DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150617

PRELIMINARY DESIGN PACKAGE FOR SOLAR HOT WATER SYSTEM

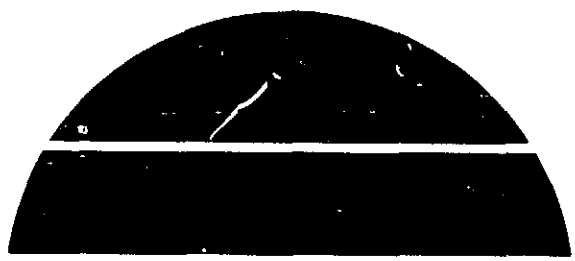
Prepared by

Solar Engineering and Manufacturing Company
1091 Southwest 1st Way
Deerfield Beach, FL 33441

Under Contract NAS8-32248 with

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

For the U. S. Department of Energy



U.S. Department of Energy

Solar Energy

TECHNICAL REPORT STANDARD TITLE PAGE

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DOE/NASA CR-150617		

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Preliminary Design Package for Solar Hot Water System	December 1977
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15. SUPPLEMENTARY NOTES

This work was done under the technical management of Mr. Valmore Fogle, George C. Marshall Space Flight Center, Alabama.

16. ABSTRACT

This report contains the information necessary to evaluate the preliminary design of the Solar Engineering and Manufacturing Company's (SEMCO) solar hot water system. This package includes technical information, schematics, drawings and brochures.

This system, being developed by SEMCO under NASA/MSFC Contract NAS8-32248, consists of the following subsystems: collector, storage, transport, control, auxiliary energy, and Government-furnished site data acquisition. The two units being manufactured will be installed at Loxahatchee, Florida, and Macon, Georgia.

Some retyping and reformatting of this document have been done for clarity.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
	Unclassified-Unlimited William A. Brooksbank, Jr. WILLIAM A. BROOKSBANK, JR. Mgr. Solar Heating and Cooling Project Office

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
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TABLE OF CONTENTS

REQUIRED DOCUMENTATION SUBMISSION

Two Weeks Prior To

PRELIMINARY DESIGN REVIEW

March 23, 1977

Subject: Contract NAS 8-32248

Technical Manager: Mr. Val Fogle/FA 32
NASA/Marshal

Site Contractor: Solar Engineering & Manufacturing Co.
Deerfield Beach Florida
David B. Aspinwall, Sr.-Project Engineer

Part I - Summary

This report includes the various document required of the Management System, Section 4.13 to be submitted to MSFC two weeks prior to the Preliminary Design Review.

Part II - Contract

This report is a part of the original contract.

Part III - Schedule

This report is to be mailed to MSFS on March 23, 1977. Said date is two weeks prior to the Preliminary Design Review that is scheduled for April 6, 1977.

Part IV - Technical

a.) Attached are drawings of the proposed Solar Water Heating system to be installed in Mr. Lee Zimmermans house in Boca Raton, Florida referred to in the Development Plan as the "Test System". They include the following:
   1.) System Skematic
   2.) Collector Drawings
   3.) Tank, Pump & Control Specifications

b.) Attached are drawings describing installation procedures and a list of special installation requirements listed by trade. No special handling or maintenance tools will be required.

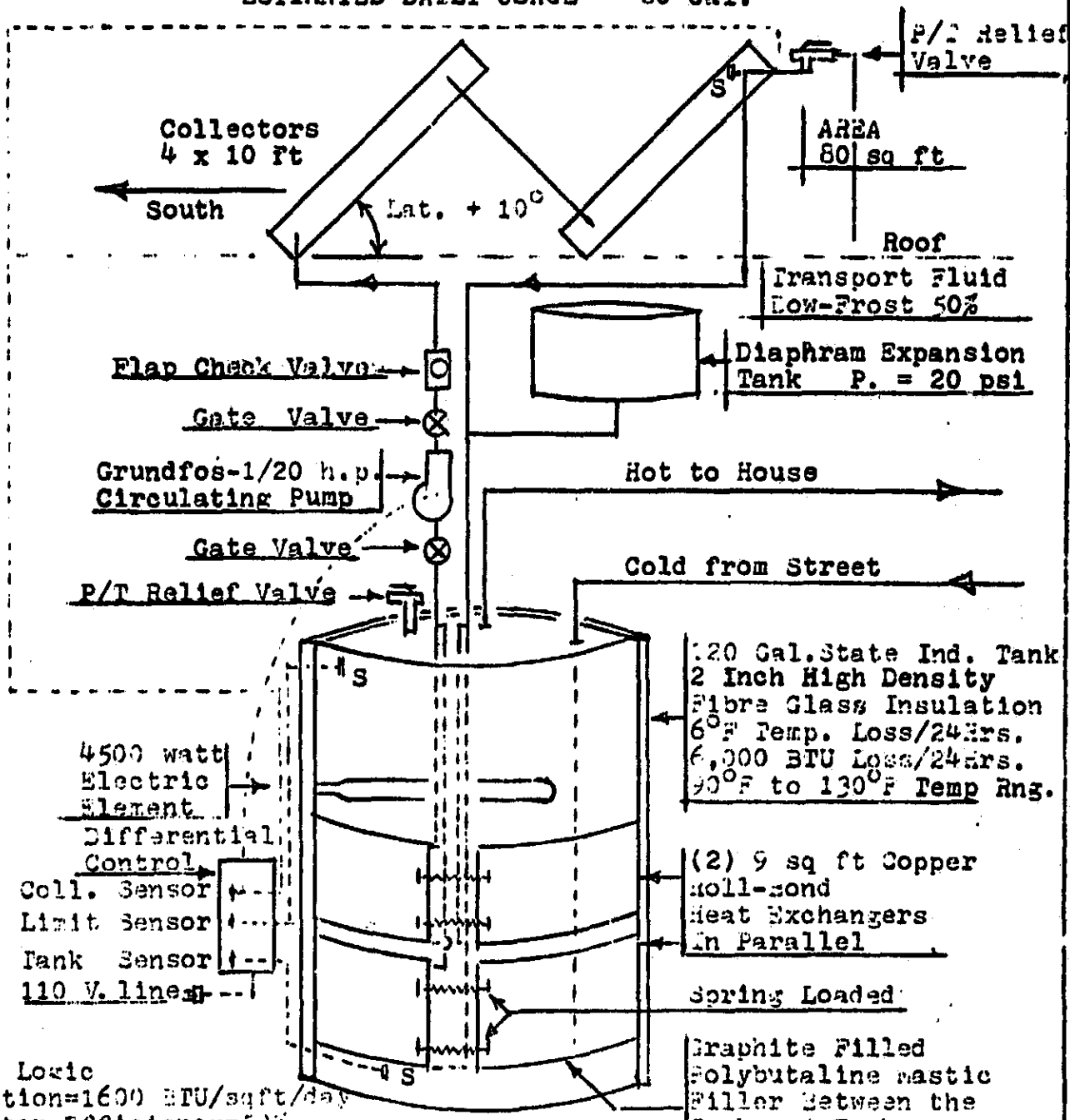
c.) There are only two major system hazards that require attention. The first is that of hurricane winds blowing the collectors off the roof and causing damage to adjacent property. This problem has been overcome by anchoring each collector to the roof at four separate points and having the anchoring procedure designed and certified by a Professional Engineer. This has been done for the subject contract. The second hazard consideration is that of static loading and pressure build up in the collector. This problem has been overcome by installing a Temperature-Pressure relief valve at the upper collector hot water outlet with a blow off line leading down to within 4 to 6 in. of the roof surface. This safety feature has been designed into the system.

d.) The data requirements leading to the Prototype Design Review are built into the "Test System" that is to be installed in Mr. Lee Zimmermans house. These include the following:

T_1 - Transport fluid temp into collector
T_2 " " " out of "
T_3 " " " into heat exchanger
T_4 " " " out of " "
T_5 Potable water temp to house
T_6 " " " from street
F Transport fluid flow rate

e.) Site Data Acquisition Subsystem hardware should be delivered to the Site Contractors facilities on or before May 20, 1977 so that the hardware may be incorporated into the contract systems prior to the First Article Review.

120 GALLON SOLAR WATER HEATER
DOUBLE WALL HEAT EXCHANGER
FAMILY OF 4 WITH AUTOMATIC WASHER
ESTIMATED DAILY USAGE - 80 Gal.

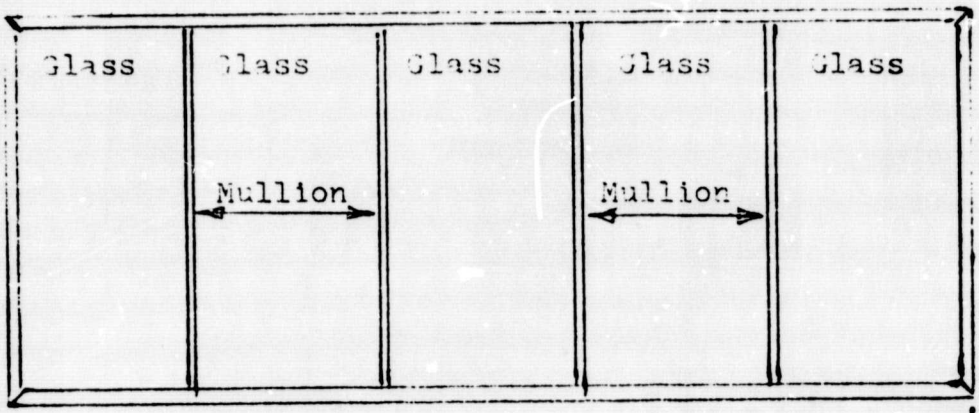


Design Logic
Insolation=1600 BTU/sqft/day
Collector Efficiency=50%
Available Energy = 800 BTU/sqft/day
80 sqft Collector x 800 BTU/sqft/day = 64,000 BTU/day
64,000 BTU/day ÷ 1,000 ÷ (120 Gal.) = 64°F Temp. Gain
Daily Temp. Gain = 76°F to 140° F (76°F + 64°F = 140°F)

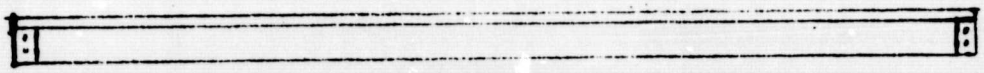
NASA Contract - NAS8-32248
Date -- March 23, 1977
Drawn by -- D.B.Aspinwall

PAGE

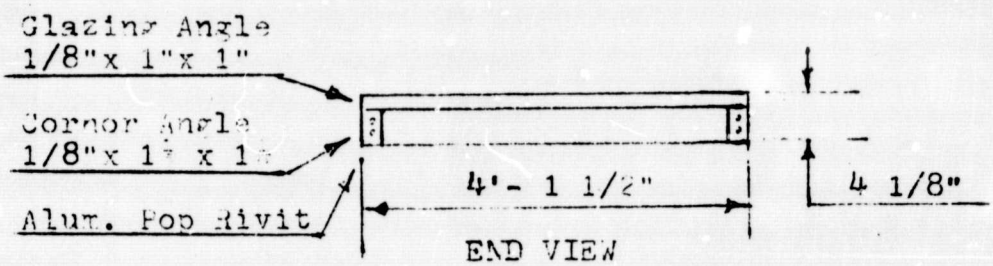
Liquid Flat Plate Solar Collector
Box Details -- 1/2"= 1'-0"



PLAN VIEW



SIDE VIEW



END VIEW

Material - Aluminum - 606-T6
Aluminum Box - 1/8"x 2"x 4" side angle - 0.020 Alum. Bottom
Glazing - Double - 1/8" DBS Glass - 5 pcs. 24" x 48"
Insulation - 1" Technifoam - TF-400 - R=9
Absorber Plate - 3/4 Copper Tube finned with 0.010 Sheet Copper
Absorber Surface - Non-selective flat black enamel
Tube Configuration - Serpentine

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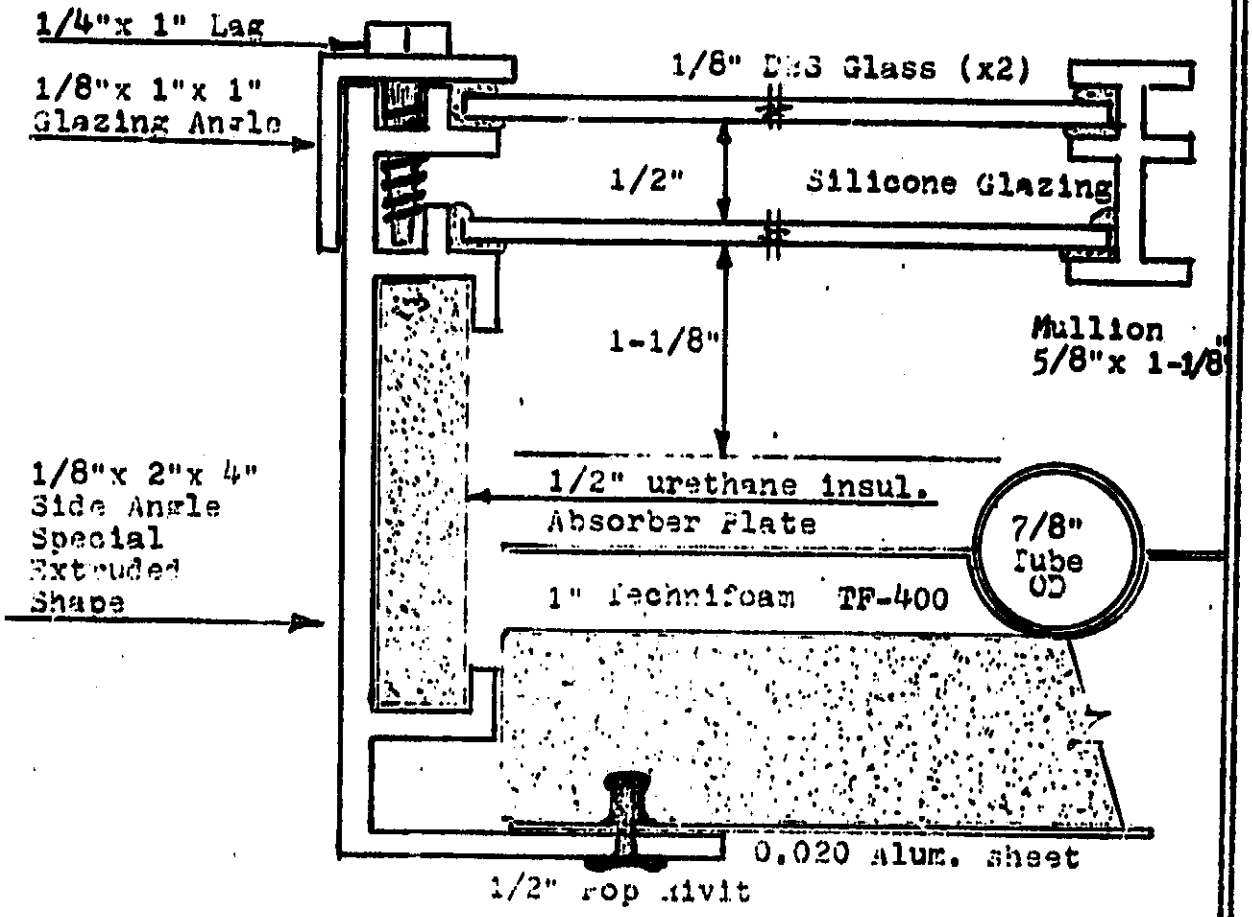
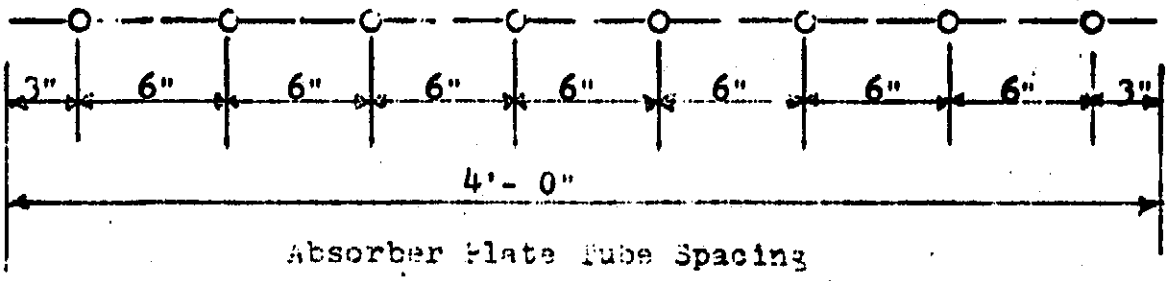
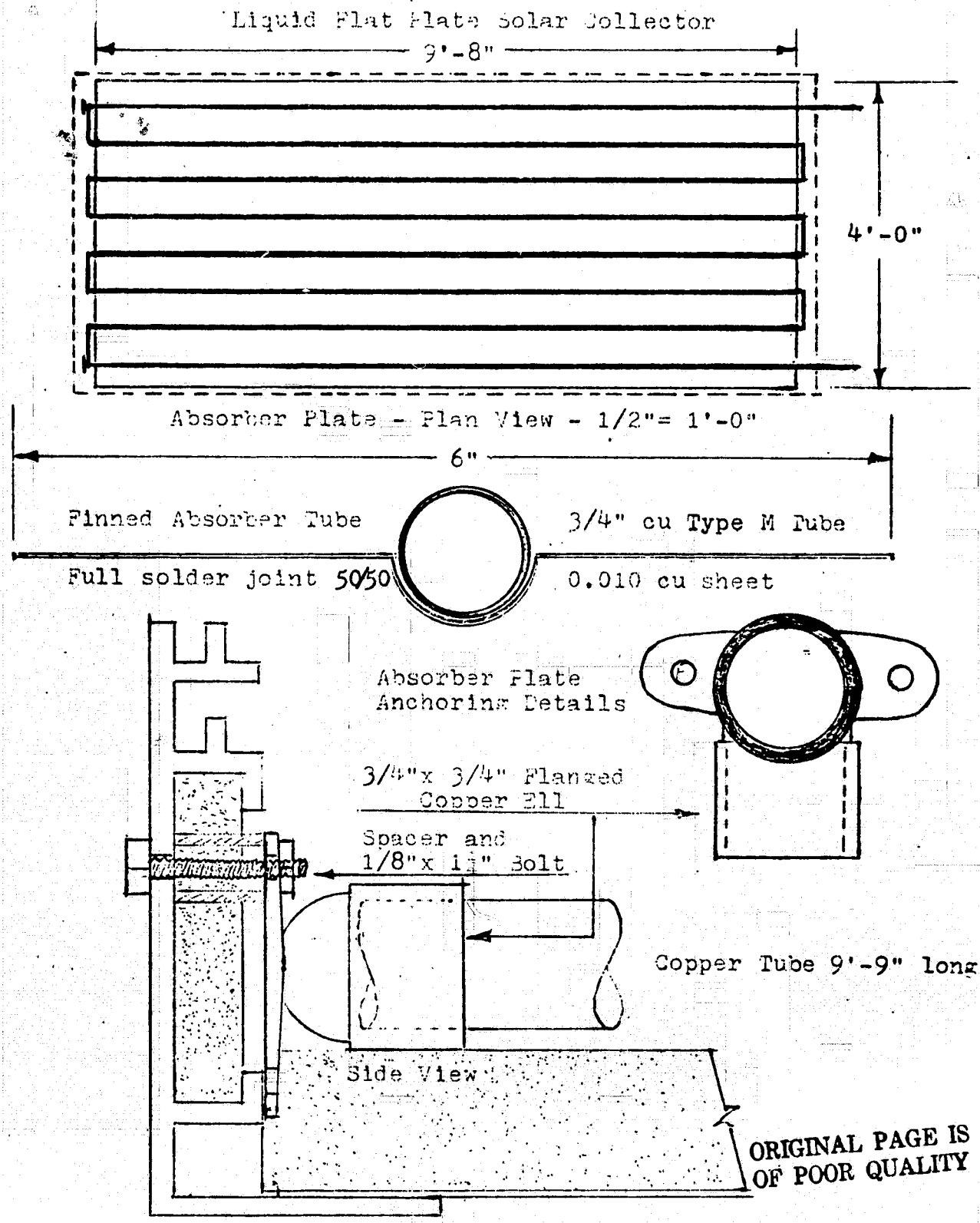
Liquid Flat Plate Solar Collector.
Section -- Full Size





Absorber Plate Tube Spacing

semco	NASA Contract - NAS8-32248 Date -- March 23, 1977 Drawn By -- D. E. Aspinwall	PAGE



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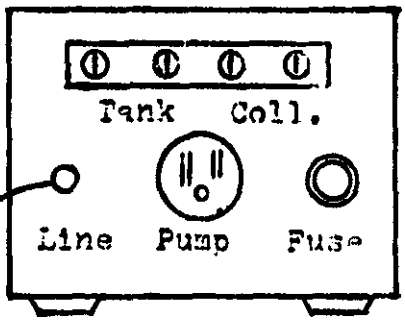
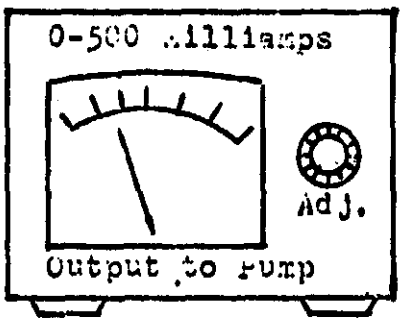
Variable Flow Differential Controller
for
Solar Water Heating Systems

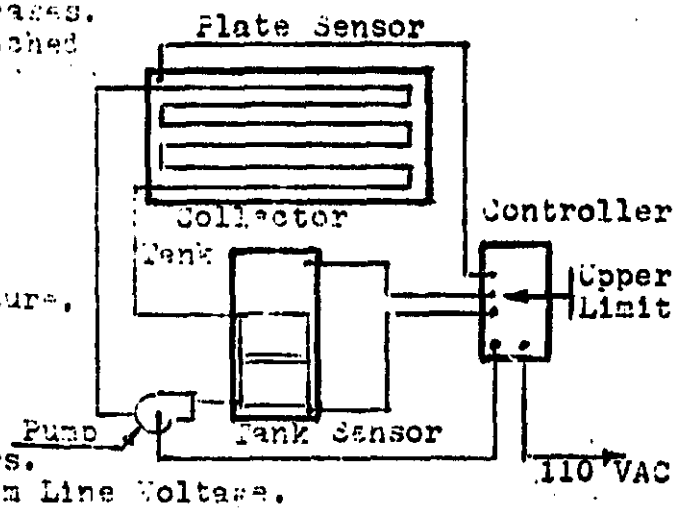


Terminal End View



Control End View

The Variable Flow Differential Controller senses the temperature difference between the plate sensor and the tank sensor. When there is a 3-4°F differential the pump starts slowly. As the differential increases the flow rate increases. Maximum flow is reached at a 23-24°F diff.



Specifications
Size - 3"x4"x4"
Weight - 3 lbs.
100% Solid State.
No Mechanical Parts.
Adjustable start up temperature.
Metered Power Output.
Fused to Protect Circuitry.
Simple Plug in Installation.
Draws Only 50 Milliamps.
Low VoltageThermister Sensors.
Control Circuit Isolated from Line Voltage.
No Limit to Length of Sensor Wires.
Sensors do not need Calibration.

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Deerfield Beach, Florida 33441
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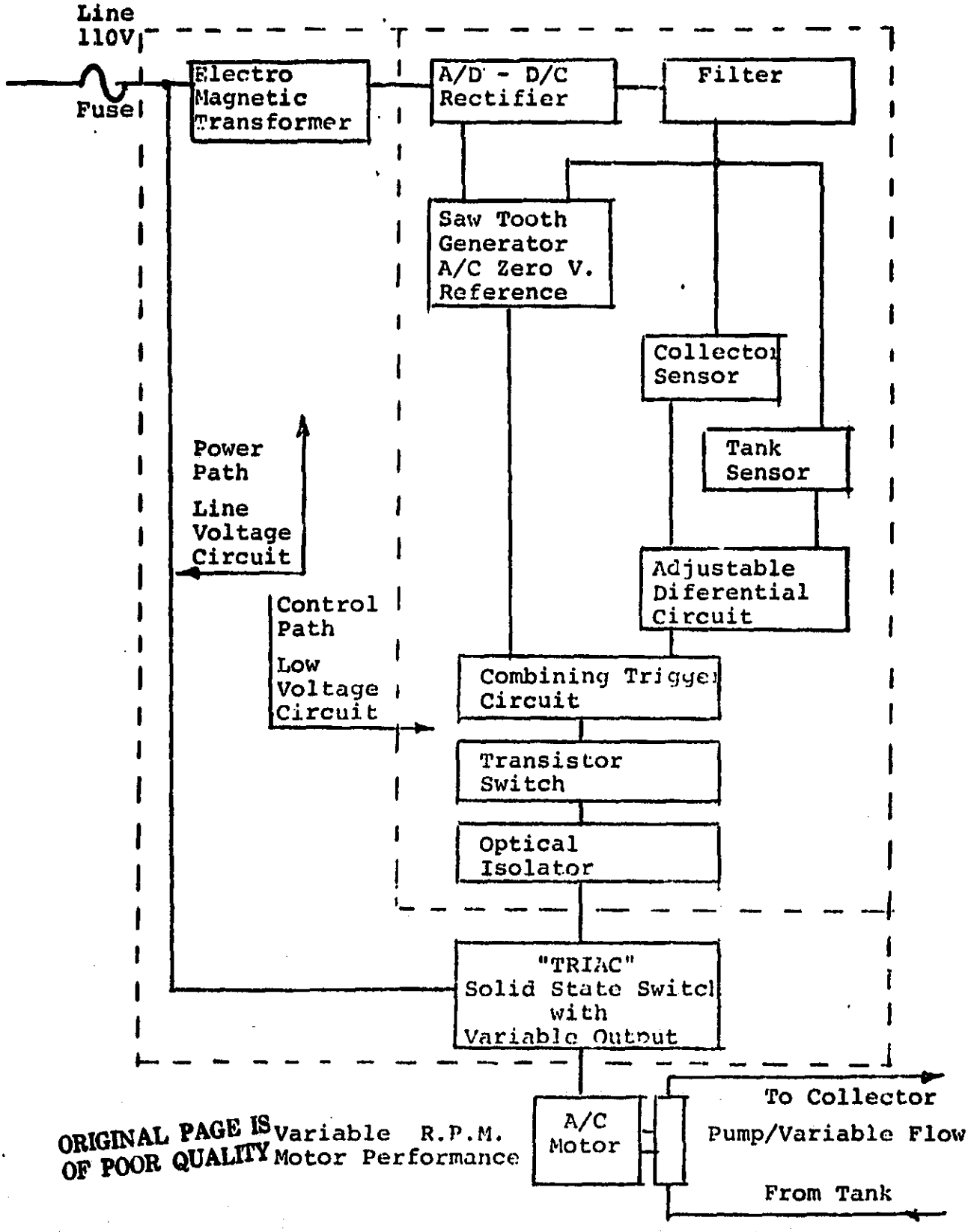
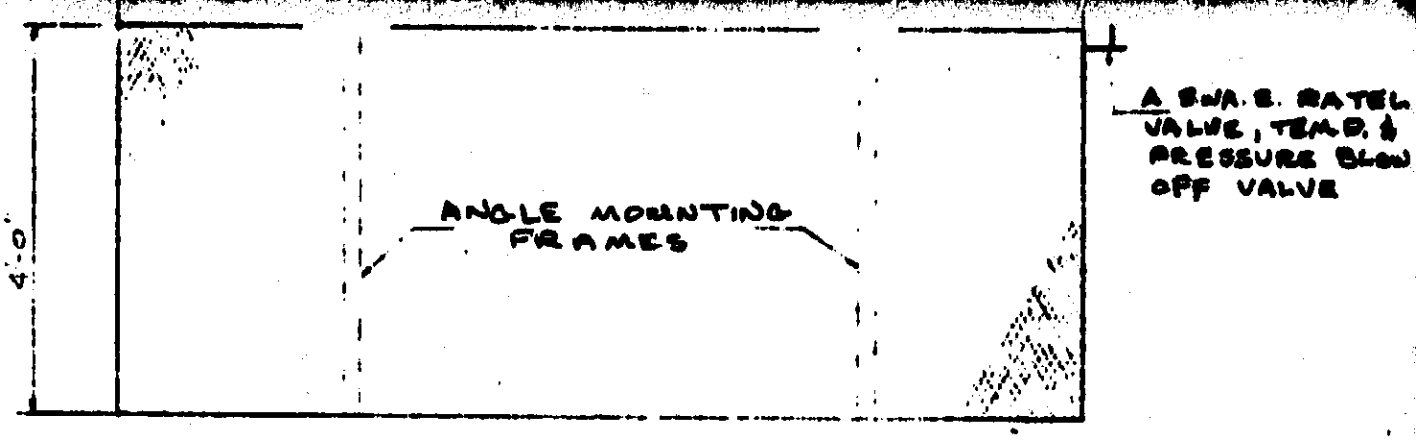
VARIABLE POWER CIRCUIT DIAGRAM



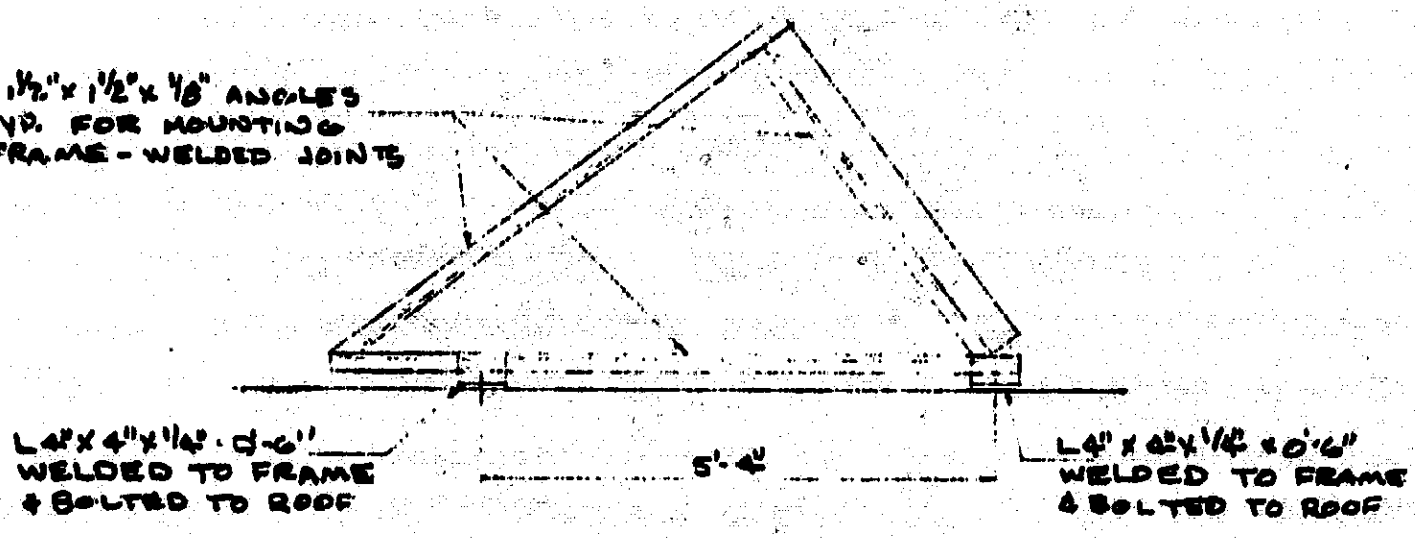
Variable R.P.M. Motor Performance



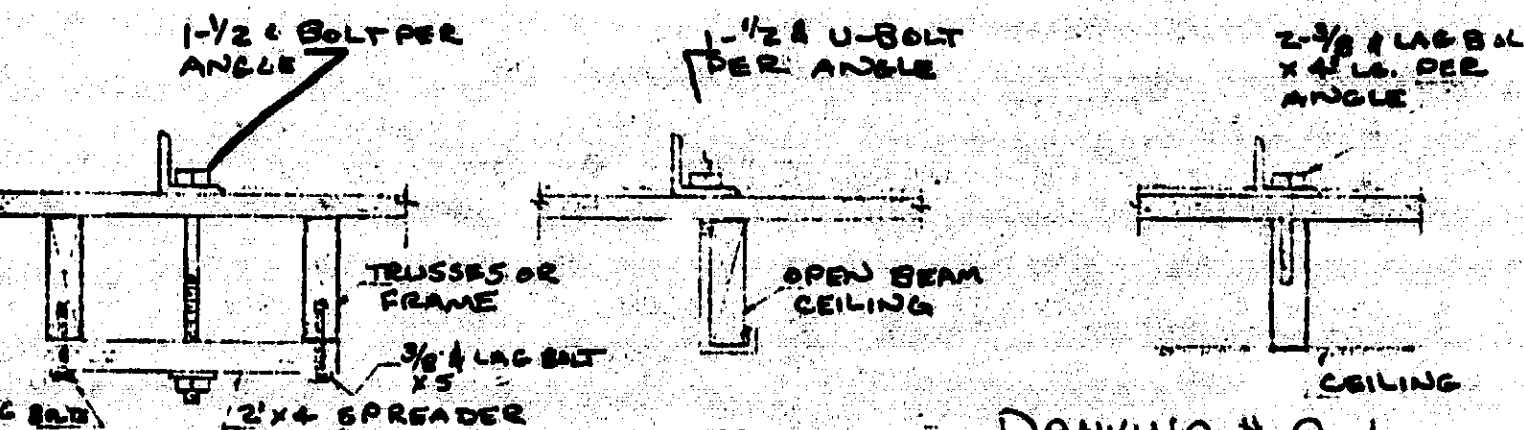
SEMCO FLAT PLATE COLLECTOR

DIMS. - 4' x 10' x 4"

WT. (TOTAL W/H2O) - 120 #



ANGLE MOUNTING FRAME (2 FRAMES PER PANEL)



DRAWING # C-1

BOLTING DETAILS

A. WIND LOAD AS PER SOUTH FLA BUILDING CODE

30 FT HEIGHT – PRESS 38 P.S.F

B. WIND LOAD ON PANEL

38 #/FT² x 10 FT x 4 FT x 1.7 — 2584 lbs

D.L. OF PANEL — 120 lbs

TOTAL LOAD — 2704 lbs

C. LOAD ON MOUNTING FRAMES

$\frac{2704 \text{ lb}}{2}$ = 1352 lb/ FRAME

D. LOAD ON BOLT & LAG BOLTS PER ANGLE

$\frac{1352 \text{ lb}}{2}$ = 676 lb/ ANGLE

FROM NATIONAL DESIGN SPECIFICATION FOR STRESS GRADE LUMBER AND ITS FASTENING BY NATIONAL FOREST PRODUCTS ASSOC

TABLE 14 ALLOWABLE WITHDRAWAL LOADS

GIVEN: 2-3/8" ϕ LAG BLTS x 4" LG GROUP II

ALLOWABLE LOAD IN WITHDRAWAL IN POUNDS PER INCH OF PENETRATION

$356 \frac{\text{lb}}{\text{IN}}$ x 4 IN x 2 BLTS = 2848 $\frac{\text{lbs}}{\text{LAG}}$ > 676 lb

TABLE 12 ALLOWABLE LOADS IN POUNDS ON ONE LOADED AT BOTH ENDS

GIVEN 1/2" ϕ BOLT 3" LENGTH OF BOLT IN MAIN M

PARALLEL TO GRAIN – 1530 lb/BLT > 676

PERPENDICULAR TO GRAIN – 970 lb/BLT > 676

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DRAWING # C-

Special Trade Requirements

Plumbing

a) Cold water line from the solar storage tank to the collector must come from an outlet located 6 to 8 in. from bottom of tank. (Direct Feed Only)
b) Cold water line must have an in line non-spring loaded check valve to prevent reverse flow at night.
c) Collector and circulating pump must have cut off valves to allow work on the collector and circulating pump without disconnecting entire house water system.
d) Collector must have T-P relief valve at the top collector outlet with blow-off line leading down to within 6 in. of roof surface.

Roofing

a) Collector leg mounting feet that bolt through the roof surface must have 2 in. x 4 in. x 4 in. pitch pans filled with roofing compoung (cold tar).

Carpentry.

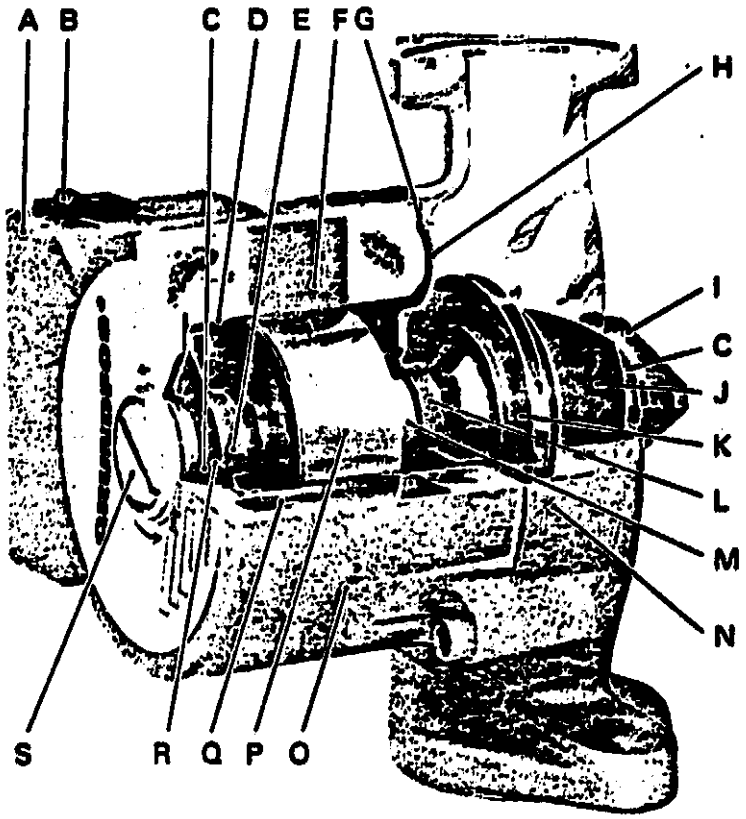
Collector leg mounting feet must be bolted to the roof rafters where the collectors are mounted.

a) Bolting may be done with 1/2 in. "J" bolt where an exposed bolt is not objectionable.
b) Where the ceiling under the mounting roof is exposed (decorative) beam, drill up through the beam and roof sheating and install 1/2 in. carriage or countersunk 1/2 in. machine bolts.
c) Where the ceiling under the mounting roof is finished plaster, locate the rafters through the roof surface, drill 2 - 1/4 in. holes 4 in. deep into the rafter and install 2 - 3/8 in. x 6 in. lag bolts for each mounting foot.
d) Where the collectors are mounted on a truss or frame roof, install a 2 x 4 spreader under the rafter system to distribute the load across two or more rafters or trusses.
e) Where the collectors are mounted on the ground, use pressure treated 4 x 4's as stringers with cable anchors set into the ground and bolted to the stringers. Drill vertically thru the stringer and install mounting feet with 1/2 in. machine bolts. Drill horizontally through the stringer and install cable anchors with 1/2 in. machine bolts.

APPENDIX A

GRUNDFOS PUMP BROCHURE

A. Terminal Box
B. Switch
C. O-rings
D. Rotor Can
E. Top Bearing
F. Stator
G. Gasket
H. Bearing Plate
I. Flow Adjustment Arm
J. Variable Flow Adjustment Plate
K. Impeller
L. Bottom Bearing
M. Thrust Bearing
N. Pump Chamber
O. Stator Housing
P. Rotor
Q. Winding Protection
R. Shaft
S. Plug/Indicator



INFORMATION: Two-speed circulator pump — UPS 20-42

The UPS 20-42 is fitted with a variable flow control and also features a two-speed motor. The head is controlled by the flow adjustment arm (I) and the choice of speed is made by hand on the switch (B) or made automatically in conjunction with remote control.

CONSTRUCTION

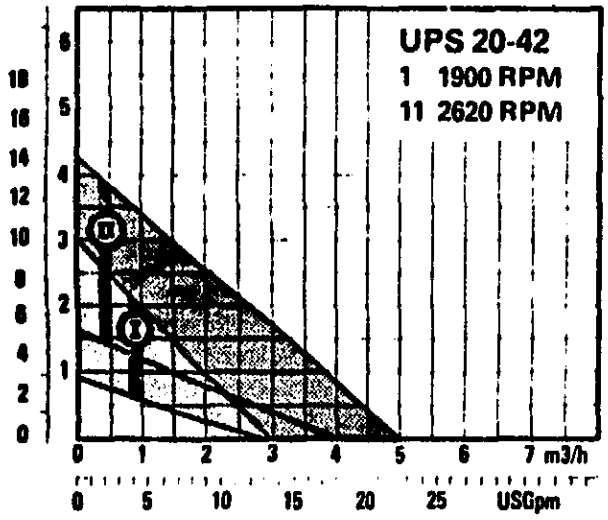
The UPS 20-42 is a water lubricated pump. However, in order to protect the rotor (P) and bearings (E,L) from damaging impurities which may be present in the circulating water, they are separated from the stator (F) and the pump chamber by a liquid filled rotor can (D). The motor shaft (R) extends out from the rotor can, into the pump chamber through the aluminum oxide bearing (L), which also functions as a seal. During initial operation, the pump is automatically self-vented; however, due to the isostatic principle, there is no further recirculation of water into the closed rotor can. The pump's "diamond-hard" aluminum oxide bearing construction, combined with the high starting torque of the motor, ensures re-start after shutdown.

MATERIALS

Stainless steel:	Rotor can, shaft, rotor cladding, bearing plate, impeller, variable flow adjustment plate, thrust bearing cover.
Aluminum oxide:	Top bearing, shaft ends, bottom bearing.
Aluminum:	Stator housing.
Carbon/aluminum oxide:	Thrust bearing.
Cast iron:	Pump housing.
Ethylene/propylene rubber:	O-rings, gasket.
Silicone rubber:	Winding Protection.

APPLICATIONS

The UPS 20-42 should only be used in closed systems (i.e. solar, hydronic) for the circulation of water. However, solutions such as ethylene glycol can be used without hindering pump performance. For open systems, order the Grundfos model UP 25-42 SF which has an all stainless steel pump housing.



The UPS 20-42 has a versatile performance range due to the variable flow control and the dual RPM switch. The high and low RPM settings are marked I and II respectively.

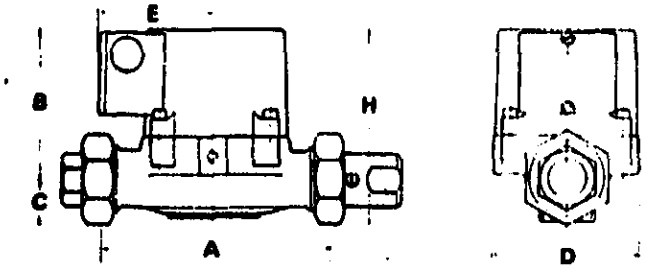
Contact Grundfos for information regarding larger circulator pumps and twin pumps.

ELECTRICAL DATA

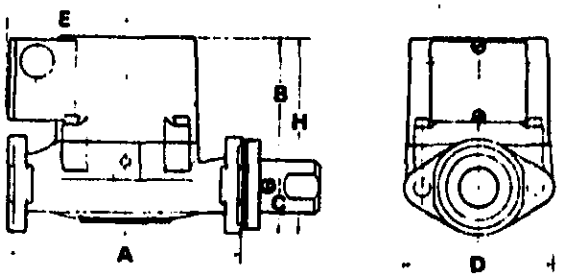
The UPS 20-42 is operated by an energy-conserving 1/20 HP motor which has built-in overload protection. The amperage on setting "I" is 0.65 and 0.85 on setting "II".

DIMENSIONS

UPS 20-42U



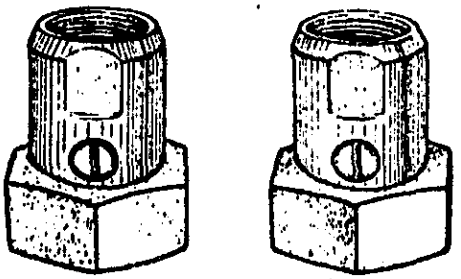
UPS 20-42F



Type	A mm inches	B mm inches	C mm inches	D mm inches	E mm inches	H mm inches	Ship. Carton 1xwxh mm/"	Pack Vol. m^3 Cb. ft.	Weight Kg Lbs.
UPS 20-42U (w/unions)	180 7 1/16	104 4 1/8	32 1 1/4	102 4 1/16	82 3 1/4	136 5 3/8	200 x 180 x 160 7 7/8 x 7 1/8 x 6 5/16	0.005 1/5	4.32 9 1/2
UPS 20-42F (w/flanges)	165 6 1/2	108 4 1/4	33.5 1 5/16	108 4 1/4	82 3 1/4	137 5 7/16	200 x 180 x 160 7 7/8 x 7 1/8 x 6 5/16	0.005 1/5	4.32 9 1/2

ISOLATION VALVES

GRUNDFOS recommends the use of isolation valves with circulation pumps in all systems.



Union Isolation Valve

Flange Isolation Valve

ORDER NUMBERS

		Unions		Flanges		Flange Valves Union Valves	
Type	Order No.	Dim.	Order No.	Dim.	Order No.	Dim.	Order No.
UPS 20-42F (w/flanges)	51.22 31 13	3/4" 1"	51.95 21 51.95 22	3/4" 1"	51.96 01 51.96 02	1"	51.97 72
UPS 20-42U (w/unions)	51.02 31 13			1¼" 1½"	51.96 03 51.96 04	1"	51.98 72

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