

DOE/NASA CONTRACTOR
REPORT

DOE/NASA CR-150876

INSTALLATION PACKAGE FOR A SOLAR HEATING SYSTEM

Prepared from documents furnished by

Solar Engineering and Equipment Company, Inc.
3305 Metairie Road
Metairie, LA 70001

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For the U. S. Department of Energy



(NASA-CR-150876) INSTALLATION PACKAGE FOR A
SOLAR HEATING SYSTEM (Solar Engineering and
Equipment Co.) 70 p HC A04/MF A01 CSCL 10A

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U.S. Department of Energy



Solar Energy

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S Y S T E M O P E R A T I O N & M A I N T E N A N C E

A. GENERAL

This is an air type solar system designed for heating during the winter and is very simple to operate. Basically the system is completely automatic and will function without further adjustment when the control switch is in the "Winter Mode" and the manual override switch is in the automatic position. NOTE: This switch must be left in the automatic position and should only be changed by an authorized serviceman. Upon conclusion of the heating season, the control switch is placed in the Summer Mode which activates the attic fan and ventilates the collector and attic. NOTE: The soffit vents located above the front door must be opened in this Mode to insure adequate ventilation. If the vent mode is not operating properly, an alarm has been provided which guards against inadequate ventilation and warns the occupant of this fact. A local serviceman should then be called to rectify said problem. A third switch has been provided to manually turn off the attic fan during overcast days or night time and is clearly marked as such. There is also a system On-Off switch which controls the power to the entire system and is provided for servicing the system.

The moving parts consist of Fans No. 1, No. 2, the attic fan, dampers and damper motors 1 - 5. Normally the only reason why the system will not operate will be because of the lack of

electricity caused by a burned out fuse, or because the driving belts have parted or slipped. These two faults can easily and quickly be determined.

If the system does not shift to the proper operating mode it may be because of lack of power to the damper control systems and this should be checked. (See damper maintenance section). Failure of sensors or jamming of operating motors or solenoids may make the dampers and the control system inoperative and the serviceman should be called. (see list of authorized servicemen).

B. FILTERS

Fan No. 2 is equipped with a standard fiberglass air filter which should be routinely checked and replaced when dirty. (see M-4 of working drawings for filter placement). This will normally be about once each month. Naturally, the air filters on the conventional unit should be checked and replaced, as per usual operation. Large mesh screening filters will be installed on the inlet and outlet to the rock storage pit and these should be checked occasionally to remove any insects or other material which may have accumulated.

C. COLLECTORS

The collectors should be self cleaning if there is normal rainfall. However, during extended dry periods it may be necessary to hose down the tops to remove accumulated dust. In all events, the local serviceman should check collector cleanliness at least once per month to ensure efficient operation. Periodic checks for water leaks evidenced by obvious rusting and caused by Tedlar damage should be conducted. New Tedlar should be ordered (see collector manufacturer) and rusted areas properly cleaned and repainted. Other than this, there is very little that should go wrong with the collector, although an annual inspection by the local serviceman is advisable to see if anything inordinate has happened.

D. DUCTS

Ducts should be checked for air leaks, cracks, or separations. Duct insulation should also be checked and repaired or replaced as necessary.

E. SITE DATA ACQUISITION

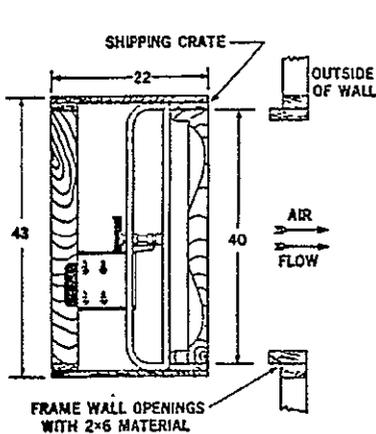
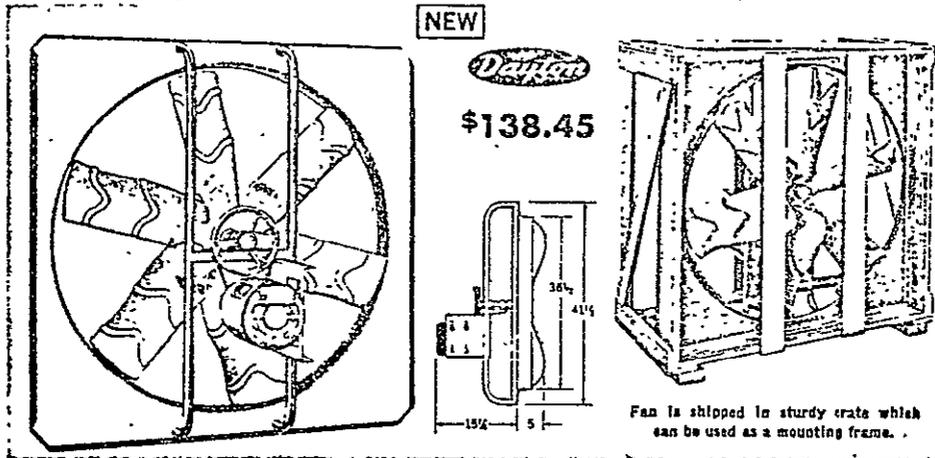
The Site Data Acquisition system should not be touched in any way. This has nothing to do with the actual operation of the SEECO heating system but merely consists of a series of temperature and flow sensors which collect and transmit data to a general computer processing and recording point by a private telephone line which is connected to the transmitter in the house.

Maintenance to dampers, damper motors, fans and the control panel is explained in detail in the following pages. Control diagrams showing the various operating modes are also provided as well as a list of servicemen to contact in the event any complications should develop.

ATTIC FAN

36" VERTICAL BELT-DRIVE POULTRY FAN

AMCA Certified Air Deliveries. 1/2 HP, Ball Bearing, TE Motor Included
Shipping Crate Can Serve as Installation Frame. Shipped Completely Assembled



Completely assembled 36" belt-drive exhaust fan with certified air delivery licensed by AMCA. Shipped in a wood crate which is specially designed for fast, easy installation in farm buildings, such as poultry and livestock houses, as shown in illustration at left. Can be easily removed from crate for installation in factories, warehouses, greenhouses, laundries, etc. Rugged construction throughout. Deep-drawn venturi frame has heavy-gauge tubular supports for vibration-free performance. Balanced six-wing fan blade is embossed for strength and rigidity. Self-aligning, sealed, ball bearing pillow blocks. Fan has 1/2 HP, 1725 RPM, 115/230V, 60 Hz, totally enclosed, ball bearing, split phase, Dayton motor with automatic reset thermal protection. Cast iron drive sheaves with belt installed. Sturdy motor base has slotted holes to allow proper belt adjustment when necessary. Venturi frame is gray enamel, blade is red finish Shpg wt. 105 lbs.

Dayton Electric Mfg. Co. certifies that the fan shown here is licensed to bear the AMCA seal. The ratings given are based on tests made in accordance with AMCA Standard 210 and comply with the requirements of the AMCA Certified Ratings Program.

No. 3C270 Fan. Retail \$231.20. Each..... \$138.45

CERTIFIED CFM LICENSED BY AMCA(*)							Fan RPM	Max. BHP(f)
0.0" SP	0.05" SP	0.10" SP	0.125" SP	0.15" SP	0.20" SP	0.25" SP		
11,300	10,750	10,200	9900	9500	8750	7750	510	0.63

(*) For fan without ducts. (f) Does not include drive losses.

ORIGINAL PARTS
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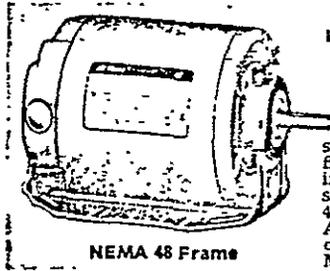
MAINTENANCE

- MOTOR** - CHECK WIRING FOR SECURE CONNECTIONS. OILING IS NOT REQUIRED AS THIS MOTOR HAS SEALED BEARINGS.
- PULLEY**- CHECK PULLEYS FOR SECURE FIT AND ALIGNMENT.
- BELT** - CHECK BELT FOR WEAR AND REPLACE AS NECESSARY. ADJUST BELT TENSION MAKING SURE ALL MOTOR MOUNTING BOLTS ARE SECURE UPON COMPLETION OF MAINTENANCE INSPECTION.

FAN HOUSING-CHECK HOUSING FOR SECURE WALL ATTACHMENT.

F - 2 FAN MOTOR

1/8 to 3/4 HP FURNACE & BELT-DRIVE BLOWER MOTORS



NEMA 48 Frame

1725 RPM, 115V, Split Phase Type. Auto. Thermal Protection
Low Noise, Reduced Starting Torque. 40°C Rise, Continuous Duty

\$24.71
1/8 HP



Built for quiet, dependable service on warm air furnaces, belt-driven fans and blowers, air conditioners, air coolers, and wherever a motor having a low noise level, reduced starting torque and low starting current is required. Low starting current reduces light flicker. Dynamically balanced rotor assembly and resilient mounting reduce vibration and electrical noises. Starting winding designed to bring load to speed at a uniform rate. 1725 RPM, 60 Hz, 40°C rise, continuous duty. Automatic-reset thermal protection. All angle mounting sleeve bearings. Rotation easily reversed by electrical reconnection. Gray finish. Recognized by UL under the Motor Component Recognition Program.

HP	RPM	Volts 60 Hz	Bear- ings	Mount- ing	Thermal Prot.	NEMA Frame (See p. 18)	Full- Load Amps @ 115V	Westing- house Style No.	Stock No.	Retail	Each	Shpg. Wt.
1/8	1725	115	Slv	Resil	Auto	48†	2.4	316P603	6K009	\$36.67	\$24.71	13
1/6	1725	115	Slv	Resil	Auto	48†	4.0	316P624	5K215	36.82	24.80	12
1/4	1725	115	Slv	Resil	Auto	48†	5.1	316P755	5K216	39.65	26.71	14
	1725	115	Slv	Resil	Auto	48/56*	5.1	317P103	6K463	39.65	26.71	13
	1725	116	Slv	Resil	Auto	56	5.1	317P002	6K105	39.65	26.71	14
1/3	1725	115	Slv	Resil	Auto	48†	5.9	316P759	5K257	46.02	31.01	14
	1725	115	Slv	Resil	Auto	48/56*	5.9	317P104	6K362	46.02	31.01	15
	1725	115	Slv	Resil	Auto	56	5.9	317P003	6K106	46.02	31.01	15
1/2	1725	115	Slv	Resil	Auto	56	7.2	317P004	6K104	64.43	43.41	18
3/4	1725	115/230	Slv	Resil	Auto	56	11.0	312P629	5K269	87.08	58.67	29

(*) Nos. 6K463, 6K362 have NEMA 48 frame body mounted on NEMA 56 frame cradle base, have 1 1/4" long, 1/2" dia. shaft and are supplied with 3/4" split steel shaft bushing.
(†) Mounting base has 48 and 56 frame mounting holes. Motor shaft height 3"; 1 1/4" long, 1/2" dia. shaft, supplied with 3/4" split steel shaft bushing.

MAINTENANCE

MOTOR - CHECK WIRING FOR SECURE CONNECTIONS. OILING IS NOT REQUIRED AS THIS MOTOR HAS SEALED BEARINGS.

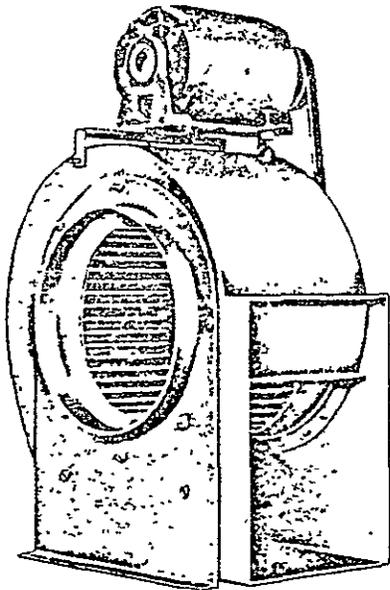
PULLEY - CHECK PULLEY FOR SECURE FIT AND ALIGNMENT

BELT - CHECK BELT FOR WEAR AND REPLACE AS NECESSARY. ADJUST BELT TENSION MAKING SURE ALL MOTOR MOUNTING BOLTS ARE SECURE UPON COMPLETION OF MAINTENANCE INSPECTION.

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SINGLE INLET BELT-DRIVE DUCT BLOWERS

Air Deliveries Based on Standard Test Codes of AMCA



9, 10⁵/₈ & 12¹/₂"', Single-Width, Multi-Vane Wheels
Adjustable on-the-Job to Any Discharge Position
Very Quiet. Adapts to Many General Applications

Economical single-inlet blowers with inlet unobstructed, for general duct ventilation, exhausting, air conditioning; processing and industrial use. Comes with bottom horizontal discharge which can be altered on the job to any required discharge position by drilling new holes and rotating blower housing on base and bolting in position. Adjustable top motor mount quickly changed from top to rear mounting.

Rugged construction of heavy gauge steel throughout. Very quiet. High volume at low velocity. Over-sized ball bearings for long life and dependable operation. Finished in baked-on gray enamel. Motor not included.

Air deliveries of blowers listed below are based on standard test codes of AMCA.

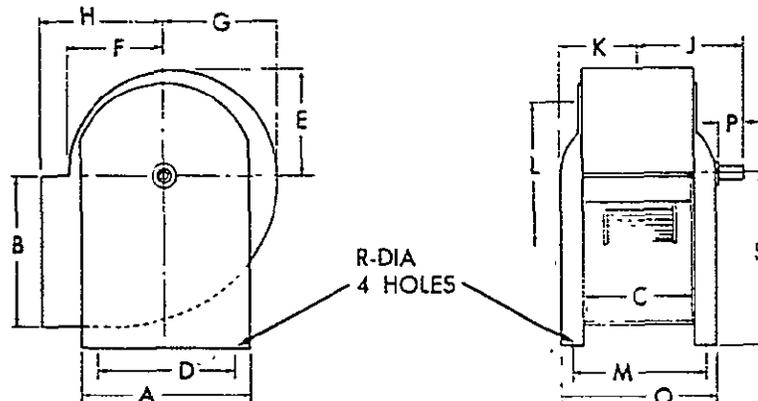


Model No.	1/4" SP	1/2" SP	3/4" SP	1" SP	1 1/4" SP	1 1/2" SP	RPM	HP	Shpg. Wt.
2C887	1100	1000	890	800	475	—	1000	1/4	25
2C888	1690	1600	1480	1370	1140	—	1000	1/2	36
2C800	I	I	I	2100	1980	1460	875	1/2	60

(* Overloaded below 1/4" SP (†) Overloaded at this SP at specified HP.

BLOWER DIMENSIONS

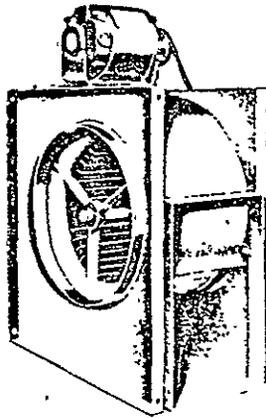
Model No.	Wheel Dia.	Size W	Shaft Dia.	A	B	C	D	E	F	G	H	J	K	L	M	O	P	R	S
2C887	9	4 1/2	3/8	10 3/4	10 3/4	6 1/2	9	6 13/16	5 5/8	7 13/16	7 1/8	6 1/4	4 1/2	8 13/16	7 3/4	8 3/4	1 1/2	3/16	9 5/8
2C888	10 5/8	5 1/4	3/4	12 3/4	11 3/4	8	11 1/2	7 15/16	6 11/16	9 3/16	8 11/16	7	5 1/8	9 13/16	9 1/2	10 1/2	1 1/2	3/16	11 1/8
2C800	12 1/2	6 1/2	3/4	16 3/4	13 1/4	9 3/4	14 3/4	10 1/8	8 1/4	11 1/2	10 1/2	8 1/4	6 3/4	13 1/4	11 1/8	12 3/4	2	3/16	17



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E-3 BOOSTER FAN

SINGLE-INLET, 4-WAY DISCHARGE BLOWERS

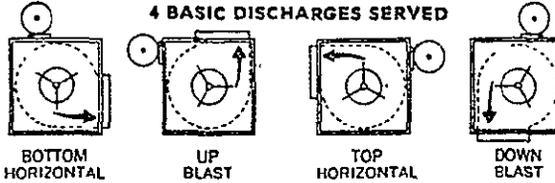


Adaptable to 4 Discharge Positions on the Job
9½ to 18½" Dia. Single-Width Wheels

Dayton
\$50.72
No. 2C986

Designed and built for general duct ventilation, exhaust, air conditioning, and industrial air moving applications. Single-inlet type for quiet, efficient performance. Adaptable to any of 4 standard discharges on the job by merely re-locating all motor mount and motor on frame—see diagrams. Belt length remains same for each discharge position. Precision, balanced, single-width wheels on ball bearings. Heavy gauge, die stamped steel housings. Gray finish. Resilient-mounted, automatic reset thermally protected Dayton motor and drive packed separately when blower is ordered complete. Request Bulletin 706.

4 BASIC DISCHARGES SERVED



Wheel Dia.	Wheel Width	Shaft Dia.	Inlet Dia.	Outlet		Overall Size			BLOWER ONLY Less Motor and Drive			Shpg. Wt. Less Mtr and Drive
				H	W	H	W	D	Stock No.	Retail	Each	
9½"	4½"	¾"	10"	10¼"	6¼"	16¼"	10¼"	14¼"	2C986	\$51.70	\$50.72	22
10½"	6	¾"	11	11¼"	8¼"	18	12½"	16½"	2C987	97.21	58.21	29
12½"	6	¾"	13¼"	13¼"	8¼"	21¼"	12½"	18¼"	2C988	151.12	91.81	46
15	6	1	15½"	15½"	8¼"	25	12½"	22½"	2C989	177.81	145.81	47
18½"	9	1	19¼"	18¾"	12¼"	30	17½"	26¾"	4C218	193.10	180.67	82

SINGLE-INLET BLOWERS WITH MOTOR AND DRIVE

Wheel Dia.	CFM AIR DELIVERY AT RPM SHOWN							BLOWER WITH 1725 RPM MOTOR AND DRIVE				
	Free Air	1/8" SP	1/4" SP	3/8" SP	1/2" SP	5/8" SP	Blower RPM	MOTOR DATA			Most With Automatic Thermal Protection	
								HP	Volts 60 Hz	Type	Stock No.	Each
9½"	1090	940	810	695	590	450	926	1 1/2	115	Split	7C808	\$80.43
	1210	1075	945	865	745	645	1030	1 1/2	115	Split	7C810	85.76
	1330	1205	1085	980	885	800	1100	1 2	115	Split	7C812	100.19
10½"	1360	1205	1030	840	600	—	705	1 1/2	115	Split	7C814	92.47
	1485	1360	1220	1065	885	625	765	1 1/2	115	Split	7C816	93.91
	1680	1575	1445	1310	1175	1010	850	1 2	115	Split	7C818	108.75
	1935	1850	1740	1610	1485	1350	1030	1 1/2	115	Cap.	7C820	121.14

MAINTENANCE

MOTOR - CHECK WIRING FOR SECURE CONNECTIONS. OILING IS NOT REQUIRED AS THIS MOTOR HAS SEALED BEARINGS.

PULLEY - CHECK PULLEY FOR SECURE FIT AND ALIGNMENT

BELT - CHECK BELT FOR WEAR AND REPLACE AS NECESSARY. ADJUST BELT TENSION MAKING SURE ALL MOTOR MOUNTING BOLTS ARE SECURE UPON COMPLETION OF MAINTENANCE INSPECTION.



TEMPERATURE CONTROLS, Inc.

Heating and Air Conditioning Service

7321 North Blvd., Okla. City, Okla. 73116

Telephone: AC 405—848-8573

CONCHO INDIAN SCHOOL

SOLAR PROJECT

TC77-13

OPERATIONS & MAINTENANCE MANUAL

This page is copyrighted. For information on the
Control Damper contact Ruskin Mfg Co, P. O. Box 129,
Grandview, MO 64030.



ENVIRONMENTAL SYSTEMS

GENERAL INSTRUCTIONS

Solid State Thermostats
Proportional Controlling

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TYPE: TP-8101

GENERAL INFORMATION: The TP-8101 design is such that it can be mounted directly to a 2x4 handy box located on the wall. It is a self-contained unit which includes a sensing element and amplifier. The unit has three pigtails for connection of the power supply and control signal to the given controlled device, such as a solid state actuator drive. The red and blue wires are used to supply the 20 VDC to the controller. The yellow and blue wires are used to connect the variable output signal from the controller to the input of the controlled device. It is capable of operating several controlled devices.

The room controller is completely factory calibrated and requires no field calibration. The throttling range is adjustable from 2-20°F by selecting the proper throttling range pin. The unit contains a combination setpoint and calibration potentiometer with a range of 55-85°F.

Terminals are available on the back of the unit to accomplish the following options: remote setpoint, remote sensing, summer-winter changeover and auxiliary selective ratio elements.

ACCESSORIES:

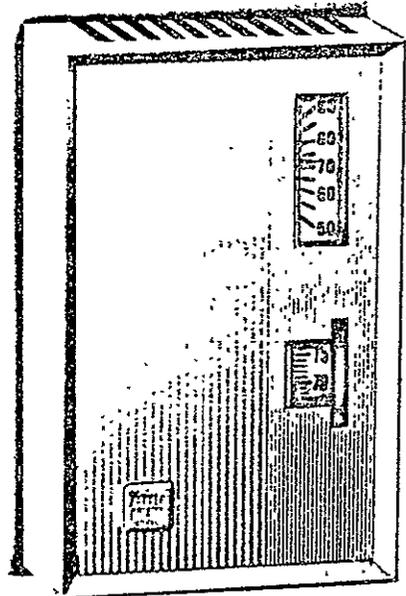
1. The AD-8951 mounting assembly is an accessory provided to permit easy panel mounting and wiring of the TP-8101 room controller. It includes a 11" x 4" piece of vinyl mounting track. See Figure 4 for wiring information.
2. Remote setpoint adjuster (AT-8158), see Figure 2 for wiring.
3. Auxiliary selective ratio element (TS-8601), see Figure 3 for wiring.

INSTALLATION INFORMATION:

Location: Locate the controller where it will be exposed to unrestricted natural air circulation and to the average conditions of the controlled space. Do not locate it near sources of heat or cold (such as lamps, motors, sunlight, radiators, and concealed pipes or ducts within the wall) which might affect the control point.

Ambient Temperature Limits:

Maximum +135°F
Minimum + 40°F



Wiring: Pigtails are provided for wiring to the controlled device. Large, coded, screw type terminals are provided for all other electrical connections. Make all electrical connections to the element in accordance with installation wiring diagrams for the job. Comply with National and Local Electrical Codes. No. 18 3-conductor thermostat cable may be used. Low voltage Class 2 wire is acceptable but No. 18 or larger 600 V wire should be used if splices are to be made in the same junction box with line voltage wiring.

The controller may be installed on either a flush switch box or surface switch box. To install, proceed as follows:

1. "Pull" all wires that are required.
2. Connect all control wiring to thermostat terminals.
3. Make electrical connections to any remote sensing elements with a conductor cable.
4. Remove the thermostat cover. To do so, loosen the screw at the bottom of the cover, pull the cover out from the bottom and up to disengage from the base.
5. Fasten the base to the box with the provided captive screws.
6. Replace cover and tighten cover screw.

1. **Remote Setpoint:** Remove dial knob from the TP-8101, Figure 1, and install the AT-8158 remote setpoint adjustor between terminals 1, 2 & 7. This is used for applications where the setpoint adjustment is mounted remote from the TP 8101 controller.

2. **Remote Sensing:** Remove the internal 1000 ohm sensor, Figure 1, and install the remote sensor (TS-8000 series) between terminals 7 & 8. This is used for applications where the sensor is mounted remote from the TP-8101 controller.

3. **Summer-Winter Changeover:** The controller operates in either the DA or RA mode.

Jumper 4 to 5 - DA (Direct Acting) = temperature increase causes output voltage increase

Jumper 3 to 4 - RA (Reverse Acting) = temperature increase causes output voltage decrease

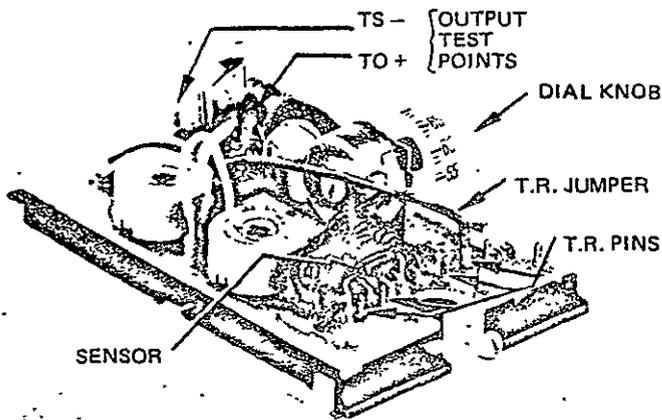


Fig. 1 - TP-8101 Component Locations

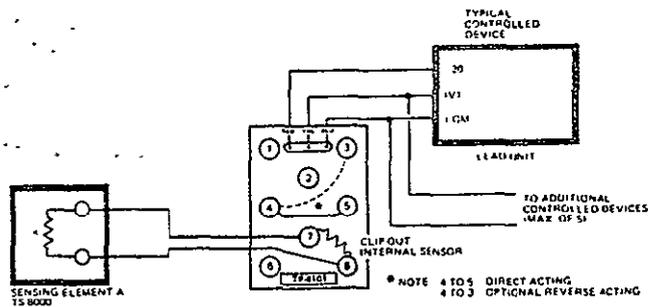


Fig. 2 - TP-8101 Terminal Arrangement Etc.

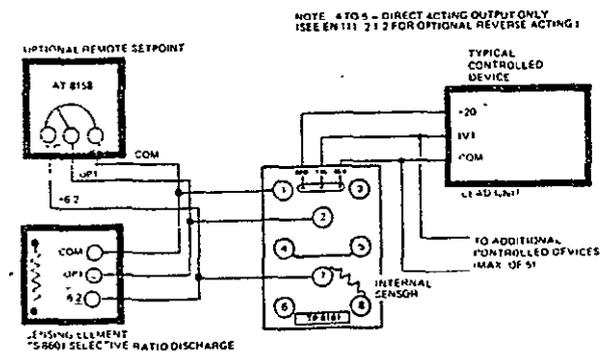


Fig. 3 - Wiring Schematic

sensor, a guide to the... This is used for room and discharge control applications.

Adjustments:

The TP-8101 has been factory calibrated to produce a 7.5 VDC output signal when the setpoint and the temperature at the sensing element agree.

Throttling range settings of 2, 3, 6 & 20 are available by placing the T.R. jumper on the proper selector pin, see Figure 1.

Service:

1. Check wiring per job wiring diagram
2. Measure with VOM
 - A. Power Supply 20 VDC - Red (+) to Blue (-) wire
 - B. Output 1-15 VDC - Yellow (+) to Blue (-) wire
 - C. Sensor 1000 ohm remote or internal
3. Consult EN III for additional service information

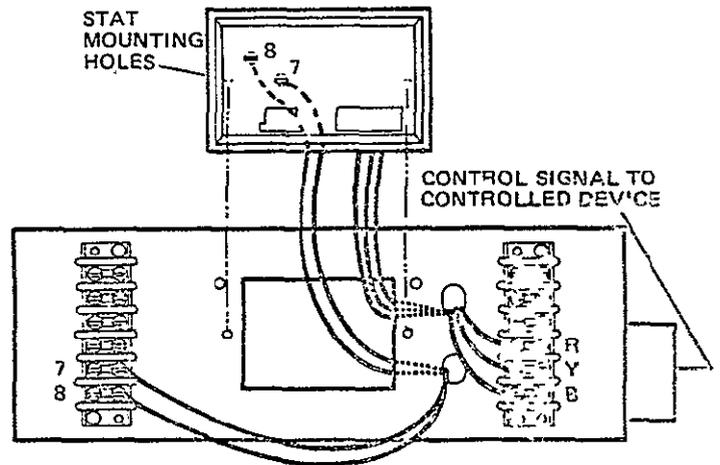


Fig. 4 - TP-8101 Mounting on AD-8951

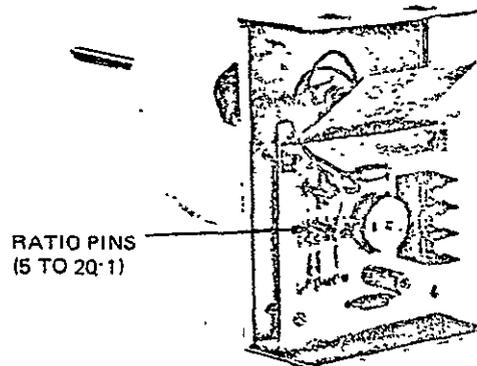


Fig. 5 - TS-8601 Ratio Discharge Sensor



General Instructions

SOLID STATE ADAPTORS Seq./Par./Rev. Module Hi-Lo Selector Module

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TYPE
AD 8101
AD 8201

General Information: Specific adaptor modules are designed to meet system applications such as sequencing/paralleling/reversing, and high-low signal selection. By placing these modules between the controller and the controlled device, complex cycles of operation can be accomplished. The design of the module centers around the use of integrated circuits and discrete type components arranged on printed circuit boards and snapped into vinyl track for mounting in a local control panel.

The high-low signal selector module, Figure 1, is designed to accomplish either high or low signal selection, depending on the pin arrangement underneath the cover, Figure 3. The device is calibrated at the factory and requires no field calibration. It has the capability of selecting either the highest or lowest signal from up to six zones. The output signal then responds to either the highest or lowest zone thermostat, depending on the application.

The sequencing/paralleling/reversing module, Figure 2, is a device which conditions the signal supplied by the controller and provides sequencing, reversing, or parallel operation to the controlled device. In the sequencing mode, the output is adjustable above or below the output voltage of the controller, permitting sequencing of two controlled devices. In the reversing mode, the output of the module is reversed with respect to the input, i.e., a 1-15 volt input provides a 15-1 volt output. In the paralleling mode, several controlled devices can be operated in parallel from the signal produced by the sequencing/paralleling/reversing module.

Installation Information: The module is designed to be track mounted and located in a local control panel. The unit is provided with a 7-1/2" piece of mounting track to permit quick and easy panel mounting, in a horizontal or vertical position. Location should be such that the unit is not subjected to severe vibration, shock, or ambient temperature conditions.

Make all connections in accordance with job wiring diagrams, complying with all national electrical codes. Wiring terminations are made at screw terminals located on the end of the printed circuit board, Figures 4 and 6.

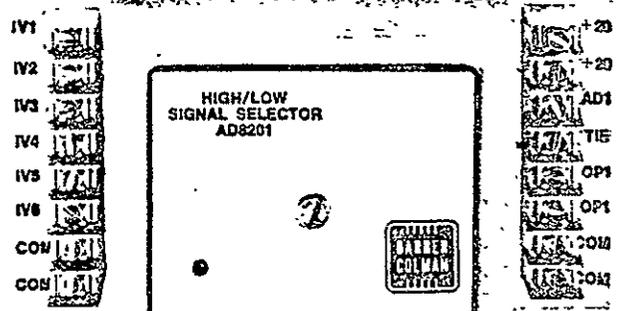


Figure 1

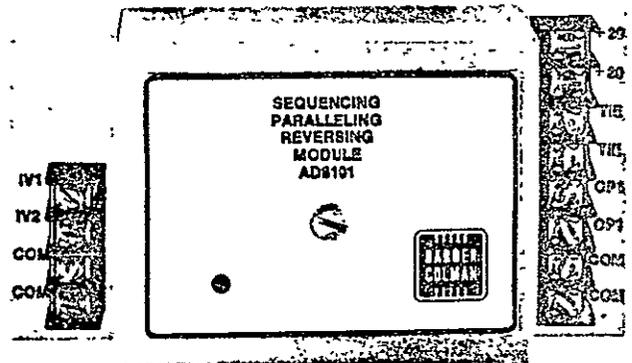


Figure 2

Ambient Temperature Limits:

Minimum - +40°F
Maximum - +135°F

Construction: The AD 8101, and 8201 adaptor modules are designed primarily for track mounting in a local or central control panel. However, they can also be located inside the AD 8910 enclosure for remote field mounted installations.

Adjustments: High-low selector module – this module is factory calibrated to provide a 1:1 ratio so that with a 6-9 volt input a 6-9 volt output is obtained. An adjustment is available so that the output of the high-low selector module can be changed ± 4 volts DC with respect to the input signal, Figure 3.

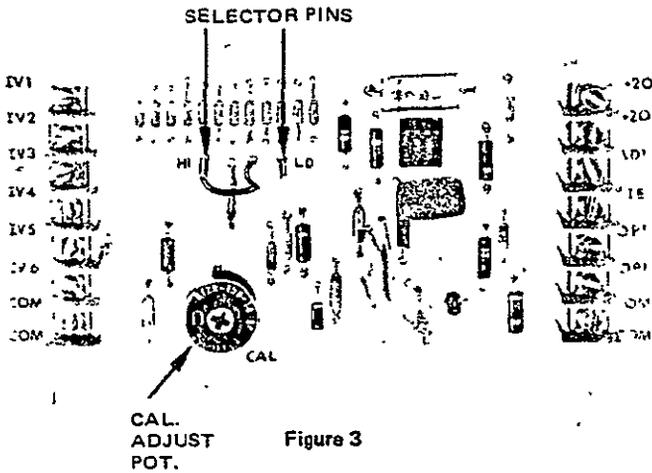


Figure 3

Service:

1. Check wiring per job wiring diagram.
2. Measure with VOM:
 - A. Power supply 20 VDC, terminals +20 and COM.
 - B. Output 1-1 VDC terminals OP1 and COM.
 - C. Input 1-15 VDC terminals IV1 through IV6 and COM.
3. Consult EN 111 for additional service information.

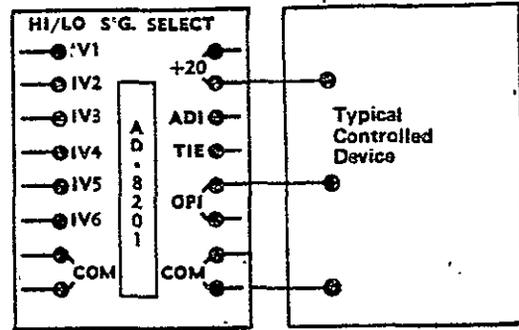


Figure 4

Adjustments: Sequencing/paralleling/reversing module is calibrated at the factory to provide a 1:1 ratio so that with a 6-9 volt input, a 6-9 volt output can be obtained. The sequencing/paralleling/reversing module has an adjustment so that the output signal may be changed ± 5 volts with respect to the input signal, Figure 5.

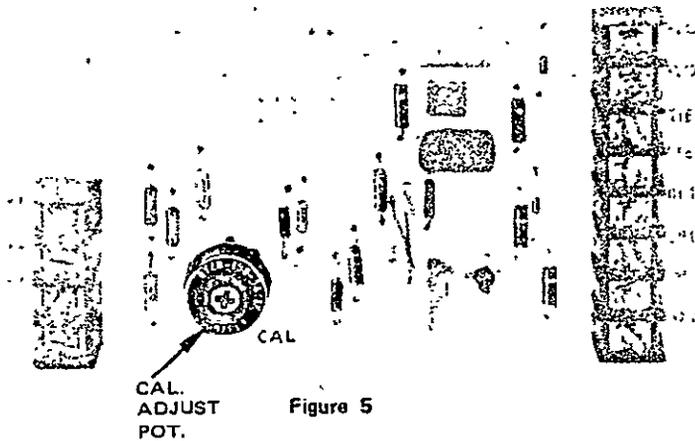


Figure 5

Service:

1. Check wiring per job wiring diagram.
2. Measure with VOM:
 - A. Power supply 20 VDC terminals +20 and COM.
 - B. Output 1-15 VDC terminals OP1 and COM.
 - C. Input 1-15 VDC terminals, IV1, IV2 and COM.
3. Consult EN 111 for additional service information.

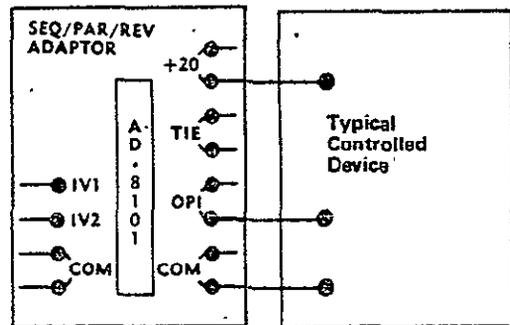


Figure 6



Product Information

Solid State Controlled Device
 Single Stage Relay
 Two Stage Relay
 Time Proportioning Relay

TYPE:
 CC 8101
 CC 8102
 CC 8103

General Information: Staging relays, Figure 1, are offered in various configurations which include single stage, dual stage, and dual stage with one stage containing heat anticipation. These staging relays require 120 volts AC for power source and contain a 20 volt DC regulated power supply which is used to supply power to other modules, such as controllers and adaptors. The staging relay receives a 1-15 volt DC input signal and by means of adjusting the drop-out voltage of each stage, the relays may be made to operate at any voltage in this 1-15 volt span. The differential of the relay is adjustable by selecting the proper pin on the printed circuit board.

The time proportioning version of the staging relays can be used to control heating-cooling applications. The heating side is built with a heat anticipation circuit which provides time proportioned control of electric heat. The second relay in the module can be used for cooling which would be connected to a single stage DX coil.

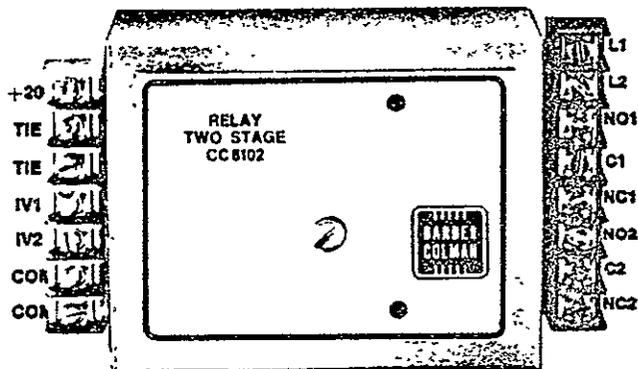
Adjustments: The staging relay has a potentiometer which will set the drop-out point of each relay between 2 - 12 volts DC. It also contains fixed deadband (pull-in to drop-out) of 1/2, 1, 2, and 4 volts DC, Figure 2. Pull-in point represents drop-out voltage plus deadband voltage setting.

Ambient Temperature Limits:
 Minimum +40°F; Maximum +135°F.

Installation Information: The module is designed to be track mounted and located in a local control panel. The unit is provided with a 7-1/2" piece of mounting track to permit quick and easy panel mounting, in a horizontal or vertical position. Location should be such that the unit is not subjected to severe vibration, shock, or ambient temperature conditions.

Make all connections in accordance with job wiring diagrams, complying with all national electrical codes. Wiring terminations are made on screw terminals located on the end of the printed circuit board. See Figure 3, 4, 5 for module wiring.

Construction: The CC 8101, 8102, and 8103 relays are designed primarily for track mounting in a local or central control panel. However, they can also be located inside the AD 8910 enclosure for remote field mounted installations.



TWO STAGE SHOWN

Figure 1

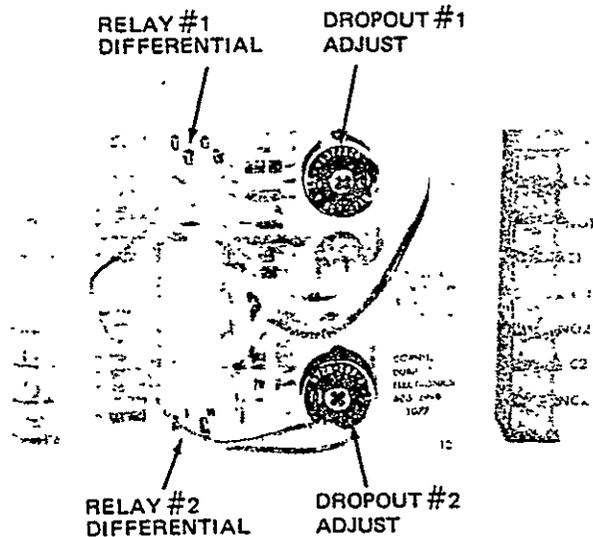
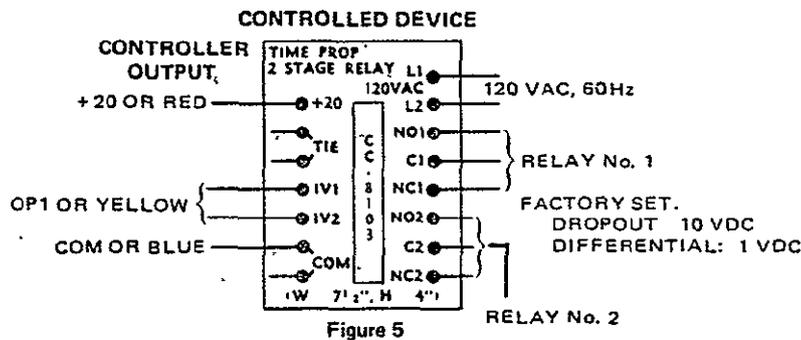
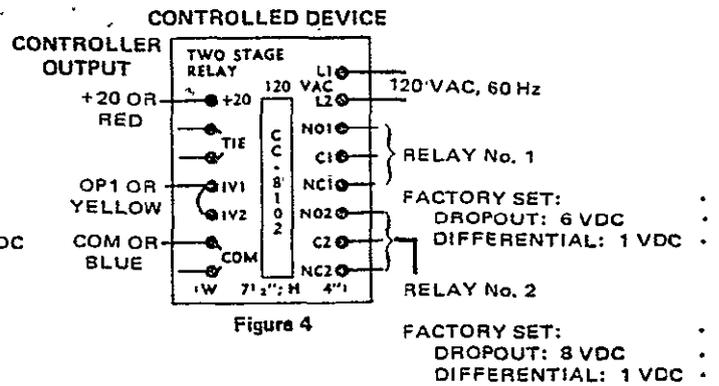
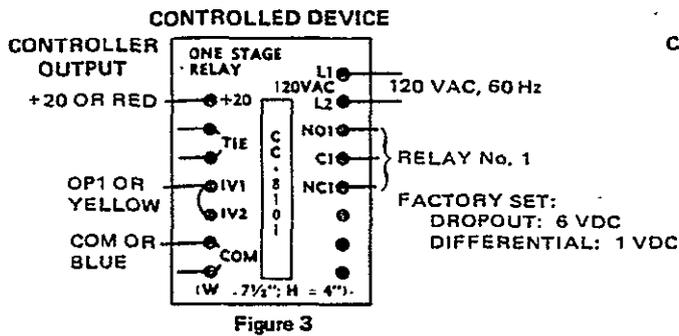


Figure 2

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FACTORY SET (NON-ADJUSTABLE)
 6 VDC INPUT - 100% DUTY CYCLE
 7.5 VDC INPUT - 50% DUTY CYCLE (45 SEC)
 9 VDC INPUT - 0% DUTY CYCLE

Calibration:

1. Apply power to relay module.
2. Connect VOM to input terminals IV1, IV2 and COM.
3. Set input voltage to desired drop-out voltage (IV1).
4. Adjust stage one for relay drop-out (R1).
5. Repeat steps 3 and 4 for stage two (R2).
6. Set differential to desired setting.

Service:

1. Check wiring per job wiring diagram.
2. Measure with VOM
 - A. Power 120 VAC terminal L1 and L2.
 - B. Power supply 20 VDC terminal +20 and COM.
 - C. Input 1-15 VDC terminal IV1, IV2 and COM.
3. Consult EN 111 for additional service information.

Barber-Colman Company
 CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A., 61101



ENVIRONMENTAL SYSTEMS

GENERAL INSTRUCTIONS

Proportional and Two-Position Hydraulic Actuators for Dampers and Valves

MA-5200 and MP-5200-0-0-1 Series

DEVICE INFORMATION

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Identification

Members of this group may be easily identified by referring to the part number displayed around the center of the cylinder. The date of manufacture (numerically, the week followed by the year) is stamped in ink on every actuator.

This General Instruction Sheet is concerned with all MP-5200 Series actuators bearing the part number suffix "-0-0-1" and all MA-5200 Series actuators. Actuators with the part number suffix "-500" have a built-in adjustable SPDT switch. When working with actuators manufactured before this series, refer to your obsolete literature file for previous GI's. F-11943-3 deals with the obsolete MP-5200 Series. F-12766-1 is the previous sheet on MA-5200 Series actuators.

MA and MP-5210 Series: These actuators are two position and proportional valve actuators, respectively.

MA and MP-5220 Series: These actuators are two position and proportional damper actuators, respectively.

Pre-Installation

MA and MP-5210 Series: These valve actuators are supplied without additional linkage or hardware. Valve bodies or linkage must be ordered separately.

MA and MP-5220 Series: These damper actuators are supplied with mounting bracket, and integral damper linkage. Also required for installation will be three 1/4-inch diameter bolts or other fasteners to mount the actuator. Additional hardware normally required for linking the damper would be:

- AM-132-0-0-1 — balljoint connector
- AM-122-0-0-1 — straight connector
- AM-125 — 5/16-inch link rod
- AM-111 thru 115 — damper shaft crank arms

When actuators have the optional auxiliary switch, an XDDH-132 adjusting wrench is available for adjustment.

Before mounting the device check for dents, bent parts and signs of oil leakage. Also check supply voltage against requirements, shown below:

Part No.	Voltage Requirements (VAC)
MA-MP-5XX0	120
MA-MP-5XX1	240
MA-MP-5XX2	208
MA-MP-5XX3	24

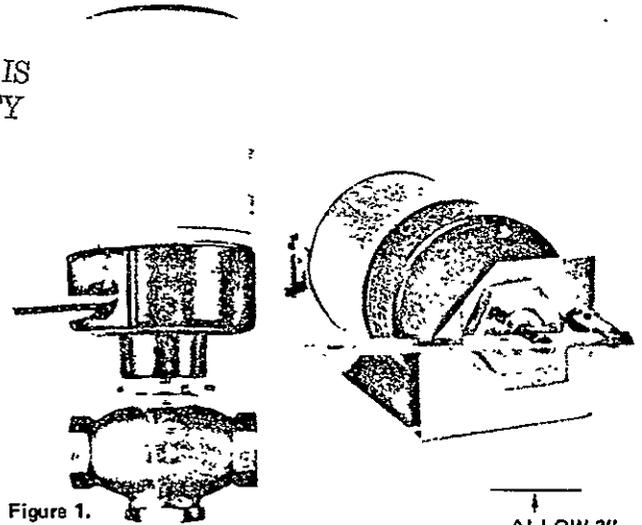


Figure 1.

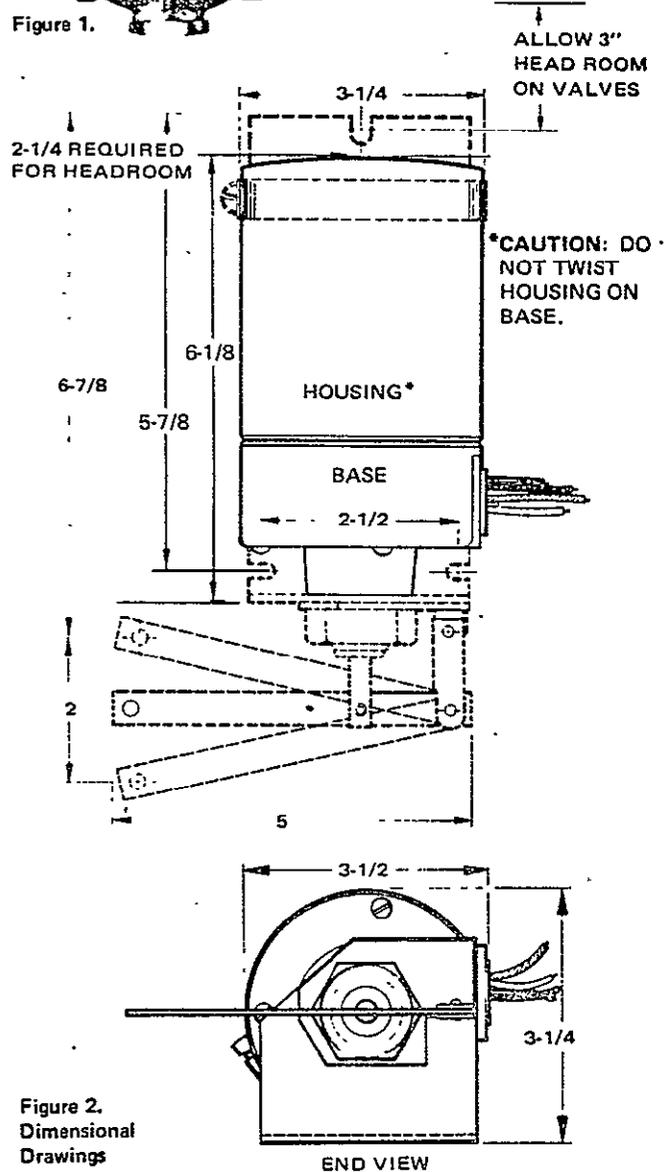


Figure 2. Dimensional Drawings

INSTALLATION

Requirements

These actuators will operate correctly in any position and are unaffected by normally encountered environmental conditions. Ambient temperature limitations: For MA Series, minimum is zero and maximum is 140°F. For MP-5220 Series, minimum is minus 20°F and maximum is 135°F. Power required is 10 watts.

Procedure

1. Before installing the device, check to be sure that it operates properly.

MA (two position) actuators: When the proper AC voltage (Figure 4) is applied, the actuator motor should run causing the actuator to extend.

MP (proportional) actuators: These actuators require the proper input voltage (Figure 3) and a control voltage of 1 to 15 VDC. As the control voltage goes through a nominal 6 to 9 VDC range, the actuator should travel through its stroke with the proper valve or damper linkage. For this checkout step, the AD-8301 manual positioner may be used to supply the control voltage.

2. Install and connect the device physically.

Damper actuators: Position actuator and mark mounting holes using the actuator bracket as a template. When mounting the actuator allow 10 inches space for wiring, and leave adequate room for linkage. Allow 2-1/4 inches to remove actuator from integral linkage.

The best position for the actuator is with the actuator crank arm and the crank arm on the driven shaft, at a 90° angle to the linkrod at midstroke. It may be necessary to swivel the actuator linkage to arrive at the best mounting location.

Allow adequate working space to wire the actuator into the system.

Drill mounting holes for the appropriate 1/4-inch diameter mounting fasteners and mount the actuator. The actuator must be mounted firmly enough to prevent excessive actuator movement under normal damper loading. If there is excessive actuator movement, the damper may not fully open or fully close.

Valve actuators: Remove the valve body from the actuator by loosening the 1-5/8-inch flange nut.

Pipe the valve body into the system. Note: Be sure that the actual flow is in the same direction as the arrows on the valve body indicate. Allow 3 inches above the actuator case for reattachment and removal.

Reattach the actuator to the valve body.

3. Wire the actuator into the system.

Low voltage units wired to NEC codes may use Class Two wiring. Wire line voltage units wired to NEC

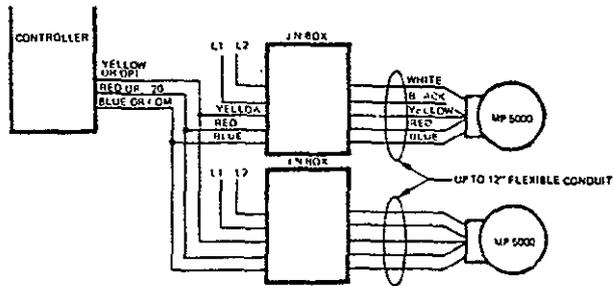


Figure 3. MP Wiring

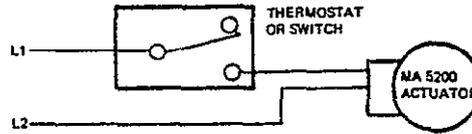


Figure 4. MA Wiring

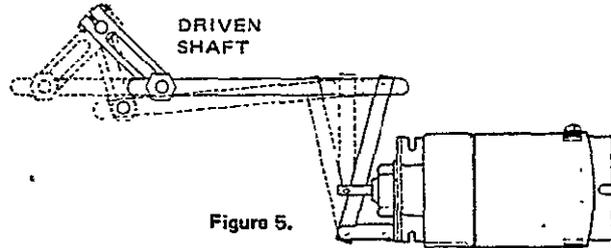


Figure 5.

codes. A maximum of 12 inches of 1/2-inch flexible conduit between the actuator and conduit box with standard 18-inch actuator leads. All actuator wires must be contained in the conduit.

POWER WIRE SIZE PER ACTUATOR

Actuator Voltage (VAC)	Wire Size (Ga)	Maximum Two Wire Run (Feet)
24	14	300
	12	480
120	14	7000

To determine the allowable maximum run for multiple actuator wiring, divide the maximum run shown above for a given wire size and voltage by the number of actuators on that run.

Use wire nuts on power leads from a Class A power source. Power lead colors are shown as follows: Black – common to all voltages that follow. White – for 120 VAC. Black with blue tracer – for 24 VAC. Black with brown tracer – 208 VAC. Black with yellow tracer – 240 VAC. All leads 18 inches except 24 VAC units which are 48 inches.

MP (proportional) actuators: Actuator wires are connected as shown in Figure 3. Barber-Colman approved, three conductor twisted 18 AWG wire has 600 volt PVC insulation and should be used from the controller. Also acceptable is any three wire (18 ga.) cable with Class I lead insulation insulated in conduit separate from line voltage (Figure 3).

MA (two position) actuators: These are wired as shown with the thermostat or switching device controlling the off-on status of the actuator motor (Figure 4).

4. Finish the damper actuator mechanical hook-up.

After wiring, assemble the straight connector, linkrod, balljoint connector, and damper shaft crank arm as shown (Figure 5).

Tighten both the actuator connector to the linkrod and the damper crank arm to the damper shaft. Both crank arms should be approximately 90° to the linkrod at midstroke. Normally dampers are linked to full heat with the actuator retracted.

Extend and retract the actuator by applying approximately a 6 to 9 VDC control signal and required voltage. The actuator crank arm will rotate 80°.

Determine the proper radius on the damper shaft crank arm to fully open and close the damper.

Tighten down the connector to the damper crank arm and the linkrod.

The installation is now complete.

Auxiliary Switch

Hydraulic actuators may be ordered with a built-in adjustable SPDT auxiliary switch (Figures 6 and 7). This switch must be ordered as part of the actuator and cannot be field installed. Note: For MP Series actuators only, the switch common wire is internally connected to the black power lead. Because of this, the switch must be wired to control the same voltage as the actuator itself. Switch rating is 10 amperes at 120/240 VAC. Leads are 18 inches except 24 VAC units which are 48 inches.

The switch's brown wire is normally open and the orange wire is normally closed. The switching point is adjustable over the entire actuator stroke and is factory set to occur at the retracted end. Use XDDA-132 to adjust the switch point.

CHECKOUT

The actuator is now installed and should run properly when the system is energized. The following checks can be easily performed to see if the device is operational.

MP Series Actuators: First, the actuator motor should run continually when power is applied. If the motor is not running, something is wrong with either actuator or the supply voltage. Second, the damper or valve should go from full heat to full cool as the control signal goes approximately from 6 to 9 VDC.

NOTE

At very low ambient temperatures (around minus 20°F) the actuator may run slowly until the oil warms up. This condition may exist for 30 minutes.

MA Series Actuators: When the proper voltage is supplied to the actuator terminals the actuator motor should run, causing the actuator to extend.

If the actuator fails to function properly, refer to the section on repairs.

RUN/ADJUST

No adjustments are made at the actuator. All adjustments are made at the controller.

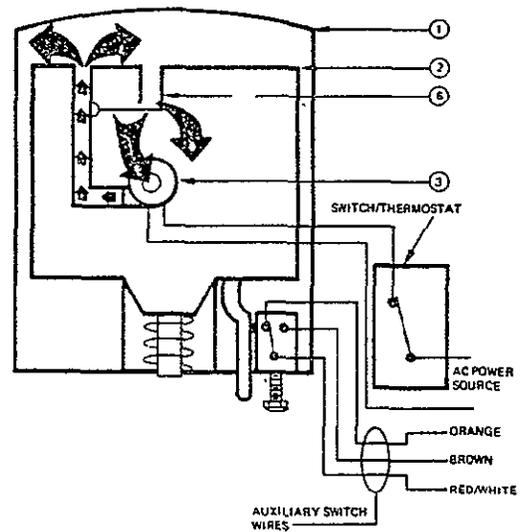


Figure 6. MA Series Actuator

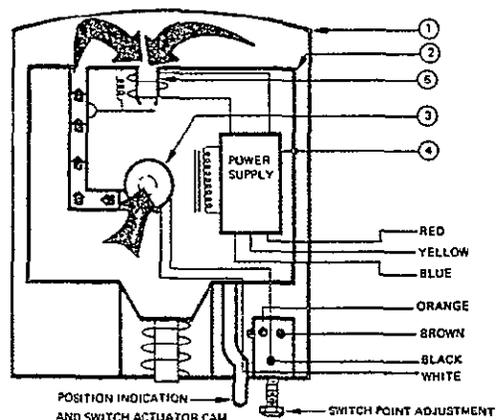


Figure 7. MP Series Actuator

Theory of Operation

See Figures 6 and 7. The permanently sealed oil filled case (1) contains a movable hydraulic piston assembly (2) and an electric pump (3) for the hydraulic system. The pump generates a fluid pressure which is transmitted to the top of the piston. Opposing the hydraulic force is the spring of the valve or damper linkage.

MA Series Actuators: The electric pump (3) is powered by the input supply voltage and runs whenever the voltage is applied. When power is removed, the oil flows back through the pump by means of check valve (6) and the actuator retracts.

MP Series Actuators: The electric pump (3) is powered by the input supply voltage, and runs continuously. An unregulated power supply (4) is powered by a transformer winding from the pump motor winding. The power supply produces 20 VDC which powers the controller. The controller returns a 1 to 15 VDC control voltage to the actuator transducer (5). This controls the internal pressure and the resultant actuator action.

MAINTENANCE

The power unit of the actuator is sealed in oil and requires no maintenance.

REPAIR

MA Series Actuators:

1. Check the actuator by applying the proper supply voltage.
2. The motor should run when power is applied, if not, the actuator is defective and should be replaced.
3. The actuator should extend, if it does not, check the mechanical linkage. Either the mechanical linkage prevents proper action or the actuator is defective.
4. If the linkage moves properly, but the actuator does not extend, replace the actuator.

5. If applying power causes the actuator to perform correctly, the actuator and linkage are functional and the wiring and thermostat should be checked.

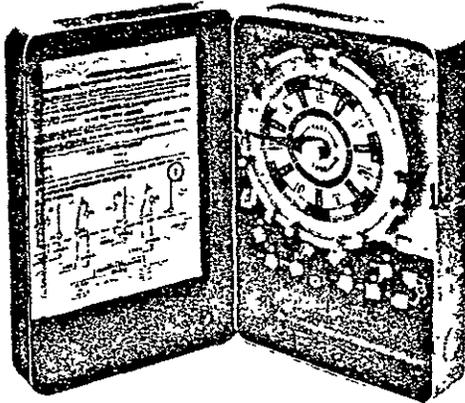
MP Series Actuators: Repairs to this device consist mainly of checking the unit wiring and replacement of the power supply. Other field repairs are not recommended. Use the procedure below to locate a malfunction.

1. The actuator motor should run continually. If it does not run, check the supply voltage and the unit wiring.
2. Voltage between the blue (-) and red (+) leads should be 20 ± 1 VDC.
3. Input voltage on the blue (-) and yellow (+) wires should be between 1 and 15 VDC. If it is not, refer to EN-111 3.1.2 for service information.



Seven Day Time Clock

- AE-174
- AE-178



For automatic switching of a building control system from "Day" to "Night" and then back to "Day" on a selectable program. **Device:** Heavy duty, sealed, permanently lubricated, synchronous timing motor drives a large seven day dial. Graduation of dial at 30 minute intervals enables accurate setting of switch trippers. Switch trippers (7 on and 7 off) may be easily installed around the outer rim of the dial to provide various (on and off) timings. By not installing trippers for a specific day of the week, that day "on" operation is automatically omitted. Entire mechanism can be snapped out of case for installation in a central control center. Unit has large, coded, screw-type terminals. Case is 187mm wide, 276mm high and 92mm deep (7-3/8 inches wide, 10-7/8 inches high and 3-5/8 inches deep). Three 6mm [1/4-inch] diameter mounting holes in back of case. Top mounting hole centered 203mm [8 inches] above two bottom holes which are 127mm (5 inches) apart. Combination 13mm (1/2-inch), 19mm (3/4-inch) knockouts provided. **AE-178:** This device includes a battery driven 8 hour carryover feature. The Ni-cad battery charge is continuously maintained by a built-in charger. Initial charge time is 48 hours. Upon power interruption a battery driven motor maintains clock operation. The battery is automatically recharged upon power resumption. **Input:** 120 volts, 60 Hz. **Output:** Four single-pole, single throw switches. Snap-acting. Two normally open; two normally closed. Formed brass jumpers included readily permit modifying switch action to SPDT, DPST and DPDT.

Part Number	Clock Motor	Switch Rating
AE-174	120V., 60 Hz	1 hp at 120/240 Volts, a.c. only.
AE-178	120V., 60 Hz Battery carryover	Pilot Duty 690 VA. Non-Inductive 40 amps at 120 or 240 volts. a.c. only.

Interval Timer



- AE-182

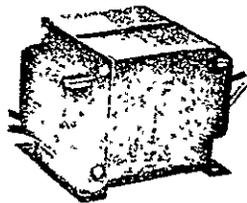
SPST, N.O., 6 hr., spring operated, for standard outlet box mounted. Includes wall plate and knob. Electrical rating: 20 amps at 120 volts, 1/3 hp.

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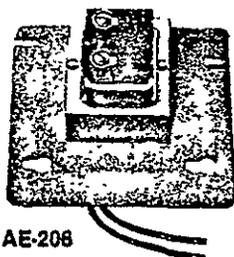


Transformers

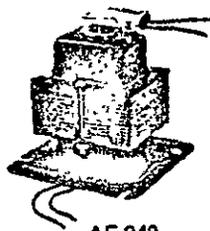
- AE-203 AE-223
 AE-206 AE-249



AE-203-223



AE-206



AE-249

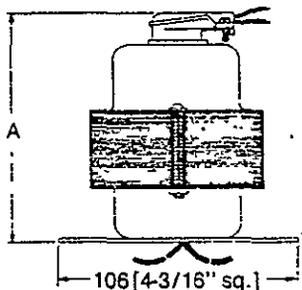


Figure 1

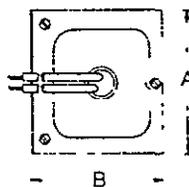
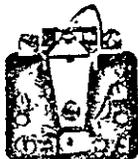


Figure 2

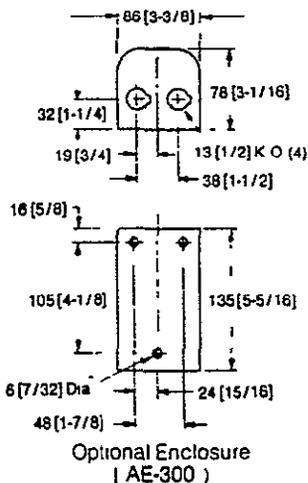
For supplying low voltage power to operate control equipment. Primarily for mounting in control centers in conjunction with disconnect switch and overload circuit breaker. **Device:** AE-206 and AE-249 are provided with a plate on the primary side for mounting on standard 4-inch outlet box. Secondary connection is screw terminals for AE-206 and provision for flexible conduit connection on the AE-249. All 170 VA transformers are provided with mounting feet for panel mounting, and wire leads.

Part Number	Capacity VA	Primary Voltage	Sec. Volt.	Frequency (Hz)	Fig.	Dimensions: mm (inches)				
						A	B	C	D	E
AE-203	170	120	24	60	2	95 [3-3/4]	80 [3-1/8]	108 [4-1/4]	83 [3-1/4]	71 [2-13/16]
AE-206	10	120	24	60	1	48 [1-7/8]	—	—	—	—
AE-223	170	240	24	60	2	95 [3-3/4]	80 [3-1/8]	108 [4-1/4]	83 [3-1/4]	71 [2-13/16]
AE-249	50	480/277, 240/208	120	60	1	111 [4-3/8]	—	—	—	—

Power Relays DPDT



- AE-304
 AE-314
 AE-334



Part Number	Coil Voltage 50/60 Hz
AE-304	24
AE-314	120
AE-334	240

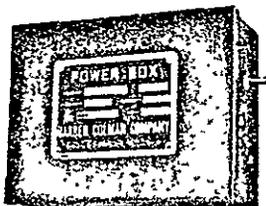
Clapper type with screw terminals. Contact Rating: 1 hp, 16 amps at 120 volts, 8 amps at 240 Vac; 25 amps non-inductive at 120/240 Vac. Optional enclosure available. Order AE-300 separately.

Time Delay Relay

- AE-347

For control of circuits requiring 3 to 5 second time delay. **Device:** Two single pole double break relays having separate electronic time delay circuitry. All components mounted on a printed circuit board which includes screw type terminals. Complete with screws and spacers for panel mounting (not illustrated). Coil: 24 Vac. Contacts rated at 5A/120 Vac, 2.5A/240 Vac.

Power Boxes



- AE-253
 AE-273

For supplying an electrically protected and enclosed low voltage power supply to operate control equipment. **Device:** A step-down transformer with a disconnect switch in the primary side and a manually reset circuit breaker in the secondary side. Mounted in a surface type steel cabinet with four convenient 13mm (1/2 inch) conduit knockouts and painted finish 203mm (8 inches) wide, 152mm (6 inches) high 89mm (3-1/2 inches) deep. **Installation:** Surface mount through four holes in the back of the cabinet.

Part No.	Capacity VA	Primary Voltage	Secondary Voltage	Frequency (Hz)
AE-253	170	120	24	60
AE-273	170	240/208*	24	60

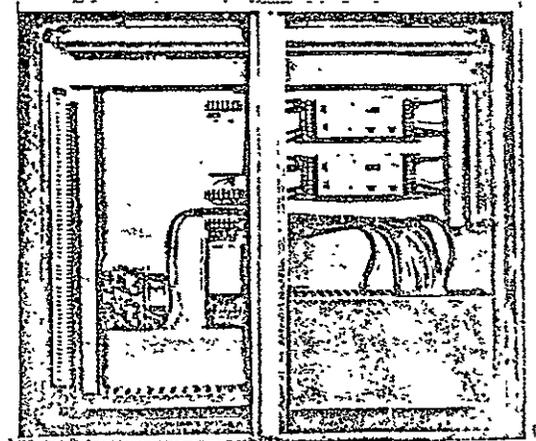
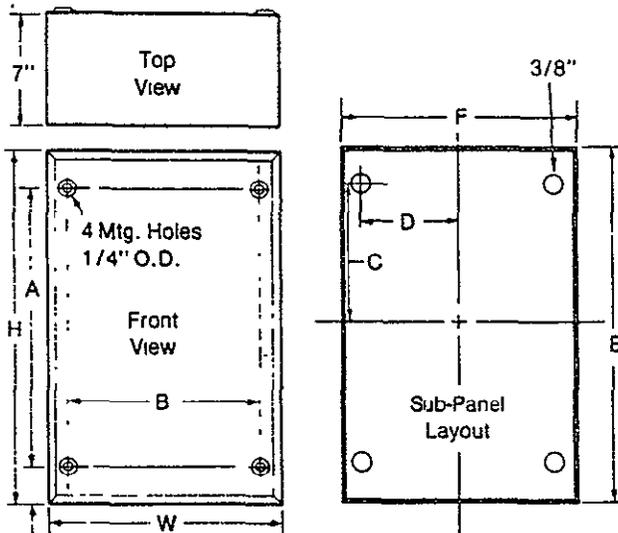
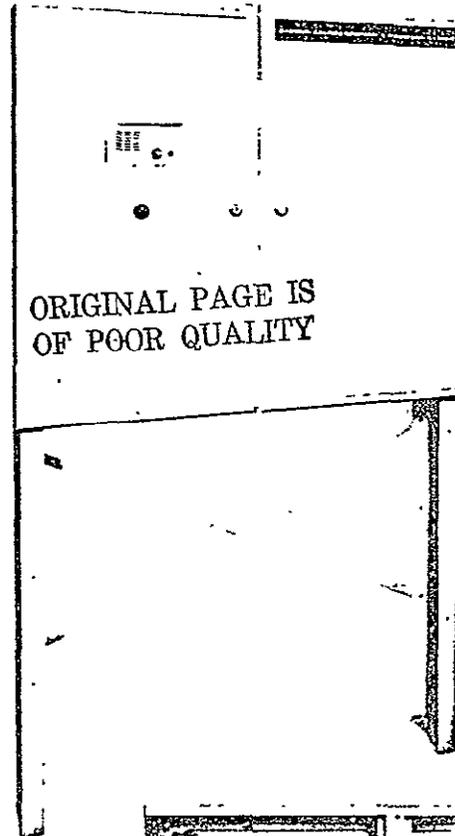
*240/208 Volt Power Boxes are normally factory wired to 240 volt winding

Barber-Colman Company
CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A., 61101



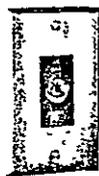
For convenient mounting of pre-assembled or field assembled control panels. Cabinets may be used for pneumatic or electric controls. **Device:** SYZE-630 and SYZE-631 are 18 gage steel. SYZE-632 is 16 gage steel. All size cabinets have knockouts for 3/4-inch and 1-inch conduit. Knockouts are aligned so that a short nipple may be used to couple the panels together, and also for interconnecting wire. The door(s) consist basically of a frame and insert. The frame is made of extruded aluminum and comes mounted with six self-tapping screws. Door(s) supplied with key lock. Standard cabinets are painted steel with beige finish. **Installation:** Cabinets are shipped from the factory completely assembled and ready for mounting. They may be installed flush or surface mounted. Legs are available for floor mounting. **Options:** See charts for equipment description and proper part number. **Ordering:** See chart for cabinet sizes available and part numbers. Sub-panels must be supplied locally.



Description	Cabinet Size		
	16" x 24"	24" x 32"	42" x 36" Double Door
Complete Cabinet (without sub-panel) Painted Steel	SYZE-630	SYZE-631	SYZE-632
Painted Steel Legs for floor mounting above cabinets	SYZE-633	SYZE-633	SYZE-634
Bracket to accommodate light fixture	N/A	SYZE-600	SYZE-600
18" Fluorescent Fixture	N/A	.	.

Dimensions (Inches)							
Cabinet				Sub-Panel			
W	H	A	B	C	D	E	F
16	24	21	13	9 1/4	6 1/2	22	14
24	32	29	21	13 1/4	10 1/2	30	22
42	36	33	39	16 1/2	18	34	40

*UB 115, SIM/KAR light fixture Purchase from local distributor, or direct from SIM/KAR Lighting Fixture Co., Philadelphia, Pa. 19134 Phone 215-425-7200



Toggle

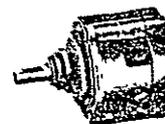


Toggle Switch

Switches, Mounting and Position Indicating Plates (Order All Parts Separately)



Rotary



Rotary Switch

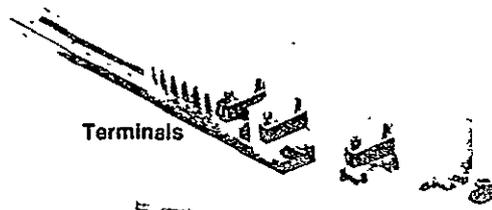
Switch Action	AC Rating		Switch Type	Switch Part No.	Mounting Plate (Flush)	Indicating Plate			
	Amp	Volt				Part No.	Position Markings	Size (Inch)	
								Width	Height
DPDT	10	250	Toggle 2 Position	CYZP-11-1	SYZE-52-3	SYZE-74-1 SYZE-75-1 SYZE-76-1 SYZE-102-1 SYZE-189-1 SYZE-271-1 SYZE-300-1	On-Off Summer-Winter None Day-Night Open-Close Manual-Auto Occupied-Unoccupied	1-1/8	2-1/16
4PDT	5	24	Toggle 2 Position	CYZP-105					
DPDT (Center Off)	10	250	Toggle 3 Position	CYZP-268					
4PDT (Center Off)	5	24	Toggle 3 Position	CYZP-427					
SPST N.O.	5	125	Push Button Momentary Contact	CYZP-346		SYZE-212-1 SYZE-255-1	On-Off-Automatic Summer-Off-Winter	1-7/8	2-1/16
SPST N.C.				CYZP-347					

NOTE: All switches mount to standard switch box. 1/2" mounting hole required.

Part Number	Description
AYZP-43-2	Circuit Breaker 10 Amp (Illustrated)
BYZP-145	12 Circuit Terminal Block (Illustrated)
BYZP-146	Marker Strip #1—12
BYZP-252	Marker Strip #13—24
BYZP-253	Marker Strip #25—36
BYZP-269-2	Mtg. Bracket for Circuit Breaker & Switch (Illustrated)
BYZP-599	Terminal End (Illustrated)
BYZP-600	Terminals (Approx. 4 per inch) (Illustrated)
BYZP-601	Terminal Channel (3') (Illustrated)
BYZP-602	Terminal Clamp (Illustrated)
BYZP-603	Terminal Marker (25') (Illustrated)
CYZP-183-1	Burnishing tool for Electric Contacts
CYZR-818-2	Arc Suppressor for SPDT Floating Switching
EYZP-504-1	Lamp, 24V, 0.073 Amp, 1.7 Watts
EYZP-504-2	Lamp, 120V, 0.025 Amp, 3.0 Watts
EYZP-504-3	Lamp, 48V, 0.053 Amp, 2.5 Watts
EYZP-721	Lamp Socket with Clip
EYZP-722-1	Lens, Red
EYZP-722-2	Lens, Green
EYZP-722-3	Lens, Amber
EYZP-722-4	Lens, Blue
EYZP-722-5	Lens, White
SYZE-81-1	Blank Nameplate 1-7/8" x 9/16"
SYZE-82-1	Blank Nameplate 2-1/2" x 3/4"
SYZE-83-1	Blank Nameplate 4" x 1-1/4"
SYZE-299-1	Tie Strap, plastic, for lacing wires, 4" long



Circuit Breaker



Terminals



Mounting Bracket
(Shown with Disconnect Switch and Circuit Breaker)



Terminal Block



Pilot Light

Barber-Colman Company
CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A., 61101



Type: Single Stage TC-4100 Series

Two Stage TC-4211

Dual Bulb TC-4151
TC-4152

DEVICE INFORMATION

Identification

Two position bulb thermostats are for on-off control of media temperature in ducts, tanks, liquid lines, etc.

TC-4100 Series **one stage** units control one electrical circuit.

TC-4211 **two stage** units control two electrical circuits in sequence.

TC-4151 and TC-4152 **dual bulb units** vary the control point of the controlled media as function of outside air temperature. One bulb senses the controlled media, the second bulb senses the outside air temperature.

Pre-Installation — All Devices

Refer to the INSTALLATION and Performance Data applicable to the part number of the device being installed. Make a visual inspection of the device for obvious signs of damage. Avoid locations where excessive moisture, corrosive fumes, vibration or high ambient exists.

INSTALLATION

Requirements

Locate the device allowing proper distance to the bulb location. The case can be mounted in any position. Refer to Figure 1 for case dimensions.

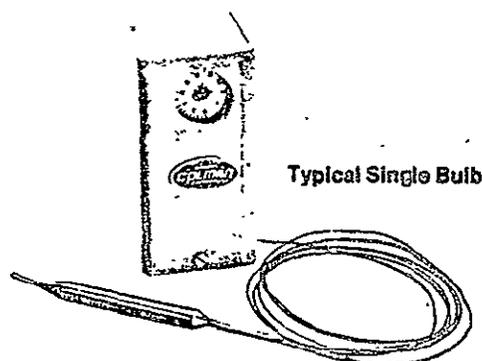
Procedure

Case Mounting

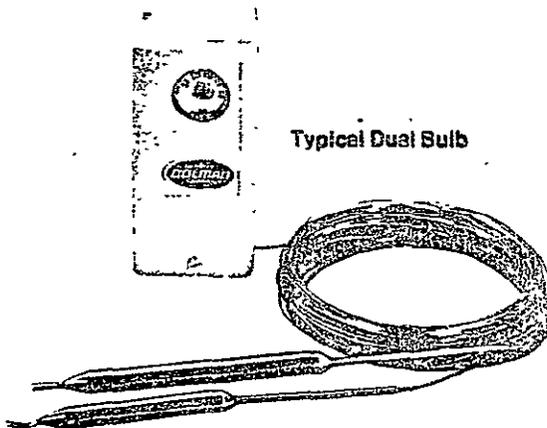
Ambient Rating: -40° to 60°C (-40° to 140°F)

1. Remove cover and provide 2 holes for #10 round head screws using the housing as the template or by using the dimensions shown in Figure 1.
2. Partially insert the mounting screws in the screw holes. Fit the housing over the screws, slide housing down on the screws and tighten the screws.

Wiring: The thermostat has one 1/2-inch to 3/4-inch conduit opening in bottom of housing. Make all electrical connections in accordance with the job wiring diagram and in compliance with national and local electrical codes. Terminal coding and switch action is shown in Figure 2, and Figure 3 shows two stage switching sequence.



Typical Single Bulb



Typical Dual Bulb

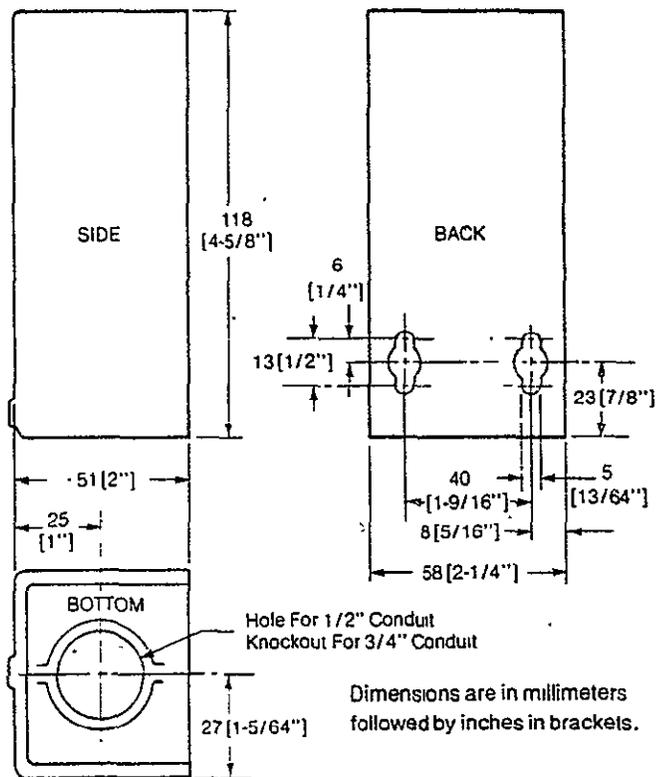


Figure 1. Case Dimensions

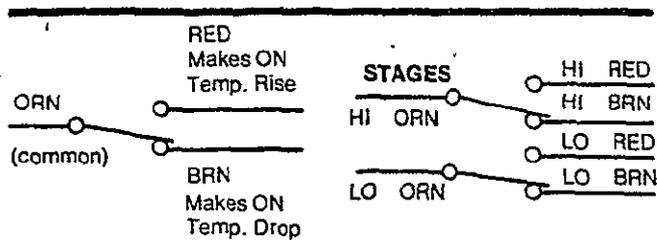


Figure 2. Terminal Coding and Switch Action

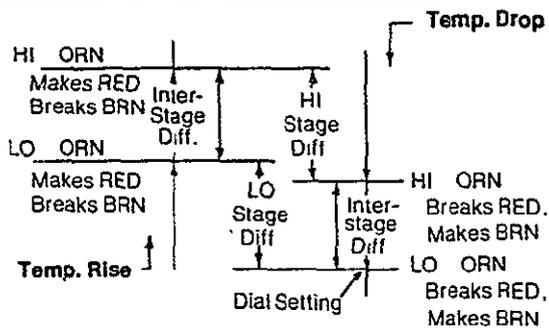


Figure 3. Two Stage Switch Sequence

Bulb Mounting

Maximum insertion length 152 mm (6 inches). Maximum safe bulb temperature 28°C (50°F) above scale range. For dual bulbs, total of indoor and outdoor bulb temperatures must not exceed 138°C (280°F).

Duct: Install bulb with AT-208 kit as shown in Figure 4

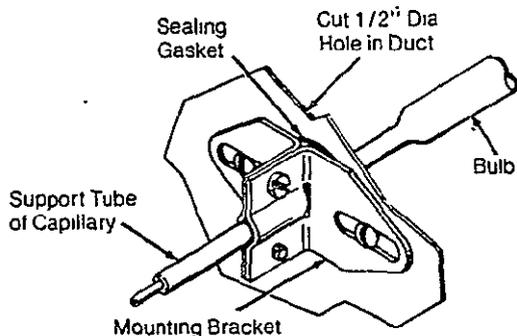


Figure 4. Duct Mounting With AT-208.

Outdoor:

Install with AT-211 kit as shown in Figure 5.

1. Mount bulb to outside wall or surface with bulb clip.
2. Place shield over bulb and fasten to mounting surface.

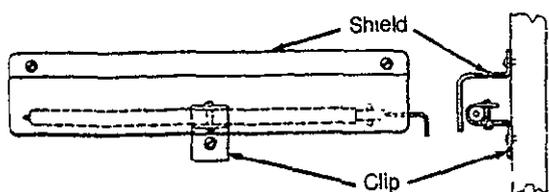


Figure 5. Outdoor Mounting With AT-211

Liquid Line and Tank

Install with AT-209 kit as shown in Figure 6. A bulb well is recommended, see Figure 7 for preferred installation and limitations. The thermal bulb is suitable for immersion mounting with 150 psig maximum pressure and/or 4 fps fluid velocity.

1. A 3/4-inch NPT hole is required.
2. Place packing nut, washers and packing over bulb support section as shown in Figure 6.
3. Install bulb well or adaptor from AT-209 kit into the 3/4-inch NPT opening.
4. Insert bulb into well or adaptor.
5. Push interlocking washers and packing into well or adaptor and tighten packing nut until firmly seated.

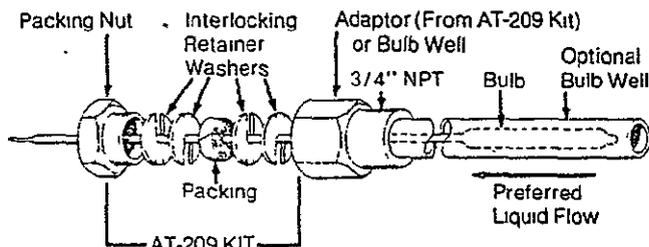
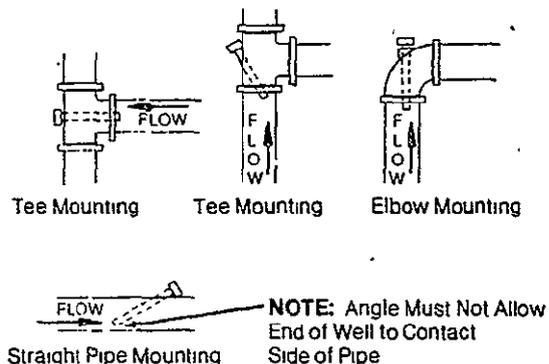


Figure 6. Liquid Line or Tank Mounting With AT-209



Application Limitations at 250°F Fluid Temp. (Max. 350°F)		
Bulb Well Part No.	Max. Recommended Velocity (FPS)	Max. Recommended Static Pressure (psig)
AT-201	11	250
AT-203	20	500

Figure 7. Bulb Well Installation

Electrical Rating: All Units Except TC-4115

Switch Rating (50/60 Hz)	24V	120V	240V	277V
Full Load Amps	—	9.8	8.0	—
Locked Rotor Amps	—	58.8	48.0	—
Pilot Duty	60	360	360	—
Non-Inductive Amps (Resistive)	—	—	—	—
Single Stage	22	22	22	22
Two Stage	16	16	8.3	7.2

CHECKOUT

After installing a thermostat, make an initial check of the switching action. Verify the switch action by listening to the switch contacts.

1. Turn the setpoint dial to a temperature above ambient. This should cause the thermostat to switch, making orange to brown.
2. Turn the setpoint dial setting down gradually. Orange to brown must break, making orange to red.
3. Compare the differential of the device to the differential shown on the performance charts by turning the dial. The differential of the devices is the difference in dial reading between the make of orange to brown and the make of orange to red on single switch units.

RUN/ADJUST

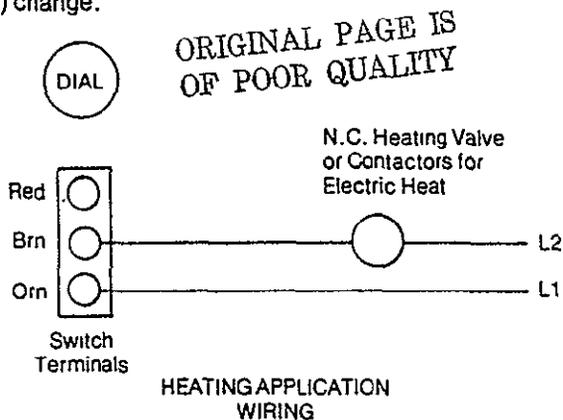
Setpoint

Screwdriver adjustment. Scales dual marked °F on front and °C on back. To change scale, remove spring retaining ring, select scale and replace retaining ring.

DIFFERENTIAL

The differential is adjustable by turning the adjustor located on side of device.

Single stage: Each line represents approximately 1.6°C (3°F) change.



Two stage: Each notch represents approximately 1.1°C (2°F) change between stages. (Differential per switch is fixed.)

To adjust differential:

1. Disconnect power to unit.
2. Remove cover.
3. Turn adjustor to approximately desired position.
4. Check out by turning dial and noting dial readings where switch contacts make.
5. After changing differential—re-calibrate.

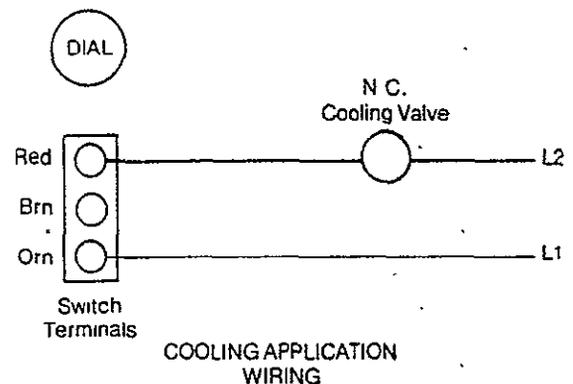
CALIBRATION

1. With all power disconnected, soak bulb(s) for 10 minutes at known temperature (must be 70°F for dual bulb).
2. Turn dial and note where switch contacts make.
3. Turn dial midway between click points.
4. Turn the calibration nut (located under dial) until the temperature of the bulb is indicated on the dial.

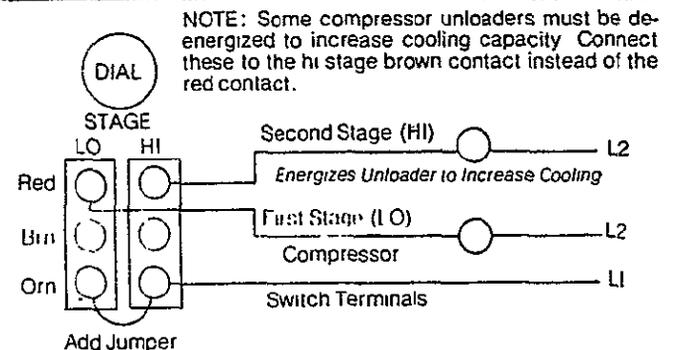
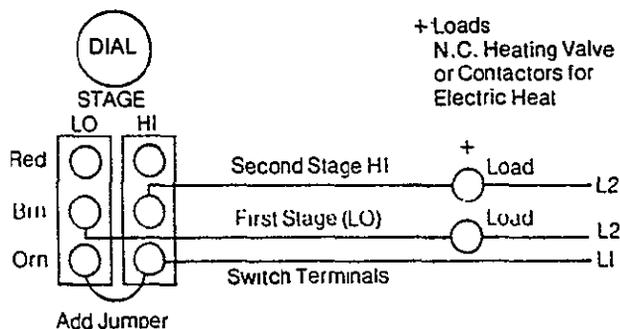
Note: On two-stage units follow above procedure on "LO" switch.

REPAIR

Field repair is not recommended. Replace defective device.



TYPICAL HEATING OR COOLING APPLICATION FOR TC-4111, TC-4111-020, TC-4121, TC-4122, TC-4123, TC-4151 AND 4152.



Two Compressor Packages May Be Sequenced With The Wiring Shown

Figure 8.

Performance and Selection Table

Type	Part Number	Setpoint Adjustment Range °C (°F)	Dial Ratio	Dimensions		Differential	
				Capillary Copper	Bulb Copper	Factory Set	Adjustable
Single Stage	TC-4111	-40 to 49 (-40 to 120)		1.8M (6')	10 x 100 mm (3/8 x 4")	1.6°C (3°F)	1.6 to 8.5°C (3 to 16°F)
	TC-4111-020			6M (20')			
	TC-4115*			1.8M (6')			
	TC-4121	3M (10') Armored					
	TC-4122			38 to 127 (100 to 260)			
	TC-4123			88 to 176 (190 to 350)			
Dual Bulb	TC-4151	21 to 49 (70 to 120)	1 1/2 **	9M (30') Each Bulb	Outdoor 10 x 100 mm (3/8 x 4")	1.6°C (3°F)	.8 to 5.5°C (1 1/2 to 10°F)
	TC-4152		1:1		Indoor 10 x 140 mm (3/8 x 5 1/2")		10 x 100 mm (3/8 x 4")	1.6 to 8.5°C (3 to 16°F)
Two Stage	TC-4211	-40 to 49 (-40 to 120)		1.8M (6')	10 x 100 mm (3/8 x 4")	1.6°C (3°F)	Per Stage Fixed Between Stages 1.1 to 5.5°C (2 to 10°F)

*TC-4115 for System 8000 and dry circuit switching. Electrical Rating: 1.0 amp at 24 Vac, .25 Amp at 24 Vdc
 **TC-4151 — For 1 1/2: 1 ratio reverse bulbs and use extra dial supplied with unit

Dual Bulb Selection

To select Ratio it is necessary to know only: (1) Outdoor design temperature, (2) Maximum water temperature at outdoor design temperature, and (3) Desired water temperature at 70 F outdoors.

Example Select ratio for panel installation with a -10 F design temperature and estimated supply water temperatures of 75 F at 70 F outdoors, and 125 F at -10 F outdoors.

From chart below, -10 F for 1 1/2 to 1 ratio, note by interpolation (70 F to 123 F with dial at 70 F; 80 F to 133 F with dial at 80 F) that water temperature varies from 75 F to 128 F as outdoor temperature drops from 70 F to -10 F, when dial is set at 75 F.

By similar means, note that a control with 1 to 1 ratio would result in water temperatures varying from 75 F to 155 F. For this application the 1 1/2 to 1 ratio should be selected.

Outdoor Temperature (F)	Ratio	Change in Water Temperature for Different Ratios as Outdoor Temperature Drops from 70F to Design Temperature					
		Dial Set at 70F	Dial Set at 80F	Dial Set at 90F	Dial Set at 100F	Dial Set at 110F	Dial Set at 120F
-30	1 to 1 1/2	70 to 220	80 to 230	90 to 240	100 to 250	110 to 260	120 to 270
	1 to 1	70 to 170	80 to 180	90 to 190	100 to 200	110 to 210	120 to 220°
	1 1/2 to 1	70 to 137	80 to 147	90 to 157	100 to 167	...	...
-20	1 to 1 1/2	70 to 205	80 to 215	90 to 225	100 to 235	110 to 245	120 to 255
	1 to 1	70 to 160	80 to 170	90 to 180	100 to 190	110 to 200	120 to 210
	1 1/2 to 1	70 to 130	80 to 140	90 to 150	100 to 160	...	...
-10	1 to 1 1/2	70 to 190	80 to 200	90 to 210	100 to 220	110 to 230	120 to 240
	1 to 1	70 to 150	80 to 160	90 to 170	100 to 180	110 to 190	120 to 200
	1 1/2 to 1	70 to 123	80 to 133	90 to 143	100 to 153	...	...
0	1 to 1 1/2	70 to 175	80 to 185	90 to 195	100 to 205	110 to 215	120 to 225
	1 to 1	70 to 140	80 to 150	90 to 160	100 to 170	110 to 180	120 to 190
	1 1/2 to 1	70 to 117	80 to 127	90 to 137	100 to 147	...	...
+10	1 to 1 1/2	70 to 160	80 to 170	90 to 180	100 to 190	110 to 200	120 to 210
	1 to 1	70 to 130	80 to 140	90 to 150	100 to 160	110 to 170	120 to 180
	1 1/2 to 1	70 to 110	80 to 120	90 to 130	100 to 140	...	...
+20	1 to 1 1/2	70 to 145	80 to 155	90 to 165	100 to 175	110 to 185	120 to 195
	1 to 1	70 to 120	80 to 130	90 to 140	100 to 150	110 to 160	120 to 170
	1 1/2 to 1	70 to 103	80 to 113	90 to 123	100 to 133	...	...
+30	1 to 1 1/2	70 to 130	80 to 140	90 to 150	100 to 160	110 to 170	120 to 180
	1 to 1	70 to 110	80 to 120	90 to 130	100 to 140	110 to 150	120 to 160
	1 1/2 to 1	70 to 97	80 to 107	90 to 117	100 to 127	...	...

Barber-Colman Company
CONTROLS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A., 61101

LITHO IN U.S.A.



**INSTALLATION AND
OPERATION INSTRUCTIONS
TYPE F62AA**

FORM 997-837

AIR FLOW CONTROL

APPLICATION

This control detects air flow or the absence of air flow in ducts, responding only to velocity of air movement. It can be wired to open one circuit and close a second circuit (SPDT) for either safety or interlock purposes.

INSTALLATION

The F62AA can be mounted on top, side or bottom of a duct. Mount so the paddle weight does not assist or oppose the spring force which sets the CFM flow required to activate the switch.

Install in a horizontal duct whenever possible and where ambient temperatures do not exceed 180° F. Avoid locations close to elbows, dampers, fans and duct openings or other areas where excessive turbulence occurs. Control should be mounted away from such areas at least five times the distance of the smallest duct dimension. Example: 3" x 8" duct mount at least 15" from the nearest bend. The standard paddle fits into ducts of 3" x 8" minimum. The paddle may be trimmed for installing in ducts as small as 3" x 6".

To install proceed as follows:

1. Select the proper location.
2. Use the mounting plate gasket as a template and mark hole positions.
3. Drill or punch screw holes.
4. Cut center hole large enough for the paddle to pass through.
5. In horizontal duct the case must be level with the paddle at approximately a right angle to the air flow.
6. When the horizontal duct is not horizontally true, check with a level and place a shim under the control mounting plate (see sketch.)

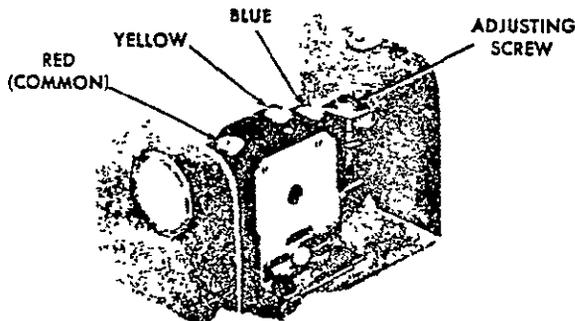


Fig. 2 — Internal view of Air Flow Control. Note adjusting screw.

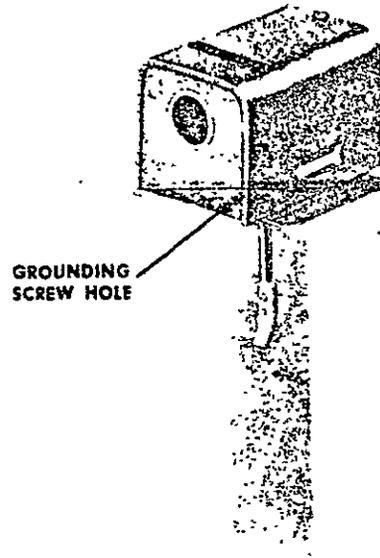
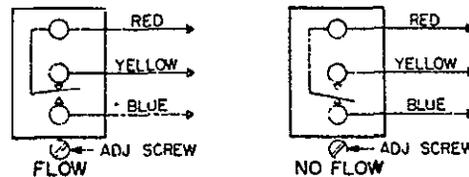


Fig. 1 — Type F62AA Air Flow Control

CAUTION: If necessary to install in a vertical duct with downward air flow, the control must be readjusted. To readjust, turn the range screw clockwise until switch operates with no air flow. Then, adjust screw one additional turn clockwise.

Wiring

All wiring should conform to the National Electrical Code and local regulations. The Pennswitch terminals are color coded as follows: Red is common, Red closes to Yellow on air flow increase, Red closes to Blue on air flow decrease (no flow).



The circuit between the red and yellow terminals will close when the required air flow velocity is reached in the duct where the control is installed. The warning light or signal, when used, will be activated when the air flow decreases or ceases.

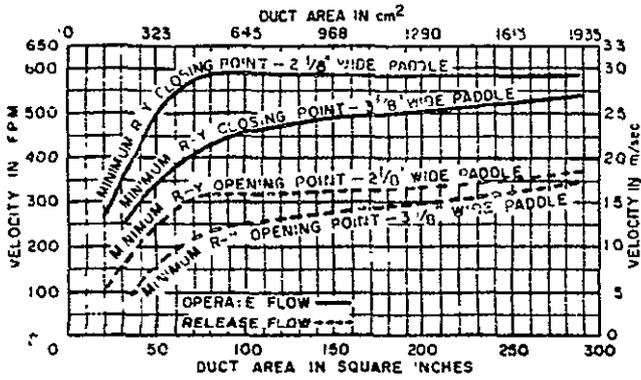
ADJUSTMENT

The flow control is factory set at the minimum flow rate shown in the graph.

To adjust:

1. Remove control cover.

2. For higher flow rate — turn adjusting screw clockwise.
3. For lower flow rate — turn adjusting screw counter-clockwise.



Air flow velocities in FPM required to actuate switch for any given duct size are shown in the graph curves. (Based on standard air density of 0.075 pounds per cubic foot.)

CHECKOUT PROCEDURE

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

REPAIR AND REPLACEMENT

Field repairs are not recommended. Flow control requiring attention should be returned to the nearest Penn-Baso Counterline Wholesaler or the factory.



PENN CONTROLS
DIVISION OF JOHNSON SERVICE COMPANY

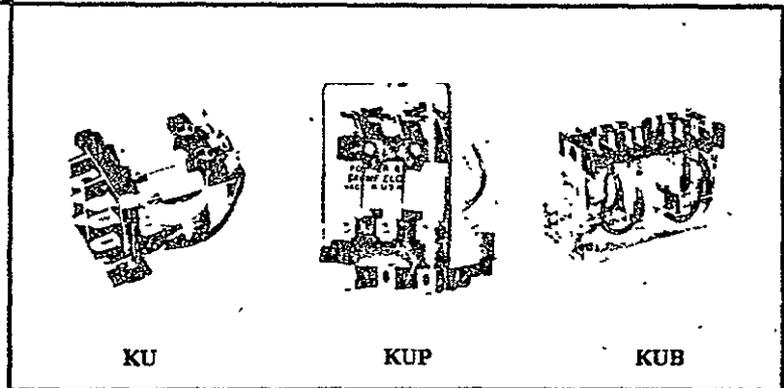
POTTER & BRUMFIELD KU SERIES RELAYS

KU

KU-KUP-KUB

POTTER & BRUMFIELD KU SERIES RELAYS

versatile,
low cost relays
with many
optional features



ORIGINAL PAGE IS
OF POOR QUALITY

ENGINEERING DATA

KU, KUP and KUB Series relays have been engineered for reliability, ease of installation and an excellent cost-to-quality relationship. An exceptionally wide choice of optional features is available with each Series. Their quick-connect/solder terminals are a substantial cost saver on modern production lines. KU and KUP Series fit four types of custom nylon sockets, making the series convenient plug-in relays.

Three general types, the KU open series, the KUP enclosed series and the KUB dual coil latching relays are available.

Standard relays are furnished with .187" terminals; .205" terminals are available upon request. The KU open series can be furnished with either a .218" or a .125" long locating tab and with or without a mounting stud.

Two styles of clear polycarbonate dust covers are available for the KUP Series relays. One is plain, for use when the relay is mounted in a socket. This case also can be furnished with a stud-and-locating-tab plate mounted on the end opposite the terminals. The other case has two slotted flanges for bracket mounting the relay directly to a chassis. The bracket-mount case is not suitable for socket mounting.

Relays with either type of dust covers (except the model with stud on end of case) can be furnished with a handy external push-button for checking circuits by manually op-

erating the movable contacts. A hold-down spring can be furnished for socket-mounted KUP Series (not applicable to screw terminal sockets). When desired, the KUP 120V and 240V AC types can be supplied with a neon lamp wired in parallel with their coils to indicate power is reaching the relay. All optional features are listed on Page 8.

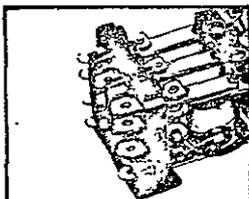
Reliability and long life of the KU/KUP/KUB Series are enhanced by long contact arms and a unique method of staking the stationary contacts, as well as barriers molded into the front.

Several types of custom nylon sockets are available. They accommodate all open KU* Series and plain case KUP Series when these relays have .187" terminals. These socket types are: solder, printed circuit, quick-connect, quick-connect with terminal barriers, and screw terminals (DPDT only). All are rated 10 amperes. Chassis layouts for these types of sockets are shown in the outline drawings on Page 6.

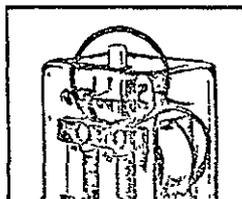
KU and KUP series are recognized under the Component Program of Underwriters' Laboratories, Inc., File No. E22575. Only standard KU and KUP series are included. Any electrical or mechanical deviations from standard relays are subject to reexamination by U/L.

**Caution should be exercised in handling socket-mounted open relays due to the inherent shock hazard.*

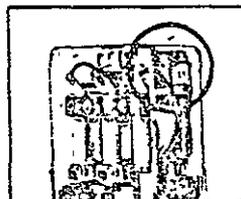
AVAILABLE WITH A WIDE CHOICE OF OPTIONAL FEATURES



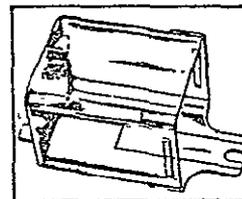
KU-KUP-KUB series are equipped with quick-connect terminals punched for soldering. .187" terminals are standard but .205" are available. Molded barriers meet U/L and CSA requirements.



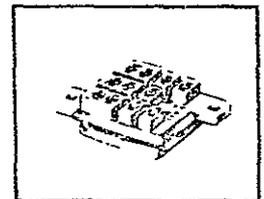
All KUP relays (except with stud on end of case) are available with push-to-test button which operates the movable contacts for manually checking circuits.



A neon lamp wired in parallel with its coil to indicate that power is available on KUP 120V and 240V AC types.



Two styles of heat and shock resistant polycarbonate dust covers can be furnished. One plain, the other with slotted flanges for direct-to-chassis mounting.



Several socket types can be supplied for the KU and KUP (plain case) series making them plug-in relays. See page 6.

SPECIFICATIONS

GENERAL:

Description: Versatile, low cost 5 or 10 amperes general purpose relays with many optional features.

Insulating Materials: Molded phenolic.

Insulation Resistance: 100 megohms minimum.

Expected Life: Mechanical: 10 million operations.

Electrical: 100,000 operations min. @ rated load.

Breakdown Voltage: 1500 volts rms 60 Hz between all elements; 500 volts rms 60 Hz between open contacts.

Temperature Range:

KU open relays: AC:

1 and 2 poles -45°C to +70°C

3 poles -45°C to +60°C

DC: -45°C to +85°C

KUP enclosed: AC:

1 and 2 poles -45°C to +55°C

3 poles -45°C to +45°C

DC: -45°C to +70°C

Time Values: (approx.): Operate: 15 milliseconds
Release: 10 milliseconds

Weights: KU open relay: 2.3 ozs. KUP enclosed relay 3.0 ozs

Operate: AC: 85% of nominal voltage @ 25°C.

DC: 75% of nominal voltage @ 25°C.

Enclosures: Two styles of heat and shock resistant, clear plastic polycarbonate. Please see Page 7.

Terminals: .187" standard, or .205" quick-connect. Both are punched for solder-connecting.

CONTACTS:

Arrangements: Please see chart, Page 4.

Material: Gold-flashed fine silver and silver-cadmium-oxide is standard. Tungsten and 75% gold alloy available.

Ratings: 5 or 10 amps @ 28 volts DC resistive, or 240 volts AC. 80% PF.

COILS:

Voltage: DC: to 110 volts. AC: to 240 volts 60 Hz.

Power: DC: 1.2 watts. AC: 1 and 2 poles 2.0 VA; 3 poles 2.7 VA.

Resistance: Please see coil data table below.

Duty: Continuous.

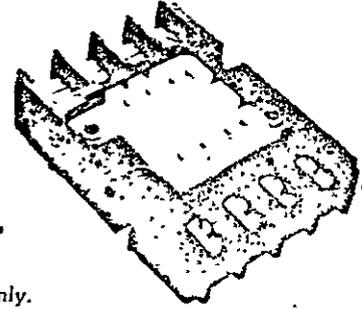
Treatment: Centrifugally impregnated with high quality electrical varnish.

Mounting: A wide choice of mountings. Please see drawings on Page 7.

CUSTOM SOCKETS:

Standard: All are rated 10 amperes. Will accept .187" terminals of all KU and plain case KUP relays. Please see Page 6.

OPTIONAL FEATURES FOR KU/KUP RELAYS



SCREW TERMINAL SOCKET*

*Will accept 2 pole relay only.

CHOICE OF NYLON SOCKETS

27E043 with
Solder Terminals

27E046 with
Printed Circuit Term.

27E067 with
Quick-Connect Term.

27E088 with
Terminal Barriers

27E097 with
Quick-Connect Term.
and Term. Barriers

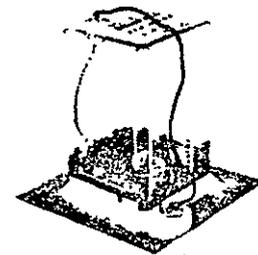
27E049 with
Screw Terminals

27E067

27E088

20C228 KUP HOLDDOWN SPRING**

**Not designed for KUL.



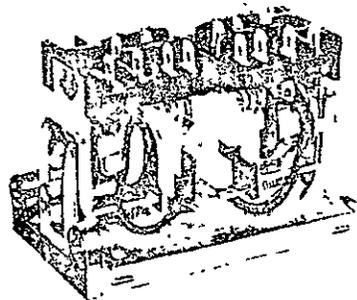
COIL DATA FOR STANDARD KU AND KUP RELAYS

DC COILS			AC COILS—1 & 2 POLE (50 60 HZ)			AC COILS—3 POLE (50 60 HZ)		
Voltage	DC Resistance In Ohms	Nominal Current In Milliamperes	Voltage 50 60Hz	DC Resistance In Ohms	Nominal Current In Milliamperes	Voltage 50 60Hz	DC Resistance In Ohms	Nominal Current In Milliamperes
6	32.1	188	6	6.0	3.15	6	4.2	460
12	120	100	12	21	1.68	12	18	230
24	472	51	24	75	.84	24	72	115
48	1,800	26.6	120	2,250	17.5	120	1,700	24
110	10,000	11.5	240	9,110	8.75	240	7,200	12
220	Use 110V relay with a 10,000 OHM 5W wire-wound resistor in series.							

KUB

POTTER & BRUMFIELD'S RELAY SERIES

dual coil latching relay



KUB

ENGINEERING DATA

Especially designed for overload or memory work, the KUB Series is a dual coil mechanical latching relay. A momentary impulse to one of the coils operates the relay to set the latch; a second pulse to the other coil releases it. Coils may be specified to operate on the same or different voltages. (See Coil Data chart for latch and release voltages.)

These positive-latching relays are mounted on a rigid zinc-alloy die-cast base to protect the relay adjustment during wiring and to provide for stable alignment of the latch bars. Relays can be furnished with contact arrangements to 6PDT (3PDT each coil).

GENERAL:

Insulating Material: Molded and laminated phenolic.

Insulation Resistance: 100 megohms.

Expected Life: Mechanical: 500,000 operations.

Electrical: 50,000 operations min. @ rated load.

Breakdown Voltage: 1,500 volts rms between all elements.

500 volts rms between open contacts.

Temperature Range: AC and DC: -45° C min. +85° C max. (intermittent duty).

Time Values: Operate: 25 milliseconds.

Approx. Weight: Open: 9.0 ozs.

Operate: AC: 85% of nominal voltage @ 25° C.

DC: 75% of nominal voltage @ 25° C.

Terminals: .187" standard, or .205" quick-connect. Both are punched for solder-connecting.

CONTACTS:

Arrangements: AC and DC to 6 Form C (6PDT) (3PDT each coil). Please see chart below.

Material: Gold-flashed fine silver and silver-cadmium-oxide is standard. Tungsten and $\frac{3}{32}$ " gold alloy available.

Rating: 5 or 10 amps @ 28 volts DC resistive, or 120 volts AC. 80% PF.

COILS:

Voltage: To 110 volts DC; to 240 volts AC. Specify voltage for both latch and release coils. Please see Coil Data chart below.

Resistance: Please see Coil Data chart below.

Power: DC: 2.5 watts min., 4 watts max.

AC: 5.0 volt-amps to 4-pole; 7.8 volt-amps to 6-pole.

Duty: DC: Continuous to +50° C.

AC: Intermittent.

CONTACT ARRANGEMENTS FOR KU, KUP, KUB AND KUL RELAYS

DESIGNATOR	FORM	Arrangement	KU / KUP	KUB	KUL
1	1 Form A	SPST-NO	●	●	●
2	1 Form B	SPST-NC	●	●	●
5	1 Form C	SPDT	●	●	●
7	2 Form A	DPST-NO	●	●	●
8	2 Form B	DPST-NC	●	●	●
11	2 Form C	DPDT	●	●	●
12	3 Form A	3PST-NO	●	●	●
13	3 Form B	3PST-NC	●	●	●
14	3 Form C	3PDT	●	●	●
15	4 Form A	4PST-NO		●	
16	4 Form B	4PST-NC		●	
17	4 Form C	4PDT		●	
18	5 Form A	5PST-NO		●	
19	5 Form B	5PST-NC		●	
20	5 Form C	5PDT		●	
23	(2) 3 Form C	6PDT		●	

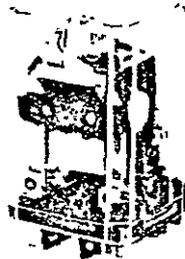
COIL DATA FOR KUB SERIES

Please specify coil voltage for both latch and release coils

DC Coils			AC Coils (50/60 Hz)		
Up to 6 Pole Relays			Up to 4 Pole Relays		
Volts	Resistance in Ohms	Av. Current Milliamperes	Volts	Resistance in Ohms	Av. Current Milliamperes
6	13.1	450	6	2.3	850
12	52.0	230	12	10	425
24	230	104	24	42	210
48	850	56.5	120	1030	44
110	4560	24	240	4100	22
220	Use 110 volt relay with 5000 Ohms, 5 watt resistor in series		For 5 and 6 pole relays		
			6	1.8	1300
			12	7.2	650
			24	27	325
			120	700	68
			240	2750	34

POTTER & BRUMFIELD'S RELAY SERIES

KUL



KUL

small, shunting magnetic latching relay

ENGINEERING DATA

The KUL is a small, commercial, magnetic latching relay that occupies approximately half the space of mechanically interlocking latching relays. The use of a permanent magnet in parallel with the normal magnetic circuit accounts for the relay's small size.

Reset is accomplished by reversing the voltage polarity in a single coil relay or by energizing the reset winding in a dual-wound coil relay. If overvoltage should occur during reset, the magnetic circuit is designed to prevent false operation of the contacts.

Relays with single or dual-wound coils are available for either AC or DC operation with contact arrangements up to 3 Form C rated 5 or 10 amperes at 28 volts DC, resistive, or 120 volts AC; 80% P. F.

A variety of nylon sockets is available that includes a choice of solder, printed circuit, quick-connect or screw terminals. All sockets are rated at 10 amperes.

A good memory stability is offered by the KUL relay which will provide a continuous latch condition during loss of power.

Continuous duty coil operation is practical because of the relay's low power requirements. This feature provides for the coil to remain energized in the latch position without damage to the relay.

The various features designed into the KUL Series make it ideal for applications as diverse as alarm systems and machine tools, battery chargers and protective devices, process controls and business machines.

GENERAL:

Description: Small, commercial magnetic latching relay.

Insulating Material: Molded phenolic.

Insulation Resistance: 100 megohms minimum.

Expected Life: Mechanical: 10 million operations.

Electrical: 100,000 operations minimum
@ rated load.

Breakdown Voltage:

1500 volts rms 60 Hz between all elements.

500 volts rms 60 Hz between open contacts.

Temperature Range: AC and DC: -45°C to +70°C.

Time Values:

Operate: 25 ms max. @ nominal voltage @ 25°C.

Reset: 10 ms max. @ nominal voltage @ 25°C.

Weight: 3.4 ozs. approximately.

Operate: AC: 85% of nominal voltage @ 25°C.

DC: 75% of nominal voltage @ 25°C.

Enclosures: Clear plastic polycarbonate heat and shock resistant case.

Terminals: .187" standard, or .205" connect.

Both are punched for solder-connecting.

CONTACTS:

Arrangements:

DC single coil: 1 Form C, 2 Form C and 3 Form C.

DC dual coil: 1 Form C and 2 Form C.

AC single coil: 1 Form C, 2 Form C and 3 Form C.**

Material: Gold-flashed fine silver and silver-cadmium-oxide.

Ratings:

5 or 10 amps @ 28 volts DC resistive,

or 120 volts AC, 80% P. F.

COILS:

Voltage: To 110 volts DC; 120 volts AC.

Resistance: Please see Coil Data chart.

Duty: Continuous

COIL DATA FOR KUL SERIES

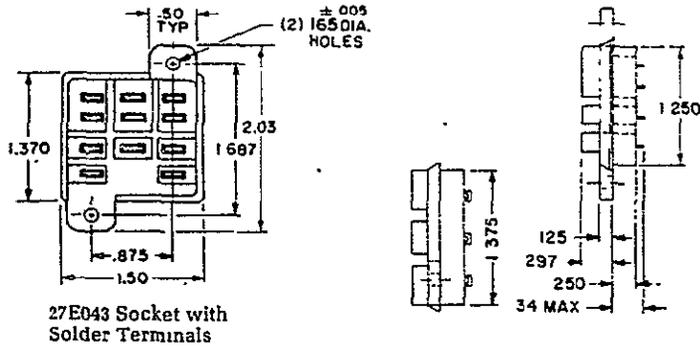
DC Single Coil		DC Dual Coil*			AC 50/60 Hz AC coil with diodes**	
Nominal Voltage	Coil Resistance ± 10% @ 25°C	Nominal Voltage	Coil Resistance ± 10% @ 25°C Latch	Reset	Nominal Voltage	DC coil resistance ± 10% @ 25°C
6	32.1	6	22	22		
12	120	12	90	90		
24	472	24	350	350		
48	1,800	48	1400	1400		
110	10,000				120	3700

*Dual coil available only with 1 or 2 Form C contacts. On standard dual coil relays, the latch and unlatch voltage must be the same. For unlike voltages, please consult factory.

**Diodes included inside relay for 1 or 2 Form C contacts. For 3 Form C, the customer must wire diodes and resistor outside relay.

SOCKETS FOR KU/KUP

WITH SOLDER TERMINALS—27E043



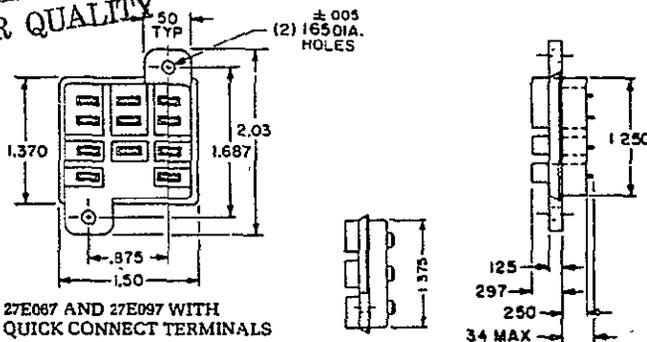
27E043 Socket with Solder Terminals

The chassis layout for sockets with solder terminals (27E043) is identical with the chassis layout for quick-connect terminals (No. 27E067), shown

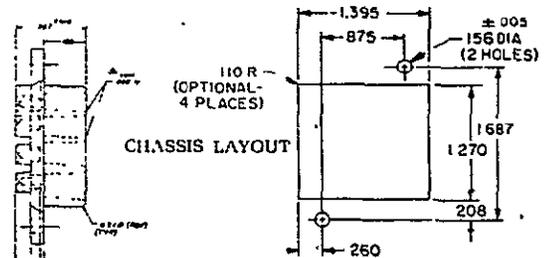
Socket Punch: Greenlee Part No. 501-8855.0 socket punch for either P&B socket No. 27E043 or No. 27E067 is available from Greenlee Tool Co., Rockford, Illinois.

WITH QUICK-CONNECT TERMINALS 27E067 AND 27E097

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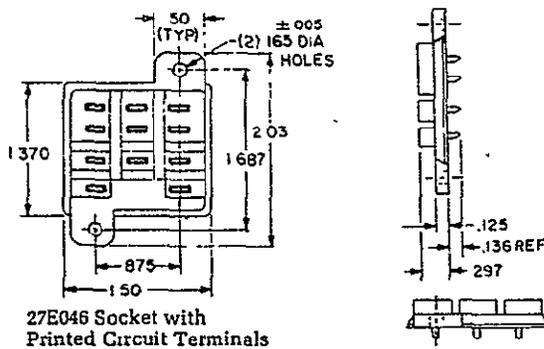


27E067 AND 27E097 WITH QUICK CONNECT TERMINALS

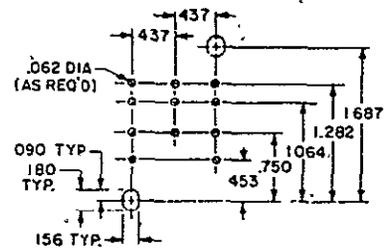


NO. 27E088 SOCKET WITH TERMINAL BARRIERS (USE AMP NO. 61347-1 QUICK-CONNECT FEMALE TERMINALS).

WITH PRINTED CIRCUIT TERMINALS—27E046



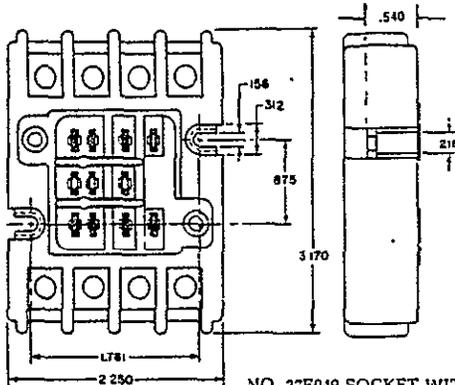
27E046 Socket with Printed Circuit Terminals



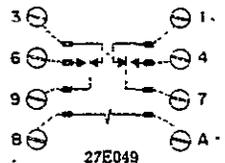
Suggested PC BOARD LAYOUT for Printed Circuit Socket (27E046)

WITH SCREW TERMINALS—27E049

Tolerances on this page unless otherwise specified:
0.XX = ± .03"
0.XXX = ± .010"



NO. 27E049 SOCKET WITH SCREW TERMINALS

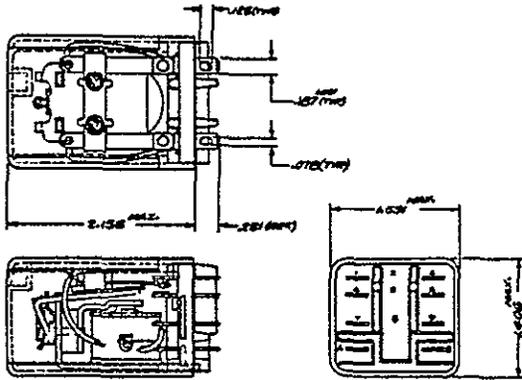


Schematic for DPDT 27E049

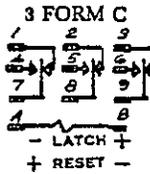
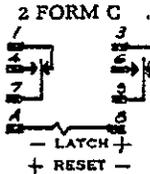
KUL LATCHING RELAYS

MOUNTINGS

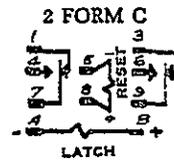
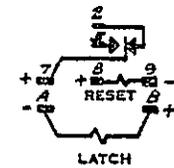
KUL CIRCUIT DIAGRAMS



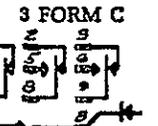
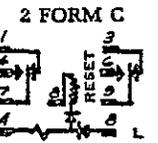
DC SINGLE COIL
1 FORM C



DC DUAL COIL
1 FORM C



AC COIL
1 FORM C



DIODES CONNECTED BY CUSTOMER

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OPTIONAL FEATURES AND CODE EXPLANATION OF KU/KUP/KUB/KUL

Type	Contact Arrang.	Coil Power	Mountings (Drawings on page 5)	Terminals & Contact Material	Example
KU Basic Open Relay			1 = # 6-32 stud, .218" locating tab 2 = 2-hole bracket, # 6-32 tapped 3 = # 6-32 tapped core, .125" locating tab. 4 = # 6-32 tapped core, .218" locating tab		KU14D15 = Open relay, 3PDT, DC, # 6-32 stud, .218" locating tab, .187 quick-connect/solder, silver-cad-oxide, 10_amps.
KUP Basic Enclosed Relay	Please see Table on Page 4	A = AC D = DC	1 = Plain case: 2 = with test button. 3 = with neon light. 4 = with test button & neon light 5 = Bracket-mount case: 6 = with test button 7 = with neon light. 8 = with test button & neon light. 9 = Stud on end of case. A = Plain case = 6-32 stud: B = with test button. C = with neon light D = with test button & neon light E = Plain case tapped core: F = with test button. G = with neon light. H = with test button & neon light.	1 = .187 quick-connect/solder, silver, 5 amps 2 = .205 quick-connect/solder, silver, 5 amps. 5 = .187 quick-connect/solder, silver-cad-oxide, 10 amps 6 = .205 quick-connect/solder, silver-cad-oxide, 10 amps	KUP11A21 = Enclosed relay, DPDT, AC, plain case with test button, .187 quick-connect/solder terminals and silver contacts, 5 amps KUP11AA1 = 24V—Enclosed relay, DPDT, AC, plain case and # 6-32 stud mounting, .187" quick-connect/solder terminals and silver contacts, 5 amps.
KUB Basic Latching Relay			1 = Standard Mounting plate 2.937" long, 1.781" wide with two .156" dia holes on .1375" centers.		KUB17A12 = Latching relay, 4PDT, AC, Stand mtg .205" quick-connect/solder, silver, 5 amps
KUL Basic Enclosed Magnetic Latching Relay			1 = Plain case: 3 = With neon light. (Sockets required)		KUL11D12D6 = Enclosed magnetic latching relay, DPDT, DC, plain case, .205 quick-connect/solder, silver, 5 amps; with dual coils for 6 volts.

(Drawings on pages 7 and 8)

XXX XX X X X (Add XX Coil Voltage)
(For KUL add: S—Single coil D—Dual coil XX—Coil voltage.)



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Honeywell



**DIFFERENTIAL
TEMPERATURE
CONTROLLER**

R7412A-F

SPECIFICATIONS

TRADELINE MODELS

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

TRADELINE MODELS AVAILABLE:

R7412F Differential Temperature Controller.

TRADELINE FEATURES:

Includes freeze and overtemperature protection and an auxiliary relay driver.

Tradeline pack with cross reference label.

STANDARD MODELS

MODEL	DIFFERENTIAL TEMPERATURE CONTROL	FREEZE PROTECTION	OVERTEMPERATURE PROTECTION	AUXILIARY RELAY DRIVER
R7412A	Yes			
R7412B	Yes	Yes		
R7412C	Yes	Yes		Yes
R7412D	Yes		Yes	
R7412E	Yes		Yes	Yes
R7412F	Yes	Yes	Yes	Yes

TEMPERATURE SETTING RANGES:

Operating Range (as defined by the temperature of the low temperature sensor)--

0 to plus 210 F [minus 18 to 99 C].

Differential Temperature Controller--

Adjustable ON and OFF differentials from minus 10 to plus 40 F [minus 5.6 to plus 22.2 C]. Factory-set at 18 F [10 C] temperature difference ON and 3 F [1.7 C] temperature difference OFF. Plug-in resistors vary settings (see Table 1, page 16).

Freeze Protection

Adjustable settings at 37, 42, or 47 F [3, 6, or 8 C].

Factory-set at 37 F [3 C].

Overtemperature

Adjustable in 5 F [3.2 C] increments from 140 to 190 F [57 to 89 C].

Factory-set at 140 F [66 C]

ELECTRICAL RATINGS:

Input Voltage--120V ac, 60 Hz; at 220/240 Volts, 50 Hz.

Load Relay Contacts--

1 N. O. Pole--12 AFL/72 ALR at 120V ac.

1 N. C. Pole--125VA at 120V ac.

Auxiliary Relay Drive--5 VA max at 24V ac, 60 Hz.

Power consumption--7 watts maximum.

AMBIENT TEMPERATURE RANGE:

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

Temperature Sensor--

minus 50 to plus 450 F [minus 46 to plus 232 C].

MOUNTING:

Controller--two screw holes in opposite corners of case.

Mounting screws not included.

Temperature Sensor--High temperature sensor either mounts with an accessory clip or sensor has a flattened end with a mounting hole.

ADJUSTMENTS AND CHECKOUT

DIFFERENTIAL TEMPERATURE SELECTION

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

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

FREEZE PROTECTION TEMPERATURE SELECTION

On models with adjustable freeze protection, the setting may be adjusted by changing the freeze protection plug-in resistor R23 (see Fig. 8). The R7412 freeze protection is factory-set at 37 F [3 C].

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

OVERTEMPERATURE SETTING SELECTION

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

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

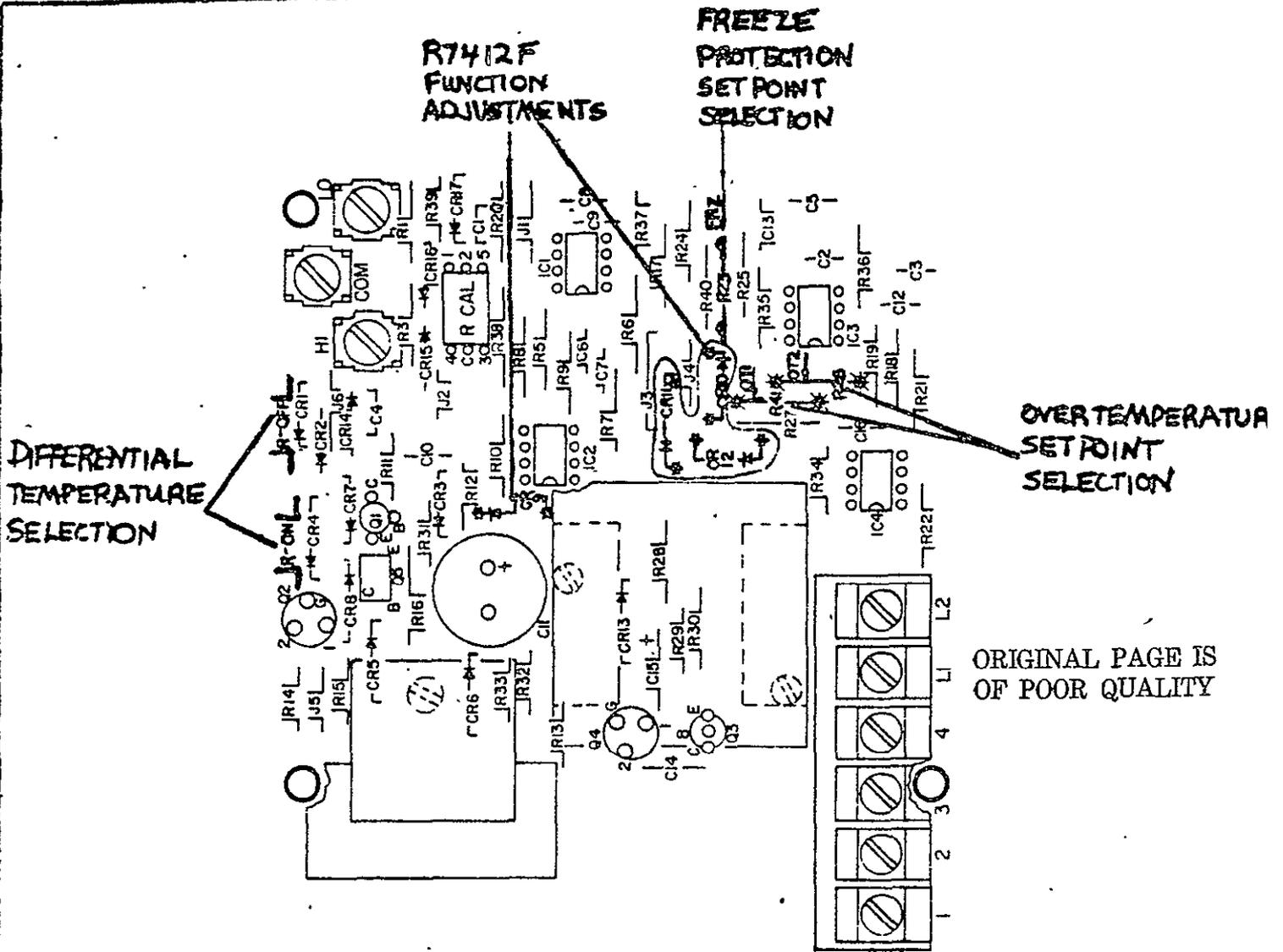


FIG. 8--ADJUSTMENT COMPONENTS OF THE R7412.

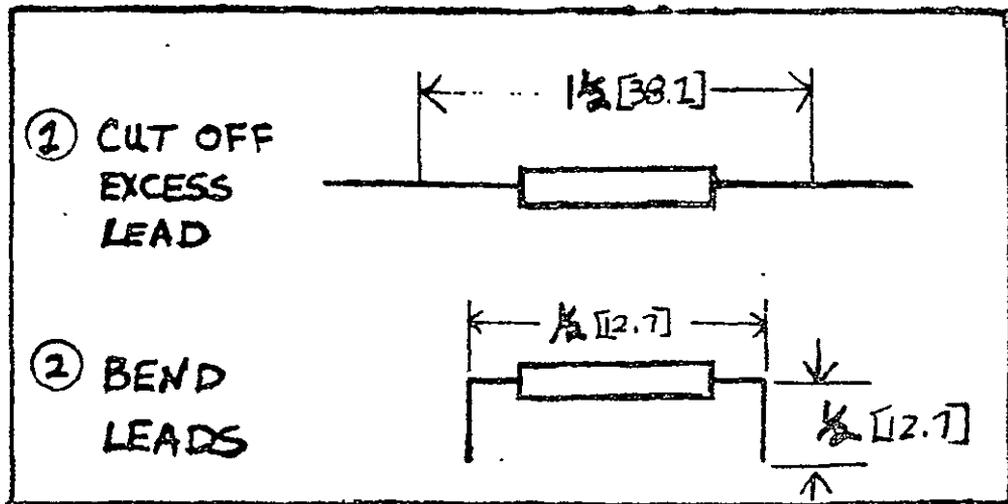


FIG. 9--PLUG-IN RESISTOR PREPARATION. DIMENSIONS IN INCHES [MILLIMETRES IN BRACKETS].

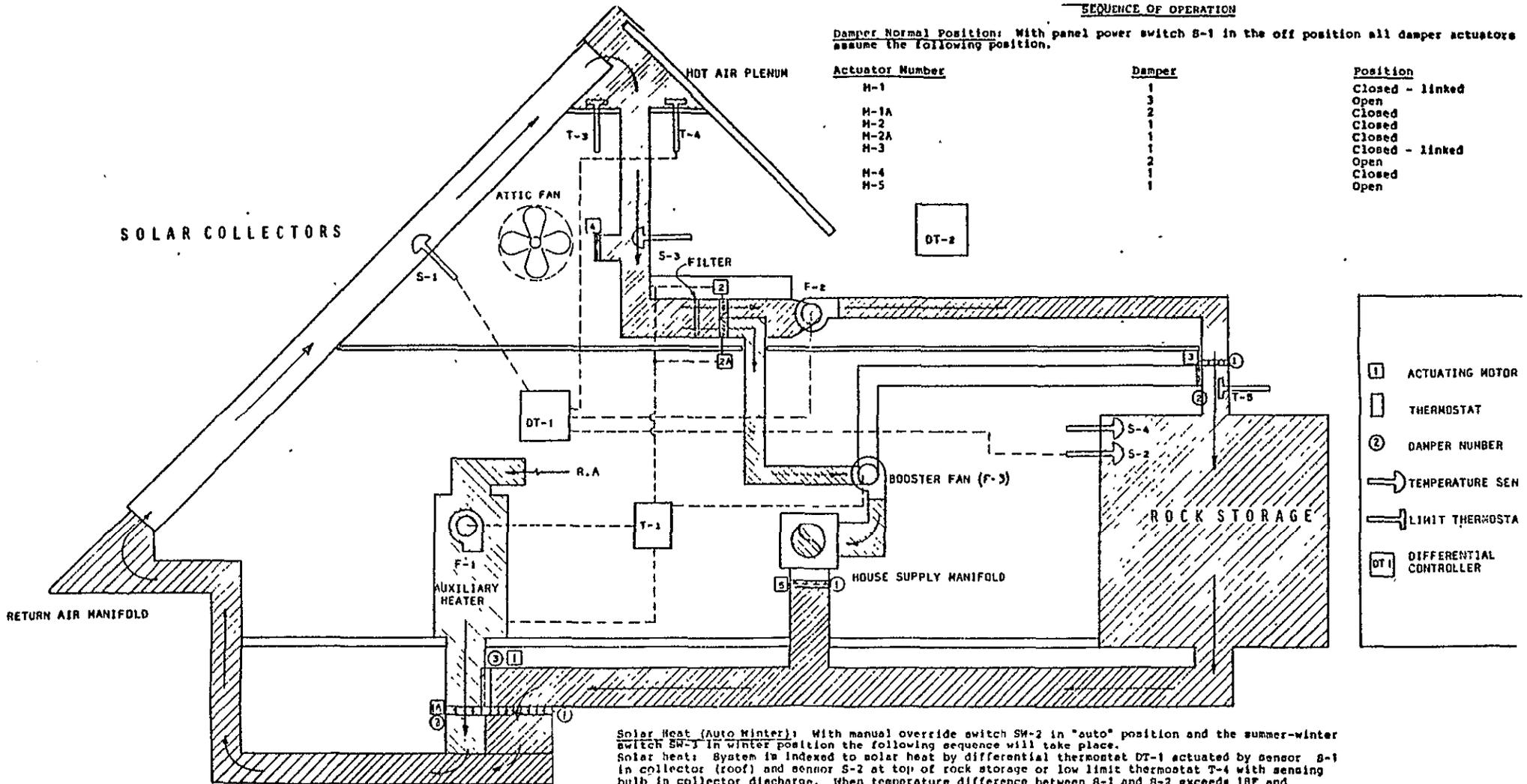
TABLE 1--DIFFERENTIAL TEMPERATURE CONTROL

FOR TEMPERATURE DIFFERENCE OF:		USE RESISTANCES BELOW FOR BOTH ON AND OFF RESISTORS (IN OHMS)
F	C	
-10	-6	27500
-5	-3	15400
0	0	11500
1	0.6	11000
2	1	10500
3	1.7	9760
4	2.2	9310
5	3	8870
6	3.3	8250
7	4	7870
8	4.4	7500
9	5	7150
10	6	6810
12	7	6340
14	8	5620
16	9	5230
18	10	4750
20	11	4220
25	14	3570
30	17	2430
35	19	1750
40	22	1210

SEQUENCE OF OPERATION

Damper Normal Position: With panel power switch S-1 in the off position all damper actuators assume the following position.

Actuator Number	Damper	Position
M-1	1	Closed - linked
M-1A	3	Open
M-2	2	Closed
M-2A	1	Closed
M-3	1	Closed - linked
M-4	2	Open
M-5	1	Closed
		Open



Solar Heat (Auto Winter): With manual override switch SW-2 in "auto" position and the summer-winter switch SW-1 in winter position the following sequence will take place.

Solar heat: System is indexed to solar heat by differential thermostat DT-1 actuated by sensor S-1 in collector (roof) and sensor S-2 at top of rock storage or low limit thermostat T-4 with sensing bulb in collector discharge. When temperature difference between S-1 and S-2 exceeds 18F and collector discharge temperature rises above 105F. When indexed to solar heat as per above solar heat relay KS will be energized causing the following:

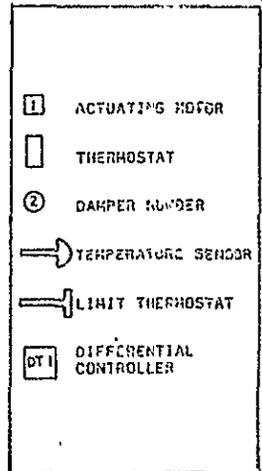
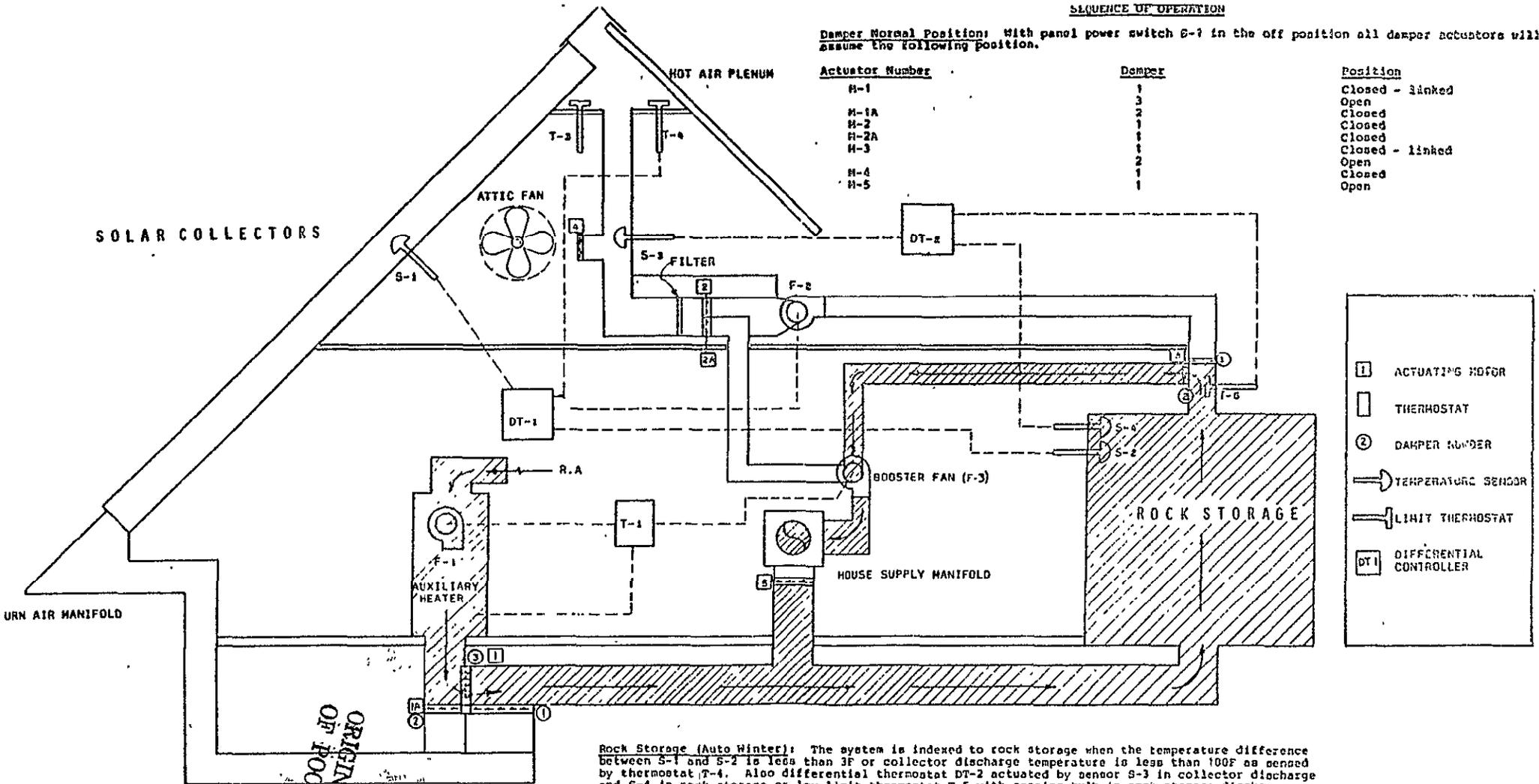
- A) Apply power to M-1 to open damper #1 and close damper #3.
- B) Apply power to M-1A to open damper #2.
- C) Apply power to M-2 and M-2A. See below for damper sequence.
- D) Apply power to M-3 to open damper #1 and close damper #2.
- E) Apply power to M-5 to close damper.
- F) Start solar circulating fan F-2.

Room thermostat T-1 modulates M-2 and M-2A, also cycles furnace fan F-1 and return air fan F-3 through electronic relay R-1 to maintain desired room temperature.

SEQUENCE OF OPERATION

Damper Normal Position: With panel power switch 6-1 in the off position all damper actuators will assume the following position.

Actuator Number	Damper	Position
H-1	1	Closed - linked
H-1A	3	Open
H-2	2	Closed
H-2A	1	Closed
H-3	1	Closed - linked
H-4	2	Open
H-5	1	Closed
		Open



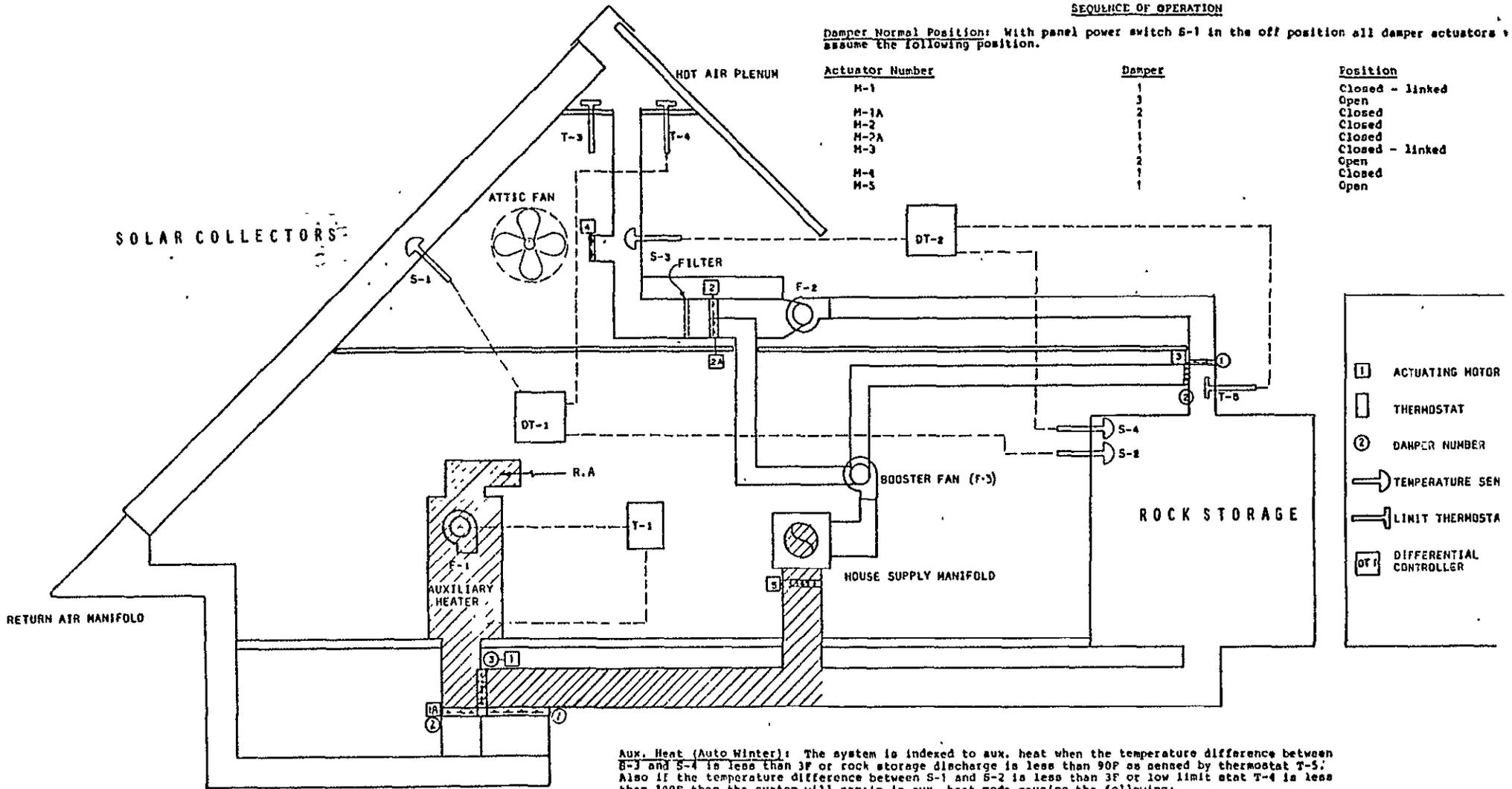
Rock Storage (Auto Winter): The system is indexed to rock storage when the temperature difference between S-1 and S-2 is less than 3F or collector discharge temperature is less than 100F as sensed by thermostat T-4. Also differential thermostat DT-2 actuated by sensor S-3 in collector discharge and 6-4 in rock storage or low limit thermostat T-5 with sensing bulb in rock storage discharge. If the temperature difference between S-3 and S-4 is above 10F and rock storage discharge is above 95F then the system will remain in rock storage mode energizing relay KR causing the following.
 A) Apply power to H-5 to closing damper. Room thermostat T-1 through electronic relay R-1 will cycle furnace fan F-1 and return air fan F-3 to maintain desired room temperature.

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SEQUENCE OF OPERATION

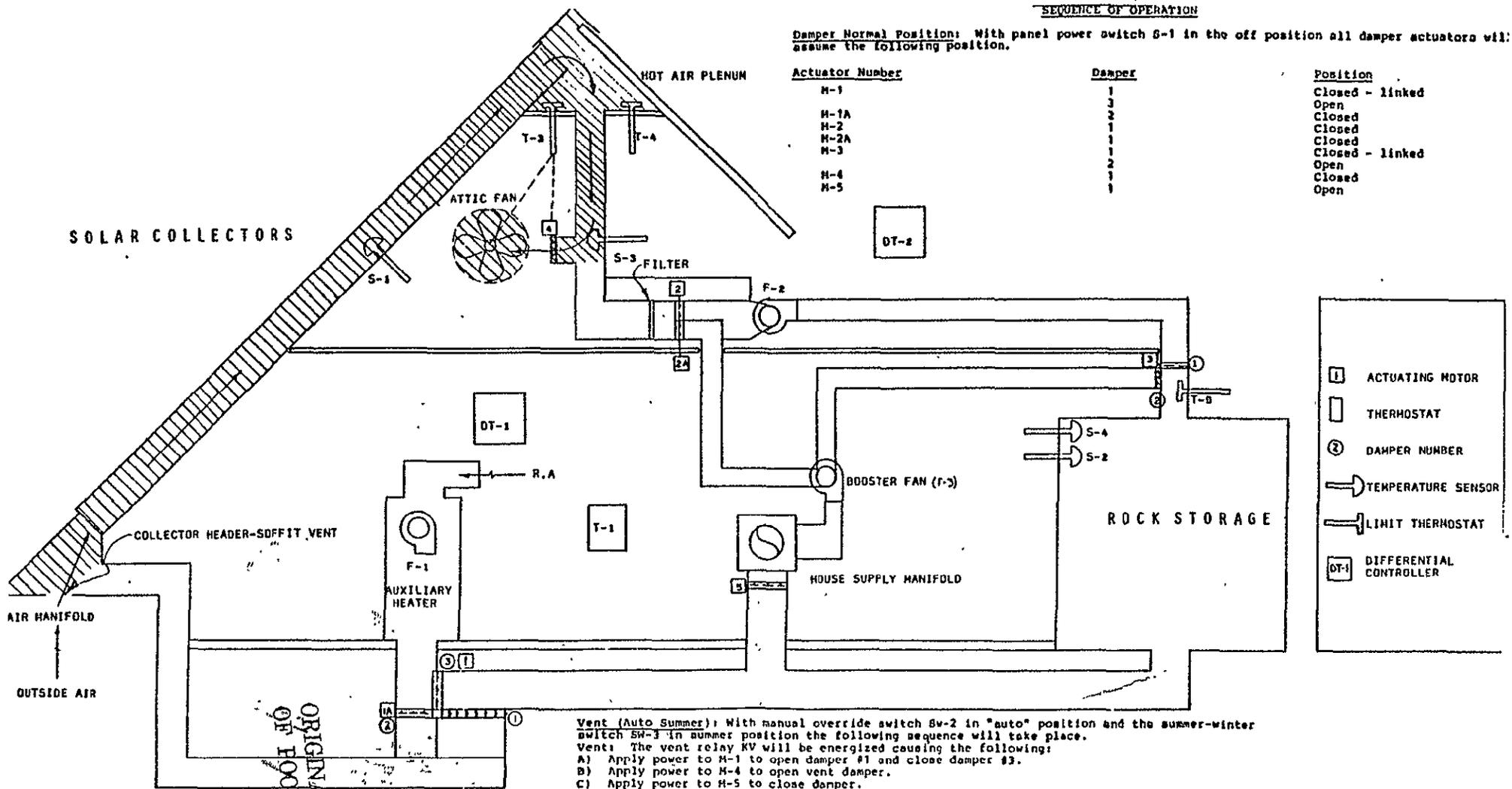
Damper Normal Position: With panel power switch S-1 in the off position all damper actuators assume the following position.

Actuator Number	Damper	Position
M-1	1	Closed - linked
M-1A	2	Open
M-2	1	Closed
M-2A	1	Closed
M-3	1	Closed - linked
M-4	2	Open
M-5	1	Closed
		Open



- ① ACTUATING MOTOR
- THERMOSTAT
- ② DAMPER NUMBER
- TEMPERATURE SEN
- ⊥ LIMIT THERMOSTA
- DT DIFFERENTIAL CONTROLLER

Aux. Heat (Auto Winter): The system is indexed to aux. heat when the temperature difference between S-3 and S-4 is less than 3F or rock storage discharge is less than 90F as sensed by thermostat T-5. Also if the temperature difference between S-1 and S-2 is less than 3F or low limit stat T-4 is less than 100F then the system will remain in aux. heat mode causing the following:
 Room thermostat T-1 will cycle the furnace gas as per conventional furnace operation.
Note: The furnace 24V control voltage is off when panel power switch S-1 is turned off or summer-winter switch S-3 is in off or summer position.



NOTE: IN THE VENT NODE, THE COLLECTOR HEADER-SOFFIT VENT MUST BE REMOVED.

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Vent (Auto Summer): With manual override switch Sw-2 in "auto" position and the summer-winter switch SW-1 in summer position the following sequence will take place.

Vents: The vent relay KV will be energized causing the following:

- A) Apply power to M-1 to open damper #1 and close damper #3.
- B) Apply power to M-4 to open vent damper.
- C) Apply power to M-5 to close damper.
- D) Start exhaust fan in attic.

Solar heat: System is inoperative.

Rock Storage: System is inoperative.

Aux. heat: System is inoperative.

Collector Overtemperature Alarm

When collector temperature exceeds the setpoint of thermostat T-3, the system is indexed to vent cycle regardless of the position of manual override switch S-2 and summer-winter switch S-3. Should exhaust fan fail to start, air flow switch will activate a pilot alarm on panel face. The alarm circuit can be activated manually by override switch S-4.

All modes can be activated manually by selecting modes required with override switch S-2.

LIST OF SERVICEMEN

ELECTRICAL CONTRACTOR

BELCO INC.
10450 Shields
Oklahoma City, OK Phone 405/794-4435

CONTROL CONTRACTOR - BARBER COLEMAN CONTROL

R & B Temperature Controls Inc.
7321 Broadway Extension
Oklahoma City, OK Phone 405/848-8573

HONEYWELL

Honeywell Service Line Center
6600 N. Broadway Extension
Oklahoma City, OK Phone 405/848-2811

COLLECTOR HARDWARE

The Binkley Company
Building Products Division
Warrenton, Missouri 63383 Phone 314/456-3455

SOLAR CONTRACTOR

Solar Engineering & Equipment Co. Inc.
3305 Metairie Road
Metairie, Louisiana 70001 Phone 504/837-7313

GENERAL NOTES AND EQUIPMENT SCHEDULE

SEQUENCE OF OPERATION

Under normal conditions with panel power switch S-1 in the off position all device actuators will assume the following positions:

Relay/Device Number	Position	Position
M-1	1	Closed
M-1A	2	Open - linked
M-2	2	Closed
M-2A	1	Closed
M-3	1	Closed
M-4	2	Open - linked
M-5	1	Closed
M-6	1	Open

Vent into summer position with manual override switch S-2 in "auto" position and summer-winter switch S-3 in summer position. The following sequence will take place:
 Note: The vent relay M-1 is energized causing the following:
 A) Apply power to M-1 to open damper #1 and close damper #2
 B) Apply power to M-2 to open check valve damper
 C) Apply power to M-3 to close damper #1
 D) Start exhaust fan F-1
 Solar Heat System is in operation.
 Note: Solar Heat System is in operation.

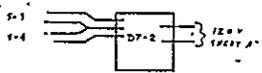
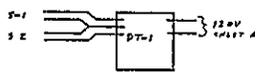
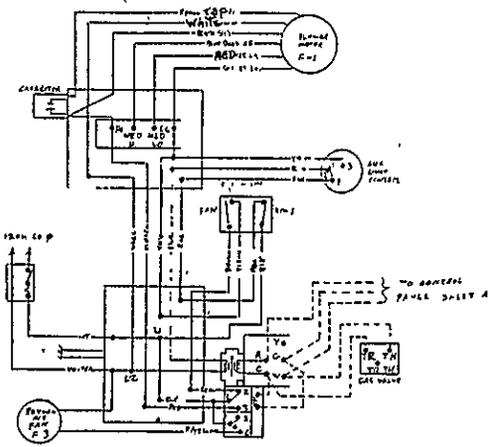
Solar Heat System: With manual override switch S-2 in "auto" position and summer-winter switch S-3 in winter position the following sequence will take place:
 Solar heat system is in operation. When indicated by differential thermostat T-1 actuated by sensor S-1 in collector (roof) and sensor S-2 at top of rock storage or low limit thermostat T-3 with sensing bulb in collector discharge. When temperature difference between S-1 and S-2 exceeds 15F or collector discharge temperature rises above 150F. When indicated solar heat as per above solar heat sequence will be energized causing the following:
 A) Apply power to M-1 to open damper #1 and close damper #2
 B) Apply power to M-4 to open damper #2
 C) Apply power to M-2 and M-2A. See below for damper sequence
 D) Apply power to M-3 to open damper #1 and close damper #2
 E) Apply power to M-5 to close damper #1
 F) Start solar circulating fan F-2
 Room thermostat T-1 controls M-1 and M-2A, also cycles furnace fan F-1 and return air fan F-3 through electronic relay R-1 to maintain desired room temperature.

Rock Storage (Auto Mode): The system is inducted to rock storage when the temperature difference between S-1 and S-2 is less than 3F or collector discharge temperature is less than 100F as sensed by thermostat T-4. Also differential thermostat T-2 actuated by sensor S-3 in collector discharge and S-4 in rock storage or low limit thermostat T-3 with sensing bulb in rock storage discharge. If the temperature difference between S-1 and S-2 is above 15F and rock storage discharge is above 100F then the system will remain in rock storage mode energizing relay R-1 causing the following:
 A) Apply power to M-1 to close damper #1
 Room thermostat T-1 through electronic relay R-1 will cycle furnace fan F-1 and return air fan F-3 to maintain desired room temperature.

Auto Vent (Auto Winter): The system is inducted to auto vent when the temperature difference between S-1 and S-2 is less than 3F or rock storage discharge is less than 50F as sensed by thermostat T-5. Also if the temperature difference between S-1 and S-2 is less than 3F or low limit stat T-4 is less than 15F then the system will remain in auto heat mode causing the following:
 Room thermostat T-1 will cycle the furnace gas as per conventional furnace operation.
 Note: The furnace 24V control voltage is off when panel power switch S-1 is turned off or summer-winter switch S-3 is in off or summer position.

Collector Overtemperature Alarm: When collector temperature exceeds the setpoint of thermostat T-3, the system is inducted to vent cycle regardless of the position of manual override switch S-2 and summer-winter switch S-3. Should exhaust fan fail to start, air flow switch will activate a pilot alarm on panel face. The alarm circuit can be activated manually by override switch S-4.

All modes can be activated manually by selecting modes required with override switch S-1.



ORIGINAL PAGE IS OF POOR QUALITY

		RAB THERMO, INC. - ANAHEIM, CALIF. 3211 West Broadway Orange, CA 92668	
DATE: 1/27/78	DESIGNED BY: J. J. ...	NO. NAME: COLMAN, JUDITH ...	LOCATION: ...
PROJECT: ...	CONTRACTOR: ...	APPROVED BY: ...	PROJECT NO.: ...
REVISIONS:	DATE:	BY:	REASON:
1	1/27/78	J. J. ...	TC-77-138
2	1/27/78	J. J. ...	TC-77-138

REV'D 8-18-78

Appendix A

S O L A R H E A T I N G

DESIGN DRAWINGS

F O R

C O N C H O S C H O O L B U I L D I N G

E L R E N O , O K L A H O M A

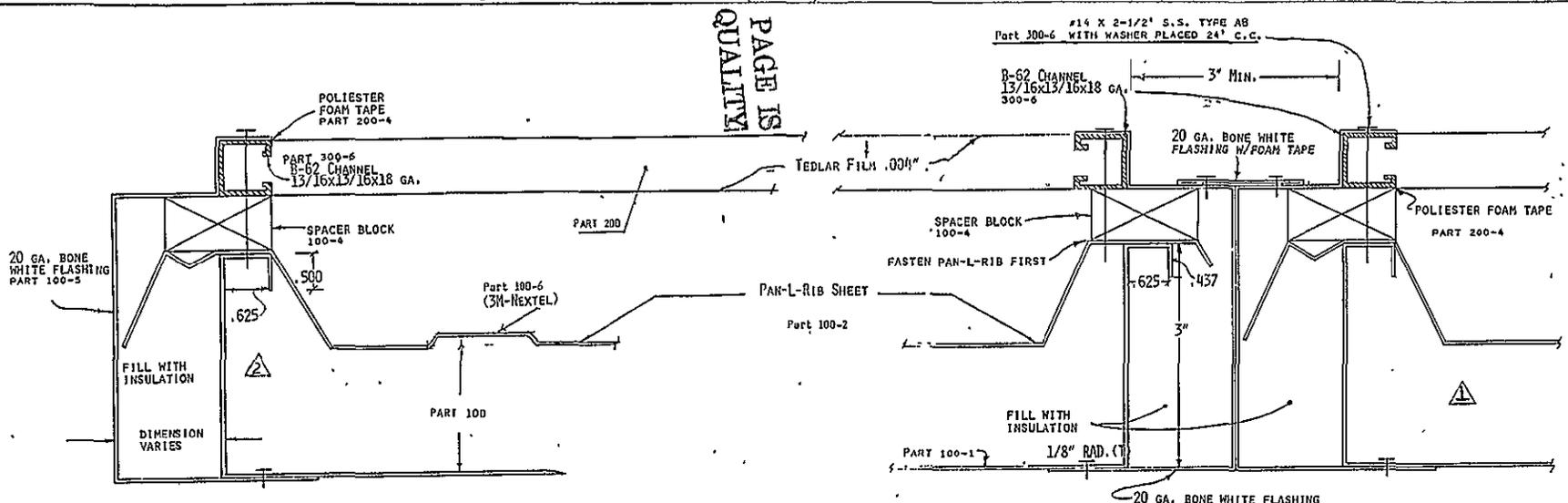
C O N T R A C T N A S 8 3 2 2 4 7

S O L A R E N G I N E E R I N G & E Q U I P M E N T C O . I I

I N D E X O F D R A W I N G S

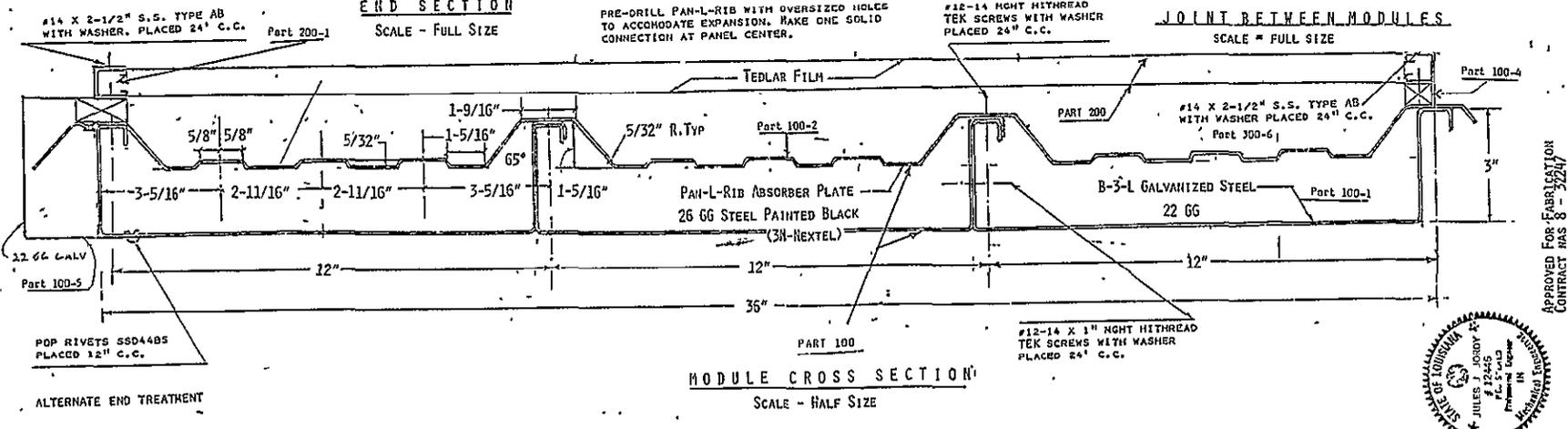
DWNG. CO.	T I T L E
S-1	Module Cross Section
S-2	Installation Details
S-3	Collector Installation Details
M-4	Ductwork in Attic
M-5	Ductwork in Crawl Space
M-6	Air Distribution Details
M-7	Details - Duct Connections
C-8	Storage Design & Air Distribution.
I-9	Instrumentation - Storage
I-10	Instrumentation Schematic
I-11	Instrumentation - Lower Attic
I-12	Instrumentation - Crawl Space
I-13	Typical SDAS Sensor Connection Details
I-14	SDAS Installation Details
C-15	Control Diagram - Solar Heating Mode
C-16	Control Diagram - Storage Mode
C-17	Control Diagram - Auxiliary Heat Mode
C-18	Control Diagram - Summer Operations Mode
C-19	Typical Control Wiring
C-20	COLLECTOR BALANCING DETAIL
C-21	Service Rig for Access to Collector Area

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END SECTION
SCALE - FULL SIZE

JOINT BETWEEN MODULES
SCALE = FULL SIZE



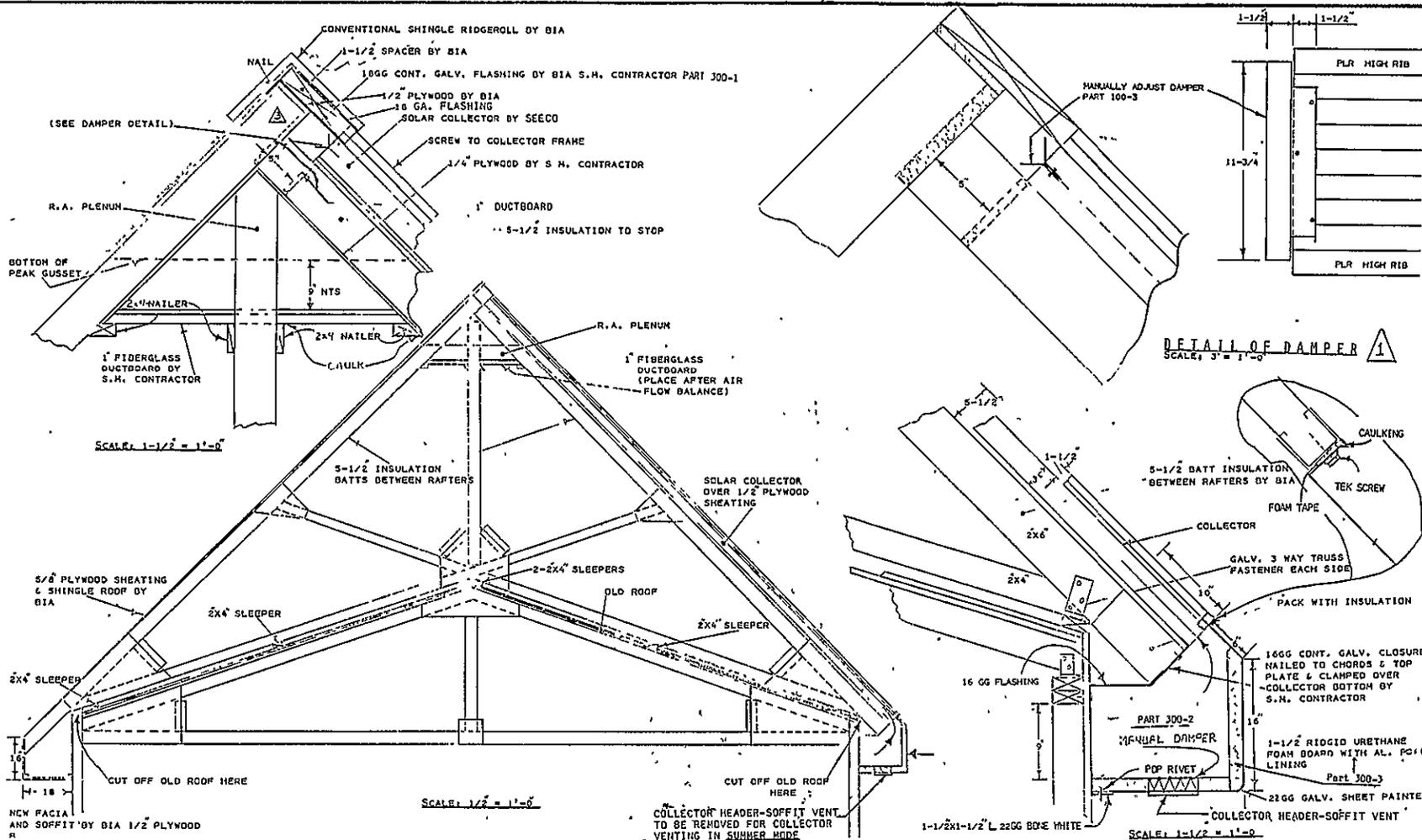
MODULE CROSS SECTION
SCALE - HALF SIZE

JOB No 406		SCALE: HALF SIZE		SHEETING S-1	
SEECO					
SOLAR ENGINEERING & EQUIPMENT COMPANY					
3305 METCALLE ROAD • METCALLE • LOUISIANA • 70001					
SEECO PROTOTYPE COLLECTOR SOURCE CONTROL DIAGRAM					
DESIGNED BY: J. J. JOYDY	DRAWN BY: J. C.	CHECKED BY: H. J.	APPROVED BY:	DATE: 10 - 1 - 76	
6/20/77	6/20/77			REVISIONS	
END SECTION	JOINT BETWEEN MODULES				
No	DATE	REMARKS			



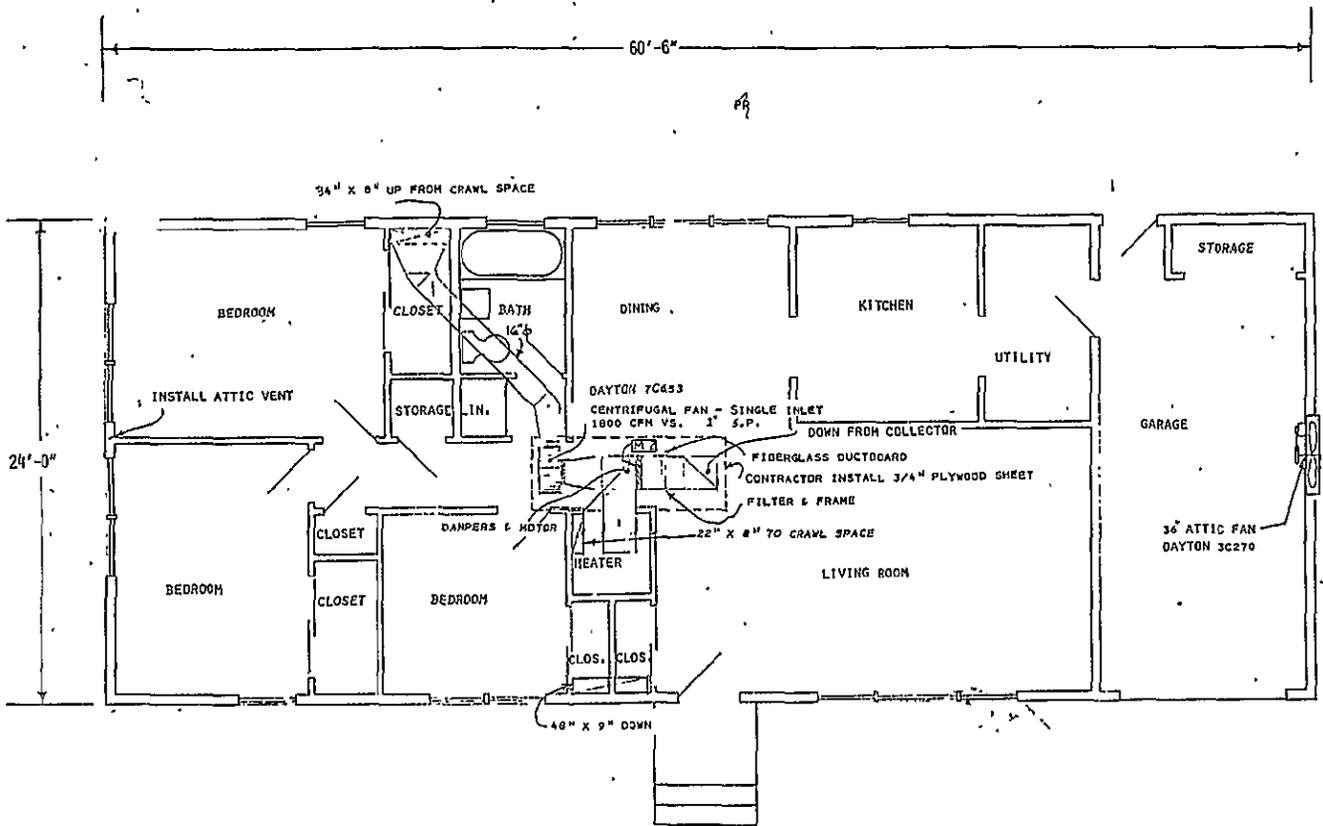
APPROVED FOR FABRICATION
CONTRACT HAS 8 - 3247

A-2



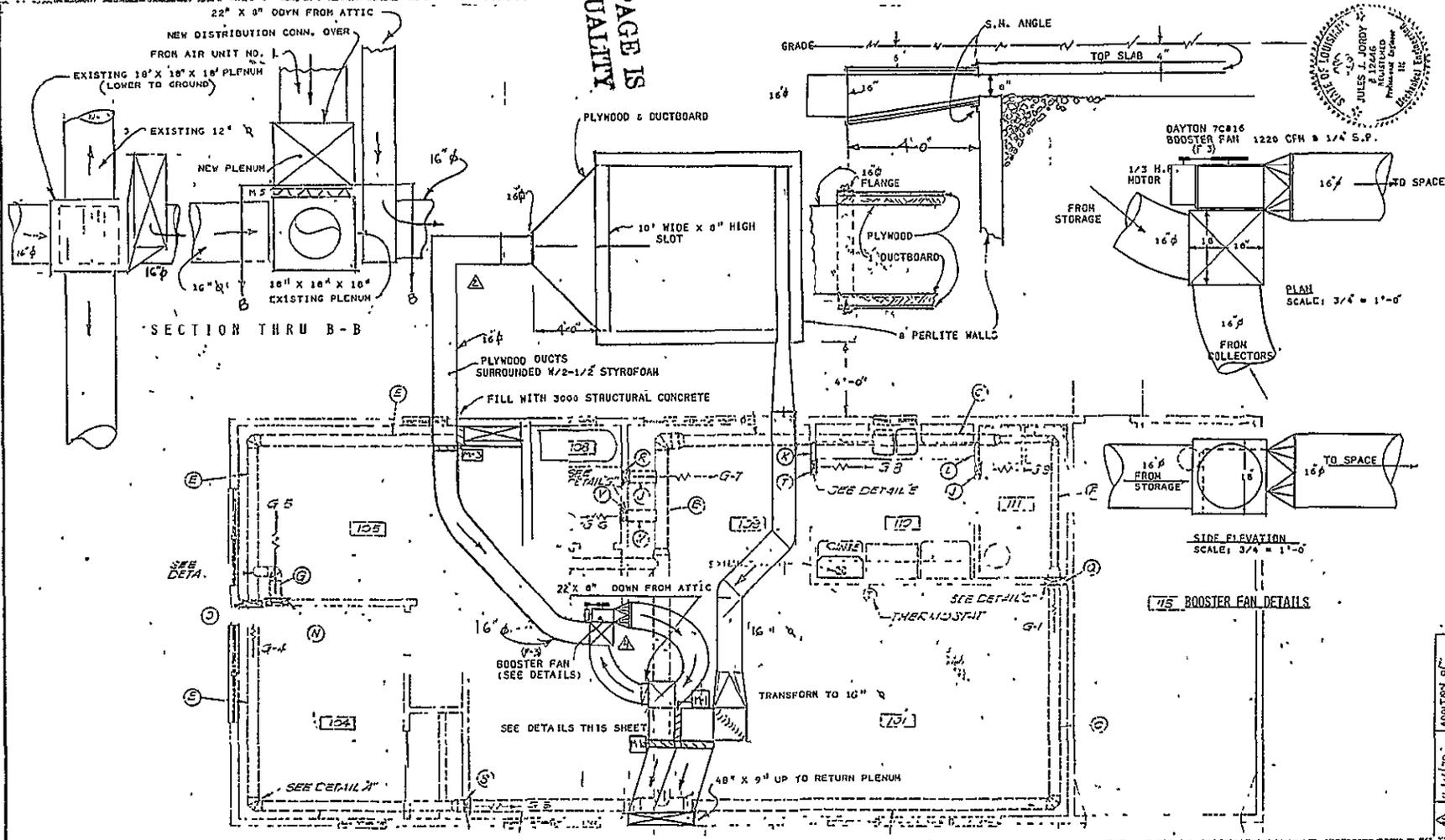
JOB No 406		SHEET No 5-2	
INSTALLATION DETAILS		SECO	
SOLAR ENGINEERING & EQUIPMENT COMPANY metairie • Louisiana •		3305 metairie road • 70001	
DESIGNED BY: J.J.J.	DRAWN BY: TGM	CHECKED BY: J.J.J.	APPROVED BY: H.S.J.
DATE: 4/11/78	REVISIONS	REMARKS	DATE
1		DAMPER DETAIL	6/21/77
2			
3			
4			

4-4



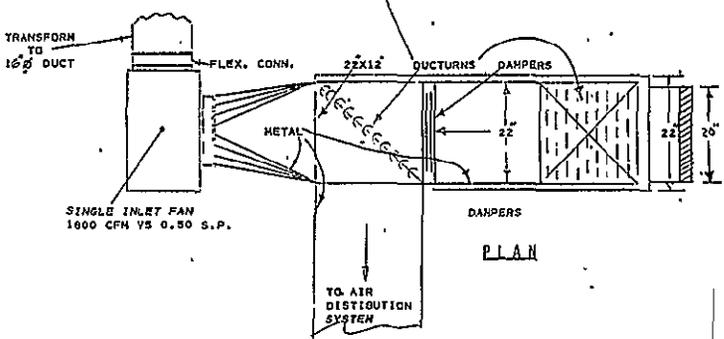
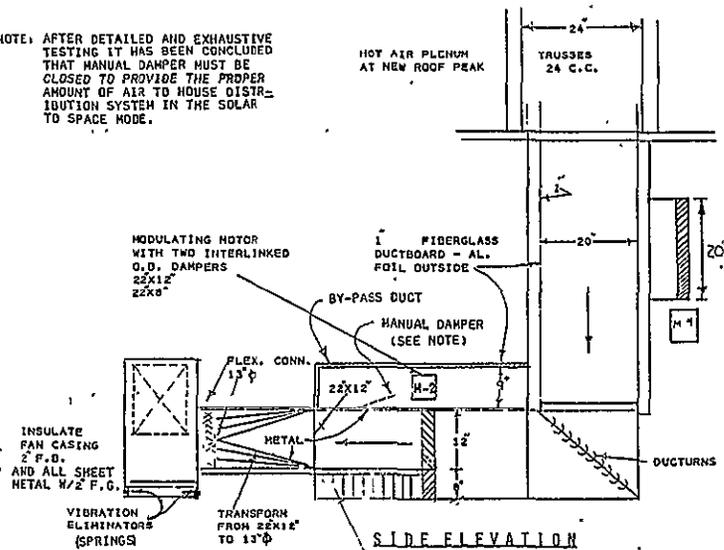
DESIGNED BY: S. J. JORDY	DRAWN BY: H. W.	CHECKED BY: W. S. J.	APPROVED BY:	JOB No 406
				SCALE:
No. DATE	REVISIONS	REVISIONS	DATE: 2-3-77	SHEET No M-4
DUCT WORK IN ATTIC				SEECO
SOLAR ENGINEERING & EQUIPMENT COMPANY				3305 Metairie Road • Metairie • Louisiana • 70001

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JOB NO A-06		SCALE:		SHEET NO M-5	
DUCTWORK IN CRAWL SPACE		SECO		SOLAR ENGINEERING & EQUIPMENT COMPANY	
				3305 Metairie Road • Metairie • Louisiana • 70001	
DESIGNED BY: J. J. J.	DRAWN BY: T. M. J.	CHECKED BY: W. S. J.	APPROVED BY:	DATE:	REVISIONS
APPROVED BY:	DATE:	REVISIONS:			

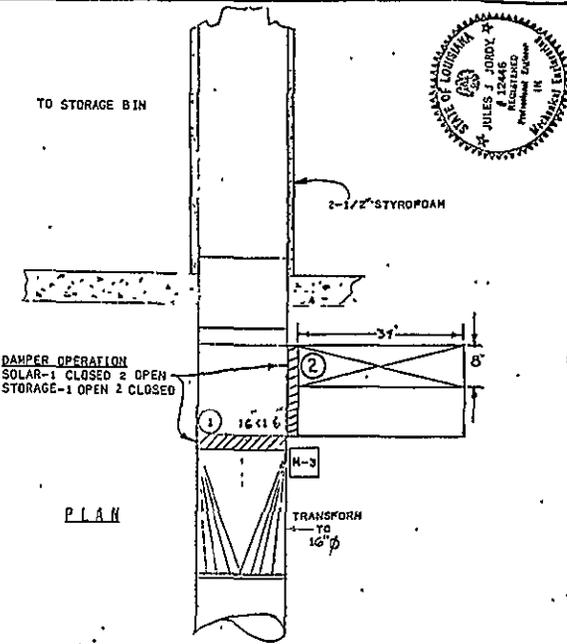
NOTE: AFTER DETAILED AND EXHAUSTIVE TESTING IT HAS BEEN CONCLUDED THAT MANUAL DAMPER MUST BE CLOSED TO PROVIDE THE PROPER AMOUNT OF AIR TO HOUSE DISTRIBUTION SYSTEM IN THE SOLAR TO SPACE MODE.



FAN UNIT #2
SCALE: 3/4" = 1'-0"

NOTE: ALL CONTROL DAMPERS ARE RUSKIN C035-676 TYPE-C035

NOTE: ALL DAMPER MOTORS ARE BARBER COLMAN MA-5200



SECTION
DAMPER M-3



DESIGNED BY:	J.J.J.	DATE:	3/18/77
DRAWN BY:	T.G.M.	REVISIONS:	
CHECKED BY:	T.G.M.	REMARKS:	
APPROVED BY:	H.S.J.		
No.			

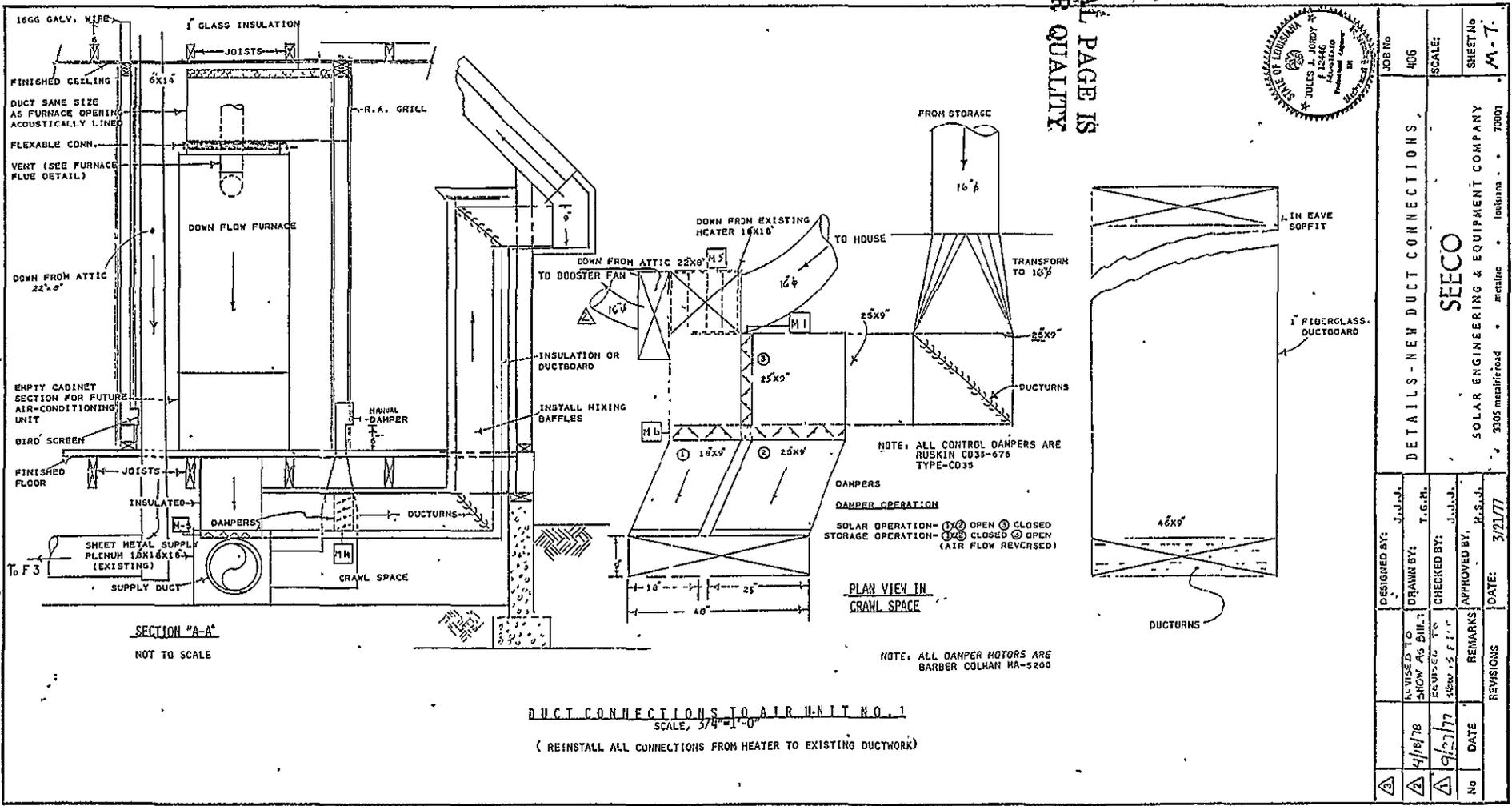
AIR DISTRIBUTION DETAILS

SECO

SOLAR ENGINEERING & EQUIPMENT COMPANY
3105 mestline road • Metairie • Louisiana • 70001

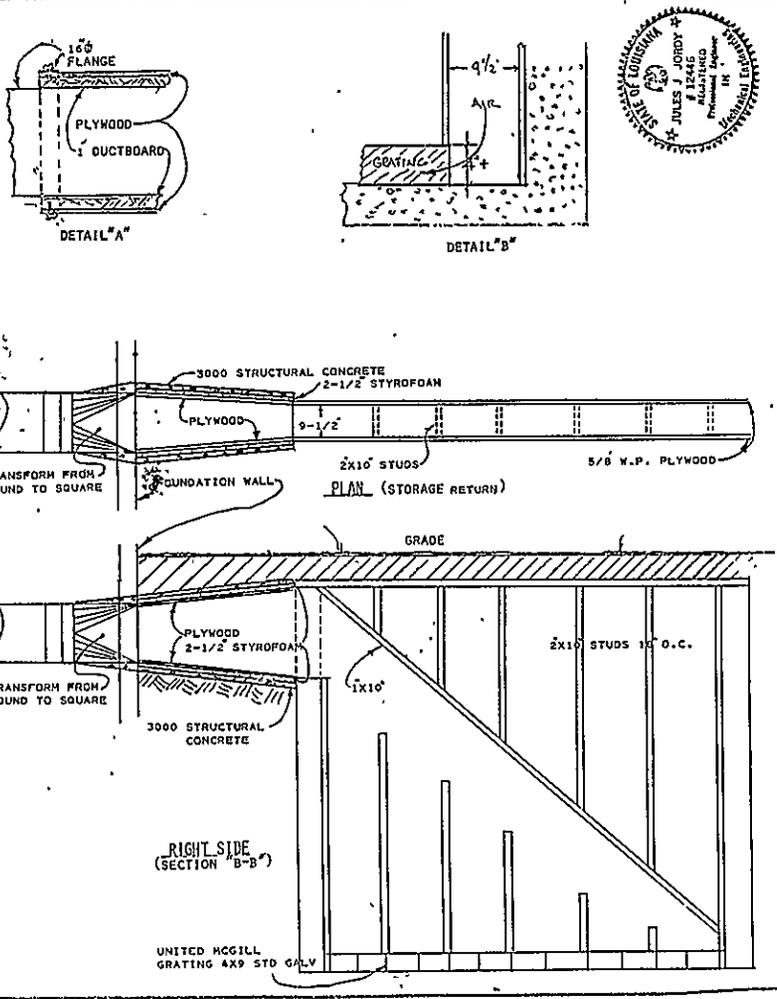
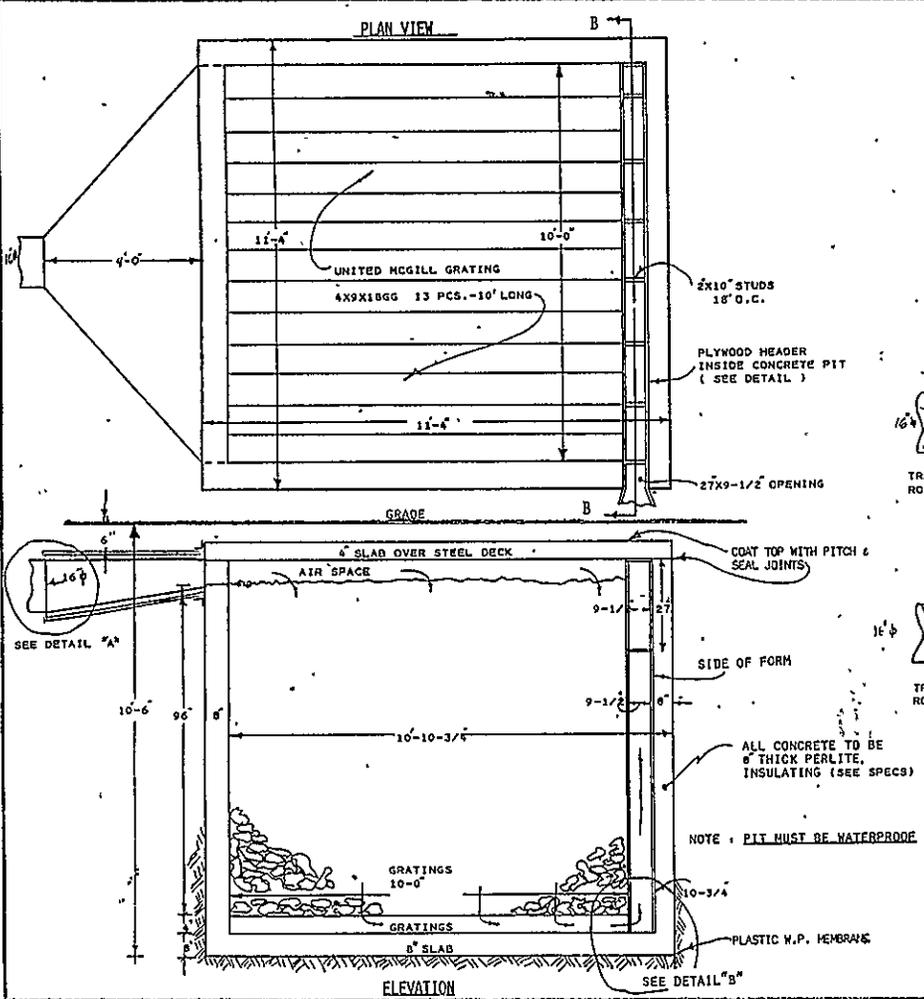
JOB No 406
SCALE:
SHEET No M-6

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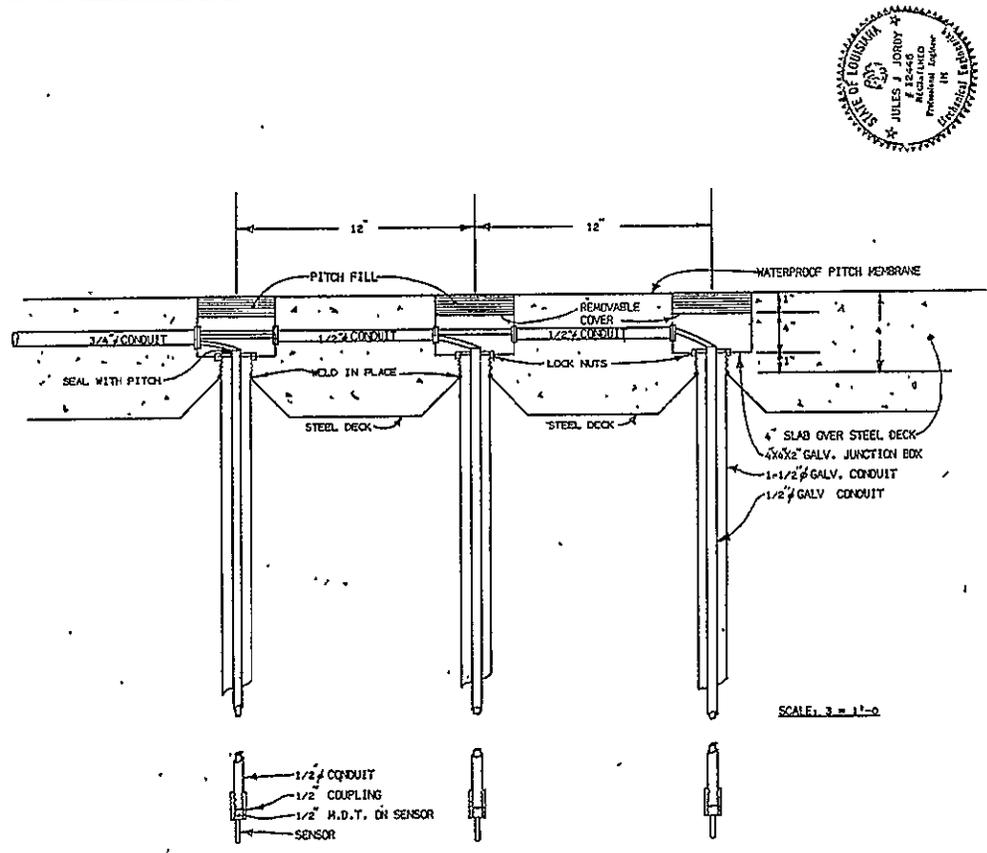
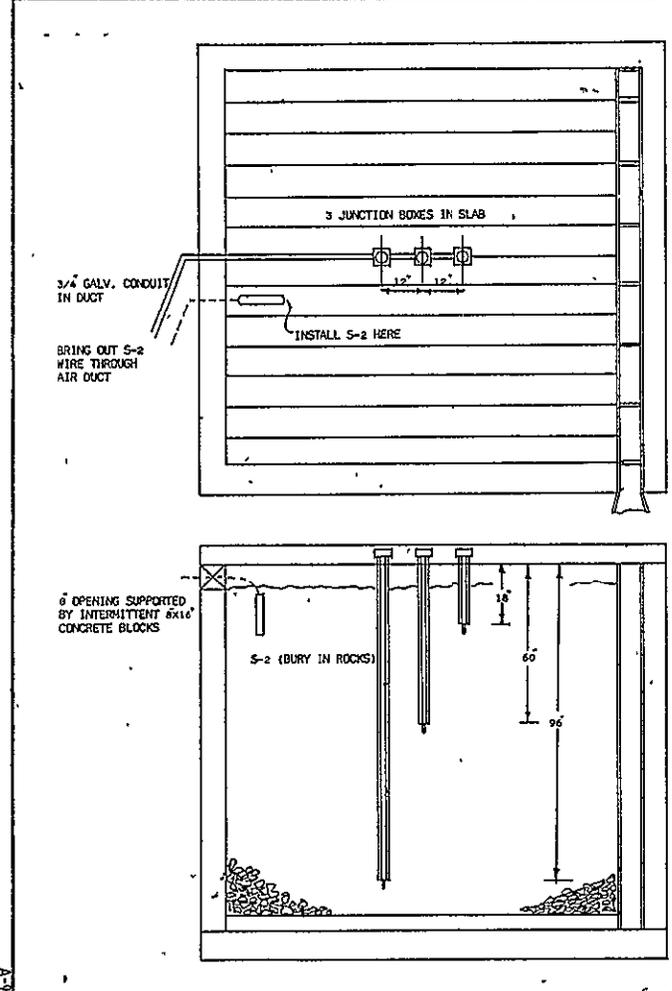


JOB No 406		SCALE 1/4" = 1'-0"		SHEET No M-7	
SECO SOLAR ENGINEERING & EQUIPMENT COMPANY 3305 Metairie Road • Metairie • Louisiana • 70001					
DETAILS - NEW DUCT CONNECTIONS					
DESIGNED BY:	J.J.J.	DRAWN BY:	T.G.H.	CHECKED BY:	J.J.J.
APPROVED BY:	H.S.J.	DATE:	3/21/77		
REVISIONS	No	DATE	REMARKS		
1	4/18/78		REVISED TO SHOW AS BUILT		
2	9/27/77		REVISED TO SHOW AS BUILT		

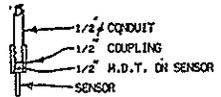
DUCT CONNECTIONS TO AIR UNIT NO. 1
 SCALE, 3/4" = 1'-0"
 (REINSTALL ALL CONNECTIONS FROM HEATER TO EXISTING DUCTWORK)



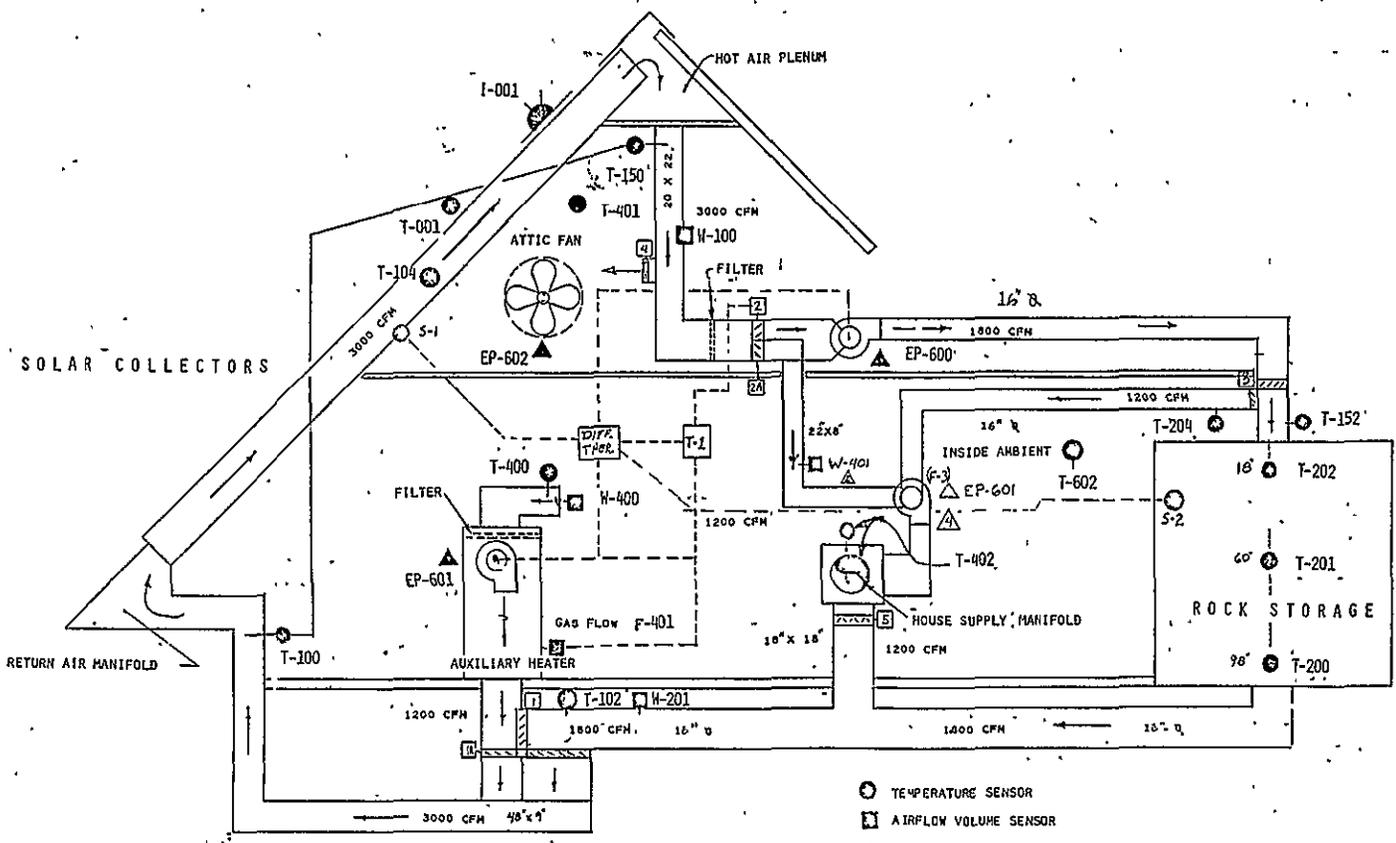
JOB No		406	
SCALE:		1/2"=1'-0"	
SHEET No		C-8	
SEECO			
SOLAR ENGINEERING & EQUIPMENT COMPANY			
2305 Metairie Road • Metairie • Louisiana • 70001			
DESIGNED BY:	J.J.J.	DATE:	6/1/77
DRAWN BY:	I.G.H.	REVISIONS	
CHECKED BY:	M.S.J.	No	
APPROVED BY:	N.S.J.	DATE	
REMARKS	C-8, C-9		
REVISIONS			



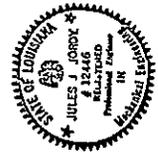
SCALE: 3/8" = 1'-0"



DESIGNED BY: J.J.J. DRAWN BY: T.G.H. CHECKED BY: J.J.J. APPROVED BY: W.S.J. DATE: 7/15/77	JOB No 406	
	SCALE: VARIOUS	
REMARKS REVISIONS	DETAILS OF TEMPERATURE SENSOR INSTALLATION IN ROCK STORAGE PIT	
	SHEET No I-9	
SECO SOLAR ENGINEERING & EQUIPMENT COMPANY <small>3305 Metairie road • Metairie • Louisiana • 70001</small>		



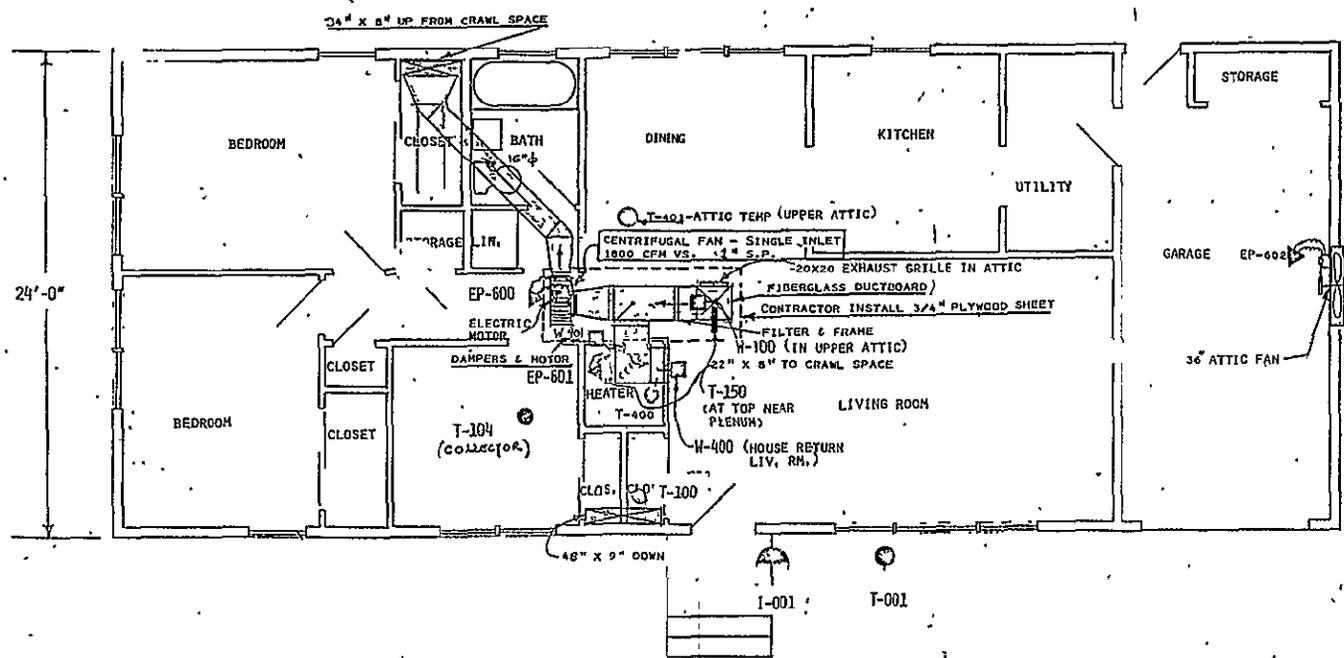
- TEMPERATURE SENSOR
- AIRFLOW VOLUME SENSOR
- ▲ ELECTRIC POWER SENSOR
- Ⓩ DAMPER ACTUATOR



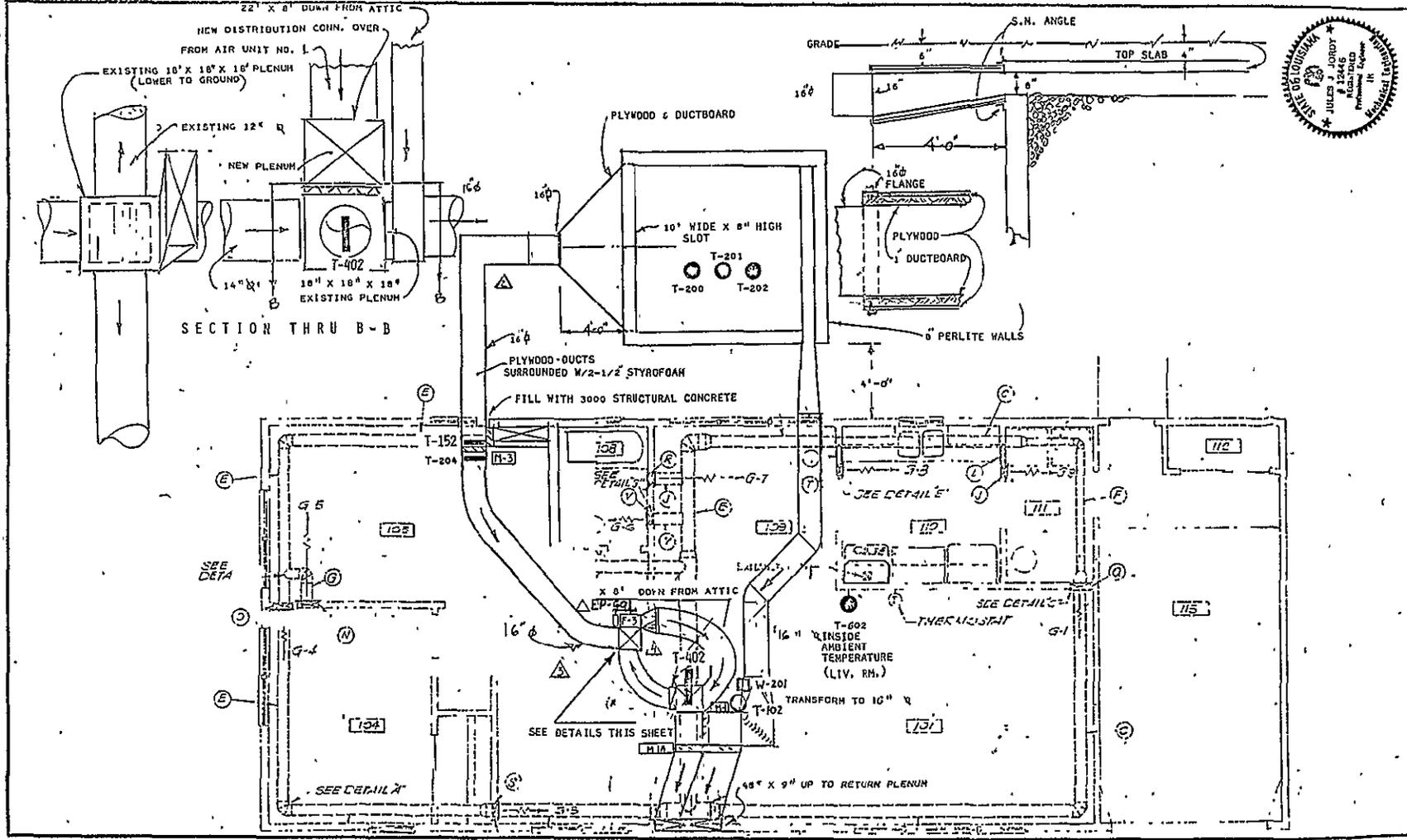
INSTRUMENTATION SCHEMATIC SECO SOLAR ENGINEERING & EQUIPMENT COMPANY 3305 Metairie Road • Metairie • Louisiana • 70001		JOB No 406	SCALE: AS SHOWN SHEET No 1-10
DESIGNED BY: J.J.J. DRAWN BY: T.G.M. CHECKED BY: J.J.J. APPROVED BY: H.S.L.	REVISIONS No DATE REMARKS	REVISIONS 4-16-78 1/13/78 1/18/77 7/22/77	DATE: 3/21/77

REVISIONS 4-16-78 1/13/78 1/18/77 7/22/77	REMARKS Revised To Show As Built Revised Plan ment of Comp Revised As Built
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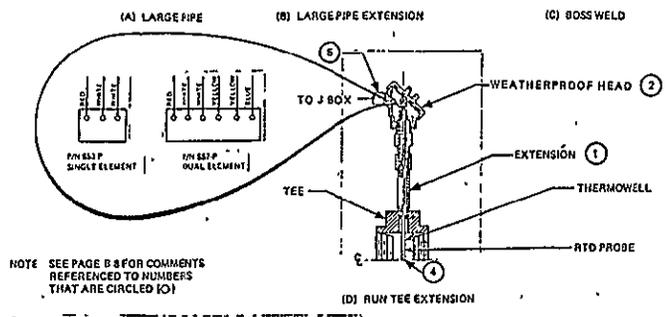
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DESIGNED BY: J.J.J.	SDAS	JOB No	406
DRAWN BY: I.G.M.	INSTRUMENTATION LOWER ATTIC	SCALE:	AS SHOWN
CHECKED BY: J.J.J.	SEECO	SHEET	1-1
APPROVED BY: M.S.J.	SOLAR ENGINEERING & EQUIPMENT COMPANY	REVISIONS	
DATE: 3/21/77	3305 Metairie Road	REMARKS	
	Metairie, Louisiana	DATE	



DESIGNED BY:		JOB No	
DRAWN BY:		405	
CHECKED BY:		SCALE:	
APPROVED BY:		NONE	
DATE:		SHEET No	
9/26/77		I-12	
<p>SDAS INSTRUMENTATION IN CRAWL SPACE.</p> <p>SEECO SOLAR ENGINEERING & EQUIPMENT COMPANY 3305 machine road • Metairie • Louisiana • 70001</p>			
REVISIONS	REMARKS		
4/18/78	REVISED TO SHOW AS BUILT		
1/24/78	REVISED TO 56000 AS BUILT		
9/26/77	REVISED TO SHOW AS BUILT		
No	DATE		



NOTE SEE PAGE B 8 FOR COMMENTS REFERENCED TO NUMBERS THAT ARE CIRCLED (O)

Figure B 1. Typical Temperature Sensor Pipe/Duct Installations

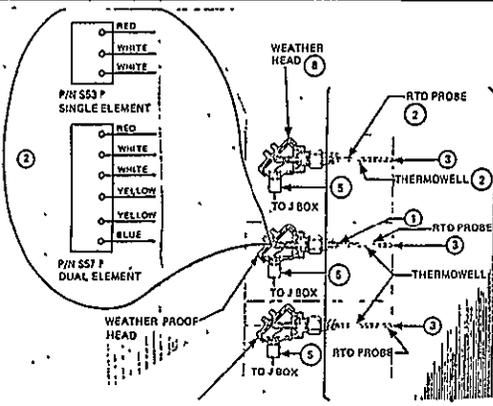


Figure B 5. Typical Temperature Sensor Tank Installation

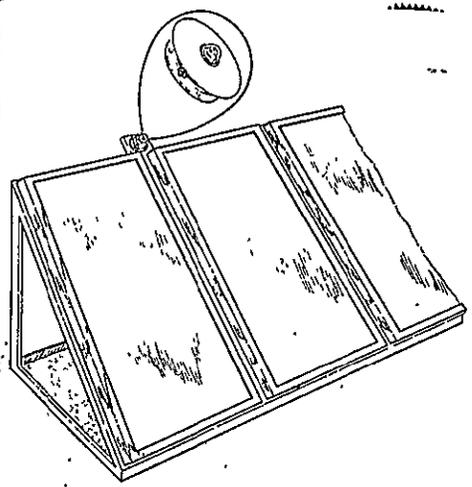


Figure B 16. Typical Flat Plate Collector Insulation Sensor Installation

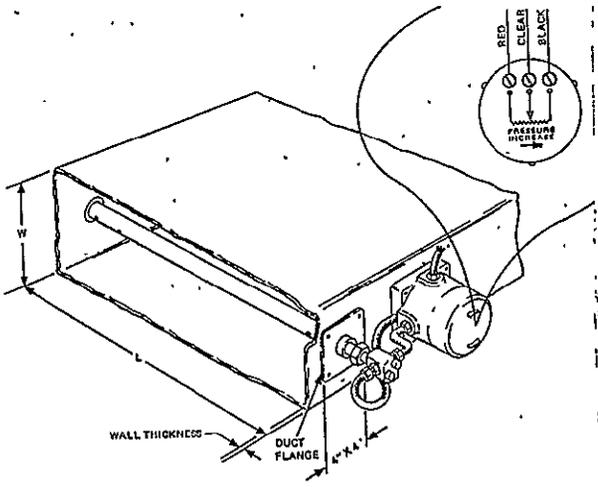
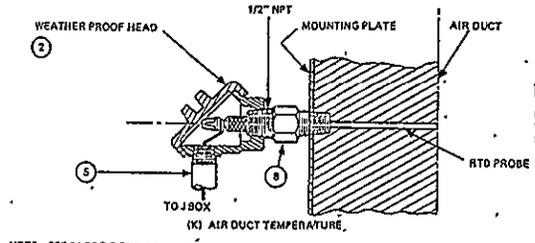


Figure B 10. Typical HVAC Duct Pirt Tube Flow Monitor Installation



NOTE SEE PAGE B 8 FOR COMMENTS REFERENCED TO NUMBERS THAT ARE CIRCLED ()

Figure B 1. Typical Temperature Sensor Pipe/Duct Installation (Continued)

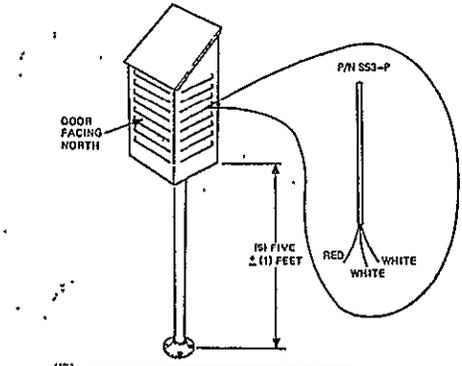


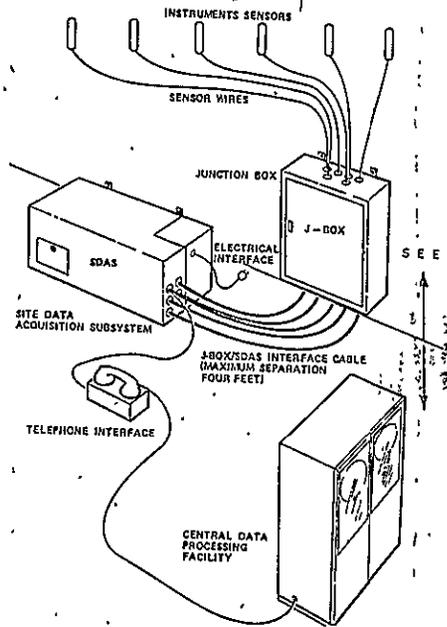
Figure B 15. Typical Outside Ambient Temperature Station

DESIGNED BY: J. J.	REVISIONS	DATE	REMARKS
DRAWN BY: H. A.			
CHECKED BY: W. S. J.			
APPROVED BY:			
DATE: 2-2-5-77			

TYPICAL SBAS SENSOR CONNECTION DETAILS	JOB No 406	SCALE:
SEECO	SHEET No I-13	
SOLAR ENGINEERING & EQUIPMENT COMPANY	metairie • Louisiana • 70001	

Measurement	Nomenclature	Estimated Range	Typical Sensor Model Number
T-100	Collector Inlet	3-230°F	S57P85236
W-100	Collector Loop	0-3000 CFM	430-2-F-132
T-150	Collector Diff. Temp.	0-50°F	S53P85236
T-402	House Differential Temp.	0-50°F	S53P85236
W-201	Storage Outlet (Dot.)	0-1800 CFM	430-2-F132
EP-602	Attic Exhaust Fan	0-1 KW	PC5-1
T-001	Ambient Air	-20 - 120°F	S53P40236
T-152	Storage Differential Temp	0 - 50°F	S53P85236
T-102	Storage Outlet	30-230°F	S57P85236
F-401	Aux. Heat Gas Flow Rate	0-10 SCFM	AL-175
T-104	Collector Absorber Temp.	30 - 450°F	S7301236
T-200	Storage Temp. - Bot.	30 - 230°F	S53P180236
T-201	Storage Temp. - Mid.	30 - 230°F	S53P600236
T-202	Storage Temp. - Top	30 - 230°F	S53P980236
T-204	Storage to House	30 - 230°F	S57P85236
T-400	House Return	-20 - 120°F	S57P85236
T-401	Attic Temp.	-20 - 150°F	S53P40236
T-602	Inside Ambient Temp	-20 - 120°F	S53P40236
EP-600	Collector Blower	0 - 1 KW	PC5-19F
EP-601	Return Air Blower	0 - 1 KW	PC5-195
I-001	Total Insolation	0-400 BTU/H/sq ft	P5P
W-401	House Supply	0-1200 CFM	430-2-P132
W-400	House Return	0-1200 CFM	430-2-P132

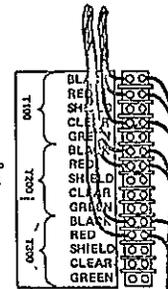
Sensor Type	Conductors	Americ
Pressure	4 + Shield	#18
Temperature & Temperature	4 + Shield	#18-4
Flow Rate	4 + Shield	#18
Solar Radiation	2 + Shield	#18
Electric Power	2 + Shield	#18
Relative Humidity	4 + Shield	#18
Wind Speed	2 + Shield	#18



TYPICAL WIRING CODE
(FURNISHED BY SDAS CONTRACTOR)

WIRE RUN LIST

MEAS. NO	FROM SENSOR		TO JUNCTION BOX		
	WIRE COLOR	TERMINAL STRIP	SDAS CH	WIRE COLOR	LEVEL
T 100	BLACK	TB1-1	2	BLACK	L0
	RED	TB1-2	2	RED	H1
		TB1-3		SHIELD	
	CLEAR	TB1-4	2	CLEAR	#3
		TB1-5		GREEN	
T 200	BLACK	TB1-6	3	BLACK	L0
	RED	TB1-7	3	RED	H1
		TB1-8		SHIELD	
		TB1-9		CLEAR	
T 300	BLACK	TB1-10		GREEN	
	BLACK	TB1-11	4	BLACK	L0
	RED	TB1-12	4	RED	H1
		TB1-13		SHIELD	
T 400	CLEAR	TB1-14		CLEAR	
		TB1-15		SHIELD	
	BLACK	TB1-16		BLACK	L0
	RED	TB1-17		RED	H1



DESIGNED BY: J.J.J.	SCALE: AS SHOWN	JOB NO 406
DRAWN BY: T.M.	SHEET NO 11	
CHECKED BY: W.S.J.	SHEETING I-14	
APPROVED BY:		
DATE: 10/3/77		
REVISIONS		

SEECO
SOLAR ENGINEERING & EQUIPMENT COMPANY
3305 Metairie Road • Metairie • Louisiana 70001

SDAS INSTALLATION DETAILS

NOTE: ALL SENSORS ARE TO BE FACTORED TO SHEET METAL DUCTWORK WITH ONE INCH OF FIBER GLASS INSULATION, EXCEPT STORAGE SENSORS WHICH WILL BE IMBEDDED IN ROCKS.

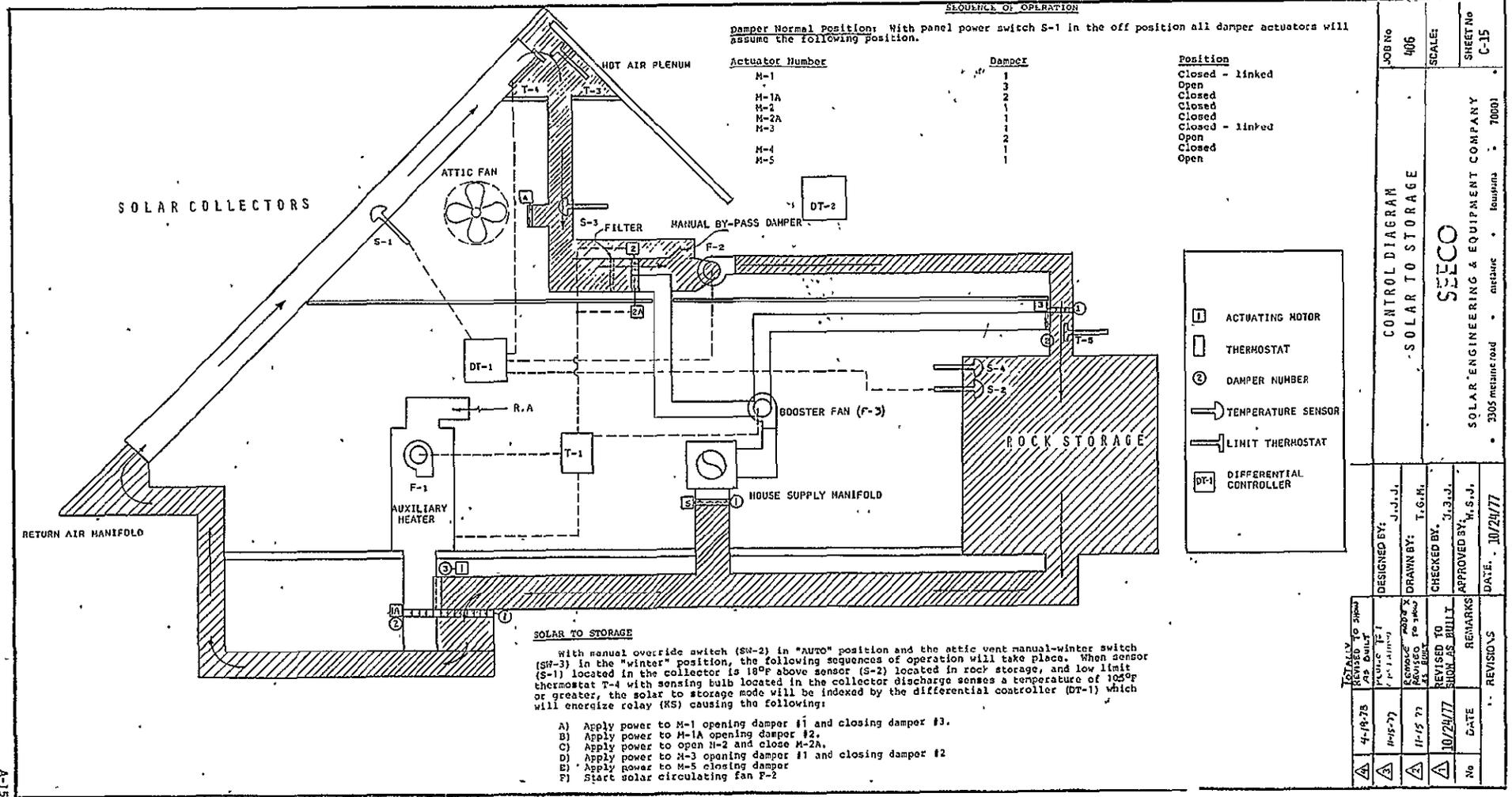
ALL WIRE SHALL BE 'U L' APPROVED COLOR CODED AUDIO INSTRUMENTATION CABLE, SHIELDED.

SEECO SHALL INSTALL 110 VOLT-60 HERTZ THREE AMPERE OUTLET (SAFETY GROUND , POWER AND RETURN) WITH A STANDARD TWIST LOCK OUTLET, AT LOCATION IN GARAGE SHOWN ON PLAN.

SDAS CONTRACTOR FURNISHED ALL SENSORS AND ALL CONNECTIONS BEYOND JUNCTION BOX.

SEECO INSTALLS SENSORS AND FURNISHES AND INSTALLS ALL WIRE AND FITTINGS FOR CONNECTION TO JUNCTION BOX.

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A POOR QUALITY



SEQUENCE OF OPERATION

Damper Normal Position: With panel power switch S-1 in the off position all damper actuators will assume the following position.

Actuator Number	Damper	Position
M-1	1	Closed - linked
M-1A	3	Open
M-2	1	Closed
M-2A	1	Closed
M-3	1	Closed - linked
M-4	2	Open
M-5	1	Closed
		Open

LEGEND

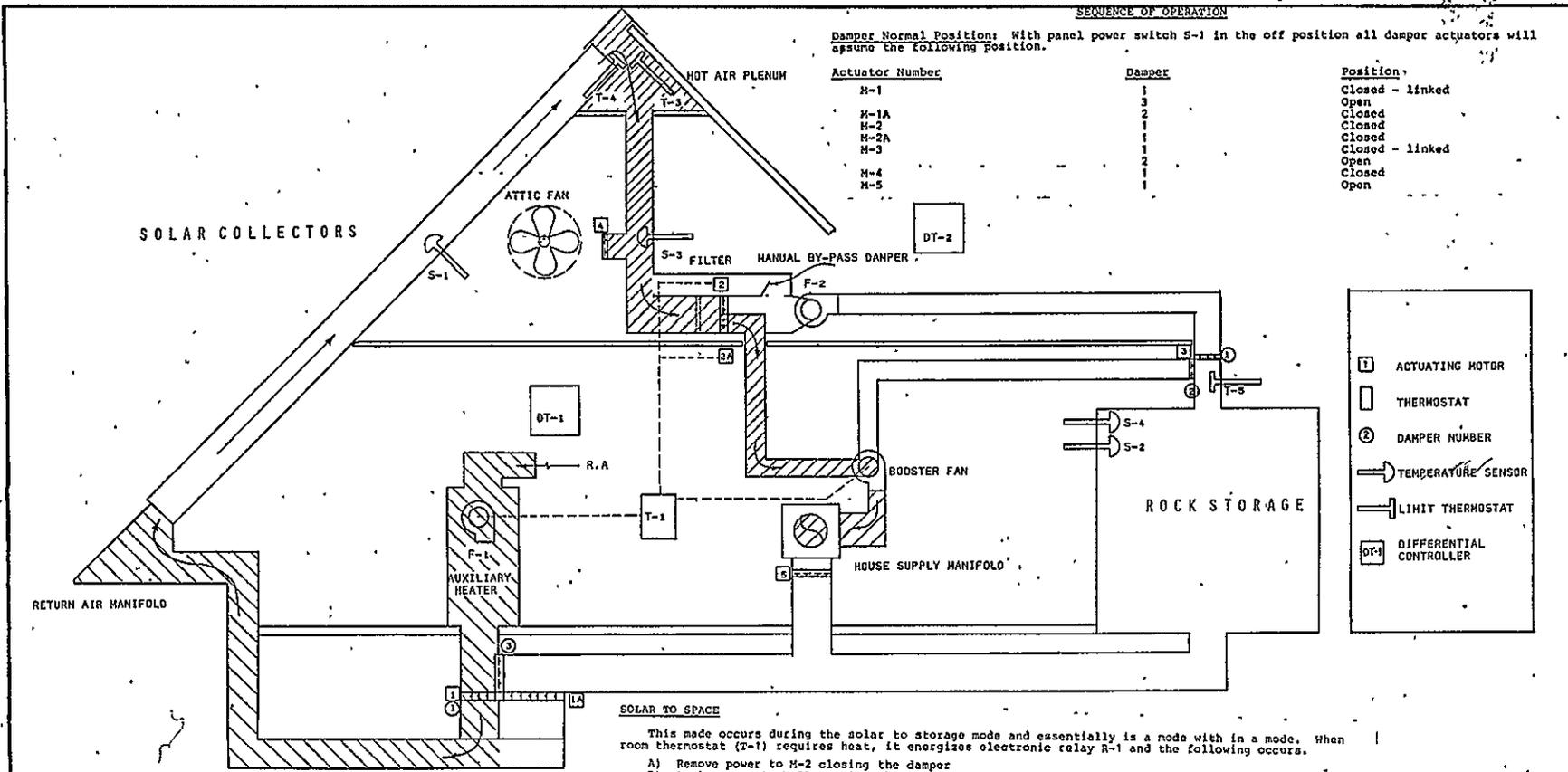
- ACTUATING MOTOR
- THERMOSTAT
- DAMPER NUMBER
- TEMPERATURE SENSOR
- LIMIT THERMOSTAT
- DIFFERENTIAL CONTROLLER

JOB No	406	SHEET No	C-15
SCALE			
CONTROL DIAGRAM - SOLAR TO STORAGE		SEECO SOLAR ENGINEERING & EQUIPMENT COMPANY • 3305 metropolitan road • Louisville • Kentucky • 40001	
DESIGNED BY:	J.J.J.	CHECKED BY:	J.L.J.
DRAWN BY:	T.G.M.	APPROVED BY:	H.S.J.
DATE:	10/24/77	REMARKS	
4-18-75	AS BUILT	REVISIONS	
10/15/77	REVISED TO SHOW		
10/24/77	REVISED TO SHOW AS BUILT		
No	DATE		

SOLAR TO STORAGE

With manual override switch (SW-2) in "AUTO" position and the attic vent manual-winter switch (SW-3) in the "winter" position, the following sequence of operation will take place. When sensor (S-1) located in the collector is 18°F above sensor (S-2) located in rock storage, and low limit thermostat T-4 with sensing bulb located in the collector discharge senses a temperature of 105°F or greater, the solar to storage mode will be indexed by the differential controller (DT-1) which will energize relay (RS) causing the following:

- A) Apply power to M-1 opening damper #1 and closing damper #3.
- B) Apply power to M-1A opening damper #2.
- C) Apply power to open M-2 and close M-2A.
- D) Apply power to M-3 opening damper #1 and closing damper #2
- E) Apply power to M-5 closing damper
- F) Start solar circulating fan F-2



SEQUENCE OF OPERATION

Damper Normal Position: With panel power switch S-1 in the off position all damper actuators will assume the following position.

Actuator Number	Damper	Position
M-1	1	Closed - linked
M-1A	1	Open
M-2	2	Closed
M-2A	1	Closed
M-3	1	Closed - linked
M-4	2	Open
M-5	1	Closed
		Open

	ACTUATING MOTOR
	THERMOSTAT
	DAMPER NUMBER
	TEMPERATURE SENSOR
	LIMIT THERMOSTAT
	DIFFERENTIAL CONTROLLER

SOLAR TO SPACE

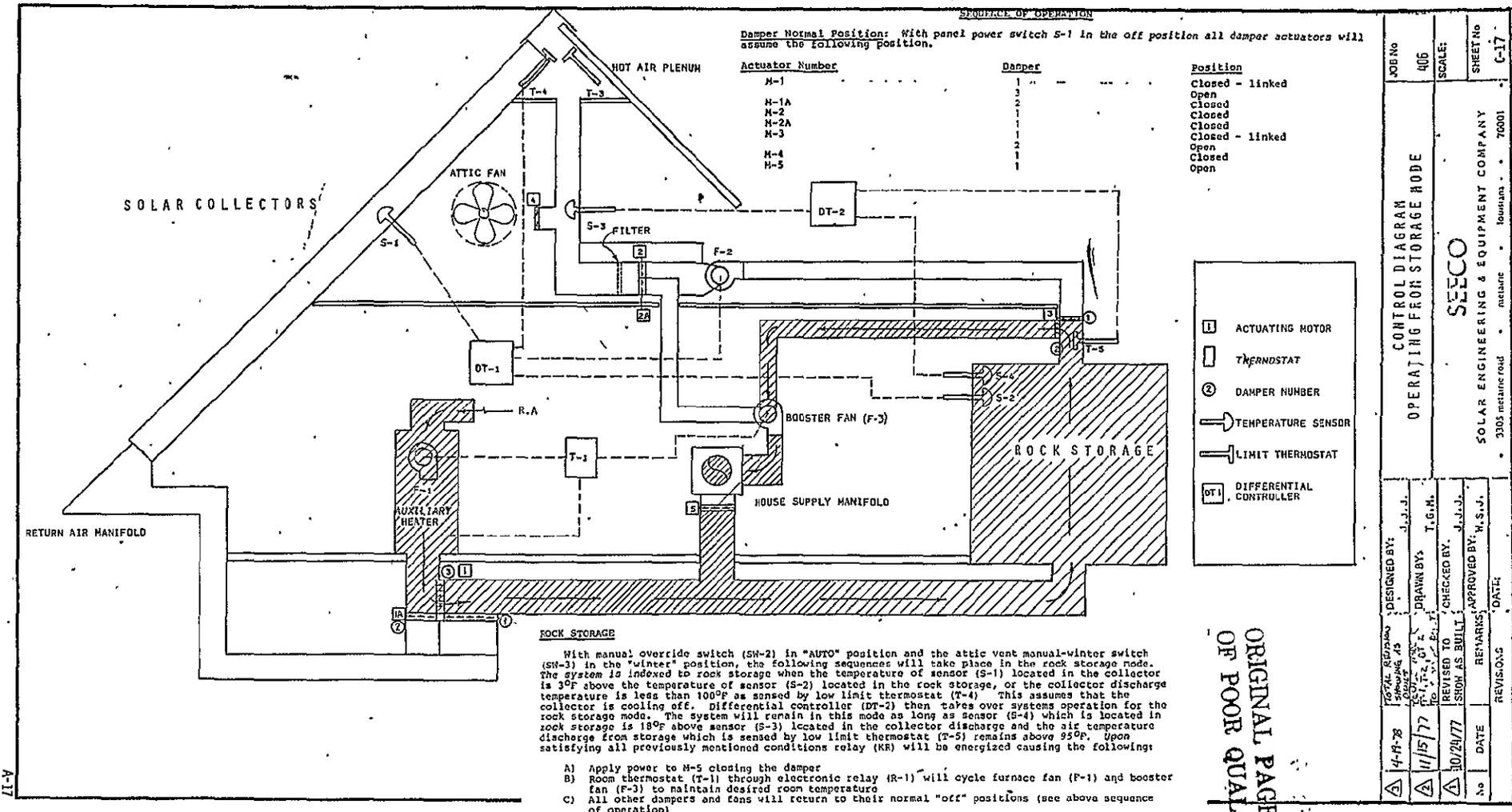
This mode occurs during the solar to storage mode and essentially is a mode with in a mode. When room thermostat (T-1) requires heat, it energizes electronic relay R-1 and the following occurs.

- A) Remove power to M-2 closing the damper
- B) Apply power to M-2A opening the damper
- C) Start furnace fan F-1
- D) Start booster fan F-3
- E) All other dampers and fans remain in their solar to storage mode positions

NOTE: Room thermostat F-1 modulates M-2 and M-2A, it also cycles furnace fan F-1 and booster fan F-3 through electronic relay R-1 to maintain desired room temperature.

NOTE: To prevent FAN (F-2) from starving in this mode, a manual by-pass has been provided to allow air to by-pass damper M-2.

DESIGNED BY: J.J.J.	DRIVEN BY: T.G.H.	CHECKED BY: J.J.J.	APPROVED BY: H.J.S.	DATE: 1-5-78
CONTROL DIAGRAM SOLAR TO SPACE MODE				
SEECO				
SOLAR ENGINEERING & EQUIPMENT COMPANY 3305 Metairie Road • Metairie • Louisiana • 70001				
JOB No	405	SCALE:	SHEET No	C-16



SEQUENCE OF OPERATION
 Damper Normal Position: With panel power switch S-1 in the off position all damper actuators will assume the following position.

Actuator Number	Damper	Position
M-1	1	Closed - linked
M-1A	3	Open
M-2	2	Closed
M-2A	1	Closed
M-3	1	Closed - linked
M-4	2	Open
M-5	1	Closed
		Open

ACTUATING MOTOR (Square with 'M')

THERMOSTAT (Square with 'T')

DAMPER NUMBER (Circle with number)

TEMPERATURE SENSOR (Arrow pointing right)

LIMIT THERMOSTAT (Arrow pointing left)

DIFFERENTIAL CONTROLLER (Square with 'DT')

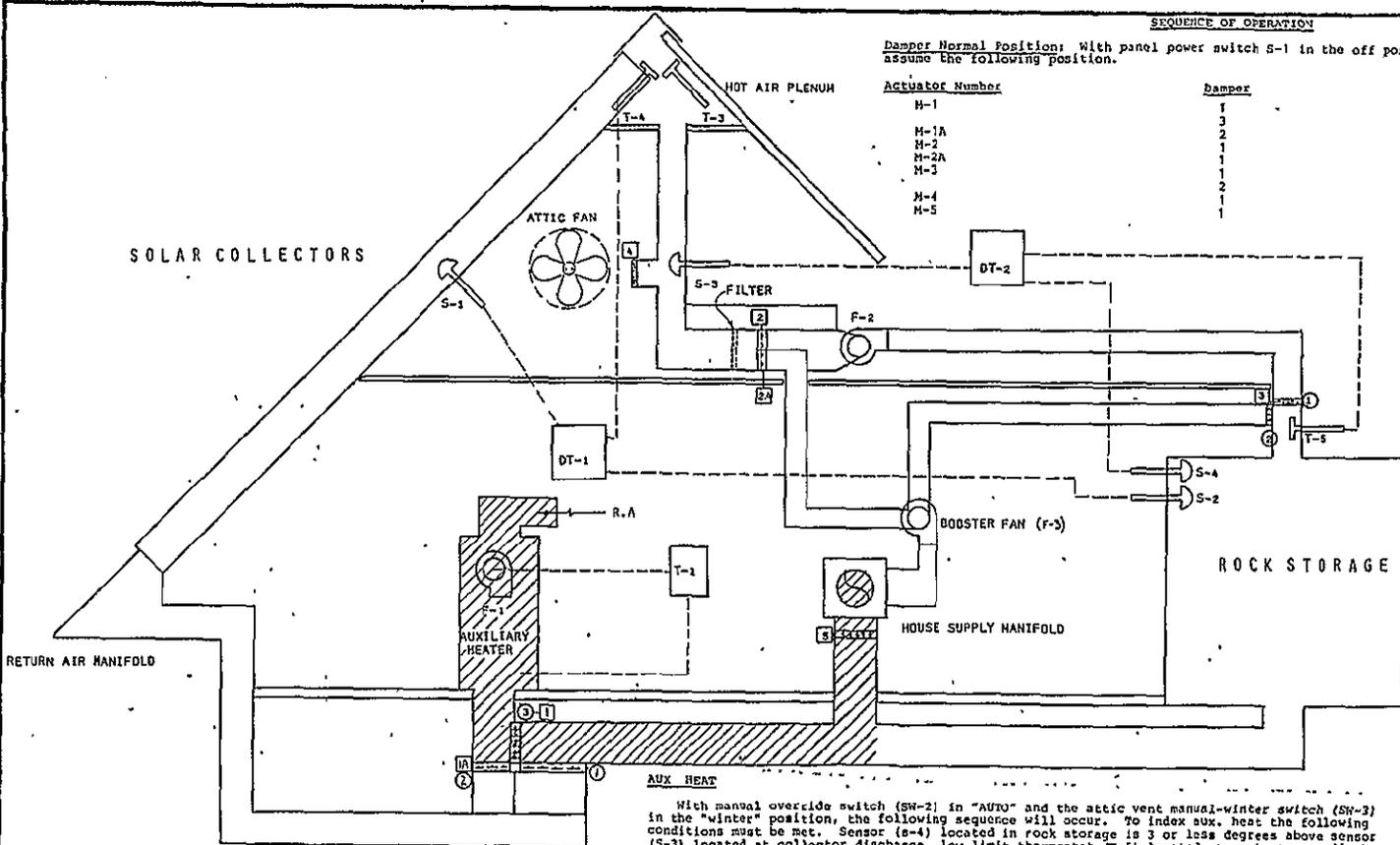
ROCK STORAGE

With manual override switch (SW-2) in "AUTO" position and the attic vent manual-winter switch (SW-3) in the "winter" position, the following sequences will take place in the rock storage mode. The system is indexed to rock storage when the temperature of sensor (S-1) located in the collector is 3°F above the temperature of sensor (S-2) located in the rock storage, or the collector discharge temperature is less than 100°F as sensed by low limit thermostat (T-4). This assumes that the collector is cooling off. Differential controller (DT-2) then takes over systems operation for the rock storage mode. The system will remain in this mode as long as sensor (S-4) which is located in rock storage is 18°F above sensor (S-3) located in the collector discharge and the air temperature discharge from storage which is sensed by low limit thermostat (T-5) remains above 95°F. Upon satisfying all previously mentioned conditions relay (KR) will be energized causing the following:

- Apply power to M-5 closing the damper
- Room thermostat (T-1) through electronic relay (R-1) will cycle furnace fan (F-1) and booster fan (F-3) to maintain desired room temperature
- All other dampers and fans will return to their normal "off" positions (see above sequence of operation)

JOB No	406	SCALE:	SHEET No
CONTROL DIAGRAM		C-17	
OPERATING FROM STORAGE MODE			
SEECO			
SOLAR ENGINEERING & EQUIPMENT COMPANY			
3305 Metairie Road • Metairie • Louisiana • 70001			
DESIGNED BY:	J.J.J.	DRAWN BY:	T.G.H.
REVISOR:	J.J.J.	CHECKED BY:	J.J.J.
DATE:	11/15/77	APPROVED BY:	H.S.J.
REMARKS:	REVISIONS		

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SEQUENCE OF OPERATION
 Damper Normal Position: With panel power switch S-1 in the off position all damper actuators will assume the following position.

Actuator Number	Damper	Position
M-1	1	Closed - linked
M-1A	2	Open
M-2	1	Closed
M-2A	1	Closed
M-3	1	Closed - linked
M-4	2	Open
M-5	1	Closed
	1	Open

Legend for symbols used in the diagram:

- [Motor symbol] ACTUATING MOTOR
- [Square symbol] THERMOSTAT
- [Circle with number symbol] DAMPER NUMBER
- [Arrow symbol] TEMPERATURE SENSOR
- [T-shaped symbol] LIMIT THERMOSTAT
- [DT symbol] DIFFERENTIAL CONTROLLER

AUX HEAT

With manual override switch (SW-2) in "AUTO" and the attic vent manual-winter switch (SW-3) in the "winter" position, the following sequence will occur. To index aux. heat the following conditions must be met. Sensor (S-4) located in rock storage is 3 or less degrees above sensor (S-3) located at collector discharge, low limit thermostat (T-5) located at rock storage discharge registers below 95°F, sensor (S-1) located in the collector is 3 or less degrees than sensor (S-2) located in rock storage, and low limit thermostat (T-4) registers less than 100°F. If all the above conditions are met the system will index aux heat causing the following:

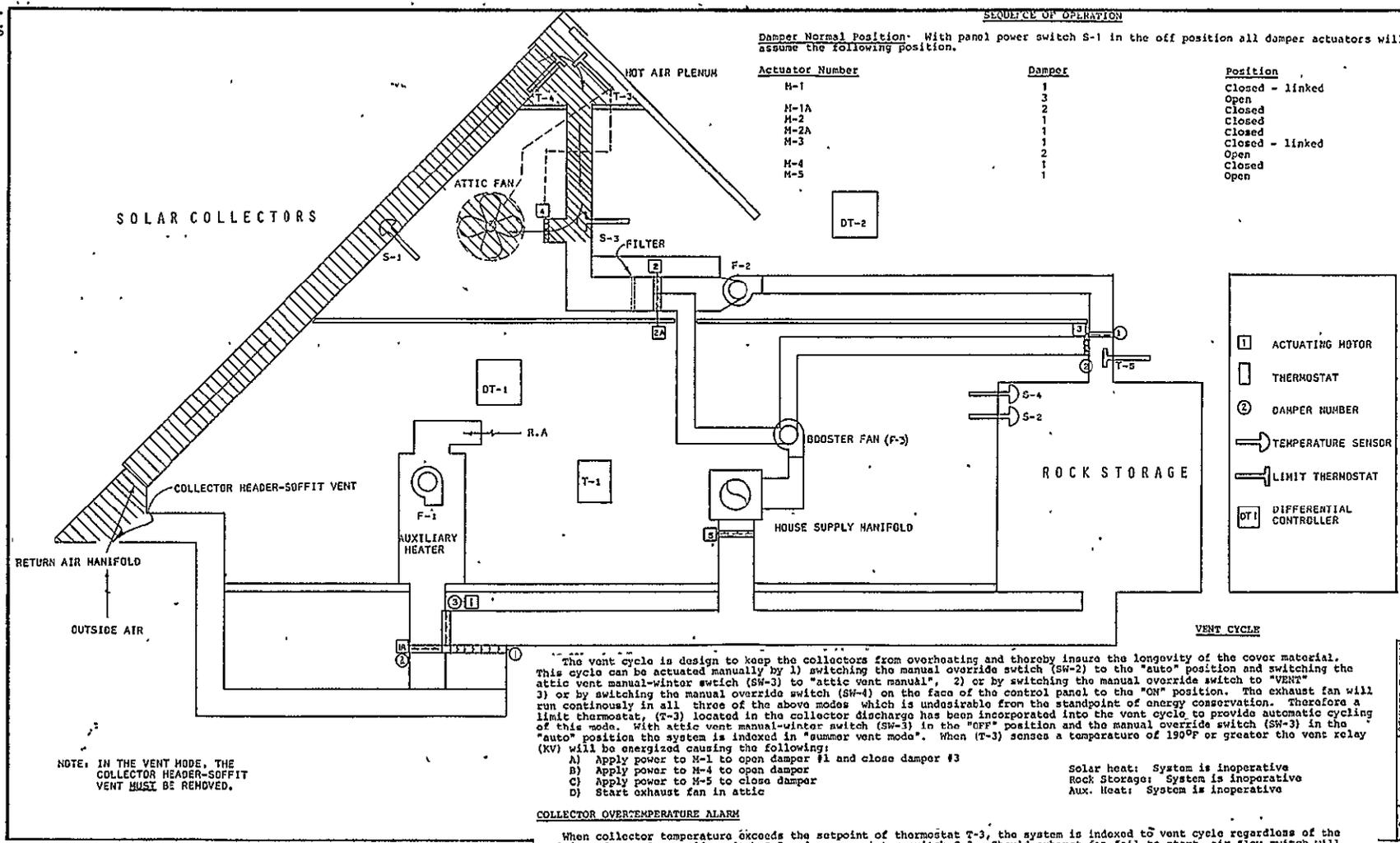
- T-1 will cycle gas valve and furnace fan (F-1) as per conventional furnace operation
- All other dampers and motors will return to their normal "OFF" position. (see above sequence of operation)

NOTE: The furnace 24V control voltage is off when panel power switch (S-1) is turned off or summer winter switch (S-3) is in off or summer position.

JOB No 406		SCALE:		SHEET No C-18	
SEECO					
SOLAR ENGINEERING & EQUIPMENT COMPANY 1105 Metairie Road • Metairie • Louisiana • 70001					
CONTROL DIAGRAM					
AUX. HEAT-CONVENTIONAL HEAT					
DESIGNED BY: J.J.J.	DRAWN BY: T.G.H.	CHECKED BY: W.S.J.	APPROVED BY: J.J.J.	DATE: 10/24/77	REVISIONS:
4-18-78	1/16/77	10/24/77			
REMARKS:					

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1-19



SEQUENCE OF OPERATION

Damper Normal Position: With panel power switch S-1 in the off position all damper actuators will assume the following position.

Actuator Number	Damper	Position
M-1	1	Closed - linked
M-1A	3	Open
M-2	1	Closed
M-2A	1	Closed
M-3	1	Closed - linked
M-4	2	Open
M-5	1	Closed
		Open

LEGEND

- 1 ACTUATING MOTOR
- 2 THERMOSTAT
- 3 DAMPER NUMBER
- 4 TEMPERATURE SENSOR
- 5 LIMIT THERMOSTAT
- DT-1 DIFFERENTIAL CONTROLLER

VENT CYCLE

The vent cycle is design to keep the collectors from overheating and thereby insure the longevity of the cover material. This cycle can be actuated manually by 1) switching the manual override switch (SW-2) to the "auto" position and switching the attic vent manual-winter switch (SW-3) to "attic vent manual", 2) or by switching the manual override switch to "VENT" 3) or by switching the manual override switch (SW-4) on the face of the control panel to the "ON" position. The exhaust fan will run continuously in all three of the above modes which is undesirable from the standpoint of energy conservation. Therefore a limit thermostat, (T-3) located in the collector discharge has been incorporated into the vent cycle to provide automatic cycling of this mode. With attic vent manual-winter switch (SW-3) in the "OFF" position and the manual override switch (SW-3) in the "auto" position the system is indexed in "summer vent mode". When (T-3) senses a temperature of 190°F or greater the vent relay (KV) will be energized causing the following:

- A) Apply power to M-1 to open damper #1 and close damper #3
- B) Apply power to M-4 to open damper
- C) Apply power to M-5 to close damper
- D) Start exhaust fan in attic

Solar heat: System is inoperative
Rock Storage: System is inoperative
Aux. Heat: System is inoperative

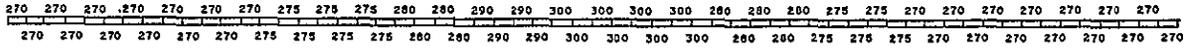
COLLECTOR OVERTEMPERATURE ALARM

When collector temperature exceeds the setpoint of thermostat T-3, the system is indexed to vent cycle regardless of the position of manual override switch S-2 and summer-winter switch S-3. Should exhaust fan fail to start, air flow switch will activate a pilot alarm on panel face. The alarm circuit can be activated manually by override switch S-4.

NOTE: IN THE VENT MODE, THE COLLECTOR HEADER-SOFFIT VENT MUST BE REMOVED.

JOB No	406	SHEET No	C-19
SCALE		COMPANY	SOLAR ENGINEERING & EQUIPMENT COMPANY
DESIGNED BY	J.J.J.	APPROVED BY	H.S.J.
DRAWN BY	T.G.M.	DATE	
CHECKED BY	J.J.J.	REVISIONS	
REVISOR		DATE	
REVISION			
4-20-78	AS BUILT		
11/15/77	AS BUILT		
10/21/77	AS BUILT		
10/24/77	AS BUILT		
No			

CONTROL PROGRAM
SUMMER OPERATION
SECS
SOLAR ENGINEERING & EQUIPMENT COMPANY
3305 Metairie Road
Metairie, Louisiana 70001



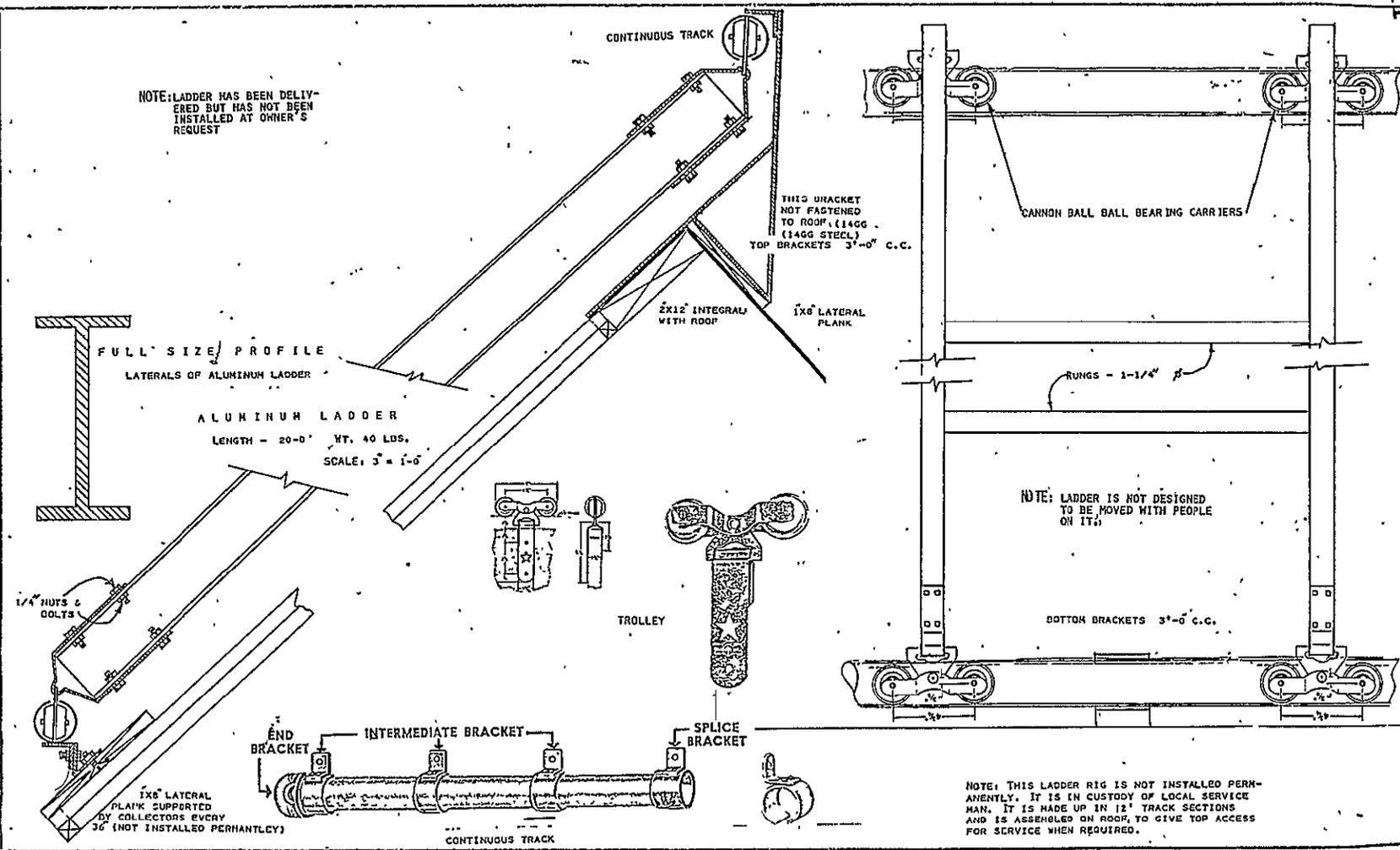
AVERAGE COLLECTOR VELOCITIES
(CFM)



DESIGNED BY: J.J.J.	JOB No	406
	DRAWN BY: T.G.H.	SCALE:
CHECKED BY: J.J.J.	REVISIONS	SHEET No C-20
APPROVED BY: H.S.J.		
DATE: 9/1/77	SECO SOLAR ENGINEERING & EQUIPMENT COMPANY 3335 Metairie Road • Metairie • Louisiana • 70001	
C O C O L L E C T O R B A L A N C I N G D E T A I L		

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A-21



DESIGNED BY: J.J.J.	DRAWN BY: T.G.M.	CHECKED BY: J.J.J.	APPROVED BY: M.S.J.	DATE: 9/29/77
				REVISIONS
REVISOR	DATE	REMARKS		
9/29/77		SHOULD BE BUILT		
LADDER RIG FOR ACCESS TO TOP OF SOLAR COLLECTORS				
JOB No 405.				
SCALE: VARIOUS SHEET No [21]				
SEECO				
SOLAR ENGINEERING & EQUIPMENT COMPANY				
3105 Metairie Road Metairie, Louisiana 70001				

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				6. PERFORMING ORGANIZATION CODE	
7. AUTHOR(S)				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Solar Engineering and Equipment Company, Inc. 3305 Metairie Road Metairie, LA 70001				10. WORK UNIT NO.	
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12. SPONSORING AGENCY NAME AND ADDRESS National Aeronautics and Space Administration Washington, DC 20546				13. TYPE OF REPORT & PERIOD COVERED Contractor Report	
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16. ABSTRACT This report contains installation information for a solar heating system installed in Concho Indian School at El Reno, Oklahoma. This package includes a system Operation and Maintenance Manual, hardware brochures, schematics, system operating modes and drawings. The Solar Engineering and Equipment Company (SEECO), under NASA/MSFC Contract NAS8-32247, developed this prototype solar heating system consisting of the following subsystems: solar collectors, control and storage.					
17. KEY WORDS			18. DISTRIBUTION STATEMENT UC-58 Unclassified-Unlimited  WILLIAM A. BROOKSBANK, JR. Mgr, Solar Heating and Cooling Project Office		
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