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DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150553

SOLAR HEATING SYSTEM FOR RECREATION BUILDING AT SCATTERGOOD SCHOOL

Prepared by

Scattergood School
West Branch, Iowa 52358

Under Contract DOE No. EX-76-C-01-2386

Monitored by

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

for the U. S. Department of Energy

U.S. Department of Energy

Solar Energy

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15. SUPPLEMENTARY NOTES

The Project Manager for this work was Dr. Conrad F. Heins, of the Scattergood School. The work was accomplished under the technical management of Hoyt M. Weathers, Marshall Space Flight Center, Alabama.

16. ABSTRACT

This project was initiated in May 1976 and was completed in June 1977. A six-month acceptance-testing period followed during which time a number of minor modifications and corrections were made to improve system performance and versatility. This Final Report describes in considerable detail the solar heating facility and the project involved in its construction. As such, it has both detailed drawings of the completed system and a section that discusses the bottlenecks that were encountered along the way. It is hoped that the report will prove useful to others who choose to use the sun's energy to provide at least part of their heating needs.

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I. INTRODUCTION

Scattergood School is a small, co-educational boarding school located in the farmland of eastern Iowa 10 miles east of Iowa City. In the fall of 1974, the governing committee of the school decided to build a badly needed recreation building that would utilize, in some fashion, solar energy to provide at least part of the heating requirements of the building. With the announcement that the federal Energy Research and Development Administration (ERDA) would be funding solar projects as part of the Solar Heating and Cooling Demonstration Program, the school began to consider systems that would suit their needs and might qualify for federal assistance as well.

It was decided to use an air, rather than a water, system. Since most of the solar energy would be used to heat the air of the building, it made sense to heat this air directly. In addition, the simplicity of an air system, with very few moving parts and no catastrophic modes of failure, was attractive. The Solaron Corporation of Denver, Colorado, a company with considerable experience in air collector systems, was invited to join with the school in preparing a proposal. Solaron complied, and in November, 1975, a proposal was submitted to, and subsequently accepted by, ERDA.

The proposal suggested the use of a 2500 square foot array of Solaron collectors, a heat storage box containing 1250 cubic feet of rock, and a 5000 cfm air handling unit. Such a system would provide an estimated 75% of the building's heating needs. In addition, an air-water heat

exchanger would serve to preheat water for a domestic hot water system.

The project was initiated in May, 1976, and was completed in June, 1977. A 6-month acceptance testing period followed during which time a number of minor modifications and corrections were made to improve system performance and versatility. This Final Report describes in considerable detail the solar heating facility and the project involved in its construction. As such, it has both detailed drawings of the completed system and a section that discusses the bottlenecks that were encountered along the way. It is hoped that the report will prove useful to others who choose to use the sun's energy to provide at least part of their heating needs.

Scattergood School is grateful to the Solar Energy Division of the Department of Energy for providing most of the funds for the solar heating system. The school would also like to acknowledge the generous technical assistance of the personnel from the National Aeronautics and Space Administration, George C. Marshall Space Flight Center, throughout the course of the project.

II. SUMMARY OF PROJECT INFORMATION

A. General Information

Owner/Builder: Scattergood School
West Branch, Iowa 52358

Contractor: Modern Metals, Inc.
Muscatine, Iowa 52761

Operational Date: June, 1977

Building:

Type: School gymnasium

Area: 7966 sq. ft.

Location: West Branch, Iowa

B. Meteorological Data

Latitude: 41.8° N

Climate Data:	Winter	Summer
Avg. temp. (°F)	41.0	71.7
Avg. insolation (Ly/d)	298	545

Degree days (heating): 7255

C. Solar Energy System

Application: Heating, 75%; hot water, 75%

Collector:

Type: Air heating, flat plate

Area: 2496 sq. ft.

Manufacturer: Solaron Corporation
Denver, Colorado 80222

Storage:

Type: 3/4-inch diameter rock

Capacity: 1,250 cu. ft.

Auxilliary/Back-Up System:

Gas fired unit heater (gymnasium)

Gas furnace (locker rooms)

Electric heater (water)

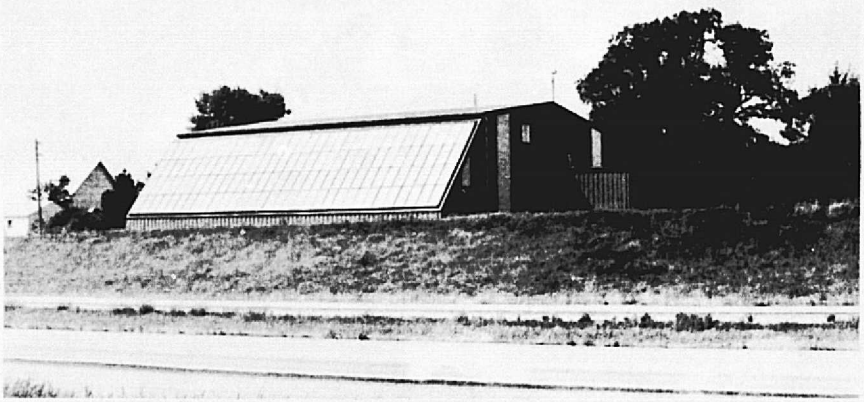
D. Project Description

The solar energy system is based on a prototype model which has been in continuous successful operation since 1957. The collector array, attached to the south side of the building, consists of 128 factory-assembled modules 36 in. by 78 in. Each module has double tempered glass covers and a sheet absorber, with an air duct below the permanent black absorber surface. The metal building is pre-engineered (Armco Metal Building Systems) with 6900 sq. ft. in the gymnasium portion and 1066 sq. ft. in the locker room/storage section. The anticipated structural heating load is 56,000 BTU per degree day.

III. DESCRIPTION OF THE SOLAR HEATED RECREATION BUILDING

The facility consists of two adjoining Armco Rigidframe buildings designed and fabricated by the Armco Steel Corporation, Metal Products Division. The gymnasium building has floor dimensions of 70 feet by 98 feet 8 inches, is 24 feet at the eave and about 29 feet at the peak. The locker room building has floor dimensions of 25 feet by 42 feet 8 inches and has an eave height of 12 feet 3 inches. The locker room building is attached to the east side of the main building. Both structures are well-insulated with fiberglass insulation. The solar heating system will provide an estimated 75% of the building's total heating needs, including hot water. Auxiliary heat is provided by two 250 KBTU propane unit heaters in the main building. A dual 5.5 kilowatt, fast-recovery, electric water heater provides domestic hot water. Intake water is preheated by the solar heating system and stored in two insulated 120-gallon, glass-lined tanks.

Blue prints showing floor plans and building details can be found in Appendix A. A photograph of the recreation building, depicting the solar panels, is shown on the next page.



1. The Scattergood School solar heated recreation building.

IV. DESCRIPTION OF THE SOLAR HEATING SYSTEM

A. Component Subsystems

Scattergood School's solar heating system consists of seven parts.

1. A solar collector.

   A 2500 square foot array of flat plate collectors purchased from the Solaron Corporation uses sunlight to heat air drawn through the system.

2. A heat storage device.

   An insulated reinforced-concrete box (10 feet by 25 feet by 7 feet) filled with 65 tons of smooth river gravel stores heat during sunny days to be used at night or on cloudy days.

3. An air handling system.

   A large blower moves air through the collectors and into ductwork that enters the building and/or the rock box.

4. A water heater.

   An air-water heat exchanger built into the ductwork preheats water for a domestic, fast-recovery electric water heater. Water is stored in two 120-gallon tanks connected in series. It is pumped through the heat exchanger whenever the panel system is collecting solar energy and the water temperature is below a predetermined temperature.

5. An automatic control system.

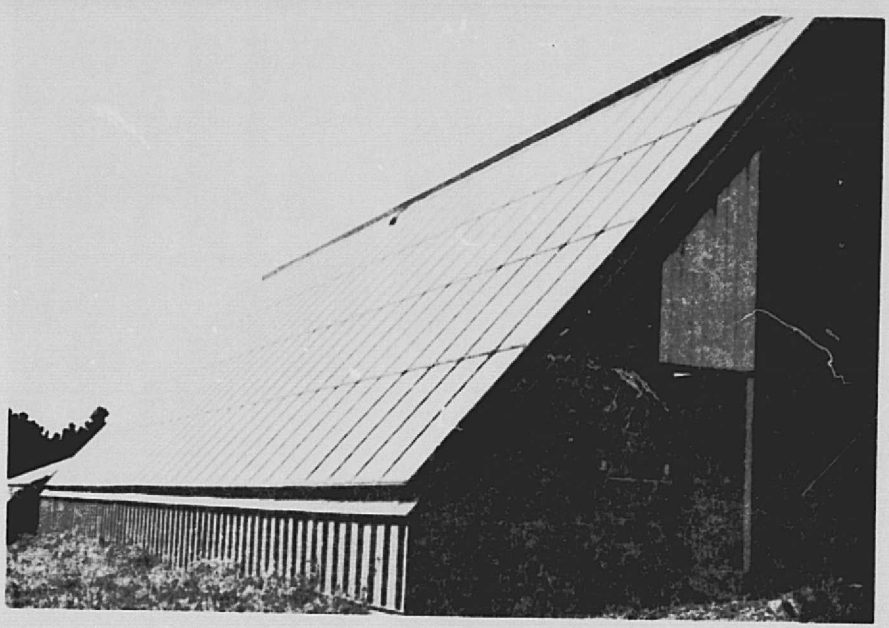
   Thermostats and other temperature sensing devices automatically regulate the water pump, the air blower and the motorized dampers used to operate the system.

6. An auxiliary heating system.

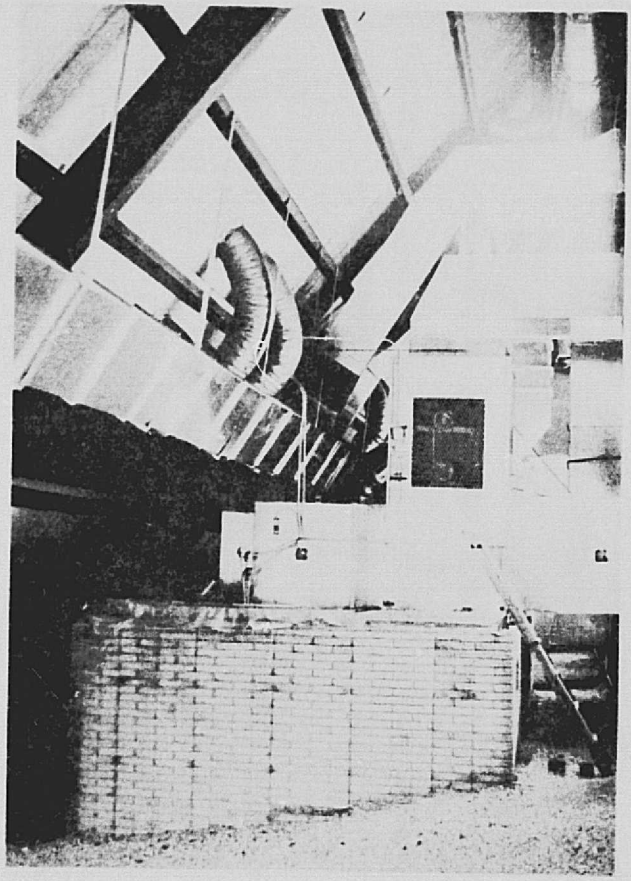
Two 250 KBTU space heaters in the main building and a 100 KBTU furnace in the locker room building provide supplemental heat as needed. A 5.5 kilowatt, fast-recovery electric water heater provides domestic hot water. The solar system preheats water for this unit.

7. A data acquisition system.

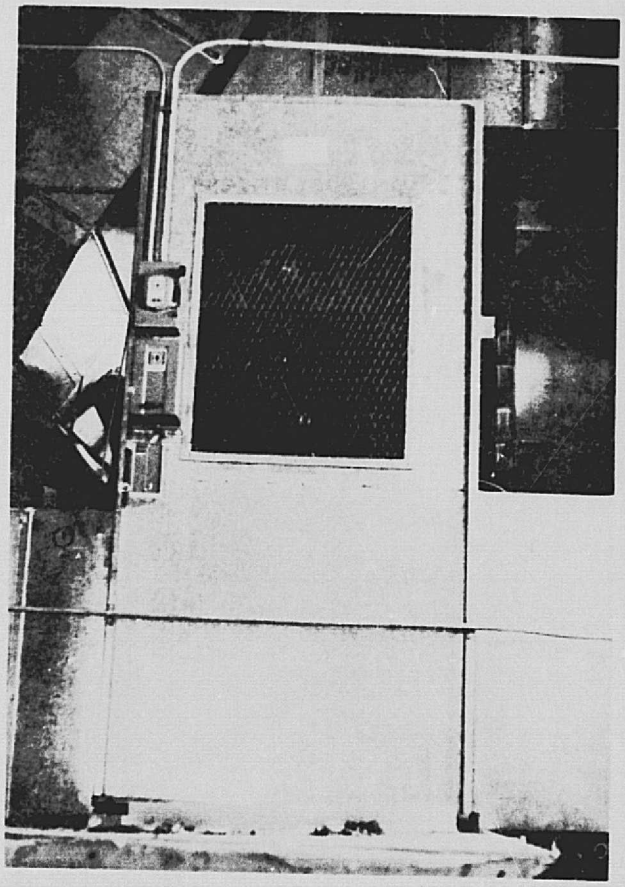
Thirty-one sensors located throughout the installation provide data on parameters such as air flow, air temperature, water temperature and sunlight striking the colector. These data are automatically stored on tape and sent daily to a data processing center in Huntsville, Alabama. This monitoring subsystem will provide answers to such key questions as system efficiency and reliability, operating costs and approximate fuel savings. Photographs of these various components are shown on the next three pages.



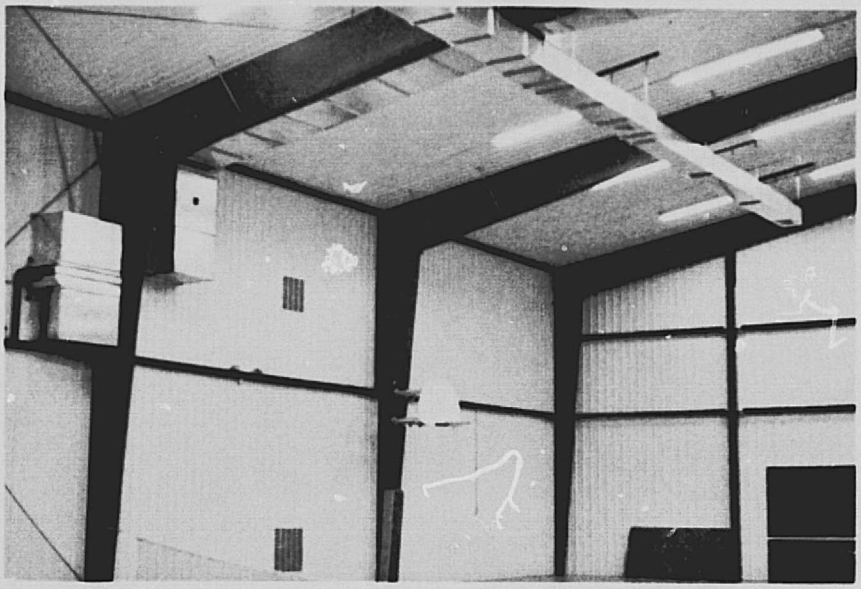
2. The collector.



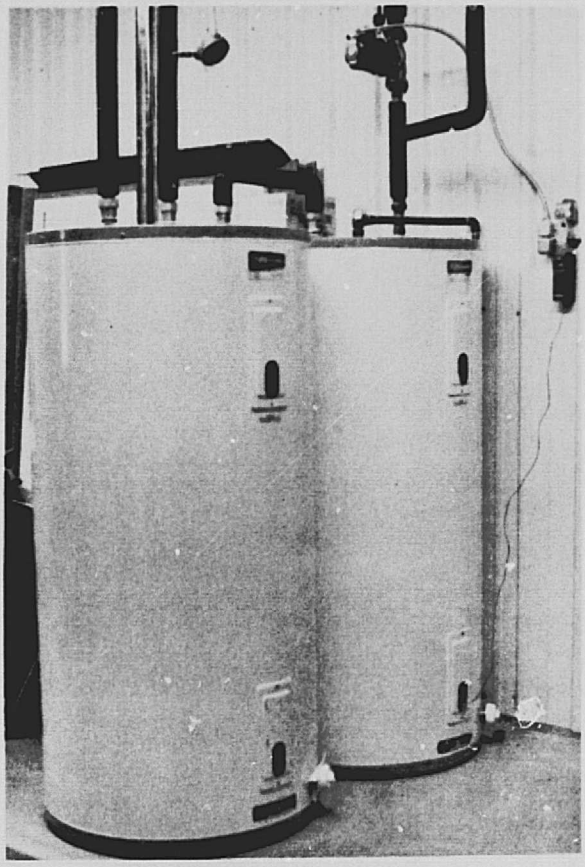
3. The rock storage box. The air handling unit, with associated ductwork, is above it. The collector panels are outside, mounted on the plywood deck.



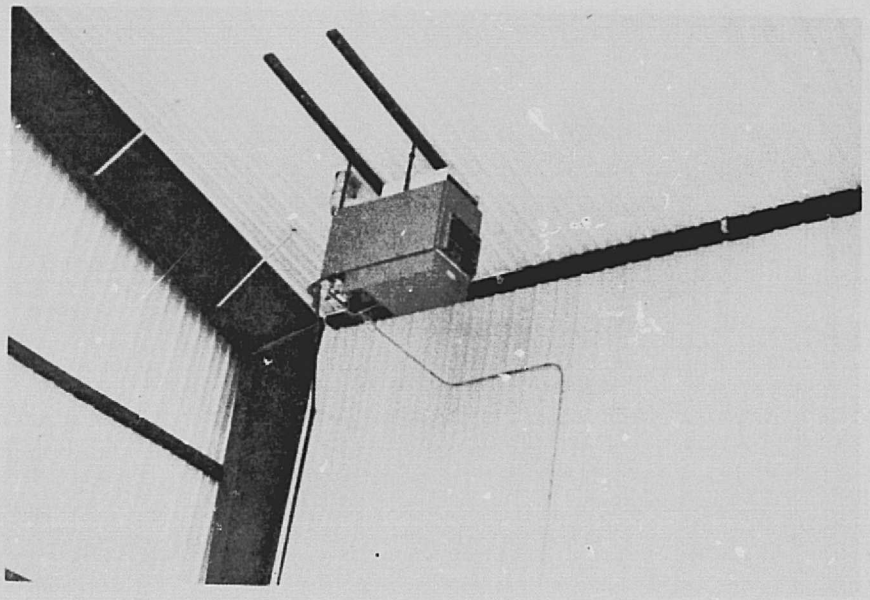
4. The air handling unit.



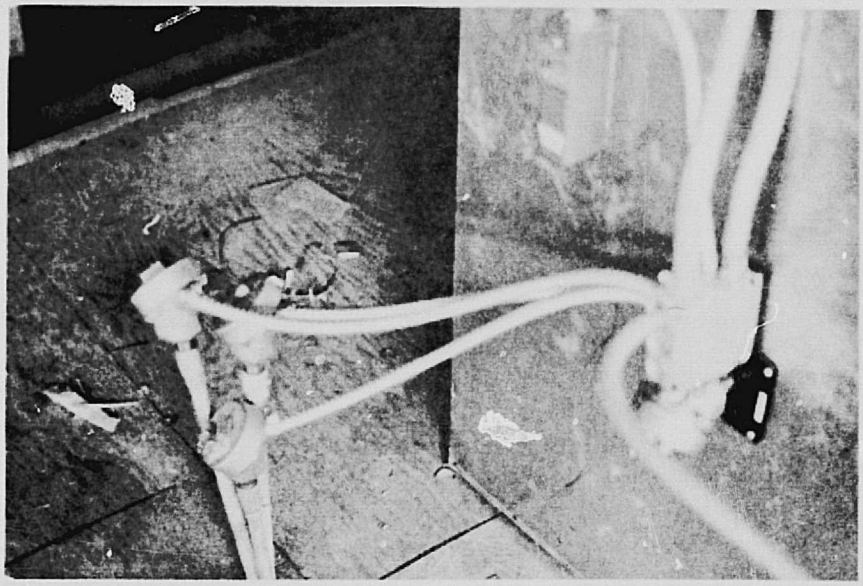
5. Interior ductwork. The heat exchanger is on the left.



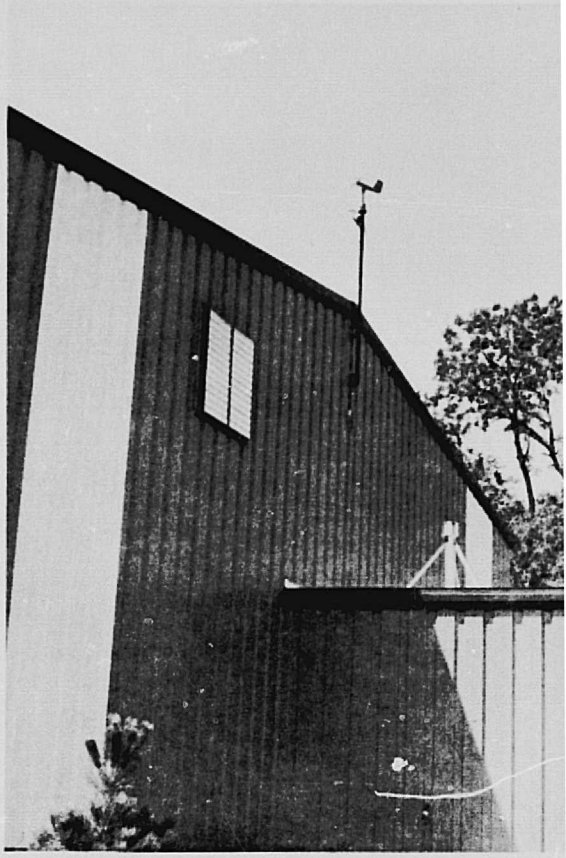
6. The hot water storage tanks. The water circulating pump is mounted above them.



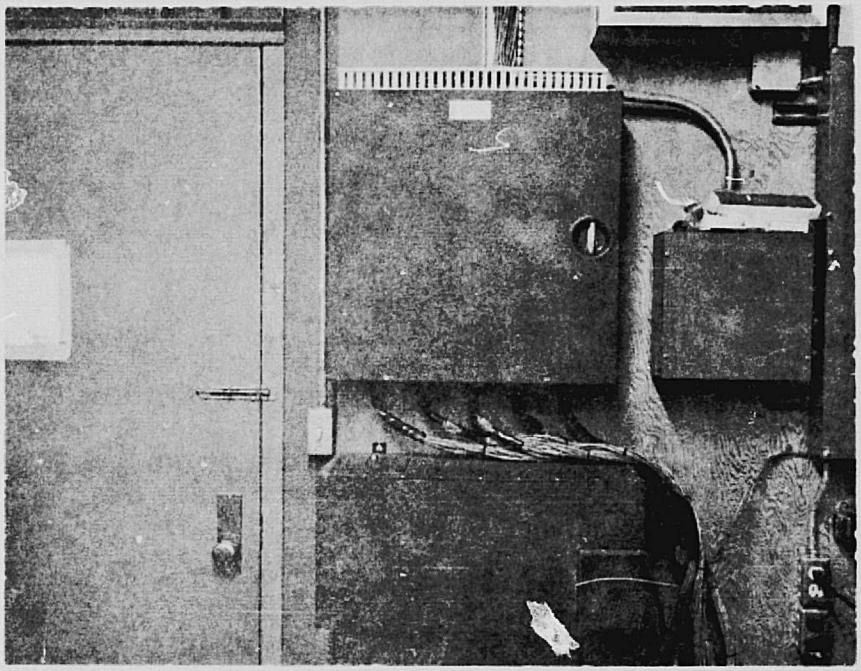
7. One of the 2 auxilliary propane heaters in the gymnasium.



8. Three thermal sensors associated with the rock storage box.



9. The wind speed, wind direction, outside ambient temperature and humidity sensors mounted above the building.



10. The junction box (upper center) for the data acquisition sensors with the Site Data Acquistion Subsystem (SDAS) below it.

B. Modes of Operation

The system has six modes of operation.

1. Heating the building with hot air from the collector.
2. Storing heat by drawing heat from the collector through the rock box.
3. Heating the building with heat stored in the rock box.
4. Heating water by drawing air from the collector past heat exchange coils and back to the collector. In this mode the building and the rock box are bypassed. Water heating also occurs during modes (1) and (3).
5. Venting the collector by opening slide gate dampers in the ductwork to permit the collector to vent by natural convection.
6. Heating with the auxiliary system. When the heating requirements of the building are more than can be supplied by the solar heating system, the auxiliary heaters automatically come on and provide the needed heat.

A schematic of the heating system and the first (4) modes of operation are shown in firgures 1 - 5. Heavy lines indicate air flow.

Further details of the solar heating system, including as-built drawing and diagrams, a description of hardware, a detailed sequence of operations, and maintenance instructions are found in Appendixes B - F.

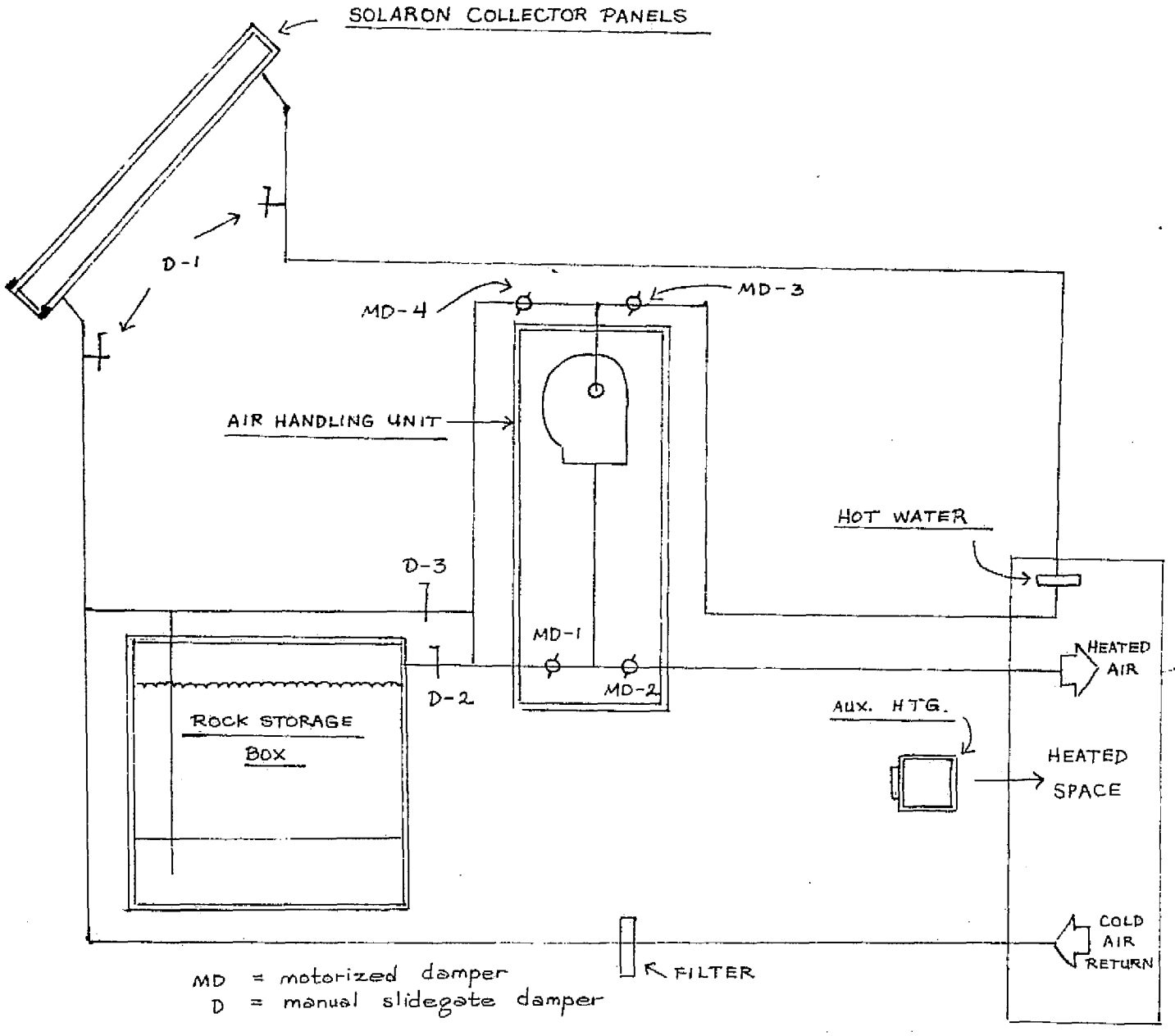
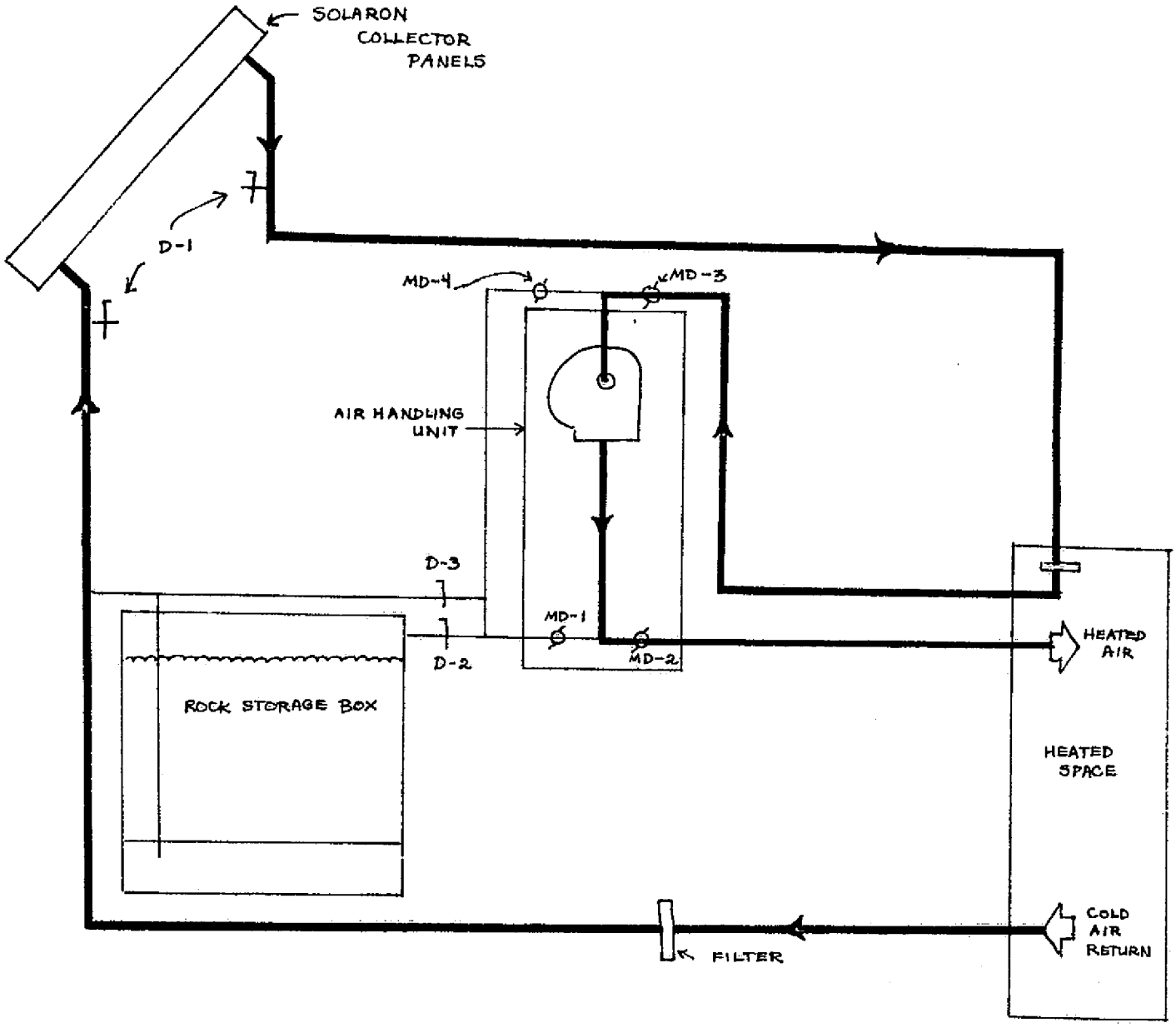


FIGURE 1 : Schematic drawing of the Solar Heating System



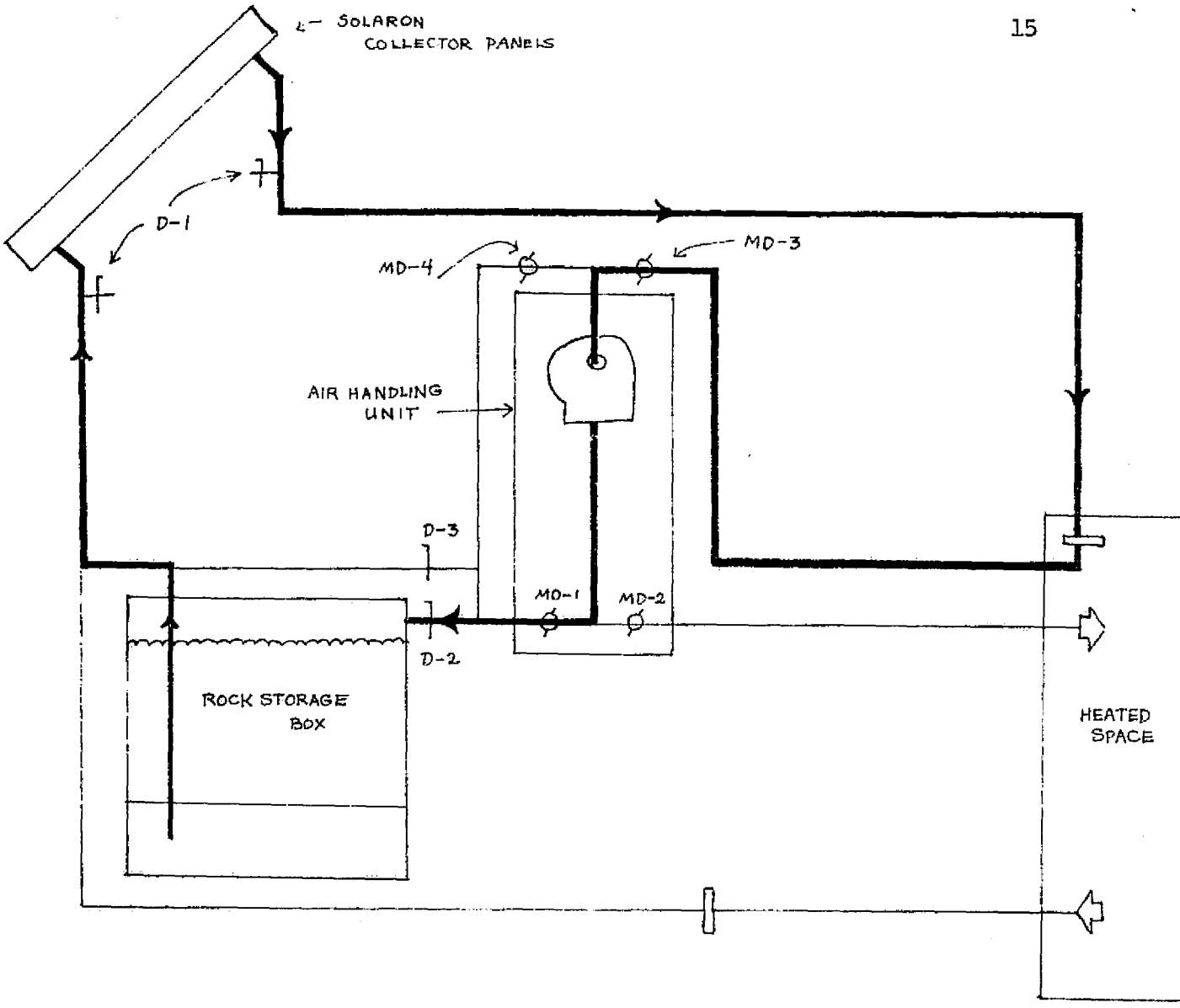
SOLAR HEATING FLOW SCHEMATIC

SEQUENCE OF OPERATION

O = OPEN C = CLOSED

MODE	MD-1	MD-2	MD-3	MD-4	D-1	D-2	D-3
HEATING FROM COLLECTOR	C	O	O	C	C	O	C

FIGURE 2: Mode 1 — Heating from the Collector



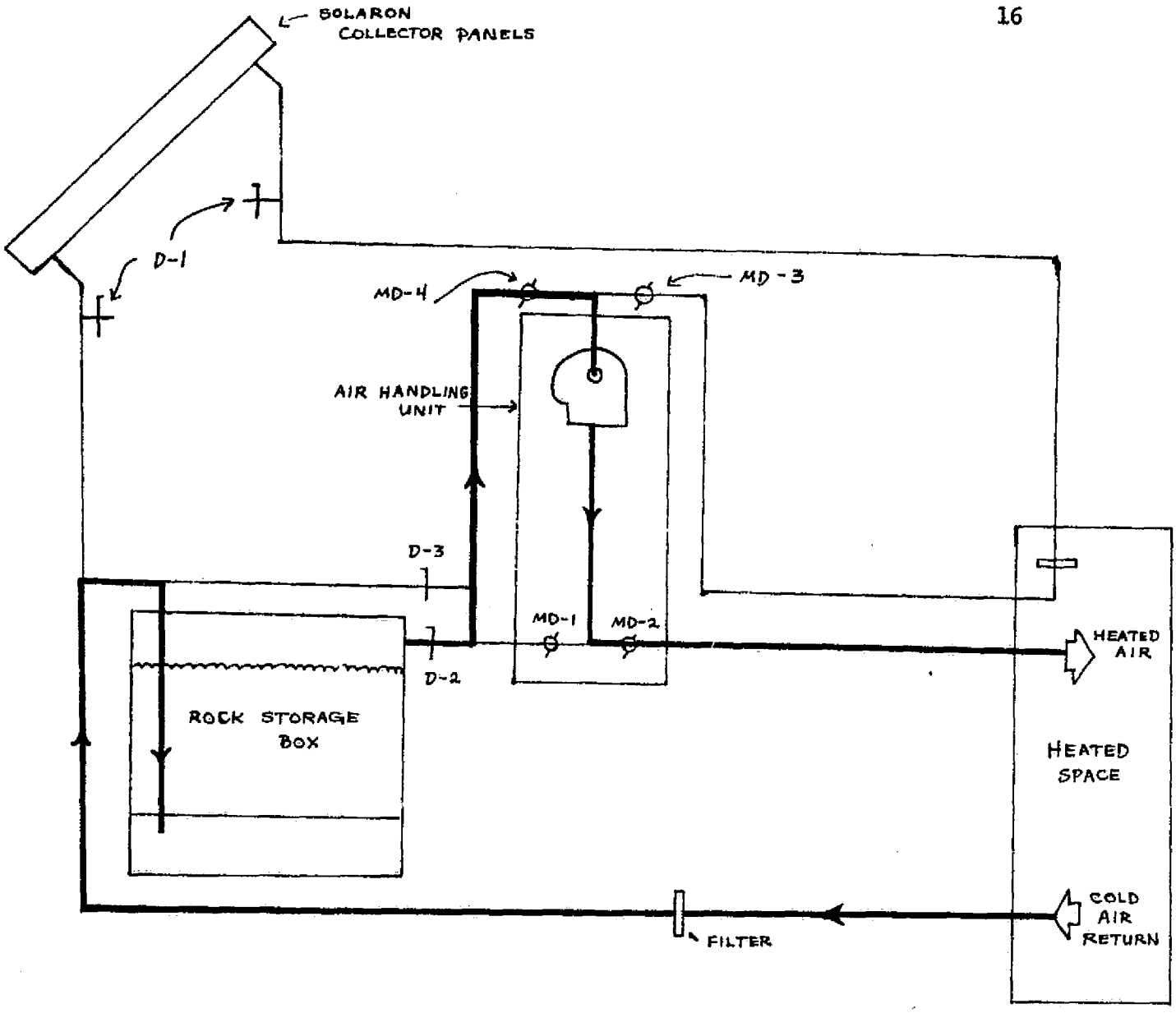
SOLAR HEATING FLOW SCHEMATIC

SEQUENCE OF OPERATION

O = OPEN C = CLOSED

MODE	MD-1	MD-2	MD-3	MD-4	D-1	D-2	D-3
STORING HEAT	O	C	O	C	C		

FIGURE 3 : Mode 2 - Storing heat in the Rock Storage Box



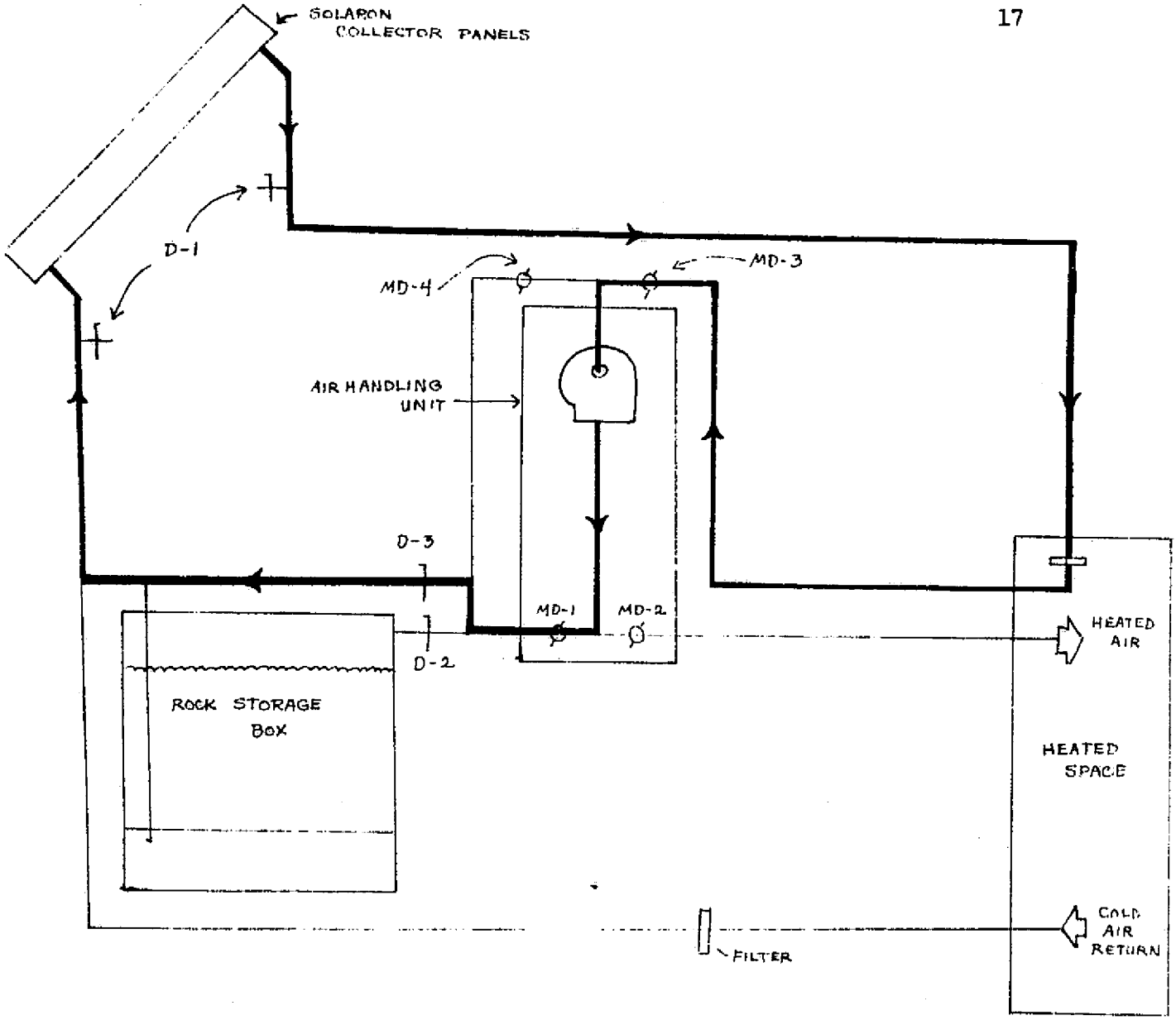
SOLAR HEATING FLOW SCHEMATIC

SEQUENCE OF OPERATION

O = OPEN C = CLOSED

MODE	MD-1	MD-2	MD-3	MD-4	D-1	D-2	D-3
HEATING FROM STORAGE	C	O	C	O	C	O	C

FIGURE 4: Mode 3 — Heating from the Rock Storage Box



SOLAR HEATING FLOW SCHEMATIC

SEQUENCE OF OPERATION

O = OPEN C = CLOSED

MODE	MD-1	MD-2	MD-3	MD-4	D-1	D-2	D-3
WATER PRE-HEAT (SUMMER)	O	C	O	C	C	C	O

FIGURE 5: Mode 4 — Heating Water Only (Summer)

V. HISTORICAL NARRATIVE OF THE PROJECT

In April, 1976, Scattergood School was informed that its proposal had been accepted, and in June, 1976 a contract was awarded to the school. The contract stipulated that the school would construct the solar heating system as proposed, and that ERDA would provide $76,289 or 88% of the total $86,692 estimated cost.

Construction began immediately. Listed below is the schedule of construction activities as they occured. Included in parentheses is the schedule as originally proposed. A short commentary on each activity is also included.

1. Site preparation -- May-June, 1976 (April, 1976).
   Most of the site preparation was carried out in conjunction with the site preparation of the gymnasium itself. Origingally scheduled for April, it was postponed until May because of wet, soft ground. Some additional site preparation for the rock storage box was carried out in June.
2. Pouring the concrete foundation -- June, 1976 (May, 1976).
   A concrete foundation for the collector support structure was poured soon after site preparation had been completed.
3. Red iron erection -- July, 1976 (June, 1976).
   Five specially fabricated columns were bolted to the foundation and to the five load-bearing columns of the south wall of the gymnasium.
4. Design Reviews -- August, 1976.
   A final design review was held at the school on August 4, 1976. A

relatively small but significant change was made in design of the air handling system to permit a water-heating-only mode of operation that could be used during the summer when there would be no need to heat the building or charge the rock storage box.

5. Constuction of the rock storage box -- August-September, 1976 (April-May, 1976).

   Originally scheduled as one of the earliest activities, construction of the rock storage box was postponed until after the erection of the main support columns. Reinforced concrete was used for the floor and walls of the structure. After being filled it was capped with a well-insulated, air-tight wooded lid strong enough to support the air handling unit.

6. Filling the rock storage box -- September, 1976 (May, 1976).

   The contractor was unable to obtain the specified 3-foot diameter, transite pipe that would serve as the duct to the bottom of the box. With Solaron's approval, a 3-foot diameter sewer pipe was used. This alteration delayed the activity; it was not until September, 1976 that the box was filled with 65 tons (1250 cubic feet) of 3/4 inch, washed river gravel. Three half-inch metal conduits with holes drilled in the bottom 3 inches to facilitate air flow were installed at the bottom, middle and top of the rock bed as the box was being filled. They were long enough to project about a foot above the lid of the box. At a later date, 3 thermal sensors were installed in these 3 conduits as part of the data acquisition system.

7. Installation of collector support structure -- September-November, 1976 (May-June, 1976).

   This activity provided another of the maddening delays that were

encountered during the course of the project. The support structure consists of 3/4-inch plywood screwed to steel perlins that are bolted every 4 feet to the steel columns. To facilitate mounting of the plywood, a special self-tapping, self-countersinking screw was used. The contractor ordered 1000 of these screws, thinking that 10 screws per plywood sheet would be enough. It was found during construction that 14 screws per sheet were needed, hence only 70 of the 100 sheets were mounted after the rock box had been filled. The contractor was unable to obtain additional screws until the end of October. The project was delayed an additional 6 weeks.

8. Installation of the solar collectors -- November, 1976- Febraury, 1977 (June-July, 1976).

The collector array consists of 128 solar panels arranged 4 high and 32 across. About 90 of the panels were mounted during the last warm weather of the year, which was in November. Once freezing weather set in, panel installation ceased; the butyl rubber tape used to seal the connection between panel unit has poor flow and adhesion properties below 40° F. Not until February, 1977 were there a few consecutive days warm enough to compelte the installation.

Installation was more time consuming than anticipated, in part because of the size of the array. Although the panels function as separate units of 8 because of the placement of the ducts leading to and returning from the array, all of the units are interconnected. In order to achieve an airtight system, alignment had to be exact, with little margin for error. Much time would have been saved if the collectors

had been equipped with off-set pins to let the workman know when the collector was in exact alignment. Time might also have been saved if the collectors had been placed as 4 units of 32 with narrow separators, such as 1-inch by 6-inch lumber, rather than as a monolithic array.

9. Installation of the air handling system -- December, 1976-May, 1977 (June-July, 1976).

Ductwork inside the building was fabricated and installed during the month of December. The major part of the air handling system, located beneath the solar panels, was completed during the late winter and early spring. The custom-made blower and fan installation was received in December and positioned on the rock storage box. Ductwork was then located around it. Fiberglass duct was found to be most satisfactory and was used where ever possible. Where sheet metal ductwork had to be used, all joints were sealed with silicone rubber.

10. Installation of water preheat system -- April, 1977 (July, 1976).

The water preheat system was installed during the last 2 weeks of April, 1977. Two insulated, glass-lined, 120-gallon tanks were installed in series in such a way that an aquastat controlling a pump moving water in a loop between the storage tanks and the heat exchanger would continue to operate until the water in both tanks had reached a predetermined temperature. Valves were installed to permit the domestic water heater alone, the solar water heater alone, or the 2 in combination to provide hot water.

11. Wiring and installation of control sensors -- April-May, 1977 (July, 1976)

Most of the installation of control sensors and wiring was done when the monitoring sensors were installed and wired.

12. Start-up -- May, 1977 (July, 1976).

The system was first operated and checked out by the Solaron Corporation field engineer assigned to the project during the week of May 16. Because a slide gate damper was incorrectly positioned, he was able to test the system in only 4 or the 5 modes of operation. A number of air leaks were found in the ductwork, and other minor items needed to be corrected.

13. Open House -- May, 1977.

An open house for the solar heated recreation building was held on May 21, 1977. Senator Richard Clark (D-Iowa); the congressional representative from our district, Michael Blouin; Robert Bauer, head of ERDA's Chicago Operations, made short presentations to a group of about 200.

14. Acceptance test -- June, 1977 (July 1976).

The acceptance test of the solar heating system was conducted by a Solaron field engineer during two visits in May and June, 1977. After the second visit the system was judged to be acceptable upon completion of a number of minor corrections. Details of the test plan and test data are found in Appendix H.

15. Installation of monitoring equipment -- April-June, 1977.

In February, 1977 the dollar amount of the contract was increased by $7,076 to provide for the installation and wiring of monitoring sensors as part of a data acquisition system. A total of 31 government furnished sensors were installed and wired during April and May, 1977. During the week of June 13, personnel from the IBM Corporation installed the Site Data Acquisition System (SDAS) and made the necessary connections to permit the data to be relayed by telephone to Huntsville, Alabama daily.

Because the SDAS had been badly damaged in shipment, a second visit by an engineer from IBM during the week of June 30 was required to make the data collection system function properly. Both the solar heating system and the data collection system are now fully operational.

16. Bottlenecks

Three serious bottlenecks were encountered during the project. Two had a significant impact on the construction schedule. The third did not because of the large delays that had already occurred.

Completion of the rock storage box. Because the rock storage box would no longer be accessible once the collector support structure was erected, the box had to be filled with rock and capped with an air-tight lid before the next phase of the project could be undertaken. A few weeks of delay in the completion of the rock storage box resulted in a few weeks delay in the project.

Installation of the solar panels, including the support structure. A key delay in the construction of Scattergood School's solar heating system resulted from delays in the construction of the panel support structure and, as a result, an even longer delay in the installation of the solar panels. Had the panels been completed during the winter. Instead, installation of ductwork under the collector array began in Febraury and was not completed unitl May, 1977.

Installation of the air handling unit. Because key parts of the duct-work are built around this fan and blower unit, a considerable amount of the duct installation was not begun until the air handling unit had been correctly positioned on the top of the rock storage box. First scheduled for delivery in September, the air handling unit arrived in early December. In Scattergood's case the delay did not affect the construction schedule because all of the solar panels had not been mounted. Otherwise, later arrival of this piece of key equipment would have delayed the project.

17. "Surprises".

Besides shipping delays, there were other things that we failed to anticipate or that we badly miscalculated in our planning. Some of these are mentioned below.

Unloading the solar panels. Ten tons of panels had to be unloaded from a moving van. With neither an unloading dock nor a fork-lift truck on hand, the building construction crew spent the better part of a day at this activity.

Filling the rock box. There was not room for a truck to unload directly into the box as had been planned. Instead, a front-end loader had to be used to transfer the rock to the box from a pile some distance away. This activity took most of a day.

Wiring the solar heating system. Wiring the system was far more time-consuming and expensive than had been anticipated. One reason for this

was that the work did not readily dovetail with the installation of the SDAS sensors, as had been hoped, and therefore was done separately.

Installation of the ductwork. Installation of all of the ductwork associated with the system took about 10 weeks, rather than the 3 or 4 that had been anticipated. Some of this time could probably have been saved if the contractor had used round ductboard where ever possible, rather than constructing the ductwork from insulated sheet metal. In any case, the requirement for a completely air-tight system was a new experience for the contractor and was considerably more time-consuming than he had planned.

18. Testing period.

Following the formal acceptance test in June, 1977, the next 6 months were used to check out the system and make any modifications or corrections needed to improve the system's performance. The following corrections or changes were made.

- Leaks in the ductwork that were not detected during construction were plugged.
- Two valves were added to the water preheat system so that the heat exchanger could be isolated from the rest of the system. This change was made so that the volume of water used in the building could be measured by the SDAS even though the heat exchanger was disconnected for cleaning and repair.
- A larger disconnect box was placed on the air handling unit to eliminate a problem of the fuse blowing every few days during hot weather.

- Motorized dampers, found to be out of adjustment, were correctly adjusted so that air would not flow through the collector when the system was heating from storage.
- Ductwork was added to the system so that the collector could be used to dry grain raised by the school for its livestock. A report of this modification can be found in Appendix J.
- The two propane unit heaters providing back-up/auxilliary heating for the gymnasium were wired to the control panel and tested.
- Double deflection diffusors, installed to distribute air inside the gymnasium, were replaced with double deflection registers.

VI. DESCRIPTION OF THE DATA ACQUISITION SYSTEM

In order to obtain information necessary for evaluation of the performance and operation of the solar heating system throughout the year, 31 sensors were installed within the system. These sensors were furnished by the government and installed at government expense in accordance with the document, "SHC-1006, August 4, 1976; Instrumentation Installation Guidelines for the National Solar Heating and Cooling Demonstration Program." In Table 2, each sensor is listed by a code designation and by the parameter measured. The number sequence in the code indicates the data groups in accordance with the following table:

Number Sequence	Data Group
001 to 099	climatological
100 to 199	collector
200 to 299	thermal storage
300 to 399	domestic hot water
400 to 499	space heating
500 to 599	space cooling
600 to 699	building/load

Each sensor provides data to a Site Data Acquisition Subsystem (SDAS) every 5 minutes around the clock. The SDAS digitizes the data and stores it on tape. Once a day the data is sent by telephone to an IBM facility in Huntsville, Alabama, where it is reduced. Monthly reports are prepared, one of which is sent to Scattergood School.

The monitoring system will permit the government to determine the following kinds of information:

- Savings in conventional energy resulting from the use of solar energy for heating and/or cooling.

- Portion of the total heating and/or cooling load supplied by the solar energy.
- Efficiency of the system in converting solar radiation into useful thermal energy.
- Thermal performance and reliablilty of major subsystems or components over the demonstration period.

It is anticipated that information obtained from the data acquisition system will also be used by Scattergood School students for science projects in earth sciences, physics and chemistry.

Table 2 describes each sensor in terms of its general location and the parameter that is being measured. The specific location of each sensor can be found in the as-built drawing of the system found in Appendix C.

TABLE 2

INSTRUMENTATION FOR SCATTERGOOD SCHOOL DATA ACQUISITION SYSTEM

Designation	Measurement
A. Climatological	
RH 001	Outside ambient relative humidity
D 001	Wind direction
V 001	Wind speed
I 001	Solar flux
T 001	Outside ambient temperature
B. Collector	
T 100	Collector array inlet temperature
TD 100	Collector array differential temperature
T 101	Rock storage outlet temperature
TD 101	Rock storage differential temperature
T 102	Collector surface temperature
W 100	Collector array air flow
E 101	Circulating air fan power
C. Thermal Storage	
T 200	Rock storage temperature - top
T 201	Rock storage temperature - middle
T 202	Rock storage temperature - bottom
D. Domestic Hot Water	
T 302	Temperature of outlet hot water preheat coil
TD 302	Differential temperature across preheat coil (+ΔT)
T 304	Temperature of inlet preheat tank
TD 304	Temperature differential across preheat tank
T 305	Temperature of cold water supply
T 306	Temperature of domestic hot water inlet
TD 306	Differential temperature across domestic hot water tank
W 302	Domestic hot water preheat loop flow rate
W 306	Preheat tank to domestic hot water tank flow rate
EP 301	Preheat tank circulating pump power
EP 300	Domestic hot water heater electric power
E. Space Heating	
T 402	Space heating inlet temperature
TD 402	Differential temperature across heated space
W 400	Air flow in return air duct of building
F 400	Propane flow to space heaters
EP 402	Space heaters, locker room & utility room fan pow
F. Building/Load	
T 600	Inside ambient temperature

VII. COSTS OF THE SCATTERGOOD SCHOOL SOLAR HEATING SYSTEM

Given in Table 3 are the estimated and the actual costs of the various phases of the project.

Overall, the costs were $101,522. This figure is $7,754, or about 8.3%, more than the original estimates. Most of the additional cost was for labor, and can be attributed to the "first time" nature of the project. Scattergood and its subcontractors were unable to visualize beforehand all that would be involved in the various phases of construction. It is significant that nearly all of the subcontractors indicated that if they were to do it again, the job would go more easily and be less expensive.

Costs were shared by the federal government and the school. The Department of Energy provided 88% of the funds to build the solar heating system and 100% of the funds to install the data acquistion system. Thus, of the total amount of $101,522, the Department of Energy paid $90,250 and Scattergood School $11,272.

The contract was modified twice to cover cost over-runs. On September 8, 1977, the dollar amount was increased by $339 (government share, 100%) to cover additional costs associated with the installation of the Site Data Acquisition Subsystem. On Novmeber 11, 1977, the contract was increased by $7,510 (government share, 88%) to pay for costs associated with the construction of the solar heating system. The school is grateful to the Department of Energy for its willingness to bear these additional costs.

TABLE 3

COST OF THE SCATTERGOOD SCHOOL SOLAR HEATING SYSTEM

	Estimated Cost	Actual Cost
A. Purchase of Solar Hardware		
Installation plans and specifications	$ 700	$ 700
128 Model 2001 Solaron Collectors	29,853	29,853
1338 foot capstrip and seals	3,231	3,231
Custom air handling unit	3,774	3,774
Custom water preheat package	207	207
Less credit for direct shipment	(1,747)	(1,747)
Cost of shipment	882	908
Additional materials for installation	---	411
Subtotal	$36,900	$37,337
B. Construction of Solar Heating System		
Site preparation	$ 500	$ 500
Collector support structure	21,650	21,650
Rock storage unit	3,737	4,948
Collector installation	5,000	7,382
Construction and installation of ductwork	9,741	11,711
Interconnect wiring for solar & back-up system	2,000	2,000
Installation of water heating system (to be paid out of contingencies)	---	1,247
Wiring of solar system (to be paid out of contingencies)	---	3,043
Contingencies	2,500	---
Subtotal	$45,128	$52,481
C. Project Supervision		
Direct labor and overhead	$ 1,664	$ 1,960
Supplies and expenses	200	195
Travel	300	---
Subtotal	$ 2,164	$ 2,155
D. Field Inspection and Acceptance Testing of System	$ 2,500	$ 1,962
E. Installation of Data Acquisition System		
Preparation of updated drawing of solar heating system	$ 450	$ 450
Installation and wiring of sensors	6,437	6,948
Project supervision	189	189
Subtotal	$ 7,076	$ 7,587
TOTAL	$93,768	$101,522

VIII. WHAT WE WOULD DO DIFFERENTLY IF WE WERE TO DO IT AGAIN

The biggest problem with the Scattergood School project was the lack of a built-in mechanism that would permit direct interaction among the various subcontractors at crucial stages of construction. In order to alleviate this problem, we would do two things differently the second time around.

1. There would be a one-day, pre-bid conference for all the subcontractors concerned. It is particularly important to have the solar hardware subcontractor specify exactly what he will supply and what must be furnished by others. Blueprints would be explained, materials and construction methods would be gone over, and each phase of the project would be discussed. As a result, subcontractors would have a clear idea of what they would have to furnish and the things they would have to do. It might be argued that all of this occurs during the Design Review. By then, however, at least in our case, it was too late. Bids had already been submitted and accepted and construction had begun.
2. There would be a much greater insistence that building subcontractors interact directly with the solar subcontractor when confronted with difficulties or when making important decisions. Perhaps a line item in the subcontract for telephone calls would facilitate such communication. The pre-bid conference also would lay the groundwork for this kind of interaction. Direct communication would have avoided a number of schedule delays, poor decisions and outright mistakes that had to be corrected during construction. It would have saved the project manager a great deal of time serving as a go-between and would have made the project run more smoothly.

IX.

INTERIM PERFORMANCE CRITERIA

CERTIFICATION

CONTRACT No. EX-76-C-01-2386

DEMONSTRATION CONTRACTOR SCATTERGOOD SCHOOL

SYSTEM LOCATION WEST BRANCH, IOWA 52358

SYSTEM TYPE SPACE HEATING AND HOT WATER

I certify that this solar system comples with the IPC Document No. 98 M10001

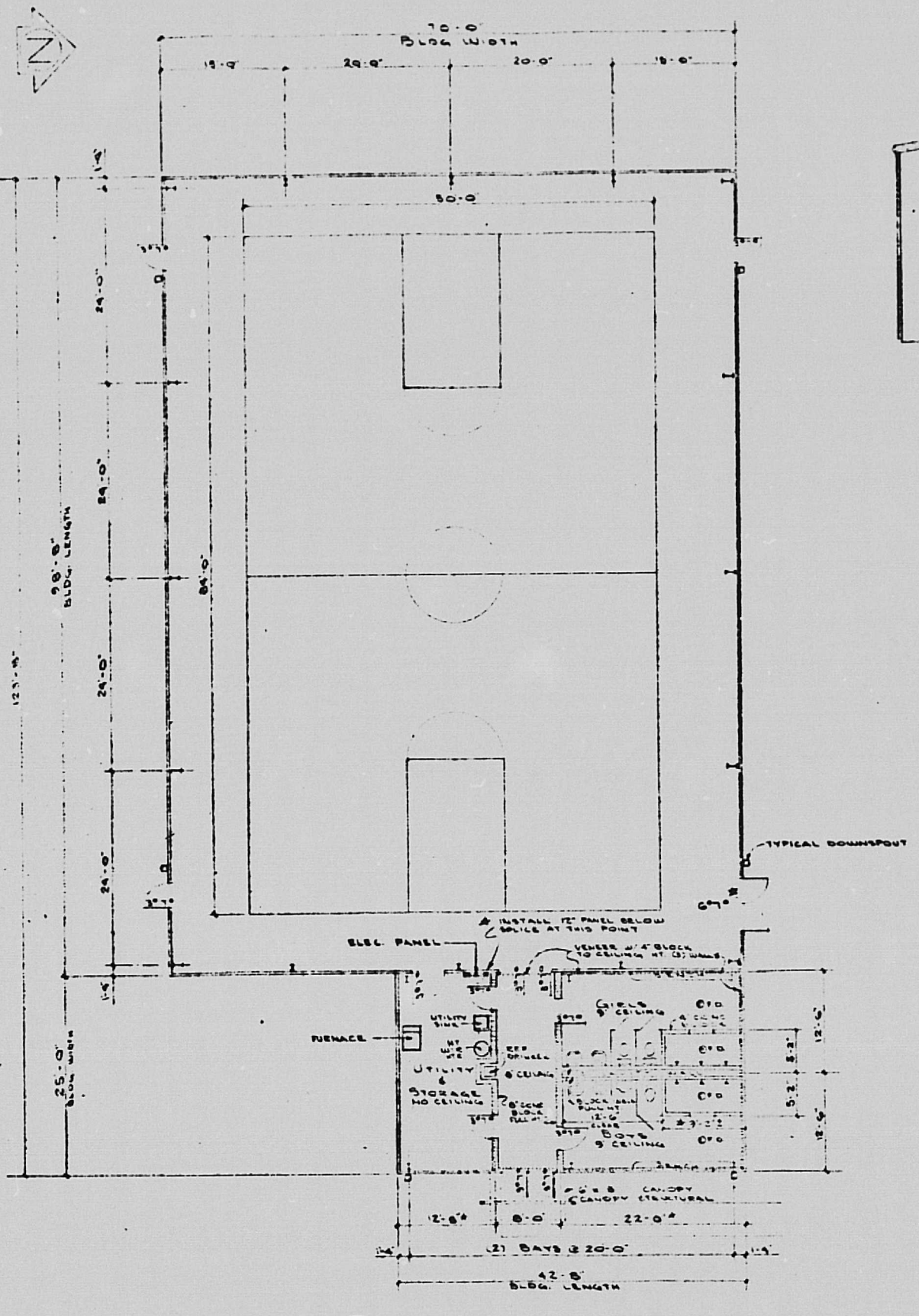
CERTIFIED BY Frank S. Mullen
Authorized Representative

DATE January 3, 1978

APPENDIX A

BUILDING DRAWINGS

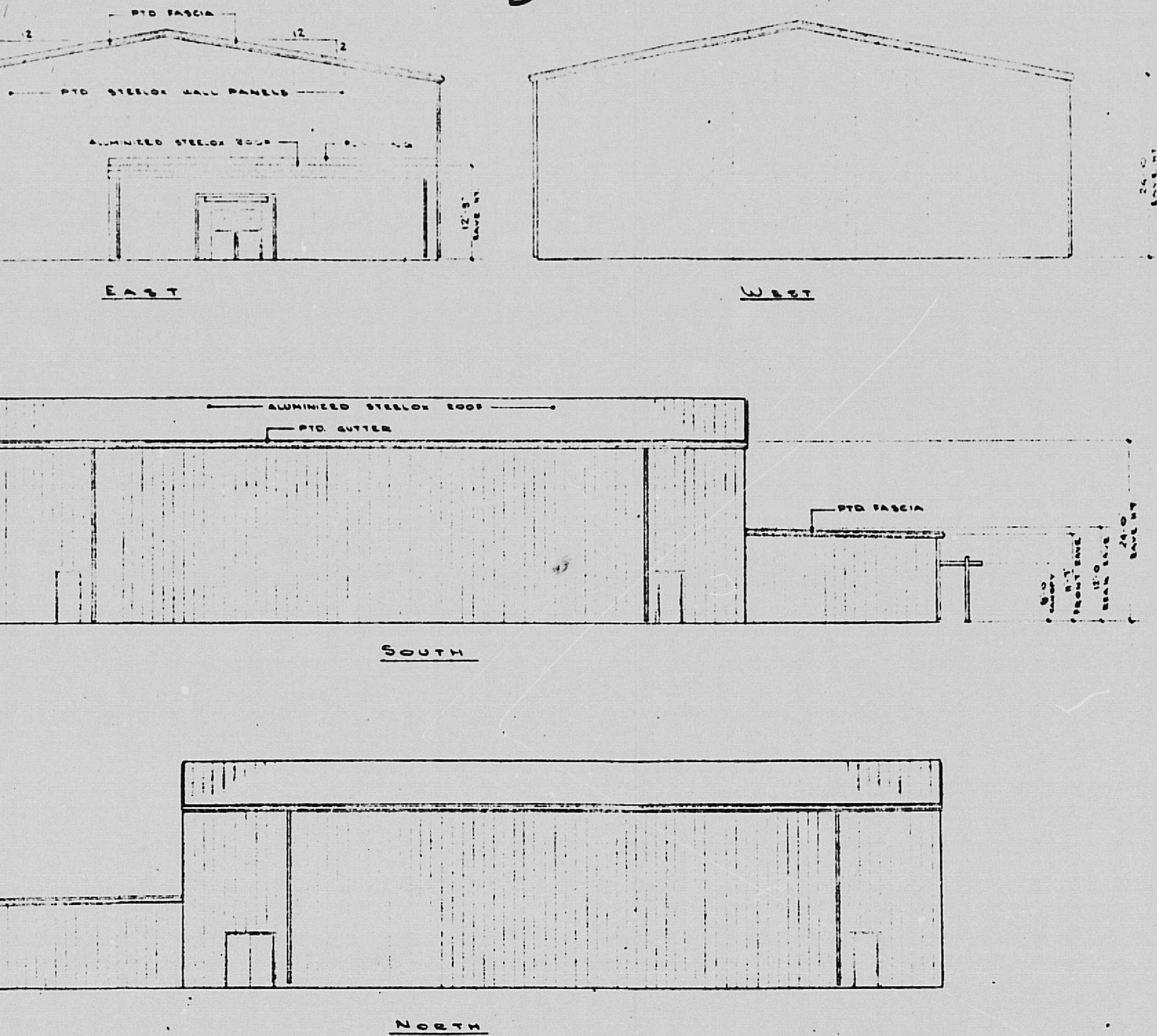
POLEBARN FRAME



PLAN

FOLDOUT FRAME

2



E L E V A T I O N S

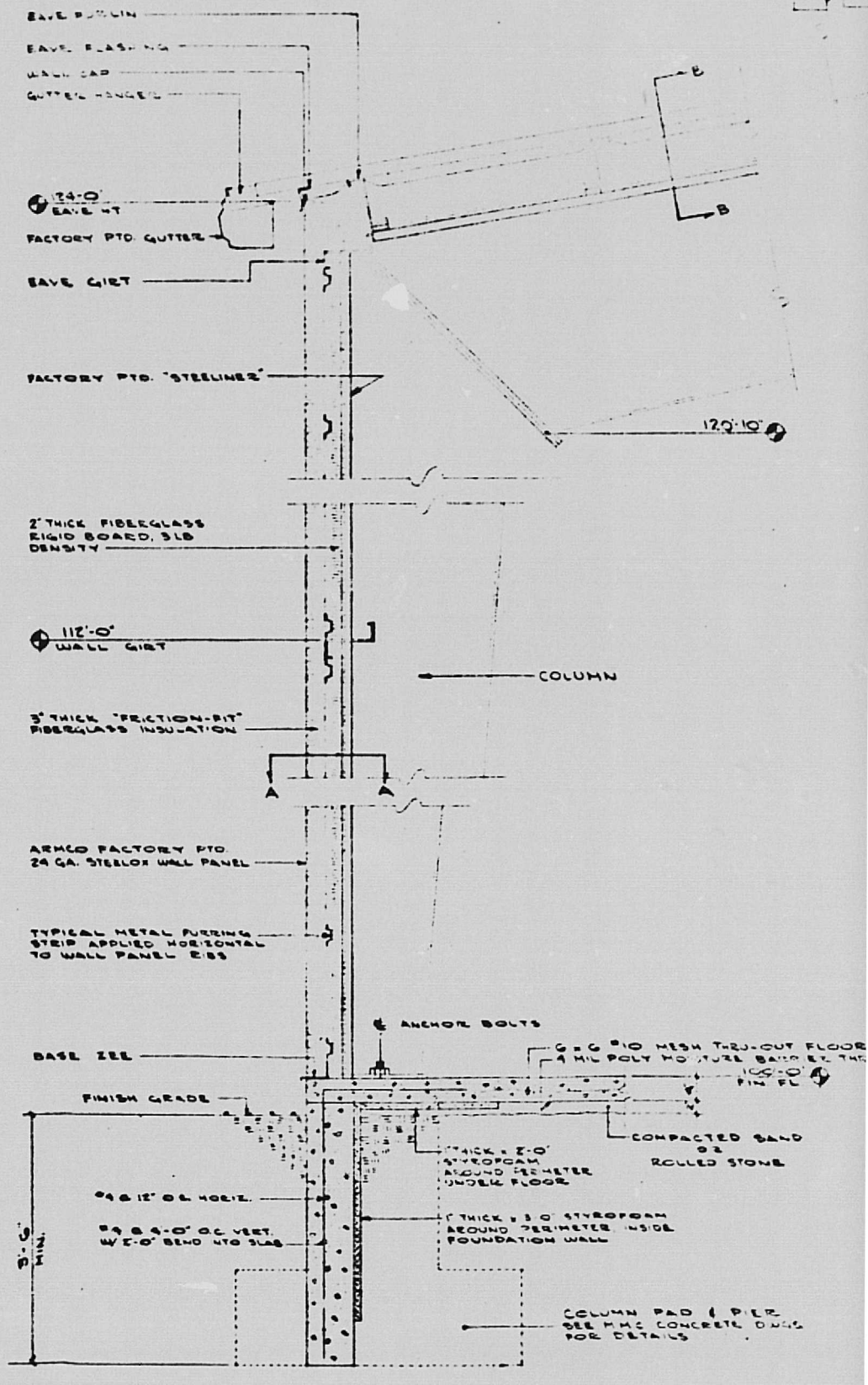
modern metals corp.
MUSCATINE, P.O. Box 711 IOWA 52761

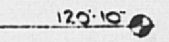
Date	Subject	JOB: SCATTERGOOD SCHOOL WEST BRANCH IOWA		
2-25-75	[illegible]	SUBJECT: RECREATION [illegible]	Scale	By: [illegible]
12-23-75	[illegible]			Date: [illegible]
1-13-76	[illegible]	APPROVED BY:		Dwg. No. 57601
2-4-76	[illegible]			

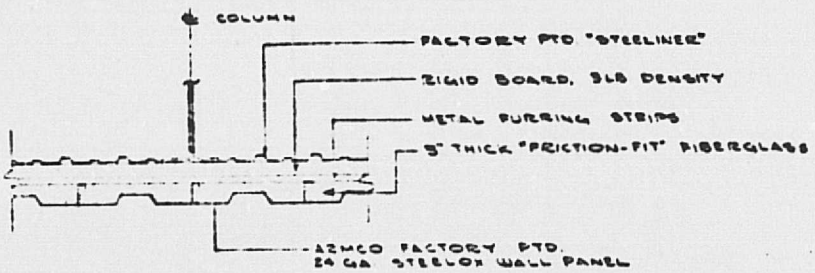
REVISIONS

A-1

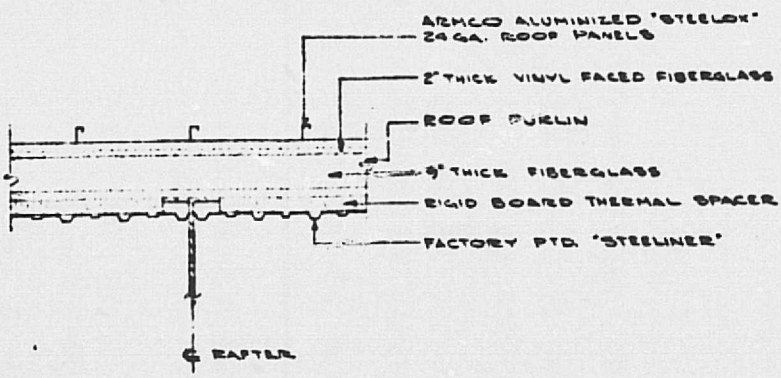
As Built 7-13-77 [illegible]







SECTION A-A



SECTION B-B

MESH THRU-OUT FLOOR
MOISTURE BARRIER THRU-OUT
100'-0" FIN FL
COMPACTED SAND OR ROLLED STONE
PAD & PIER CONCRETE DWGS

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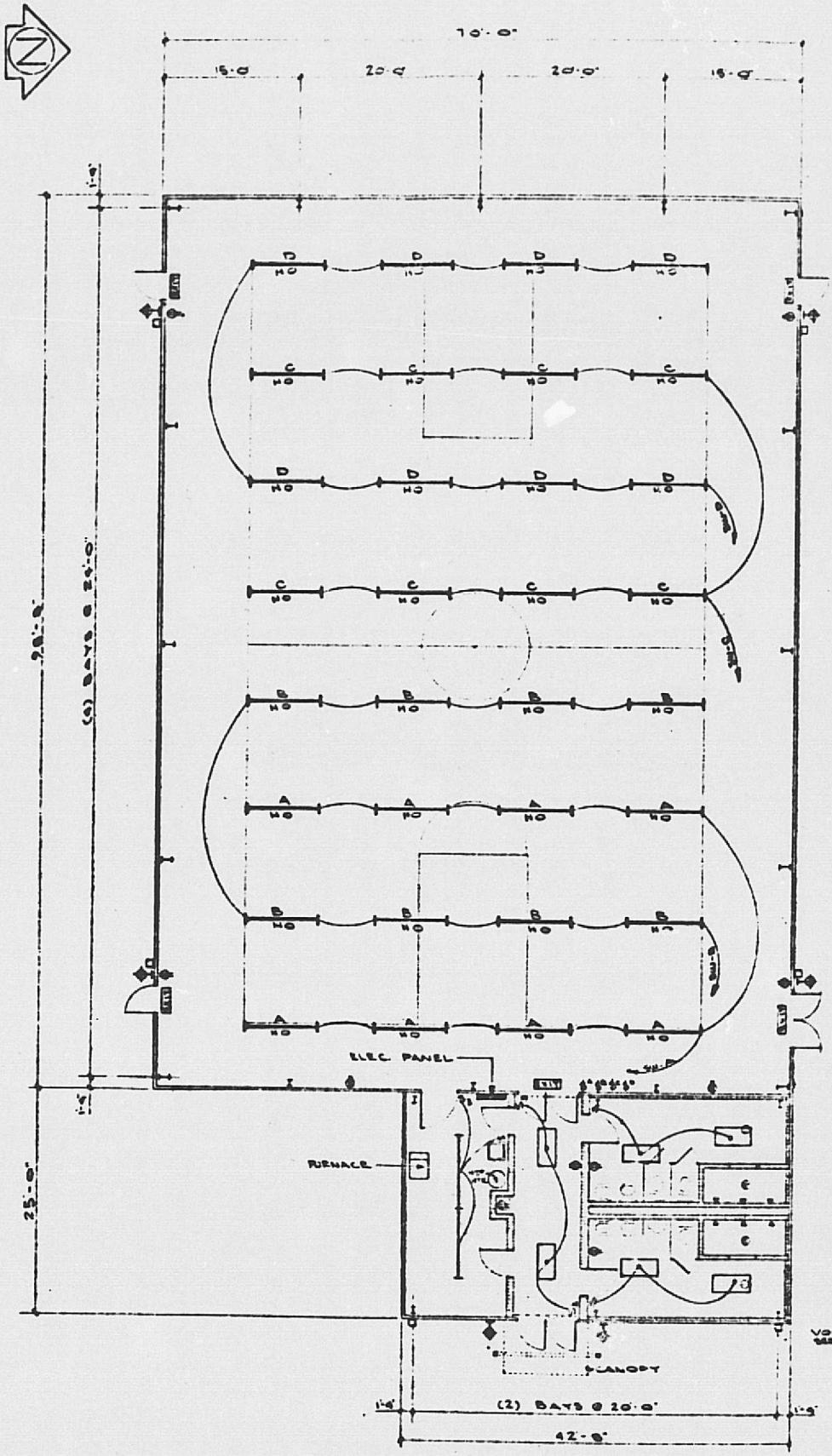
MUSCATINE, P.O. Box 711 IOWA 52761

Date	Subject	JOB: SCATTERGOOD SCHOOL WEST BRANCH, IOWA		
		SUBJECT: DETAIL AT WALL & ROOF	Scale 1"=1'-0"	By: [illegible] Date: [illegible]
		APPROVED BY:		Dwg. No. [illegible]

A-2

FOLDOUT FRAME

1



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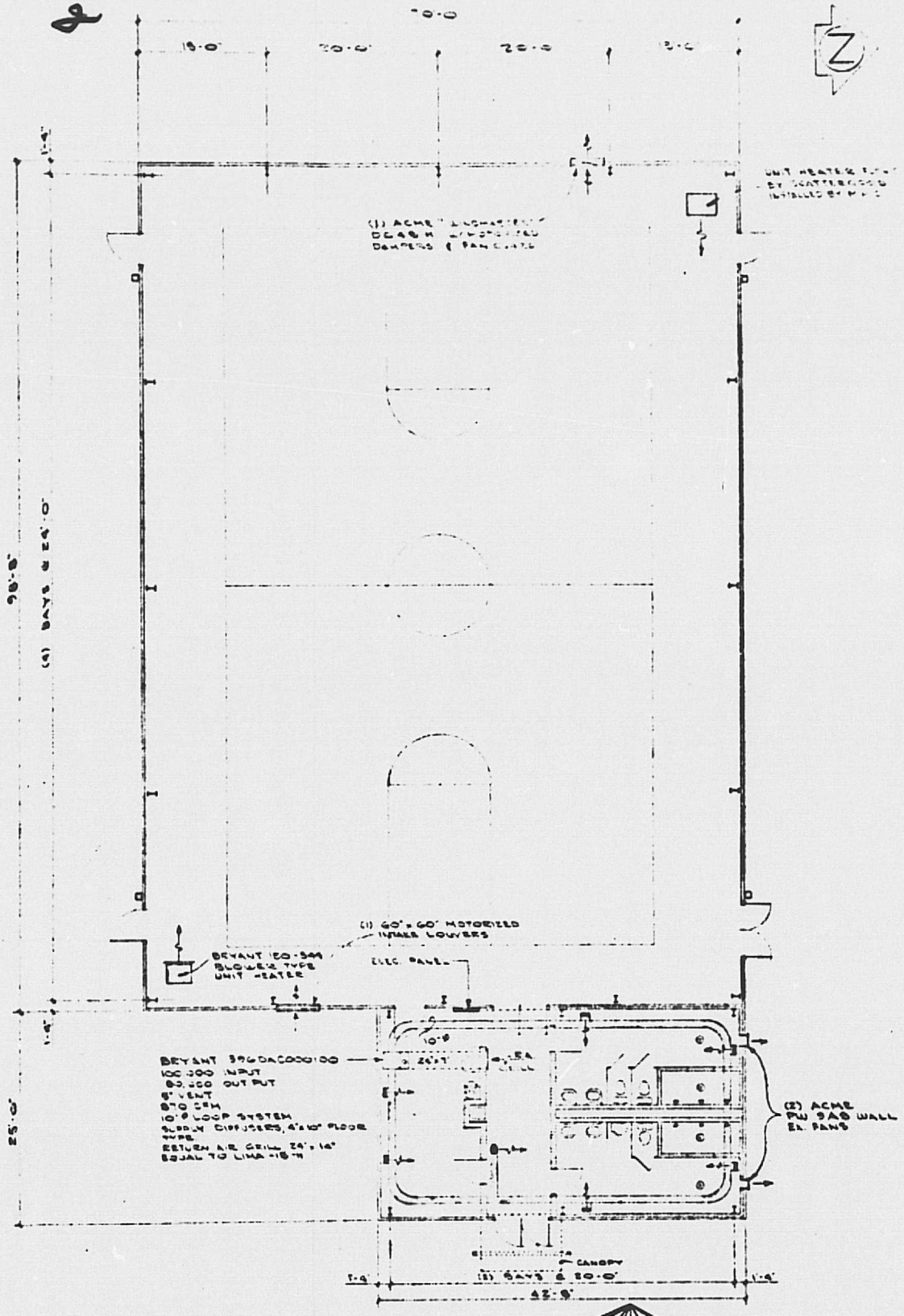
ELECTRICAL



Legend

(2) Exhaust Fans
(32) "Lithonia" EF-296 HO w/ Shades & Guards
(6) "Lithonia" 2G-440 A12 Troffers
(2) "Lithonia" C-296 8'-0" Surface
(5) "Lithonia" Exit Lights
(6) "Benjall" Vandal Proof Exterior Lights
(9) 120V Convenience Wall Outlets
(4) Three Way Switches
(6) Single Pole Switches
(1) Electrical Service Panel

Heating & Ventilating

MMC
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Revisions	Date	Subject
	1-10-76	Added Mechanical
	2-9-76	[illegible]

JOB: Scattergood School, West Branch, Iowa

SUBJECT: Mechanical — Scale 1/8"=1'-0" — By: [illegible] — Date: [illegible]

APPROVED BY: — Dwg. No. [illegible]

A-3

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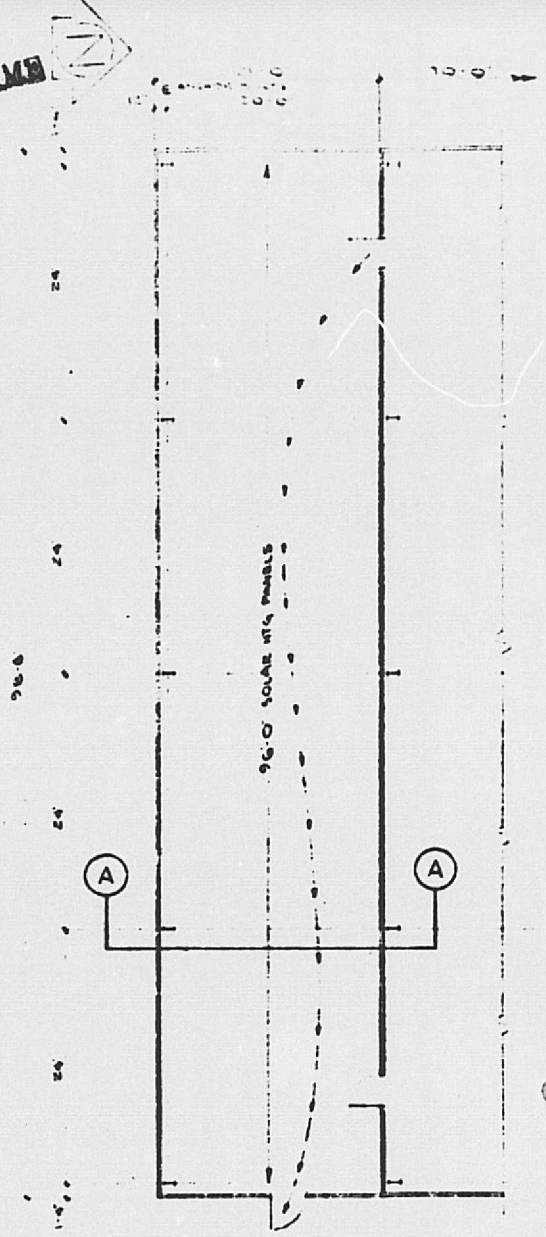
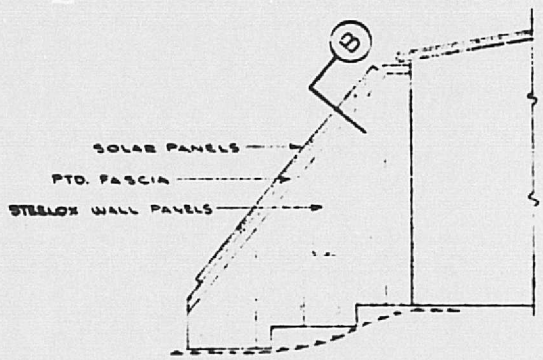
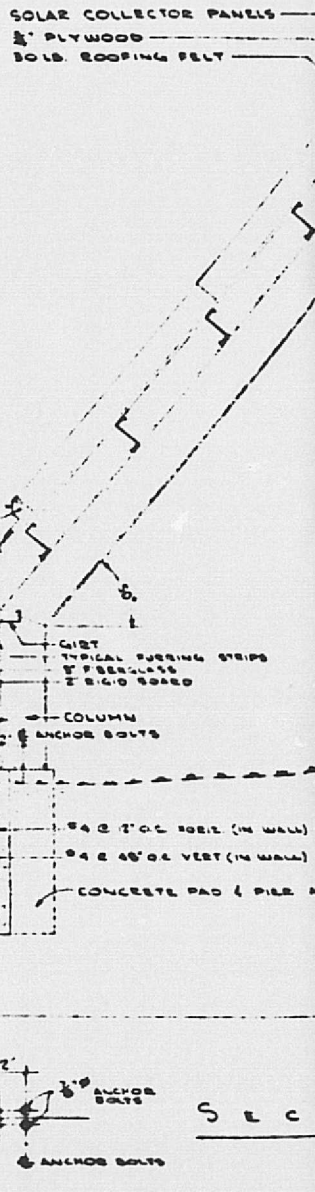


PLAN
1/8"=1'-0"

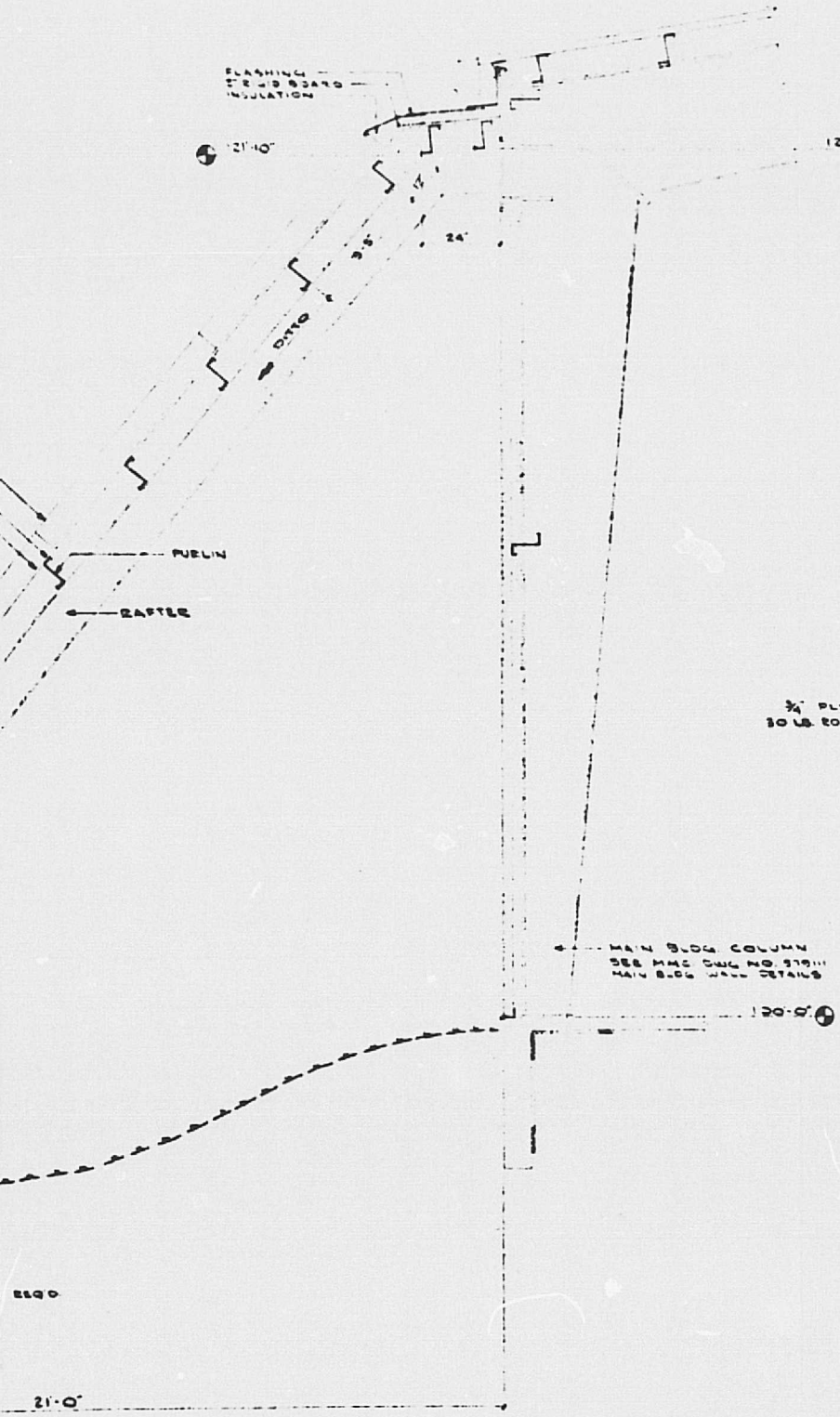


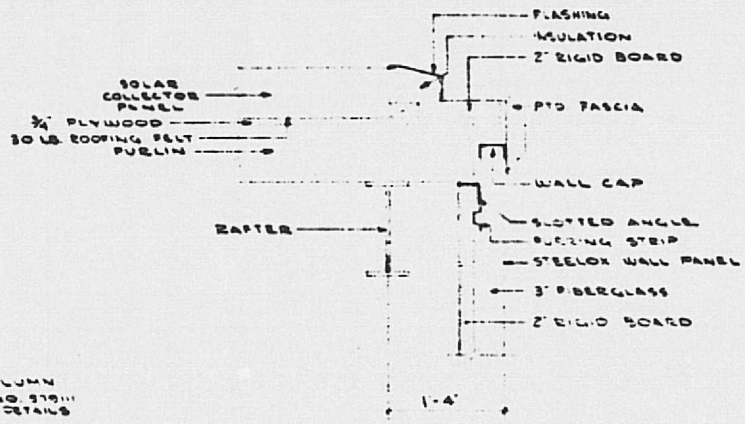
EAST ELEVATION
WEST ELEVATION SIMILAR
1/8"=1'-0"



ANCHOR BOLT SETTING PLAN

SEC





SECTION (B)
1" = 1'-0"

SECTION (A) (A)
¼" = 1'-0"

modern metals corp.
MUSCATINE, P.O. Box 711 IOWA 52761

REVISIONS	Date	Subject

JOB: SCATTERGOOD SCHOOL
WEST BRANCH, IOWA

SUBJECT: SOLAR HEATING STRUCTURE

Scale AS SHOWN

By: R.A.

Date: 5-6-76

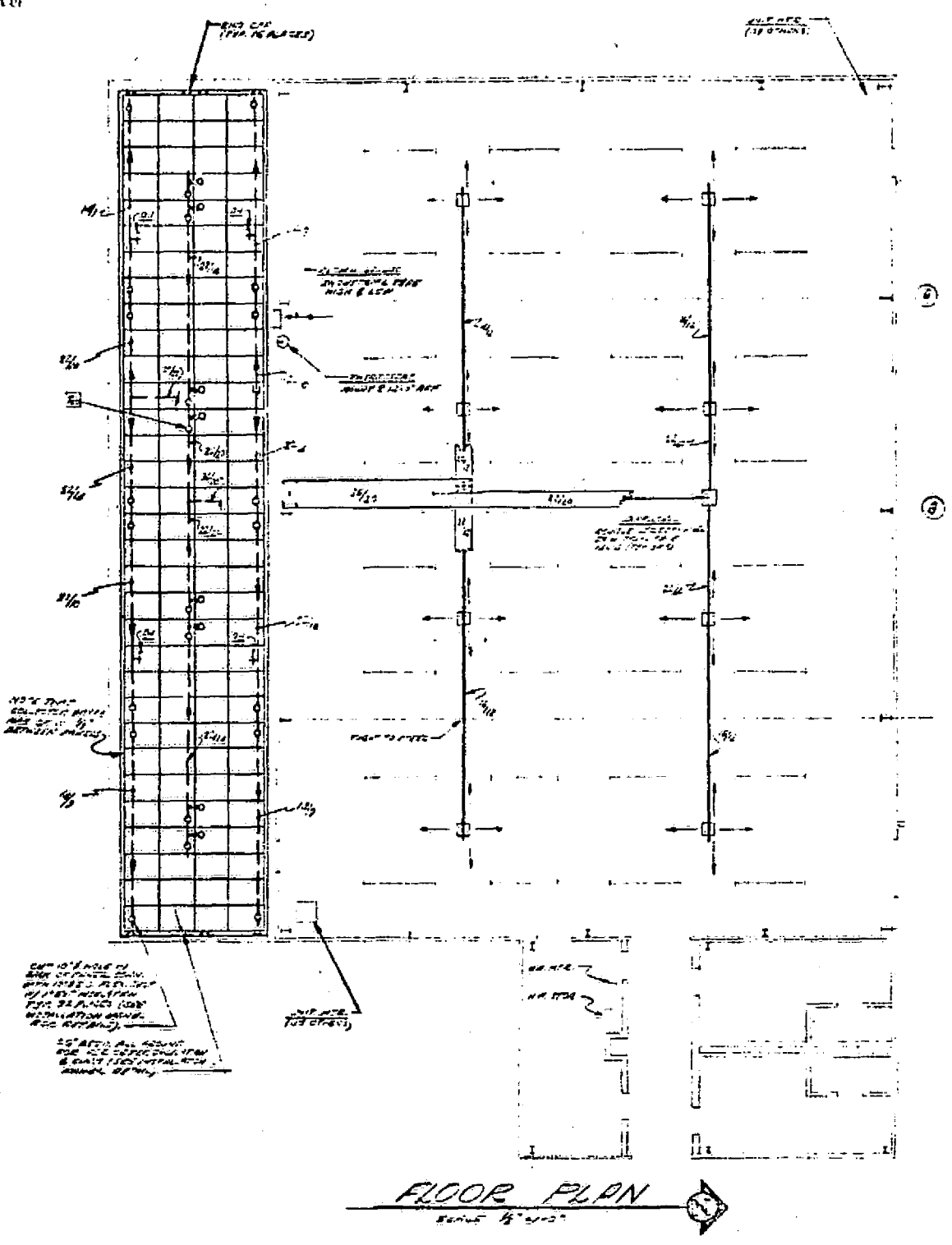
APPROVED BY:

Dwg. No. 6765

A-4

APPENDIX B

DESIGN AND SCHEMATIC DRAWINGS OF THE SOLAR HEATING SYSTEM



FLOOR PLAN

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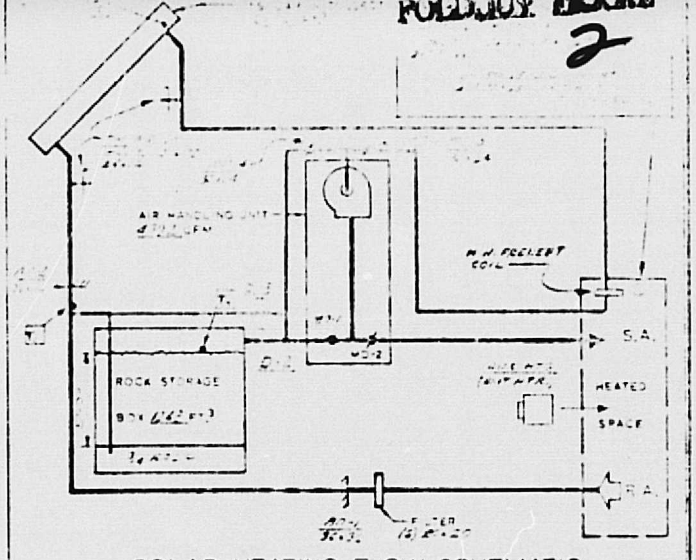
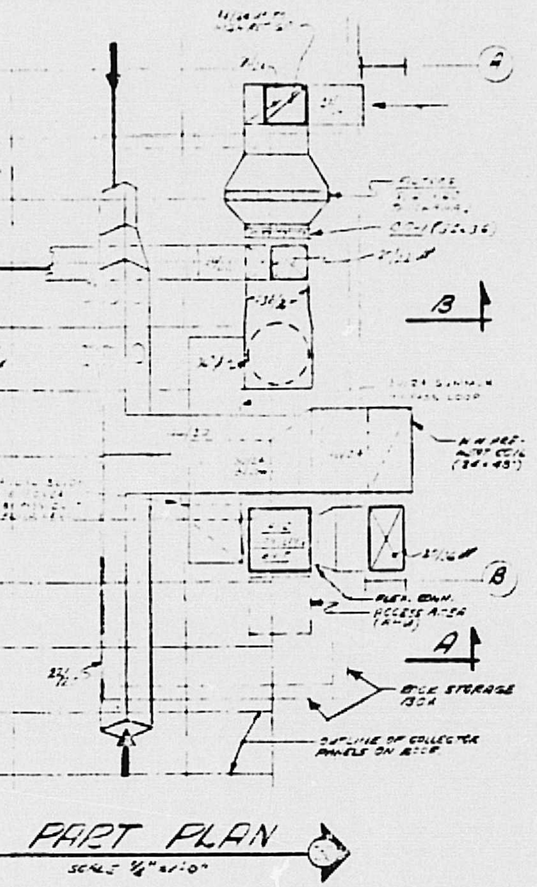
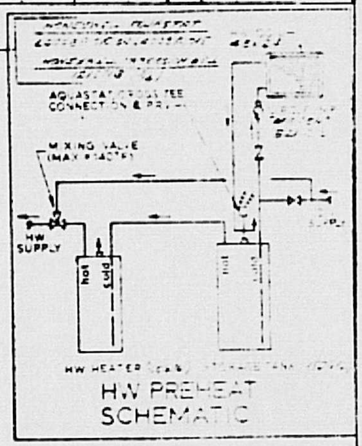
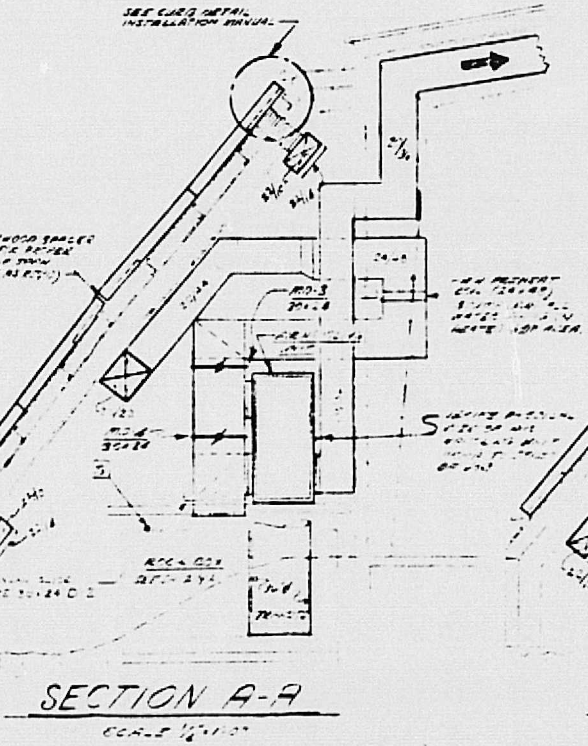
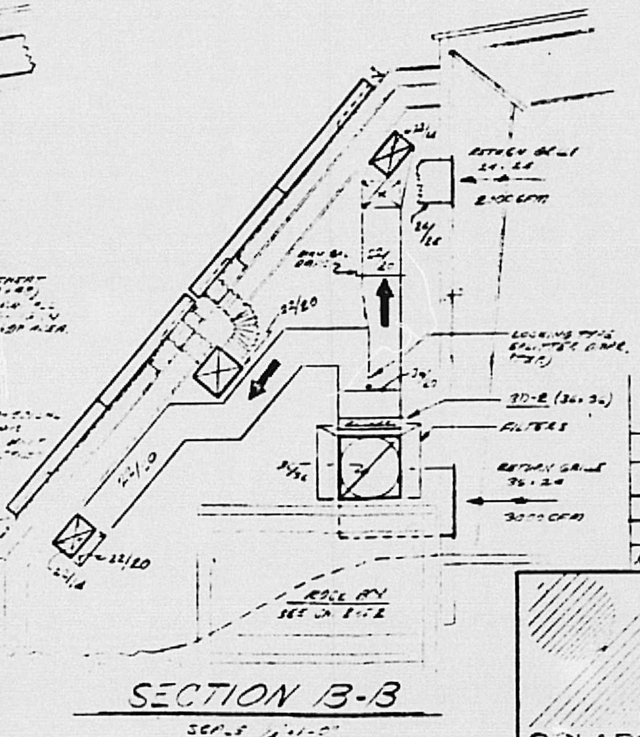


O = OPEN C = CLOSED	SEQUENCE OF OPERATION						
MODE	MD-1	MD-2	MD-3	MD-4	[illegible]	[illegible]	[illegible]
HEATING FROM COLLECTOR	C	O	O	C	[illegible]	[illegible]	
HEATING FROM STORAGE	C	O	C	O	C	[illegible]	[illegible]
STORING HEAT	O	C	O	C	C	O	[illegible]
NATURAL CONVECTION [illegible]	O	C	O	C	O	O	[illegible]
WATER PRE-HEAT (SUMMER)	O	C	O	C	C	C	O









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2	[illegible]	[illegible]
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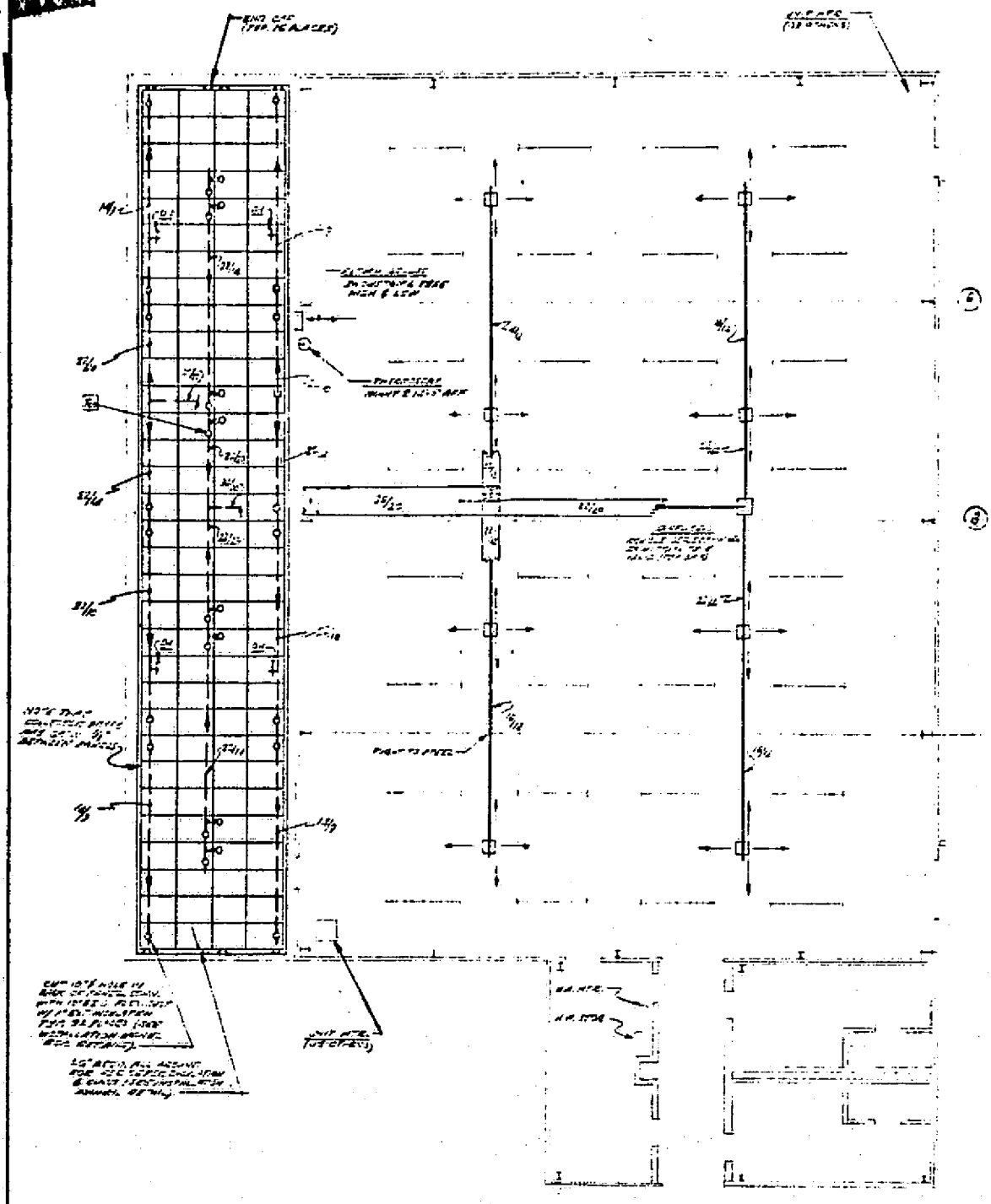
SOLAR ENERGY SYSTEMS

SCATTERGOOD SCHOOL

SOLARON

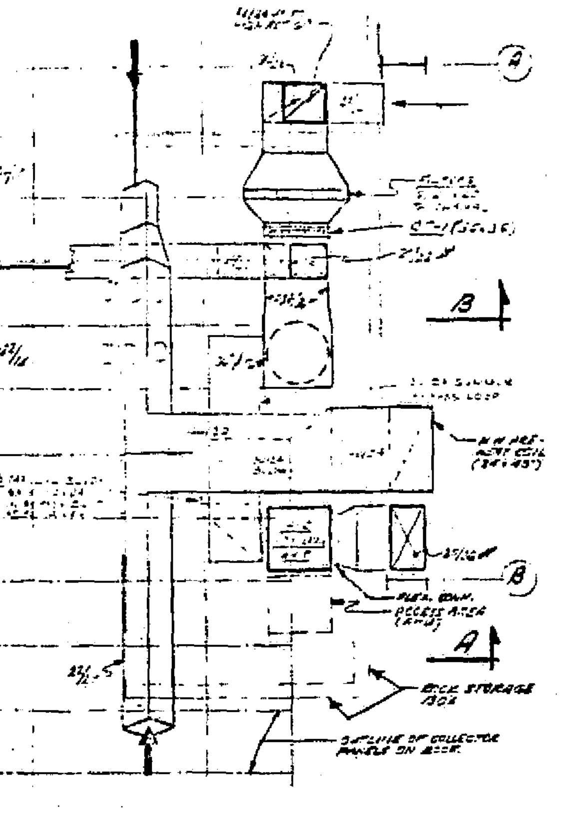
P-1151

B



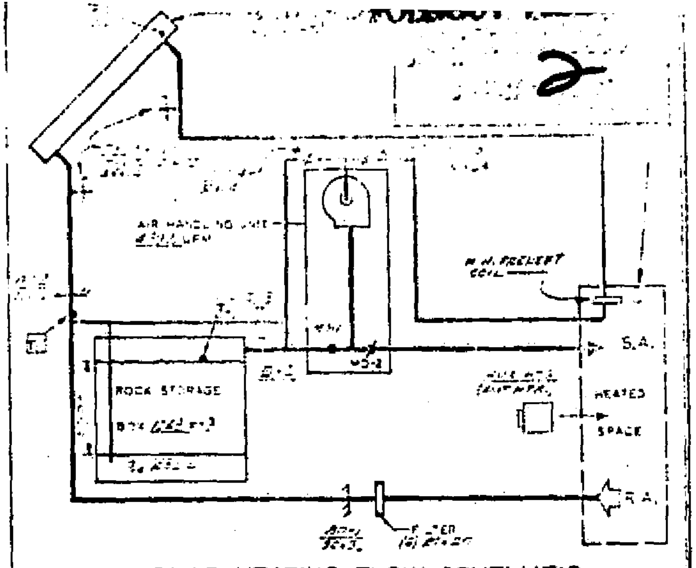
FLOOR PLAN

SCALE: 1/4"=1'-0"



PART PLAN

SCALE 1/4"=1'0"



SOLAR HEATING FLOW SCHEMATIC

O: OPEN C: CLOSED	SEQUENCE OF OPERATION						
MODE	MD-1	MD-2	MD-3	MD-4	[illegible]	[illegible]	[illegible]
HEATING FROM COLLECTOR	C	O	O	C	[illegible]	[illegible]	
HEATING FROM STORAGE	C	O	C	O	C	[illegible]	[illegible]
STORING HEAT	O	C	O	C	C	O	[illegible]
[illegible]	O	C	O	C	O	[illegible]	[illegible]
WATER PRE-HEAT (SUMMER)	O	C	O	C	C	C	O

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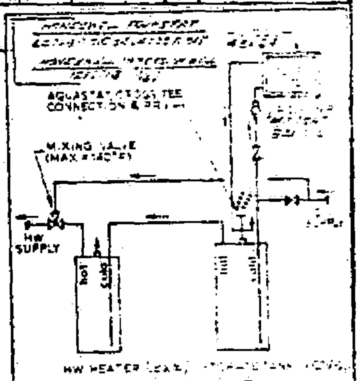
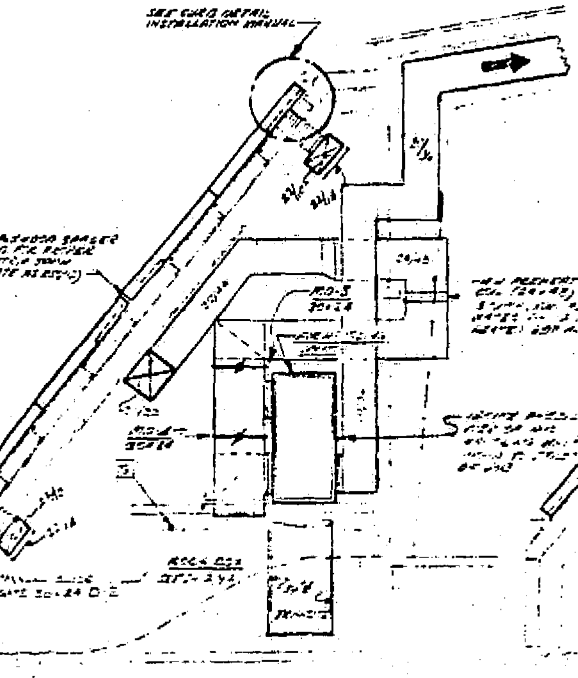
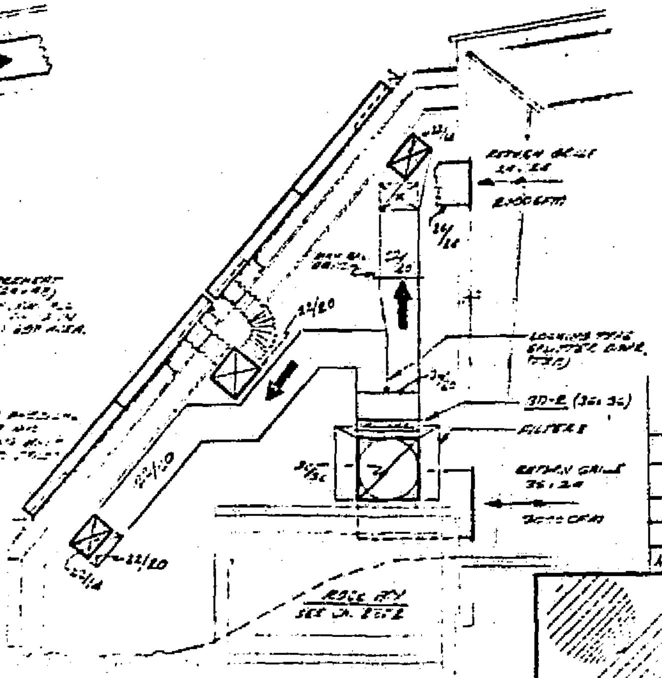


HW PREHEAT SCHEMATIC



SECTION A-A

SCALE 1/4"=1'0"



SECTION B-B

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2	[illegible]	[illegible]
1	[illegible]	[illegible]

SOLAR ENERGY SYSTEMS
Commerce City, Colo.

SCATTERGOOD SCHOOL

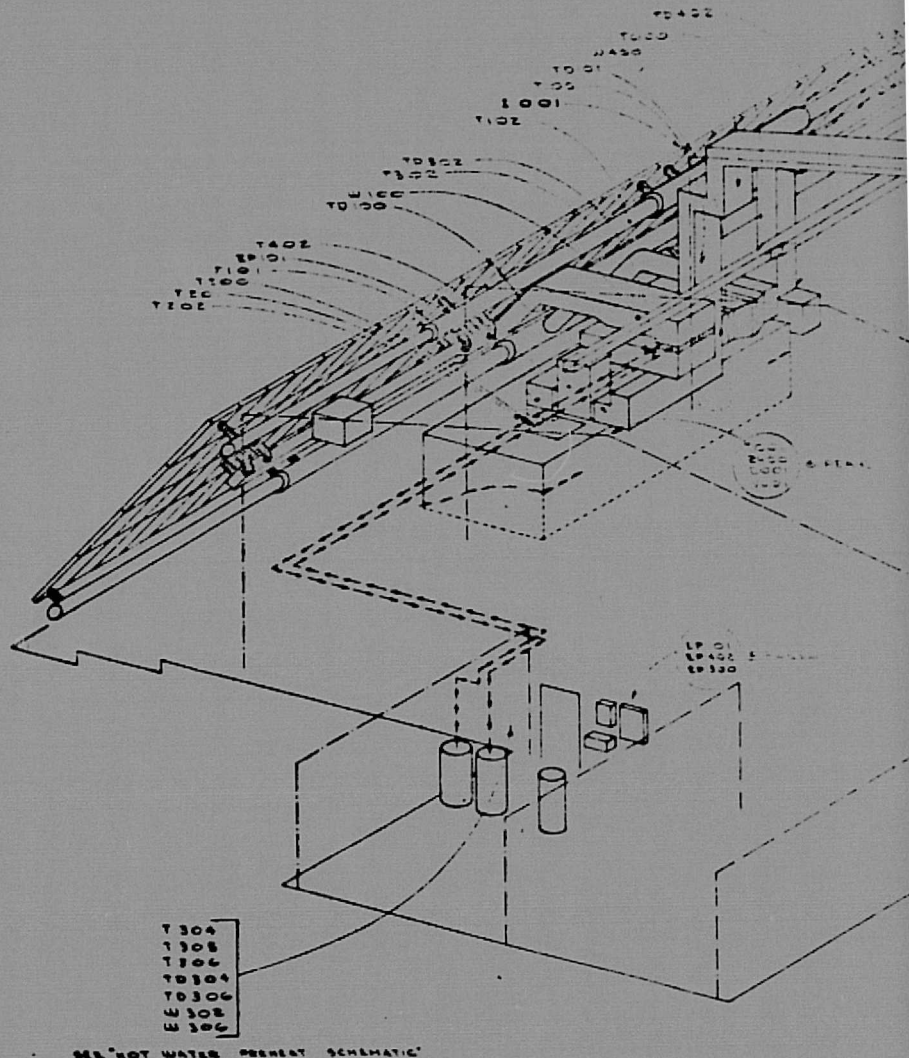
P-1151

SOLARON

APPENDIX C

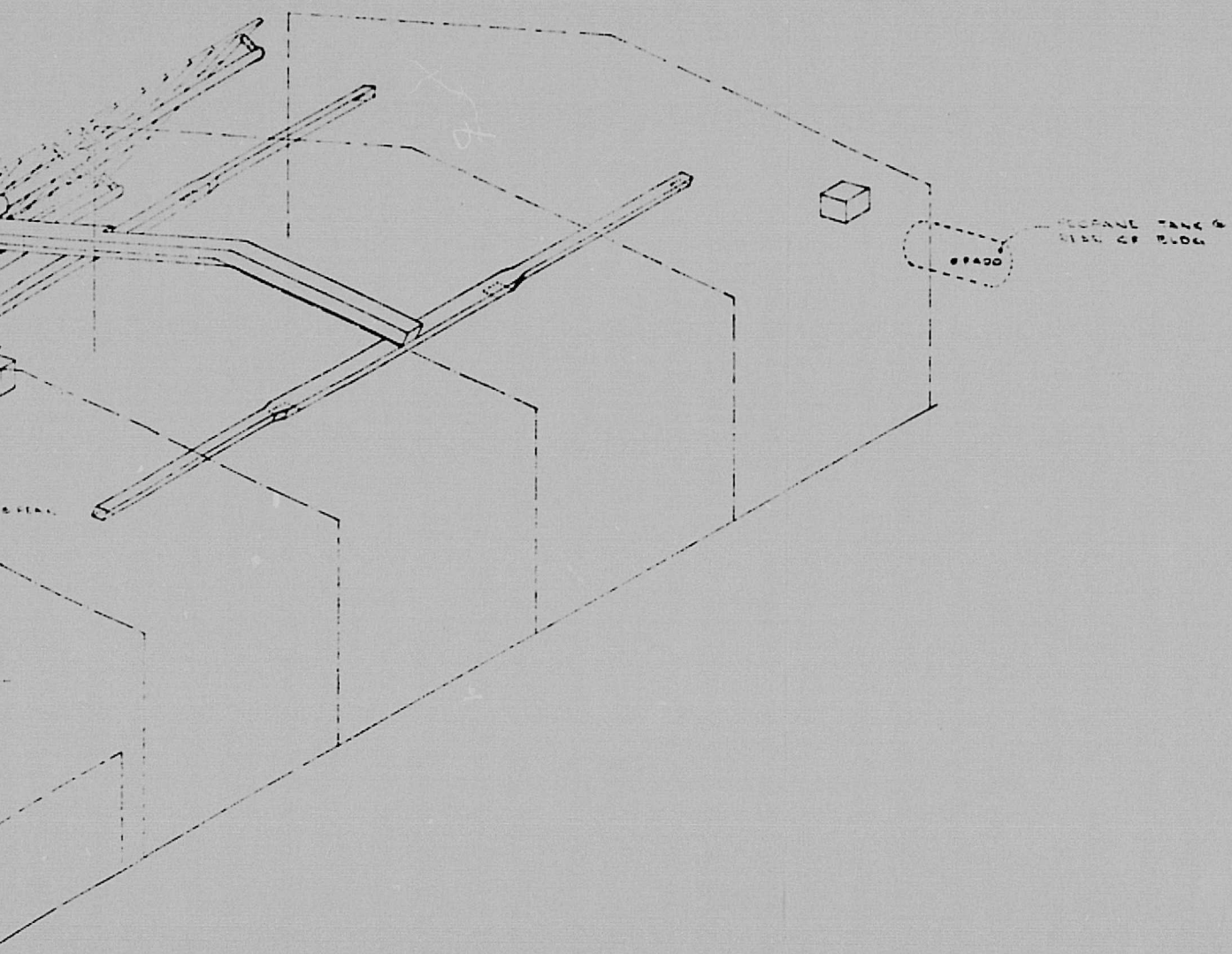
AS BUILT DRAWINGS OF THE SOLAR HEATING SYSTEM

RH 001	RELATIVE HUMIDITY
D001	WIND DIRECTION
V001	WIND VELOCITY
T100	COLLECTOR ARRAY INLET TEMPERATURE
TD100	COLLECTOR ARRAY DIFFERENTIAL TEMPERATURE
T101	ROOF SPACE OUTLET TEMPERATURE
TD101	ROOF STORAGE DIFFERENTIAL TEMPERATURE
T102	COLLECTOR SURFACE TEMPERATURE
T200	ROCK STORAGE TEMPERATURE - TOP
T201	ROCK STORAGE TEMPERATURE - MIDDLE
T202	ROCK STORAGE TEMPERATURE - BOTTOM
T302	TEMPERATURE OUTLET HOT WATER PREHEAT COIL
TD302	TEMPERATURE DIFFERENTIAL ACROSS HOT WATER PRE-HEAT COIL
T304	TEMPERATURE INLET PREHEAT TANK
TD304	TEMPERATURE DIFFERENTIAL ACROSS PREHEAT TANK
T306	TEMPERATURE DOMESTIC HOT WATER INLET
T308	COLD WATER SUPPLY TEMPERATURE
TD306	TEMPERATURE DIFFERENTIAL ACROSS DHW TANK
T402	SPACE HEATING INLET TEMPERATURE
TD402	TEMP. ACROSS DIFFERENTIAL ACROSS HEATED SPACE
T600	INSIDE AMBIENT
T251	OUTSIDE AMBIENT
W100	COLLECTOR ARRAY FLOW
W302	DHW PRE-HEAT LOOP FLOW
W306	FLOW PRE-HEAT TO DHW TANK
W400	OUTLET FLOW AT DUCT
F450	FLOWAGE FLOW TO SPACE HEATING
EP101	CIRCULATING AIR FAN POWER
EP402	SPACE HEATER FAN POWER
EP300	DHW ELECTRIC POWER
I 001	SOLAR FLUX



SEE "HOT WATER PREHEAT SCHEMATIC" DWG NO 77119 FOR EXACT SENSOR LOCATIONS IN UTILITY ROOM

2



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MUSCATINE, P.O. Box 711 IOWA 52761

REVISIONS	Date	Subject

JOB: SCATTERGOOD SCHOOL
WEST BRANCH, IOWA

SUBJECT: SOLAR HTG SYSTEM

Scale

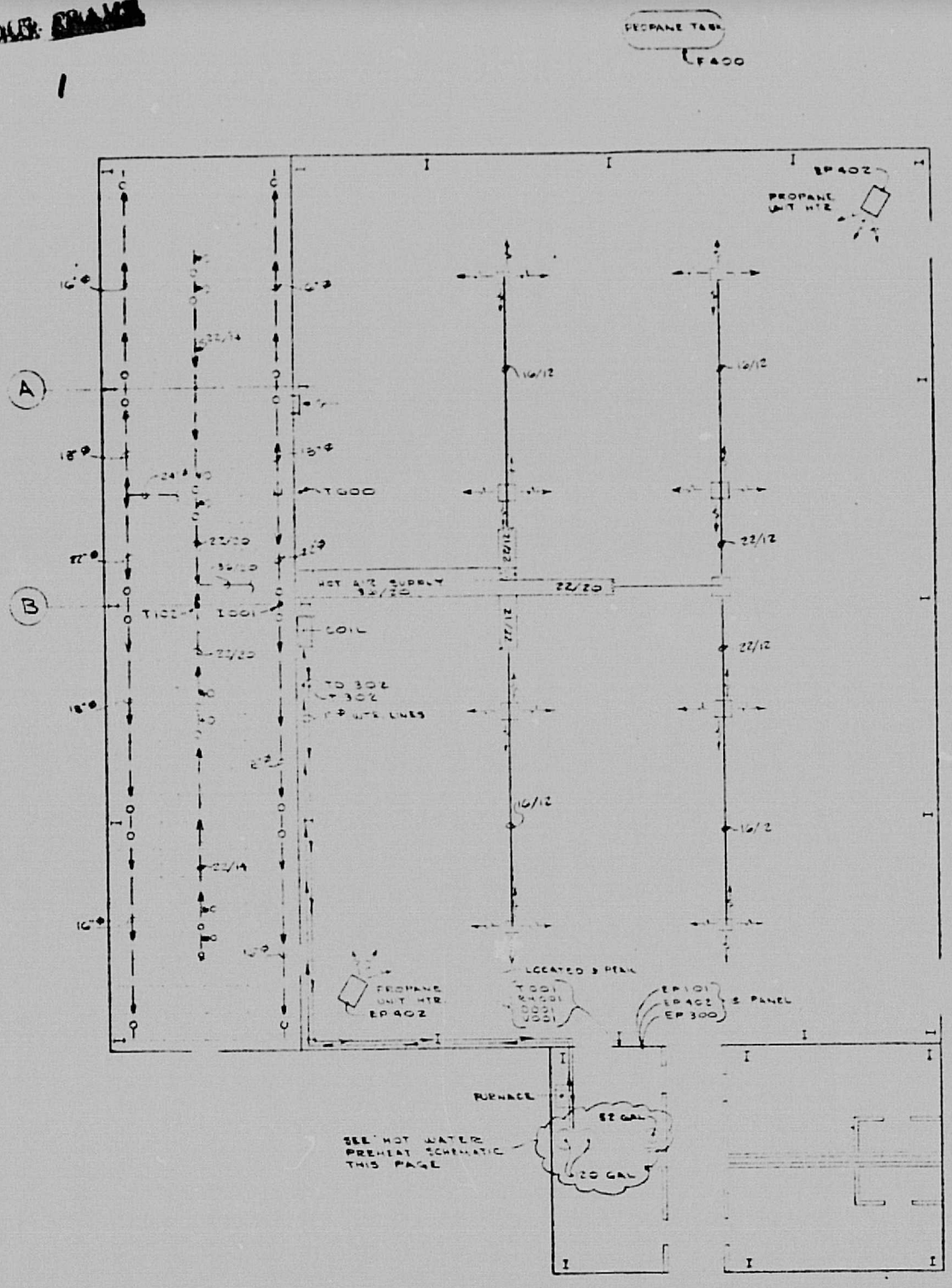
By:

Date:

APPROVED BY:

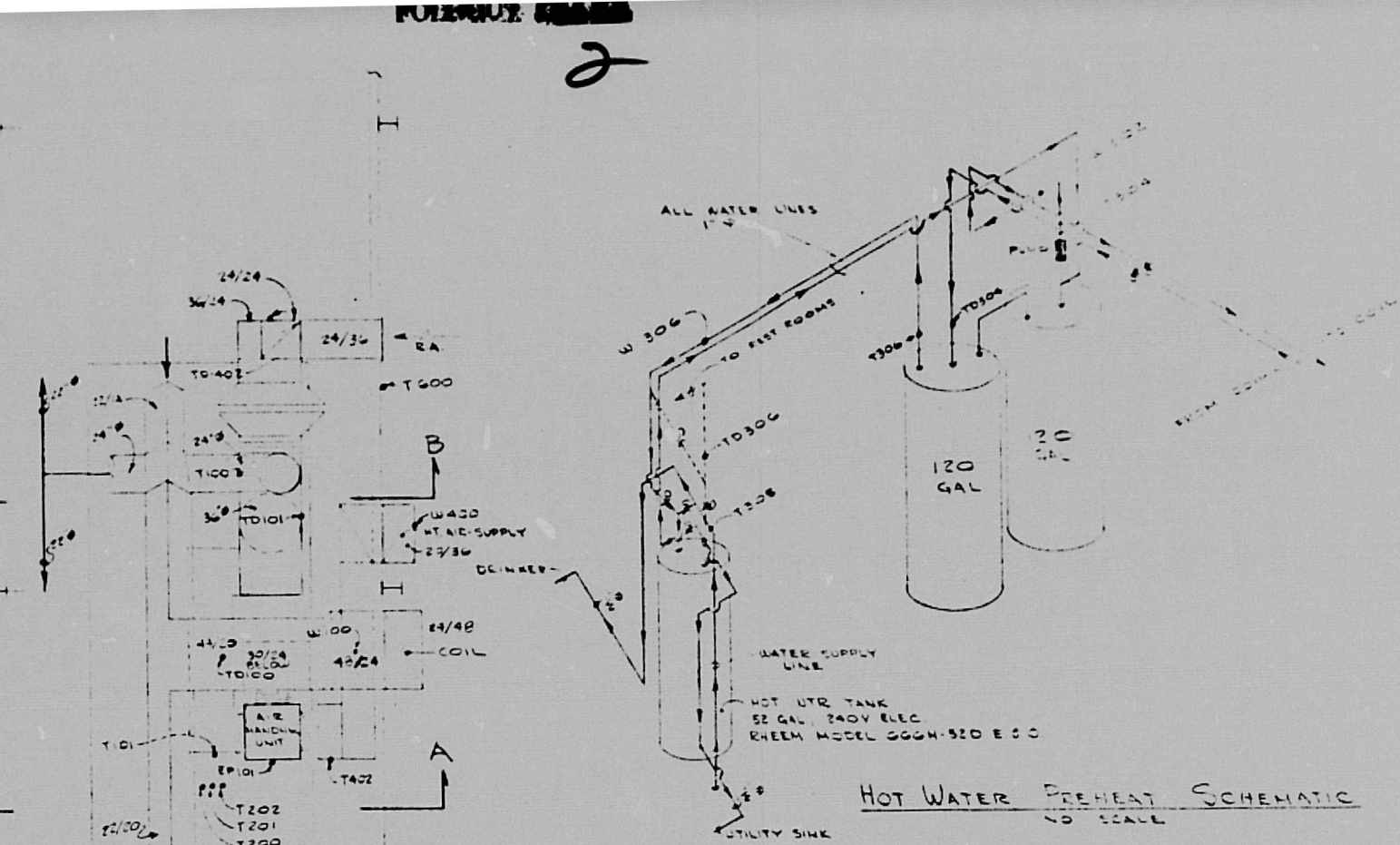
Dwg. No.

C-1



FLOOR PLAN

1/4" = 1'-0"



HOT WATER PREHEAT SCHEMATIC
NO SCALE

PLAN
½"=1'-0"

A - A
½"=1'-0"

B - B
½"=1'-0"

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MUSCATINE, P.O. Box 711 IOWA 52761

REVISIONS	Date	Subject

JOB: SCATTERGOOD SCHOOL WEST BRANCH, IOWA

SUBJECT: SOLAR HEATING SENSOR LOCATION

Scale: AS SHOWN

By: S.B.

Date:

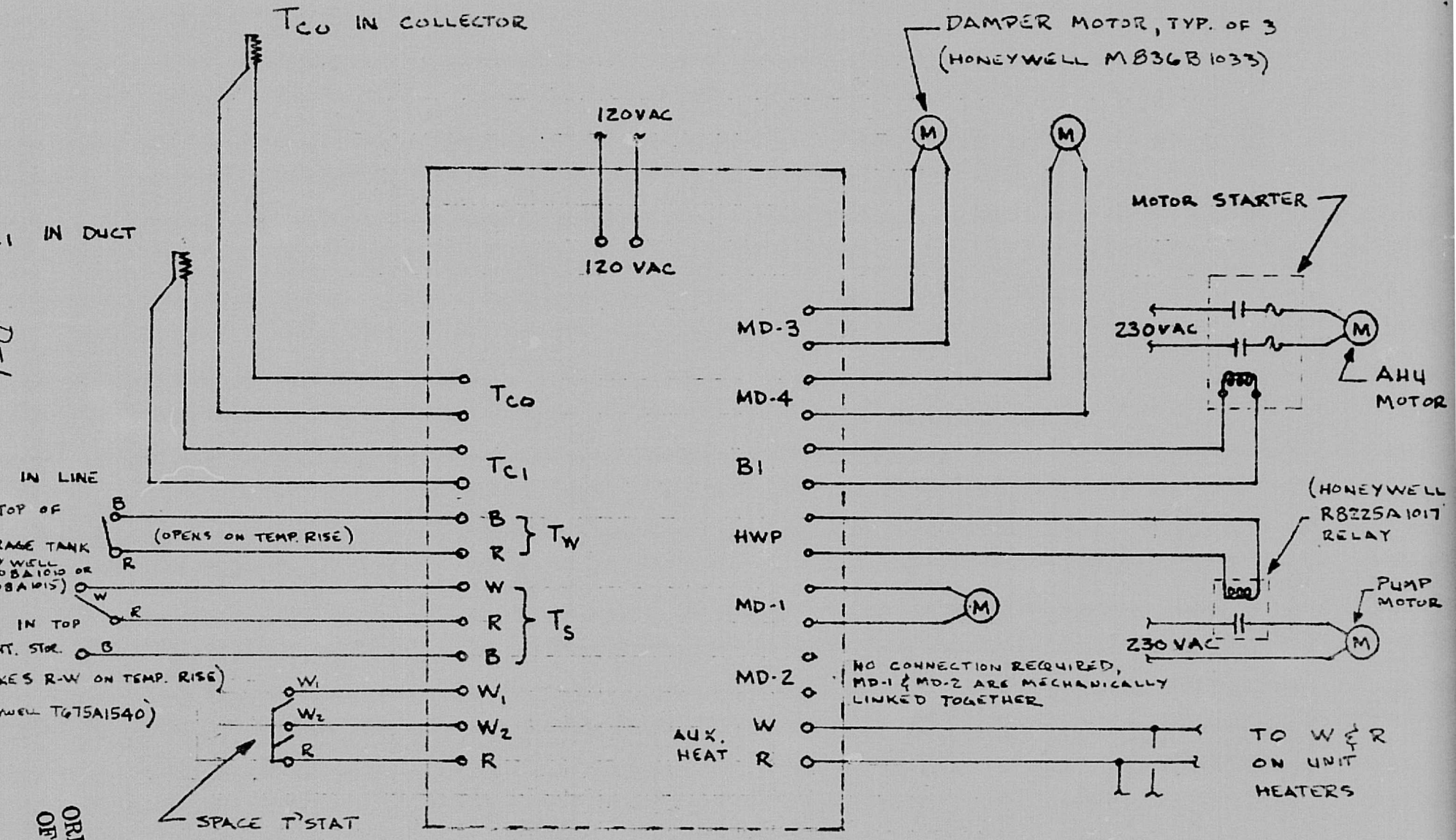
APPROVED BY:

Dwg. No. 77-117

C-2

APPENDIX D

WIRING DIAGRAMS OF THE SOLAR HEATING SYSTEM



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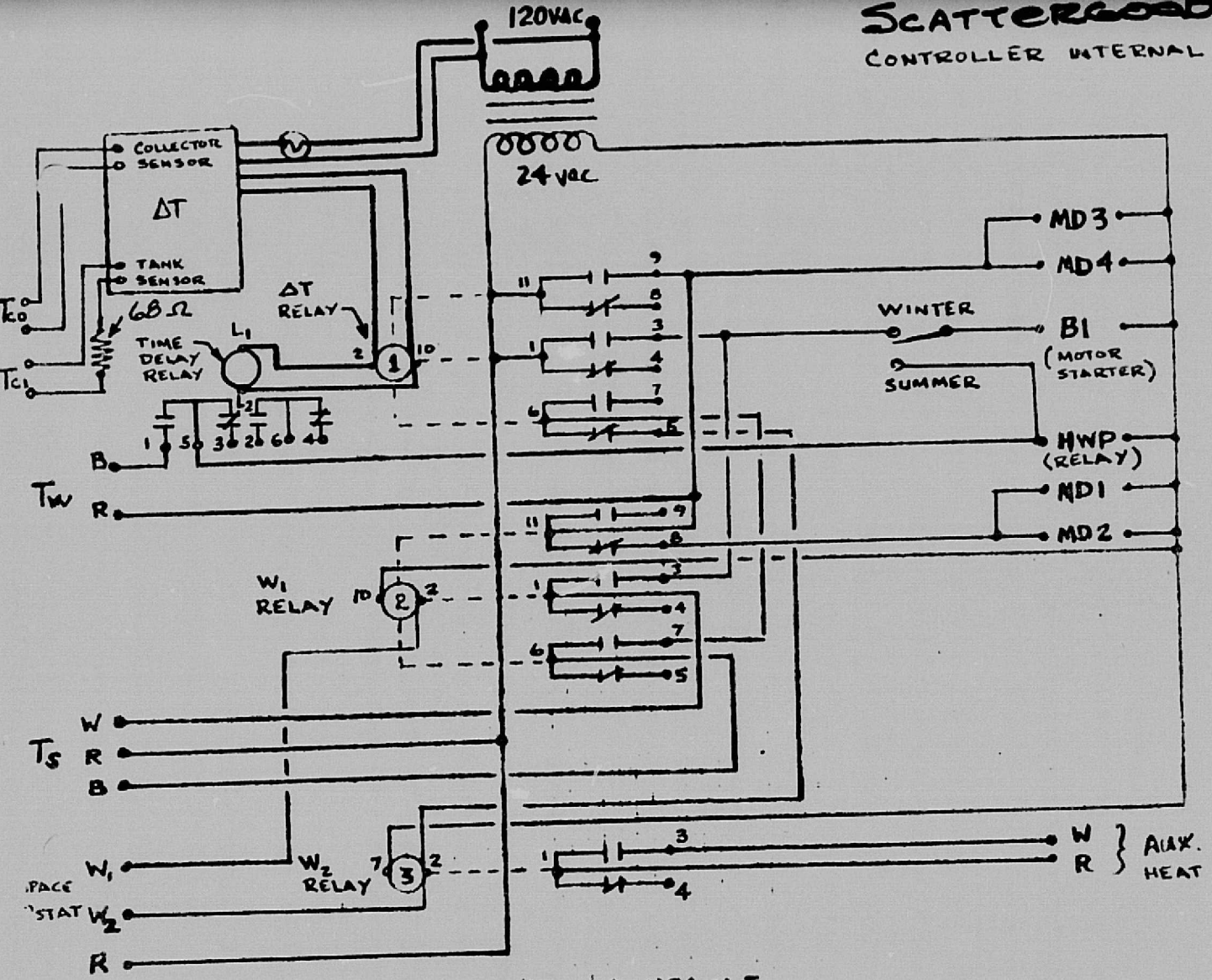
SCATTER GOOD SCHOOL CONTROL PANEL CONNECTIONS

SCATTERGOOD SCHOOL

CONTROLLER INTERNAL WIRING



EQUIPMENT SCHEDULE

ΔT - R34 Penn Diff Cntrlr w/ fuse

Transf - 100 VA

T_S - Honeywell T675A1540 Temp Cntrlr.

1 - 3PDT Sealed Relay Plug in Type
120V coil

2 - 3PDT Sealed Relay Plug in Type
24 V coil

3 - 3PDT Sealed Relay Plug in Type
24 V coil

APPENDIX E

SEQUENCE OF OPERATIONS OF THE SOLAR HEATING SYSTEM

SCATTERGOOD SCHOOL

SEQUENCE OF OPERATION

WINTER OPERATION

Place "Summer-Winter" switch in "Winter" position and set time delay relay at three minutes. When there is a 45 degree F temperature differential between the collector outlet temperature (T_{co}) and the collector inlet temperature (T_{ci}) the ΔT relay is energized (cut-out differential 30 degrees F). This closes the damper (MD-4) from the heat storage to the inlet of the air handling unit and opens the damper (MD-3) from the collectors to the AHU inlet. The damper (MD-1) from the discharge of the AHU to the heat storage opens and the damper (MD-2) from the AHU discharge to the heated space closes. Simultaneously, the AHU fan starts and if the water in the storage tank is below the set-point (140 degrees F, adjustable) of the temperature controller (T_w) the circulating pump will run after the time delay cycle. When the space thermostat calls for heat at this time, MD-1 closes and MD-2 opens to direct the solar heated air through the building space. [redacted] When the ΔT relay is de-energized (no solar heat available from collectors) and the space thermostat calls for heat the AHU fan will run and use the heat from storage if the storage temperature is above 90 degrees F (the set-point [adjustable] of T_s). In the event that the storage temperature is above 90 degrees F and the air from storage is not enough to off-set the building heat loss the second stage heating circuit in the thermostat will make when the space temperature drops approximately 1-1/2 degrees F below the set point of the first stage. This will stop the AHU and bring on the auxiliary heat (unit heaters). If the storage temperature is below 90 degrees F the AHU will remain off and the auxiliary heating system will be automatically controlled by the first stage heating circuit. During "Winter" operation manual dampers D-1 and D-3 shall be closed and D-2 open.

SCATTERGOOD SCHOOL

SEQUENCE OF OPERATION

2.

SUMMER OPERATION

Place "Summer-Winter" switch in "Summer" position and set time delay relay at twenty minutes. The system shall be energized by differential control as in "Winter" operation The heat storage box is bypassed by removing D-3 and installing D-2 with D-1 left closed. The motorized dampers will operate as if storing heat as described above and the fan and pump will run after the time delay cycle is completed. The system will shut down when the water in the storage tank reaches the set point of T_W. If the insolation is relatively low the system will shut down on the differential control before T_W is satisfied. The time delay relay will prevent short-cycling. Manual damper D-1 can be opened to vent the collectors and the system power shut off if there is no need for hot water preheating in the summer.

APPENDIX F

MAINTENANCE INSTRUCTIONS FOR THE SOLAR HEATING SYSTEM

MAINTENANCE INSTRUCTIONS

The following items should be performed semi-annually:

1. Inspect V-belt and sheaves for wear, check belt tension.
2. Inspect damper linkage.
3. Clean or replace filters (more frequent if required)
4. Oil pump motor with #20 non-detergent oil - do not over lubricate.
5. Oil AHU blower motor with #20 non-detergent oil - do not over lubricate

The following is to be done on annual basis:

1. Damper motors - lubricate the felt pads located on each of the motor bearings and on the two shafts in the gear train with #10 non-detergent oil.

APPENDIX G

SUBCONTRACTORS ASSOCIATED WITH THE SOLAR HEATING SYSTEM

SUBCONTRACTORS ASSICIATED WITH THE CONSTRUCTION OF THE SOLAR HEATING SYSTEM

1. Solar	Solaron, Inc. 300 Galleria Tower 720 South Colorado Boulevard Denver, Colorado 80222
2. General	Modern Metals, Inc. P.O. Box 711 Muscatine, Iowa 52761
3. Structural Erection	Quality Builders Route 4 Box 120 Muscatine, Iowa 52761
5. Concrete	Franz Construction Company P.O. Box 209 Iowa City, Iowa 52240
6. Electrical	P and S Electric 1029 Hershey Avenue Muscatine, Iowa 52761
7. Sensor Installation	Titronics, Inc. P.O. Box 2202 Iowa City, Iowa 52240

APPENDIX H

ACCEPTANCE TEST OF THE SOLAR HEATING SYSTEM

SOLARON CORPORATION
Solar Energy Systems

SCATTERGOOD SCHOOL ACCEPTANCE TEST PLAN

A visual inspection shall be made to assure ducting functionally conforms to the plans. Manual dampers D-1 and D-3 shall be closed and D-2 open. Space thermostat heat anticipators shall be set with first stage at 0.10 amp and second stage at 0.10 amp. Set thermostat so there is no call for heat. "Summer-Winter" switch on control panel shall be placed in the "Winter" position. System power shall be turned on. If solar energy is sufficient to activate the Δ T controller the AHU fan and water pump will start and run in the storing heat mode. (If solar energy is not available disconnect Tco lead to simulate). Static pressure and temperature shall be measured in the collector inlet and outlet ducts and at the heat storage inlet and outlet ducts. The collector Δ P will be used to estimate the flow and the fan speed will be adjusted accordingly if required. Fan motor amperage shall be measured.

The space thermostat shall be set to make the first stage of heating. This will reposition the dampers shifting the solar heated air into the building space. Static pressures, temperatures and amperage shall be measured in this mode.

Jumpering Tco terminals (or opening Tci) will simulate no solar energy available at the collector. The system will then go into the heat from storage mode. Static pressures, temperatures and amperage will be recorded. Adjusting the set point of Ts upward to the air temperature out of storage will simulate the storage temperature dropping to the normal set point of 90^{o} F. When Ts switches the solar AHU will stop and the unit heaters will start and maintain the set point of the first stage of the thermostat. Ts shall then be reset down to place system back in the heating from storage mode. Increasing the set point of the space

space thermostat to make the second stage of heating simulates a further drop in space temperature indicating the heat taken from storage is insufficient to offset the building heat loss. This will shut down the solar AHU and start the unit heaters. Jumper shall be removed from Tco.

"Summer" operation for preheating water shall be tested by removing manual damper D-3 and installing D-2 to by-pass the heat storage unit and placing the "Summer-Winter" switch in the "Summer" position. Static pressures, air temperatures and amperage shall be recorded. The aquastat, Tw, shall be reset down so that the set point is below the water temperature (if water temperature is below the minimum set point a lead can be disconnected). This will simulate the water temperature rising to the set point and will stop the pump and AHU fan.

V. ACCEPTANCE TEST PLAN DATA SHEET FOR SCATTERGOOD SCHOOL

I. Visual Inspection

A. Ductwork configuration **OK**

B. Placement of dampers **OK**

C. Other **OK**

II. Winter--storing heat mode

	collector inlet	collector outlet	heat storage inlet	heat storage outlet
Static pressure	-0.12" W.C.	-0.40"	+0.38" W.C.	+0.01"
	ΔP = 0.28" W.C.		Δ P = 0.37" W.C.	
Temperature	--	--	--	--

Calculated air flow (showing calculations) **Air flow was measured in store-heat-from-collector mode, Air flow in other modes was calculated from data obtained in this mode. See attached sheets.**

Fan motor amperage **12.6 amps**

Synchronous operation of AHU and water pump? **yes**

III. Winter--heating from collector mode

	collector inlet	collector outlet
Static pressure	-0.20" W.C.	-0.52" W.C.
	Δ P = 0.30" W.C.	
Temperature	--	--

Calculated air flow **4870 cfm**

Fan Motor amperage **12.5 amps**

Synchronous operation of AHU and water pump? **yes**

IV. Winter--heating from storage mode

	heat storage inlet	heat storage outlet
Static pressure	-0.13" W.C.	-0.68" W.C.
	Δ P =.55" W.C.	
Temperature	--	--

ACCEPTANCE TEST PLAN DATA SHEET (Cont.)

IV. Winter--heating from storage mode (cont.)

	heat storage inlet	heat storage outlet
Calculated air flow	5500 cfm	
Fan motor amerage	14.1 amps	
Water pump off when AHU on?	yes	

V. Summer mode

	collector inlet	collector outlet
Static pressure	-0.06" W.C.	-0.37" W.C. $\Delta P = 0.31"$
Temperature	--	--
Calculated air flow	4780 cfm	
Fan Motor amerage	12.4 amps	
Synchronous operation of AHU and water pump?	yes	
AHU and pump on when aquastat setting above water temperature?	yes	
AHU and pump off when aquastat setting below water temperature?	yes	

VI. Unit heater operation mode

Heaters on when Ts raised to air temperature out of storage? Wiring to unit heaters not mompleted. Control circuits functioning properly.
Heaters on when building thremostat raised?

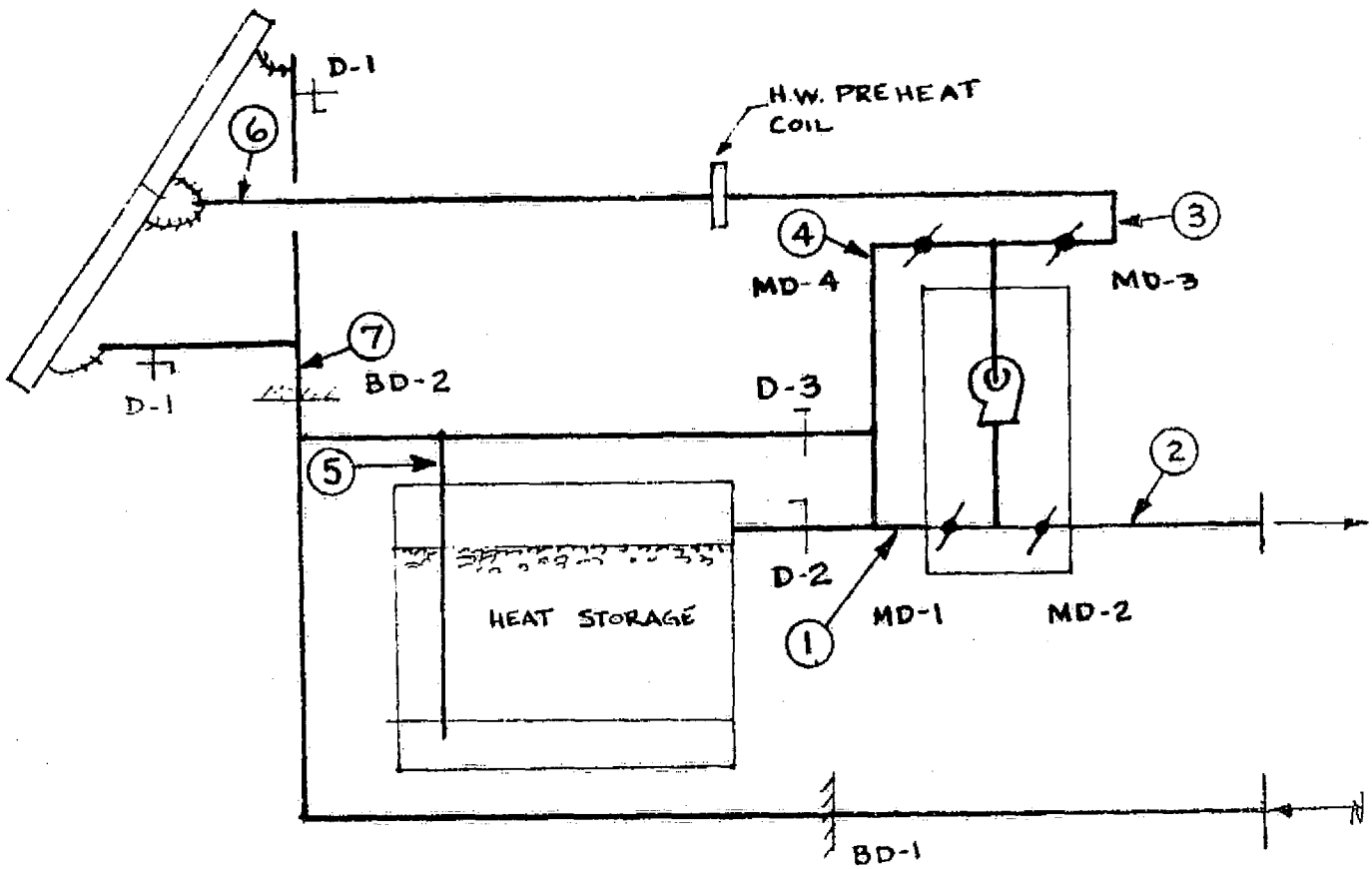
Water pump and AHU off when heaters on? yes

VII. Miscellaneous observations A time delay relay has been provided to prevent the system from short-cycling in summer water heating mode. The sequence of operation and wiring diagram have been revised to show this.

VIII. Statement of acceptability of system

See attached copies of "items to be corrected" dated 20 May and 14 June, 1977.

SCATTERGOOD SCHOOL
EQUIPMENT DATA

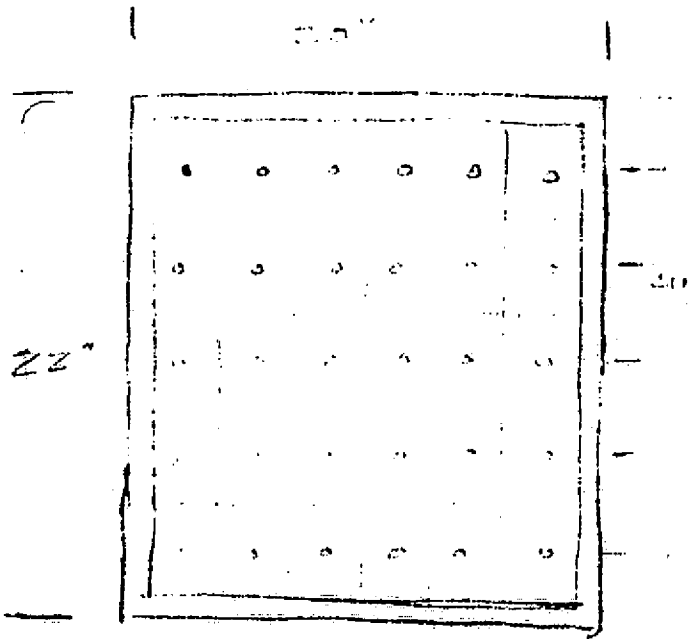


AHU MOTOR DATA: MAKE: DAYTON MODEL 5K9676G FRAME L184T HP 3
VOLTAGE 115/208-230 AMPS 30/15.7 PHASE 1 SERVICE FACT. 1.0
RPM 1740 SHEAVE 2VP56 X 1⅛"

FAN DATA: MAKE: DAYTON MODEL 3C048
RPM 1410 SHEAVE 2BK70H, H X 1 3/16 BELTS 2-4L51

MOTOR AMPERES AND STATIC PRESSURE ("W.C.) FOR VARIOUS MODES

	SUMMER OPER. (W. ER HEATING)	STORING HEAT	HEATING FROM COLLECTOR	HEATING FROM STORAGE
AMPS	12.4	12.6	12.5	14.1
STATIC PRESS. POINT ①	+.15"	+.38"	-.09"	-.68"
②	-.01"	-.02"	+.38"	+.40"
③	-.63"	-.65"	-.76"	-.06"
④	+.17"	+.49"	-.08"	-.85"
⑤	+.15"	+.01"	-.09"	-.13"
⑥	-.37"	-.40"	-.52"	-.06"
⑦	-.06"	-.12"	-.20"	-.06"



22" × 20" OD ⇒ 20" × 18" ID

$\frac{20}{5}$ · 1" $\frac{18}{6}$ · 3"

4"/2 = 2+1 · 3", 7", 11", 15", 19"
3/2 = 1½+1 · 2½", 5½", 8½, 11½, 14"

VELOCITY MEASURED AT 30" UP AT CENTER OF 4" × 3" SEGMENTS IN EAST AND WEST BRANCHES OF COLLECTOR OUTLET DUCT. SYSTEM IN STORING HEAT MO

VELOCITIES READ WITH SIERRA INSTRUMENTS MODEL 441 AIR VELOCITY METER.

WEST BRANCH

690	800	870	860	870
830	850	900	950	970
860	870	920	950	950
830	910	920	960	1050
780	850	930	900	1030
700	[illegible]	830	850	1000

TEMP 90°F

AVG FPM · 893 × 2.5 FT² = 2208 C

EAST BRANCH

780	720	780	950	980
830	790	820	780	1040
880	820	870	980	1110
910	830	930	1080	1120
920	870	930	1040	1080
970	890	910	790	950

TEMP 90°F

AVG FPM 920 × 2.5 FT² 2302 CFM

4510 CFM

AIR FLOW CALCULATIONS

MEASURED AIR FLOW IN STORING HEAT MODE 4510 CFM
COLLECTOR $\Delta P = 0.28$" w.c., STORAGE $\Delta P = 0.37$" w.c.

USING THE FOLLOWING RELATIONSHIPS OF FLOW RATES AND STATIC PRESSURE DROPS THE FLOW RATES FOR OTHER MODES ARE OBTAINED:

COLLECTORS:

$$\frac{\Delta P_2}{\Delta P_1} = \left(\frac{CFM_2}{CFM_1}\right)^{1.75}$$

STORAGE

$$\frac{\Delta P_2}{\Delta P_1} = \left(\frac{CFM_2}{CFM_1}\right)^{2}$$

HEATING FROM STORAGE:

$$\frac{.37"}{.55"} = \left(\frac{4510}{CFM}\right)^2$$

$$\sqrt{.6727} = \frac{4510}{CFM}$$

$$.82\,CFM = 4510$$

$$CFM = 5500$$

HEATING FROM COLLECTOR:

$$\frac{.28}{.32} = \left(\frac{4510}{CFM}\right)^{1.75}$$

$$\sqrt[1.75]{.875} = \frac{4510}{CFM}$$

$$.9265\,CFM = 4510$$

$$CFM = 4870$$

SUMMER WATER HEATING:

$$\frac{.28}{.31} = \left(\frac{4510}{CFM}\right)^{1.75}$$

$$\sqrt[1.75]{.9032} = \frac{4510}{CFM}$$

$$.9435\,CFM = 4510$$

$$CFM = 4780$$

SOLARON
SOLAR ENERGY SYSTEMS
Profit from the sun
T.M.

LETTER OF TRANSMITTAL

Date: 20 MAY 1977

To: CONRAD HEINS

Page: ____ of ____

Re: ITEMS TO BE CORRECTED Proj. No. ____

Forwarded Herewith: ☐ Technical Data ☐ Plans ☐ Specifications ☐ Other

Purpose: ☐ For Your Info. ☐ As Requested ☐ For Review & Comment ☑ For Your Action

Remarks:

1) MANUAL DAMPER D-3 MUST BE RELOCATED ← DONE
2) DUCT JOINTS AND COLLARS INTO COLLECTORS & DUCTS NEED SEALING ← DONE
3) GYM SHOULD HAVE DOUBLE DEFLECTION REGISTERS TO INDUCE AIR FLOW. DONE
4) TINNERMAN NUTS NOT INSTALLED ON UNDERSIDE OF COLLECTORS
5) IT APPEARS THAT NO SEALANT WAS USED BETWEEN CAPSTRIP AND FLASHING, SEE GENERAL NOTE "G" ON PLANS DONE
6) SUCCESSIVE CAPSTRIP SCREWS ARE NOT SECURED PROPERLY
7) SCRATCHES IN CAPSTRIP NEED TO BE SANDED AND TOUCHED UP TO STOP RUSTING.
8) REVISE WATER PIPING PER SKETCH ← DONE

Copy to: ____

Signed: [signature]

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SOLARON CORPORATION 300 GALLERIA TOWER 720 SO. COLORADO BLVD. DENVER, COLO. 80022
PHONE: (303)759-0101

SOLARON
SOLAR ENERGY SYSTEMS
Profit from the sun ™

LETTER OF TRANSMITTAL

Date: 6-14-77

To: C ONRAD HEINS

Page: ____ of ____

Re: ITEMS TO BE CORRECTED Proj. No. ____

Forwarded Herewith: ☐ Technical Data ☐ Plans ☐ Specifications ☐ Other

Purpose: ☐ For Your Info. ☐ As Requested ☐ For Review & Comment ☐ For Your Action

Remarks:
1. REPLACE DISCONNECT BOX WITH PROPERLY SIZED BOX DONE
2. SEAL LEAKS IN TOP OF ROCK BOX
3. SEAL LEAK AROUND DAMPER SHAFTS DONE
4. " GAT IN DUCT DOWNSTREAM OF FILTERS DONE
5. COMPLETE ITEMS ON LIST DATED 20 MAY 1977
6. ~~RETURN EXTRA DAMPER T'STAT & PULL-UP TOOL~~
7. COMPLETE CONTROL WIRING CONNECTION TO UNIT HEATERS DONE

Copy to: ____

Signed: [signature]

SOLARON CORPORATION 300 GALLERIA TOWER 720 SO. COLORADO BLVD. DENVER, COLO. 80022
PHONE: (303)759-0101

APPENDIX I

REPORT ON GRAIN DRYING MODIFICATION TO SCATTERGOOD SCHOOL SOLAR HEATING SYSTEM

REPORT ON THE GRAIN DRYING MODIFICATIONS TO THE SCATTERGOOD SCHOOL SOLAR HEATING SYSTEM

Introduction

In the summer of 1977, Scattergood School was invited to participate in a research project on solar grain drying directed by Dr. Carl Bern, a professor in the Department of Agricultural Engineering at Iowa State University. The project would involve adapting the recently completed solar heating system, built as part of the National Solar Heating and Cooling Demonstration Program and used to heat the school's gymnasium, so that hot air from the collector could be directed into a 6,000-bushel grain drying silo. Air temperatures and the moisture content of the grain, in this case, corn, would be monitored. The necessary changes to the existing system would be relatively minor and would not affect its primary operation.

Industry was interested in the experiment. The Butler Manufacturing Company, a leading manufacturer of grain storage and drying apparatus, was willing to furnish the school a new, 6,000-bushel Stir-Ator™ grain-drying silo at a considerable reduction in cost. Scattergood felt the opportunity was attractive, and requested permission of their Contracting Officer's Representative (COR) to make the required modifications. The COR supported the school's request, and permission was granted under the following conditions.

1. The grain drying system be operated only when the gymnasium and the rock storage system do not require heat.

2. Ambient air rather than air from the gymnasium comprise the cold air intake during grain drying operations.

3. Three government-furnished sensors to monitor inlet temperature, outlet temperature and volume of air flow during grain drying operations be installed in the new ductwork and connected to the existing Site Data Acqisition Subsystem.

4. The grain drying project have no cost impact on the main project.

The school agreed to these conditions, and the grain drying system was constructed during October, 1977.

Description of the System

The grain drying system consists of a 6,000-bushel Butler Stir-Ator™ grain drying silo equipped with an air heater and an air handling unit. Air is drawn into the bottom of the silo by a 5 hp fan with a capacity of about 8,000 cfm. A propane heater, positioned immediately after the fan, provides additional heat when needed. Air from the solar collector enters a short distance from the fan intake. The 5-inch gap between the end of the solar ductwork and the fan housing permits additional, ambient air to be introduced. The silo is located about 35 feet west of the gymnasium.

The following modifications were made to the existing solar heating system.

1. A 2-ft diameter duct was connected to the hot air ductwork leading to the gymnasium at the place where the duct makes a 90° bend from horizontal to vertical and ascends t enter the gymnasium. Two new slide-gate dampers were introduced, one in the new duct close to the point of attachmen and the other in the gymnasium duct about one foot above t e elbow.

2. The new hot air duct was extended through the west wall of the "A-frame" (the enclosure formed by the collector and the south wall of the gymnasium) and further extended to the grain drying silo. The duct was wrapped with fiberglass insulation for its entire length and, where outside, wrapped with a double layer of 6-mil polyethylene film.

3. A 2-ft diameter air return duct was connected to the existing ductwork where the top and bottom cold air return ducts coming from the gymnasium join. Three additional slide-gate dampers were introduced--one in the new duct close to the point of attachment and the other two in the upper and lower gymnasium air return ducts near where they join.

4. The new air return duct was extended through the west wall of the A-frame and projects out about 4 inches. It is positioned directly below the hot air duct.

The opening in the west wall of the A-frame around the ducts was closed with a piece of exterior siding; small cracks were sealed with fiberglass. Covers for both ducts were made. they are in place whenever the grain drying system is not in operation.

A schematic diagram of the system, with alterations marked in red, is shown on the next page.

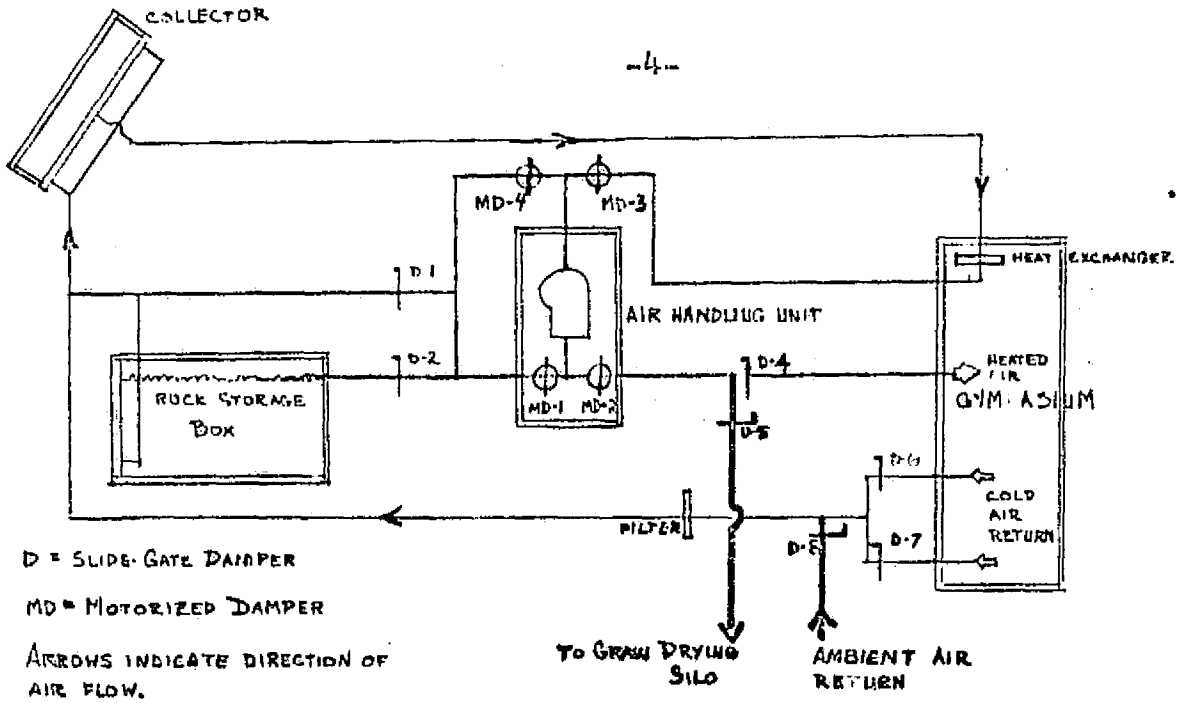


Figure 1. Schematic Diagram of the Altered Solar Heating System

Operation of the Grain Drying System in 1977

The solar grain dryer saw only limited used during 1977. Tabulated below are the times the system was in operation.

Date	Fan On	Fan off	Time in Use (hr)
October 28	1:50 pm	2:40 pm	0.83
November 11	11:45 am	12:50 "	1.08
" 13	1:00 pm	4:30 "	3.50
" 14	10:00 am	5:10 "	7.17
" 17	12:45 pm	5:00 "	5.25
" 18	10:30 am	4:00 "	5.50
" 21	1:30 pm	2:30 "	1.00

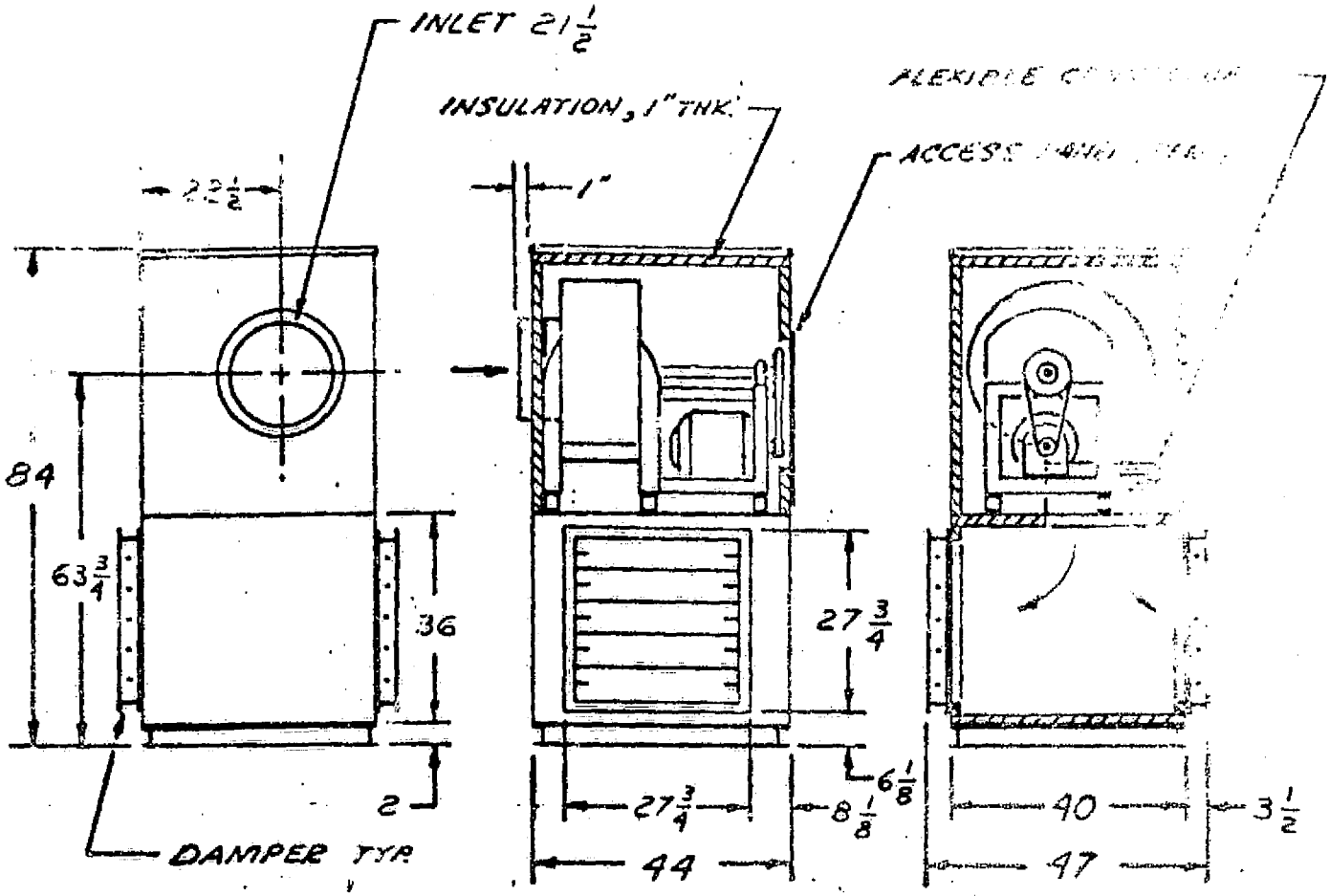
The moisture content of the corn was reduced from about 19.2 to 18% during this time. No supplementary heat was used. On December 22 the corn was frozen by blowing through cold, ambient air. In this condition the grain should keep until

Spring. At that time we plan to use the collector to complete the drying process, lowering the moisture content of the corn to about 14 %. We anticipate that by this date the flow and temperature sensors will be installed so that we can measure accurately the total solar energy used.

APPENDIX J

PRODUCT LITERATURE FOR COMPONENTS OF THE SOLAR HEATING SYSTEM

Because the information originally included on pages J-1, J-2, J-3, and J-4 is copyrighted (1976), these pages are deleted from this document. For Solar Collector information, contact the Solaron Corporation, 4850 Olive Street, Commerce City, Colorado, 80022, or phone 303/289-5971. The reference is to the Air Type Solar Collector, series 2000.



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EST. WT. 673

	FAN	MOTOR
Job Name: SCATTERGOOD SCHOOL	Fan Size: 20"	HP: 3
Job No.:	Class: 1	RPM: 1725
Address: WEST BRANCH, IOWA	CFM: 5000	Volts: 230/460
Engineer:	SP: 1.8	Cycle: 60 HZ
Contractor:	Air Density: .075	Phase: 1
Rep:	RPM: 1350	Mfg:
Tag:	BHP: 2.59	

TEMPMASTER

5000 CFM SOLAR FURNACE

DWN BY: LGH
DATE: 12-XX-

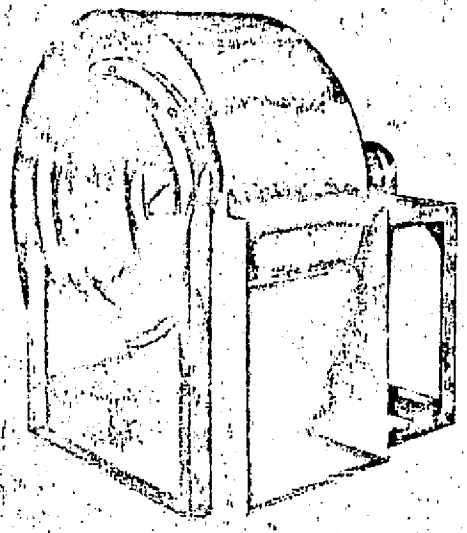
1

90

BELT-DRIVE UTILITY BLOWERS

Deliver up to 26,000 CFM. AMCA Class I Construction
12¼ to 36½" Backward Incline Wheels, Non-Overloading
12¼ to 24½" Forward Curve Wheels, Extra Quiet

BULLETIN
703
JUNE 1976



Dayton non-overloading, heavy-duty, belt-drive blowers are widely used for heating, ventilating, kitchen exhaust and similar systems that require up to 26,000 CFM. Built for efficient, continuous duty. Performance charts on following pages.

Forward-curve wheel blowers are widely used for air conditioning, ventilating, processing, drying and similar systems that require up to 12,420 CFM. Quiet, efficient, and economical. Performance chart on page 4. All Dayton blowers are available from local dealer and distributor stocks.

All blowers listed in this bulletin are designed to meet Class I construction specifications as designated by AMCA. Operation beyond the performance ratings given requires a blower of Class II construction or higher.

DAYTON BLOWER FEATURES

EFFICIENT, LOW-NOISE OPERATION. Both types of wheels used on these blowers have die-formed steel blades. Wheels are dynamically balanced and factory tested in assembled blowers to assure perfect balance. Drive shaft operates in rubber mounted bearings. V-belt drive is practically soundless. Air deliveries are based on standard test codes of AMCA.

INLETS. Non-overloading blowers have a deep-spun steel venturi inlet that overlaps wheel. Forward-curve blowers have a rigidly-formed steel inlet. Both assure streamlined, efficient air flow into wheel.

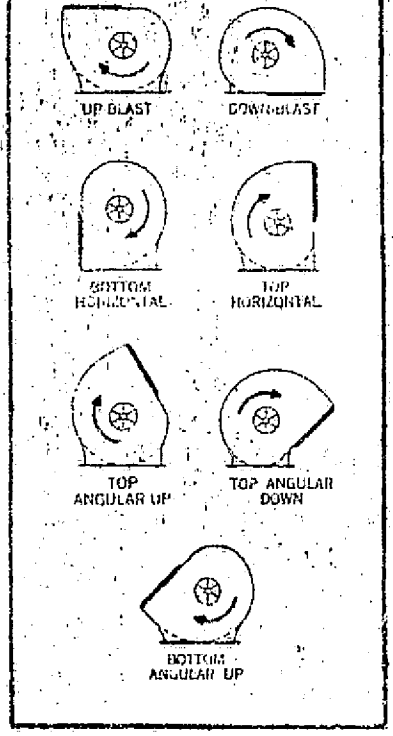
ADJUSTABLE DISCHARGE. Discharge can be changed in the field to any of seven optional directions shown in illustration at left. Blowers are shipped set for CW rotation, bottom horizontal discharge.

LONG-LIFE BEARINGS. Ground and polished drive shaft operates in two self-aligning, pre-lubricated and sealed ball bearings on rubber mounted pillow blocks.

MOTOR MOUNT has pivot base that permits easy motor installation and belt adjustment. Base has slotted holes to facilitate mounting NEMA frame motors. Blowers are shipped less motor and drive.

RIGID CONSTRUCTION. Sturdy, heavy-gauge arc-welded steel housing and frame with angle-braced sides and drive supports. Surfaces are pre-treated against rust and corrosion and finished in baked-on gray enamel.

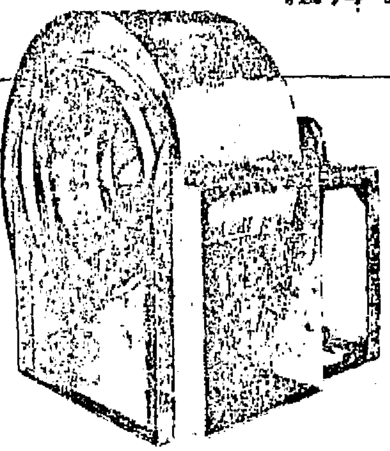
ADJUSTABLE BLOWER DISCHARGE POSITIONS



J-6

12¼ to 24½" NON-OVERLOADING BLOWERS

Flat-Blade, Backward-Incline Wheel

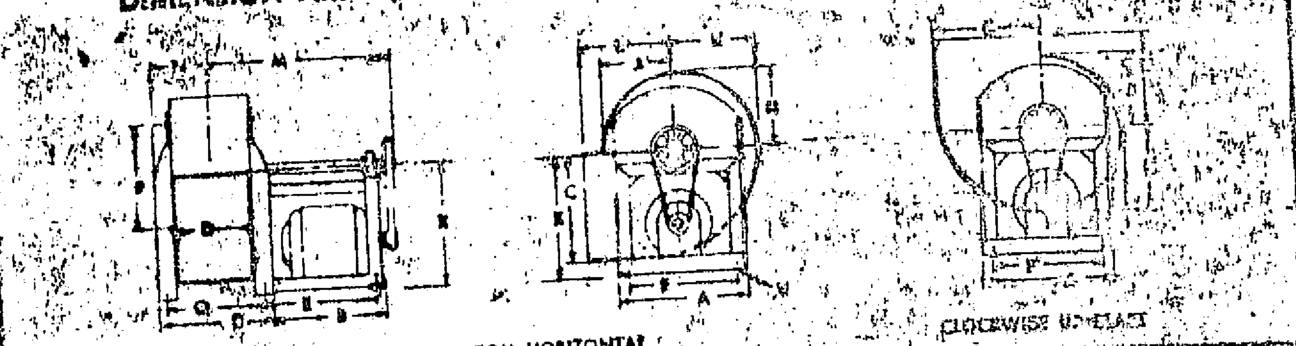


Features flat-blade, backward-incline wheel that delivers up to 10,380 CFM. Wheel operates with deep venturi cone that matches blower inlet contour. Designed for low to medium static pressure heating, ventilating, kitchen exhaust and similar systems with high efficiency and low noise level. Motor can not be overloaded at a given RPM and horsepower, regardless of amount of static pressure applied to the system. Has all the built-in, quality features specified on page one. Shipped less motor, pulleys and belts. Optional matching weather covers listed on following page.

MODEL	Volume	Outlet Vel.	1/4" SP		1/2" SP		3/4" SP		1" SP		1¼" SP		1½" SP		2" SP		2½" SP	
	CFM	FPM	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP	RPM	BHP
	858	1000	961	.08	1123	.12	1268	.17	1409	.22	1558	.28	1698	.35				
No. 4C333	1020	1200	1087	.11	1233	.15	1365	.22	1486	.27	1599	.31	1722	.40	[illegible]	.56	[illegible]	.73
12¼" Dia. Wheel	1115	1300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.47	[illegible]	.58	[illegible]	[illegible]
Tip Speed =	1201	1400	1222	.16	1351	.21	1471	.27	1583	.34	1695	.40	1767	[illegible]	1940	.62	[illegible]	[illegible]
3.207xRPM	1287	1500	1290	.18	1412	.24	1528	.31	1635	.38	1736	.44	1834	.51	[illegible]	.66	[illegible]	[illegible]
	1459	1700	1429	.24	1539	.32	1645	.39	1745	.46	1838	.54	1932	.61	2103	.77	[illegible]	[illegible]
Outlet 0.858 sq. ft.	1630	1900	1571	.32	1672	.40	1768	.48	1861	.56	1949	.64	2035	.73	2197	.89	2342	1.07
	1716	2000	1643	.37	1741	.45	1832	.53	1922	.62	2007	.70	2090	.79	2246	.96	2397	1.15
Inlet 0.921 sq. ft.	1888	2200	1788	.48	1878	.56	1962	.65	2046	.75	2126	.88	2204	.93	2351	1.12		
	2059	2400	1934	.60	2017	.70	2097	.79	2174	.89	2251	.99	2323	1.09	2464	1.30		
	2231	2600	2079	.74	2159	.86	2235	.95	1307	1.06	2378	1.16	2446	1.27				
	2402	2800	2225	.91	2303	1.03	2375	1.14	2444	1.26								
	1024	800	654	.07	826	.13	980	.20	1119	.28								
No. 3C073	1280	1000	739	.10	879	.16	1016	.24	1142	.32	1261	.41	1372	.51				
15" Dia. Wheel	1536	1200	834	.14	951	.21	1070	.29	1184	.39	1293	.49	1396	[illegible]	1535	[illegible]	[illegible]	[illegible]
Tip Speed =	1792	1400	936	.20	1036	.28	1138	.36	1239	.46	1339	.57	1434	.68	[illegible]	.91	1782	[illegible]
3.93xRPM	2048	1600	1041	.27	1132	.36	1220	.45	1308	.55	1396	.66	1485	.78	1592	1.03	1810	[illegible]
	2304	1800	1148	.36	1232	.46	1310	.56	1388	.66	1467	.78	1545	.90	[illegible]	1.16	[illegible]	[illegible]
Outlet 1.28 sq. ft.	2560	2000	1256	.48	1334	.58	1406	.69	1478	.80	1546	.92	1617	1.04	1755	[illegible]	[illegible]	[illegible]
	2816	2200	1365	.62	1439	.72	1506	.84	[illegible]	.96	1633	1.09	1698	1.21	[illegible]	1.50	1956	[illegible]
Inlet 1.37 sq. ft.	3072	2400	1476	.77	1545	.89	1609	1.02	[illegible]	1.15	1727	1.28	1786	1.42	[illegible]	1.71	[illegible]	[illegible]
	3328	2600	1598	.95	1652	1.09	1713	1.23	1768	1.36	1824	1.50	1879	1.65	[illegible]	1.95		
	3584	2800	1701	1.16	1761	1.31	1818	1.46	1872	1.61	1924	1.76	1975	1.91				
	3840	3000	1813	1.40	1871	1.56	1924	1.72	1977	1.89	2026	2.04						
	1520	800	544	.10	622	.19	808	.29	926	.40								
No. 3C074	1900	1000	613	.15	732	.25	840	.35	941	.47	1040	.61	1134	.75				
18¼" Dia. Wheel	2280	1200	691	.22	792	.33	889	.41	980	.57	1066	.70	1159	.85	1310	1.18	1464	[illegible]
Tip Speed =	2660	1400	774	.31	862	.43	948	.55	1030	.69	1109	.83	1184	.98	1329	1.32	1469	[illegible]
4.78xRPM	3040	1600	859	.42	938	.55	1014	.69	1089	.84	1162	.99	1232	1.15	1365	1.50	1491	[illegible]
	3420	1800	946	.56	1019	.70	1088	.86	1155	1.02	1221	1.19	1286	1.36	1410	1.73	[illegible]	[illegible]
Outlet 1.90 sq. ft.	3800	2000	1034	.72	1107	.89	1165	1.05	1226	1.23	1287	1.41	1346	1.59	1462	1.98	[illegible]	[illegible]
	4180	2200	1123	.92	1187	1.11	1246	1.28	1302	1.48	1358	1.67	1412	1.86	1521	2.28	[illegible]	[illegible]
Inlet 2.02 sq. ft.	4560	2400	1218	1.16	1274	1.36	1330	1.56	1382	1.76	1432	1.96	1484	2.17	1585	2.62		
	4940	2600	1304	1.44	1361	1.65	1475	1.87	1464	2.08	1510	2.29	1559	2.52	1653	3.00		
	5320	2800	1396	1.76	1449	1.99	1500	2.22	1547	2.45	1592	2.68	1636	2.92				
	5700	3000	1487	2.12	1538	2.37	1586	2.52	1631	2.87								
	1858	800	500	.13	626	.23	740	.35	845	.49								
No. 3C048	2320	1000	565	.19	671	.30	770	.43	863	.58	952	.74	1036	.91				
22" Dia. Wheel	2780	1200	638	.27	728	.40	815	.54	898	.69	972	.86	1054	1.04	1200	1.44	1336	1.68
Tip Speed =	3250	1400	715	.38	795	.53	871	.68	945	.84	1017	1.02	1086	1.21	1219	1.52	[illegible]	2.08
5.24xRPM	3710	1600	794	.52	867	.68	934	.85	1001	1.03	1066	1.22	1129	1.41	1251	1.84	[illegible]	2.31
	4170	1800	874	.69	942	.88	1003	1.06	1063	1.25	1123	1.45	1180	1.66	1293	2.11	1402	
Outlet 2.22 sq. ft.	4640	2000	957	.90	1019	1.11	1076	1.31	1131	1.52	1185	1.73	1238	1.95	1342	2.62	1442	[illegible]
	5100	2200	1040	1.15	1098	1.38	1151	1.60	1202	1.83	1251	2.05	1300	2.29	1397	2.73	1500	[illegible]
Inlet 2.44 sq. ft.	5560	2400	1123	1.45	1178	1.70	1229	1.94	1277	2.19	1322	2.43	1367	2.68	1457	3.21	1544	3.75
	6030	2600	1207	1.80	1259	2.07	1308	2.33	1353	2.60	1396	2.86	1438	3.13	1521	3.62		
	6490	2800	1292	2.20	1341	2.49	1387	2.78	1430	3.06	1472	3.35	1511	3.63				
	6950	3000	1377	2.66	1424	2.97	1467	3.28	1503	3.58								
	2770	800	[illegible]	.18	507	[illegible]	603	.50	690	[illegible]								
No. 3C049	3460	1000	461	.26	543	.42	624	.61	703	.83	775	1.05	845	1.30				
24½" Dia. Wheel	4150	1200	522	.37	592	.55	660	.75	728	.98	794	1.23	858	1.49	970	2.05	1089	2.65
Tip Speed =	4840	1400	585	.51	648	.72	707	.94	765	1.18	824	1.44	881	1.71	932	2.32	1096	2.97
6.41xRPM	5530	1600	651	.69	708	.93	761	1.17	813	1.43	864	1.69	915	1.99	1015	2.61	1112	3.30
	6230	1800	717	.91	770	1.18	819	1.45	865	1.73	911	2.01	956	2.31	1047	2.96	1136	3.67
Outlet 3.46 sq. ft.	6920	2000	786	1.19	834	1.48	879	1.78	922	2.08	964	2.39	1005	2.70	1093	3.37	1163	4.11
	7610	2200	855	1.52	899	1.84	941	2.16	982	2.40	1021	2.83	1055	3.16	1137	3.85	1207	4.57
Inlet 3.65 sq. ft.	8300	2400	925	1.90	966	2.25	1006	2.68	1043	2.96	1080	3.32	1115	3.63	1198	4.42		
	8990	2600	995	2.36	1033	2.73	1071	3.11	1106	3.49	1141	3.83	1174	4.27	1233	5.00		
	9680	2800	1066	2.87	1101	3.27	1137	3.69	1170	4.10	1203	4.51	1235	4.93				
	10380	3000	1136	3.47	1170	3.89	1204	4.34	[illegible]	4.78								

Data underlined indicates quietest and most efficient blower performance. Performance ratings shown above are based on standard test code of AMCA.

DIMENSION PRINTS, NON-OVERLOADING & FORWARD CURVE BLOWERS



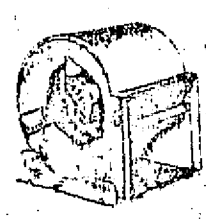
CLOCKWISE BOTTOM HORIZONTAL

CLOCKWISE UPBLAST

DIMENSIONS FOR NON-OVERLOADING & FORWARD CURVE BLOWERS

Model No.	Ref. Page	Wheel Dia.	Shaft Dia.	A	B	C	D	E	F	H	J	K	L	M	N	P	Q	R	V	X	Ship. Wt.
4C?93	2	12¼	1	16⅞	13½	13¼	9⅝	13½	14¾	10⅛	8½	11½	10½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17	[illegible]
[illegible]	2	15	1	19¼	15⅛	16¼	11¾	15½	17⅞	12⅝	10⅝	14⅞	12¾	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	2	18¼	1³⁄₁₆	23⅛	17	19⅝	14¼	17½	21⅛	15	12⅝	17⅞	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3C0?9	2	20	1³⁄₁₆	25	17	21½	15⅞	17	23⅜	16⅞	13⅞	18⅞	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	350
[illegible]	2	24½	1⁷⁄₁₆	30⅛	16½	26¼	19¼	16¼	23⅜	20⅛	16⅝	23	[illegible]	[illegible]	12⅞	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	3	27	1⁷⁄₁₆	33	16½	29	21¼	16½	[illegible]	22½	18½	25¼	21½	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3C110	3	30	1¹¹⁄₁₆	36¼	16½	32¼	23⅜	16½	29¼	24⅝	20½	28¼	23¾	35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	660
3C111	3	36½	1¹⁵⁄₁₆	43¼	21⅜	39⅛	28⅝	21⅜	36⅝	30	24⅞	31⅝	28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	840
[illegible]	4	12¼	1	16⅝	13½	13¼	9⅝	13½	14¾	10⅛	8¼	11½	10¾	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17	[illegible]
2C703	4	15	1	19¼	15⅛	16¼	11¾	15½	17⅞	12⅝	10⅝	14⅞	12¾	[illegible]	7½	[illegible]	[illegible]	[illegible]	[illegible]	17⅝	120
2C739	4	18¼	1³⁄₁₆	23⅛	17	19⅝	14¼	17½	21½	15	12⅝	17⅞	[illegible]	30⅞	9⅛	[illegible]	[illegible]	[illegible]	[illegible]	21⅞	160
3C009	4	22¼	1³⁄₁₆	27⅛	16½	24	17⅞	17	25¼	18⅛	15¼	20⅞	[illegible]	32½	11½	[illegible]	[illegible]	[illegible]	[illegible]	26⅛	200
3C010	4	24½	1⁷⁄₁₆	30⅛	16½	26¼	19¼	16¼	23⅜	20⅛	16⅞	23	[illegible]	33⅞	12¼	[illegible]	[illegible]	[illegible]	[illegible]	27½	375

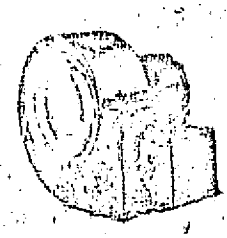
OTHER *Dayton* BLOWERS



UNIVERSAL-MOUNT BLOWERS
BELT & DIRECT DRIVE
Request Bulletin 701

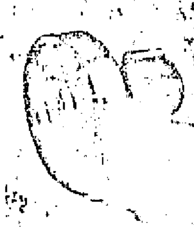
HIGH-CAPACITY BLOWERS
Request Bulletin 701

SINGLE-INLET DUCT BLOWERS
Request Bulletin 70?

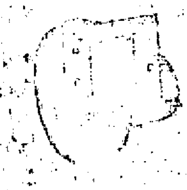


HIGH VOL. & PRESSURE BLOWERS
Request Bulletin 706

SELF-CLEANING BLOWERS
Request Bulletin 708



HIGH-PRESSURE BLOWERS
Request Bulletin 700



SHADED POLE BLOWERS
Request Bulletin 705

Honeywell

M436 AND M836 ARE SPRING RETURN DAMPER MOTORS FOR RESIDENTIAL AND LIGHT COMMERCIAL APPLICATIONS IN SERIES 40 AND SERIES 80 CIRCUITS.

- Motors provide 2-position zone control.
- Used to operate outdoor air dampers for combustion or makeup air, changeover dampers for heating and cooling systems, minimum position dampers for ventilation and similar applications.
- Damper motors have an internal spdt switch for controlling auxiliary equipment, additional motors, or to provide a burner interlock switch.
- M436 models require 120 or 240V, 60 Hz supply; M836 models are for 24V, 60 Hz supply.
- Case and cover on all models.
- Spring returns the motor to the start position in case of power interruption or failure.
- Hexagonal output shafts on both ends of the motor with rotational direction stamped on the motor case.
- M436A and M836A are equipped with a thermal breaker for overload protection during the lifting stroke or if the motor becomes stalled.
- M836A with bracket, Part No. 128499, directly replaces the M87A Damper Motor.

H.A.
REV.10-75(.025)

DAMPER MOTORS

M436A
M836A,B

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 AVAILABLE:
M436A Damper Motor—120 or 240V, 60 Hz.
M836A,B Damper Motors--24V, 60 Hz.

ACCESSORIES INCLUDED: Mounting brackets, Part Nos. 126809, 128336, and 128499, and bag assembly containing the drive bushings, adapter, and coupling necessary for direct drive applications and the crank arm lever and clamp necessary for crank arm drive applications.

ADDITIONAL FEATURES: Tradeline pack with cross reference label and [illegible]ction sheet.

STANDARD MODELS

MODELS (also refer to Table I):

M436A Damper Motor—120 or 240V ac, spring return motor for use with 2-wire thermostats or other spst controllers. Includes internal adjustable spdt switch for controlling auxiliary equipment.

M836A Damper Motor—24V ac, spring return motor for use with spst controllers without heat anticipation. Includes internal adjustable spdt switch for controlling auxiliary equipment.

M836B Damper Motor—24V ac, spring return motor for use with spst controllers. If circuit has thermostat heat anticipation, the anticipator should be set at 0.75 amp. Includes internal adjustable spdt switch for controlling auxiliary equipmen..

AMBIENT TEMPERATURE RATING: 32 to 125 F [0 to 52 C].

FINISH: Gray.

DIMENSIONS: See Fig. 1.

UNDERWRITERS LABORATORIES INC. LISTED (M436A, M836A): File No. E4436, Guide No. XAPX.

AUXILIARY SWITCH RATINGS (in amperes):

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

Pilot duty: 40 VA at 120 or 240V ac.

AUXILIARY SWITCH ACTION: Spdt—normally open (R-B) contacts close during the power stroke and open during the return stroke. May be adjusted to operate at any point between 5 and 70 degrees of motor stroke.

ANGULAR STROKE: 75 degrees.

WEIGHT: 4 lb., 10 oz. [2.1 kg].

OPTIONAL SPECIFICATIONS:

1. M436A with crank arm.

2. 50 Hz M436A Damper Motors for international applications. Models for 220 or 240V ac, with 50 sec opening stroke, 25 sec closing stroke. Includes ground and cover screws and 7640JL Bag Assembly.

3. 50 Hz M836A Damper Motor for international applications. Model is for 24V ac, with 50 sec opening stroke, 25 sec closing stroke. Includes ground and cover screws and 7640JL Bag Assembly.

(continued on page 3)

ORDERING INFORMATION

WHEN ORDERING REFER TO THE TRADELINE CATALOG OR PRICE SHEETS, PUBLICATION NUMBER, OR . . .

SPECIFY—
1. MODEL NUMBER; SPECIFY TRADELINE MODEL, IF DESIRED.
2. VOLTAGE AND FREQUENCY.
3. OPTIONAL SPECIFICATIONS, IF DESIRED.
4. ACCESSORIES, IF DESIRED.

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

TABLE I

MODEL NUMBER	VOLTAGE (60 HZ)	NOMINAL CURRENT (AMP)		NOMINAL POWER (WATT)		MAXIMUM LOAD TORQUE (LB.-IN.)	BREAKAWAY TORQUE[a] (LB.-IN.)	OPENING TIME[b]	CLOSING TIME[b]	DAMPER BLADE AREA
		OPENING	HOLDING	OPENING	HOLDING					
M436A	120	0.37	0.12	27.0	8.5	20	30	30 sec (nominal)	25 sec (nominal)	13 sq ft
	240	0.19	0.06	27.0	8.5					
M836A	24	1.85	0.6	27.0	8.5	20	30	30 sec (nominal)	25 sec (nominal)	13 sq ft
M836B	24	1.34	0.73	20.3	11.2	15	30	25 sec (nominal)	25 sec (nominal)	10 sq ft

[a]Breakaway torque is available to overcome an occasionally frozen or seized damper or valve. THE MOTOR MUST NOT BE USED CONTINUOUSLY AT THIS RATING.

[b]40 sec maximum.

ACCESSORIES:

1. 16254AC Bag Assembly--mounting bracket, Part No. 128499, and screws (see Figs. 2 and 6).
2. 7640JE Bag Assembly--drive bushings, adapter, and coupling for direct drive (Figs. 4 and 7).
3. 7640JL Bag Assembly--clamp and crank arm lever (for crank arm drive). Refer to Figs. 5 and 6.
4. 7640JM Bag Assembly--mounting bracket, Part No. 126809, and screws (Figs. 3, 4, and 7).
5. 7640JN Bag Assembly--mounting bracket, Part No. 128336, and screws (Figs. 2 and 6).
6. 4074BRU Bag Assembly--extension adapter and screws for mounting Q607 Auxiliary Switch to M436A Damper Motor.
7. Q298B Linkage--damper crank arms, bushings, 1/4 inch [6.5 mm] steel rod, and ball joint assemblies (Fig. 6).

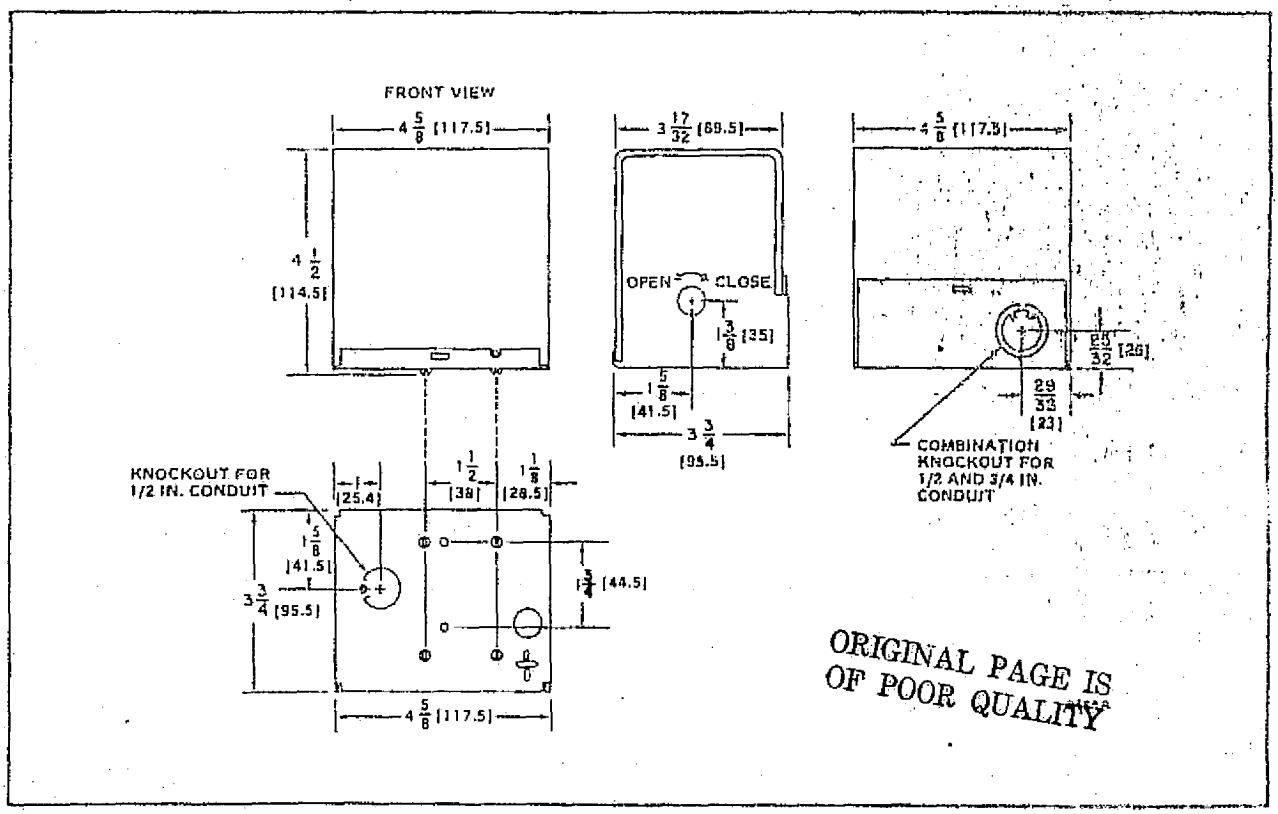


FIG. 1--DIMENSIONS OF M436 AND M836 DAMPER MOTORS, IN INCHES [MILLIMETERS SHOWN IN BRACKETS].

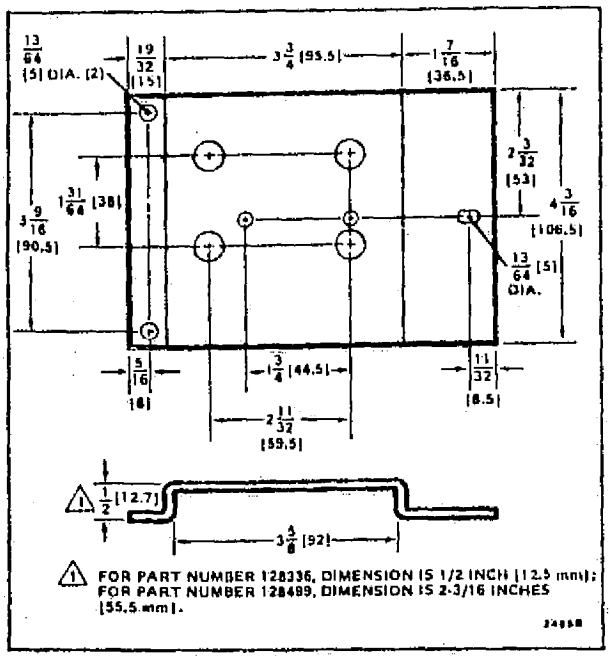


FIG. 2–DIMENSIONS OF 128336 AND 128499 BRACKETS, IN INCHES [MILLIMETERS SHOWN IN BRACKETS].

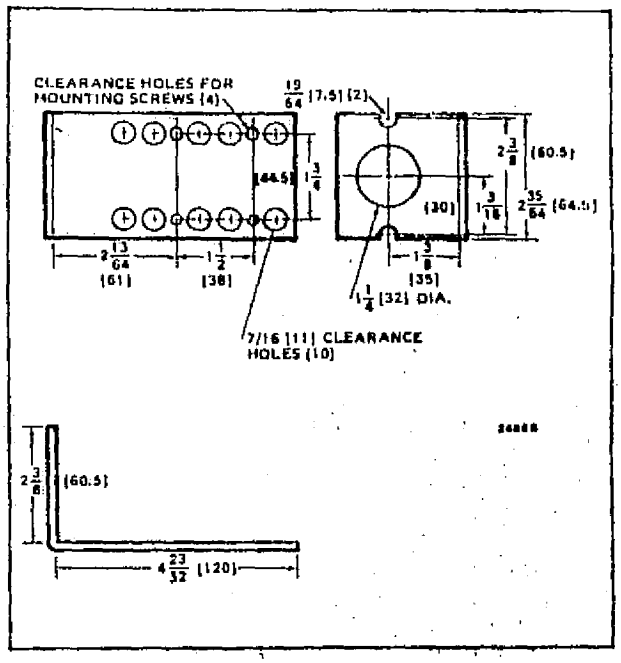


FIG. 3–DIMENSIONS OF 126809 BRACKET, IN INCHES [MILLIMETERS SHOWN IN BRACKETS].

INSTALLATION

CAUTION

Installer must be a trained, experienced service man.

Disconnect power supply before beginning installation.

Perform conduct a thorough checkout when installation is complete.

LOCATION AND MOUNTING

IMPORTANT

Mount M436 and M836 motors with shaft in horizontal position.

Locate as near as possible to the equipment to be controlled. Mounting brackets and bag assemblies for direct drive and crank arm drive are furnished with Tradeline models of these motors or may be ordered separately if required for the installation. Refer to the Accessories section for specifications, Figs. 2 and 3 for dimensions, and Figs. 4-7 for installation drawings.

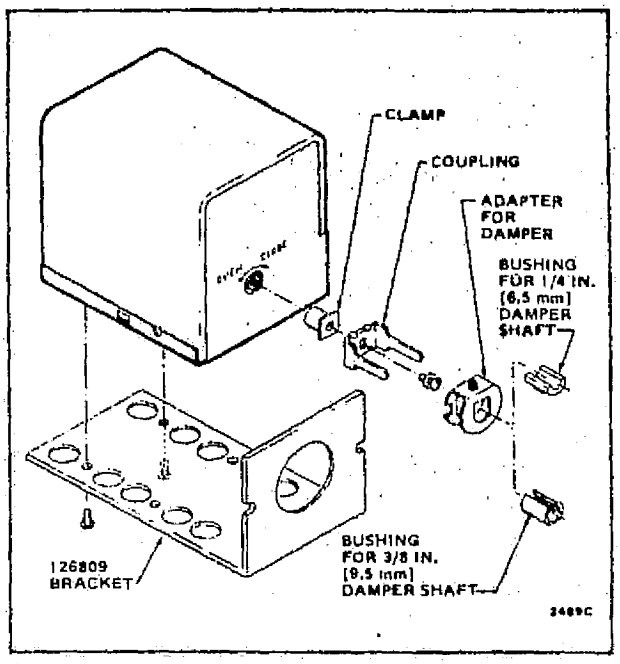


FIG. 4–EXPLODED VIEW SHOWING HOW TO MOUNT 7640JE DAMPER SHAFT COUPLING AND 7640JM MOUNTING BRACKET ASSEMBLY TO MOTOR.

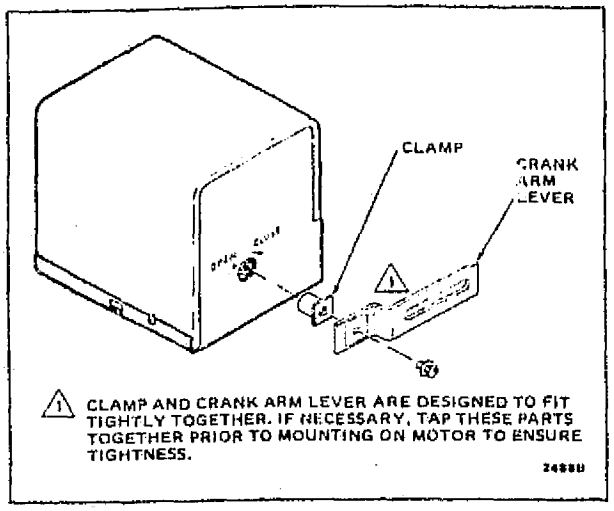


FIG. 5—EXPLODED VIEW SHOWING HOW TO MOUNT 7640JL CRANK ARM ASSEMBLY TO MOTOR.

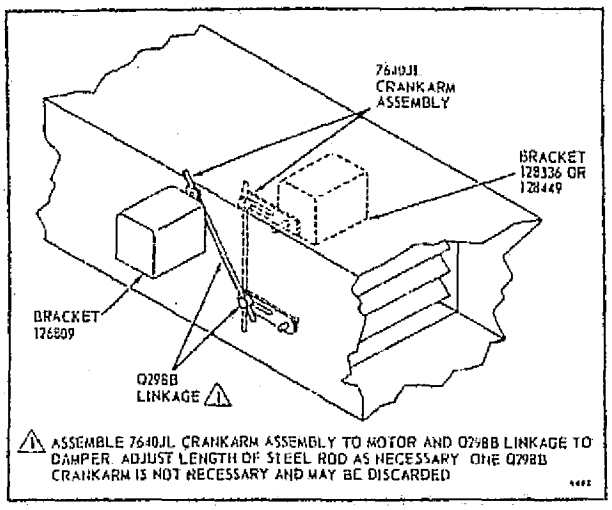


FIG. 6—OFFSET MOUNTING WITH 7640JL CRANK ARM ASSEMBLY AND Q298B LINKAGE.

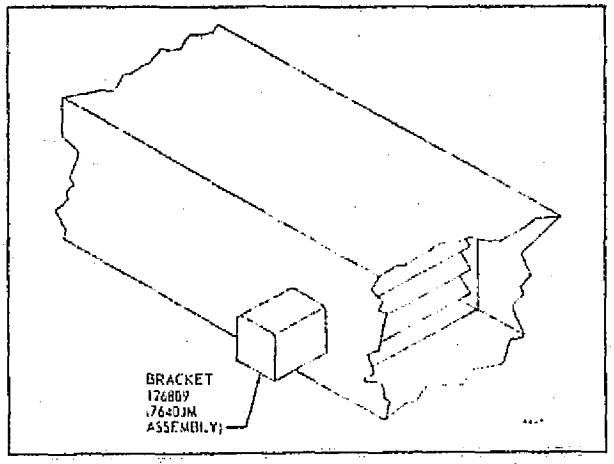


FIG. 7—DAMPER MOTOR DIRECTLY COUPLED TO DAMPER USING 7640JM MOUNTING BRACKET ASSEMBLY AND 7640JE DRIVE COUPLING ASSEMBLY.

WIRING

CAUTION!
Disconnect power supply before wiring to prevent electrical shock and equipment damage.

All wiring must comply with applicable local codes, ordinances, and regulations. Refer to Figs. 8 and 9 for typical hookup diagrams and to information furnished with the system equipment.

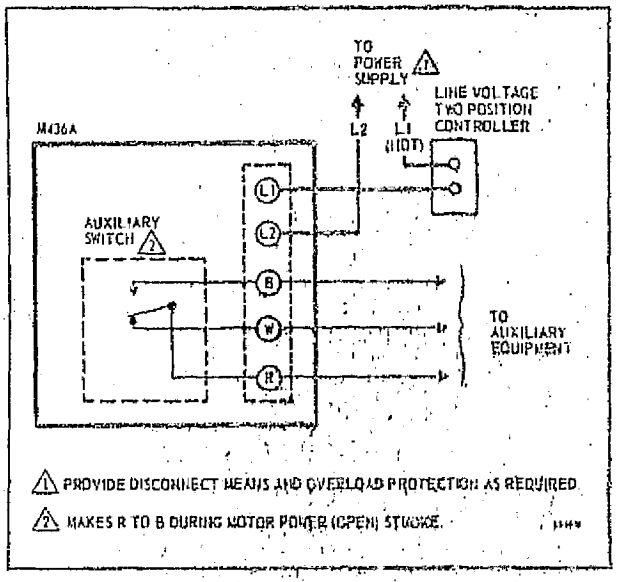


FIG. 8—TYPICAL HOOKUP OF M436 DAMPER MOTOR.

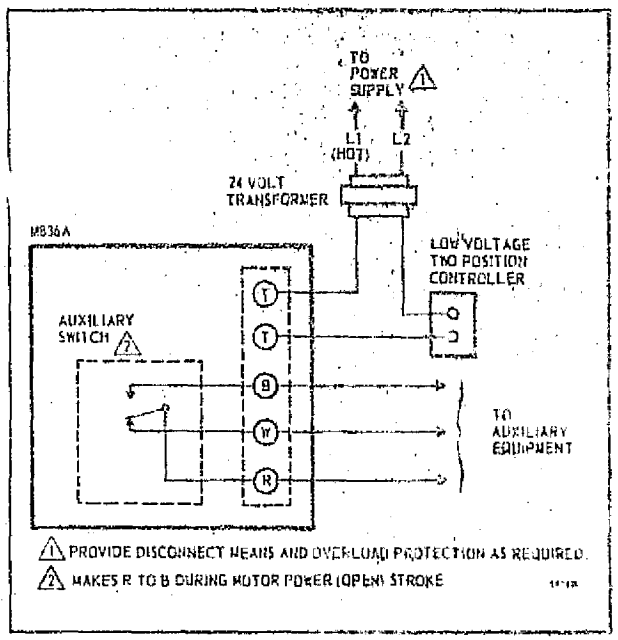


FIG. 9—TYPICAL HOOKUP OF M836 DAMPER MOTOR.

ADJUSTMENT AND CHECKOUT

AUXILIARY SWITCH ADJUSTMENT

The internal spdt auxiliary switch of the M436/M836 can be adjusted to operate at any point between 5 and 70 degrees of the motor stroke. It has a 1-2 degree nonadjustable differential. The switch makes R-B during the power stroke (motor shaft moves in direction of the OPEN arrow on outside of case).

Power the motor so it runs to the open position. Note the point of the motor stroke at which the switch operates (audible click, or check for continuity across R-B terminal). If switch operates correctly for the application, proceed to check out the installation. If the switch needs to be adjusted, proceed as follows.

1. Determine the number of degrees that the switch cam must be adjusted to operate switch at the desired point of motor stroke.

IMPORTANT

Switch should not be adjusted to operate closer than 5 degrees from ends of the motor stroke.

2. Remove motor cover.

CAUTION

Disconnect power supply while adjusting the switch cam.

3. Insert a screwdriver in a slot in the switch cam (white plastic) located near the center of the motor. Refer to the cutaway view, Fig. 10. Each slot in the cam equals approximately 20 degrees of motor rotation.

4. Select a reference point and move cam the correct number of degrees as follows.

   a. To adjust switch to operate nearer the open (maximum rotation) motor position, move cam in direction of the CLOSE arrow on outside of motor case.

   b. To adjust switch to operate nearer the closed motor position, move cam in direction of the OPEN arrow on outside of motor case.

Repower the motor and check point at which the switch makes and breaks. Readjust if necessary.

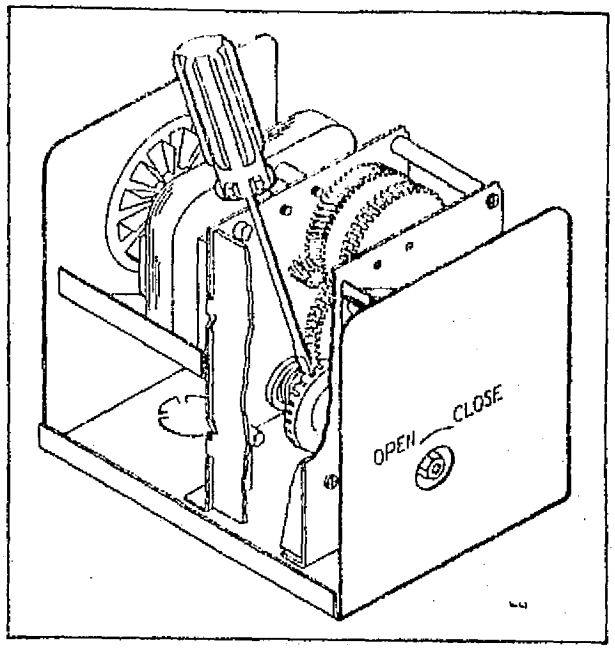


FIG. 10—USING SCREWDRIVER TO ADJUST AUXILIARY SWITCH CAM.

CHECKOUT

Operate the motor through its complete open-close stroke. Be prepared to release one of the previously tightened linkage connections, if necessary, to prevent damage. Check for proper operation, making sure that the linkage does not bind and that the motor travels smoothly through its fully open and closed positions. If there is excess length of linkage rod, cut it to size.

Make necessary minor adjustments until desired operation is obtained, and tighten all nuts and setscrews. A motor checkout should prove that:

1. The motor operates the load.
2. The motor responds properly to the controller.
3. There is no binding of the linkage or motor stalling at any point of travel.

If motor does not operate properly, check for proper voltage or mechanical binding in linkage or damper.

To insure long life, lubricate the felt pads located on each of the motor bearings and on the 2 shafts in the gear train annually. Use Anderol 465 or equivalent. DO NOT OVER LUBRICATE.

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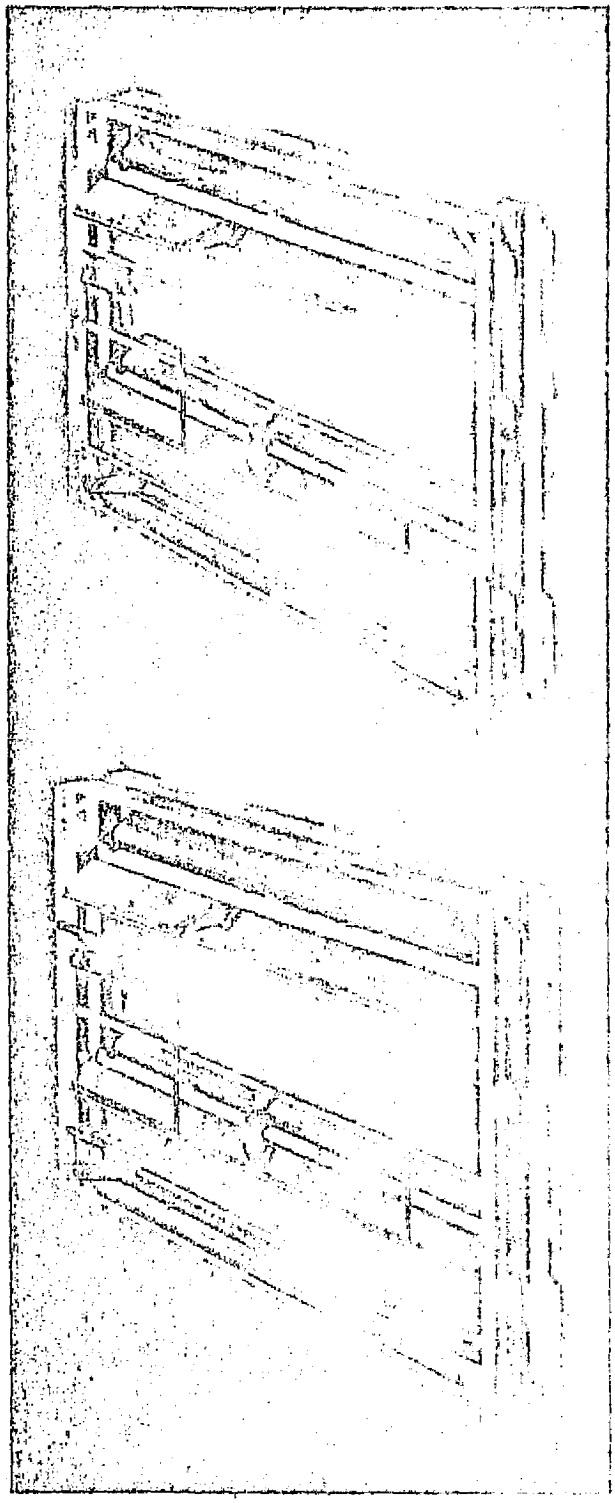
Honeywell

Moduflow*
Dampers

MODEL NUMBER D640-D645

The BTU Savers Keep Air Flow Under Control
Cut Heating/Cooling Energy Costs



Using louvered dampers to control air flow in a temperature control system is a concept as old as air conditioning itself. Honeywell's excellence in the field of temperature control continues with the high quality line of Moduflow dampers. The difference between Honeywell's modern, well engineered dampers and others in use today is as great as the difference between modern freon compressors and the early ammonia machines.

Moduflow dampers are designed with the needs of the final consumer in mind and engineered to meet the most demanding air flow control requirements. They are manufactured in a factory devoted entirely to damper production, utilizing the most modern metal fabrication machinery and processes.

Features

All Honeywell dampers are designed to provide economical air flow control, yet the D640 and D641 standard Honeywell dampers cut in half the amount of leakage allowed by an ordinary damper. When even more stringent requirements are demanded the D642 through D645 low leakage Moduflow dampers cut leakage to one half of one percent of the rated flow. With these features Honeywell dampers can keep costly heating and cooling energy from escaping through intake, exhaust, or hot/cold deck dampers.

*Trademark
Rev. 4-76
M.J.C.

Form Number 77-5929

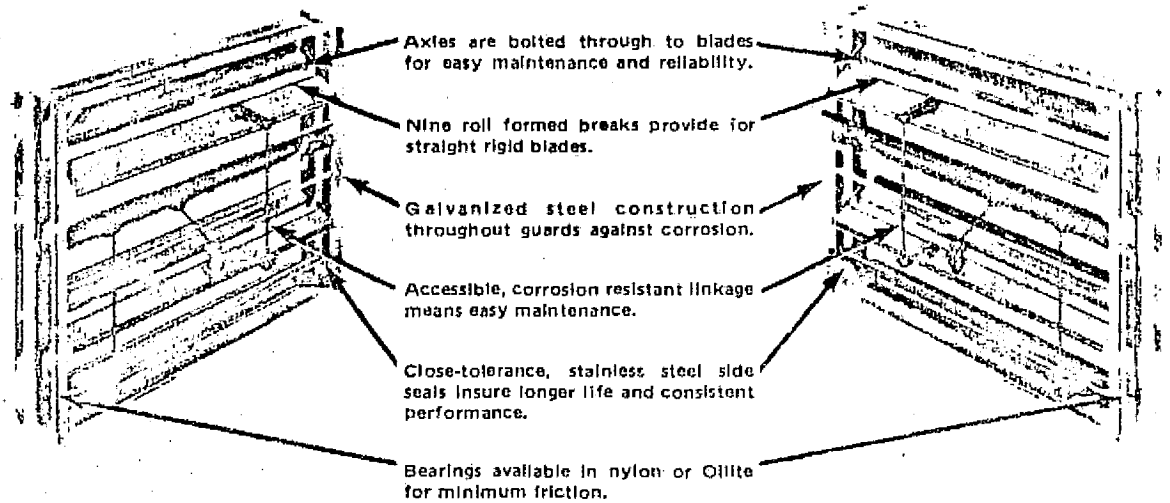
Moduflow* Dampers

Honeywell

Honeywell dampers provide two levels of performance in the area of pressure, velocity, and leakage. The D640 parallel blade and D641 opposed blade standard Honeywell dampers meet most application requirements in these areas. However, the D642 and D643 low-leakage Moduflow dampers are available as explained in the following text.

Low leakage Moduflow dampers allow for ultra-low leakage while providing high velocity characteristics for both high and low pressure applications. These dampers utilize many parts common to the standard dampers but important differences in construction give them characteristics needed to meet the most demanding requirements. These dampers are available as the D642 and D644 parallel blade dampers, or the D643 and D645 opposed blade dampers. The D644 and D645 are especially useful in smoke damper applications.

Honeywell's Moduflow dampers have taken their place alongside the thermostat, control valve, and other precision control devices that go into making up a complete automatic control system. These dampers are designed for vertical or horizontal mounting with precise air flow control and superior construction as prime criteria.



D641: OPPOSED BLADE MODUFLOW DAMPER ILLUSTRATED. D640: PARALLEL BLADE MODUFLOW DAMPER ALSO AVAILABLE.

D643 & D645: OPPOSED BLADE INFLATABLE SEAL MODUFLOW DAMPERS ILLUSTRATED. D642 & D644: PARALLEL BLADE INFLATABLE SEAL DAMPERS ALSO AVAILABLE.

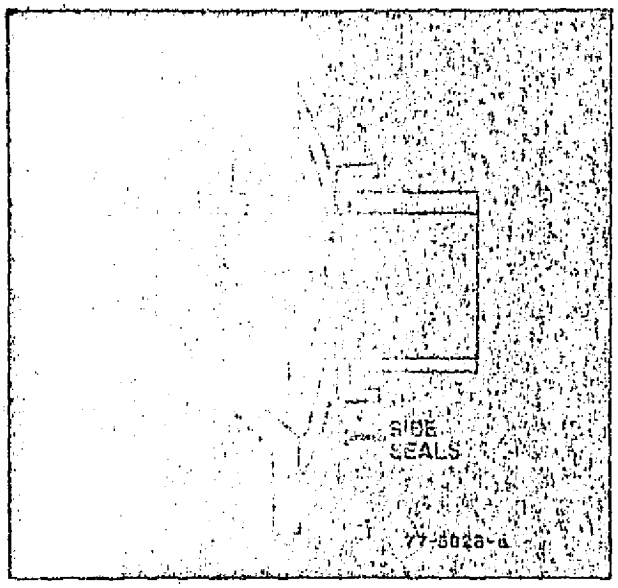


Fig. 1—Continuous Spring Stainless Steel Side Seals Cut Leakage to a Minimum, Promote Longer Seal Life, and Consistent Performance.

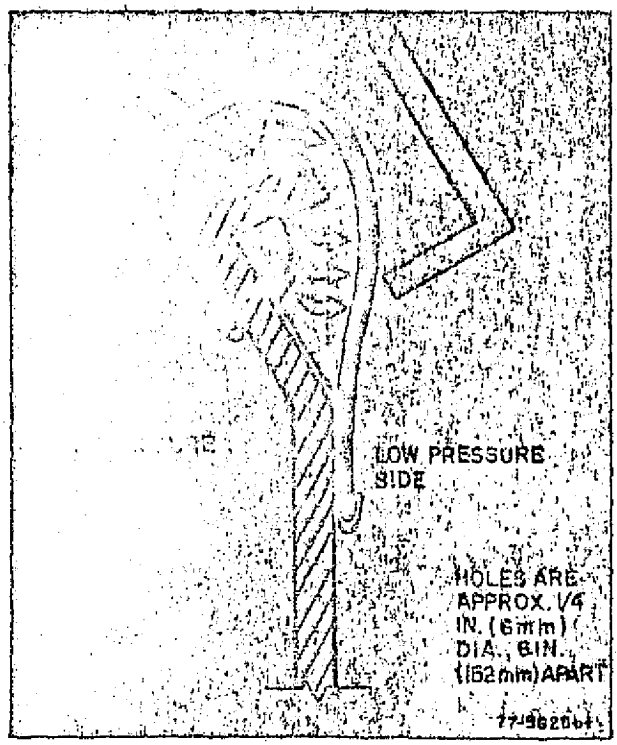


Fig. 2—Inflatable Seals Give Maximum Seal Off at High Pressures.

Specifications

Honeywell dampers include the following high quality construction features:

SIZES

Dampers range from 8 in. (203mm) horizontal and vertical to 48 in. (1219mm). Size increases in two-inch (51mm) increments. Requirements of more than 48 inches (1219mm) are made up of conventional dampers connected as multisection units either vertically or horizontally with easy to install hardware. NOTE: Minimum size for opposed blade dampers is 14 in. x 14 in. (356mm x 356mm).

FRAME

Horizontal members are roll formed .094 in. [(2.4mm) approx. 13 gauge] galvanized steel channel with "triple U" cross section for extra frame stiffness. Vertical frame members are roll formed .094 in. (2.4mm) galvanized steel, extra deep for frame strength (see Fig. 3).

BLADES

All but the 12-in. (305mm) dampers use 6- or 8-inch (152 or 203mm) blades or a combination of both. A single 10-in. (254mm) blade is used on 12-inch (305mm) dampers. Blades are roll formed .062 in. [(1.6mm) approx. 16 gauge] steel for blade rigidity.

The drive blade on D640/D641 dampers with a horizontal dimension of 36 inches (914mm) or larger is reinforced with a .062-in. (1.6mm) stiffener plate. Inflatable seal dampers 30 inches (762mm) and larger have all blades reinforced.

BLADE SEALS

Blade ends are sealed with tight-clearance, spring stainless steel continuous seal strips. On standard Moduflow dampers the mating edges of blades meet with interlocking formed steel edges. Closed cell neoprene foam edging [3/16 x 1/2 in. (5 x 13mm)] is optional for mating edges. On low leakage dampers inflatable seal blade edges are expandable fabric-reinforced neoprene rubber to insure minimum leakage (see Fig. 2).

HARDWARE

Linkage bracket and linkage connecting rods [5/16 in. (8mm dia.)] are zinc plated steel. All trunnion rods are brass. Set screws and mounting bolts are zinc plated. Bearings are nylon (standard) with Oilite bearings optional.

SPECIAL MODELS

D644 and D645 high temperature dampers are available for high temperature applications such as smoke dampers. They are constructed and have characteristics similar to D642/D643 low leakage inflatable seal dampers but have higher temperature ratings.

AXLES

All axles are 1/2 in. (13mm) diameter zinc plated steel. Axles are fastened to the blades with through-bolts. Drive blades on all dampers have adjustable axles that can extend to 4 inches (102mm) beyond the frame.

FINISH

Galvanized steel frame and blades.

OPERATOR MOUNTING

Mounting lugs are furnished for internally mounted pneumatic or electric operators. Drive blades feature extendable axles for external operator mounting.

TEMPERATURE RANGES

D640-D643; -40 to 200F (-40 to 93C).
D644 & D645; -40 to 400F (-40 to 202C).

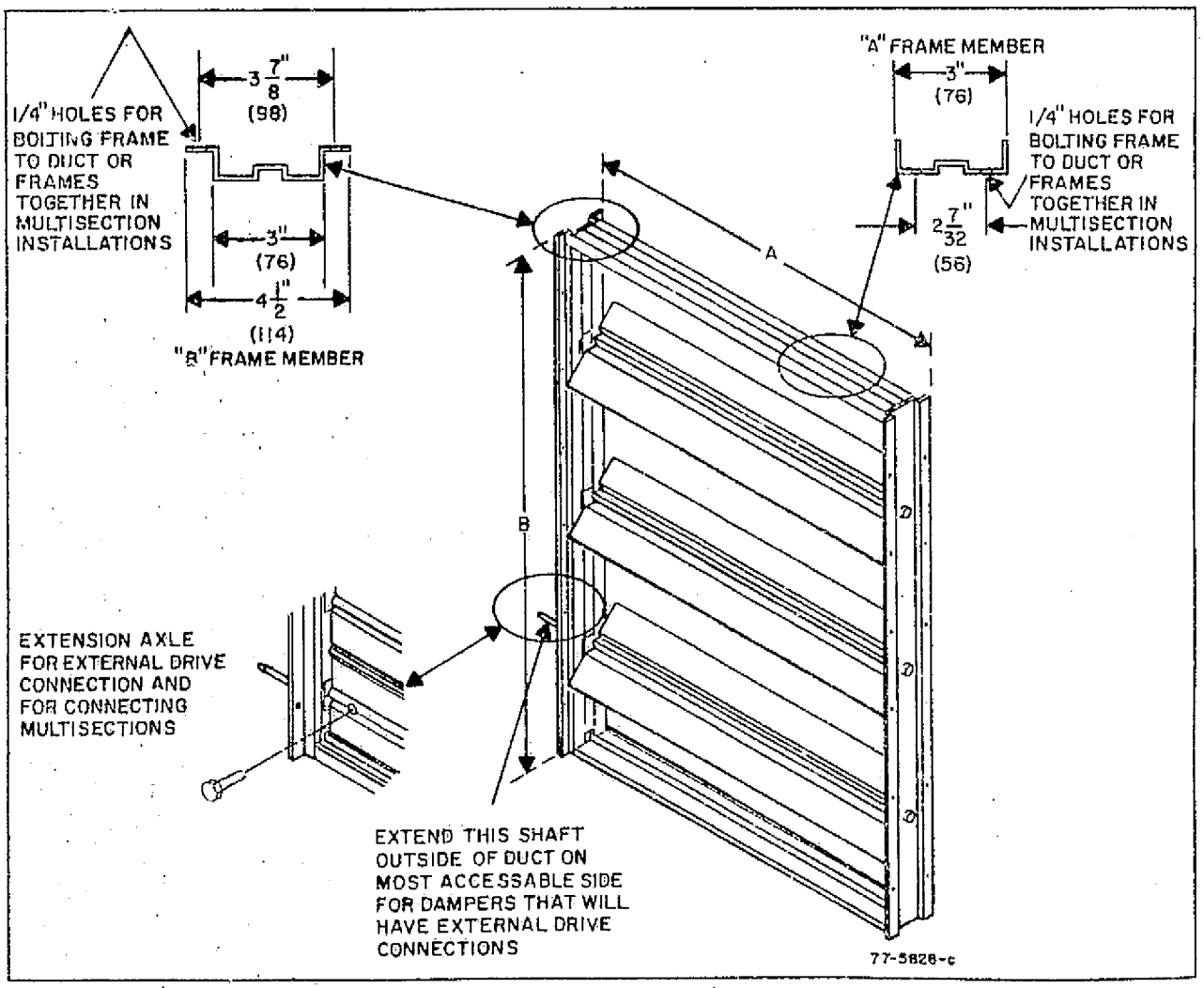


Fig. 3—Frame Member Cross Section Construction and Dimensions in Inches (Millimeters).

MAXIMUM PRESSURE DIFFERENTIAL

D640/D641 - 3 in. wc (76mm).
D642-D645 - 6 in. wc (152mm).

MAXIMUM APPROACH VELOCITY (Non-Turbulent)

D640/D641 - 1500 fpm (7.7 m/s).
D642-D645 - 4000 fpm (20 m/s).

VERTICAL BLADE CONSTRUCTION

All models of Moduflow dampers are available with special construction features for mounting with the blades in the vertical position. A slight increase in leakage can be expected.

ROLL FORMED FRAMES AND BLADES

These dampers are constructed of high quality material and are manufactured with automated roll forming and automatic welding machines. This increases the consistency in quality and guarantees completely uniform dampers. The consistence in dimensions, square frames, and close tolerances is especially important for multisection damper construction.

MULTISECTION DAMPERS

Individual Honeywell Moduflow dampers are constructed in "nominal" sizes ranging up to 48 inches (1219mm) on either measurement, in two-inch (51mm) increments. For applications requiring dampers larger than 48 inches (1219mm) dampers are supplied as multisection units (see Fig. 4). Figures 4a and 4b show typical vertical and horizontal expansion of two-section dampers.

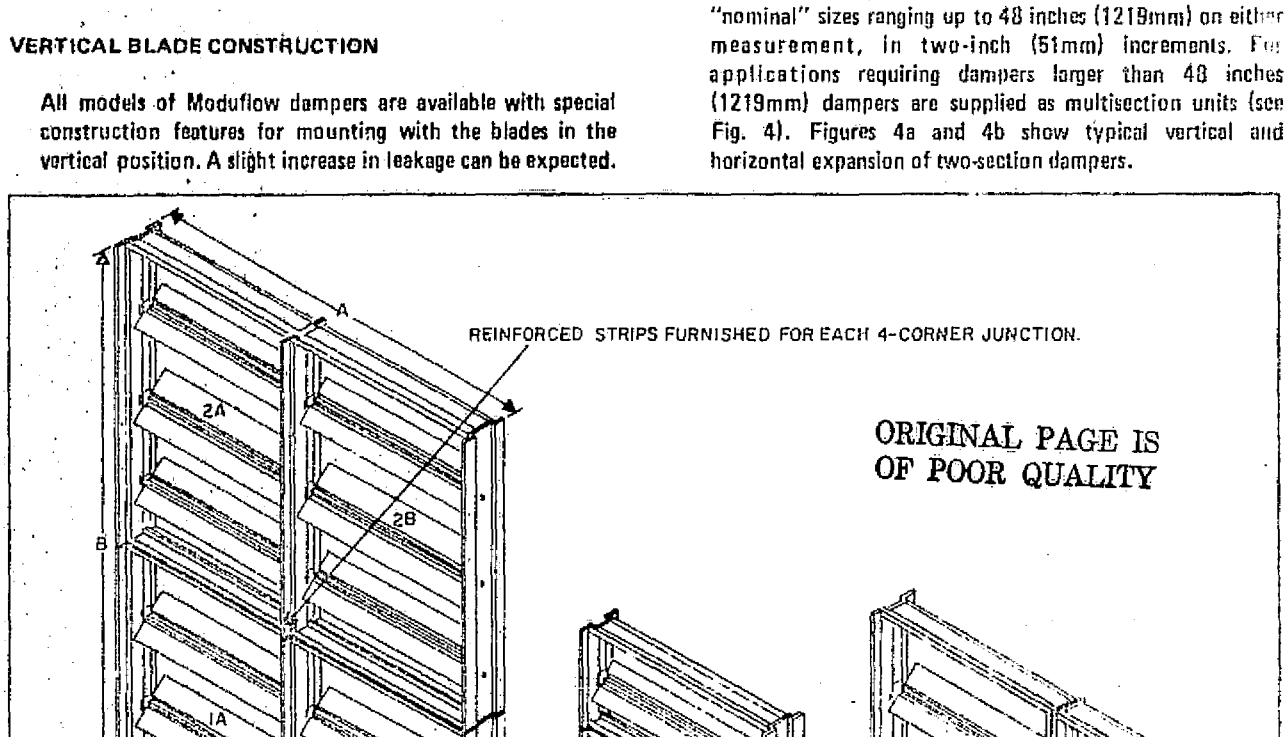


Fig. 4—Multisection Damper Construction (Horizontal Blade).

Fig. 4a—Vertical Expansion. Fig. 4b—Horizontal Expansion.

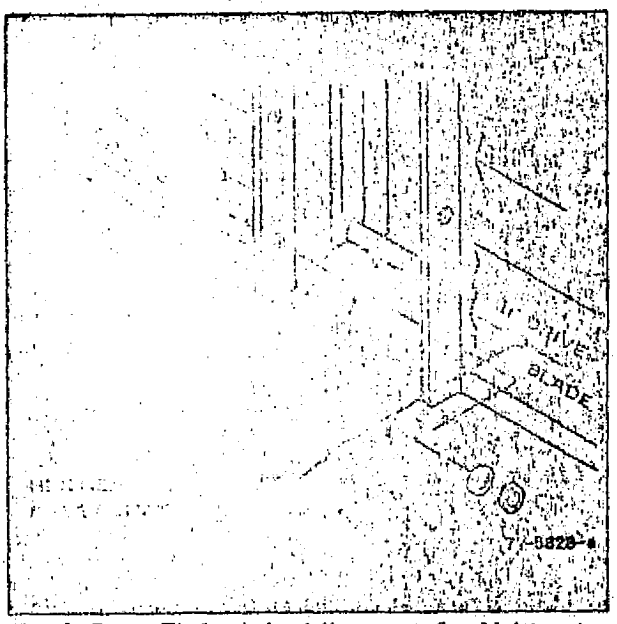


Fig. 5—Drive Blade Axle Adjustment for Multisection Installation.

Multisection damper construction is made easy because the flange and bolt hole arrangement on Honeywell dampers is such that they lend themselves to quick, easy alignment. Figure 4 is a typical four-section damper, constructed from four equal size damper sections.

Damper blade motion is transmitted from one horizontal section to another by use of interconnected drive axles (see Fig. 5). Blade motion is transmitted vertically through the use of interconnected drive linkages (see Fig. 6).

Honeywell's dampers are designed to minimize installation effort and save time. The frame and blade construction provides maximum squareness and rigidity (see Fig. 3). The flanged "B" frame members make bolting multisection dampers together easier. They also provide a convenient means for duct mounting.

Moduflow dampers are packaged in 10 mil, polyethylene, shrink pack with linkage and corner protectors to prevent damage during storage and handling. In the case of multisection damper installations the SECTION ASSEMBLY KEY (Fig. 7) is visible without opening the package until it is time to install that damper section.

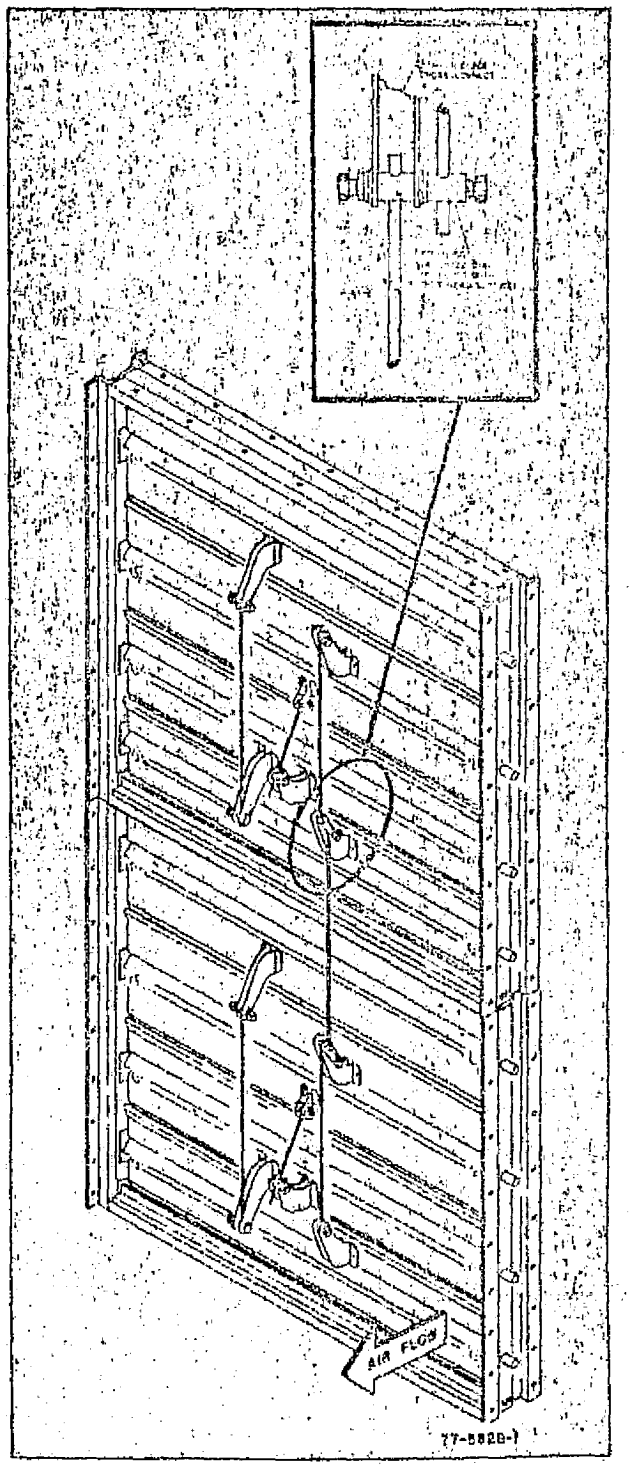


Fig. 6—Attaching the Vertical Section Drive Linkage.

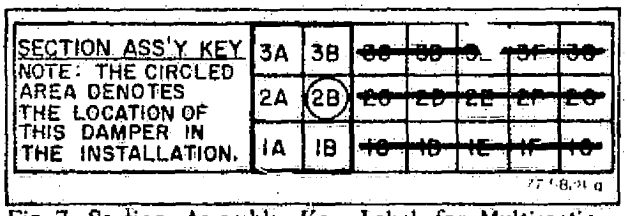


Fig. 7—Section Assembly Key Label for Multisection Dampers (as viewed from the downstream side).

This section assembly key informs the installer not only of the location of the particular damper in hand but also how many sections (6 in example) will make up the complete installation.

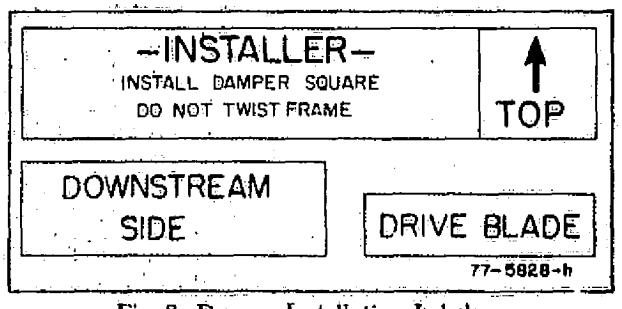


Fig. 8—Damper Installation Labels.

The labels shown in Figure 8 are also attached to the damper blades. Mounting the low leakage damper with the DOWNSTREAM SIDE label on the proper side insures maximum close-off and smooth operation of the damper motor.

The INSTALLER label has an important message for the installer. Misalignment of the damper can cause twist in the frame creating blade and linkage bind. This in turn will overload the damper motor or render it inoperative.

Located on the bottom blade of Honeywell dampers is the DRIVE BLADE label. It is important that the damper operator be connected to this blade only. On standard dampers 36 inches (914mm) and larger the drive blade is reinforced to prevent twist caused from the torque of the operator. (The drive blade is the only blade reinforced on standard dampers.) On low leakage dampers 30 inches (762mm) and larger all blades are reinforced.

RULES FOR INSTALLATION

Damper blades must always be installed horizontally except in the case of the special vertical blade models of each damper. Vertical dampers are constructed differently from horizontal dampers and the two cannot be interchanged. However, installation procedures for them is almost the same.

To work smoothly dampers must be installed square and plumb (flat).

Allow at least 8 inches (203mm) clearance front and back for correct damper blade operation.

Dampers larger than 48 inches (1219mm) will be provided as multisection units.

Multisection damper installations larger than 96 inches (2438mm) will require field fabricated bracing. The brace should be from the damper framing near the center of the assembly to the floor, ceiling beams, duct framing, or other solid structural member adjacent to the damper.

DO NOT WELD MULTISECTIONS TOGETHER, use the bolts provided.

MASK THE SIDE SEALS NEXT TO THE DAMPER BLADES if field painting is required.

Dimension "A" always represents blade length (either vertical or horizontal).

LEAKAGE

The design and construction of a damper will determine how much separation will exist between the blades and the frame. Any separation reduces the efficiency of the damper.

If a damper is not constructed with effective sealing elements, the amount of leakage will be proportional to the amount of differential pressure applied to the blade. Causing the blades to twist by increasing the closing force has little effect on reducing leakage.

However, closing force is important when a compression type seal is used. The force available must be great enough to compress the seal from its first point of contact to its last point of contact. This force must be stated for true damper comparisons.

The effect of damper leakage may be to:
Decrease capacity of a unit;
Limit controllability;
Limit effectiveness of isolation as in smoke damper applications;
Waste valuable energy.

J-21

The leakage ratings of simple dampers average approximately 50 cfm/sq. ft. (0.25m^3/sec/m^2) with 1.5 in water static pressure.

Provisions which Honeywell takes to insure minimal leakage on standard dampers are:

BLADES – Constructed of .062 in. galvanized steel with nine longitudinal "breaks" in the cross section to provide rigidity plus reinforcing of the drive blade.

BLADE SEALS – Mating edges of the standard dampers meet with interlocking formed steel edges.

Following are nominal leakage figures for the Honeywell line of dampers:

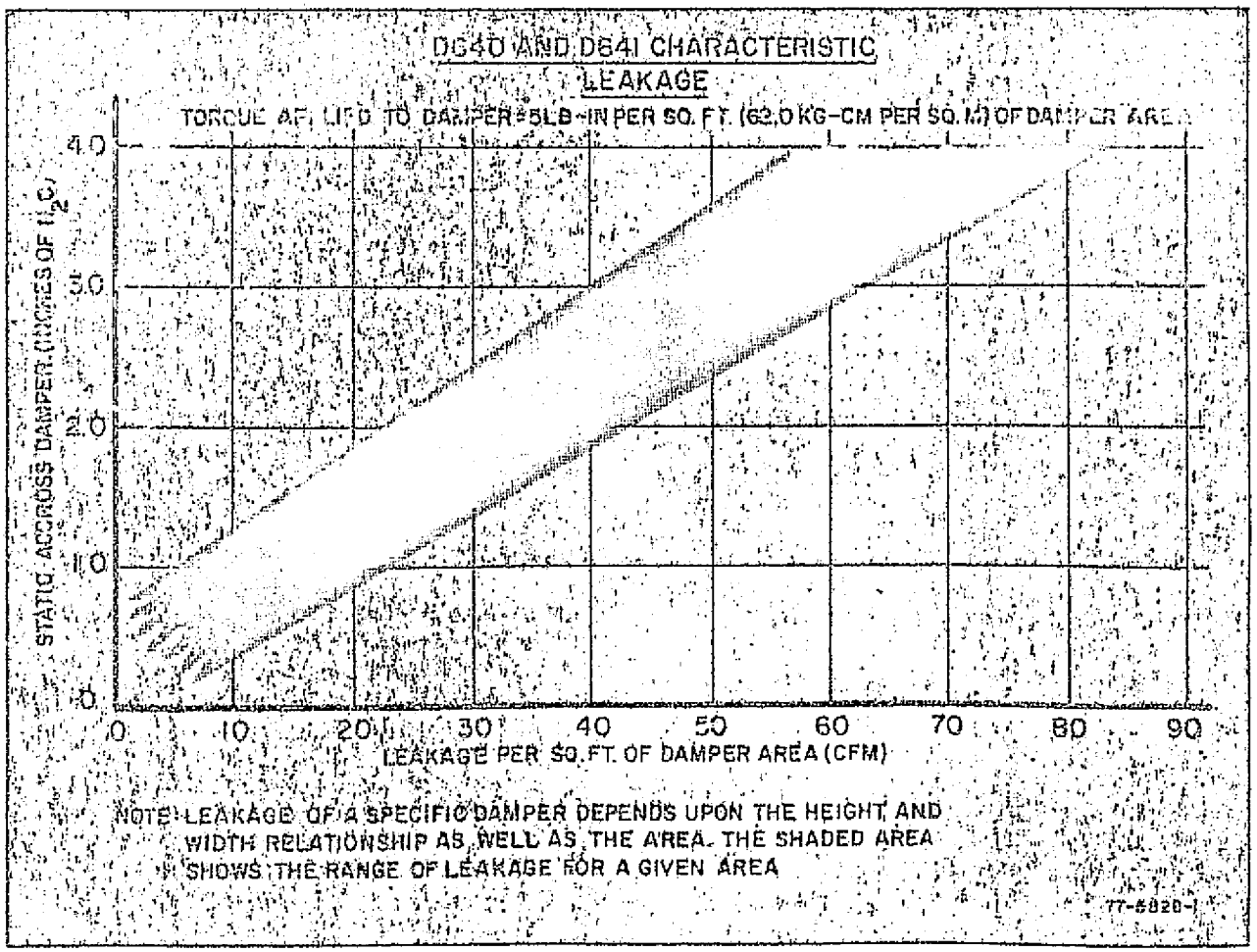


Fig. 9–D640, D641 Standard Damper Leakage Curve.

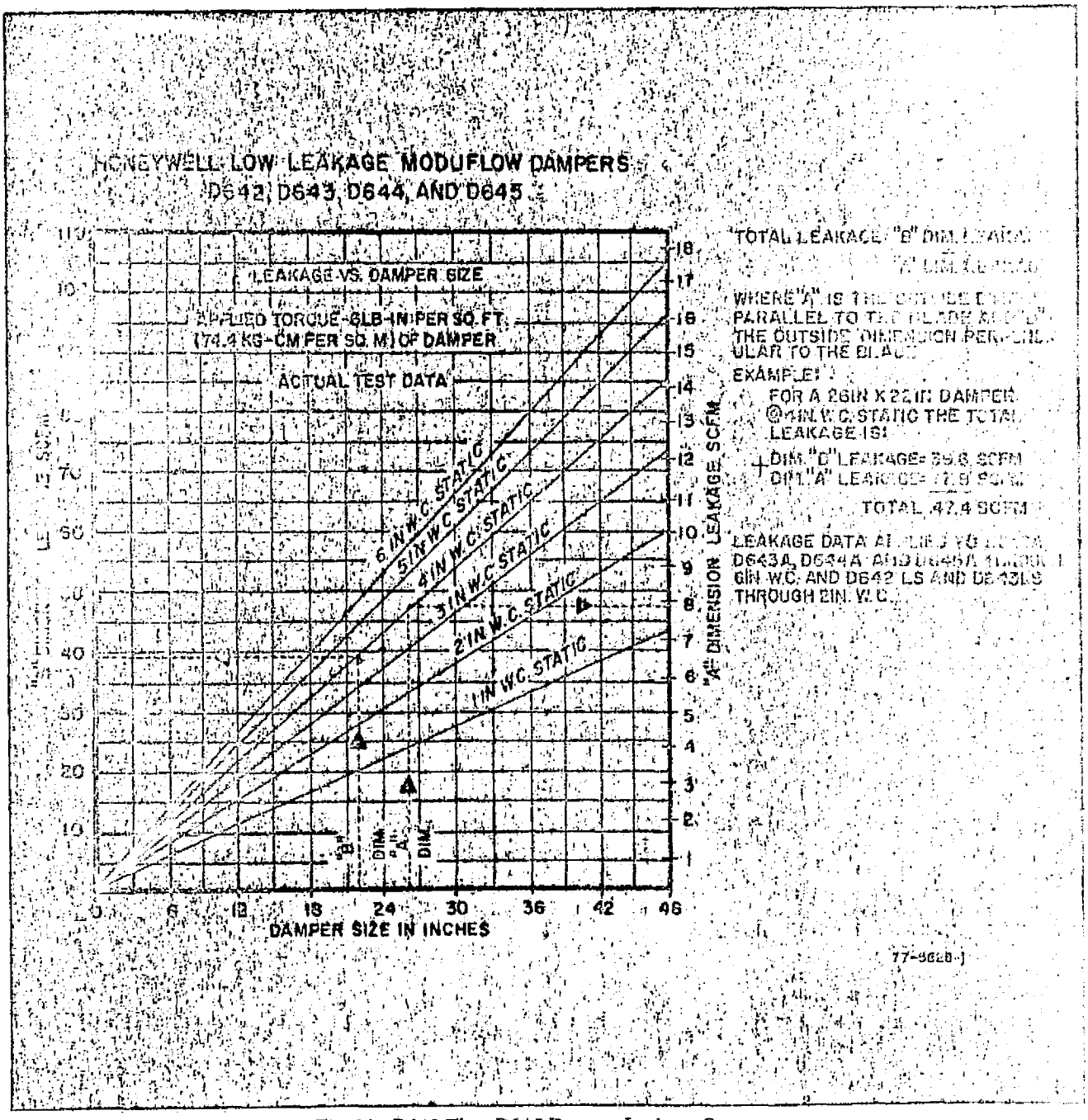


Fig. 10--D642 Thru D645 Damper Leakage Curves.

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Table 1–Maximum Damper Operator Rating in Square Feet (Square Meters) of Damper Area.

Damper Type Operation		D640 & D641			D642 & D643		
		Modulating Service		2 Pos. Service	Modulating Service		2 Pos. Service
Motor	Spring psi (kPa)	13 psi M (90 kPa)	18 psi M (125 kPa)	18 psi M (125 kPa)	13 psi M (90 kPa)	18 psi M (125 kPa)	18 psi M (125 kPa)
MP909A	2-7 (15-50)	2 (.2)*	2 (.2)*	2 (.2)	1.5 (.1)*	1.5 (.1)*	1.5 (.1)
"	3-13 (20-90)	----	4 (.4)	3.5 (.3)	----	3 (.3)	3 (.3)
"	5-10 (35-70)	3.5 (.3)	4 (.4)	5.5 (.5)	3 (.3)	3 (.3)	4.5 (.4)
"	7-13 (50-90)	----	4 (.4)	5.5 (.5)	----	3 (.3)	4.5 (.4)
"	10-15 (70-105)	----	4 (.4)	3.5 (.3)	----	3 (.3)	3 (.3)
MP909B	2-7 (15-50)	5 (.5)*	5 (.5)*	5 (.5)	4 (.4)*	4 (.4)*	4 (.4)
"	3-13 (20-90)	----	8 (.7)	8 (.7)	----	7 (.7)	7 (.7)
"	5-10 (35-70)	8 (.7)	8 (.7)	12 (1.1)	7 (.7)	7 (.7)	10 (.9)
"	7-13 (50-90)	----	8 (.7)	12 (1.1)	----	7 (.7)	10 (.9)
"	10-15 (70-105)	----	8 (.7)	8 (.7)	----	7 (.7)	7 (.7)
MP909C	2-7 (15-50)	8 (.7)*	8 (.7)*	8 (.7)	7 (.7)*	7 (.7)	7 (.7)
"	3-13 (20-90)	----	12 (1)	12 (1)	----	10 (.9)	10 (.9)
"	5-10 (35-70)	12 (1)	12 (1)	20 (1.9)	10 (.9)	10 (.9)	16 (1.5)
"	7-13 (50-90)	----	12 (1)	20 (1.9)	----	10 (.9)	16 (1.5)
MP904A	7-13 (50-90)	----	45 (4.2)	45 (4.2)	----	36 (3.4)	36 (3.4)
(MP904A w/20 psi [140 kPa] m)		----	(60) (5.8)	(60) (5.8)	----	(50) (4.7)	(50) (4.7)
MP904B	2-7 (15-50)	20 (1.9)*	20 (1.9)*	20 (1.9)	----	15 (1.4)*	15 (1.4)
"	3-13 (20-90)	----	30 (2.8)*	30 (2.8)	----	25 (2.3)	25 (2.3)
"	7-13 (50-90)	----	30 (2.8)	45 (4.2)	----	25 (2.3)	31 (2.9)
MP903A	3-13 (20-90)	----	8 (.7)	8 (.7)	----	7 (.6)	7 (.6)

*2-Position Force Limitation

Electric & Electronic Motor Damper Ratings (Ft^2 of Damper)

Motor (1 min. stroke)	Damper Rating D640 & D641	Damper Rating D642 & D643
M634, M734, M934 (35 lb-in.)	15 (1.4)	12 (1.1)
M445, M745, M845, M945 (50 lb-in.)	21 (2)	18 (1.7)
M644, M744, M944 (150 lb-in. 200 lb bearing limit)	47 (4.4)	39 (3.6)

NOTES:

1. Two position ratings are based on standard dampers requiring 5 lb-in./ft^2 of closing torque and low leakage dampers requiring 6 lb-in./ft^2 closing torque to properly close the damper.
2. Modulating ratings are based on 2/3 of the above torques and 2 psi (15 kPa) maximum offset and are applicable throughout the performance range of damper intended.
3. 150 lb-in. Modutrol* motor sizing limited by 200 lb bearing load limit.

*Trademark

Table 1 illustrates the maximum operator rating for various pneumatic and electric damper operators. By referring to this table the installer can determine which operator or how many operators are needed for a particular installation.

EXAMPLE: A damper required for installation has an "A" dimension of 120 inches (3048mm), and a "B" dimension of 78 inches (1981mm). This damper has an equivalent area of 70 square feet (6.5 sq m). Checking the operator table you see that three MP904B pneumatic operators with a 3 to 13 psi (.2 to .9 bar) spring range are needed to operate a multisection damper this size.

Although differences in damper design from one damper to another may not be obvious they are of utmost importance in terms of the performance and reliability you want. Through quality design, materials, and workmanship Honeywell Moduflow dampers provide you with highly efficient, low-leakage air flow control without sacrificing economy.

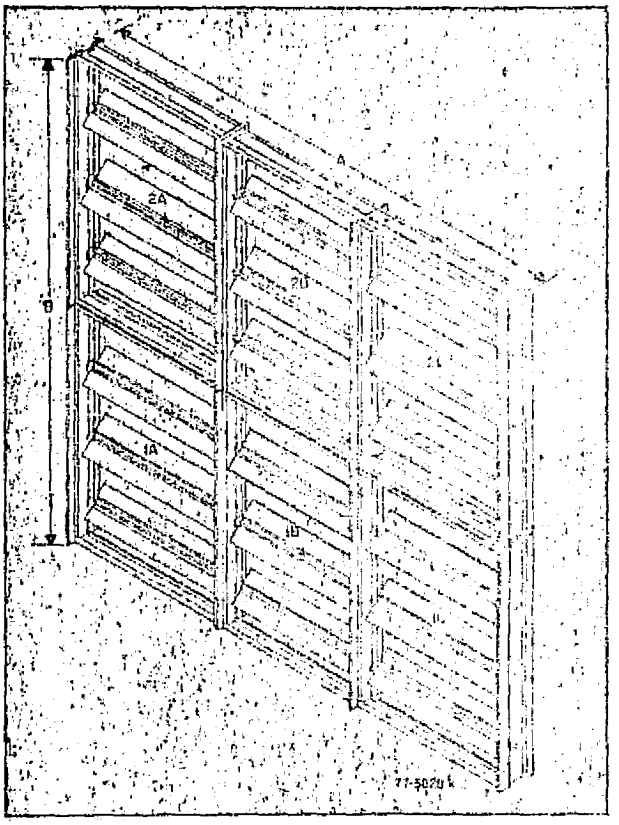


Fig. 11.

series R34, A41W

SOLID STATE DIFFERENTIAL TEMPERATURE CONTROLLER AND SENSOR

For Solar Heating Applications

APPLICATION

The Series R34 differential temperature controller was designed for use on solar heating applications. It automatically turns on a circulating pump or blower to transfer hot liquid or air from the collector to the storage facility when a predetermined temperature differential is exceeded. The pump or blower is turned off when the medium temperature from the collector approaches the storage temperature. This controller is also for other differential temperature control applications.

The Type A41W temperature sensor is a nickel wire wound temperature element for use with the Series R34 controller. It is for temperatures up to 350° F (177° C) with a resistance of 1000 ohms ± 1% at 70° F (21° C). It has a temperature coefficient of approximately 3 ohms per degree Fahrenheit.

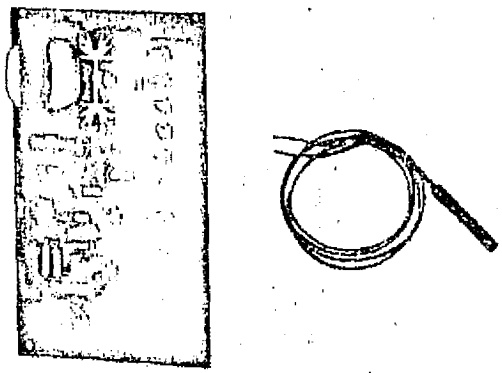


Fig. 1 — Type R34AAB controller and Type A41W sensor.

FEATURES

— All solid state components.

— Easy to install and wire.

— Shielded wire not normally required.

— Accurate sensitive nickel wire sensing element.

GENERAL DESCRIPTION

The differential temperature controller has all solid state components and operates from two Type A41W precision nickel resistance temperature sensors. One sensor is located at the collector panel and the other in the storage facility.

The output triac is isolated from the control circuitry with an optically coupled isolator. The "isolated tab" output triac inherently provides an electrically insulated heat sink.

The Type R34AAB is open construction and mounts on four standoffs within the controlled equipment. External wiring is connected to identified screw terminals on a terminal strip. The high and low set points are set and sealed at the factory to the customers specifications. The Type R34AAA is supplied in a NEMA Type 1 enclosure.

The sensing elements mount directly to the collector panel and in a bulb well in the storage tank on hot water systems. A well is not required for the storage sensor when the air storage system is used. The sensors have two 22" long #18 AWG wire leads.

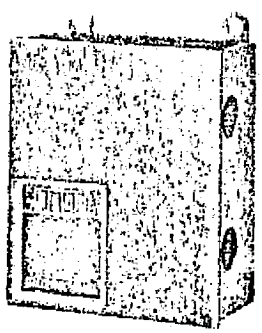


Fig. 2 — Type R34AAA controller.

SPECIFICATIONS

Product Number	Description	Temperature Differential Settings °F (°C)	
		Turn-On	Turn-Off
A41W-1	Sensor	—	—
R34AAA-1	Controller in NEMA Type 1 Enclosure	20±5 (11±3)	5±3 (3±2)
R34AAB-1	Controller	20±5 (11±3)	5±3 (3±2)

Type A41W

Electrical Connections: Two 22" long #18 AWG stranded wire leads.

Operating Temperature Ranges: −40° to 350° F (−40° to 177° C).

Reference Resistance: 1000 ohms at 70° F (21° C).

Resistance Tolerance: 1% at 70° F (21° C).

Sensing Element: Temperature sensitive nickel wire wound.

Temperature Coefficient: Positive at approximately 3 ohms per degree Fahrenheit. (5.4 ohms per degree Celsius.)

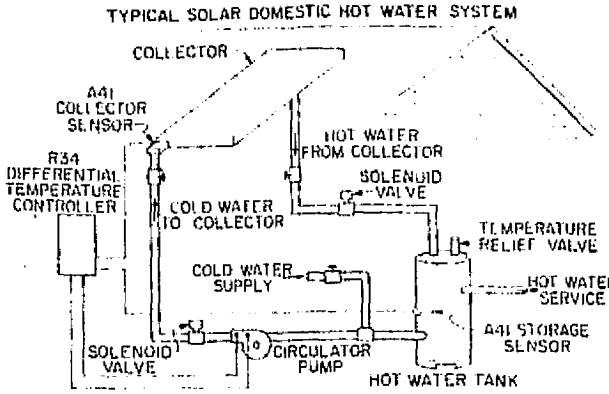


Fig. 3 — Drawing of typical solar domestic hot water system.

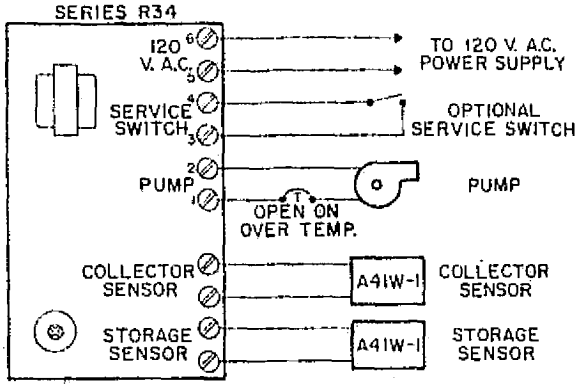


Fig. 4 — Typical wiring diagram.

Types R34AAA, R34AAB

Ambient Temperature: 0° to 120° F (−18° to 49°C). Maximum heat sink temperature is 194° F (90° C).

Electrical Connections: Identified terminal screw on terminal strip. See Fig. 5.

Electrical Load: 120 V. A.C., 2 amps. maximum.

Supply Voltage: 120 V. A.C.

ACCESSORIES

Bulb Wells For Type A41W

Part Number	Insertion Length	Type of
WEL12A-600R	2 13/16"	Sweat
WEL16A-600R	2 3/8"	1/2" NPT

SHIPPING WEIGHT

Product Number	Individual	
	lbs.	
A41W-1	.06	.027
R34AAA-1	1.84	.84
R34AAB-1	.4	.18

REPAIRS AND REPLACEMENT

Field repairs must not be made. Replacement units may be obtained from the nearest Penn Commercial Systems Wholesaler. When ordering a replacement controller or sensor, specify Product Number shown on the units.

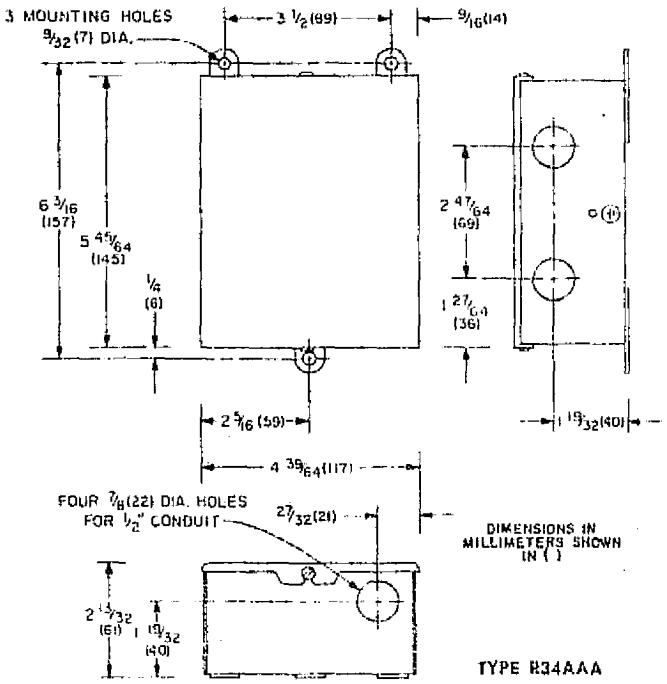
For trouble-shooting procedure, see Series R34 Installation and Operation Instructions Form 996-94.

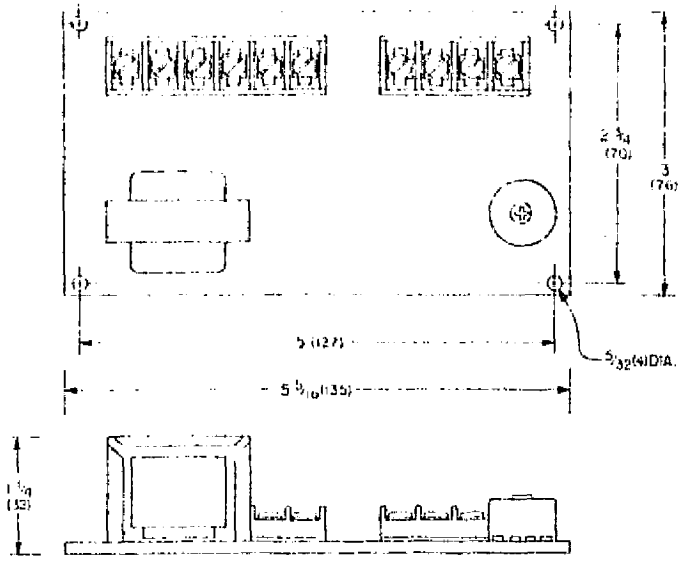
ORDERING INFORMATION

To order, specify:

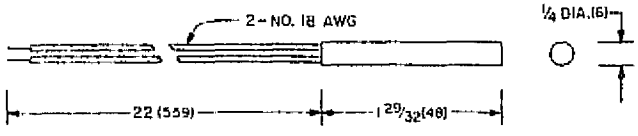
1. Complete Product Number.
2. Bulb well Part Number for Type A41W, when required.
3. If set points other than shown in Bulletin are desired, write Customer Service.

DIMENSIONS

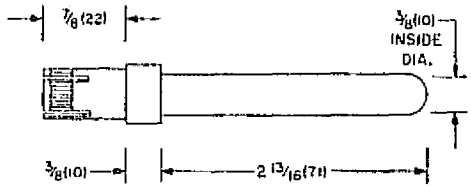




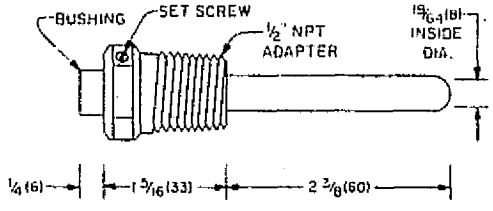
TYPE R34AAB



TYPE A41W



PART NUMBER WEL12A-600R



PART NUMBER WEL16A-600R

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

PENN BASO

PENN CONTROLS
DIVISION OF JOHNSON SERVICE COMPANY

INSTALLATION AND OPERATION INSTRUCTIONS

SERIES R34

FORM 996-94-1

SOLID STATE DIFFERENTIAL TEMPERATURE CONTROLLER

APPLICATION

This differential temperature controller was designed for use on solar heating applications. It automatically turns on a circulating pump or blower to transfer hot liquid or air from the collector to the storage facility when a predetermined temperature differential is exceeded. The pump or blower is turned off when the medium temperature from the collector approaches the storage temperature. This controller can also be used for other differential temperature control applications.

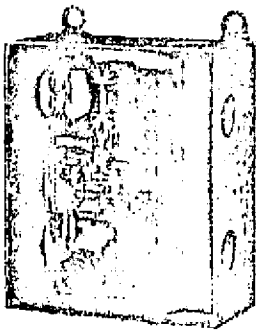


Fig. 1 — Type R34AAA controller with cover removed.

INSTALLATION

Follow equipment manufacturer's instructions where available. If not available, proceed as follows.

Locating and Mounting

Locate the controller in any convenient, protected location near the controlled equipment. Under full load conditions the controller dissipates approximately 4 watts and must be mounted with adequate clearance around the device to allow convection cooling of the triac heat sink. Mount Type R34AAA by the three mounting lugs on the enclosure. Mount Type R34AAB on four standoffs.

Locate the controller where the ambient temperature does not exceed 120° F (49° C) or go below 0° F (−18° C). The maximum heat sink temperature is 194° F (90° C).

Wiring

CAUTION: Disconnect power supply before wiring and mounting connections are made to prevent electrical shock or possible damage to equipment.

All wiring must be in accordance with local regulations and the National Electrical Code.

Check rating of circulating pump or blower motor to be sure it does not exceed rating of the Series R34 controller. If rating of motor exceeds the Series R34 rating, install an adequately rated relay or contactor to operate motor.

Make wiring connections to identified screw terminals on the barrier strip. The sensor leads should be at least No. 18 wire for lengths up to 50 ft. No. 14 wire should be used for runs up to 250 ft. Splices should be made with wire nuts or by soldering and taping.

CAUTION: Make all wiring connections and check for correctness before applying power. Improper wiring may cause permanent damage.

ADJUSTMENTS

This controller is set at the factory and cannot be adjusted in the field.

CHECKOUT PROCEDURE

When components are installed and wiring is completed recheck the wiring and apply power.

Before leaving the installation, a complete operating cycle should be observed to see that all components are functioning properly.

Fig. 2 — Type R34AAB controller.

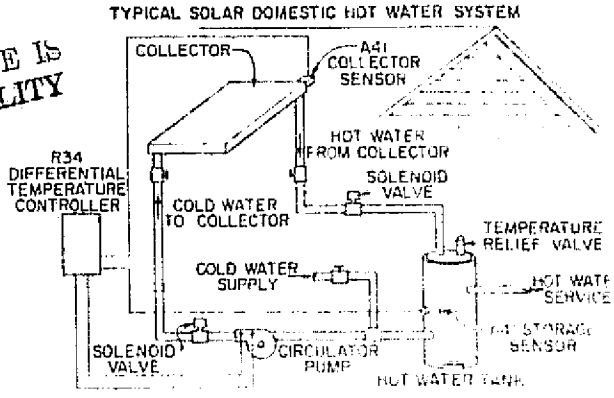


Fig. 3 — Drawing of typical solar domestic hot water system.

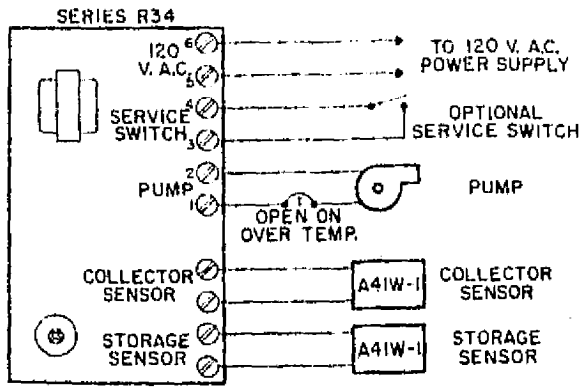


Fig. 4 — Typical wiring diagram.

TROUBLE-SHOOTING PROCEDURE

If circulating device (pump or blower) fails to energize when conditions indicate it should be running, proceed as follows:

1. Use a thermometer and check to be sure the proper differential does exist.
2. Check for proper voltage (120 V. A.C.)supply to terminals 5 and 6, see Figure 4.
3. If Steps 1 and 2 check all right, disconnect the collector sensor leads from the Series R34 controller. This simulates a very high collector panel temperature and the pump (blower) should energize.

   Another way to test this function would be to reconnect the collector sensor and short circuit the storage sensor. This simulates an extremely low storage temperature and the pump (blower) should energize.

   If this step energizes the pump, a defective collector sensor and/or storage sensor is indicated. Refer to sensor checkout instructions in Series A41 instruction Form 996-104.
4. If the Type A41W sensors are operational per Step 3, short circuit terminals 3 and 4 for the manual override and if the pump (blower) energizes, a defective manual override switch is indicated. Check wiring to switch. Replace the switch if bad.

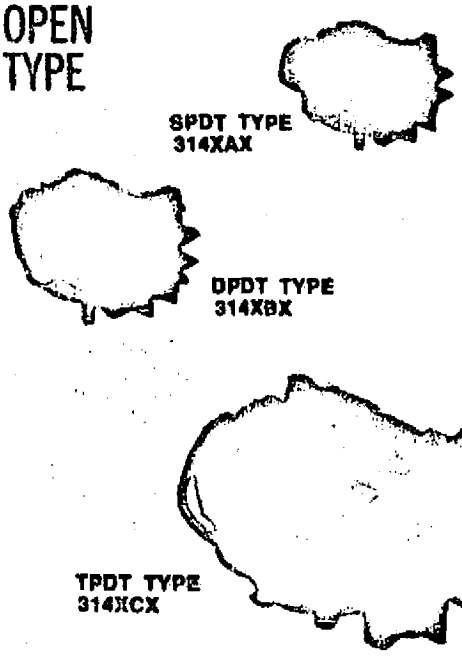
> CAUTION: Use extreme care. These terminals are line voltage and could cause electrical shock.

5. If short circuiting the service switch terminals does not energize the pump (blower), a defective Series R34 is indicated and should be returned to the factory for repair.

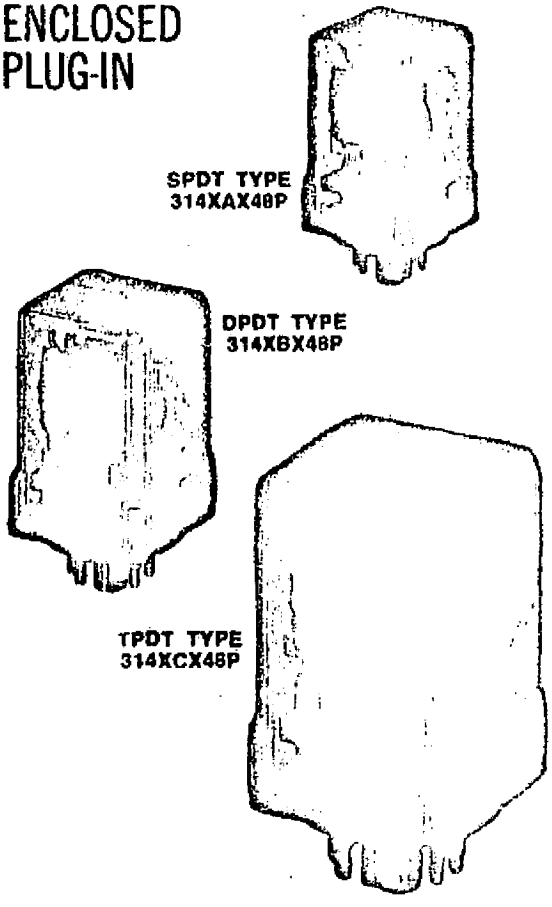
REPAIRS AND REPLACEMENT

Field repairs must not be made. Replacement units may be obtained from the nearest Penn Commercial or Systems Wholesaler. When ordering a replacement controller, specify Product Number shown on the controller.

OPEN TYPE



ENCLOSED PLUG-IN



A314 FRAME

Compact Industrial Relays

1, 2, OR 3-POLE DT
10-AMPERE CONTACTS

- **U.L. RECOGNIZED***
- **OPEN OR PLUG-IN ENCLOSED TYPES**
- **10 MILLION MECHANICAL LIFE**

DUNCO A314 Frame relays are medium-duty units for general-purpose industrial applications requiring excellent reliability and packaging density in low-cost U.L. Recognized components.*

OPEN A314 Frame relays require only two small mounting holes, one for a #6 mounting stud, the other for a guide tab.

PLUG-IN, ENCLOSED A314 Frame relays are equipped with standard 8 or 11-pin octal style plugs, and dust-tight, flame-resistant, clear polycarbonate covers. Those with 120 volt, 60 Hz ac, or 115 volt dc coils are also available with built-in lamps to indicate when power is being applied to coil.

APPLICATIONS for the A314 Frame relays span a wide range of logic and load handling jobs for the control of instruments, small motors, solenoid valves, heating elements, and other industrial devices.

* Under U.L. Component Recognition Program — File E13224

Typical Specifications: **A314 Frame Relays**

Configurations and Type Designations:

CONTACT CONFIGURATION	OPEN TYPES	ENCLOSED, PLUG-IN TYPES	
		Basic	with Neon Lamp
SPDT	A314XAX	A314XAX48P	A314XAX48PL
DPDT	A314XBX	A314XBX48P	A314XBX48PL
TPDT	A314XCX	A314XCX48P	A314XCX48PL

Contact Ratings:

10 amperes or ¼ hp at 120 volts ac.
5 amperes or ½ hp at 240 volts ac.

Dielectric Strength:

1500 volts ac for 1 minute

Electrical Spacings:

⅛" minimum through air; ⅛" minimum over surfaces between current-carrying parts.

Coil Data—continuous duty

AC Coils, 50/60 Hz

VOLTAGE (Nominal)	Current in mA	Resistance in Ohms
6	335.	6
12	168.	21
24	83.	85
120	17.5	2250
240	8.75	9110

DC COILS

NOMINAL VOLTAGE (dc)	DC RESISTANCE (ohms)
6	32.1
12	120
24	472
48	1800
115	10000

Voltage Operating Range:

AC relays operate at 85% and withstand 110% of nominal voltage.
DC relays operate at 80% and withstand 110% of nominal voltage.

Operating Ambient Temperature:

-45° to +50° C.

Mechanical Life Expectancy:

10 million operations, minimum.

Weight:

Open types—2 ounces, approx.
Enclosed, plug-in types—3 ounces, approx.

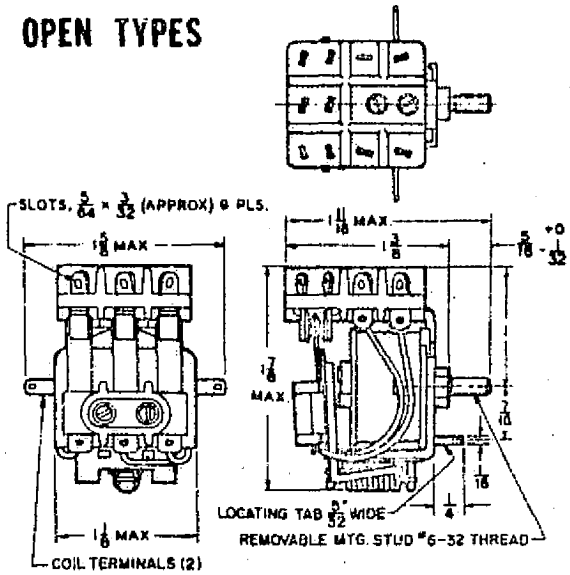
U.L. Recognition:

Open and basic enclosed plug-in relays are recognized under the Underwriters' Laboratories Inc., Component Recognition Program-file number E13224.

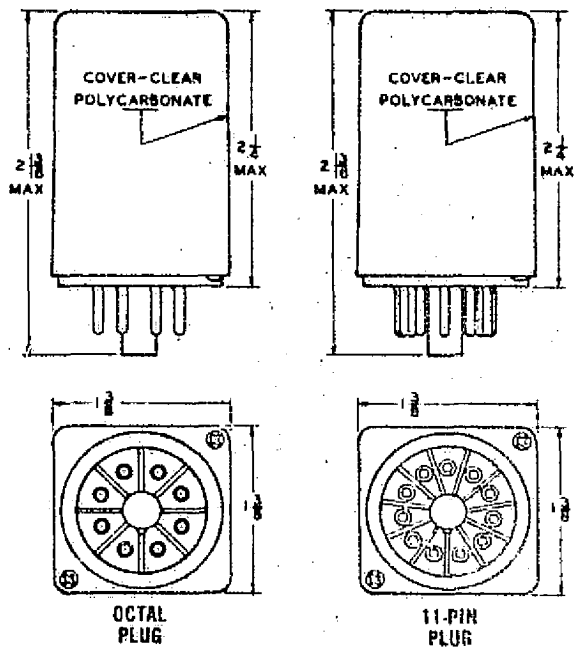
ORDERING INFORMATION:

Always specify relay type number, and coil voltage and frequency.

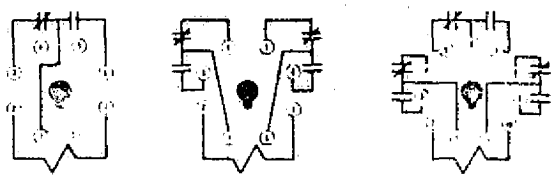
OPEN TYPES



PLUG-IN ENCLOSED TYPES



INTERNAL WIRING—Terminal Plug View



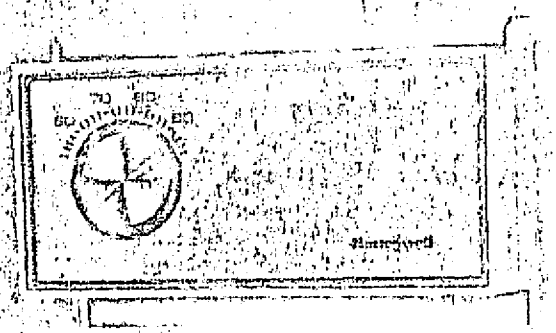
J-32

Honeywell

MULTISTAGE THERMOSTAT AND SUBBASE

THESE THERMOSTATS AND SUBBASES PROVIDE LOW VOLTAGE CONTROL OF MULTISTAGE HEATING AND COOLING SYSTEMS INCLUDING HEAT PUMP SYSTEMS.

- T872 Thermostat requires a Q672 Subbase.
- Q672 Subbase provides system and fan switching, wiring terminals and mounting base for T872 Thermostat.
- T872 Thermostat has silent dust-free mercury switches operated by coiled bimetal elements.
- Q672 Subbase mounts on wall or horizontal outlet box.
- Adapter plate available for mounting Q672 Subbase on vertical outlet box.
- Heat anticipator(s) are adjustable; cooling anticipator(s) are fixed.
- External levers and scale for temperature setting located on top of thermostat case.
- Cover thermometer on all T872 Thermostat models.
- Locking cover and locking lever screws available for T872 Thermostats.



T872A-H,L
M,Q,R,T
Q672A-G,K,L

N.J.
9-75 (.125)

SPECIFICATIONS

TRADELINE MODELS

Tradeline models are selected and packaged to provide ease of stocking, ease of handling, and maximum replacement value.

T872 Thermostat Tradeline models provide one or 2 stage heat and/or cool operation as shown in the chart below.

T872	A	B	C	D	E	F
HEATING STAGES	1	1	2	2	–	2
COOLING STAGES	1	2	1	2	2	–

Q672 switching subbase Tradeline models provide system and fan switching as listed.

Q672	SYSTEM	FAN
A	Heat-Auto-Cool	Auto-On
B	Heat-Off-Cool	Auto-On
E	Off-Heat-Auto-Cool	Auto-On

TRADELINE FEATURES:

- Tradeline package with cross reference label and special instruction sheet.
- T872A and D models with adjustable temperature locking stops.
- All Tradeline T872 models are supplied with locking lever and locking cover accessories.
- All Tradeline T872 models include 130821A Adapter Plate Assembly for mounting T872-Q672 on a vertical outlet box.
- All Tradeline thermostat models are compatible with all Tradeline switching subbase models.

T872 THERMOSTATS

MODELS: See Table 1.

ELECTRICAL RATING: 24 to 30V ac.

SWITCHING: Coiled bimetal elements operate mercury switches.

TEMPERATURE ADJUSTMENT. Heating and cooling setting levers, with common scale located on top of thermostat base. Common lever for heating and cooling on T872R, 1 cooling lever on T872E, and 1 heating lever on T872F.

TEMPERATURE SCALE RANGE: 44 to 86 F. Scale is marked every 2 F and labeled 50, 60, 70 and 80 F.

THERMOMETER RANGE: 52 to 98 F.

CHANGEOVER DIFFERENTIAL: 3 F minimum between heating and cooling. Levers may be set apart for greater separation.

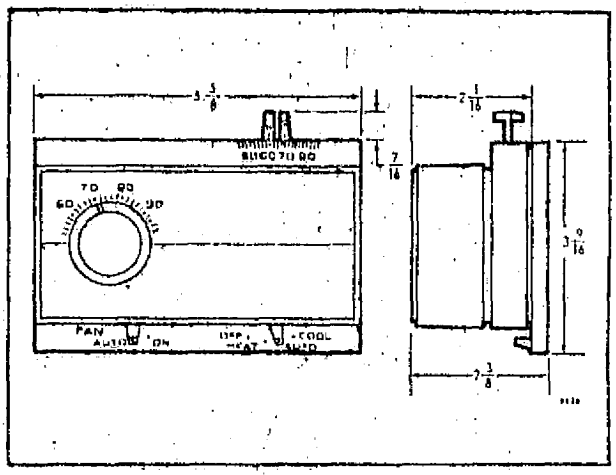


FIG. 1–DIMENSIONS OF T872 THERMOSTAT MOUNTED ON Q672 SUBBASE.

(continued on page 3)

ORDERING INFO

WHEN ORDERING, REFER TO THE TRADELINE CATALOG [illegible]

SPECIFICATION NUMBER, OR

ORDER FROM

1. MODEL NUMBERS:
   T872 THERMOSTAT TRADELINE, IF DESIRED.
   Q672 SUBBASE TRADELINE, IF DESIRED.
2. OPTIONAL SPECIFICATIONS, AS REQUIRED.
3. ACCESSORIES, AS REQUIRED.

1. [illegible]
2. HONEYWELL
   [illegible] DOUGLAS DRIVE [illegible]
   MINNEAPOLIS, [illegible]
   IN CANADA—HONEYWELL CONTROLS LIMITED
   [illegible] ELLESMERE ROAD
   SCARBOROUGH, ONTARIO [illegible]
   INTERNATIONAL SALES AND SERVICE OFFICES
   IN ALL PRINCIPAL CITIES OF THE WORLD.

INTERSTAGE DIFFERENTIAL: 1 F between heating or cooling stages.

FINISH: Silver bronze.

MOUNTING MEANS: T872 Thermostat mounts on Q672 Subbase. Subbase mounts horizontally on wall or outlet box. Mounts on vertical outlet box with optional 130821A Adapter Plate Assembly.

OPTIONAL SPECIFICATIONS (T872 only):

1. Locking cover and locking lever.
2. Nonadjustable factory added stop. Limits heating set point to 75 F maximum, cooling set point to 75 F minimum.
3. Customer personalization.
4. Centigrade scale.
5. Fast cycling on heating stage(s) for electric heat applications.
6. Adjustable locking temperature stops.
7. Thermostat cover less thermometer.

ACCESSORIES:

1. Locking cover and locking lever assembly, Part No. 133627AA; includes two No. 4 x 1/4 panhead screws to lock set point levers plus screws and Allen wrench for locking cover.
2. Universal thermostat guard–
   - –Part No. 133722A, clear plastic cover and beige plastic mounting base;
   - –Part No. 133722D, clear plastic cover and clear plastic "ring type" mounting base. Thermostat need not be removed from wall to install guard;
   - –Part No. 133723A, beige plastic cover and beige plastic mounting base.

TABLE 1–T872 THERMOSTAT SPECIFICATIONS

MODELS AND OPTIONS	REPLACES	APPLICATION STD OR HT PUMP	SYSTEM STAGES			ANTICIPATION			
						HTG (ADJ)		COOLING (FIXED)	
			HEAT	COOL	OTHER	STAGE 1	STAGE 2	STAGE 1	STAGE 2
T872A –Standard and Tradeline	T870A	STD	1	1	–	0.1-1.2A	–	0-1.5A	–
–75 F scaleplate stop w/locking cover		STD	1	1	–	0.1-1.2A	–	0-1.5A	–
–Adj heater set .4 amp		STD	1	1	–	0.1-1.2A	–	0-1.5A	–
–Adjustable locking temperature stops (T/L)		STD	1	1	–	0.1-1.2A	–	0-1.5A	–
T872B –Standard and Tradeline	T870B	STD	1	2	–	0.1-1.2A	–	0–1.2A	0-1.0A
–Adj heater set .4 amp		STD	1	2	–	0.1-1.2A	–	0-1.2A	0-1.0A
T872C –Standard and Tradeline	T870C	STD	2	1	–	0.1-1.2A	0.1-1.2A	0-1.5A	–
–75 F scaleplate stop w/locking cover		STD	2	1	–	0.1-1.2A	0.1-1.2A	0-1.5A	–
–Fast cycling		Elec Heat	2	1	–	0.12-0.6A	0.12-0.6A	0-1.5A	–
T872D –Standard and Tradeline	T870D	STD	2	2	–	0.1-1.2A	0.1-1.2A	0-1.2A	0-1.0A
–Adjustable locking temperature stops (T/L)		STD	2	2	–	0.1-1.2A	0.1-1.2A	0-1.2A	0-1.0A
T872E –Standard and Tradeline	T870E	2-Stage Cool	–	2	–	–	–	0-1.2A	0-1.0A
T872F –Standard and Tradeline	T870F	2-Stage Heat	2	–	–	0.1-1.2A	0.1-1.2A	–	–
–Locking cover		2-Stage Heat	2	–	–	0.1-1.2A	0.1-1.2A	–	–
–Fast cycling		Elec Heat	2	–	–	0.12-0.6A	0.12-0.6A	–	–
T872G –Fast cycle stage 2 heat	T870G	Ht Pump	2	1	1[g]	0-1.0A[b]	0.12-0.6A	–	0-1.0A
T872H –Use with Q672C	New	Ht Pump	1	1	1[g]	0-0.8A[b]	–	–	0-0.8A
T872M–Motel heating-cooling application (Requires manual changeover remote switching)	T870M	Remote Panel Switching	1	1	1[c]	0.1-1.2A	–	0-1.5A	–
T872Q –Night setback heating	T870Q	STD	1	–	1[f]	0.1-1.2A	–	–	–
T872R –Standard	T870R	Ht Pump[e]	2	1	1[d]	0-1.5A[b]	–	0-1.5A	–
T872T –Representative model	New	STD–Vent Stage	1	2	1[g]	0.1-1.2A	–	0-1.0A	0-1.0A

[a] Changeover stage–operates with cooling.
[b] Fixed voltage type anticipation.
[c] Nonadjustable heating changeover stage set at 60 F.
[d] Changeover stage–operates with heating.
[e] Manual changeover stage–use Q672B,L subbase.
[f] Night setback.
[g] Ventialting stage. (See Fig. 10.)

TABLE 2–Q672 SUBBASE SPECIFICATIONS

MODELS	RE-PLACES SUBBASE	USE WITH THERMO-STAT	SWITCHING FAN	SWITCHING SYSTEM	SUBBASE TERMINALS G	W_1	W_2	Y_1	Y_2	R_C	R_H	B	O	R	Y	W	E	X_1	X_2	SCHE-MATIC
Q672A –Standard and Tradeline models.	Q412A	T872A-D	AUTO-ON	HEAT-AUTO-COOL	X	X	X	X	X	X	X									Fig. 6
–Removable R_C-R_H jumper.			AUTO-ON	HEAT-AUTO-COOL	X	X	X	X	X	X	X									Fig. 6
–Removable R_C-R_H jumper and indicator light.			AUTO-ON	HEAT-AUTO-COOL	X	X	X	X	X	X	X							X		Fig. 6
Q672B –Standard and Tradeline models.	Q412B	T872A-D,R	AUTO-ON	HEAT-OFF-COOL	X	X	X	X	X	X	X	X	X							Fig. 7
–G terminal isolated on heating to provide fan relay operation from external low voltage switch.			AUTO-ON	HEAT-OFF-COOL	X	X	X	X	X	X	X	X	X							Fig. 8
–Reset for impedance relay.			AUTO-ON	HEAT-OFF/RESET-COOL	X	X	X	X	X	X	X	X	X							Fig. 7
–Removable R_C-R_H jumper.			AUTO-ON	HEAT-OFF-COOL	X	X	X	X	X	X	X	X	X							Fig. 7
–With indicator light.			AUTO-ON	HEAT-OFF-COOL	X	X	X	X	X	X	X	X	X					X		Fig. 7
–Auto fan operation on both heating and cooling elec. furnace.			AUTO-ON	HEAT-OFF-COOL	X	X	X	X	X	X	X	X	X							Fig. 9
–Special for T872R only.			AUTO-ON	HEAT-OFF-COOL	X								X		X	X		X		Fig. 27
Q672C –Standard models.	Q412C	T872A-F,H,S	AUTO-ON	OFF-AUTO	X	X	X	X	X	X	X	X	X							Fig. 11
–Use with T872H only.			AUTO-ON	OFF-AUTO	X			X	X			X	X							Fig. 25
Q672D –Standard models.	Q412D	T872A-F,M,Q	(None)	(None)		X	X	X	X	X	X									Fig. 12,13
Q672E –Standard and Tradeline models.	Q412E	T872A-D	AUTO-ON	OFF-HEAT-AUTO-COOL	X	X	X	X	X	X	X									Fig. 14
–Removable R_C-R_H jumper.			AUTO-ON	OFF-HEAT-AUTO-COOL	X	X	X	X	X	X	X									Fig. 14
–Common R terminal for heating and cooling.			AUTO-ON	OFF-HEAT-AUTO-COOL	X	X	X	X	X					X						Fig. 21
–Internal W_1-Y_2 and R_C-R_H jumper for heat pump application (for use with T872G).			AUTO-ON	OFF-HEAT-AUTO-COOL	X	X	X	X						X						Fig. 24
–Internal W_1-Y_2 and R_C-R_H jumper and check light.			AUTO-ON	OFF-HEAT-AUTO-COOL	X	X	X	X						X				X		Fig. 24
–Internal W_2-Y_1 and R_C-R_H connection.			AUTO-ON	OFF-HEAT-AUTO-COOL	X	X	X	X	X	X	X									Fig. 22
–Special terminals.			AUTO-ON	OFF-HEAT-AUTO-COOL	(Special terminals: V,F,R,Y,M)															Fig. 23
Q672F –Standard models.	Q412F	T872A-D,G	AUTO-ON	OFF-EM.HT.-HEAT-AUTO-COOL	X	X	X	X	X					X			X	X	X	Fig. 15
–EM.HT. light operates through W_2 with stage 2 heat.			AUTO-ON	OFF-EM.HT.-HEAT-AUTO-COOL	X	X	X	X	X			X	X	X			X	X	X	Fig. 16
–EM.HT. relay and light operates with switch in EM.HT.			AUTO-ON	OFF-EM.HT.-HEAT-AUTO-COOL	X	X	X	X	X			X	X	X			X	X	X	Fig. 17
–For heat pump application, use with T872G only.			AUTO-ON	OFF-EM.HT.-HEAT-AUTO-COOL	X								X	X	X	X	X	X	X	Fig. 26
–Special terminals.					(Special terminals: X,V,F,Y,R,M,E)															Fig. 28
Q672G –Standard models.	–	T872A-F	(None)	OFF-AUTO		X	X	X	X	X	X									Fig. 18
–O and B terminals for fan in AUTO position.			(None)	OFF-AUTO		X	X	X	X	X	X	X	X							Fig. 18
Q672K –Special color.	–	T872A-D Special color	(None)	OFF-HEAT-AUTO-COOL		X	X	X	X	X	X									Fig. 19
Q672L –Use with T872R only.	–	T872R	ON-AUTO	EM-HT.-HEAT-OFF-COOL				(Special terminals: Y,F,V,X,M,R,W)												Fig. 20

ELECTRICAL RATING:
Switch contacts–2.5 amp at 30V ac (7.5 amp inrush).
Malfunction light (optional)–24 to 30V ac.

SWITCHES: Two snap-acting switches, operated by levers. Switch position is shown on scaleplate.

MOUNTING: Designed to mount horizontally on an outlet box or wall. Adapter plate assembly available for mounting on a vertical outlet box (see Accessories).

FINISH: Silver bronze.

DIMENSIONS (inches): 3-9/16 high; 5-5/8 wide; 5/16 deep (see Fig. 1).

OPTIONAL SPECIFICATIONS (Q672 only):

1. Malfunction indicator light with replaceable bulb available on all models. Indicator can show FILTER, CHECK, or EM. HT. (emergency heat). Specify indication when ordering.

2. Jumper between R_C-R_H for common heating-cooling transformer. Jumper is field removable.

3. System switching marked HEAT-OFF/RESET-COOL for systems requiring impedance relay reset. Available on Q672B only.

4. "G" terminal isolated on heating to provide fan relay operation from external low voltage fan switch (Q672B only).

5. Auto fan operation on both heat and cool (Q672B only).

ACCESSORIES:

1. Adapter plate assembly, Part No. 130821A, for mounting on vertical outlet box. Assembly includes adapter ring and cover plate.

2. Adapter plate assembly, Part No. 130821B, for covering old thermostat marks on wall. Cover plate only.

3. Indicator replacement bulb, Part No. 129571.

4. Field addable indicator light assembly, Part No. 135734A. Assembly includes retainer plate, 2 self-tapping screws, light bulb with 2-3/4 inch leadwires with spade terminals and lenses. The Q672 lenses indicate FILTER, CHECK or EM. HT.

INSTALLATION

CAUTION

1. Installer must be a trained, experienced serviceman.
2. Disconnect power supply to prevent electrical shock and equipment damage.
3. Do NOT short across primary terminals to check system operation. This may burn out the heat anticipator(s).
4. Always conduct a thorough checkout when installation is complete.

LOCATION

Locate the thermostat and subbase about 5 feet above the floor on an inside wall where there is good natural air circulation and where the thermostat will be exposed to average room temperatures. Avoid locations behind curtains, in corners, alcoves, or in drafty areas. Avoid sources of heat or cold such as air ducts, water pipes, and electrical appliances.

SUBBASE MOUNTING

The subbase is designed for mounting on a wall or horizontal outlet box. (Adapter assembly, Part No. 130821B, with cover plate only is available for covering wall marks from old thermostat.) An adapter assembly, Part No. 130821A, with adapter ring and cover plate is available for mounting on a vertical outlet box. To mount subbase, proceed as follows:

1. At the location selected, prepare an opening for the thermostat wires.

2. Run low voltage thermostat wires to the location, and pull about 4 inches through the wall opening.

NOTE: It is recommended that color-coded thermostat cable be used to facilitate proper wiring.

3. If mounting the subbase on a vertical outlet box (Fig. 2), install the adapter ring with the 2 screws provided.

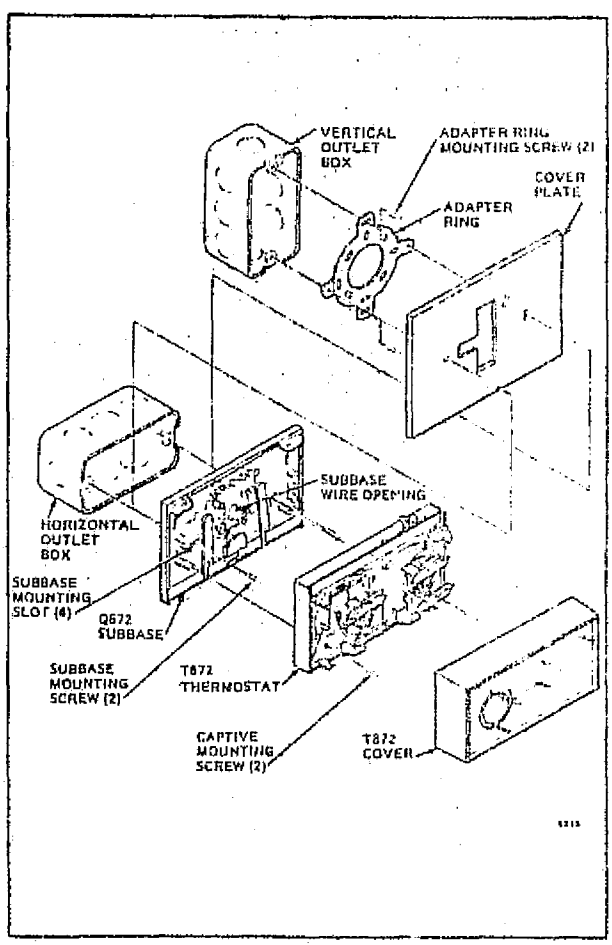


FIG. 2–INSTALLATION OF Q672 SUBBASE ON OUTLET BOX.

4. Pull thermostat cable through cover plate (if used) and subbase opening. Secure the cover plate and subbase with the 2 screws provided, but do not tighten.

IMPORTANT

Thermostats are calibrated at the factory using subbases mounted at true level. Inaccurate subbase leveling will cause thermostat control deviation.

5. The subbase mounting slots provide for minor out of level adjustments. Level the subbase using a spirit level, as shown in Fig. 3, and tighten subbase mounting screws.

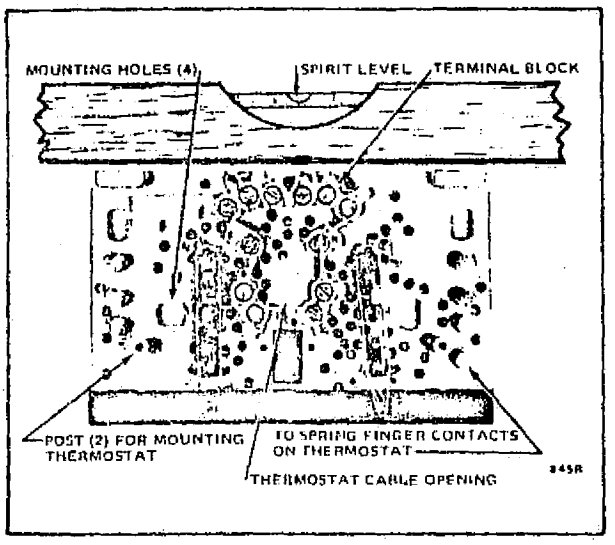


FIG. 3—LEVELING THE SUBBASE.

WIRING

CAUTION

Disconnect power supply to prevent electrical shock and equipment damage.

All wiring must comply with local electrical codes and ordinances.

A letter code is near each terminal for easy identification. Typical terminal designation and wiring connections are listed in Table 3.

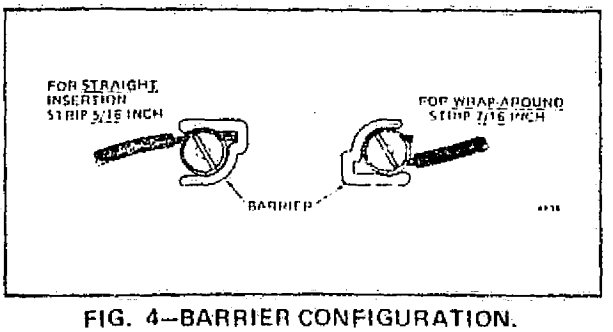


FIG. 4—BARRIER CONFIGURATION.

TABLE 3—TERMINAL DESIGNATIONS

TERMINAL	TYPICAL CONNECTION
B	Heating damper motor; changeover valve (if used).
E	Emergency heat relay.
G	Fan relay coil.
O	Cooling damper motor; changeover valve (if used).
R	Power connection to transformer (internally connected).
R_C	Power connection to cooling transformer.
R_H	Power connection to heating transformer.
W_1	Stage 1 heating control.
W_2	Stage 2 heating control.
Y_1	Stage 1 cooling control.
Y_2	Stage 2 cooling control.
X	Clogged filter switch.

The shape of the terminal barrier permits insertion of straight or conventional wrap-around (Fig. 4) wiring connections. Either method is acceptable. When making connections, strip wire to the length specified in Fig. 4.

Follow the equipment manufacturer's wiring instructions, if available, when wiring the subbase. If not available, Figs. 6-29 show typical T872-Q672 system hookups.

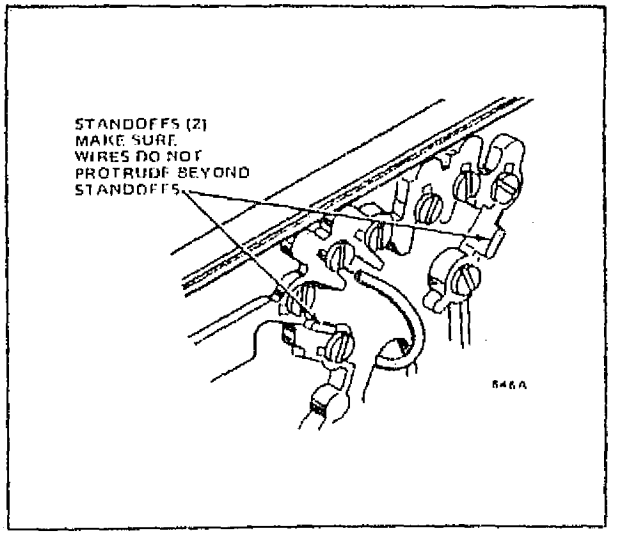


FIG. 5—INDIVIDUAL SCREW WIRING FOR Q672 SUBBASE.

CAUTION

Run wires as close to the subbase as possible. To prevent interference with the thermostat linkage, keep wire length to a minimum, and make certain wires do NOT protrude outward beyond standoffs (Fig. 5). Push excess wire back into the hole, and plug hole to prevent drafts from affecting thermostat operation.

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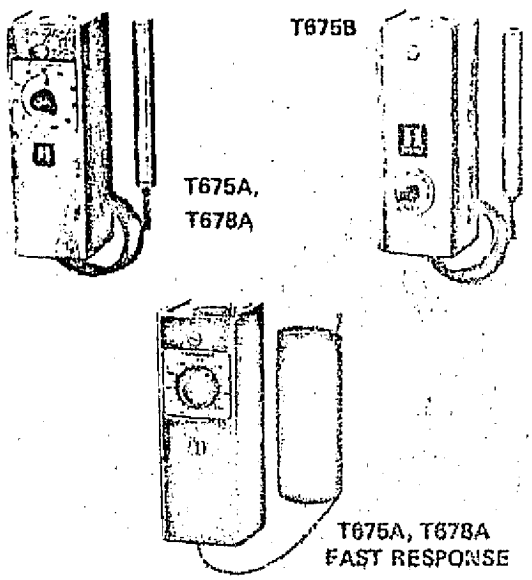
TEMPERATURE CONTROLLERS

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)

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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.

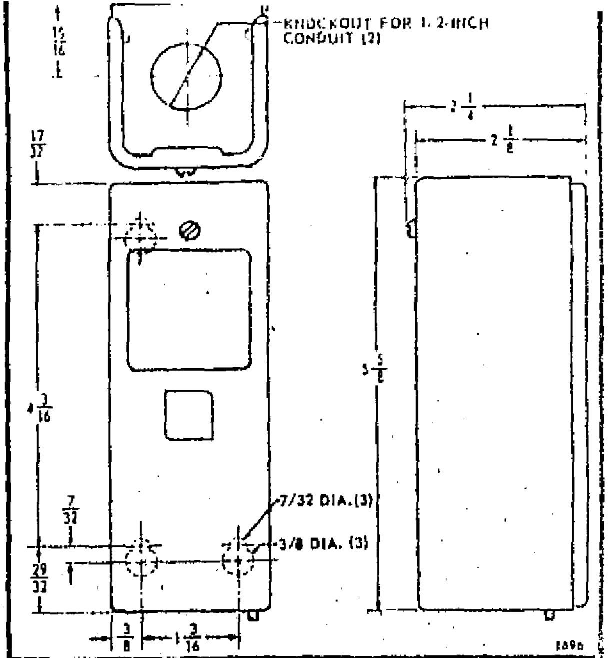

FIG. 1—DIMENSIONS (IN INCHES) OF T675 AND T678 CONTROLLERS.

INSTALLAT

CAUTION

...supply before making wiring connections...

...experienced serviceman...

...checked when installation is...

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.

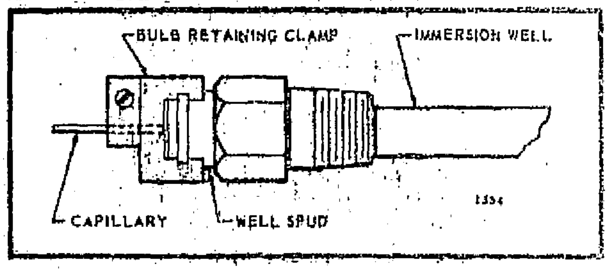

FIG. 3—IMMERSION WELL ASSEMBLY FOR MOUNTING SENSING BULB.

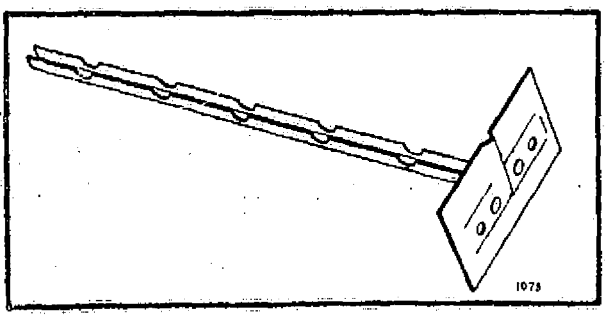

FIG. 2—BULB HOLDER FOR MOUNTING SENSING ELEMENT.

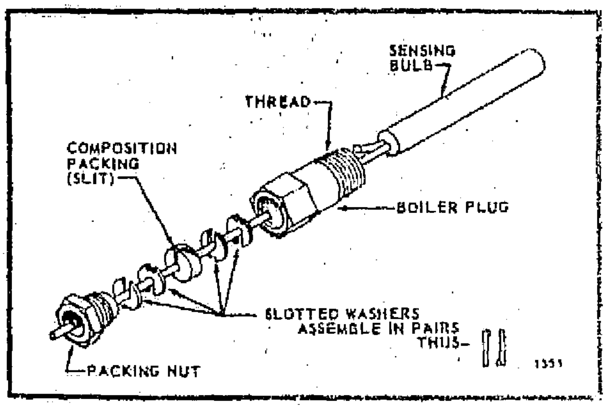

FIG. 4—COMPRESSION FITTING FOR PRESSURE TIGHT MOUNTING OF SENSING ELEMENT.

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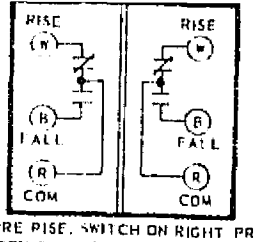
WIRING

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.



ON TEMPERATURE RISE, SWITCH ON RIGHT PROVIDES FIRST STEP SWITCHING; SWITCH ON LEFT PROVIDES SECOND STEP SWITCHING.

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.

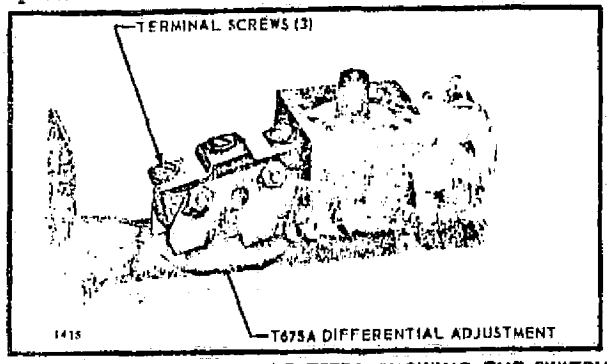


FIG. 6–INTERNAL VIEW OF T675A SHOWING THE SWITCH DIFFERENTIAL ADJUSTMENT WHEEL (APPLICABLE MODELS).

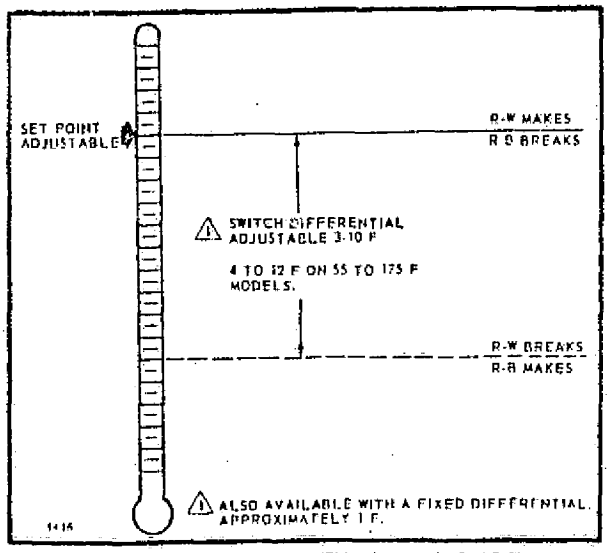


FIG. 7–DIFFERENTIAL ADJUSTMENT RANGE OF T675A.

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.

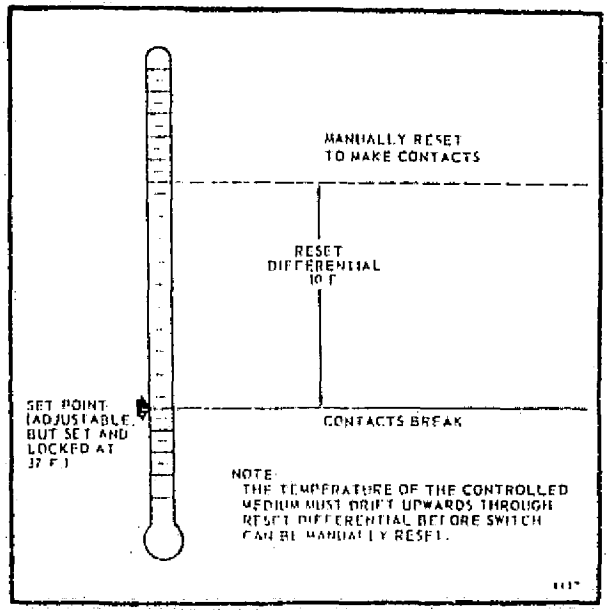


FIG. 8- DIFFERENTIAL ADJUSTMENT RANGE OF T675B.

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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.

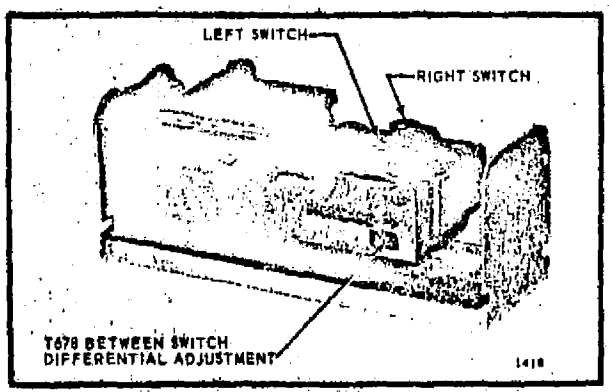

FIG. 9—INTERNAL VIEW OF T678A SHOWING THE BETWEEN SWITCH DIFFERENTIAL ADJUSTMENT.

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.

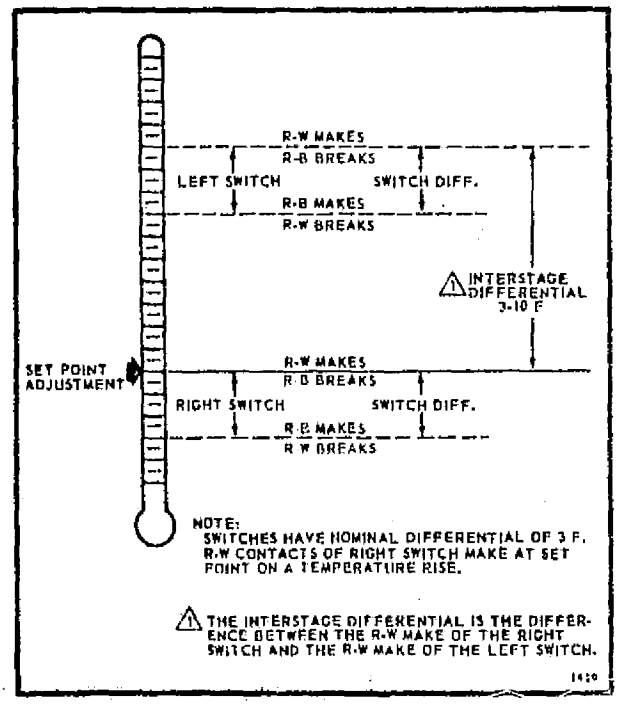

FIG. 10—DIFFERENTIAL ADJUSTMENT RANGE OF T678A.

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

AQUASTAT CONTROLLERS ARE IMMERSION TYPE DEVICES FOR LIMITING OR REGULATING THE TEMPERATURE OF LIQUIDS IN BOILERS, STORAGE TANKS, AND OTHER APPLICATIONS WHERE TEMPERATURE CONTROL OF LIQUIDS IS REQUIRED. AS THE TEMPERATURE OF THE CONTROLLED MEDIUM RISES TO THE SET POINT, EXPANSION OF THE FLUID IN THE SENSING ELEMENT OPERATES THE INTERNAL SWITCH OR SWITCHES.

☐ The L4006, 7, and 8 provide spst switching for high or low limit control of a burner.

☐ The L4006G model has two spst switches that make and break in sequence to provide boiler sequencing.

☐ The L6006 and 8 provide spdt switching for low limit and circulator control.

☐ Models which break contact on a temperature rise to the set point are calibrated for high limit use. They are also suitable for low limit control if a separate high limit control is used.

☐ Ambient compensated models are available to prevent control-point shift caused by temperature fluctuation at the case.

☐ Visible control point scale and external adjustment screw permit easy setting.

☐ Models are available for either horizontal or vertical insertion of the sensing element. The sensing element may be directly immersed or placed in an immersion well.

☐ Remote bulb models are available if the controller must be mounted at a location away from the sensing element.

☐ Remote bulb models may also be used to sense air temperature in ducts and in outside air sensing applications.

☐ Totally enclosed Micro Switch snap-acting switches are used in all models.

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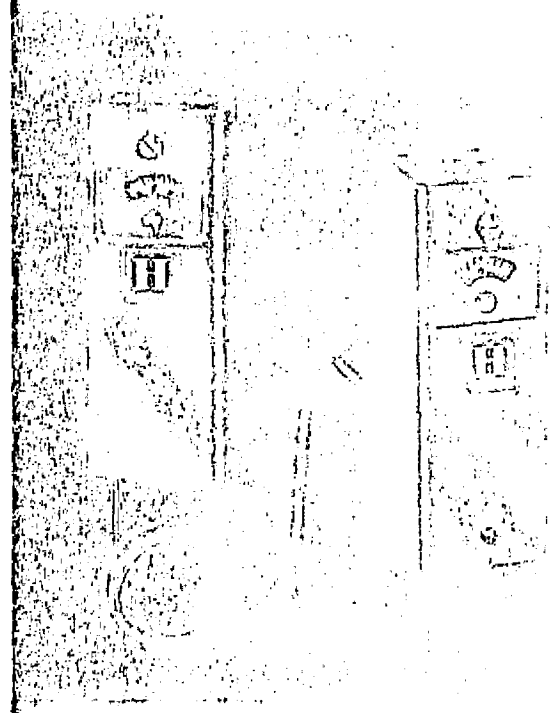
7-75

AQUASTAT CONTROLLERS



L4006,7,8;
L6006,8

J-45

SPECIFICATIONS

SPST MODELS:

MODEL	APPLICATION	RANGE (F)	MIDSCALE DIFFERENTIAL (F)	INSERTION[a]	SWITCHING ON TEMP. RISE	AVAILABLE OPTIONS
L4006A	high or low limit	40 to 180 100 to 240	2 or 5 fixed or 5 to 30 adj.	horizontal	breaks	Tradeline models which include well and tube of heat conductive compound. Plastic shield for covering well in water heater applications. 3/4 in. NPT brass spud. Centigrade scale markings. Factory set stops at 160 F, 185 F, 190 F, 200 F, or 220 F. Dial marked WARM, NORMAL, HOT. Insulation depths of 1-1/2, 3, or 5 inches.
L4006B	circulator	40 to 180 or 100 to 240	5 fixed or 5 to 30 adj.	horizontal	makes	3 inch insulation depth. 3/4 inch NPT brass spud.
L4006C	high or low limit	100 to 240	2 or 5 fixed	horizontal direct	breaks	10 in. element. Factory set stop at 205 F.
L4006E[b]	high limit	110 to 250	manual reset	horizontal or vertical	breaks	3/4 in. NPT brass spud. 3 in. insulation depth.
L4006G	sequencing	100 to 240	5 fixed interstage 3-10 F adj.	horizontal or vertical	breaks two switches	———
L4007A	high or low limit	100 to 240	2 or 5 fixed, 5 to 30 adj.	vertical	breaks	Centigrade scale markings.
L4007B	circulator	100 to 240	5 fixed or 5 to 30 adj.	vertical	makes	———
L4008A[a]	high or low limit	40 to 180 or 100 to 240	2 or 5 fixed, 5 to 30 adj.	remote bulb	breaks	5 ft.6 in., 8 ft.6 in. or 10 ft. remote capillary. Factory set scale stop at 120 or 200 F. External adjusting knob. Centigrade scale markings.
L4008B[a]	circulator	100 to 240	5 fixed or 5 to 30 adj.	remote bulb	makes	8 ft.6 in. capillary.
L4008C[a]	ambient compensated high limit	0 to 70 or 40 to 180	2 or 5 fixed	remote bulb	breaks	7 ft.6 in., 20 ft.capillary or fast response element. External adj. knob. 150 va rating at 120, 240v ac. High limit stamped on case scale lock.

L4008 models continued on page 3

[a]Copper well or fitting is supplied with all models except remote bulb type. When ordering, specify boiler tapping size (1/2 or 3/4 inch) and insulation depth.

[b]Manual reset (trip-free)—Switch breaks circuit and locks out when controlled medium reaches set point. Controlled temperature must drop 20 degrees below set point before contacts can be manually reset.

ORDERING INFORMATIO

REFER TO THE TRADELINE CATALOG OR PRICE SHEET FOR COMPLETE ORDERING INFORMATION.

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)

SPST MODELS CONTINUED:

MODEL	APPLICATION	RANGE (F)	MIDSCALE DIFFERENTIAL (F)	INSERTION[a]	SWITCHING ON TEMP. RISE	AVAILABLE OPTIONS
L4008D[a]	ambient compensated circulator	0 to 70 or 40 to 180	2 or 5 fixed	remote bulb	makes	Tradeline model available. Centigrade scale markings. Hot tinned 8 ft.capillary. Electrical rating: 2,3 amp at 120-240v ac, full load. Fast response, 10 ft.armored capillary with 3 ft. bulb. External adjustment knob. Factory set scale stops at 120, 220, or 250 F. Plastic shield for covering well in water heater applications.
L4008E[ab]	high limit	40 to 80 or 110 to 290	manual reset	remote bulb	breaks	Factory set scale stop at 250 F. 8 ft.6 in. capillary.
L4008J[a]	high limit	100 to 240	5 fixed	remote bulb	breaks	All models less case and cover. 18 in. capillary and 1/2 in. well assy. Factory set scale stop at 220 F.
L4008K[a]	circulator	40 to 180	5 fixed	remote bulb	makes	All models less cover.

SPDT MODELS:

MODEL	APPLICATION	RANGE (F)	MIDSCALE DIFFERENTIAL (F)	INSERTION[a]	AVAILABLE OPTIONS
L6006A[a]	circulator and low limit or high limit	100 to 240 or 110 to 290	5 fixed or 5 to 30 adj.	horizontal	Tradeline model which includes well adapter and tube of heat conductive compound, 3/4 in. NPT brass spud, 3 in. insulation depth. Horizontal or vertical mount available on same models.
L6006B	circulator and low limit or high limit	100 to 240	5 fixed or 5 to 30 adj.	horizontal	3/4 in. brass bulb compression fitting.
L6008A[a]	circulator and low limit cooling	100 to 240 -30 to 70	5 fixed or 5 or 30 adj.	remote bulb	Tradeline model with 5 ft.capillary. Range of -30 to 70 F. Centigrade scale markings. Without cover.
L6008C[a]	dual fuel changeover	0 to 70 40 to 180	2 or 5 fixed	remote bulb. May be duct mounted.	Tradeline model. 150 va switch rating. Centigrade scale markings. 7 ft.6 in. armored capillary. External adjustment knob. Lock type cover. 20 ft. element. Averaging element.
L6008E[a]	ambient compensated	40 to 180	5 fixed	remote bulb	All models less enclosure. Front mounted.

[a]Copper well or fitting is supplied with all models except remote bulb type. When ordering, specify boiler tapping size (1/2 or 3/4 inch) and insulation depth.

[b]Manual reset (trip-free)—Switch breaks circuit and locks out when controlled medium reaches set point. Controlled temperature must drop 20 degrees below set point before contacts can be manually reset.

NOTE: The following specifications are standard. Variances, available as options, are noted in the preceding table.

ELECTRICAL RATING (AMPS):

Models with 2 F fixed differential—

	120v ac	240v ac
FULL LOAD	2.6	1.3
LOCKED ROTOR	15.6	7.8

Models with 5 F differential—

	120v ac	240v ac
FULL LOAD	8	5.1
LOCKED ROTOR	48	30.6
INDUCTIVE CURRENT	.25 at 1/4 to 12v dc	

PRESSURE RATING:
Capillary bulb (direct immersion)—200 psi.
Immersion well—255 psi.

SENSING BULB MATERIAL: Copper.

SENSING BULB FILL: Liquid. Toluene or Silicone.

CAPILLARY LENGTH (including bulb): Remote bulb models—60 inches.

SENSING BULB DIMENSIONS (inches): 2-7/8 long, 3/8 diameter.

INSERTION DEPTH: 3-3/8 inches.

INSULATION: Brass, 1-1/2 or 3 inches. Specify when ordering.

PROVISION FOR WIRING: Screw terminals.

MOUNTING: Horizontal and vertical models mount directly to an immersion well installed in a boiler fitting. Remote bulb models have 3 mounting holes rear of case for screw mounting to a vertical surface.

FINISH: Gray.

INSTALLATION DIMENSIONS: See Figs. 1 and 2.

IMMERSION WELL DIMENSIONS: See Fig. 3.

BOILER FITTING AND BULB DIMENSIONS: See Fig. 4.

ACCESSORIES:
Weatherproof enclosure—Q615.
Immersion wells—
Copper, 1/2 NPT, 1-1/2 inch insulation—Part No. 121371A.
Copper, 1/2 NPT, 3 inch insulation—Part No. 121371L.
Copper, 3/4 NPT, 1-1/2 inch insulation—Part No. 121371B.
Copper, 3/4 NPT, 3 inch insulation—Part No. 121371M.
Copper, 3/4 NPT, 1-1/2 inch insulation, plastic sleeve—Part No. 121131K.
Copper, 3/4 NPT, 3 inch insulation, plastic sleeve—Part No. 121371N.
Stainless steel, 1/2 NPT, 1-1/2 inch insulation—Part No. 121371E.
Stainless steel, 3/4 NPT, 1-1/2 inch insulation—Part No. 121371F.
Bulb Compression Fittings (see Fig. 6)—
Brass, 1/2 NPT plug. 1-1/2 inch insulation—Part No. 104486B.
Brass, 3/4 NPT plug. 1-1/2 inch insulation—Part No. 104486C.
Capillary Compression Fittings (see Fig. 7)—
Copper, 1/2 NPT plug. 1-1/2 inch insulation—Part No. 104484C.
Copper, 3/4 NPT plug. 1-1/2 inch insulation—Part No. 104484B.

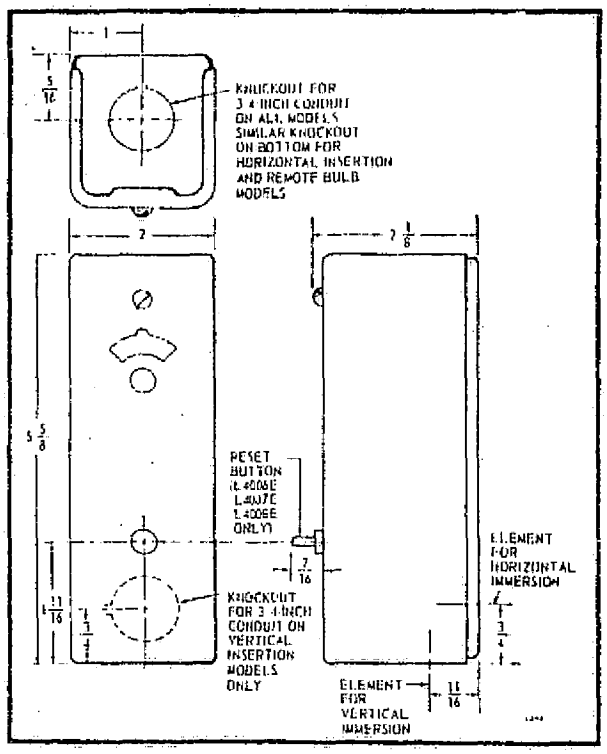


FIG. 1—INSTALLATION DIMENSIONS.

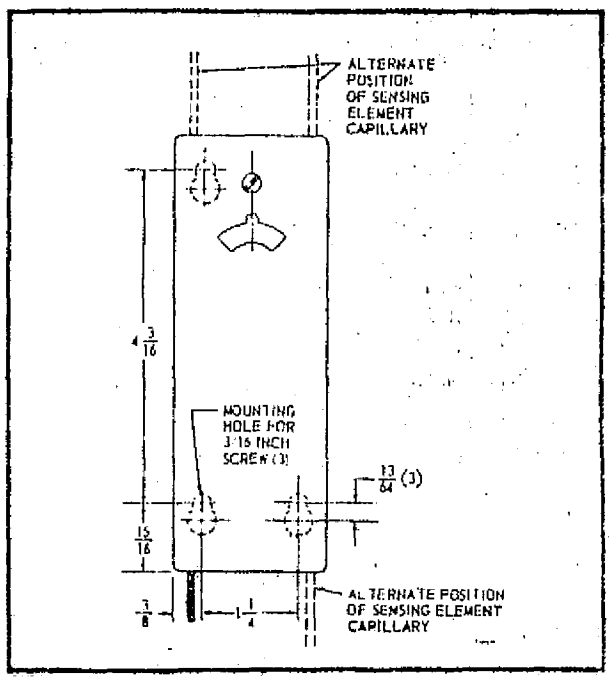


FIG. 2—INSTALLATION DIMENSIONS FOR REMOTE BULB MODELS. OTHER DIMENSIONS SAME AS FIG. 1.

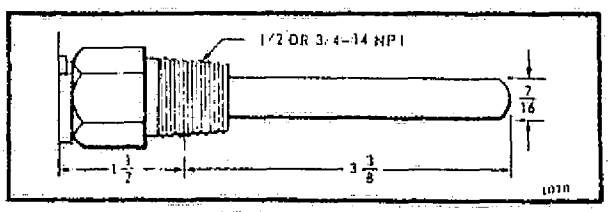


FIG. 3—IMMERSION WELL DIMENSIONS FOR ALL MODELS EXCEPT L4006C, L4007D, AND L6006B.

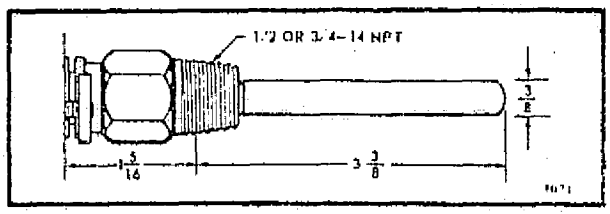


FIG. 4—BOILER FITTING AND BULB DIMENSIONS FOR L4006C, L4007D, AND L6006B.

The manufacturer usually provides a tapping for insertion of the controller's sensing element. This tapping is located at a point where typical water temperature can be measured. Depending on model, the element is inserted in an immersion well, through a boiler fitting, or directly immersed.

Installation should be made by a qualified serviceman. Follow the instructions furnished by the system manufacturer, if available. Otherwise, refer to appropriate procedure listed below.

IMPORTANT

Controller may be used with or without immersion well. Well, if used, must fit sensing bulb snugly for good thermal response. Insert bulb until it rests against bottom of well, then hold it there while tightening the tubing clamp.

MOUNTING REMOTE BULB MODELS

The remote temperature-sensing bulb can either be installed in an immersion well (Fig. 5) that extends into the boiler or tank, or it can be directly immersed in the liquid. For installations not using a well, secure the remote bulb with a bulb compression fitting (Fig. 6), or capillary compression fitting (Fig. 7).

Well, bulb compression fitting or capillary compression fitting must be ordered separately. Sizes available: 1/2 in., 3/4 in. NPT spud. Well, if used, must fit sensing bulb snugly for good thermal response. Insert bulb until it rests against bottom of well, then hold it there while tightening the tubing clamp. (See Fig. 5.)

The boiler manufacturer generally provides a tapping for the insertion of the Aquastat controller's sensing element. This tapping should be located at a point where typical water temperature can be measured. The bulb or protecting immersion well must never be located close to a hot or cold water inlet or a steam coil.

If the system is filled, drain system to a point below the boiler tapping, or wherever the sensing bulb is to be installed.

The bulb can also be installed in the supply line of an indirect water heater, in the direct water heater itself, or in the feed riser, about 6 in. above the boiler. If the riser is valved, the bulb can be installed between the boiler and the valve.

NOTE: Avoid making sharp bends or kinks in the capillary. Bends should be no sharper than 1 inch radius.

After installing, carefully coil excess capillary at the bottom of the controller case.

IMMERSION WELL MOUNTING

1. Screw the well into the boiler, tank, or pipe tapping.

2. Insert bulb in well, pushing tubing until bulb bottoms in well.

3. Attach retainer clamp to end of well spud. Loosen draw nut and spread jaws of clamp with screwdriver if necessary.

4. With retainer clamp attached to well spud (be sure jaws of clamp hook over ridge at end of spud, as shown at points "A"), adjust tubing to fit through retainer clamp groove, as shown at point "B."

5. Tighten draw nut so that retainer clamp is firmly attached to well spud and tubing is held securely in place.

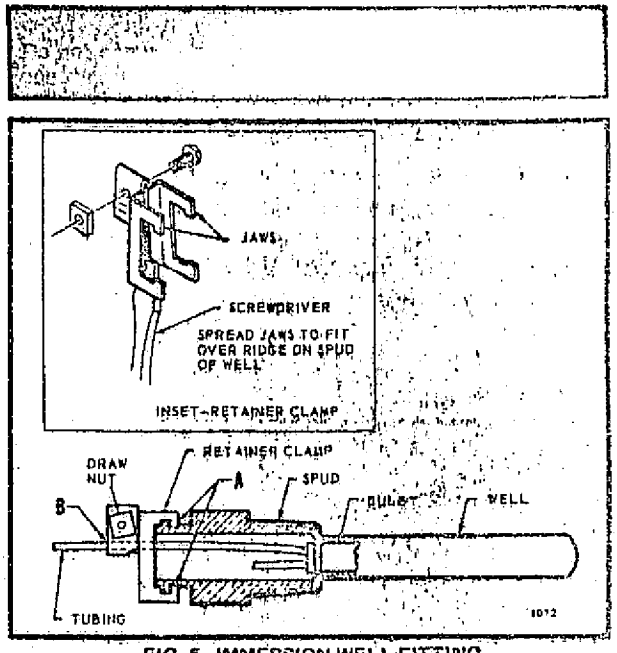


FIG. 6—IMMERSION WELL FITTING.

MOUNTING WITH BULB COMPRESSION FITTING

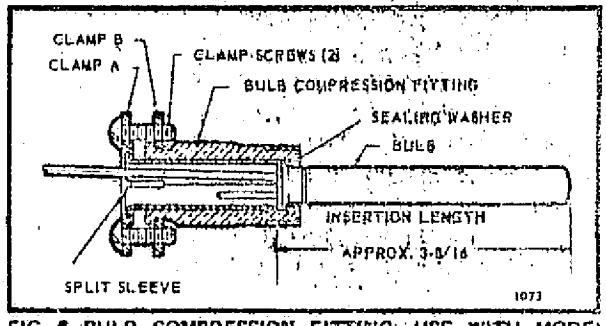


FIG. 8—BULB COMPRESSION FITTING. USE WITH MODEL L4008A,B,E,J, OR L6008A.

1. Screw the fitting into boiler or pipe tapping.

2. Slide sealing washer onto bulb.

3. Insert bulb into boiler fitting until bulb bottoms.

4. Slide split sleeve into fitting.

5. Place clamps A and B on assembly so that sleeve is drawn into fitting when screws are tightened. Note: make sure that nub on clamp A engages space between sleeve and clamp.

6. Tighten clamp screws evenly.

MOUNTING WITH CAPILLARY COMPRESSION FITTING

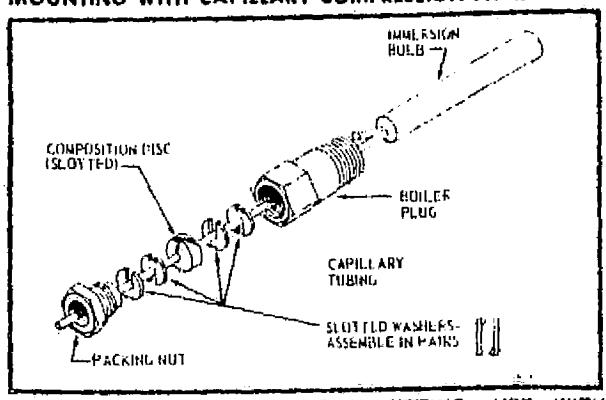


FIG. 7–CAPILLARY COMPRESSION FITTING. USE WITH MODEL L4008C,D,K, OR L6008C,E.

1. Screw fitting into boiler or pipe tapping.

2. Place packing nut on tubing.

3. Slide bulb completely through fitting.

4. Place composition disc and 4 slotted brass washers on tubing in the order shown in Fig. 7. Turn brass washers so that slots are 180 degrees apart.

5. Slide seal assembly into fitting and tighten packing nut.

DUCT MOUNTING

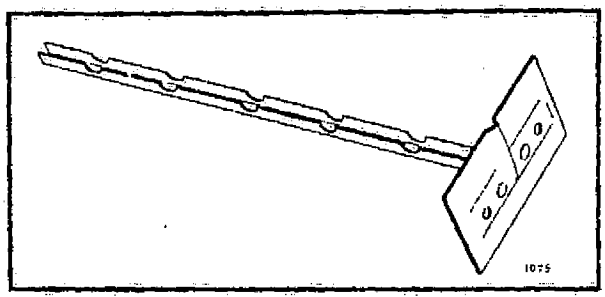


FIG. 8–BULB SUPPORT.

1. Drill a 3/4 inch hole in the duct wall large enough to admit the sensing bulb into the holder.

2. Using the holder as a template, mark and drill holes for bulb holder mounting screws.

3. Break holder to desired length (Fig. 9).

NOTE: Holder must be long enough to hold sensing bulb in freely circulating air away from duct wall. Neatly coil excess capillary at controller case or at bulb holder.

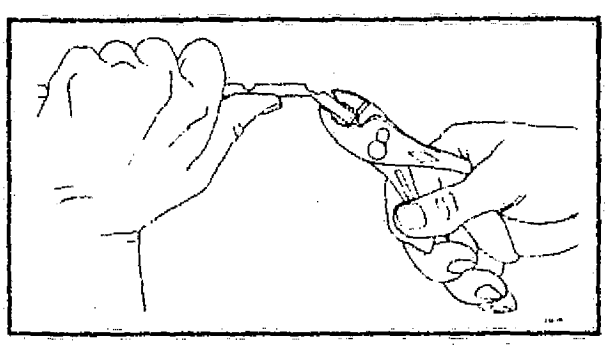


FIG. 9–REMOVING EXCESS BULB SUPPORT.

4. Place capillary in bulb holder channel. Pinch top edges of holder together at each segment (Fig. 10).

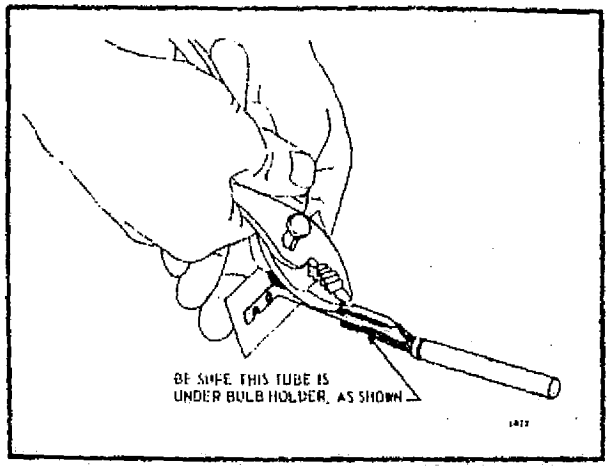


FIG. 10–SECURING CAPILLARY IN BULB HOLDER.

5. Insert bulb holder into controlled area through hole prepared in step 1 above.

6. Fasten bulb holder to duct wall with screws furnished.

MOUNTING DIRECT IMMERSION MODELS

FOR MODELS USING AN IMMERSION WELL

The well of the Aquastat controller must always be exposed to circulation of the medium under control, but must never be located close to a hot or cold inlet or steam coil. Where the tapping is on the side of the boiler, use an Aquastat controller with horizontal well. Where the tapping is on top of the boiler, use a model with a vertical well.

INSTALLING THE IMMERSION WELL

On existing installations, shut off the power and remove the old control. If the old immersion well appears suitable, and if the adapter clamp on the Aquastat controller fits the old well spud, the well need not be replaced.

1. If the system is filled, drain system to a point below the boiler tapping.

2. Remove plug (or old well) from boiler tapping.

3. Install the No. 121371 Immersion Well included with the controller. If boiler tapping is greater than 1/2 inch a reduction fitting must be used to adapt the boiler opening to the 1/2 inch threads that are standard with the well or fitting. Fittings with 3/4 inch threads are also available.

4. Fill the system. Make sure that the well is screwed in tightly enough to prevent leakage. Do NOT tighten or apply force to case after controller is secured to well.

INSTALLATION OF SENSING BULB IN IMMERSION WELL

a. Loosen screw (at top of case, above scale-setting), and remove cover. Loosen two screws that secure adapter clamp. See Fig. 11.

b. Insert the sensing element into the immersion well.

c. Fasten the case of the Aquastat controller to the well with the adapter clamp. Make certain that the clamp is properly positioned over the groove of the well spud. Also be sure the flange at the opening of the well fits snugly into the opening of the case. The sensing element bulb must bottom in the well.

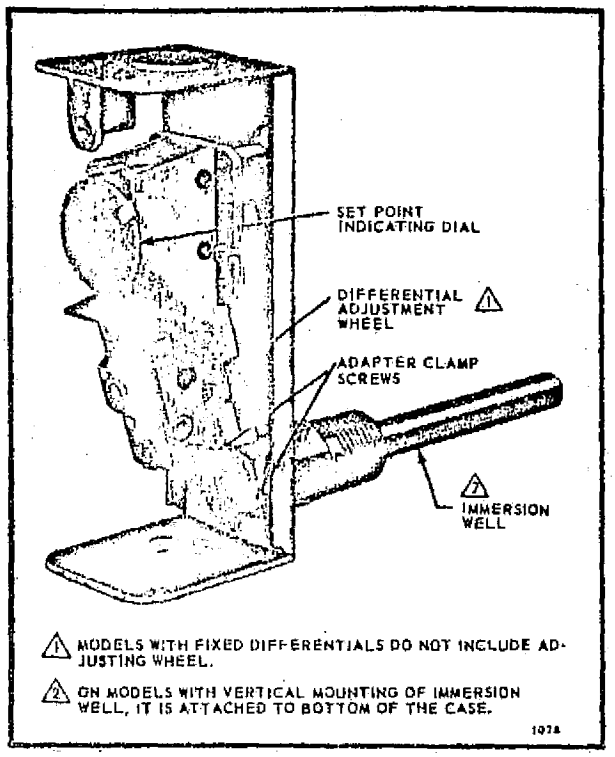


FIG. 11—INTERNAL VIEW OF L6006A.

MODELS DESIGNED FOR DIRECT IMMERSION (WITHOUT WELL)

Some models, which provide direct immersion of the sensing element into the boiler, include a No. 104486 bulb compression fitting assembly instead of an immersion well. Install fitting in boiler tapping. Be sure sealing washer is in place as shown in Fig. 12. Make sure that spud of bulb compression fitting is screwed in tightly enough to prevent leaking. Insert immersion bulb (sensing element) through bulb compression fitting. Adjust the adapter clamp so that it fits over the groove at the opening of the bulb compression fitting. Tighten adapter clamp screws so that Aquastat controller is firmly attached to bulb compression fitting.

MOUNTING DUAL FUEL CHANGEOVER MODELS

These models have a five foot capillary. This capillary establishes the maximum distance between the case and the outdoor mounting.

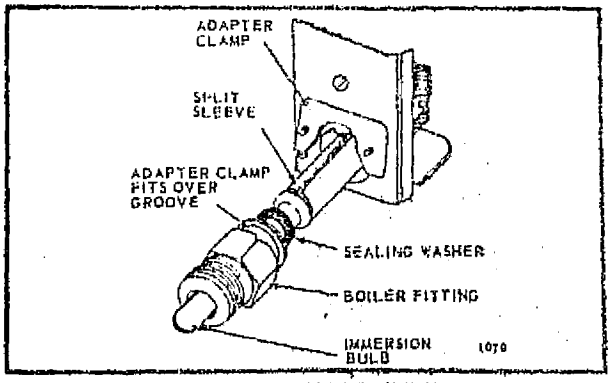


FIG. 12—DIRECT IMMERSION MODEL WITH BULB COMPRESSION FITTING PARTIALLY REMOVED.

The bulb should be installed on the outside of the building in the shield provided (see Fig. 13) where it will be exposed to representative air temperature, but not to direct sunlight. It should be mounted high enough so that accumulated snow, leaves, or other debris cannot obstruct circulation of air around it, and where children cannot reach it. Avoid vents from the building.

Install the case at the indoor location selected, fastening with screws through holes in back of the case. Bring the bulb and tubing out through a 3/4 inch hole in the outside wall. In uncoiling the tubing, carefully avoid sharp bends or kinks. Excess tubing should be left coiled near the case. Do not make sharp bends near the case or bulb.

Slip the bulb through the supports in the shield. Pinch the split supporting clip until it holds the bulb firmly in position. If the seal-off tube protrudes from under the shield, it may be bent under as shown in Fig. 13.

Hold the shield over the mounting position and form a small-radius bend in the tubing. Place the split plug around the tubing and move the shield into mounting location as a unit. Push the split plug into the hole until it is wedged securely in place. Fasten the shield in place on the wall with the screws provided.

NOTE: If the tubing is properly shaped and the split plug installed as directed, the shield will cover the split plug, and the hole in the wall will be hidden from sight.

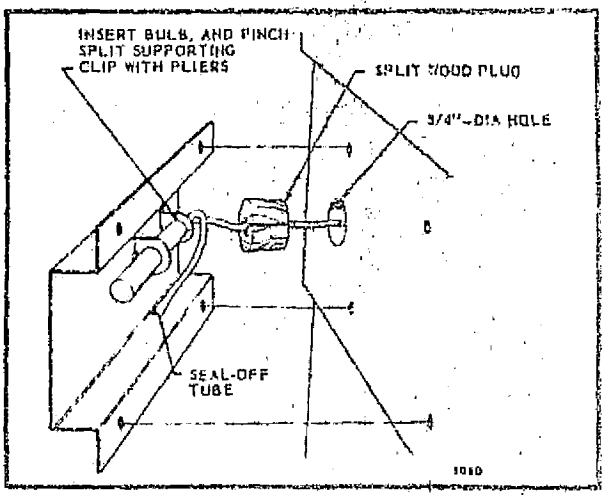


FIG. 13—MOUNTING BULB IN SHIELD OUTSIDE BUILDING.

MOUNTING THE L6008A REMOTE BULB COOLING THERMOSTAT

MOUNTING WITH GUARD BRACKET

Mount the bulb in the guard bracket as shown in Fig. 14. Locate the bulb and bracket combination in freely circulating air in the controlled area. With screws provided, fasten the bracket in place.

MOUNTING ON SUCTION LINE

1. In cooling units with more than one suction line, sensing bulb should be placed on the common line.

2. Make certain the bulb is at least 2 feet from the point at which the suction line leaves the cooler. This will prevent the outside temperature from being transmitted to the remote bulb through the copper tubing of the suction line.

3. Place the remote sensing bulb on the side of the horizontal suction line between the coil and trap (not on the trap).

4. Attach the sensing bulb to the suction line with clips or straps.

5. Coil the excess length of capillary tubing near the L6008A case.

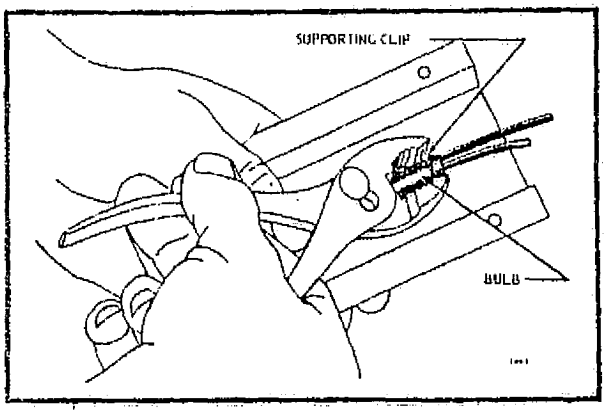


FIG. 14—SECURING REMOTE BULB IN CLIP.

WIRING

All wiring must comply with local codes and ordinances regarding wire size, type of insulation, enclosure, etc. Figures 16 through 23 show typical hook-up diagrams.

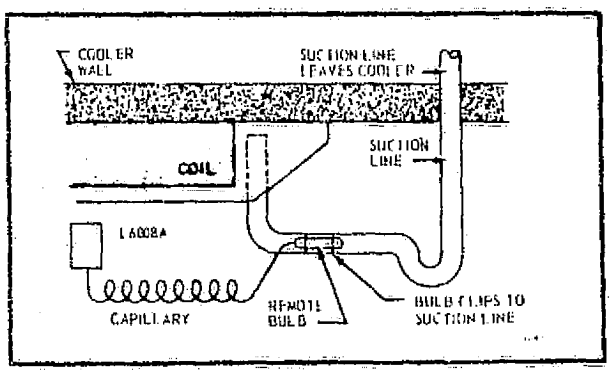


FIG. 15—ATTACHING REMOTE BULB TO HORIZONTAL SUCTION LINE.

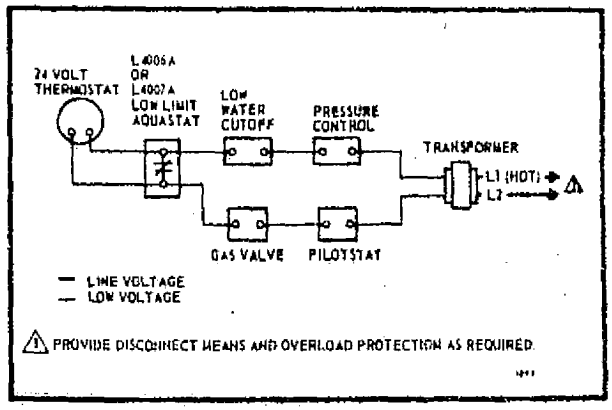


FIG. 16—TYPICAL GAS-FIRED SYSTEM WITH DOMESTIC HOT WATER.

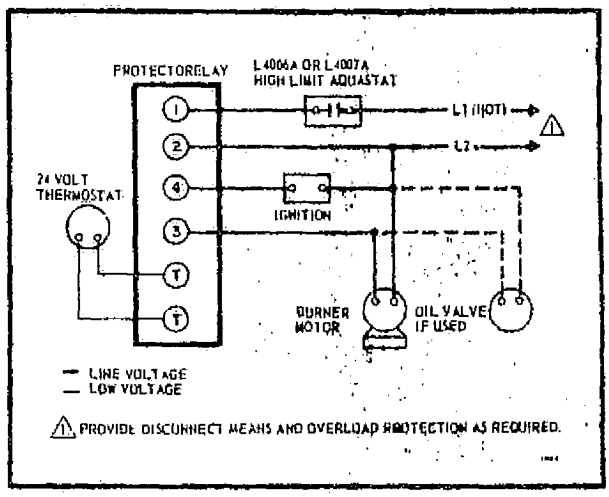


FIG. 17—TYPICAL OIL-FIRED GRAVITY SYSTEM.

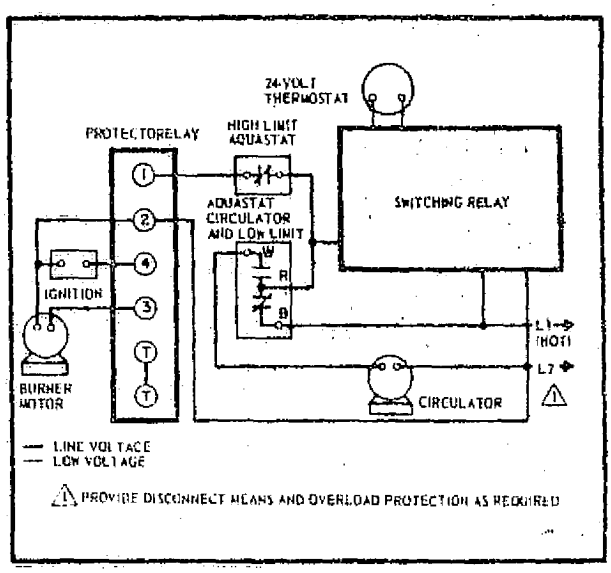


FIG. 18—TYPICAL OIL-FIRED HYDRONIC SYSTEM WITH DOMESTIC HOT WATER.

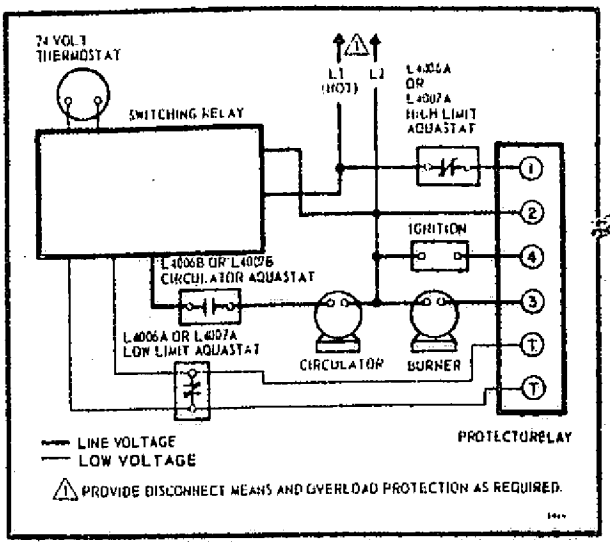


FIG. 19—OIL-FIRED SUMMER-WINTER HYDRONIC SYSTEM WITH DOMESTIC HOT WATER.

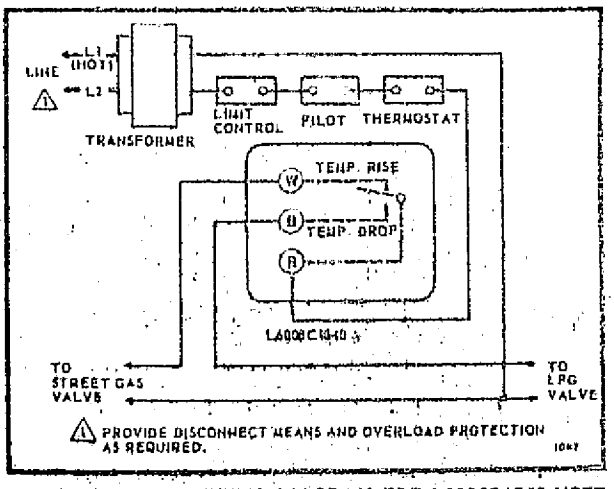


FIG. 21—TYPICAL WIRING DIAGRAM FOR L6008C1040 USED TO SWITCH STREET GAS TO LPG ON TEMPERATURE DROP.

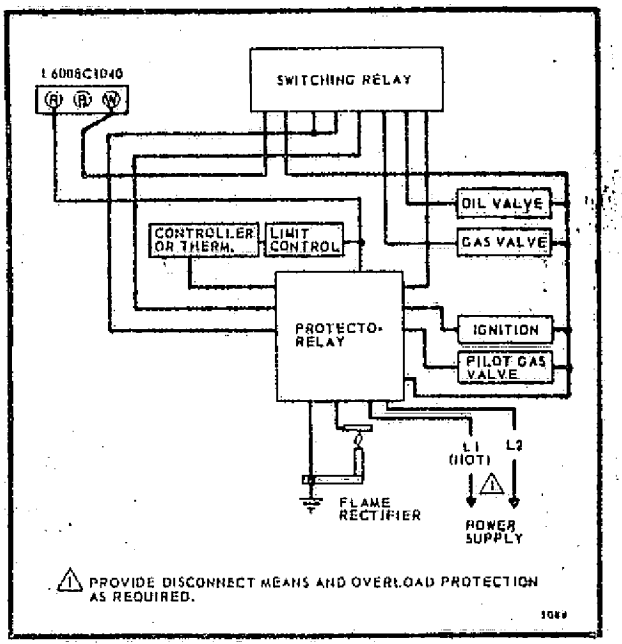


FIG. 20—TYPICAL WIRING DIAGRAM FOR L6008C1040 USED TO SWITCH FROM GAS TO OIL ON TEMPERATURE DROP.

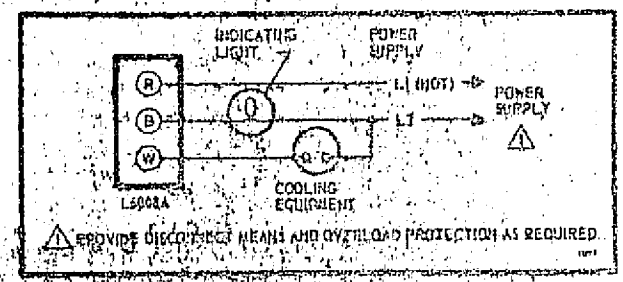


FIG. 22—L6008A USED TO CONTROL COOLING EQUIPMENT AND INDICATING LIGHT.

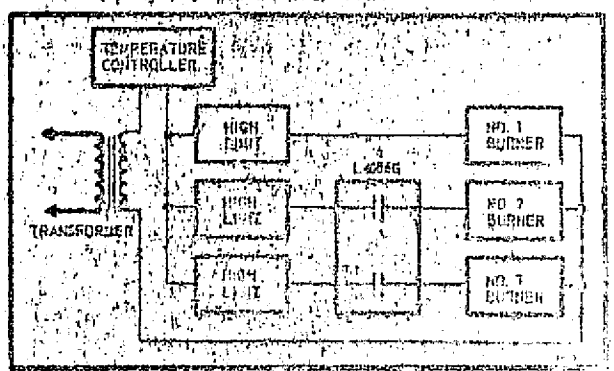


FIG. 23—TYPICAL HOOKUP FOR L4086G BOILER SEQUENCING AQUASTAT.

OR

For proper selection of settings, follow the boiler manufacturer's recommendations.

HIGH LIMIT CONTROLLER

Shuts off burner if water temperature exceeds high limit setting. Burner restarts when temperature drops to high limit setting, less differential.

NOTE: On manual reset models, the reset button on the front of the case must be pushed in to allow the burner to operate after a high limit shutdown.

LOW LIMIT CONTROLLER

Maintains minimum boiler temperature for domestic hot water. Turns on boiler at temperature setting, minus differential.

CIRCULATOR CONTROLLER

Prevents circulation of water that is below the desired heating temperature. Breaks circulator circuit on temperature drop below setting minus differential, remakes on rise to setting.

ADJUSTING

Set the differential to correspond with the boiler manufacturer's recommendations. To adjust models with adjustable differential, rotate the wheel on the back of the snap switch until the desired reading is aligned with the "V" notch in the frame. The wheel provides an adjustment from 5 to 30 F. Replace the cover on the Aquastat controller.

Adjust the control point to correspond with the boiler manufacturer's recommendations. To adjust, insert a screwdriver in the slotted screw-type head located beneath the window in the cover. Turn the scale to the desired control point.

L6008A LOCATION DIFFERENTIAL CALIBRATION

The L6008A1093 is calibrated for applications with both the bulb and case located in the room in which the temperature is being controlled. A correction will be necessary if the temperature of the case is different from the desired dial setting.

1. If the case is at a higher temperature than the desired dial setting, raise the desired dial setting by the correction determined from the table at right.

2. If the case is at a lower temperature than the desired dial setting, lower the desired dial setting by the correction determined from the table below.

Temperature difference between desired room temperature and case temperature (F)	Correction (Degrees F)
0	0
5	3/4
10	1-1/2
15	2
20	2-3/4
25	3-1/2
30	4-1/4
35	5
40	5-3/4
45	6-1/2
50	7
55	8
60	8-1/2
70	10
80	11-1/2

START-UP

Check to make certain that the Aquastat controller has been installed and adjusted properly. Put the system into operation and observe the action of the device through several cycles to make certain that it provides proper control of the system as described under OPERATION. Further adjustments then can be made to meet more exact comfort requirements.

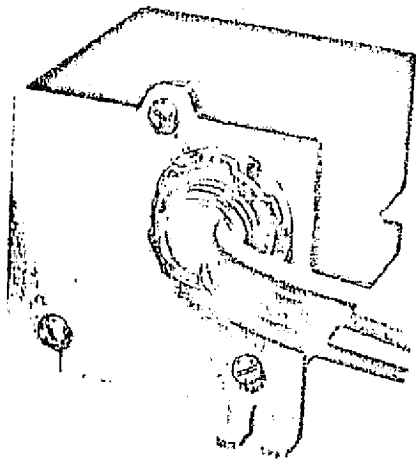
J-54

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

FAN RELAYS



R8225A-D

R8225 Fan Relays provide low voltage control of line voltage fan motors and auxiliary circuits in heating, cooling, or heating-cooling systems.

- ☐ Half inch conduit spud fitting for mounting on junction box.
- ☐ Color coded leadwires for wiring.
- ☐ Totally enclosed for long, trouble-free service life.

C.S.
1-76 (.028)

Form Number

J-55

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 AVAILABLE: R8225A Fan Relay—spdt switching.

ADDITIONAL FEATURES: Tradeline pack with cross reference label and special instruction sheet. Includes flush mounting bracket.

ELECTRICAL RATINGS:

CONTACTS	120V AC	240V AC
Normally open	1 hp	1 hp
	16 AFL	8 AFL
	96 ALR	48 ALR
	16 A Res.	8 A Res.
Normally closed	3/4 hp	3/4 hp
	13.8 AFL	6.9 AFL
	82.8 ALR	41.4 ALR
	14 A Res.	7 A Res.

STANDARD MODELS

MODELS:

R8225A Fan Relay—spdt switching; one normally open and one normally closed 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.

ELECTRICAL RATINGS:

CONTACTS	120V AC	240V AC
Normally open	3/4 hp	1 hp
	13.8 AFL	8 AFL
	82.8 ALR	48 ALR
	16 A Res.	8 A Res.
Normally closed	3/4 hp	3/4 hp
	13.8 AFL	6.9 AFL
	82.8 ALR	41.4 ALR
	14 A Res.	7 A Res.
Auxiliary	1/10 hp	1/8 hp
	3 AFL	1.9 AFL
	18 ALR	11.4 ALR
	3 A Res.	2 A Res.

COIL CHARACTERISTICS:
Coil Voltage—24v, 60 Hz.
Inrush—11 va maximum.
Sealed—6 va maximum.
Pull-in voltage—18v at 75 percent rated voltage.

CONTACTS: Silver cadmium oxide.

MAXIMUM OPERATING AMBIENT: 115 F.

CASE: Molded plastic with steel mounting plate.

MOUNTING MEANS: Mounts with threaded 1/2 inch conduit spud.

DIMENSIONS: See Fig. 1.

LISTING BODIES: R8225A-D Fan Relays are listed by Underwriters' Laboratories, Inc. under file number E14480, guide number NLDX, and by the Canadian Standards Association under file 1620.

ACCESSORY: Flush mounting bracket 134259. See Fig. 2.

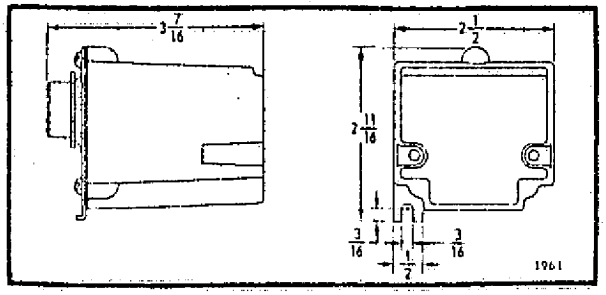


FIG. 1—R8225 INSTALLATION DIMENSIONS (IN INCHES).

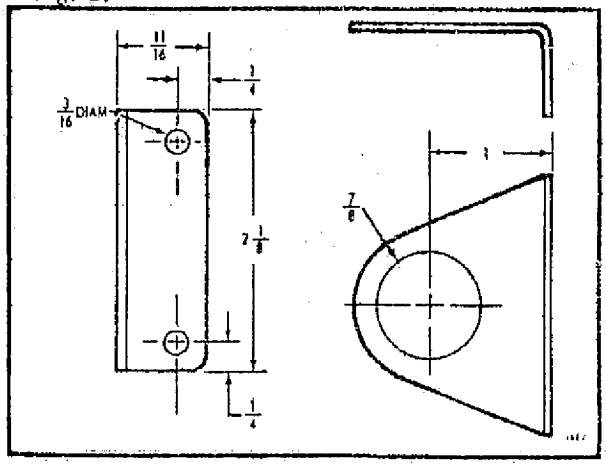


FIG. 2- MOUNTING BRACKET DIMENSIONS (IN INCHES).

ORDERING INFORMATION

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

SPECIFY—
1. MODEL NUMBER.
2. ACCESSORY, 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.

INSTALLATION

LOCATION AND MOUNTING

R8225A-D Fan Relays may be mounted in any position. They have a 1/2 inch conduit spud for mounting on a junction box.

To mount, remove the conduit spud nut and place the spud through the junction box knockout. Replace nut and tighten. Drill a hole in the mounting surface and secure relay in place using a screw through tab of the mounting plate. See Fig. 1 for mounting dimensions.

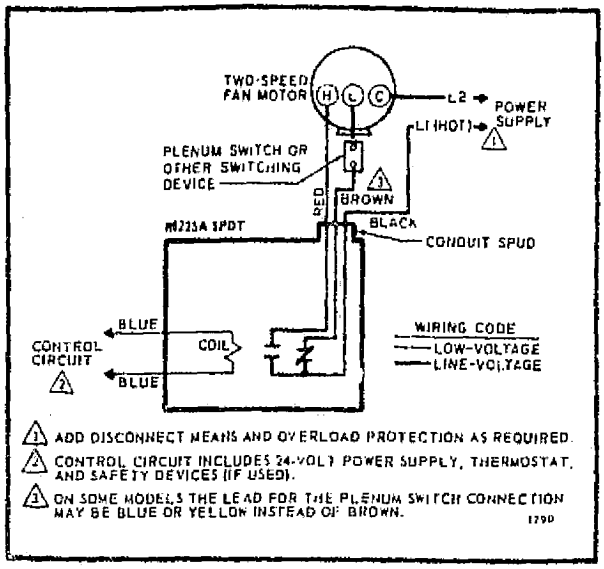


FIG. 3–R8225A TYPICAL HOOKUP WITH TWO SPEED FAN.

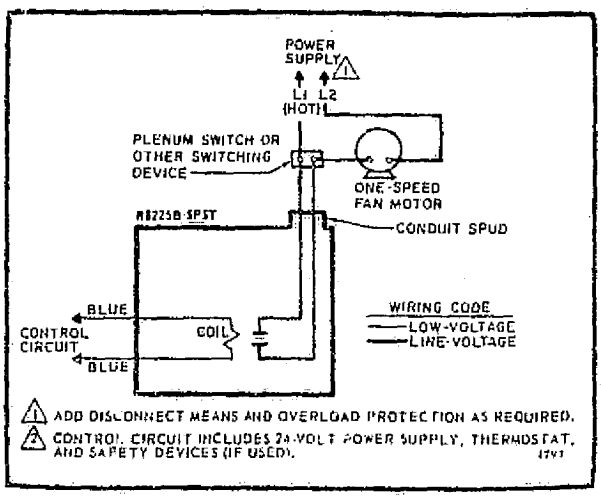


FIG. 4–R8225B TYPICAL HOOKUP WITH ONE SPEED FAN.

WIRING

All wiring must comply with local codes and ordinances. Refer to information furnished with system equipment and to Figs. 3-6 when wiring.

CAUTION!

Disconnect power supply before making wiring connections to prevent electrical shock and equipment damage.

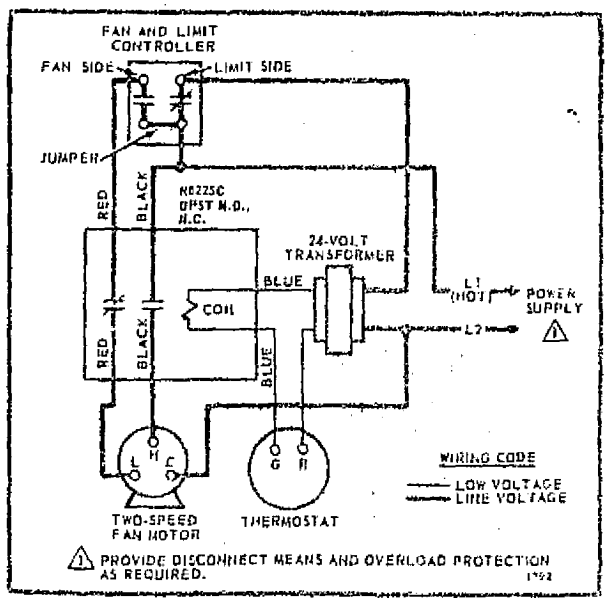


FIG. 5–R8226C TYPICAL HOOKUP WITH TWO SPEED FAN AND COMBINATION FAN AND LIMIT CONTROLLER.

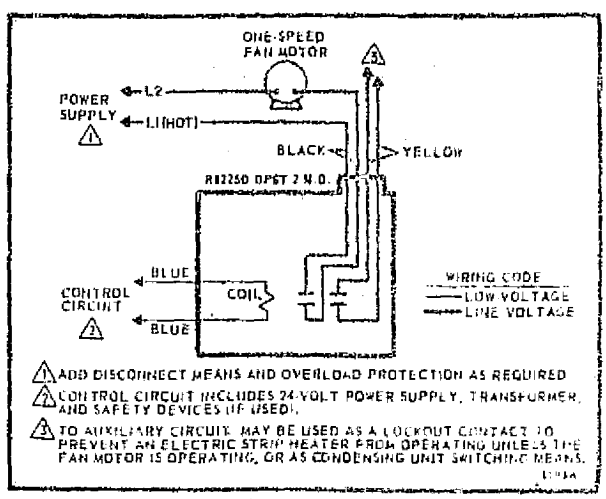


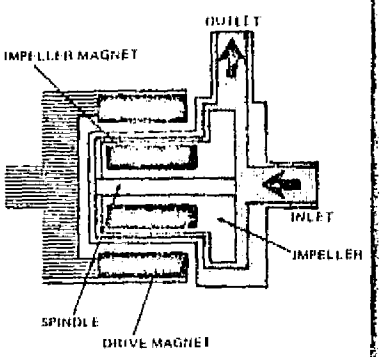
FIG. 6–R8225D WITH ONE SPEED FAN AND AUXILIARY LOAD.

CHECKOUT

Operate the system, following the manufacturer's instructions. Operate through at least one complete cycle on both heating and cooling to make sure that system and fan relay operate as intended.

March Circulators are designed for closed and open boiler or domestic hot water systems, and as replacements for hydronic zone valves. Eight models with two capacities are offered. Bronze head pumps are recommended for open systems to resist rust and foreign deposit build-up. Cast iron volutes should be used only on closed circuits where the water is circulated constantly and mineral deposits are minimized.

March's proven magnetic drive eliminates the troublesome, old-fashioned shaft seal. There can be no seal wear, power-robbing friction or leakage thru the seal. Impeller and drive magnets are permanent ceramic type. They prevent slippage and insure that full motor horsepower is converted into pumping power.



Energy requirements are lowered as all the energy produced by the motor is utilized, especially important in solar energy systems.

Seal-less drive also provides for faster, easier motor service, as the motor can be removed without draining, refilling and reheating the system.

March circulators are easily installed, either vertically or horizontally, with a choice of standard flanges on the 821 series. Whisper-quiet operation is assured by micro-balanced motor fan and dynamically balanced magnets. Just two more reasons why March should be your first choice for most every application!

SERIES 809

The compact, bronze head Model 809 is ideal for domestic and commercial loops, providing instantaneous hot water at every outlet. Compared with standard circulators, the 3 gpm 809 is smaller, lighter and more economical to buy and operate.

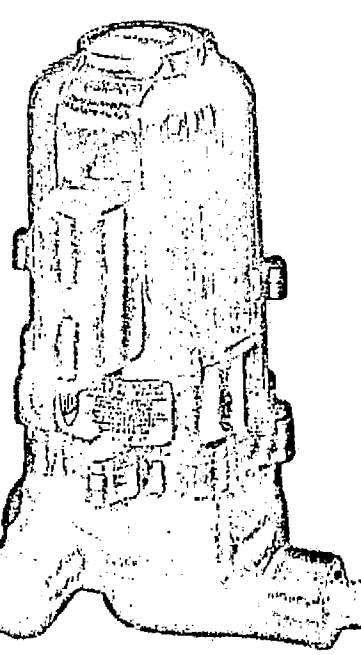
Model 809 DF

Same as above except equipped with dual fans for quieter, cooler running in closed-in or hot ambients.

Model 809 DF-24

24 volt version to replace troublesome hydronic zone valves. Eliminates the need for a main boiler circulator.

SERIES 821



Model 821 is a high capacity, 22 gpm, cast iron circulator for closed systems not requiring bronze construction. The March design drastically reduces weight and bulk and costs less than conventional circulators. Common flange sizes of ¾", 1", 1¼", and 1½" plus a standard 6⅜" flange to flange dimension makes the 821 a perfect replacement pump.

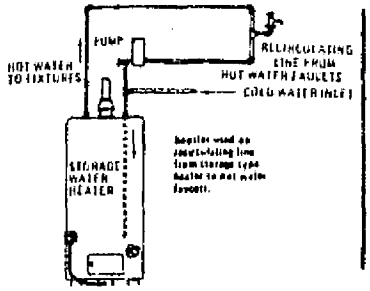
Model 821-BR

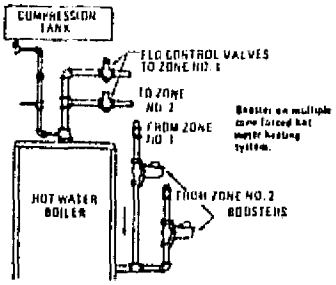
Same as above except for bronze pump head and flanges. The right one for domestic hot water systems.

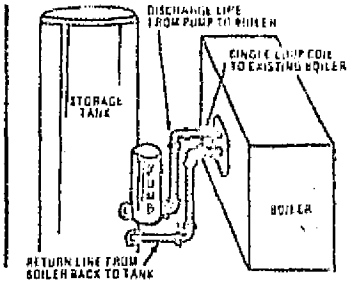
Model 821-VBR

Vertical mount bronze unit ideal for hot water heaters and aquastat boosters. ¾" FPT inlet and outlet are 90° apart and in a horizontal plane, permitting fast and easy corner installation.

TYPICAL INSTALLATIONS







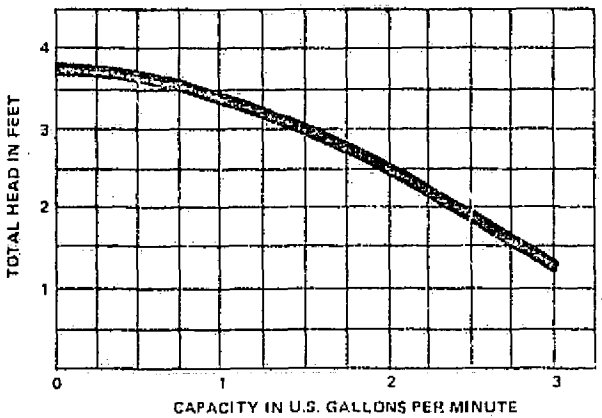
SPECIFICATIONS

809 809 DF 809 DF-24	3 gpm	3.5'	1.5	½" MPT	1/200	1600	115 or 230 24	60	Single	30	.36	4.5 lbs.
821 821-BR 869	22 gpm	8.5'	3.4	¾", 1", 1¼", 1½" Flanges.	1/20	1600	115 or 230	60	Single	110	1.8	11 lbs.
821-VBR 869-V	22 gpm	8.5'	3.4	threaded ¾" FPT	1/20	1600	115 or 230	60	Single	110	1.8	11 lbs.

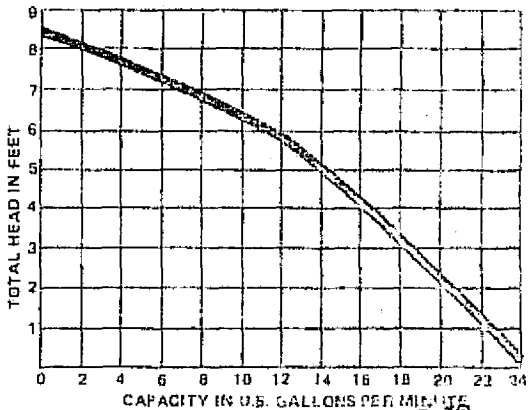
* On flanged models, please specify flange size desired.
** Continuous duty motor, thermal overload protected. 230 volt motors available—consult factory.
*** Pumping room temperature water.

PERFORMANCE RATINGS

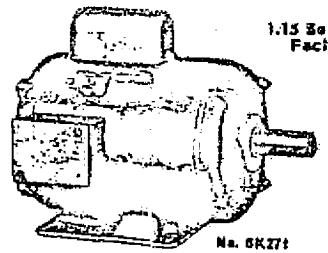
MODEL 809

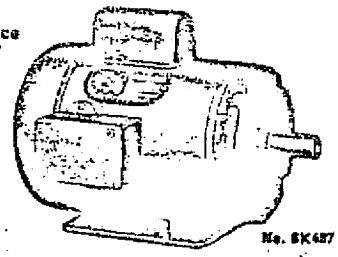


MODELS 821 AND 869



GENERAL PURPOSE T-FRAME CAPACITOR MOTORS

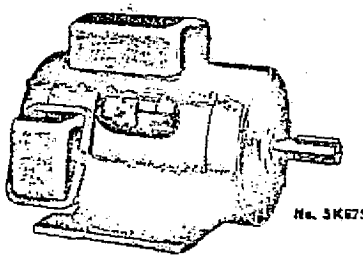




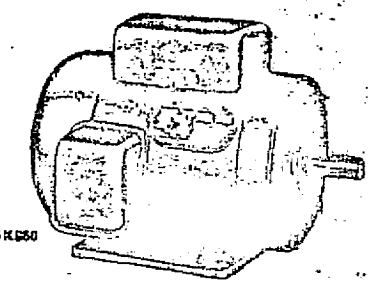
Dayton

$83.59
1 HP
Dripproof

$91.85
1 HP
TEFC



DRIPPROOF



TOTALLY ENCLOSED, FAN-COOLED

Built in accordance with the latest NEMA standards. For general purpose applications—pumps, air compressors, conveyors, machinery, etc. Open, dripproof models; and TEFC motors for operation in dusty, oily, moist locations. Available in capacitor-start, induction run and capacitor-start, capacitor-run types, 1800 and 3600 RPM, 115/208-230, 115/230 and 230V, 60 Hz. Rigid mount. Pre-lubricated, double-shielded ball bearings. 40°C ambient, 1.15 or 1.0 service factors, Class B insulation (60 or 75°C rise), continuous duty. Rotation easily reversed by electrical reconnection. Recognized by UL for construction under the Motor Component Recognition Program. CSA approved. Gray finish. Dayton brand.

1 to 10 HP DRIPPROOF NEMA T-FRAME MOTORS—RIGID MOUNT

Ball Bearings • 60°C Rise • 1.15 Service Factor • Class B Insulation

HP	RPM	Volts 60 Hz	NEMA Frame (See p. 18)	Full-Load Amps @230V	Stock No.	Retail	Each	Shpg. Wt.	COMPLETE with MAGNETIC STARTER Stk. No.	COMPLETE with MAGNETIC STARTER Each*	COMPLETE with MANUAL STARTER Stk. No.	COMPLETE with MANUAL STARTER Each*
¼	1800	115/208-230	56HZ**	7.5	6K271	$127.66	$93.69	39	7K247	$142.71	7K259	$112.79
1½	1800	115/208-230	56HZ**	10.5	6K272	160.75	103.26	38	7K249	154.35†	7K231	121.45†
2	1800	115/230	182T	13.5	6K963	180.00	144.00	52	7K919	233.12†	7K313	160.80†
3	1800	115/230	184T	18.6	6K975	241.50	183.20	70	7K234	223.62†	7K297	229.70†
5	1800	230	213T	25.0	5K073†	307.50	204.60	100	7K235	378.45	7K377	348.85
7½	1800	230	215T	36.0	6K977†	507.00	403.00	124	7K236	535.53	—	—
10	1800	230	215T	44.0	6K100†	633.00	503.40	114	7K241	717.58	—	—

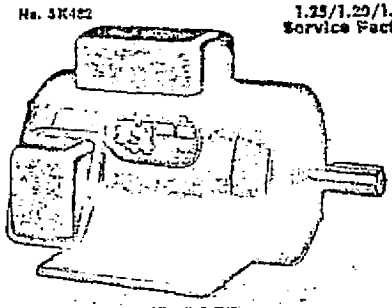
1 to 7½ HP TEFC NEMA T-FRAME MOTORS—RIGID MOUNT

Ball Bearings • 75°C Rise • 1.0 Service Factor • Class B Insulation

¼	1800	115/208-230	56HZ**	6.5	6K407	$140.26	$91.85	33	7K229	$159.97	7K262	$121.05
1½	1800	115/208-230	56HZ**	8.2	6K419†	173.36	113.52	41	7K231	172.84†	7K263	142.72†
2	1800	115/230	182T	11.8	6K966	258.50	205.20	57	7K316	284.32†	7K321	261.70†
3	3600	115/230	182T	14.8	6K145	297.00	237.60	65	7K242	304.02†	7K343	274.10†
	1800	115/230	184T	14.5	6K567†	324.00	255.20	79	7K317	328.62†	7K322	295.70†
5	3600	230	184T	23.0	6K146†	406.50	325.20	88	7K244	407.68	7K375	377.70
	1800	230	213T	23.0	5K003†	442.50	354.00	106	7K319	423.43	7K374	403.56
7½	3600	230	213T	32.0	6K179†	523.50	418.00	112	7K428	550.02	—	—
	1800	230	215T	34.0	6K170†	598.50	478.50	136	7K245	610.92	—	—

**) Has same shaft and mounting dimensions as 143T and 145T frames.
†) Capacitor-start, capacitor-run type; all others, capacitor-start, induction run.
*) Prices shown are for motors with 115 or 230V thermal protected starters. Specify voltage. Start-stop station included with magnetic starters.
(†) Price is slightly higher where 115V is specified. (‡) Starter available for 230V only.

HEAVY DUTY U-FRAME CAPACITOR MOTORS



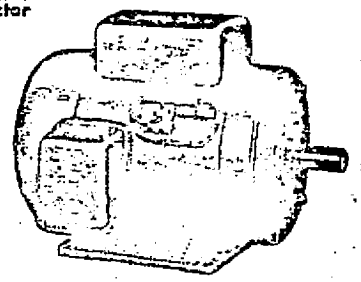
1.25/1.20/1.15 Service Factors

Dayton

$126.00
½ HP
Dripproof

$184.80
1 HP
TEFC

1.0 Service Factor



DRIPPROOF

TOTALLY ENCLOSED, FAN-COOLED

Heavy duty capacitor motors designed and built for dependable performance on air compressors, machinery, farm equipment, pumps, conveyors, etc. High starting torque with normal starting current characteristics. Totally enclosed, fan-cooled models for areas where dirt, dust, moisture and other contaminants are present. Capacitor-start, induction-run type except 5 HP units are capacitor-start, capacitor-run. 1800 RPM, 115/230 and 230V, 60 Hz. Rigid mount. Pre-lubricated, double-shielded ball bearings. Cast aluminum end bells, cast aluminum, perfectly balanced rotor for smooth, quiet operation. Solid steel frame. 40°C ambient, Class A insulation (40 or 55°C rise), continuous duty. Open, dripproof motors have 1.25 (1 HP), 1.20 (1½ and 2 HP) and 1.15 (3 and 5 HP) service factors; TEFC models, 1.0 service factor. Precision constructed in accordance with NEMA mechanical and electrical standards. Large conduit box for easy wiring. NEMA 182 to 215 frames. Recognized by UL for construction under the Motor Component Recognition Program. CSA approved. Gray enamel finish. Dayton brand.

1 to 5 HP DRIPPROOF NEMA U-FRAME MOTORS—RIGID MOUNT

Ball Bearings • 40°C Rise • 1.25/1.20/1.15 Service Factors† • Class A Insulation

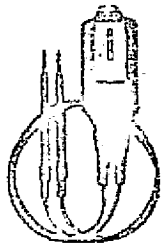
HP	RPM	Volts 60 Hz	NEMA Frame (See p. 18)	Full-Load Amps @230V	Stock No.	Retail	Each	Shpg. Wt.	COMPLETE with MAGNETIC STARTER Stk. No.	COMPLETE with MAGNETIC STARTER Each*	COMPLETE with MANUAL STARTER Stk. No.	COMPLETE with MANUAL STARTER Each*
1	1800	115/230	182	7.2	5K480	$157.50	$126.00	42	7K210	$185.12	7K253	$155.29
1½	1800	115/230	184	11.0	5K481	189.75	151.80	49	7K211	218.52†	7K254	181.00†
2	1800	115/230	213	12.5	5K482	225.00	180.00	68	7K212	253.12†	7K255	216.80†
3	1800	115/230	215	16.5	5K483	302.25	241.80	86	7K213	293.23†	7K256	278.30†
5	1800	230	215	24.0	5K484†	459.75	367.80	102	7K274	450.23	7K378	420.35

1 to 5 HP TEFC NEMA U-FRAME MOTORS—RIGID MOUNT

Ball Bearings • 55°C Rise • 1.0 Service Factor • Class A Insulation

1	1800	115/230	182	8.0	5K485	$231.00	$184.80	49	7K223	$243.02	7K257	$214.00
1½	1800	115/230	184	8.0	5K429	270.00	216.00	56	7K225	278.12†	7K258	245.20†
2	1800	115/230	213	12.6	5K437	321.00	256.80	80	7K227	316.52†	7K259	293.30†
3	1800	115/230	215	16.8	5K488	405.00	324.00	100	7K229	390.42†	7K260	380.30†
5	1800	230	215	21.0	5K450†	553.50	442.80	120	7K278	625.23	7K376	495.30

(*) Prices shown are for motors with 115 or 230V thermal protected starters. Specify voltage. Start-stop station included with magnetic starters. (†) Capacitor-start, capacitor-run type.
(†) Price is slightly higher where 115V is specified.
(‡) Service factors: 1 HP, 1.25, 1½ and 2 HP, 1.20, 3 and 5 HP, 1.15.



SQUARE D VOLTAGE TESTER

110/220/440/550VAC 60 Hz. 125/250/400VDC

$11.55 Quickly determines nominal voltage of DC and 60 Hz AC circuits. Easy to use, safer and more rugged than many other testers. Test prod tips are safely-designed, with spring-loaded retractable shrouds surrounding hardened steel spear points to prevent accidental contact of spear point with exposed terminals or bare wire. Entire unit completely sealed in shockproof molded case for operator safety and to protect mechanism from dust, dirt and foreign objects. Tester comes complete with two 30" heavy duty test leads and magnet. DC polarity. Individually cartoned. Square D brand (5008). Ships. wt. 8 oz.

No. 4X409. Square D AC/DC Voltage Tester. Retail $21.00. Each.....$11.55

Phone the Friendly People at Grainger's—They Can Help You

SEE WARRANTY INFORMATION ON PAGE BEFORE INDEX

Installation Instructions

344 & 344S
Series A

BLOWER UNIT HEATERS

bryant

39344D1
11/15/71

Before proceeding to install Models 344 and 344S Blower Unit Heaters, refer to Bryant form No. 39003D1 "Procedures for Gas Appliances" (packaged with the equipment) for information concerning combustion, venting, piping, and other standard installation practices. The current edition of the American National Standard "Installation of Gas Appliances and Gas Piping", Z21.30, takes precedence over all other reference publications pertinent to this installation instruction. Both models are shipped factory-assembled. Installation comprises the following:

* I. Inspection
* II. Location and Suspension
* III. Gas Piping
IV. Wiring
* V. Venting
VI. Start-up and Adjustment
VII. Service and Maintenance

*To perform these sections (or installation steps), refer to the appropriate sections of Bryant form No. 39003D1 (packaged with this equipment).

SPECIAL AIRPLANE HANGAR AND GARAGE APPLICATION PRECAUTIONS

NOTE: Refer to NFPA No. 409-1969, "Standard on Aircraft Hangars," and NFPA No. 88-1968, "Standard for Garages."

1. A clearance of 10 feet to bottom of Heater from top of a wing or fuselage of aircraft likely to be housed in hangar must be maintained.

2. A minimum clearance of 8 feet from floor to bottom of Heater in other sections of aircraft hangar, such as offices and shops which communicate with areas used for servicing or storage, must be maintained.

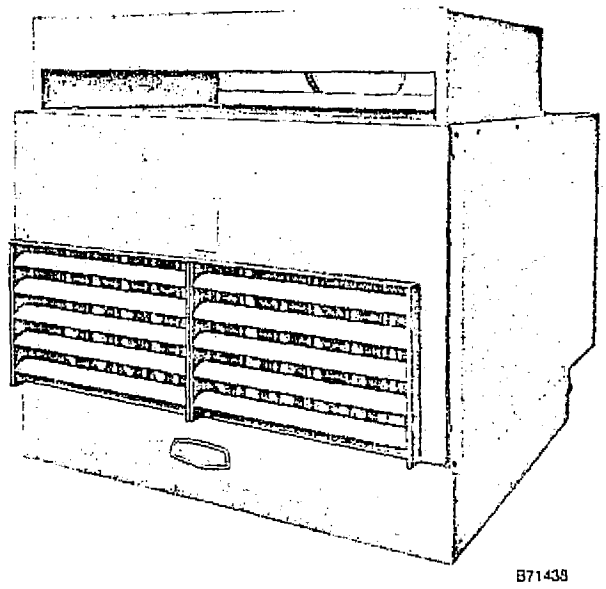


Figure 1

3. Heater must be so located that it is protected from damage by aircraft or other objects such as cranes or movable scaffoldings. In addition, it must be located to be accessible for servicing and adjustment.

4. A clearance of 6 inches from combustible material must be maintained from top and flue connector. Eighteen inches on each side and 24 inches from any obstruction at bottom of Heater must be maintained.

TABLE I—CONTROL OPTIONS[1]

COMPONENT	PROPANE GAS D2	NATURAL D4	NATURAL D5
Bryant Auto Pilot	—	x	x
Bryant Gas Valve*	x	x	x
Gas Pressure Regulator*	—	x	x
Transformer	x	x	x
100% Shutoff	x	—	x
Thermocouple Pilot	x	—	x
Pilot Relay or Pilostat	x	—	x

[1]All three options available on 344 & 344S are available with D2 propane and D5 natural gas only.

**A-643 Bryant Gas Valve with integral Gas Pressure Regulator is used on D4 and D5 for size 150; A-641 Gas Valve without regulator is used on D2 for all sizes. A-641 with separate Gas Pressure Regulator is used on D4 and D5 for sizes 200 thru 400.*

J-61

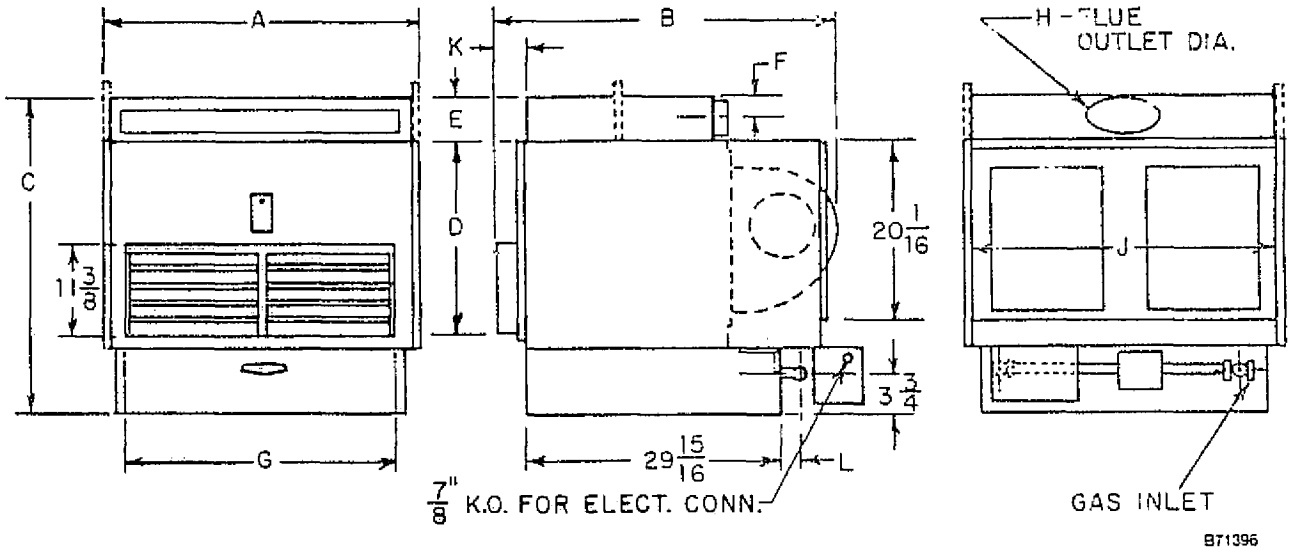


Figure 2 - Dimensional Drawing

TABLE II—DIMENSIONS IN INCHES—MODEL 344

Size	A	B	C	D	E	F	G	H	J	K	L	Gas Inlet	Approx. Shipping Weight
150	18-1/2	44-3/16	30-1/16	21-3/4	5-11/16	2-7/8	14-3/8	7	17	3-3/16	3-7/16	1/2	215
200	24-1/2	44-3/16	34-9/16	21-3/4	5-11/16	2-7/8	17-3/8	8	23	3-3/16	3-7/16	1/2	280
250	33-1/2	44-3/16	34-9/16	21-3/4	5-11/16	2-7/8	28-3/4	8	32	3-3/16	3-9/16	3/4	380
300	39-1/2	44-3/16	36-9/16	21-3/4	7-11/16	3-7/8	34-3/4	9	38	3-3/16	3-9/16	3/4	465
400	51-1/2	44-3/16	38-1/16	21-3/4	9-3/16	4-5/8	46-3/4	10	50	3-3/16	3-5/16	3/4	625

Specific Location and Suspension Precautions

For general location and suspension information, refer to Section II of Bryant form No. 39003D1. In addition, the following precautions should be observed when selecting a mounting site.

1. Direct heated airstream toward area having greatest heat loss.

2. For multiple installations, locate Heaters so that each will warm a specific area. Arrange so that overall air pattern results in continuous circular flow of warm air throughout space.

3. Do not locate Heater in areas where combustion air is limited, or is not replaced.

4. If located in spaces equipped with exhaust fans, provide sufficient makeup air to allow proper venting of Heater.

5. Two 1/2-inch pipe tappings are provided in top casing for use in suspending Heater. Use pipe unions to join Unit Heater to ceiling hangar. Two additional 1/2-inch pipe tapped brackets are supplied for balancing Heater.

IV. WIRING

Make all electrical connections in accordance with the National Electric Code and any local codes that may apply.

If aluminum conductors are to be used, the wire size selected must have a current capacity not less than that of the copper wire specified and must not create a voltage drop between the service panel and the unit in excess of 2% of the unit rated voltage. As a minimum, aluminum wire must be treated to prevent oxidation.

With electric power turned off, recheck all electrical connections (both factory and field) for tightness. Be sure to check power supply connections, especially if aluminum conductors are used.

The Blower Unit Heater is completely wired at the factory and is ready for connections to power source. See wiring diagram.

The heat anticipator on the thermostat should be set at 0.8 amps.

TABLE III—THROW CHART

Model	Velocity High Speed ft/min	High Speed		Low Speed		EFFECTIVE THROW* AND MOUNTING HEIGHT												
		CFM	Temp Rise °F	CFM	Temp Rise °F	Distance from Floor to Top of Heater in Ft.												
						8	10	12	14	16	18	20	22	24	26	28	30	32
150-344	2100	1650	65	1340	80	100	98	95	93	90	88	85	83	80	78	75	73	70
200-344	2100	2100	67	1700	85	100	98	95	93	90	88	85	83	80	78	75	73	70
250-344	2100	3100	60	2600	70	120	118	115	113	110	108	105	103	100	98	95	93	90
300-344	2100	3600	60	3000	70	130	128	125	123	120	118	115	113	110	108	105	103	100
400-344	2100	4200	67	3400	85	130	128	125	123	120	118	115	113	110	108	105	103	100

*Effective throw as shown is the horizontal distance in feet that the heated airstream travels from the outlet of the unit heater with louvers positioned for maximum throw with air reaching the floor. Spread or width of the air pattern is approximately 20% of the maximum throw. For additional spread, use vertical louvers. Above data are test results.

VI. START-UP AND ADJUSTMENT

1. Start unit using procedure outlined on lighting instruction plate attached to Heater.

2. Adjust pilot flame. Use adjusting screw under screw cap on pilot valve for this purpose.

For D4 controls, flame should be long enough for good impingement on metal element of Bryant automatic pilot. For D5 and D2 controls, flame should surround thermocouple element of pilot and extend downward to include 3/8 to 1/2 inch of thermocouple. Flame should never come in contact with any other part of thermocouple or its lead wire.

To adjust pilot flame on units equipped with a Model A-643 valve, adjustment screw is located in pilot outlet portion of valve body. Remove capscrew, make necessary adjustment, and replace capscrew.

3. Check input. Input should be checked at meter to make sure that it corresponds with input shown on rating plate attached to unit. See Bryant form No. 39003D1 for method.

4. Final Checkout. Move thermostat setting above and below room temperature several times, pausing between each "on" and "off" cycle to make sure that main burners ignite properly.

Attach a low-voltage test light to electrical leads of gas valve. With thermostat set above room temperature, close manual pilot valve. If light goes out when pilot cools, pilot is functioning properly. The test light should go out within 45 seconds after pilot gas supply is turned off.

Check the operation of temperature limit control. This can be done by allowing burners to operate while fan is not running to see that limit switch opens.

Check all connections in the gas piping for leaks. Use a soap-and-water solution.

WARNING: Never use a flame to check for leaks.

VII. SERVICE AND MAINTENANCE

1. Pilot Orifice - is located in bottom fitting of pilot and is readily accessible for inspection and cleaning.

2. Main Burner Orifices - The orifice is readily unscrewed from manifold after burner is removed.

3. Removing Main Burners - Lift rear of burner and push it away from manifold enough to disengage orifice spud from mixer shield. Then pull down and out of Heater. End of burner away from manifold seats in a slotted burner support. It is necessary to lift burner out of this slot before attempting to push burner back. See Figure 8.

NOTE: Disconnect the pilot tubing and wires to remove the burner that holds the pilot. However, it is not necessary to remove the pilot itself from the burner.

4. Cleaning - Heat exchanger tubes should be inspected at regular intervals and cleaned when necessary.

a. Shut off gas and electricity. Heater should be cool.

b. Disconnect pilot tube and wires.

c. Remove main burners and pilot.

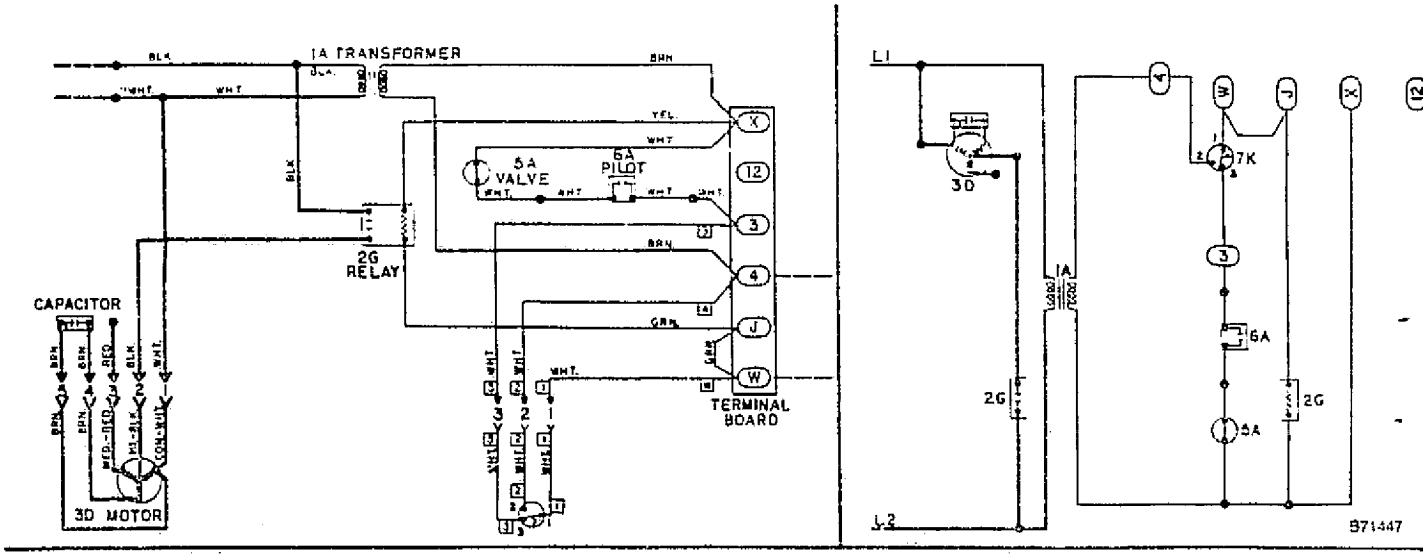
d. Use stiff brush to scrub heat exchanger tubes. Remove all loose scale and any soot that may have collected.

e. Replace burners and pilot. Reconnect pilot tube and wires.

f. Unit is now ready for relighting.

5. Oiling-direct-drive sleeve-bearing blower motors are prelubricated and normally will not need further oiling for approximately 5 years. Lubricating then should be performed by an experienced serviceman as blower assembly will have to be disassembled.

Each sleeve bearing on above motors should be oiled with 25 drops of SAE 20 nondetergent motor oil annually after 5 years. Avoid over-oiling.



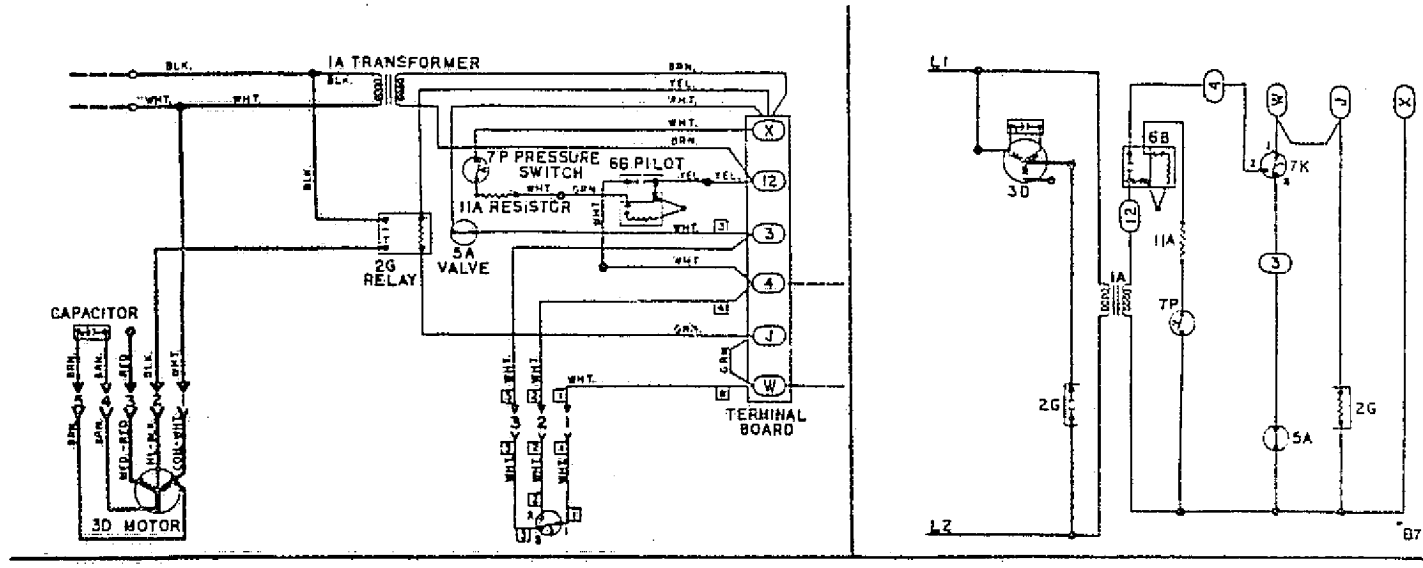
IF ANY OF THE ORIGINAL WIRE AS SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACED WITH TYPE SFF-2 150C FOR 24-VOLT CIRCUITS AND APPLIANCE WIRING MATERIAL 105C FOR LINE VOLTAGE CIRCUITS.

THIS UNIT IS APPROVED FOR 0.25 WC STATIC 55° TO 85° RISE, SEE INSTALLATION INSTRUCTIONS OR APPLICATION MANUAL BEFORE CHANGING SPEED TAPS OR ADDING DUCTWORK.

— FACTORY LINE VOLTAGE
— FACTORY LOW VOLTAGE
– – – FIELD LINE VOLTAGE
– – – FIELD LOW VOLTAGE

1A-TRANSFORMER
2G-BLOWER RELAY
3D-BLOWER MOTOR
5A-HEAT MOTOR VALVE
6A-PILOT SWITCH (OMIT ON PROPANE
7K-TEMPERATURE LIMIT CONTROL

Figure 3 - With 732 Pilot Installed Non 100% Shutoff, Nat. Gas (D4)



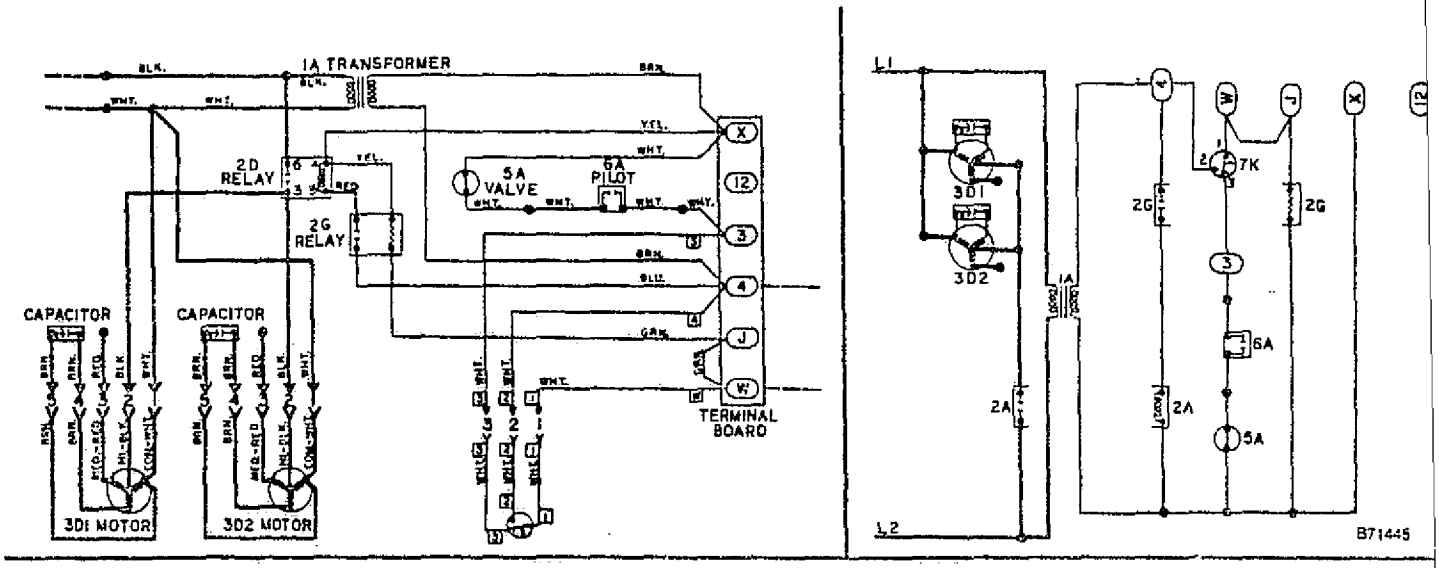
IF ANY OF THE ORIGINAL WIRE AS SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACED WITH TYPE SFF-2 150C FOR 24-VOLT CIRCUITS AND APPLIANCE WIRING MATERIAL 105C FOR LINE VOLTAGE CIRCUITS.

THIS UNIT IS APPROVED FOR 0.25 WC STATIC 55° TO 85° RISE, SEE INSTALLATION INSTRUCTIC ` OR APPLICATION MANUAL BEFORE CHANGING SPEED TAPS OR ADDING DUCTWORK.

— FACTORY LINE VOLTAGE
— FACTORY LOW VOLTAGE
– – – FIELD LINE VOLTAGE
– – – FIELD LOW VOLTAGE

1A-TRANSFORMER
2G-BLOWER RELAY
3D-BLOWER MOTOR
5A-HEAT MOTOR VALVE
6B-733 PILOT (REIGNITION)
7K-TEMPERATURE LIMIT CONTROL
7P-PRESSURE SWITCH SPST
11A-RESISTOR

Figure 4 - With 733 Pilot Installed Automatic Electric Reignition (D1)



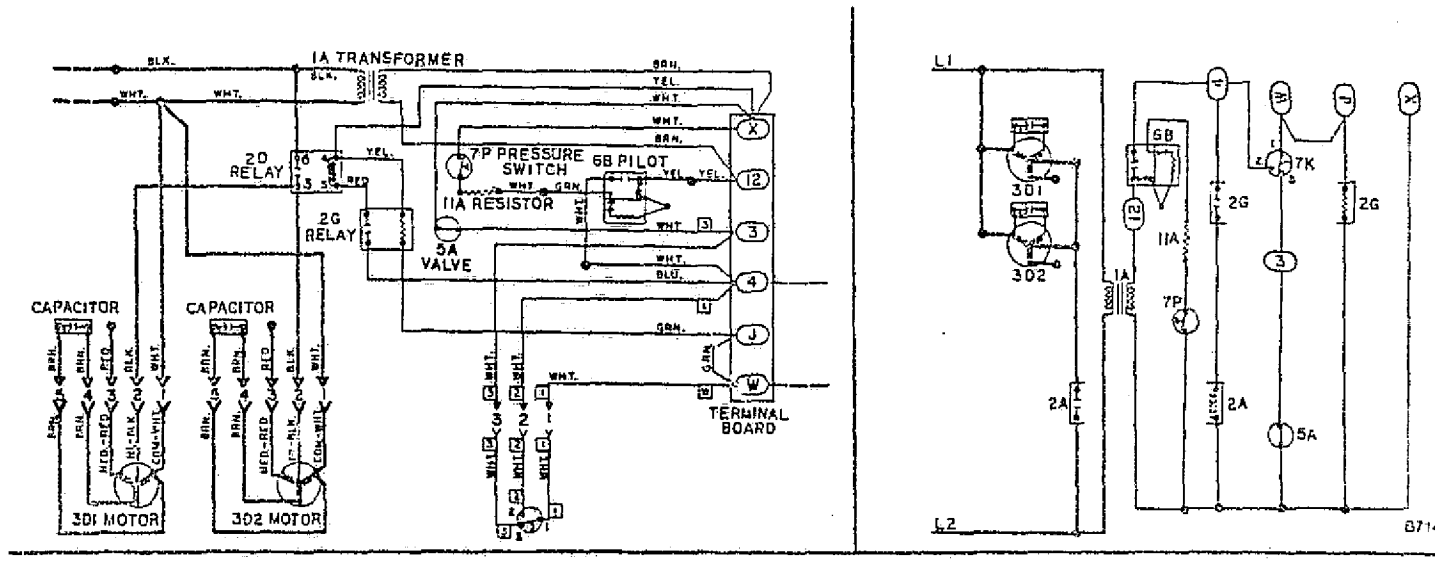
IF ANY OF THE ORIGINAL WIRE AS SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACED WITH TYPE SFF-2 150C FOR 24-VOLT CIRCUITS AND APPLIANCE WIRING MATERIAL 105C FOR LINE VOLTAGE CIRCUITS.

THIS UNIT IS APPROVED FOR 0.25 WC STATIC 55° TO 85° RISE, SEE INSTALLATION INSTRUCTIONS OR APPLICATION MANUAL BEFORE CHANGING SPEED TAPS OR ADDING DUCTWORK.

——— FACTORY LINE VOLTAGE
——— FACTORY LOW VOLTAGE
- - - FIELD LINE VOLTAGE
- - - FIELD LOW VOLTAGE

1A-TRANSFORMER
2A-BLOWER RELAY
2G-HEAT-MOTOR-OPERATED RELAY
3D1&2-BLOWER MOTOR
5A-HEAT MOTOR VALVE
6A-PILOT SWITCH (OMIT ON PROPANE)
7K-TEMPERATURE LIMIT CONTROL

Figure 5 - With 732 Pilot Installed Non 100% Shutoff, Nat. Gas (D4)



IF ANY OF THE ORIGINAL WIRE AS SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACED WITH TYPE SFF-2 150C FOR 24-VOLT CIRCUITS AND APPLIANCE WIRING MATERIAL 105C FOR LINE VOLTAGE CIRCUITS.

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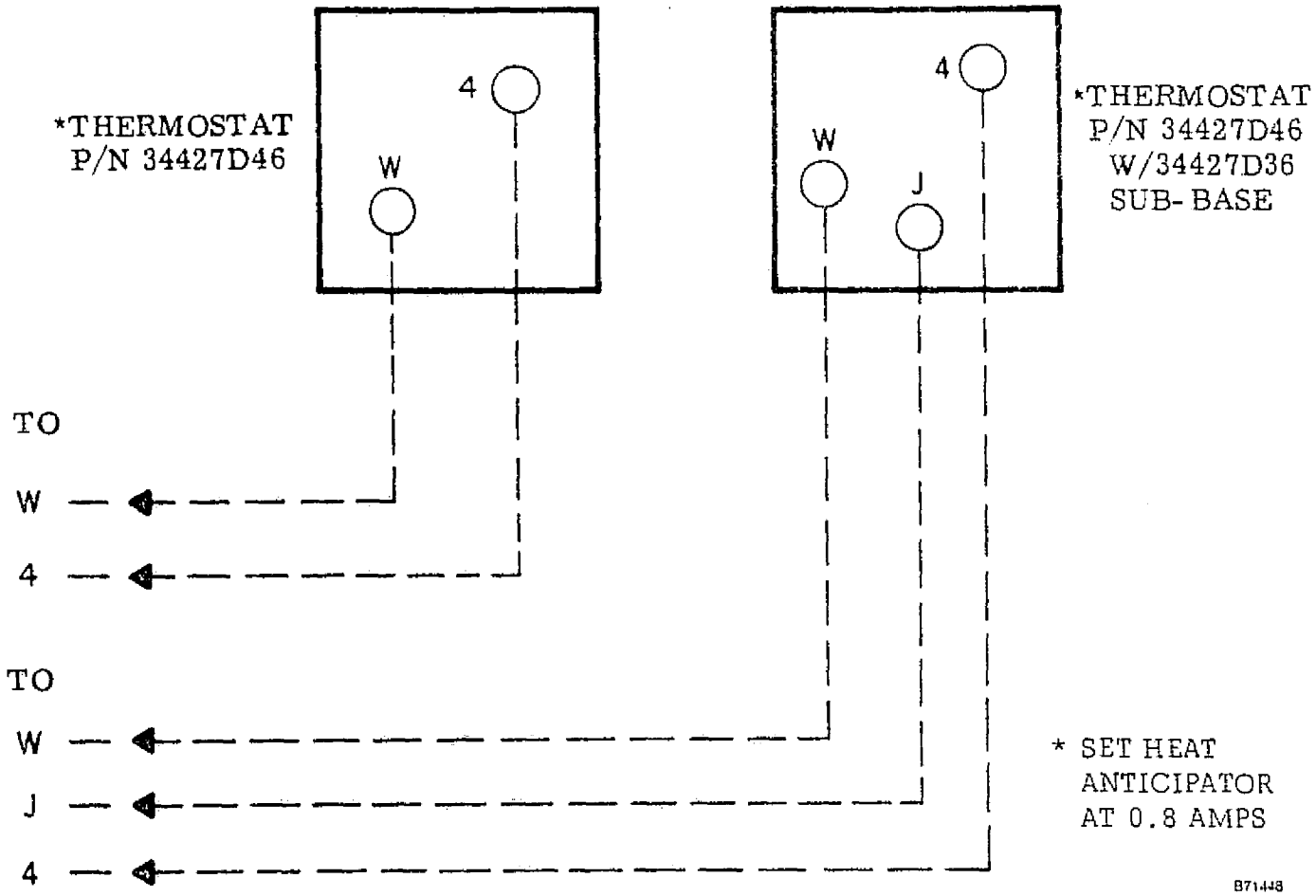
——— FACTORY LINE VOLTAGE
——— FACTORY LOW VOLTAGE
- - - FIELD LINE VOLTAGE
- - - FIELD LOW VOLTAGE

1A-TRANSFORMER
2A-BLOWER RELAY
2G-HEAT-MOTOR-OPERATED RELAY
3D1&2-BLOWER MOTOR
5A-HEAT MOTOR VALVE
6B-733 PILOT (REIGNITION)
7K-TEMPERATURE LIMIT CONTROL
7P-PRESSURE SWITCH SPST
11A-RESISTOR

Figure 6 - With 733 Pilot Installed Automatic Electric Reignition (D1)



SEPARATE WIRES MARKED W & J AT THERMOSTAT CONNECTIONS WHEN SUB-BASE P/N34427D36 IS USED FOR SUMMER FAN

Figure 7 - Thermostat Field Wiring

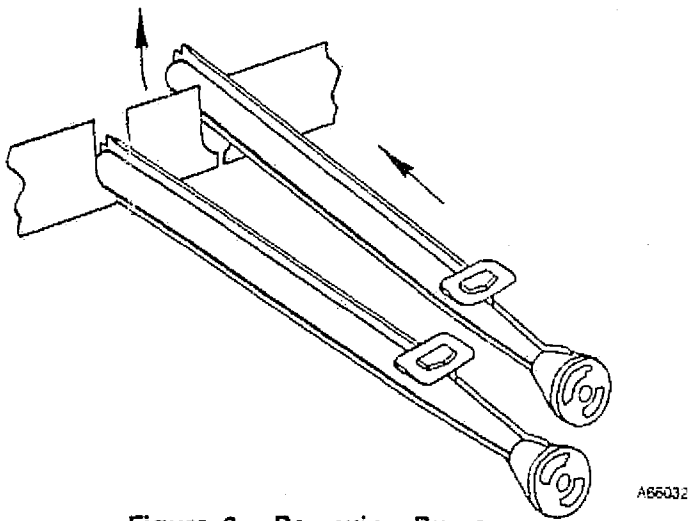


Figure 8 - Removing Burner

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