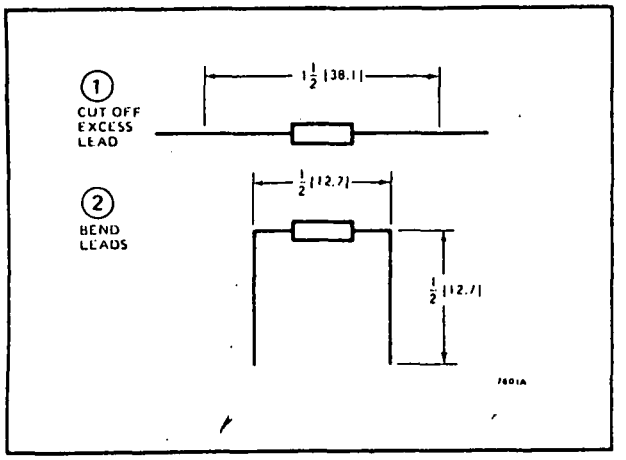


FIG. 9–PLUG-IN RESISTOR PREPARATION. DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

TABLE 1–ON, OFF DIFFERENTIAL TEMPERATURE CONTROL

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

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

R7412F FREEZE PROTECTION TEMPERATURE SELECTION

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

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

R7412F OVERTEMPERATURE SETTING SELECTION

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

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

TABLE 2–OVERTEMPERATURE CONTROL

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

ADJUSTING FUNCTIONS OF THE R7412F

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

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

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

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

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

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

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

TABLE 3–R7412F ADJUSTMENTS

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

OPERATION AND CHECKOUT

OPERATION

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

CHECKOUT

Check control for proper operation as follows:

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

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

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

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

OPTIONAL APPLICATIONS

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

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

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

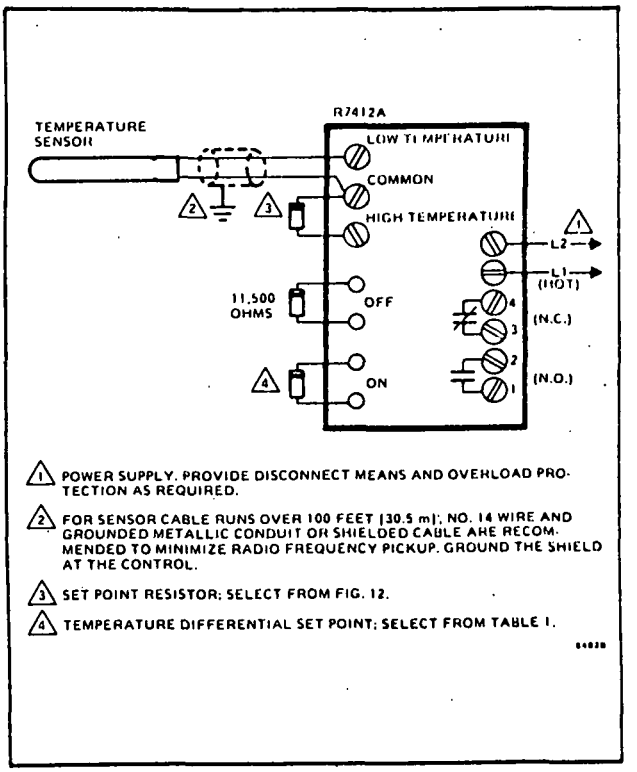


FIG. 11—SINGLE FUNCTION SET POINT CONTROL. CONTROL MAKES ON TEMPERATURE FALL TO SET POINT MINUS DIFFERENTIAL, BREAKS ON TEMPERATURE RISE TO SET POINT.

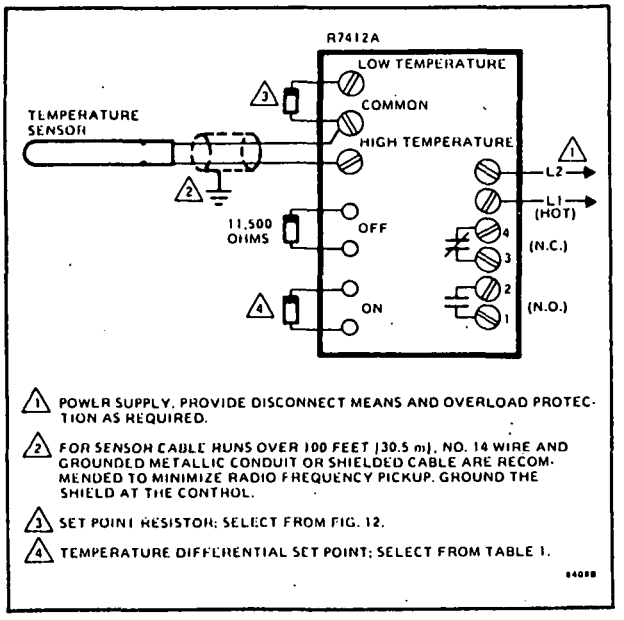


FIG. 10—SINGLE FUNCTION SET POINT CONTROL. CONTROL MAKES ON TEMPERATURE RISE TO SET POINT PLUS DIFFERENTIAL, BREAKS ON TEMPERATURE FALL TO SET POINT.

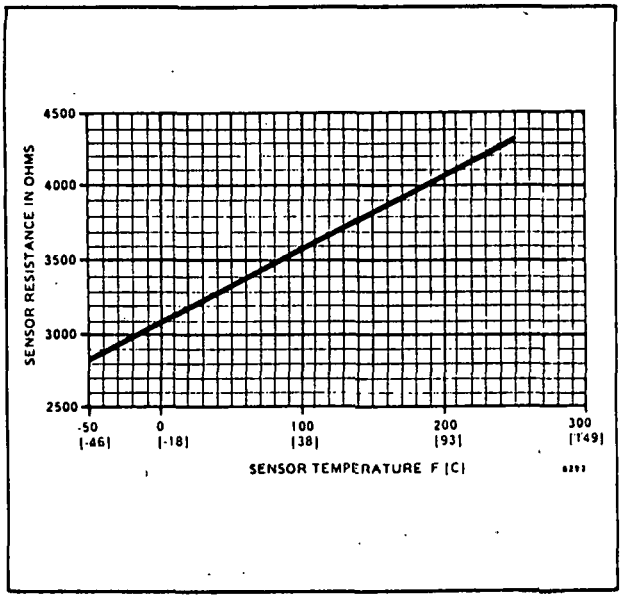


FIG. 12—R7412A SINGLE FUNCTION TEMPERATURE SET POINT. CHOOSE A RESISTANCE ACCORDING TO THE DESIRED SET POINT.

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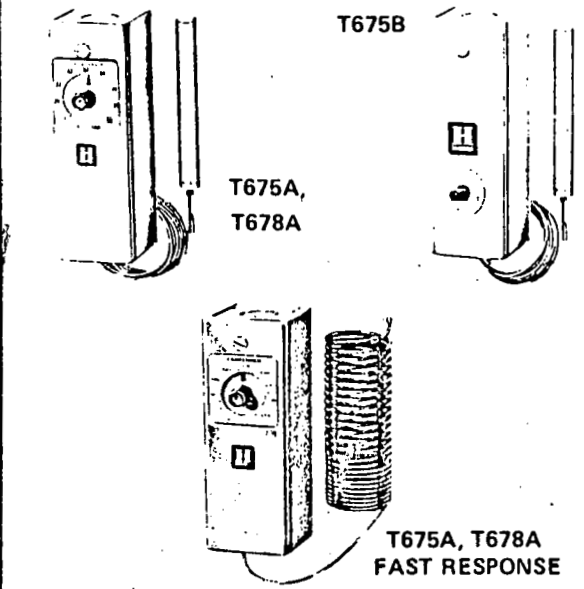
TEMPERATURE CONTROLLERS

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

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



T675A,B T678A

Honeywell

E.S.
REV. 11-75

FORM 60-2200 —1
RESIDENTIAL DIV.

SPECIFICATIONS

MODELS (also refer to Table I):

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

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

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

TABLE I

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

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

SWITCH DIFFERENTIALS:

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

T675B—fixed 10 F (5.6 C).

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

ELECTRICAL RATINGS:

T675A adjustable models and T678A:

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

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

T675B 125 va at 240v ac pilot duty.

MAXIMUM AMBIENT OPERATING TEMPERATURE: 125 F.

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

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

MAXIMUM BULB PRESSURE: 50 psig direct immersion.

CAPILLARY LENGTH AND MATERIAL:

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

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

T675B—10 foot copper.

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

(continued on page 3)

ORDERING INFORMATION

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

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

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

DIMENSIONS: See Fig. 1.

LISTING BODIES: Listed by Underwriters' Laboratories, Inc.

ACCESSORIES:

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

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

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

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

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

6. Calibration wrench 801534.

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

8. Q615A weatherproof enclosure.

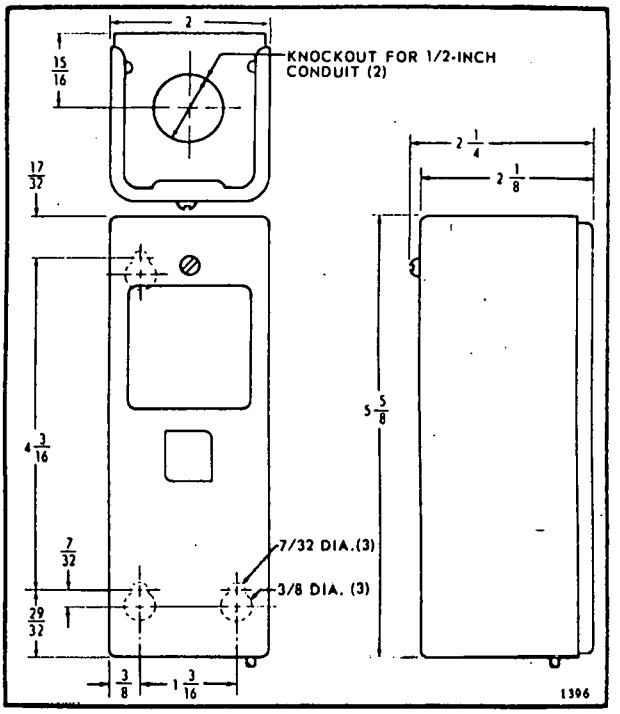


FIG. 1—DIMENSIONS (IN INCHES) OF T675 AND T678 CONTROLLERS.

INSTALLATION

CAUTION

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

LOCATION AND MOUNTING

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

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

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

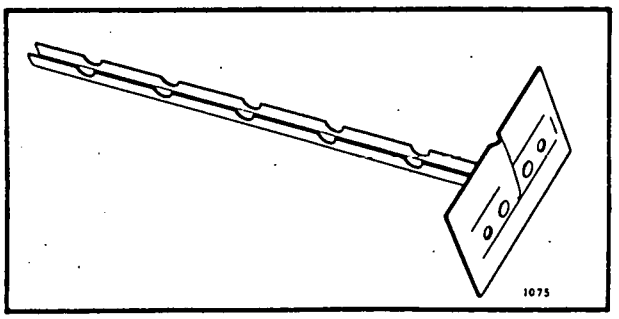


FIG. 2—BULB HOLDER FOR MOUNTING SENSING ELEMENT.

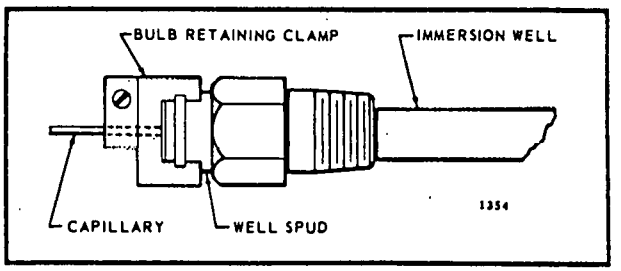


FIG. 3—IMMERSION WELL ASSEMBLY FOR MOUNTING SENSING BULB.

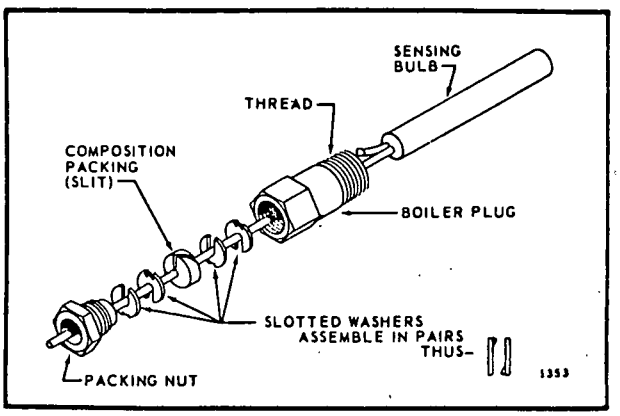


FIG. 4—COMPRESSION FITTING FOR PRESSURE TIGHT MOUNTING OF SENSING ELEMENT.

WIRING

All wiring must comply with local electrical codes and ordinances.

CAUTION
Disconnect the power supply before proceeding with wiring.

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

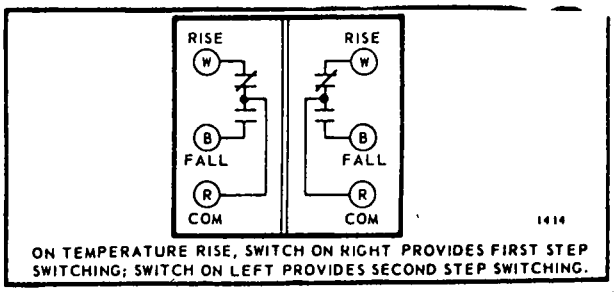


FIG. 5–T678A SWITCHING ACTION. T675A IS SIMILAR BUT HAS ONLY ONE SPDT SWITCH. T675B HAS ONE SPST SWITCH.

OPERATION

T675A

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

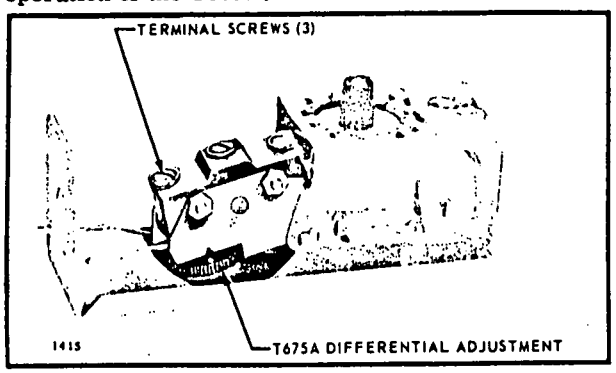


FIG. 6–INTERNAL VIEW OF T675A SHOWING THE SWITCH DIFFERENTIAL ADJUSTMENT WHEEL (APPLICABLE MODELS).

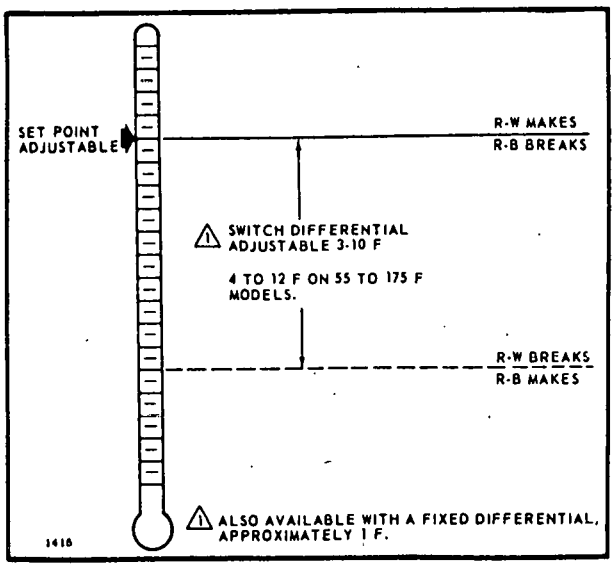


FIG. 7–DIFFERENTIAL ADJUSTMENT RANGE OF T675A.

FREEZE-UP PROTECTION

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

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

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

This ensures adequate safety factor for freeze-up protection.

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

T675B

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

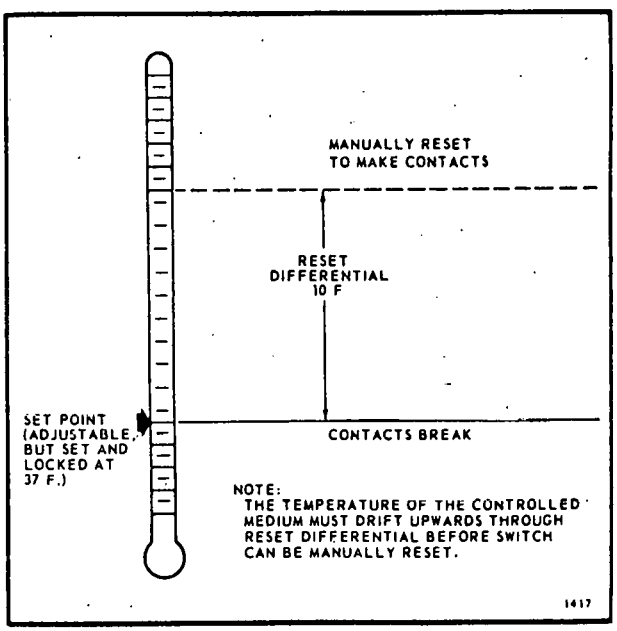


FIG. 8–DIFFERENTIAL ADJUSTMENT RANGE OF T675B.

T678A

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

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

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

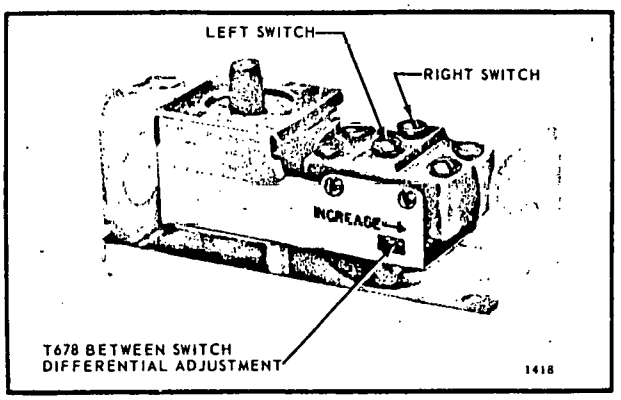


FIG. 9–INTERNAL VIEW OF T678A SHOWING THE BETWEEN SWITCH DIFFERENTIAL ADJUSTMENT.

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

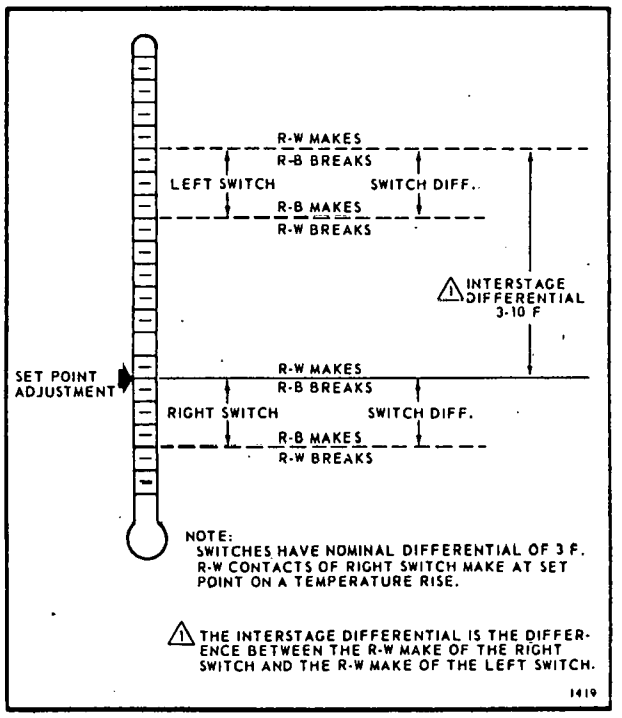


FIG. 10–DIFFERENTIAL ADJUSTMENT RANGE OF T678A.

CALIBRATION

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

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

T675A

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

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

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

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

T675B

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

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

T678A

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

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

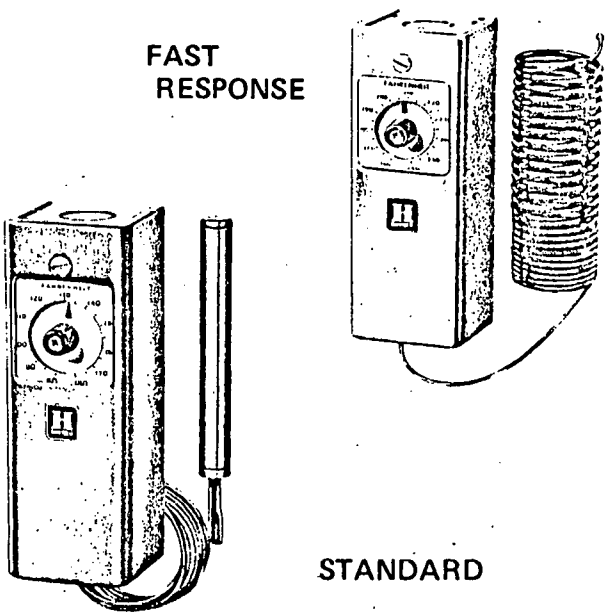
If it differs from the set point, follow the procedure outlined for the T675A.

CHECKOUT

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

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

PROPORTIONAL TEMPERATURE CONTROLLERS



T991A

60-2196 6/71

T991A Proportional Temperature Controllers provide modulating control of water or air temperatures in ducts, tanks, and similar applications. Standard models have a sensing bulb and capillary; fast response models have a coiled sensing element that operates at least four times faster than standard controllers, depending upon operating conditions.

- ☐ All models compensate for effects of ambient temperature on the case and tubing.
- ☐ Controls temperature of air or liquids.
- ☐ Sensing element capillary tubing allows remote mounting of sensing element.
- ☐ Set point may be read and adjusted through cover.
- ☐ Throttling dial inside case adjusts proportioning range.

Residential Div. Form Number 60-2196 6-71 J.A.

SPECIFICATIONS

MODELS: T991A Temperature Controller—standard or fast response.

ELECTRICAL RATING: 24 to 30v ac.

POTENTIOMETER RESISTANCE: 135 ohms (280 ohms available as option on model with 55 to 175 F range).

TEMPERATURE RANGES AND LIMITS:

Range	Maximum Ambient Temperature for Controller	Maximum Operating Temperature for Bulb
0 to 100 F	125 F	125 F
55 to 175 F[a]		200 F
80 to 180 F		200 F
160 to 260 F		280 F
-15 to 35 C	52 C	52 C
15 to 75 C[a]		93 C
30 to 80 C		93 C
75 to 125 C		138 C

[a]Available in 20 ft x 7/64 O. D. averaging element (copper)—senses temperature along length of element.

PROPORTIONING RANGE: Adjustable from approximately 3 to 30 degrees F (1.7 to 17 degrees C); set point is always the center point of proportioning range.

BULB PRESSURE RATING: 50 psi maximum for direct immersion.

CAPILLARY LENGTH AND MATERIAL (5/64 inch O.D.):
Copper: 5, 10, 20, or 24 feet.
Stainless steel: 20 feet.

MOUNTING MEANS: Three holes in back of case for furnished screws.

DIMENSIONS: See Fig. 1.

FINISH: Gray.

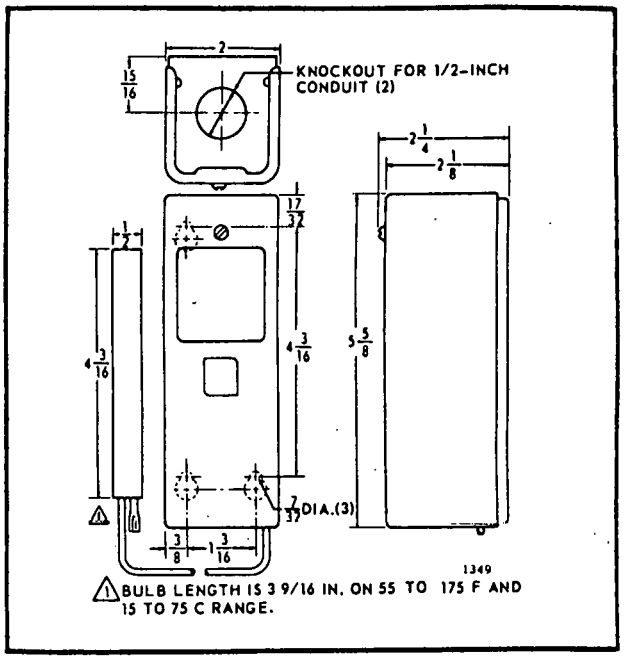


FIG. 1—APPROXIMATE DIMENSIONS IN INCHES.

ACCESSORIES:
1. Separable immersion wells, to be screwed into tank or boiler: 112622AA—1/2 inch NPT, or 112630AA—3/4 inch NPT.
2. Pressure fitting 7617ABY—1/2 inch NPT, rated at 50 psi water or 15 psi air pressure.
3. Duct Bulb Holder 107324A.
Duct Coil Holder 131524A.
4. T-Strap 105900 for strapping bulb to a pipe.
5. Bracket assembly 7640HY (a standoff bracket for mounting T991A to insulated duct).
6. Assembly 7640HX for mounting T991A with averaging element when access into duct is not available.
7. Calibration wrench 801534.
8. Weatherproof enclosure Q615A.

OPTIONAL SPECIFICATIONS:
1. 280 ohm potentiometer on 55 to 175 F model.
2. Averaging element available on 55 to 175 F model or 15 to 75 C model.

ORDERING INFORMATION

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

SPECIFY—
1. MODEL NUMBER.
2. SCALE RANGE.
3. CAPILLARY LENGTH AND MATERIAL.
4. OPTIONAL SPECIFICATIONS OR ACCESSORIES, IF DESIRED.

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

INSTALLATION

CAUTION: Disconnect power supply.

Installation should be made only by a qualified serviceman. Follow instructions of system manufacturer, if available.

LOCATION

The T991A may be mounted in any convenient position on a flat surface where the ambient temperature does not exceed 125 F. When mounting on a hot or cold surface, mount the case on a wood board or other insulating material. The capillary tube provides for remote mounting.

MOUNTING

On replacement applications, mount the T991A in place of old control if requirements under LOCATION above, are met. Mount case according to instructions below. Use old sensing bulb hole, bulb holder, immersion well, or compression fitting if these are suitable; otherwise, follow the instructions below for new applications.

MOUNT THE CONTROLLER CASE:

1. Remove cover. Using the case as a template, mark three screw hole locations on mounting surface, then punch or drill holes.
2. Fasten T991A securely to mounting surface with the furnished mounting screws.

TO INSTALL SENSING BULB IN AIR DUCT:

Locate the sensing bulb where duct air of average temperature can circulate freely around it. Avoid mounting the bulb close to hot pipes, cooling coils, and other places where air temperatures are not representative.

To support the bulb in the duct, use bulb holder accessory (see Fig. 2).

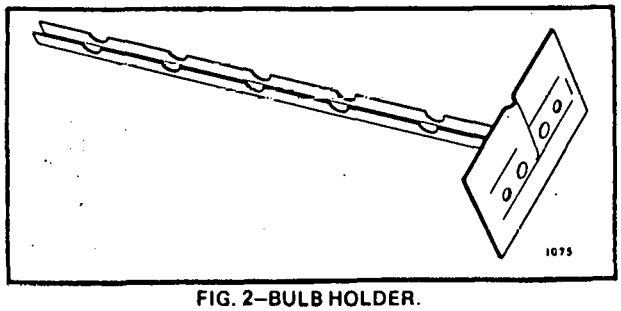


FIG. 2–BULB HOLDER.

1. Drill a 3/4 inch hole in the duct wall to admit the sensing bulb and holder.
2. Using the holder as a template, mark and drill holes for bulb holder mounting screws.

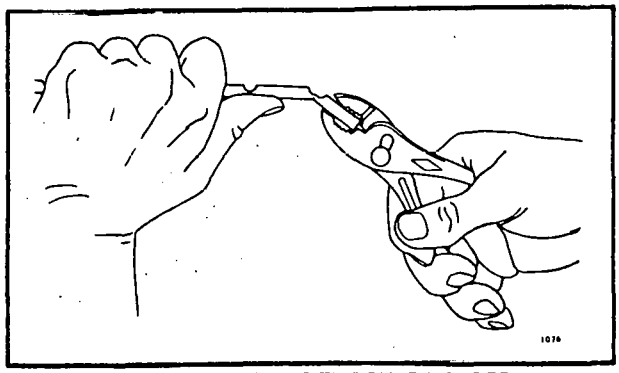


FIG. 3–SHORTENING THE BULB HOLDER.

3. Break off bulb holder to desired length, as shown in Fig. 3. NOTE: Holder should be long enough to hold sensing bulb in freely circulating air, away from duct wall. Neatly coil any excess capillary tubing at controller case or at bulb holder.

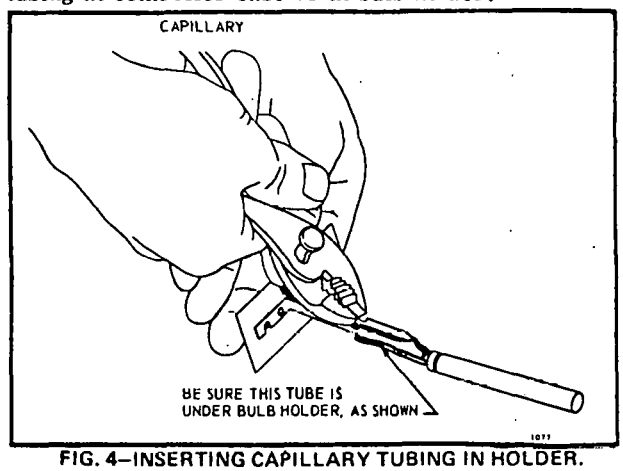


FIG. 4–INSERTING CAPILLARY TUBING IN HOLDER.

4. Place capillary tubing in bulb holder channel, and pinch top edges of holder together at each segment, as shown in Fig. 4.

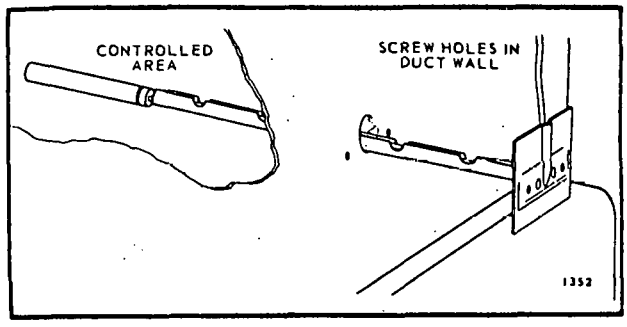


FIG. 5–INSERTION INTO DUCT.

5. Insert bulb and holder into controlled area through hole prepared in Step 1 (Fig. 5).

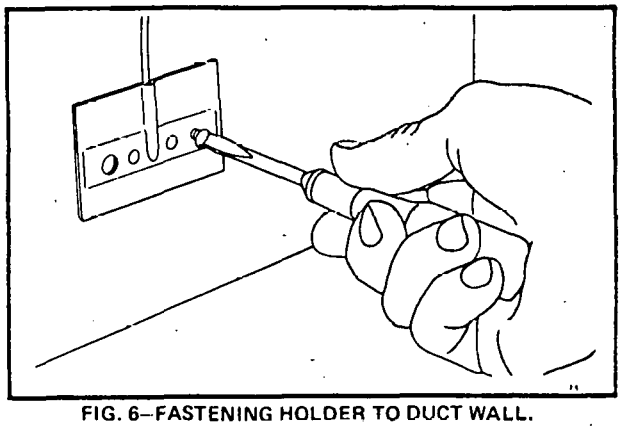


FIG. 6–FASTENING HOLDER TO DUCT WALL.

6. Fasten bulb holder to duct wall with screws furnished, as shown in Fig. 6.

TO INSTALL A FAST RESPONSE MODEL:

Use duct holder assembly for the sensing coil. Drill a 1-5/8 inch hole in the duct wall to receive the whole coil, and then use the mounting procedure for the standard model. WARNING: Do not stretch the coil more than eight inches on the holder.

TO INSTALL SENSING BULB IN TANK OR BOILER:

The bulb may be inserted directly into a tank or boiler tapping by means of a pressure fitting (see ACCESSORIES), or the bulb may be inserted into an immersion well that is screwed into the tank or boiler (see ACCESSORIES).

To install pressure fitting:

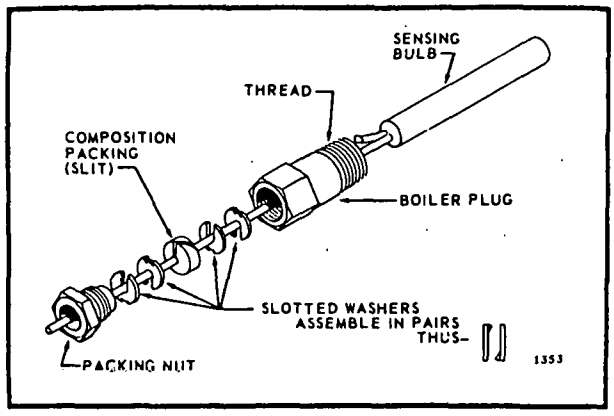


FIG. 7–PRESSURE FITTING ASSEMBLY.

1. Drain system, and screw boiler plug into properly sized and threaded boiler or pipe tapping (1/2-14 NPT).

2. Place packing nut on T991A capillary tube.

3. Slide sensing bulb completely through boiler plug.

4. Place composition disc and the four slotted brass washers on tubing in the order shown in Fig. 7.

5. Slide the assembly into the boiler plug, and tighten the packing nut.

6. Refill the system and check for leaks. Neatly coil excess capillary tubing at T991A case.

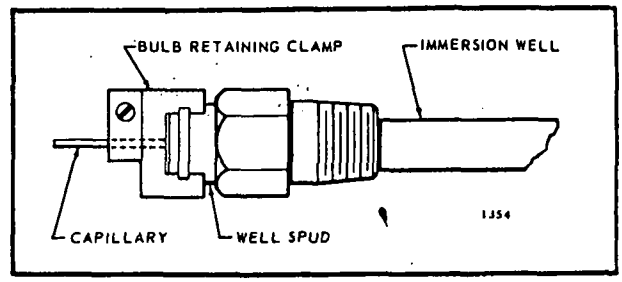


FIG. 8–IMMERSION WELL ASSEMBLY.

To install immersion well:

1. Drain system. Screw the well into properly sized and threaded boiler tapping or pipe fitting.
2. Refill the system and check for leaks.
3. Insert sensing bulb into well until it bottoms.
4. Fit bulb retaining clamp over immersion well flange and capillary tubing, and tighten screw, as shown in Fig. 8.

Coil excess capillary tubing at T991A case.

WIRING

All wiring must comply with local codes.

Two knockouts are provided at top and bottom of case for 1/2 inch conduit. Follow any wiring instructions furnished with heating or cooling system. In replacement applications, make certain the T991A is wired in the system to operate the same way as old control. Fig. 9 shows typical wiring.

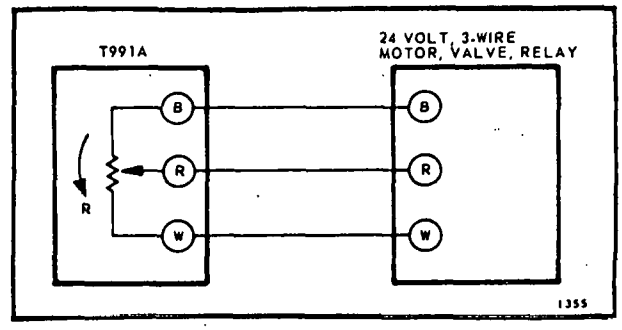


FIG. 9–TYPICAL HOOKUP.

ADJUSTMENTS AND CHECKOUT

TEMPERATURE SETTING: Turn knob on front of case until pointer indicates desired set point temperature. This is the center point of the proportional range.

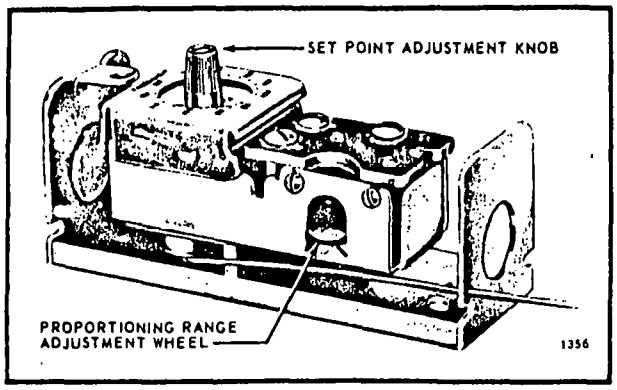


FIG. 10–PROPORTIONING RANGE ADJUSTMENT.

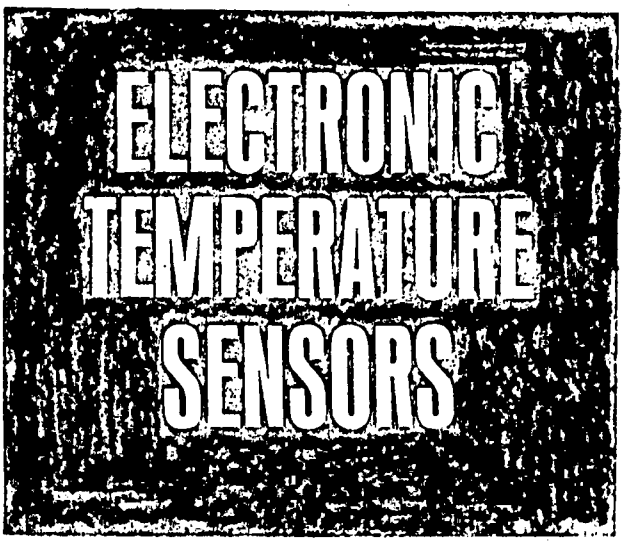
RANGE ADJUSTMENT: The T991A may be adjusted to vary the temperature range within which proportional action is desired. With cover off, turn adjustment wheel until pointer indicates desired range.

Example: If the temperature of the controlled medium is to be maintained at 130 F, and proportional action from 125 F to 135 F (a range of 10 degrees) is desired—turn the temperature set point indicator to 130 F and the proportional range adjustment wheel to 10.

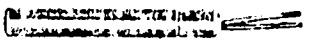
CHECKOUT

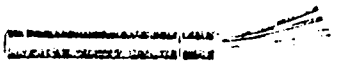
After mounting and wiring have been completed, let the controlled equipment operate until system temperature stabilizes (from 1 to 3 hours). Observe the motor action to see if it stabilizes. If the motor shaft constantly moves back and forth, widen the T991A proportional range (about five degrees at a time) until the system is stable.

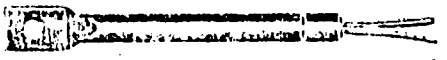
Honeywell

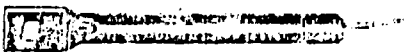


THE C773 IS A PLATINUM FILM SENSOR WHICH HAS A POSITIVE TEMPERATURE COEFFICIENT. ON A RISE IN AMBIENT TEMPERATURE THE RESISTANCE OF THE SENSOR INCREASES.

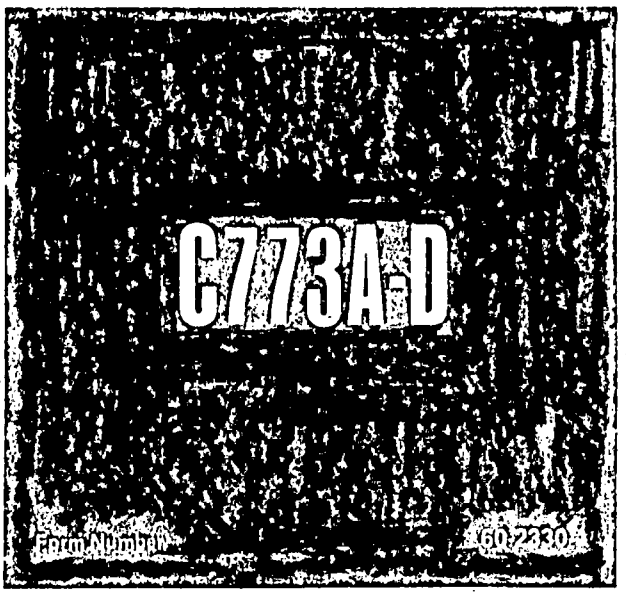








- C773A contains a single sensor for storage tank or solar collector mounting.
- C773B contains a double sensor for storage tank or solar collector applications.
- C773C contains a single sensor with a flattened end and mounting hole for easy solar collector installation.
- C773D contains a double sensor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



R.L.
10-77 (.03)

SPECIFICATIONS

IMPORTANT

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

TRADELINE MODELS AVAILABLE:

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

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

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

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

LEADWIRE:

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

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

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

DIMENSIONS: See Figs. 2 and 3.

ACCESSORIES:

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

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

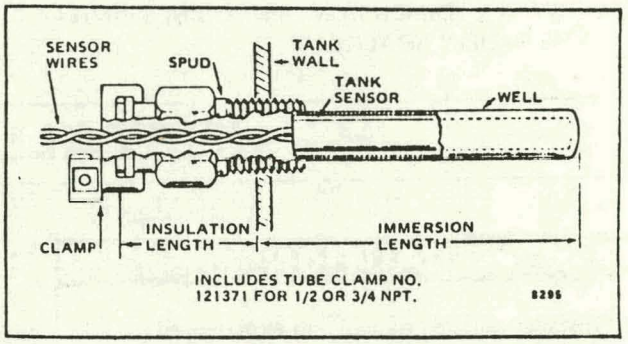


FIG. 1–TANK SENSOR INSERTED IN IMMERSION WELL.

TABLE 1–IMMERSION WELL TABLE

IMMERSION LENGTH		INSULATION LENGTH		SELECT WELL MATERIAL AND ORDER NUMBER BELOW			
				COPPER		STAINLESS STEEL	
in.	mm	in.	mm	1/2 NPT	3/4 NPT	1/2 NPT	3/4 NPT
3-3/8	85.7	1-1/2	38.1	121731A	121371B	121371E	121371F
3-3/8	85.7	1-1/2	38.1	–	121371K[a]	–	–
3-3/8	85.7	3	76.2	121371L	121371M	–	–
3-3/8	85.7	4	101.6	122554A[a]	122555A[a]	–	–
5-3/8	136.5	4	101.6	122554B[a]	122555B[a]	–	–
6	152.4	1-1/4	31.8	112620BB	–	–	–

[a]Has plastic sleeve on insertion well.

continued on page 3

ORDERING INFORMATION

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

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

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

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

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

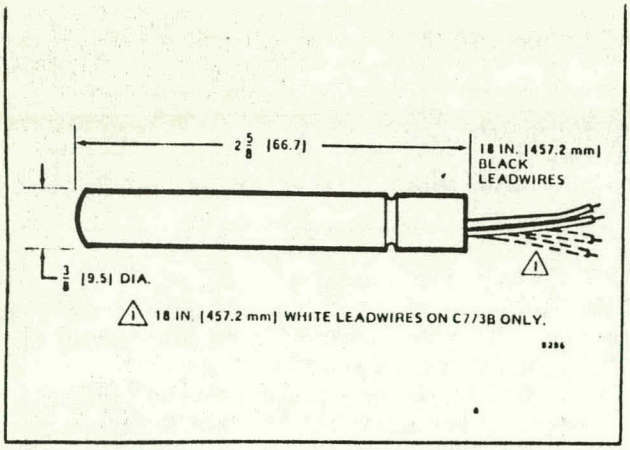


FIG. 2–C773A,B DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

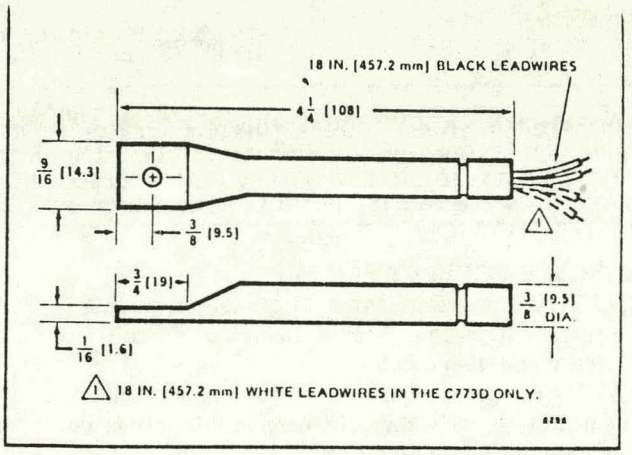


FIG. 3–C773C,D DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

INSTALLATION

CAUTION

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

LOCATION

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

MOUNTING SENSOR

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

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

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

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

WIRING

WARNING

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

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

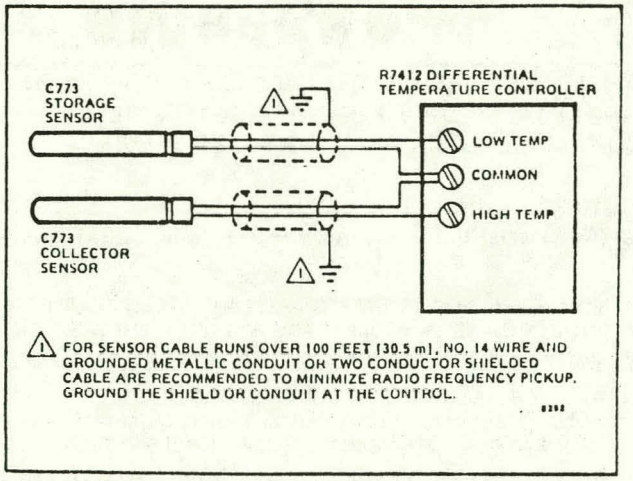


FIG. 4–WIRING C773 TO R7412 DIFFERENTIAL TEMPERATURE CONTROLLER.

60-2330–1

the two black leadwires belong to one sensor and the two white leadwires belong to the other sensor.

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

Remote Sensor Wiring Compartment (Part No. 111892F) is available for tank sensor wiring (see Accessories).

OPERATION AND CHECKOUT

OPERATION

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

CHECKOUT

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

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

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

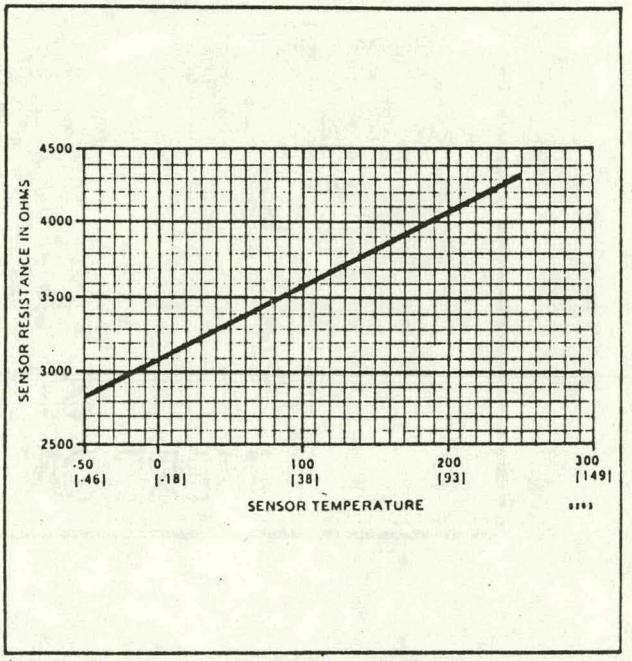


FIG. 5–CONVERTING SENSOR RESISTANCE INTO DEGREES F [C].

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

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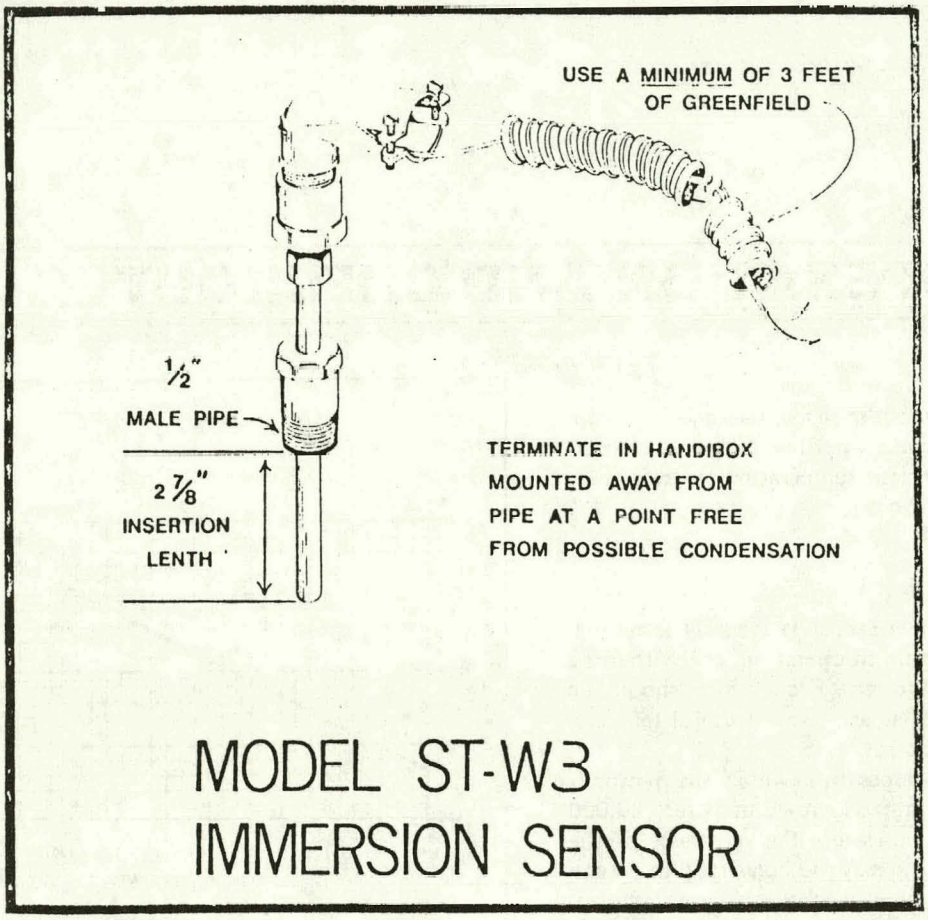


MODEL ST-W3 IMMERSION SENSOR

APPLICATION: INDICATION OF WATER TEMPERATURE

DESCRIPTION: Precision High Resistance Thermistor in a brass and copper immersion well with greenfield connector and 7' wire leads.

MOUNTING: Mount in pipe as shown on job control diagrams. For smaller than 3" locate at a tee or elbow.

WIRING: Apply no voltage to the sensor. If line voltage is accidentally applied, replace the unit as its accuracy will have been destroyed. This high resistance electronic element requires solder or crimp type butt splice connections for reliable long term operation. Do not make connections closer than 3' to the sensing well. Connections must be made in a box mounted as far as possible from chilled water lines. Any condensation at the point of the splice may cause erroneous (high) readings.

Wire Size	Maximum Run
#18	3000 Ft.
#16	4750 Ft.
#14	7550 Ft.
CHART Nº 1	

Chart 1 shows minimum wire size for the run back to the indicating meter. USE SMALLEST SIZE STRANDED WIRE PERMITTED BY THE CHART. Wiring is class II.

Sensor wiring can be run in the same conduit as other low power control wiring. Do not run sensor wiring with power wiring. For most applications #18 2 conductor rip cord is ideal for sensor wiring. Make field connections according to the job wiring diagrams.

ST-W3 SPECIFICATIONS	
RANGE:	30°F to 240°F
MAXIMUM SAFE TEMPERATURE:	300°F
ACCURACY:	±.36F° up to 160°F ±.52F° above 160°F
STABILITY:*	Typical ±.1F° Maximum ±.2F°
REFERENCE RESISTANCE:	14.78K @ 60°F
WARRANTY:	Five Years Against Drift or Failure
* Based on a seven year study by the National Bureau of Standards.	

PHOTOVOLTAIC PYRANOMETER and STRIP CHART RECORDER

RS1008 and RS1009

RS1008

The RS1008 operates on the principle that the "short circuit" voltage output of the silicon cell is directly proportional to the radiant input. This principle permits construction of an inexpensive but accurate instrument to measure solar radiation.

The RS1008 is temperature-compensated. The sealed space under the glass dome is connected to a rechargeable desiccant reservoir to ensure dry air conditions. The RS1008 may be conveniently mounted on a photographic-type tripod or on a standard 1/4-20 bolt. It may be leveled with the spring-loaded adjusting screws.

Specifications:

a) Instantaneous response
b) Output approximately 100MV at 100 Btu/ft^2-hr solar input
c) Cosine response essentially identical to thermopile pyranometers
d) Temperature compensated to maintain pyranometer within -2.2% at 0°C (datum point = 30°C) and +0.8% at 60°C (datum point = 30°C)
e) Accuracy within 5% of daily integrated value of Class 1 instrumentation.
f) Calibration constant and instructions provided with each instrument
g) Weight: Approximately 1 lb.
h) Size: 5" diameter x 4" high

RS1009

The instrument is designed to provide a historical record of the output of the RS1008 photovoltaic pyranometer. The unit can be calibrated in Btu/ft^2-hr, W/M^2, Langleys, or other engineering units.

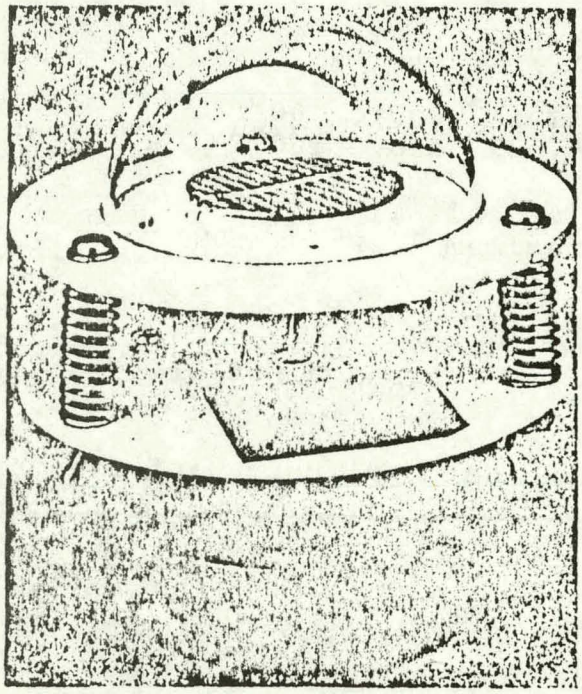
The high output of the silicon cell pyranometer permits direct connection to the recorder without an amplifier. Each recorder is calibrated individually with the pyranometer which accompanies it.

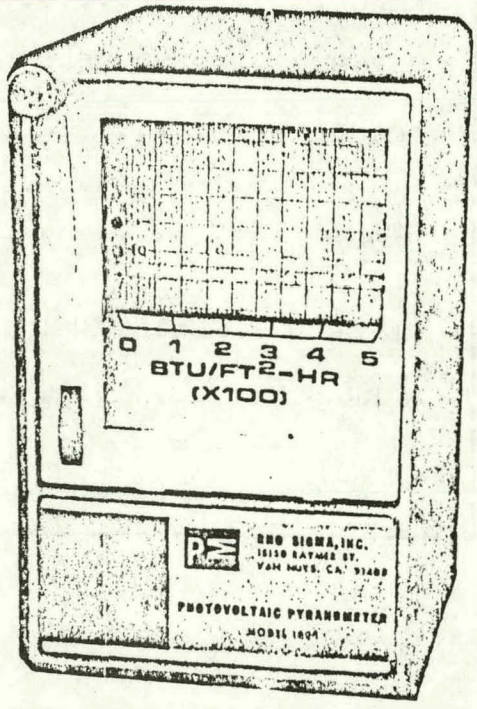
Specifications:

a) Writing speed: 1 strike/2 seconds
b) Chart speed. inch/hr
c) Duration of roll: 1 month
d) Accuracy: ± 4% of full scale
e) Input power: 120 VAC
f) Weight: Approximately 3 lbs.
g) Size: 5½" deep x 4½" high x 3½" wide

A full set of wiring instructions and recorder operations is provided with each unit.

NOTE: The RS1008 (photovoltaic pyranometer) and the RS1009 (strip chart recorder) can be purchased either as a package or separately.





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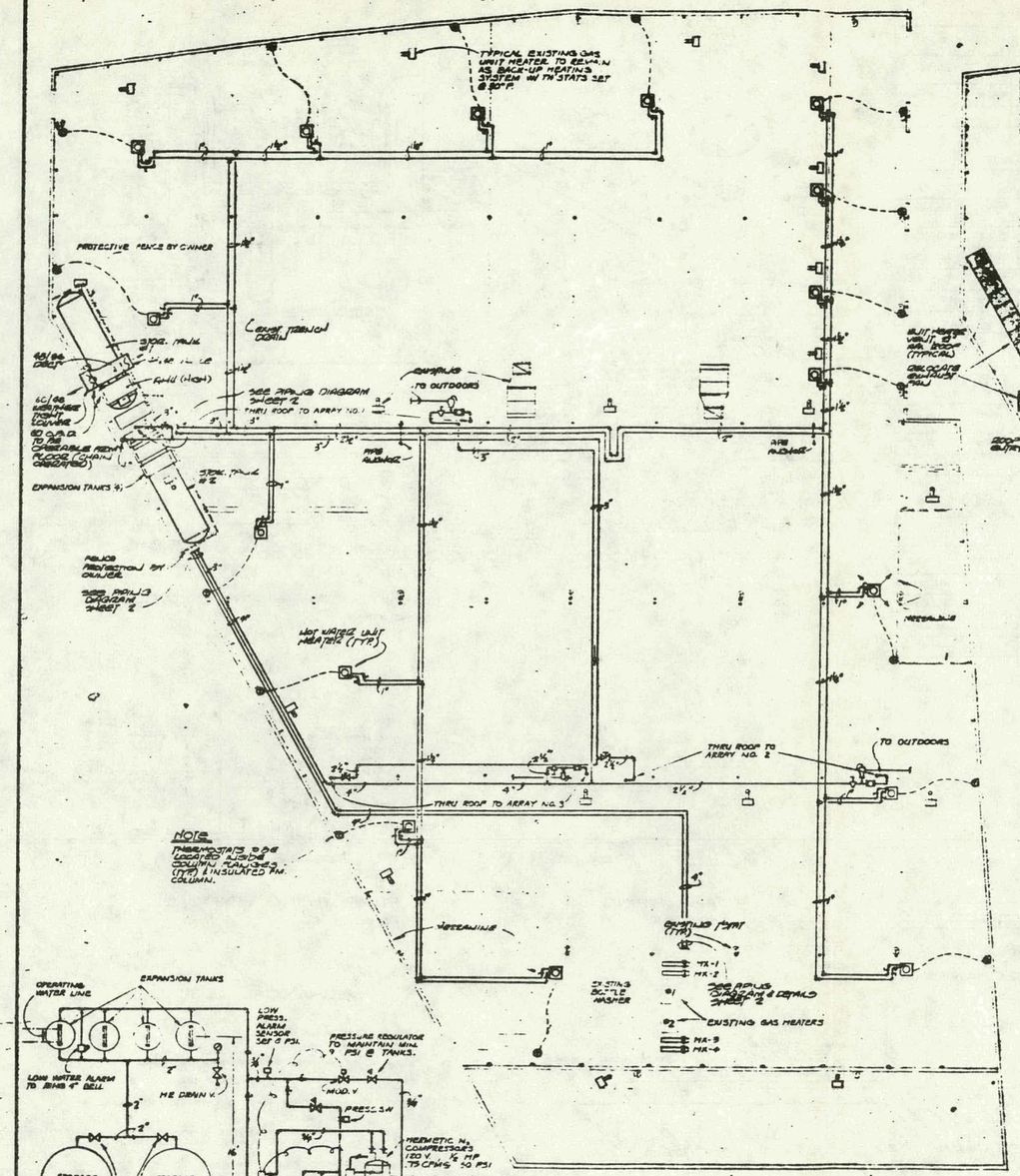
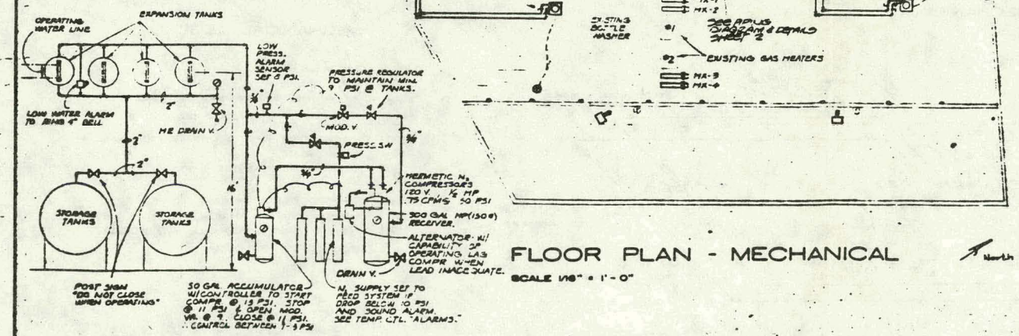
APPENDIX D

PROJECT DRAWINGS



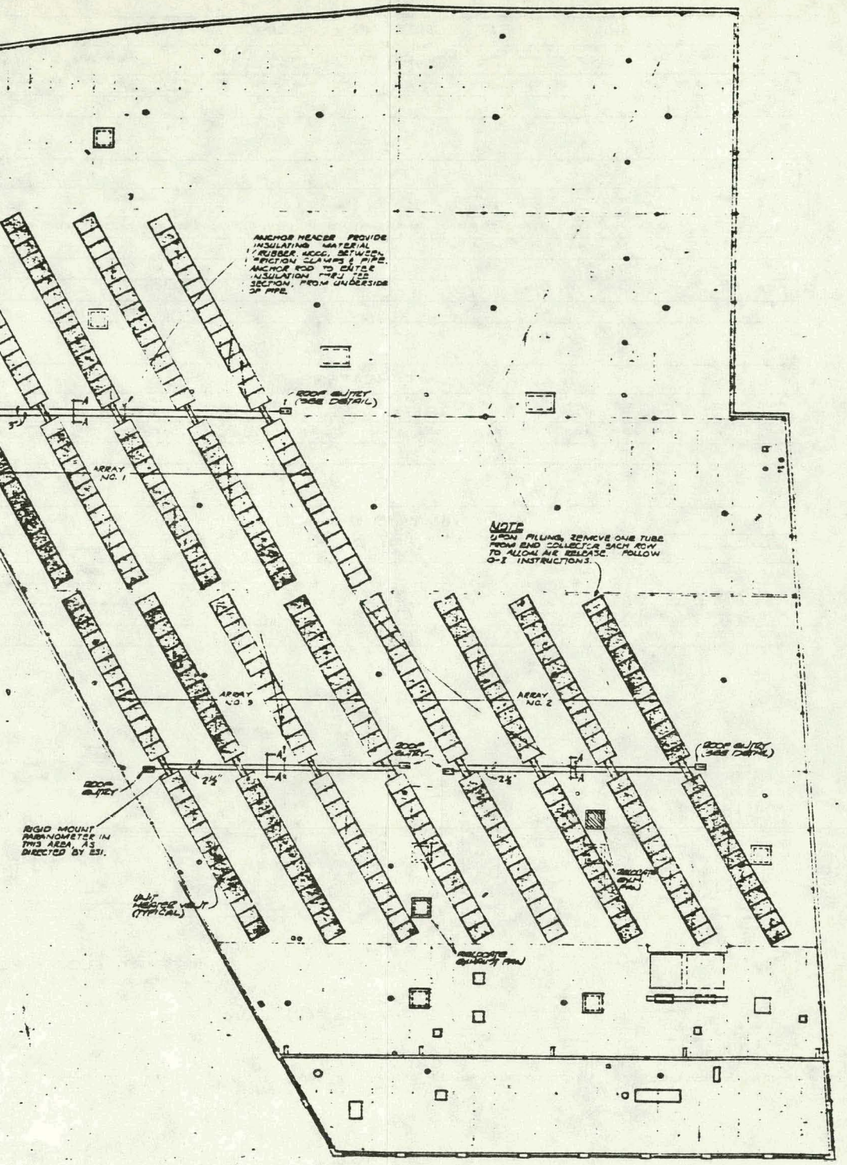
FLOOR PLAN - MECHANICAL

SCALE 1/16" = 1'-0"



PRESSURE CONTROL SYSTEM

NO SCALE



ROOF PLAN - MECHANICAL

SCALE 1/16" = 1'-0"

REVISIONS

SCHEDULE OF DRAWINGS

1	MECHANICAL - FLOOR PLAN & ROOF PLAN
2	MECHANICAL - LEGEND, DIAGRAMS, DETAILS
3	ELECTRICAL - FLOOR PLAN, CONTROL DIAGRAMS
4	STRUCTURAL - COLLECTOR MOUNTING
5	STRUCTURAL DETAILS
6	STRUCTURAL - ROOF PLAN & DETAILS

D-2

ENERGY SOLUTIONS INCORPORATED
PROJECT MANAGER / SOLAR ENERGY SYSTEM ENGINEERS

OFFICE OF GRIFFITH C. BURR, INC.
CONSULTING ENGINEERS

BURR & COLE
STRUCTURAL ENGINEERS

SOLAR HEATING DEMONSTRATION PROJECT

DEPARTMENT OF ENERGY
SOLAR CONTRACT EG-77-A-01-4092

COCA-COLA BOTTLING WORKS OF JACKSON, INC.

JACKSON, TENNESSEE

DATE 17 July, 78
JOB 7650
DRAWN JTE
CHK. HCB
SHEET 1 OF 6

HEAT PURGE AIR HANDLING UNIT

MARK	TYPE	GPM	COIL RD.	MBTU/HR	WATER IN (°F)	AIR IN (°F)	CFM	ESP	MOTOR HP/Φ/VOLT	MOTOR CONTROLLER	REMARKS	MFR.	MODEL
AHU	HORIZONTAL	173	4'	2188	240°F	80°F	18,000	0.5	15/3/240	MAG./COMB.	PROVIDE WITH 2" TH. T.A. FILTERS. SUSPEND FROM ROOF STRUCTURE.	TRANE	CLCH-25

PUMPS

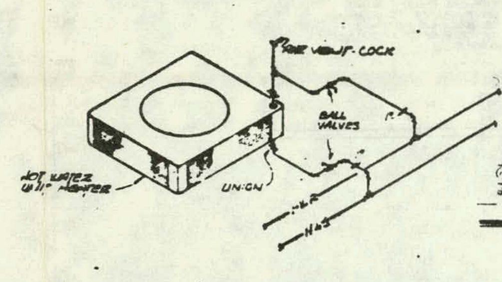
MARK	SERVICE	MIN. % EFF.	GPM	HEAD (FT.)	MAX. RPM	MOTOR HP/Φ/VOLT	MOTOR CONTROL	TYPE SEAL	REMARKS	MFR.	MODEL
P-1	UNIT HEATERS	68%	79	43'	1750	2/3/240	MAG./COMB.	MECH.	FLEXIBLE COUPLED END SUCTION, COUPL. GUARD	B&G	1510-2AB
P-2	PROCESS HT. EXCH.	68%	244	48'	1750	5/3/240	"	"	"	B&G	1510-2½B
P-3	SOLAR COLLECTORS	60%	173	55'	1750	5/3/240	"	"	"	B&G	1510-2BB
P-3A	STANDBY SOLAR COLLECTORS	60%	173	55'	1750	5/3/240	"	"	"	B&G	1510-2[illegible]

UNIT HEATERS

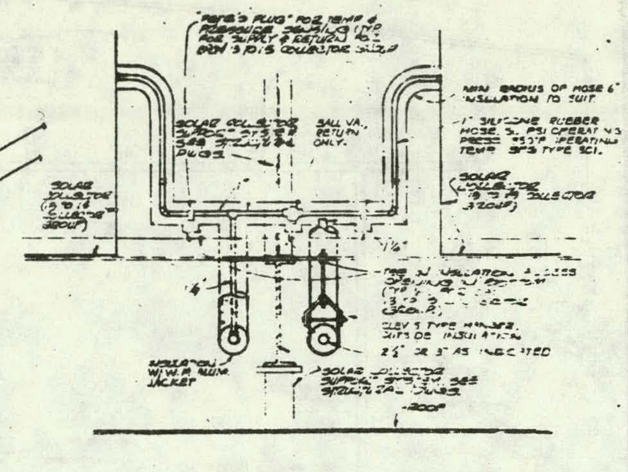
MARK	MBH	ENT. WATER	ENT. AIR	CFM 360°	GPM	P.D. (FT.)	ELECTRICAL RPM	ELECTRICAL HP	ELECTRICAL PH	ELECTRICAL VOLTS	MOTOR	CONTROL	APPROX. M.H. HEIGHT	REMARKS	MFR.	MODEL
VUH	114	180°F	60°F	4160	5.7	1	1070	1/6	1	120	PSC	STAT W/ SUMMER FAN SW.	20 FT. ±	VERTICAL TYPE WITH LOUVER CONE DIFFUSER	TRANE	292-P

HEAT EXCHANGERS

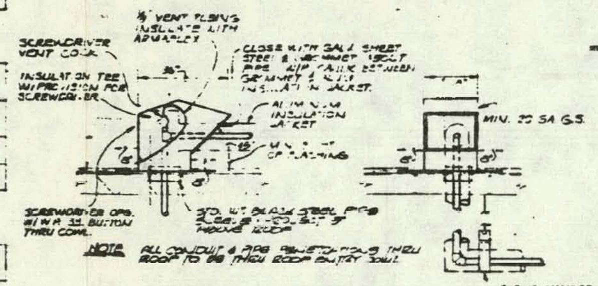
MARK	SERVICE	TUBE (SOLAR) WATER FLOW GPM	P.D. (FT. H₂O)	ENT. (°F)	LVG. (°F)	SHELL (PROCESS) WATER FLOW GPM	P.D. (FT. H₂O)	ENT. (°F)	LVG. (°F)	HEATING SURFACE (SQ. FT.)	FOULING FACTOR	DIMENSIONS DIA. (IN.)	LENGTH (IN.)	REMARKS	MFR.	MODEL
HX-1	COMPARTMENT #1	63	2.5	160	140	63	1.5	120	140	124	.001	10	942	4 PASS - U TUBE	B&G	WU 107-45
HX-2	COMPARTMENT #2	90	4.1	190	179	63	1.1	160	175	150	"	12	873	"	"	WU 123-46
HX-3	COMPARTMENT #3	56	4.5	190	175	42	0.5	160	177	75	"	8	942	"	"	QWU 89-43
HX-4	COMPARTMENT #4	35	2.2	160	140	35	2.5	120	140	75	"	8	942	"	"	WU 89-44



UNIT HEATER PIPING
NO SCALE

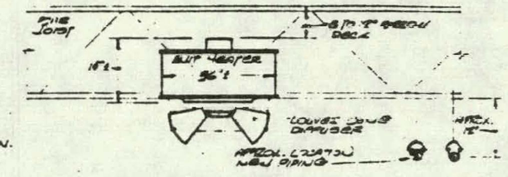


SECTION AA
SCALE 3/4" = 1'-0"

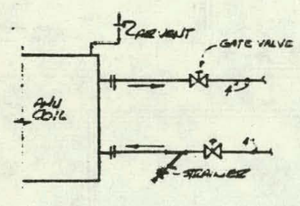


NOTE: ALL CONDUIT & PIPE PENETRATIONS THRU ROOF TO BE THRU ROOF ENTRY COWL.

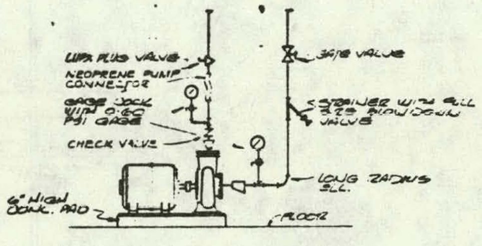
ROOF ENTRY COWL
NO SCALE



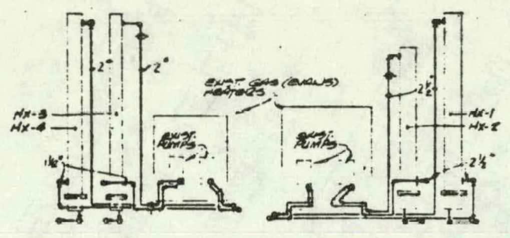
UNIT HEATER MTG. LOCATION
NO SCALE



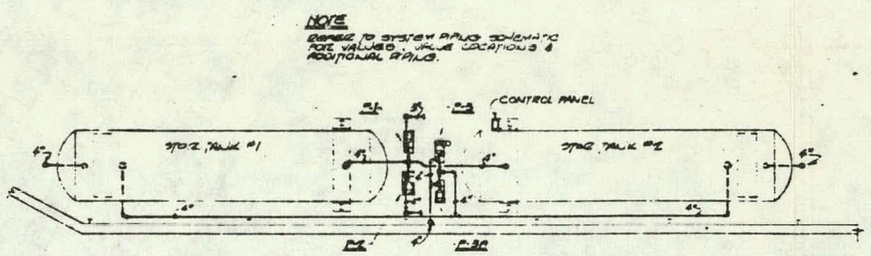
AHU PIPING
NO SCALE



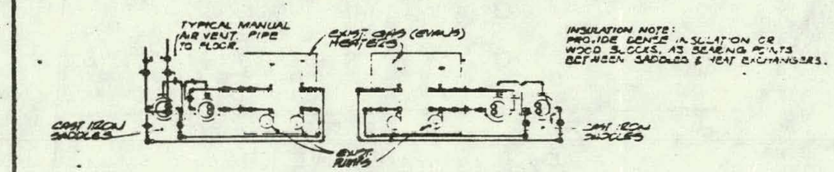
PUMP PIPING (TYPICAL)
NO SCALE



PLAN



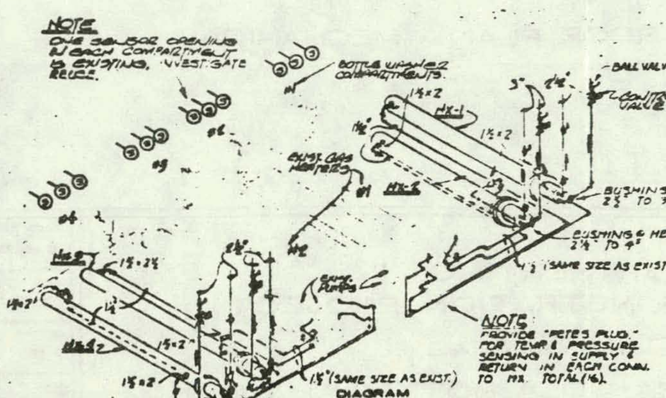
PART FLOOR PLAN - MECHANICAL
SCALE 1/8" = 1'-0"



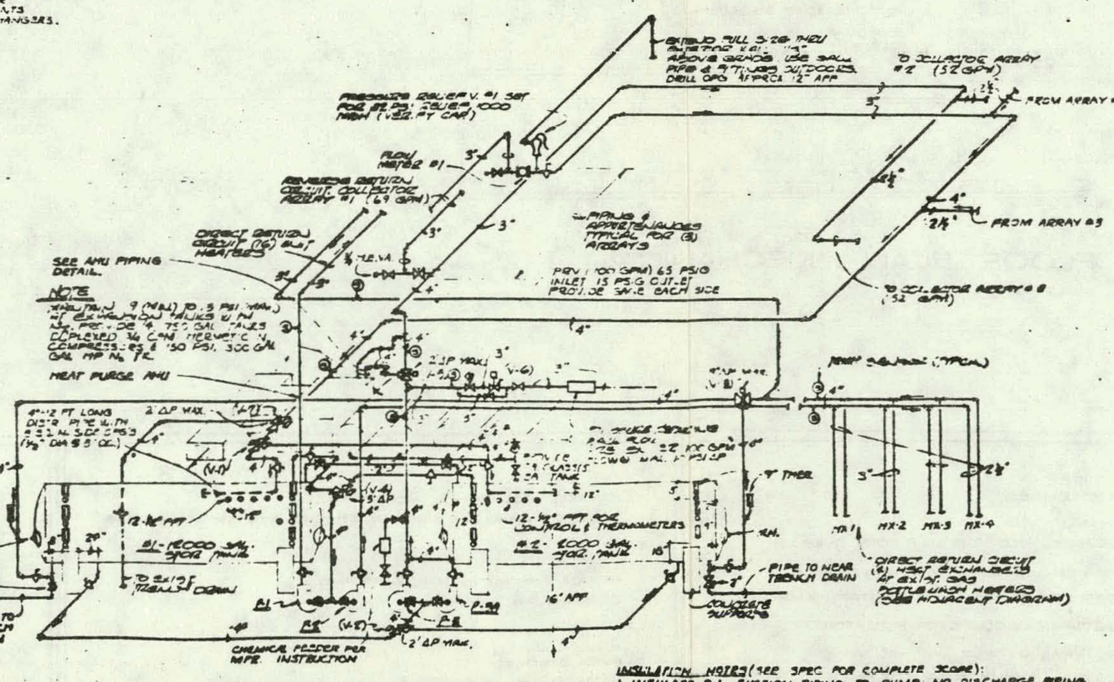
ELEVATION

MECHANICAL LEGEND

- LUB. PLUG VALVE
- BALL VALVE
- ½" FPT FOR TEMPERATURE SENSOR
- MOTOR OPERATED 3-WAY CONTROL VALVE
- MOTOR OPERATED 2-WAY CONTROL VALVE
- GATE VALVE
- THERMOMETER (W/ LINE SIZE WYE FITTING WHERE IN PIPE) 30-240° RANGE, 9" SIZE, SEPARABLE SOCKET TYPE
- O.B.D. OPPOSED BLADE DAMPER
- THERMOSTAT (TO BE LOCATED INSIDE COLUMN ENCLOSURES)
- PRESSURE GAGE W/GAGE COCK, MIN. 4" SIZE.
- PRESSURE REGULATING VALVE



BOTTLEWASHER HEATER PIPING
NO SCALE



INSULATION NOTES (SEE SPEC FOR COMPLETE SCOPE):
1. INSULATE P-1 SUCTION PIPING TO PUMP, NO DISCHARGE PIPING.
2. INSULATE ENTIRE EXPANSION TANK HEADER. NOT TANKS.

SYSTEM PIPING SCHEMATIC
NO SCALE

REVISIONS	SOLAR HEATING DEMONSTRATION PROJECT COCA-COLA BOTTLING WORKS OF JACKSON, INC. JACKSON, TENNESSEE ENERGY SOLUTIONS INCORPORATED PROJECT MANAGER / SOLAR ENERGY SYSTEM ENGINEERS	
JOB 1690 / DATE 17 July 78 / DRN. JTC / CHK. [signature]	OFFICE OF GRIFFITH C. BURR, INC. CONSULTING ENGINEERS 136 SCOTT STREET MEMPHIS, TENNESSEE 38112	SHEET 2 OF 6

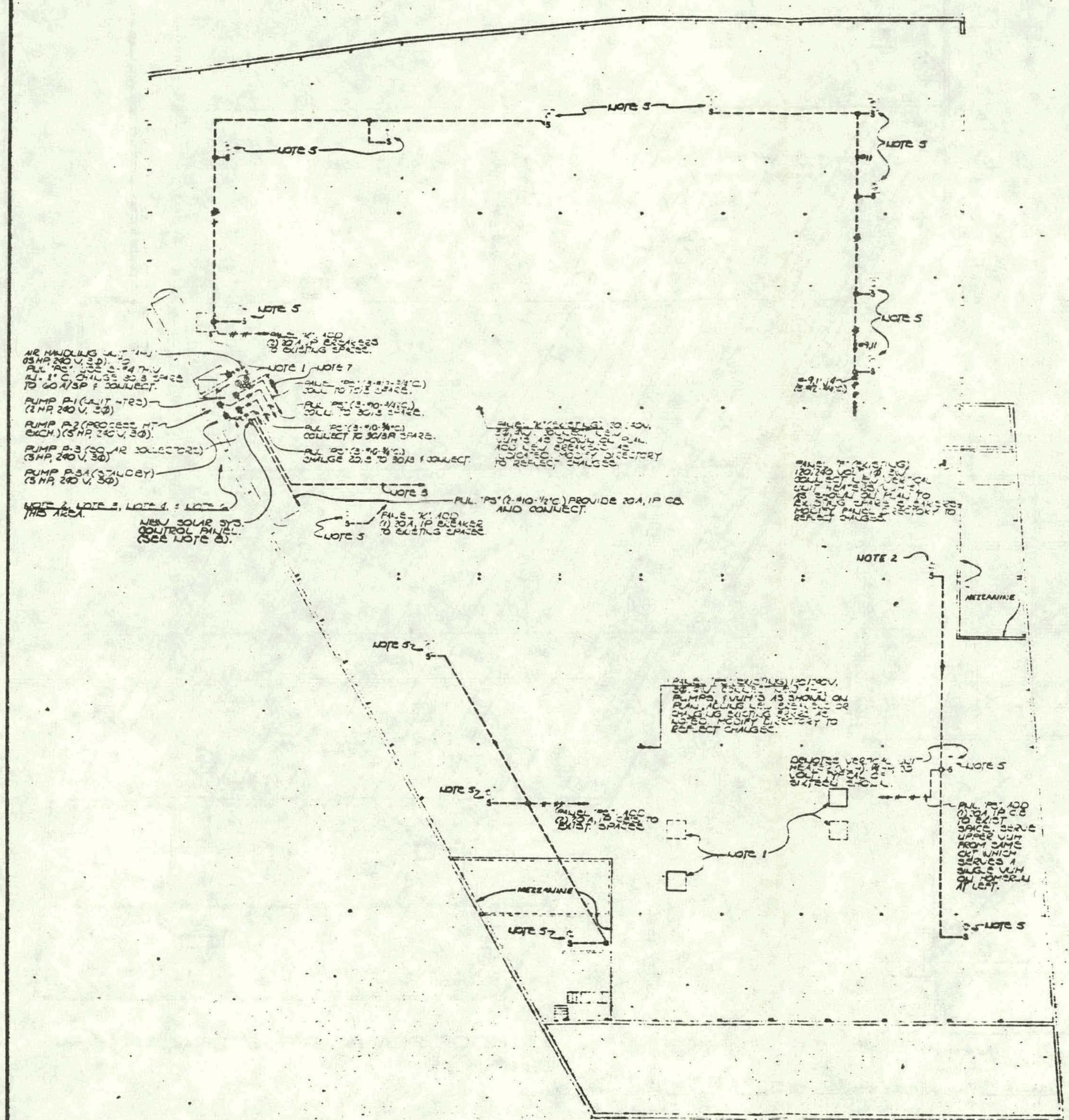
ELECTRICAL LEGEND

S	TOGGLE TYPE DISCONNECT SWITCH. 15 AMP MAXIMUM.
◘	JUNCTION BOX.
——	CONDUIT EXPOSED ON WALL OR CEILING.
P-9,11	HOMERUN TO PANELBOARD. LETTERS DENOTE PANEL; NUMBERS DENOTE CIRCUITS; CROSSBARS DENOTE NUMBER OF WIRES. NO CROSSBARS DENOTES A TWO WIRE CIRCUIT.
	DISCONNECT SWITCH.
	MAGNETIC MOTOR STARTER
	COMBINATION MAGNETIC MOTOR STARTER AND DISCONNECT SWITCH
	PANELBOARD, NEW OR EXISTING AS NOTED ON PLAN.
2	MOTOR. NUMERAL DENOTES HORSEPOWER.
	THERMOSTAT. SEE NOTE 5 BELOW.

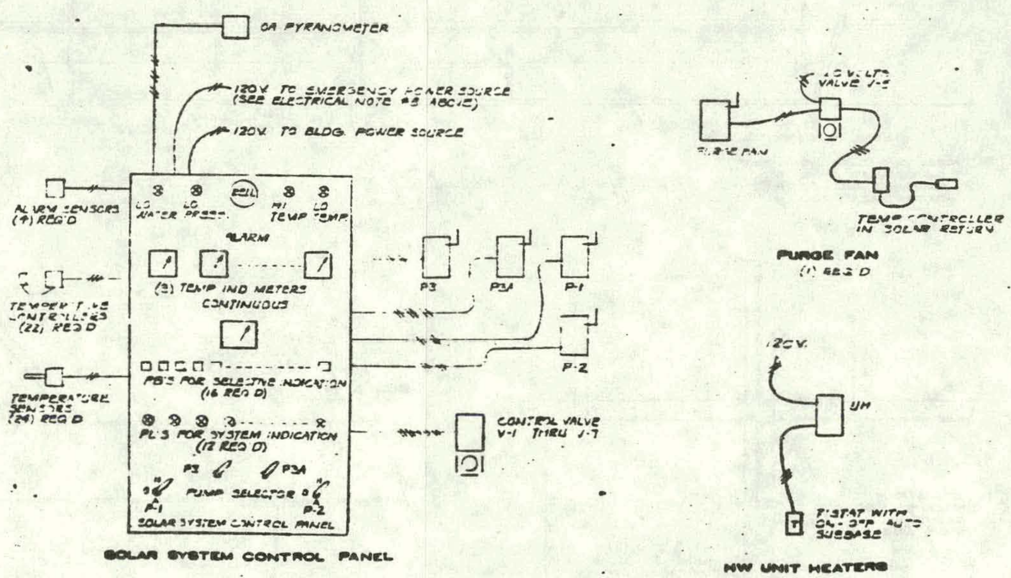
NOTE: WIRING SHALL BE COPPER WITH TYPE "THW" INSULATION, MINIMUM #12 AWG & 1/2" C UNLESS NOTED OTHERWISE

ELECTRICAL NOTES

1. DENOTES NEW (SOLID) AND FORMER (DASHED) POSITIONS OF EXISTING EXHAUST FANS. RELOCATE ALL POWER AND CONTROL WIRING REQUIRED BY THE RELOCATION OF EXIST. EXH. FANS.
2. FURNISH AND INSTALL (1) FLUORESCENT LIGHTING FIXTURES TO BE SURFACE MOUNTED BENEATH [illegible] SUPPORT FRAME. FIXTURE SHALL BE SIMILAR TO EXIST. FIXTURES IN LOADING & PARKING AND STACKING AREAS. CONNECT TO EXISTING CKT AT NEAREST AVAILABLE FIXTURE. REFER TO MECHANICAL AND STRUCTURAL PLANS FOR SUPPORT FRAME DETAILS.
3. PROVIDE 120V CONNECTION TO VALVE V-5 WITH DISC. SW. IF REQUIRED. REFER TO "SYSTEM PIPING SCHEMATIC" ON SHEET #2 FOR APPROXIMATE LOCATION AND RELATIONSHIP TO ASSOCIATED EQUIPMENT. SEE ALSO "PURGE FAN" DIAGRAM BELOW. PROVIDE 120V [illegible] FROM PANEL "P5", USING EXISTING SPACE. PROVIDE NEW CKT. BREAKER, TRIP AT 20 AMPS.
4. PROVIDE 120 VOLT CONNECTION TO SOLAR SYSTEM CONTROL PANEL (SEE DIAGRAM BELOW) FROM PANEL "P5" USING EXISTING SPACE. PROVIDE NEW CKT BREAKER; TRIP AT 20 AMPS. VERIFY PANEL LOCATION.
5. REFER TO SHEET #1 FOR NEW THERMOSTAT LOCATIONS SERVING NEW VERTICAL UNIT HEATERS. ELECTRICAL CONNECTION REQUIRED. SEE "HW UNIT HEATERS" DIAGRAM BELOW.
6. APPROXIMATE LOCATION OF PUMPS P-1, P-2, P-3, & P-3A ONLY. VERIFY PRIOR TO INSTALLATION.
7. CHANGE (2) 1P SPACES IN PANEL "P5" TO (2) 15A/1P CKTS & CONNECT TO (2) COMPRESSOR MOTORS (EACH [illegible] 120V). PROVIDE REQ'D DISCONNECT. VERIFY CONTROL REQUIREMENTS.
8. 120 VOLT BRANCH CIRCUIT TO EMERGENCY SYSTEM LOCATED ACROSS ALLEY AT OLDER BUILDING. ROUTE UNDERGROUND ACROSS ASPHALT PAVED ALLEY USING RIGID STEEL CONDUIT. ADD 20/1 C.B. IF REQ'D. USE 2-#8THW IN 1/2" CONDUIT. VERIFY LOCATIONS AT SITE.

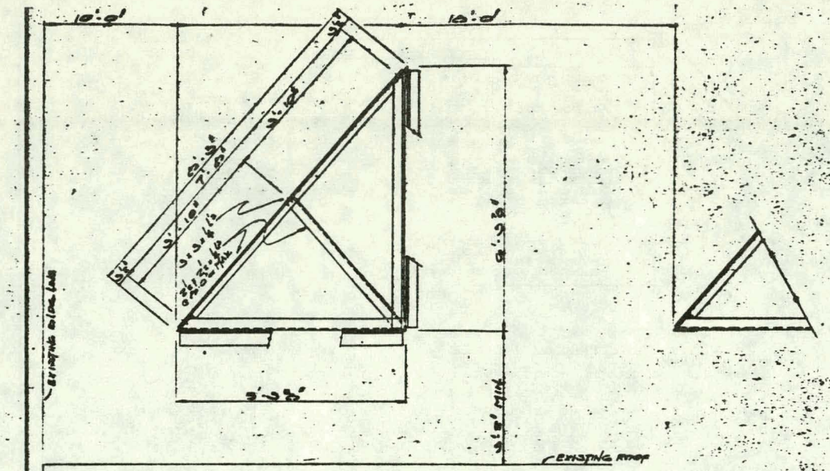


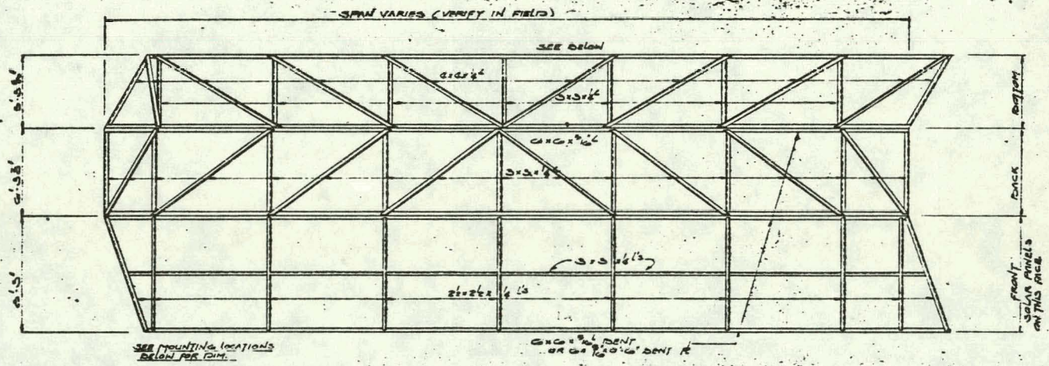
FLOOR PLAN - ELECTRICAL
SCALE 1/16" = 1'-0"

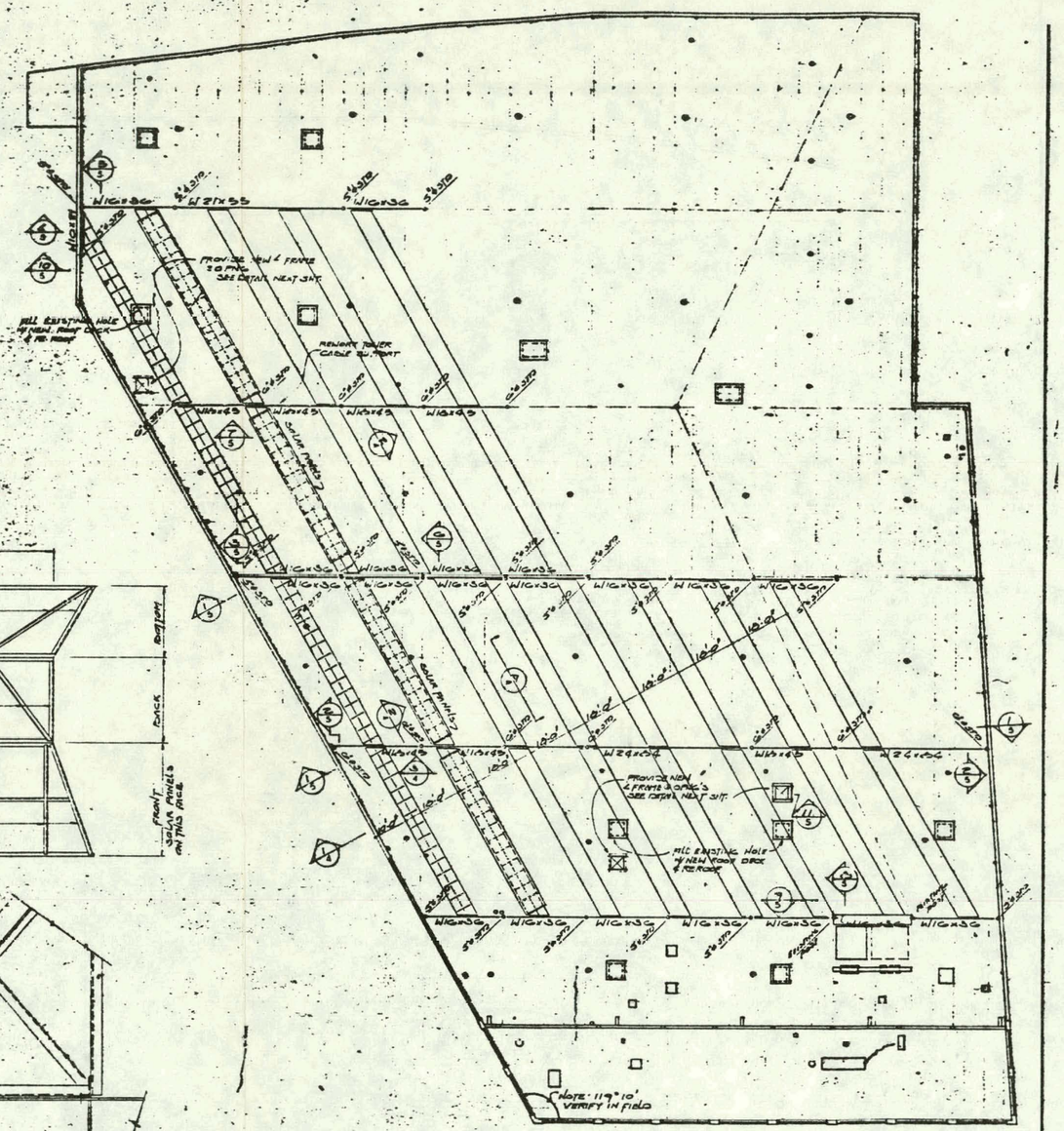


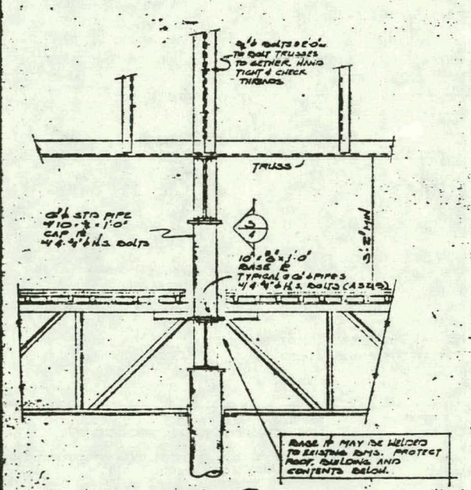
TEMPERATURE CONTROL DIAGRAMS.
SEE SHEET 2 FOR SYSTEM PIPING SCHEMATIC

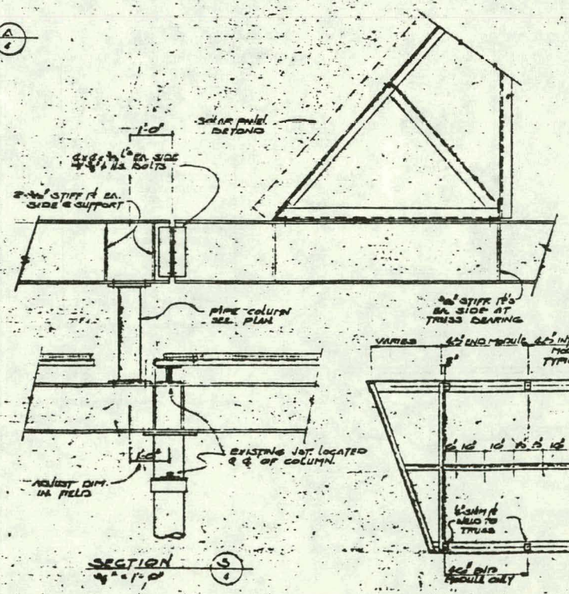
REVISIONS	SOLAR HEATING DEMONSTRATION PROJECT COCA-COLA BOTTLING WORKS OF JACKSON, INC. JACKSON, TENNESSEE ENERGY SOLUTIONS INCORPORATED PROJECT MANAGER / SOLAR ENERGY SYSTEM ENGINEERS
JOB 7680 · DATE 17 July 78 · DRN. DSM · CHK.	OFFICE OF GRIFFITH C. BURR, INC. CONSULTING ENGINEERS 139 SCOTT STREET MEMPHIS, TENNESSEE 38112 SHEET 3 OF 6

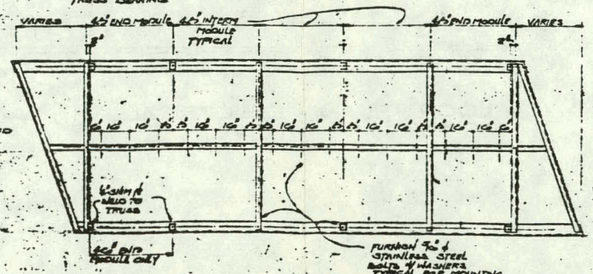












COLLECTOR ASSEMBLY MOUNTING LOCATIONS

NOTE: VERIFY LOCATION W/ MFR.

REVISIONS	SOLAR HEATING DEMONSTRATION PROJECT COCA-COLA BOTTLING WORKS OF JACKSON, INC. JACKSON, TENNESSEE ENERGY SOLUTIONS INCORPORATED PROJECT MANAGER / SOLAR ENERGY SYSTEM ENGINEERS

JOB	DATE	OFFICE OF GRIFFITH C. BURR, INC. CONSULTING ENGINEERS 139 SCOTT STREET MEMPHIS, TENNESSEE 38112	SHEET 4 OF 6
7650	11 June '78		
DRN	CHK		
DJC	BCB		

BURR & COLE CONSULTING ENGINEERS
MEMPHIS, TENNESSEE

SECTION 1/S — 3/4"=1'-0"

SECTION 2/S — 3/4"=1'-0"

SECTION 3/S — 3/4"=1'-0"

SECTION 4/S — 3/4"=1'-0"

SECTION 5/S

SECTION 6/S — 3/4"=1'-0"

REMARK EXISTING TOWER CABLE SUPPORT BRACKET AND WELD TO NEW BEAM AS CLOSE TO TOWER AS POSSIBLE

PIPING SEE MECH. SECTION A-A SHT 2

TRUSS BEYOND

DETAIL G COLLECTOR PIPING STEPS 3/4"=1'-0"

EXISTING COOLING TOWER

NEW BEAM BEYOND

EXISTING BEAMS, POST & PITCH POCKET

SECTION 7/S — 3/4"=1'-0"

SECTION 8/S — 3/4"=1'-0"

SECTION 9/S — 3/4"=1'-0"

SECTION 10/S — 3/4"=1'-0"

SECTION 11/S — 3/4"=1'-0"

SECTION 12/S — 3/4"=1'-0"

SECTION 13/S — 3/4"=1'-0"

FOUNDATION PLAN & STORAGE TANK 1/4"=1'-0"

SUPPORT FOR EXPANSION TANKS 1/4"=1'-0"

SECTION 14/S — 3/4"=1'-0"

REVISIONS

SOLAR HEATING DEMONSTRATION PROJECT

COCA-COLA BOTTLING WORKS OF JACKSON, INC.
JACKSON, TENNESSEE

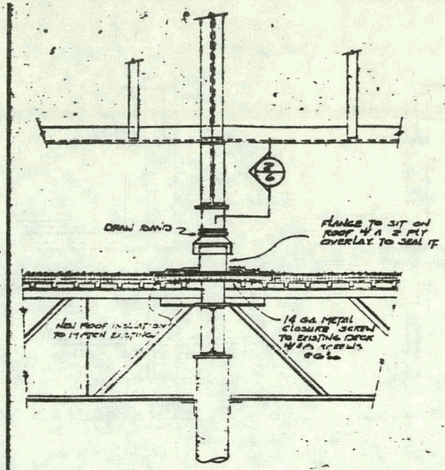
ENERGY SOLUTIONS INCORPORATED
PROJECT MANAGER / SOLAR ENERGY SYSTEM ENGINEERS

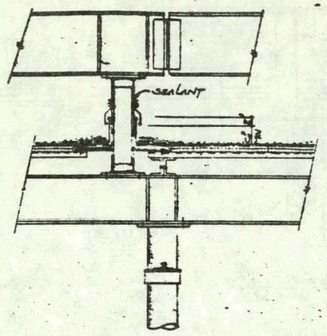
BURR & COLE CONSULTING ENGINEERS
MEMPHIS, TENNESSEE

JOB	DATE
7650	17 July 78
DRN.	CHK.

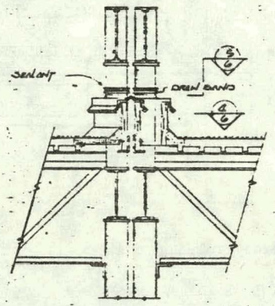
OFFICE OF GRIFFITH C. BURR, INC.
CONSULTING ENGINEERS
130 SCOTT STREET
MEMPHIS, TENNESSEE 38111

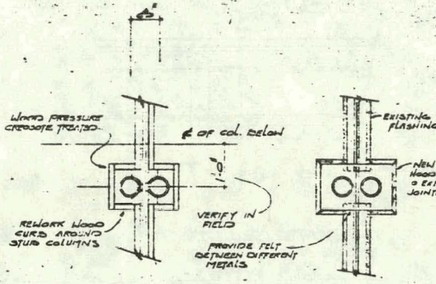
SHEET 5 OF ●

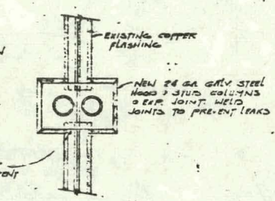




TYPICAL DETAIL @ NEW PIPE SUPPORT



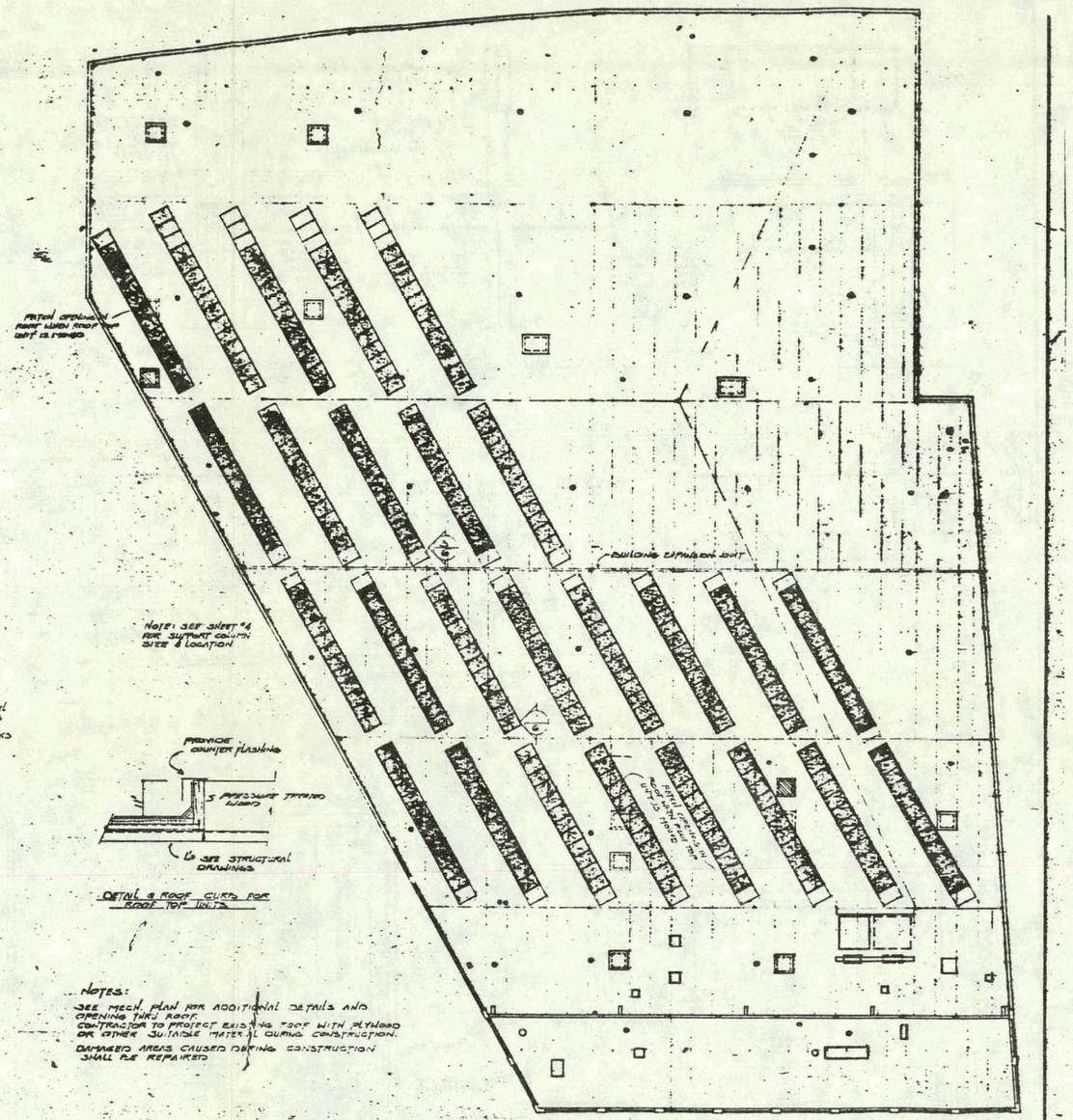




TYPICAL DETAIL @ EXPANSION JOINT PIPE SUPPORTS

DETAIL @ ROOF CURB FOR ROOF TOP UNITS

NOTES:
SEE MECH. PLAN FOR ADDITIONAL DETAILS AND OPENING THRU ROOF.
CONTRACTOR TO PROTECT EXISTING ROOF WITH PLYWOOD OR OTHER SUITABLE MATERIAL DURING CONSTRUCTION.
DAMAGED AREAS CAUSED DURING CONSTRUCTION SHALL BE REPAIRED

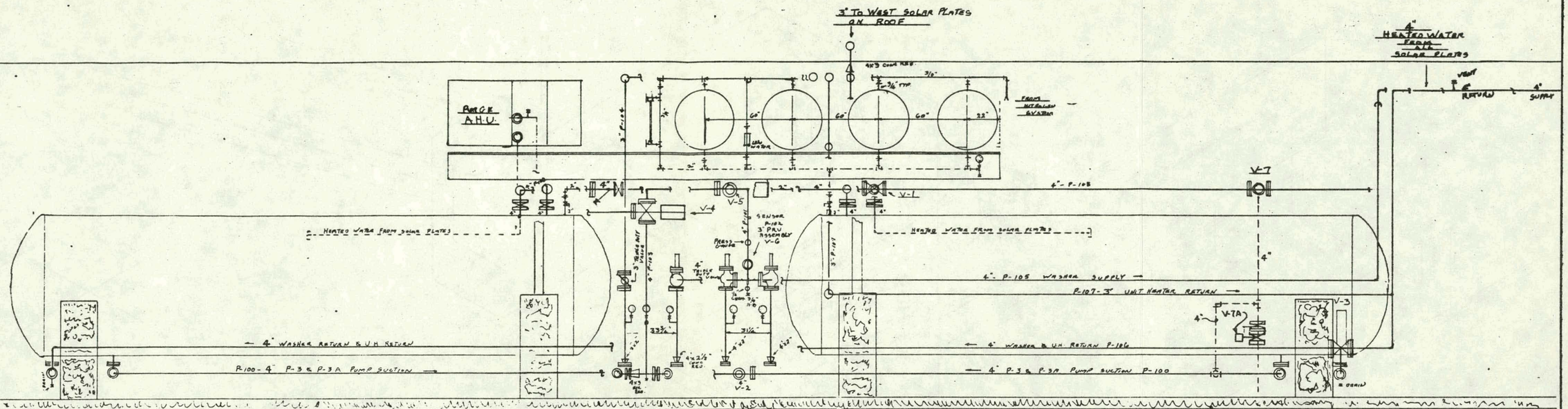


ROOF PLAN

SCALE 1/16" = 1'-0"

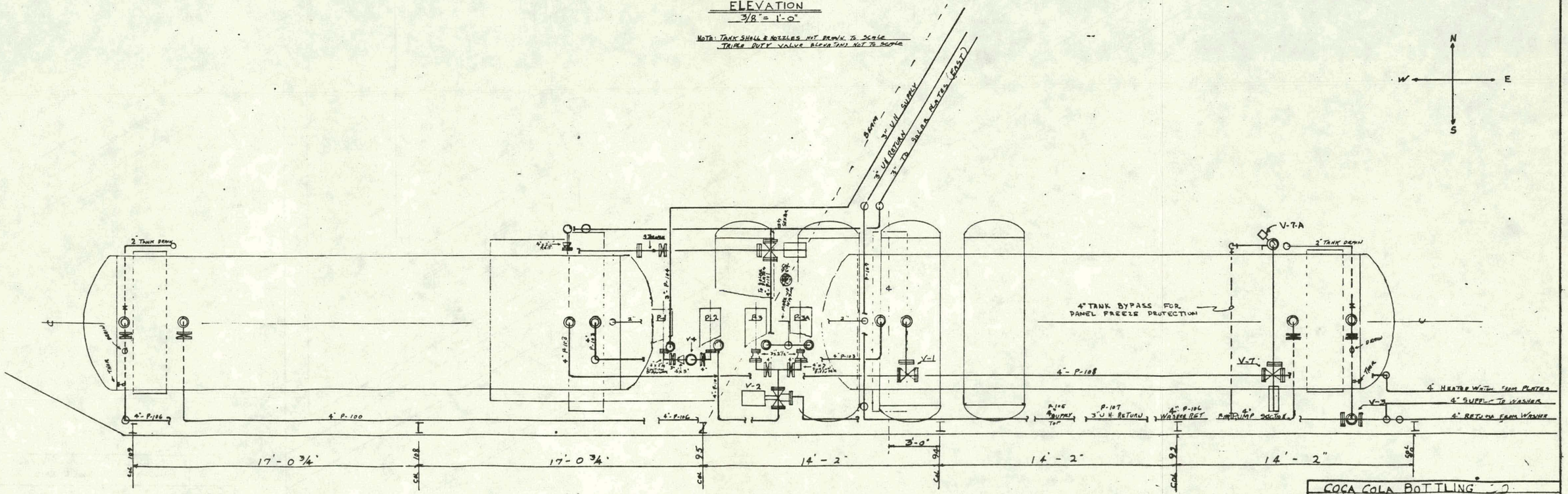
North

REVISIONS	SOLAR HEATING DEMONSTRATION PROJECT COCA-COLA BOTTLING WORKS OF JACKSON, INC. JACKSON, TENNESSEE ENERGY SOLUTIONS INCORPORATED PROJECT MANAGER / SOLAR ENERGY SYSTEM ENGINEERS	
	BURR & COLE CONSULTING ENGINEERS MEMPHIS, TENNESSEE	OFFICE OF GRIFFITH C. BURR, INC. CONSULTING ENGINEERS 139 SCOTT STREET MEMPHIS, TENNESSEE 38103
JOB 7650 DATE 11 July 78 DRN. BJC CHK.		SHEET 6 OF 8



ELEVATION
3/8" = 1'-0"

NOTE: TANK SHELL & NOZZLES NOT DRAWN TO SCALE
TRIPLE DUTY VALVE ELEVATION NOT TO SCALE



PLAN
3/8" = 1'-0"

COCA COLA BOTTLING CO. JACKSON, TENN.	
SOLAR HEATING SYSTEM	SCALE 3/8"-1'-0"
PIPING AT TANKS	DESIGNED BY WP
PROCESS CONTRACTING CO. MEMPHIS, TENN.	
DATE 1/23/79	APPROVED BY
	DRAWING NUMBER 100

AS-BUILT DRWG. - 7/1/80
MORGAN & TURNER, INC

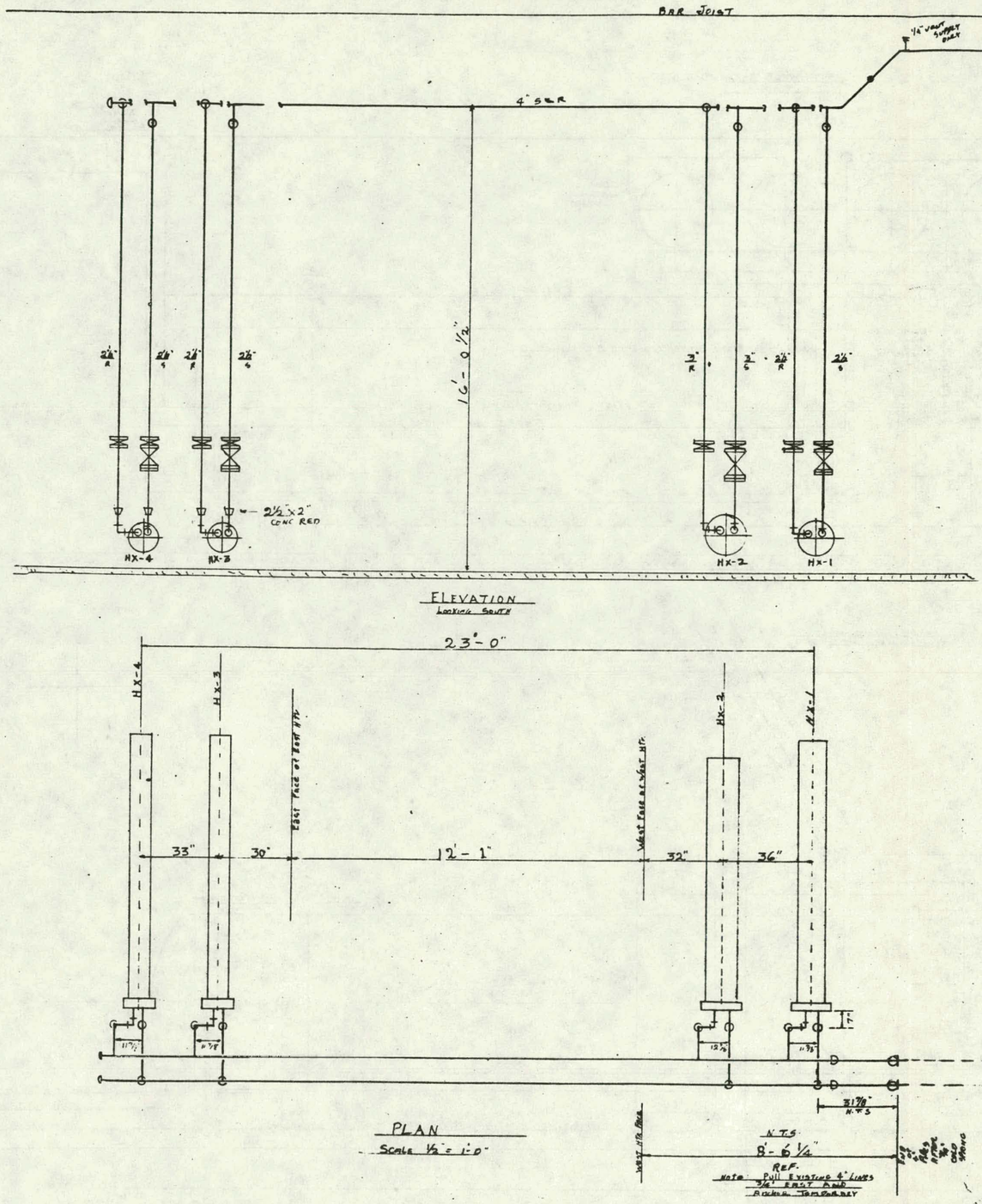
ISOMETRIC LOOKING NORTH
AT
STORAGE TANKS

SEE DWG 100
FOR PLAN & ELEVATION

"AS-BUILT" DRWG. - 7/1/80
MORGAN - TURNER, INC.

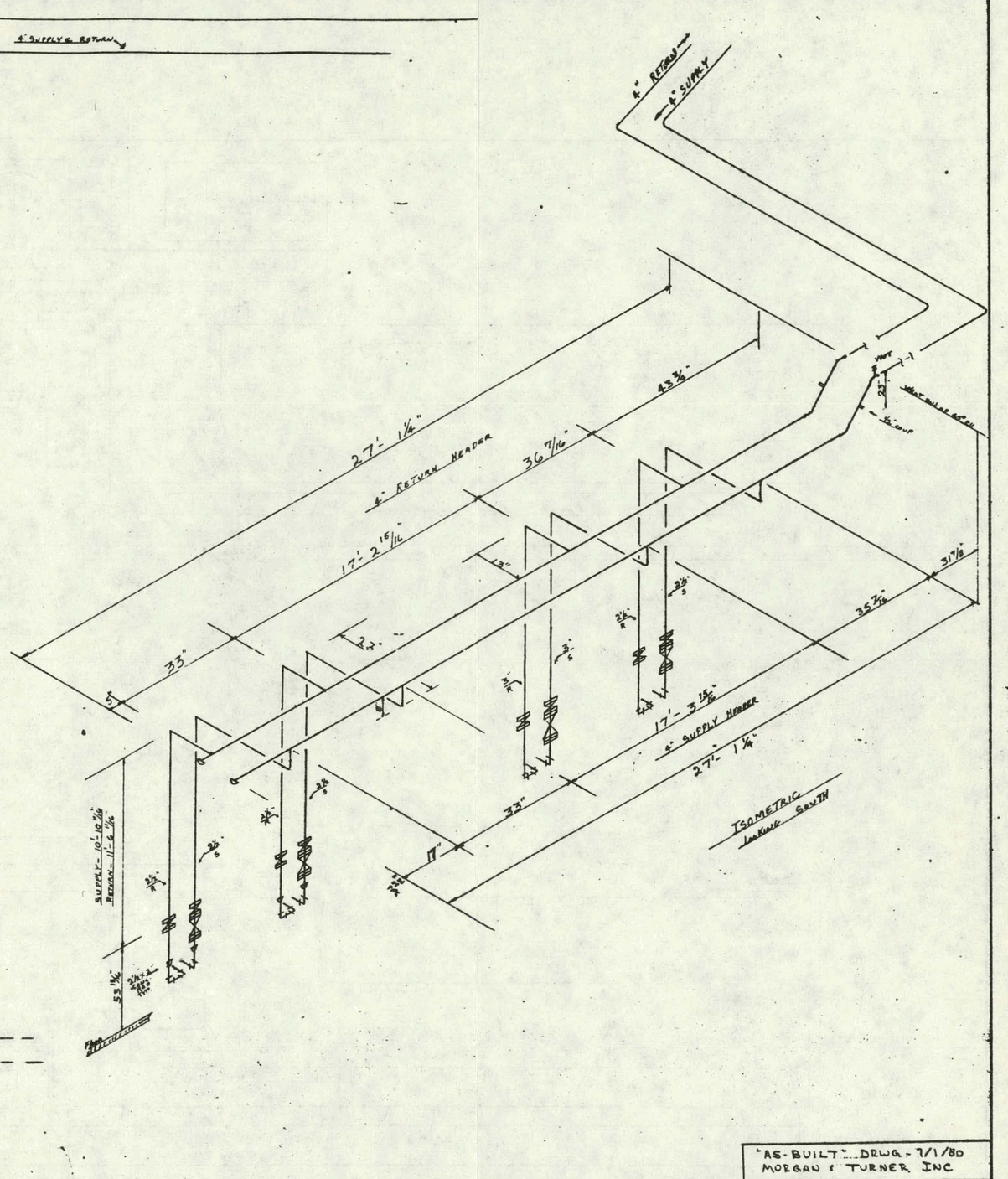
COCA COLA BOTTLING CO.
JACKSON, TENN.

SOLAR HEATING SYSTEM	SCALE	DRAWN BY	WP
PIPING AT STORAGE TANKS	NONE	REVISED	
PROCESS CONTRACTING CO.			
MEMPHIS, TENN.			
DATE 1-24-79	APPROVED BY	DRAWING NUMBER	101



ELEVATION
LOOKING SOUTH

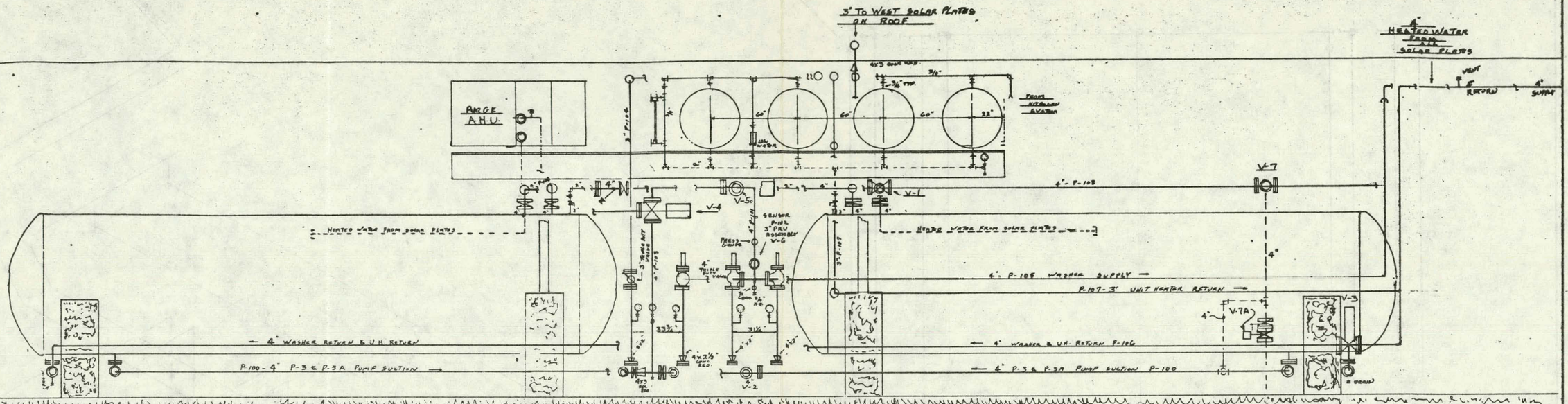
PLAN
SCALE ½" = 1'-0"



ISOMETRIC
LOOKING SOUTH

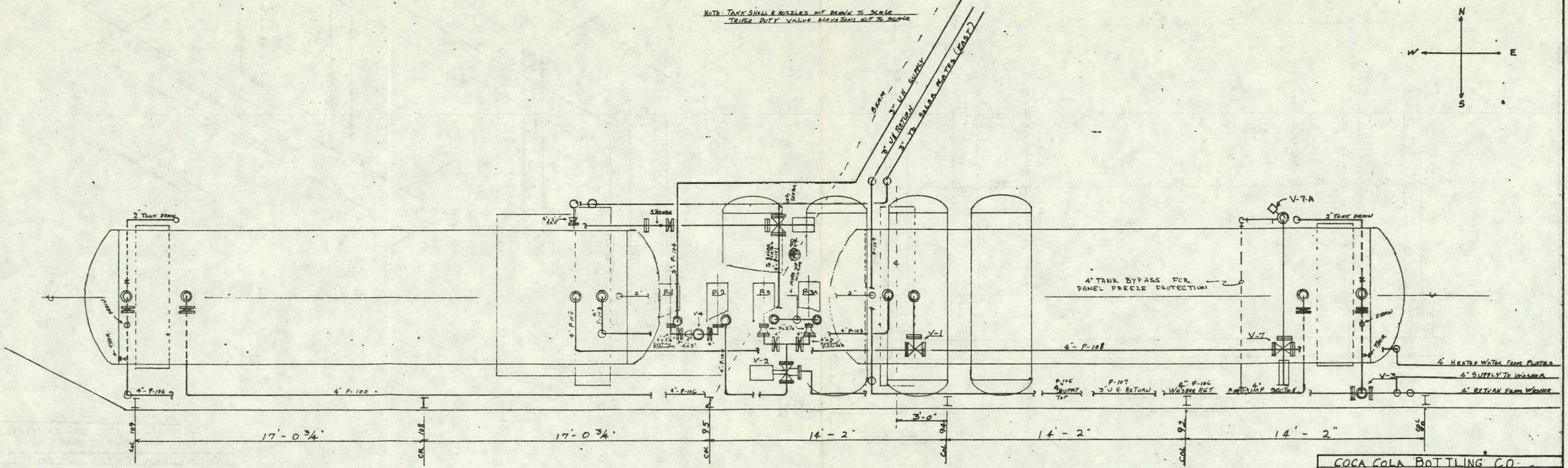
"AS-BUILT" DRWG - 7/1/80
MORGAN & TURNER INC

COCA COLA BOTTLING CO. JACKSON, TENN.		
SOLAR HEATING SYSTEM	SCALE 1/2=1-0	DRAWN BY JWP
PIPING H.W. AT H.E.		REVISED
PROCESS CONTRACTING CO. MEMPHIS, TENN		
DATE 2-28-79	APPROVED BY	JOB NUMBER 102



ELEVATION
3/8" = 1'-0"

NOTE: TANK SHELL & NOZZLES NOT DRAWN TO SCALE
TRIPLE DUTY VALVE & VALVE TAGS NOT TO SCALE



PLAN
3/8" = 1'-0"

N
W E
S

D-11

COCA COLA BOTTLING CO.
JACKSON, TENN.
SOLAR HEATING SYSTEM
PIPING AT TANKS
PROCESS CONTRACTING CO.
MEMPHIS, TENN.
SCALE 3/8"-1'-0"
DRAWN BY WP
REVISED
DATE 1/23/79
APPROVED BY
DRAWING NUMBER 100

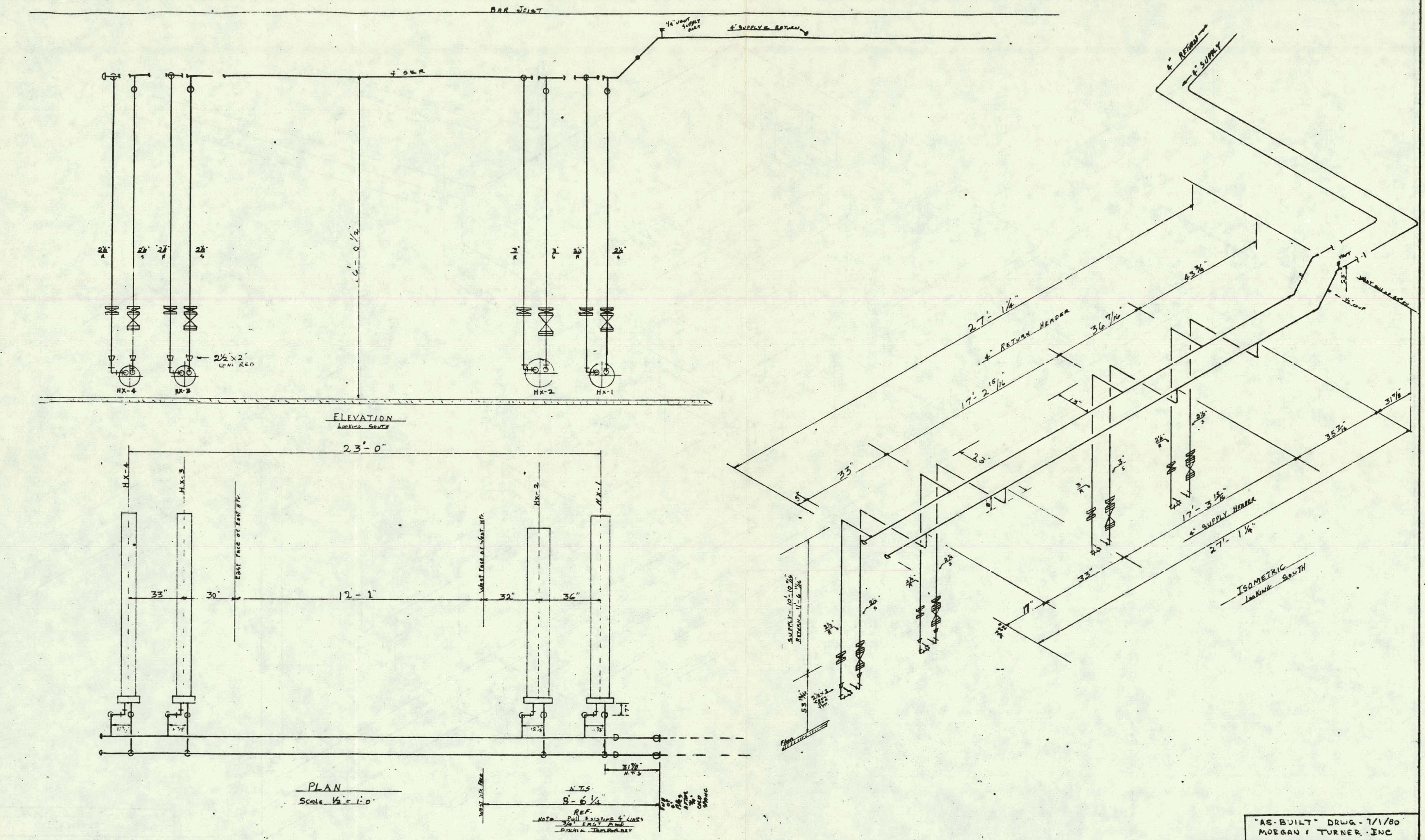
AS-BUILT DRWG. - 7/1/80
MURGAN & TURNER, INC

ISOMETRIC LOOKING NORTH AT STORAGE TANKS

SEE DWG 100 FOR PLAN & ELEVATION

"AS-BUILT" DRWG.- 7/1/80
MORGAN - TURNER, INC.

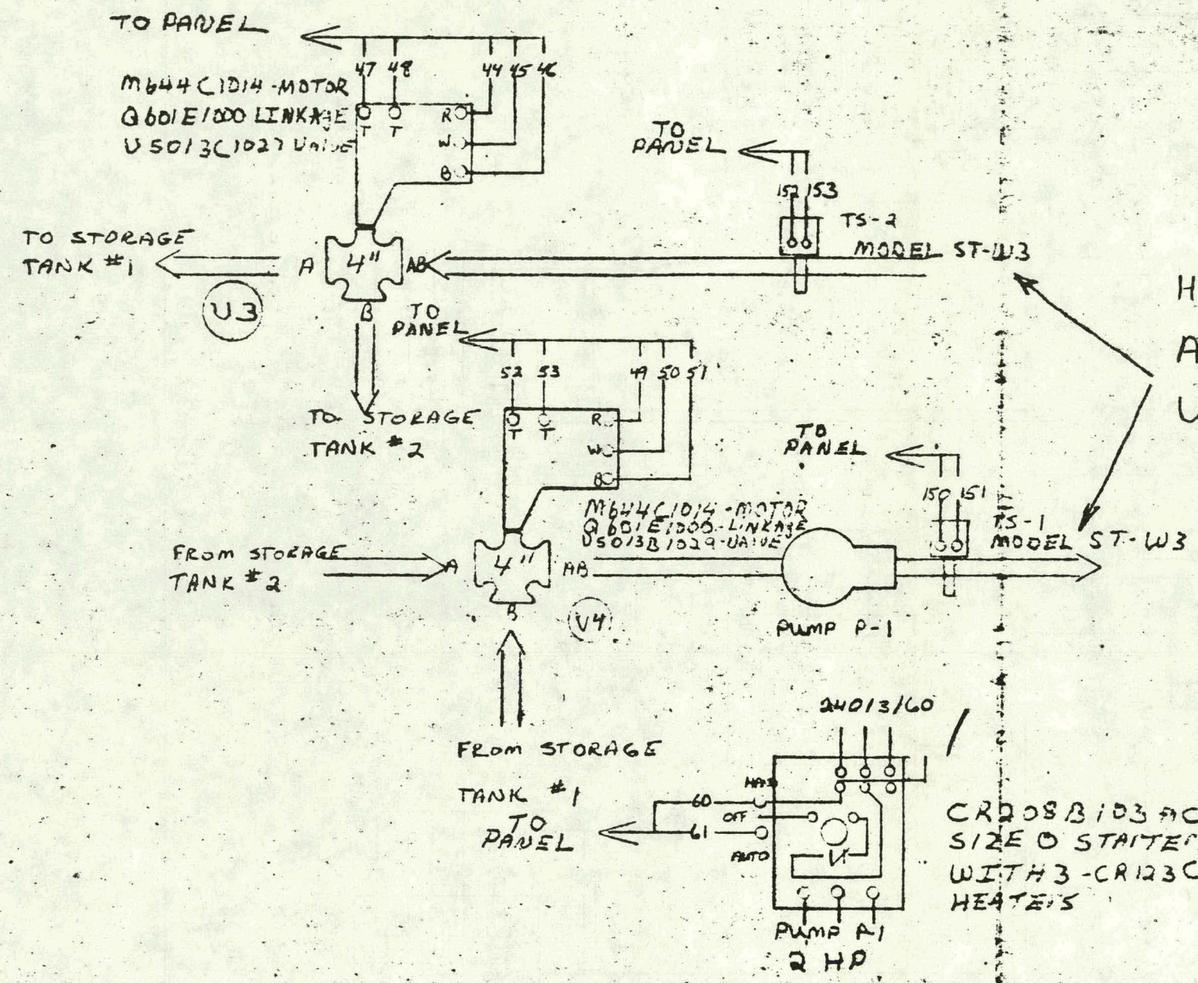
COCA COLA BOTTLING CO. JACKSON, TENN.		
SOLAR HEATING SYSTEM	SCALE	DRAWN BY WP
PIPING AT STORAGE TANKS	NONE	REVISED
PROCESS CONTRACTING CO. MEMPHIS, TENN.		
DATE 1-24-79	APPROVED BY	DRAWING NUMBER 101



"AS-BUILT" DRWG - 7/1/80
MORGAN & TURNER · INC

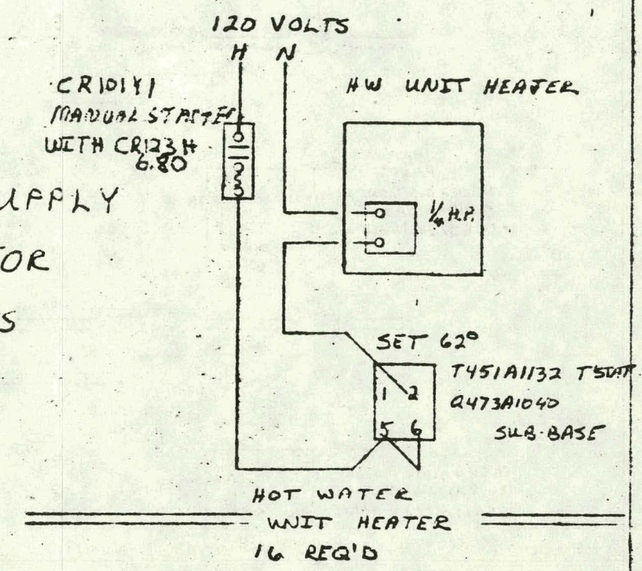
COCA COLA BOTTLING CO. JACKSON, TENN.		
SOLAR HEATING SYSTEM PIPING H.W. AT H.E.	SCALE ½=1'-0"	DRAWN BY WP / REVISED
PROCESS CONTRACTING CO. MEMPHIS, TENN		
DATE 2-28-79	APPROVED BY	DRAWING NUMBER 102

MADE IN U.S.A.



SPACE HEATING CONTROL
ONE REQ'D

HOT WATER SUPPLY
AND RETURN FOR
UNIT HEATERS



TEMPERATURE CONTROLL SYSTEM		
COCA COLA JACKSON, TENN.		
INDUSTRIAL MECHANICAL SUPPLIERS		
JOB # G-255	JAN. 31, 1979	SHEET 9 OF 10

TO PANEL
M644A1016 MOTOR
Q618A1024-LINKAGE
U5011A1734-VALVE
99 100 96 97 98
T T R W B
HEAT EXCHANGER #1
R
TO PANEL
TS-5
158 159 160 161
2 MODEL ST-W3
TS-6
TO PANEL
88 89 70 91
PUMP
BURNER
TO PANEL
174 175
TS-13
MODEL ST-W3
TO PANEL
190 191 78 79 73 72
TC-5 MODEL ST-W3
115° 120°
COMPARTMENT #1
2-T675A1540
55° TO 175° T'STAT
WITH 11262GAA TO
½" X 4" WELL
EVANS HEATER
TO PANEL
M644A1016 MOTOR
Q618A1029 LINKAGE
U5013A1767 VALVE
137 138 134 135 136
T T R W B
HEAT EXCHANGER #2
R
TO PANEL
162 163 164 165
TS-7
2 MODEL ST-W3
TS-8
PUMP
BURNER
126 127
139 129
TO PANEL
176 177
TS-14
MODEL ST-W3
TO PANEL
192 193 116 117 110 111
TC-6 MODEL ST-W3
155° 160°
COMPARTMENT #2
2-T675A1540
55° TO 175° T'STAT
WITH 11262GAA TO
½" X 4" WELL
TO PANEL
M644A1016 MOTOR
Q618A1024 LINKAGE
U5011A1734 VALVE
142 143 139 140 141
T T R W B
2½"
HEAT EXCHANGER #3
R
TO PANEL
166 167 168 169
TS-9
2 MODEL ST-W3
TS-10
TO PANEL
130 131 132 133
PUMP
BURNER
TO PANEL
178 179
TS-15
MODEL ST-W3
TO PANEL
194 195 120 125 122 123
TC-7 MODEL ST-W3
155° 160°
COMPARTMENT #3
2-T615A1540
55° TO 175° T'STAT
WITH 11262GAA TO
½" X 4" WELL
EVANS HEATER
TO PANEL
M644A1016 MOTOR
Q618A1024 LINKAGE
U5011A1734 VALVE
104 105 101 102 103
T T R W B
2½"
HEAT EXCHANGER #4
R
TO PANEL
170 171 172 173
TS-11
2 MODEL ST-W3
TS-12
PUMP
BURNER
92 93 94 95
TO PANEL
TO PANEL
180 181 196 197 86 87 84 85
TS-16
MODEL ST-W3
TC-8 MODEL ST-W3
115° 120°
COMPARTMENT #4
2-T615A1540
55° TO 175° T'STAT
WITH 11262GAA TO
½" X 4" WELL
240/3/60
TO PANEL
HAND
OFF
AUTO
CR208C103CA
STARTER WITH 3
CR123C16B HEATERS
PUMP P-2
5 HP
TO PANEL
154 155
MODEL ST-W3
TS-3
P-2
TO HEAT EXCHANGES
1, 2, 3 AND 4
154 157
TS-4
MODEL ST-W3
RETURN FROM H.E
1, 2, 3 AND 4
PROGRESS HEATING
CONTROL
ONE REQ'D

TEMPERATURE CONTROL SYSTEM
COCA COLA
JACKSON, TENN.
INDUSTRIAL MECHANICAL SUPPLIERS
JOB # G-255 | JAN. 31, 1979 | SHEET 2 OF 10

CONTROL SEQUENCE

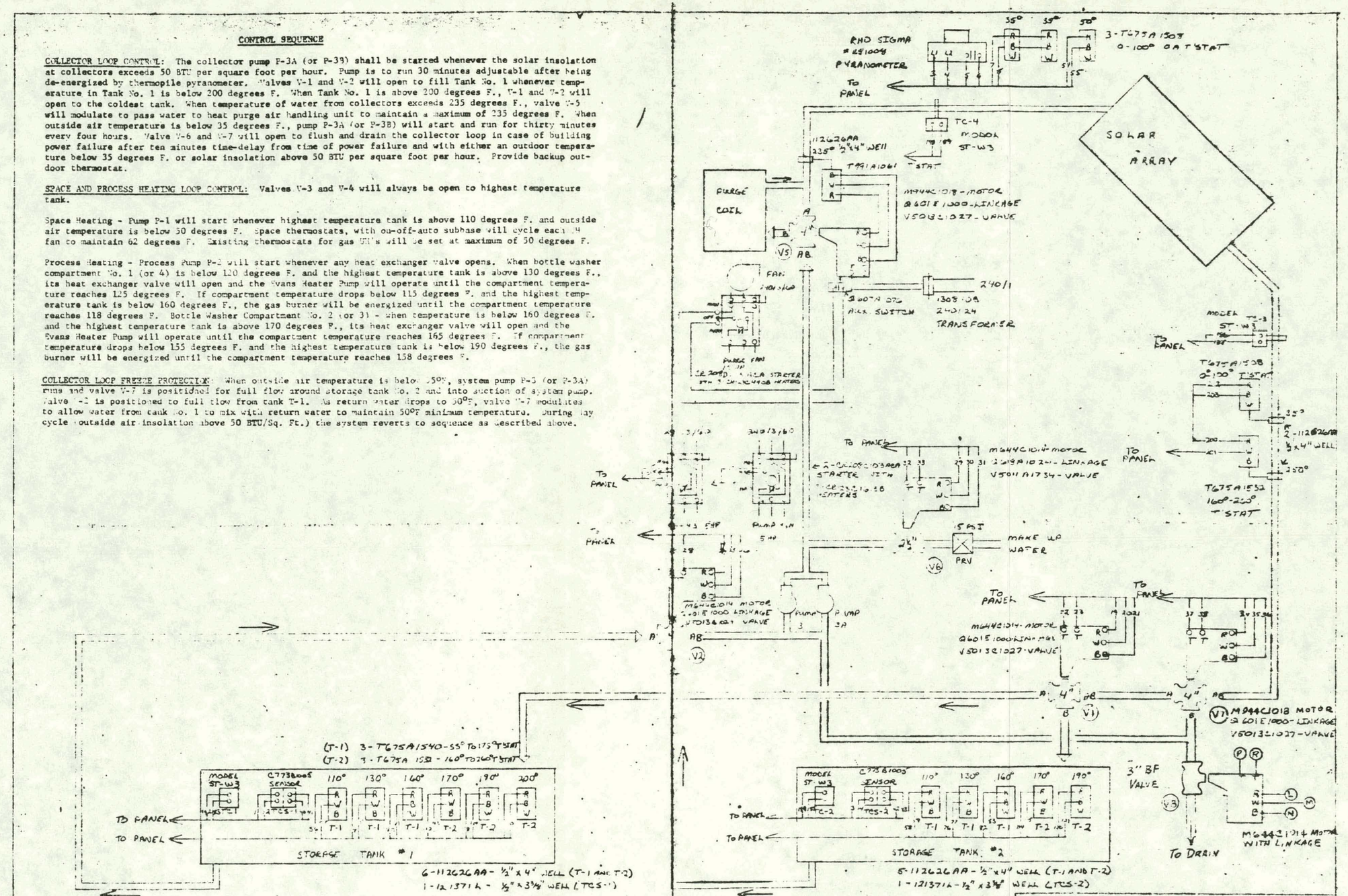
COLLECTOR LOOP CONTROL: The collector pump P-3A (or P-3B) shall be started whenever the solar insolation at collectors exceeds 50 BTU per square foot per hour. Pump is to run 30 minutes adjustable after being de-energized by thermopile pyranometer. Valves V-1 and V-2 will open to fill Tank No. 1 whenever temperature in Tank No. 1 is below 200 degrees F. When Tank No. 1 is above 200 degrees F., V-1 and V-2 will open to the coldest tank. When temperature of water from collectors exceeds 235 degrees F., valve V-5 will modulate to pass water to heat purge air handling unit to maintain a maximum of 235 degrees F. When outside air temperature is below 35 degrees F., pump P-3A (or P-3B) will start and run for thirty minutes every four hours. Valve V-6 and V-7 will open to flush and drain the collector loop in case of building power failure after ten minutes time-delay from time of power failure and with either an outdoor temperature below 35 degrees F. or solar insolation above 50 BTU per square foot per hour. Provide backup outdoor thermostat.

SPACE AND PROCESS HEATING LOOP CONTROL: Valves V-3 and V-4 will always be open to highest temperature tank.

Space Heating - Pump P-1 will start whenever highest temperature tank is above 110 degrees F. and outside air temperature is below 50 degrees F. Space thermostats, with on-off-auto subbase will cycle each AH fan to maintain 62 degrees F. Existing thermostats for gas AH's will be set at maximum of 50 degrees F.

Process Heating - Process Pump P-2 will start whenever any heat exchanger valve opens. When bottle washer compartment No. 1 (or 4) is below 120 degrees F. and the highest temperature tank is above 130 degrees F., its heat exchanger valve will open and the Evans Heater Pump will operate until the compartment temperature reaches 125 degrees F. If compartment temperature drops below 115 degrees F. and the highest temperature tank is below 160 degrees F., the gas burner will be energized until the compartment temperature reaches 118 degrees F. Bottle Washer Compartment No. 2 (or 3) - When temperature is below 160 degrees F. and the highest temperature tank is above 170 degrees F., its heat exchanger valve will open and the Evans Heater Pump will operate until the compartment temperature reaches 165 degrees F. If compartment temperature drops below 155 degrees F. and the highest temperature tank is below 190 degrees F., the gas burner will be energized until the compartment temperature reaches 158 degrees F.

COLLECTOR LOOP FREEZE PROTECTION: When outside air temperature is below 35°F, system pump P-3 (or P-3A) runs and valve V-7 is positioned for full flow around storage tank No. 2 and into suction of system pump. Valve V-2 is positioned to full flow from tank T-1. As return water drops to 50°F, valve V-7 modulates to allow water from tank No. 1 to mix with return water to maintain 50°F minimum temperature. During day cycle (outside air insolation above 50 BTU/Sq. Ft.) the system reverts to sequence as described above.



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