DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150740

DESIGN AND INSTALLATION PACKAGE FOR A SOLAR POWERED PUMP

Prepared from material furnished by

Calmac Manufacturing Company
150 S. Van Brunt Street
Englewood, New Jersey 07631

Under Contract NAS8-32253 with

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

For the U. S. Department of Energy

(NASA-CR-150740) DESIGN AND INSTALLATION PACKAGE FOR A SOLAR POWERED PUMP (CALMAC Mfg. Co.) 34 p HC A03/MF A01 CSCL 10A
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G3/44 28484

U.S. Department of Energy

Solar Energy

TABLE OF CONTENTS

SUBSYSTEM PERFORMANCE SPECIFICATION

CALMAC MFG CORP
SOLAR OPERATED PUMP

SPECIFICATION NO SHC-3050
REVISION 2
DATE 2/1/78

SUBSYSTEM PERFORMANCE SPECIFICATION
TABLE OF CONTENTS

Specification No. SHC-3050
Revision 2
Date 2/1/78

SUBSYSTEM PERFORMANCE SPECIFICATION

1.0 INTRODUCTION

This Performance Specification establishes the requirements for the design and performance of the subsystem for use with solar heating and combined heating and cooling systems. It designates the Interim Performance Criteria applicable to the subsystem and defines the deviations.

2.0 APPLICABLE DOCUMENTS

SHC-1006	Interim Performance Criteria for Solar Heating and Combined Heating/Cooling Systems and Dwellings dated January 1, 1975
NASA 98M10001	Interim Performance Criteria for Commercial Heating and Combined Heating/Coolings Systems and Facilities dated February 28, 1975.

3.0 APPLICATION OF INTERIM PERFORMANCE CRITERIA

The application of each paragraph of the Interim Performance Criteria to each type subsystem is provided in the following table, Number 1.

4.0 DEVIATIONS FROM INTERIM PERFORMANCE CRITERIA

None.

5.0 GOVERNMENT FURNISHED PROPERTY

None.

6.0 GOVERNMENT DIRECTED REQUIREMENTS

None.

7.0 SUBSYSTEM GENERAL PERFORMANCE SPECIFICATION & FEATURES

General

The Subsystem Performance Specification is detailed in the following paragraphs. It is for a solar operated pump that is silent in operation, produces no vibration, is hermetically sealed, can be made of non-corrodible materials, can be located outside (such as on a roof), needs no controls or electrical connection, and is inexpensive to manufacture. The pump is a positive displacement type, essentially, and will provide whatever pressures are needed to do the pumping.

8.0 WARRANTY

Contractor warrants that for a period of one year the pump materials will be free of defects in quality and workmanship. Warranty is limited to shipping replacement parts prepaid, which in suppliers opinion are required to correct such defects. No field labor is included.

SPECIFICATION NO. SHC-3050
REVISION 2
DATE 2/1/78

TABLE I

RESIDENTIAL SUBSYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

SHEET 1 OF 6

SUBSYSTEM APPLICATION

A – APPLICABLE TO TYPE SYSTEMS INDICATED

NA – NOT APPLICABLE

TYPE SYSTEMS

H – HEATING

HC – HEATING AND COOLING

HW – HOT WATER

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS			RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS		
	H	HC	HW		H	HC	HW
1.1 H and HC Performance	NA	NA	NA	1.3.1 Collector Efficiency	NA	NA	NA
1.1.1 Heating Design Temperatures	NA	NA	NA	1.4 Thermal Storage	NA	NA	NA
				1.4.1 Storage Capacity	NA	NA	NA
1.1.2 Cooling Design Temperatures	NA	NA	NA	1.5 Habitability of Occupied Spaces	NA	NA	NA
1.1.3 Relative Humidity and Water Vapor Pressure	NA	NA	NA	1.5.1 Heat or Humidity Transfer Effects	NA	NA	NA
1.1.4 Solar Contribution	NA	NA	NA	1.6 Energy Transport Efficiency	NA	NA	NA
1.1.5 Operation Impairment	NA	NA	NA	1.6.1 Thermal Losses and Electrical Power	NA	NA	NA
1.2 HW System/Subsystem Performance	NA	NA	NA	1.7 Control	NA	NA	NA
				1.7.1 Installation and Maintenance	NA	NA	NA
1.2.1 Water Design Temperature	NA	NA	NA				
				1.7.2 Manual Adjustment	NA	NA	NA
1.2.2 Storage Design Capacity	NA	NA	NA	1.7.3 Inhabited Space Temperature	NA	NA	NA
1.2.3 Solar Contribution	NA	NA	NA	1.7.4 Hot Water Temperature	NA	NA	NA
1.2.4 Operational Impairment	A	A	A	1.8 Auxiliary Energy	NA	NA	NA
1.3 Collector Performance	NA	NA	NA	1.8.1 Design Loads	NA	NA	NA

TABLE I

RESIDENTIAL SUBSYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

SUBSYSTEM APPLICATION

A – APPLICABLE TO TYPE SYSTEMS INDICATED

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HC – HEATING AND COOLING

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RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS H	HC	HW
2.1 System Design Conditions	A	A	A
2.1.1 Equipment Capabilities	A	A	A
2.1.2 Noise or Erosion - Corrosion	A	A	A
2.1.3 Operating Conditions	A	A	A
2.1.4 Fluid Flow in Collectors	NA	NA	NA
2.1.5 Entrapped Air	NA	NA	NA
2.1.6 Thermal Expansion of Fluids	NA	NA	NA
2.1.7 Pressure Drops	NA	NA	NA
2.1.8 Condensate Removal	NA	A	NA
2.2 Mechanical Stresses	A	A	A
2.2.1 Vibration Stress Levels	A	A	A
2.2.2 Vibration from Moving Parts	A	A	A
2.2.3 Water Hammer	NA	NA	NA
2.2.4 Vacuum Relief Protection	A	A	A
2.2.5 Thermal Changes	A	A	A
2.2.6 Flexible Joints	NA	NA	NA
2.3 Leakage Prevention	A	A	A
2.3.1 Pressure Test: Nonpotable Fluids	A	A	A
2.3.2 Pressure Test: Potable Water	NA	NA	NA
2.3.3 Air Transport Systems	NA	NA	NA
2.4 Collector Adjustment	NA	NA	NA
2.4.1 Orientation and Tilt	NA	NA	NA
2.4.2 Mutual Shadowing	NA	NA	NA
2.5 Subsystem Isolation	NA	NA	NA
2.5.1 Shutdown in Multi-family Housing	NA	NA	NA
2.6 Heat Transfer Fluid Quality	A	A	A
2.6.1 Liquid Quality	A	A	A
2.6.2 Air Quality	NA	NA	NA
2.6.3 Fluid Quality	NA	NA	NA
2.6.4 Freezing Protection	A	A	A
2.7 Piping Supports	A	A	A
2.7.1 Applicable Plumbing Standards	A	A	A
2.8 Excessive Pressure and Temperature Protection	A	A	A
2.8.1 Relief Valves and Vents	A	A	A
3.1 Structural Design Basis	A	A	A

TABLE I

SPECIFICATION NO. SHC-3050
REVISION 2
DATE 2/1/78

RESIDENTIAL SUBSYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

SHEET 3 OF 6

SUBSYSTEM APPLICATION

A – APPLICABLE TO TYPE SYSTEMS INDICATED

NA – NOT APPLICABLE

TYPE SYSTEMS

H – HEATING

HC – HEATING AND COOLING

HW – HOT WATER

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS			RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS		
	H	HC	HW		H	HC	HW
3.1.1 Applicable Standards	A	A	A	3.8.1 Foundation Settlement	A	A	A
3.1.2 Service Loads	A	A	A	3.9 Ponding Condition	NA	NA	NA
3.2 Failure Loads and Load Capacity	A	A	A	3.9.1 Design Provisions	NA	NA	NA
3.2.1 Ultimate Load Combinations	A	A	A	4.1 Plumbing and Electrical Installation	A	A	A
3.2.2 Ice Loads	NA	NA	NA	4.1.1 Plumbing Codes	A	A	A
3.2.3 Vehicular Loads	NA	NA	NA	4.1.2 Electrical Codes	NA	NA	NA
3.2.4 Load Capacity	NA	NA	NA	4.2 Fail-Safe Controls	A	A	A
3.3 Damage Control	A	A	A	4.2.1 System Failure Prevention	A	A	A
3.3.1 Resistance to Damage	A	A	A	4.2.2 Automatic Pressure Relief Valves	A	A	A
3.3.2 Glazing Design	NA	NA	NA	4.3 Fire Safety	A	A	A
3.4 Cyclic Loads	A	A	A	4.3.1 Applicable Fire Standards	A	A	A
3.4.1 Deflection Limitations	A	A	A	4.3.2 Penetrations through Fire Rated Assemblies	NA	NA	NA
3.5 Cutting of Structural Elements	NA	NA	NA	4.4 Toxic	A	A	A
3.5.1 Design Provisions	NA	NA	NA	4.4.1 Provisions of Catch Basins	A	A	A
3.6 Creep and Residual Deflection	NA	NA	NA	4.4.2 Detection of Toxic and Flammable Fluids	NA	NA	NA
3.6.1 Deflection Limitations	NA	NA	NA	4.5 Safety	A	A	A
3.7 Hail Resistance	NA	NA	NA	4.5.1 Emergency Egress and Access	NA	NA	NA
3.7.1 Hail Size and Loading	NA	NA	NA	4.5.2 Identification and Location of Controls	A	A	A
3.8 Constraint Loads	A	A	A				

TABLE I

RESIDENTIAL SUBSYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

SUBSYSTEM APPLICATION

A – APPLICABLE TO TYPE SYSTEMS INDICATED

NA – NOT APPLICABLE

TYPE SYSTEMS

H HEATING

HC HEATING AND COOLING

HW HOT WATER

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS H	HC	HW	RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS H	HC	HW
4.6 Protection of Potable Water & Circulated Air	A	A	A	5.2.3 Thermal Cycling Stresses	A	A	A
4.6.1 Contamination by Materials	NA	NA	NA	5.2.4 Leakage	A	A	A
4.6.2 Separation of Circulation Loops	NA	NA	NA	5.2.5 Deterioration of Gaskets and Sealants	A	A	A
4.6.3 Backflow Prevention	NA	NA	NA	5.2.6 Transmission Losses Due to Outgassing	NA	NA	NA
4.6.4 Growth of Fungi	A	A	A	5.3 Chemical Compatibility of Components	A	A	A
4.7 Excessive Surface Temperatures	A	A	A	5.3.1 Materials/Transfer Fluid Compatibility	A	A	A
4.7.1 Protection from Heated Components	A	A	A	5.3.2 Corrosion of Dissimilar Materials	A	A	A
5.1 Effects of External Environment	A	A	A	5.3.3 Corrosion by Leachable Substance	A	A	A
5.1.1 Solar Degradation	A	A	A	5.3.4 Effects of Decomposition Products	A	A	A
5.1.2 Soil Corrosion	NA	NA	NA	5.4 Components Involving Moving Parts	A	A	A
5.1.3 Airborne Pollutants	A	A	A	5.4.1 Wear and Fatigue	A	A	A
5.1.4 Dirt Retention on Cover Plate Surface	NA	NA	NA	6.1 Accessibility for Maintenance	A	A	A
5.1.5 Abrasive Wear	NA	NA	NA	6.1.1 Access for System Maintenance	A	A	A
5.1.6 Fluttering by Wind	NA	NA	NA	6.1.2 Access for System Monitoring	A	A	A
5.2 Temperature & Pressure Resistance	A	A	A	6.1.3 Draining and Filling of Liquids	A	A	A
5.2.1 Thermal Degradation	A	A	A	6.1.4 Flushing of Liquids Subsystems	A	A	A
5.2.2 Deterioration of Heat Transfer Fluids	A	A	A				

TABLE I

RESIDENTIAL SUBSYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

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RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS		
	H	HC	HW
6.1.5 Filters	A	A	A
6.1.6 Potable Water Shutoff	NA	NA	NA
6.2 Installation, Operation and Maintenance Manual	A	A	A
6.2.1 Installation Instructions'	A	A	A
6.2.2 Maintenance and Operation Instructions	A	A	A
6.2.3 Maintenance Plan	A	A	A
6.2.4 Replacement Parts	A	A	A
6.3 Repair and Service Personnel	A	A	A
6.3.1 Maintenance of H and HC Systems	A	A	A
6.3.2 Maintenance of DHW System	A	A	A
7.1 Design	NA	NA	NA
7.1.1 Dwelling Design	NA	NA	NA
7.1.2 Mobile Home Design	NA	NA	NA
7.1.3 Site Design	NA	NA	NA
7.1.4 Passive Use of Solar Energy	NA	NA	NA
7.2 Adequate Space	NA	NA	NA
7.2.1 Collector Area	NA	NA	NA

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS		
	H	HC	HW
7.2.2 Storage Area	NA	NA	NA
7.2.3 Utility Chases	NA	NA	NA
7.3 Functioning of Dwelling Site	NA	NA	NA
7.3.1 Space Use	NA	NA	NA
7.3.2 Shading of Adjacent Structures	NA	NA	NA
7.3.3 Impace of Environment	NA	NA	NA
7.3.4 View	NA	NA	NA
8.1 Interference with Mechanical Operation	NA	NA	NA
8.1.1 Blockage of Solar Subsystem	NA	NA	NA
8.1.2 Shading of Collector	NA	NA	NA
8.1.3 Sensor Location	NA	NA	NA
8.2 Mechanical & Electrical Functioning of Dwelling and Site	NA	NA	NA
8.2.1 Exhaust and Venting	NA	NA	NA
8.2.2 Utilities	NA	NA	NA
8.3 Mechanical & Electrical Functioning of Connections	NA	NA	NA
8.3.1 Plumbing Connections	A	A	A

SPECIFICATION NO SHC-3050
REVISION 2
DATE 2/1/78

TABLE I

RESIDENTIAL SUBSYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

SHEET 6 OF 6

SUBSYSTEM APPLICATION

A – APPLICABLE TO TYPE SYSTEMS INDICATED

NA – NOT APPLICABLE

TYPE SYSTEMS

H - HEATING

HC – HEATING AND COOLING

HW – HOT WATER

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS		
	H	HC	HW
8.3.2 Electrical Connections	NA	NA	NA
9.1 Structural Integrity	NA	NA	NA
9.1.1 Movements in Adjacent Structures	NA	NA	NA
9.2 Structural Integrity of Dwelling	NA	NA	NA
9.2.1 Loads	NA	NA	NA
9.2.2 Penetration of Structural Members	NA	NA	NA
9.3 Structural Connections	NA	NA	NA
9.3.1 Structural Connections	NA	NA	NA
9.3.2 Brittle Subsystem	NA	NA	NA
9.3.3 Strength and Stiffness	NA	NA	NA
10.1 Safety of Dwelling and Site	NA	NA	NA
10.1.1 Fire	NA	NA	NA
10.1.2 Accidents	NA	NA	NA
11.1 Durability	NA	NA	NA
11.1.1 Vegetation	NA	NA	NA
11.2 Durability and Reliability of Dwelling and Site	NA	NA	NA
11.2.1 Chemical Corrosion	A	A	A

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEMS		
	H	HC	HW
11.2.2 Heat and Moisture	A	A	A
11.2.3 Exterior Penetrations	NA	NA	NA
11.3 Durability and Reliability of Connections	NA	NA	NA
11.3.1 Material Compatibility	A	A	A
12.1 Maintainability of H, HC, HW Systems	NA	NA	NA
12.1.1 Accessibility	NA	NA	NA
12.1.2 Misuse	NA	NA	NA
12.1.3 Permanent Maintainance Accessories	NA	NA	NA
12.2 Maintainability of Dwelling and Site	NA	NA	NA
12.2.1 Accessibility	NA	NA	NA
12.2.2 Ice Dams	NA	NA	NA
12.3 Connections	NA	NA	NA
12.3.1 Accessibility	NA	NA	NA
13.1 Visual Characteristics of Dwelling and Site	NA	NA	NA
13.1.1 Dwelling	NA	NA	NA
13.1.2 Neighborhood	NA	NA	NA

SUBSYSTEM PERFORMANCE SPECIFICATION
APPENDIX A

Pump Data

Size: 16 inches diameter by 14 inches high
Pressure output: Variable, 0-50 ft. head, average 25 ft.
Flow rate: Up to 10 GPM
Thermal efficiency: Approximately 18%
Vapor temperature: 255°F (40% glycol and 25 ft. head)
Maximum pumped liquid temperature: 200°F
Suction Head: 5 ft.

Thermo-Ten Solar-Powered Pump

Installation, Operation & Service Manual
Applications Guide

INDEX

The Thermo-Ten is a heat-operated pump designed to be powered by steam from solar concentrating collectors.

The information in this manual has been prepared to save time, obtain the best possible installation and to insure trouble-free operation. Much time and effort can be saved by reading through this booklet before starting work in order to get an overall understanding of the pump and its function.

ALL work must be performed in accordance with LOCAL, STATE and NATIONAL Codes.

GALMAG MANUFACTURING CORPORATION
Box 710, 150 S. Van Brunt St., Englewood, N.J. 07631 • (201) 569-0420 • (212) 586-5178

I. PUMP DESCRIPTION

1. General. The Thermo-Ten is a heat operated pump designed to be powered by steam from solar concentrating collectors. The fluid used to operate the pump--water--is the same fluid that the system is designed to pump.

2. Mechanical Configuration. The pump housing is a 22-quart cast aluminum pressure cooker. Attached to the cover of the 13-inch diameter vessel are inlet and outlet check valves, through which pass the fluid to be pumped, and a special steam supply fitting for the steam from the concentrating collector. Makeup water to the collector flows through a check valve located at the base of the pressure cooker. An inner cylinder of steel covered with 1/2" thick cork and measuring about 9" in diameter and 11" deep is attached to the cover of the cooker. Attached near the top of the inner cylinder is a serpentine vapor tube made out of copper tubing. The down leg of the tube is insulated by the cork wall of the inner cylinder. The lowest point of the vapor tube marks the trip point of the thermopump cycle. After that point the tube leads up to discharge in the pump's condenser section--the space between the inner cylinder and the outer wall. An insulated round float rides on top of the water in the inner cylinder.

3. Pump Cycle. The thermopump starts operating completely full of the fluid to be pumped. Steam enters from the collector at the top of the pump and begins to fill the central chamber created by the inner cylinder. As the steam comes in, it forces the float and liquid level down. The liquid level in the down leg of the vapor tube stays even with the inside level of liquid. As more and more steam enters, the level falls further and liquid is pumped out of the outlet check valve in equal volume to the volume of the steam vapor in the pump.

When the liquid level in the vapor tube reaches the trip point at the bottom of the vapor tube, steam vapor starts to get by the trip point and rush up to the tube outlet in the pump's condenser section. Along the way it starts to condense, since the tube is cooler than the vapor. At this point a thermosiphon action takes place. In the pump there is a closed fluid loop of two up and two down legs--namely, up in the inner vapor chamber, down in the outer condenser section, and up and down legs in the vapor tubes. Just before the trip the system is stable--one up (the vapor tube up leg) and one down leg (the condenser section leg) are liquid, and one up (the inner chamber leg) and one down leg (the vapor tube down leg) are vapor. As soon as the vapor goes past the trip point and rises up filling the vapor tube up leg because it is lighter, an imbalance occurs with three legs filled with vapor and one with liquid. Also, at this time the pressure falls because of the rapid condensation taking place. As a result, there is a very rapid refilling of the vapor collector chamber, which drives the remaining vapor out of the vapor tube to the condenser. Liquid rushes in through the inlet check valve to replace all of the vapor volume as it is condensed. This whole action--the suction stroke--takes only about three seconds so that the refilling is done before much more vapor can get out of the collector.

4. Application. The thermopump can be used as a circulator to pump the heat transfer fluid between the solar collectors and the storage system in a solar heating or cooling system. It is designed to be mounted outdoors. Indoors installation is possible; however, the pump is noisy and the noise may be objectionable if the pump is locateu near a living space.

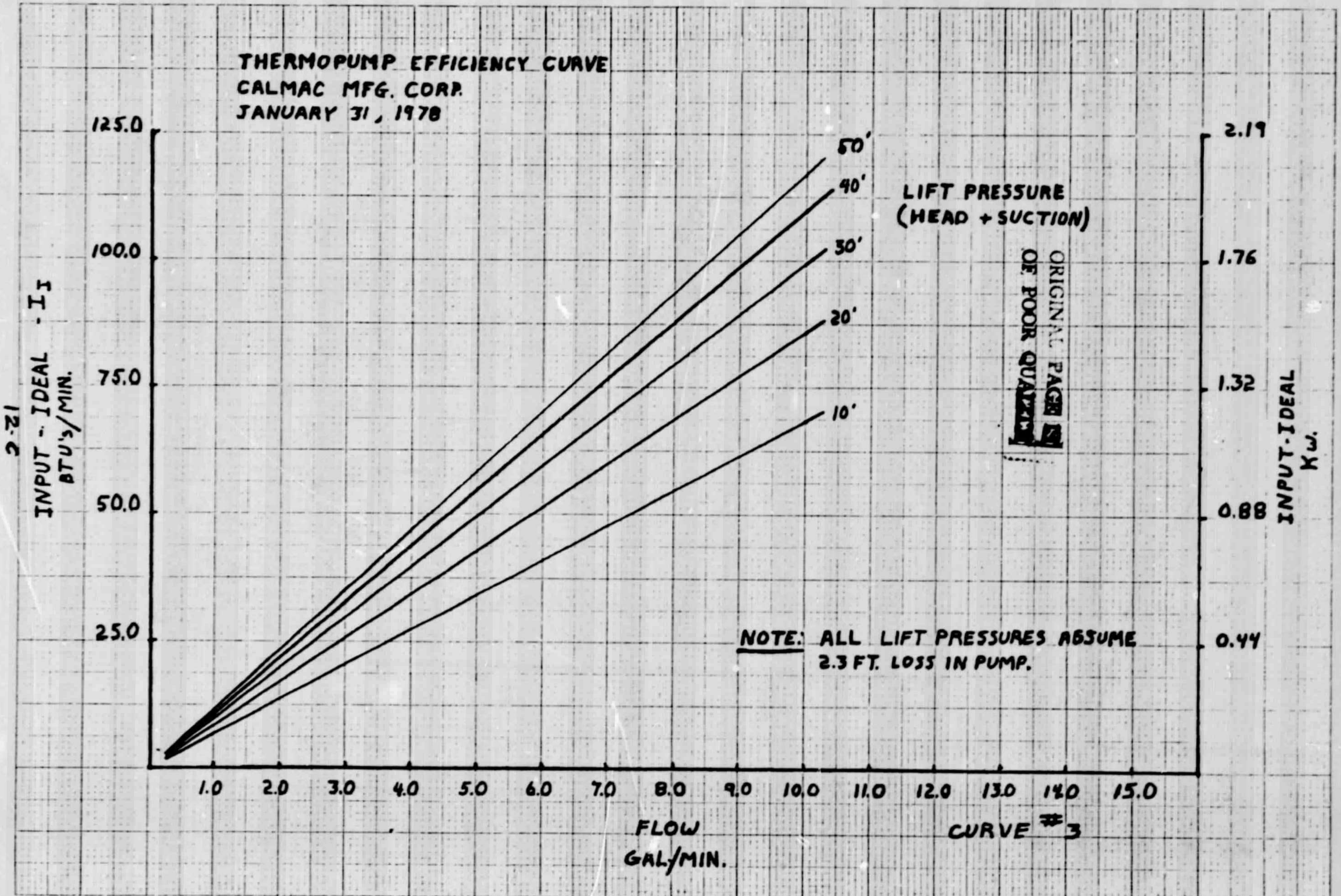
5. Pumping Characteristics and Concentrating Collector Requirements. The pump can be driven with either stationary or tracking concentrating collectors. The collectors used must be able to generate steam. The amount of collector steam output required depends on three variables: required flow rate in GPM, pumped fluid temperature (T_f), and head pressure (P_h). After these variables have been specified they can be used along with the curves on Page 4 to determine the required input from the collectors.

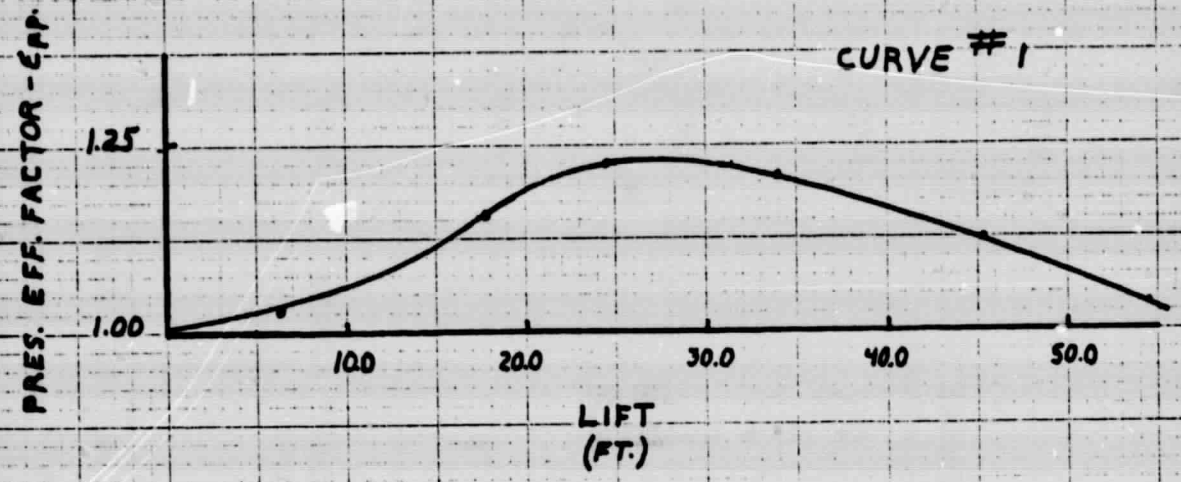
First, determine the required lift in ft. of H_2O, which is equal to the head pressure, P_h, plus the suction pressure, P_s. Then determine the Pressure Efficiency Factor, $\mathcal{E}_{pp}$, (curve #1) and then the Thermal Efficiency Factor, $\mathcal{E}_t$, (curve #2). Multiplying them together yields the Thermal Pumping Efficiency, $\mathcal{E}_{pt}$. Next determine the Ideal Input, I_I from curve #3. (This is the required input if the pump were 100% efficient). $I_I \times 100/\mathcal{E}_{pt}$ is equal to the amount of energy (in KW or Btu's/min.) the collector must produce, I_c. The collector output must be determined from specifications for the particular collector being used.

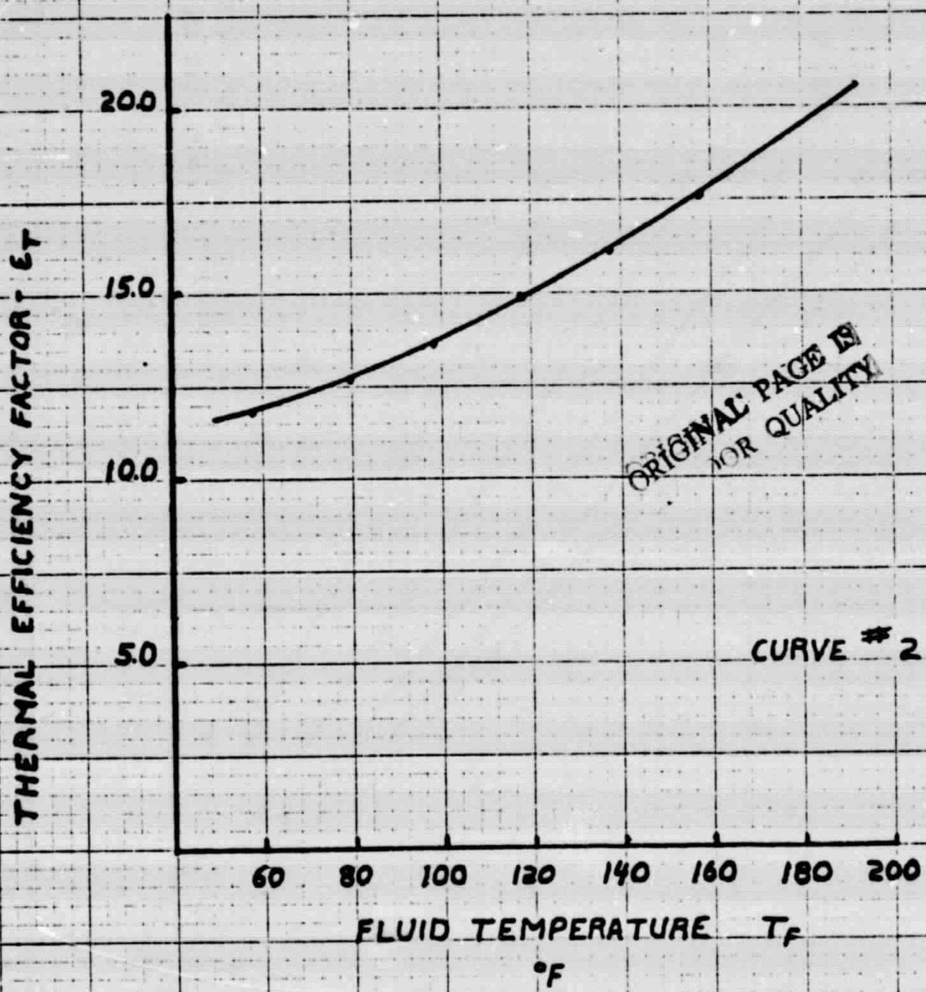
Example: Flow: 5 GPM
T_f: 160°F
P_h: 20 ft.
P_s: 5 ft.

Therefore from the curves

$$pp := 1.227$$
$$t = 17.8\%$$
$$\mathcal{E}_{pp} \cdot \mathcal{E}_t = \mathcal{E}_{pt} = 21.8\%$$
$$I_I = 46.25 \text{ Btu's/min} = 0.81 \text{ KW}$$
$$I_c = \frac{46.25 \times 100}{21.8} = 212 \frac{\text{Btu}}{\text{Min}} = 3.7 \text{ KW}$$


THERMOPUMP EFFICIENCY CURVE
CALMAC MFG. CORP.
JANUARY 31, 1978
INPUT - IDEAL - I_I
BTU's/MIN.
125.0
100.0
75.0
50.0
25.0
INPUT - IDEAL
Kw.
2.19
1.76
1.32
0.88
0.44
50'
40'
30'
20'
10'
LIFT PRESSURE
(HEAD + SUCTION)
NOTE: ALL LIFT PRESSURES ASSUME
2.3 FT. LOSS IN PUMP.
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
FLOW
GAL/MIN.
CURVE #3
ORIGINAL PAGE IS
OF POOR QUALITY





$\varepsilon_{T} \times \varepsilon_{PP} = \varepsilon_{PT}$

$\dfrac{I_I \times 100}{\varepsilon_{PT}}$ = INPUT REQUIRED

THERMOPUMP EFFICIENCY CURVES
CALMAC MFG. CORP.
JANUARY 31, 1978

II. INSTALLATION

1. Mounting. Location of the pump in relation to the concentrating is fairly critical. On the suction stroke, when the vapor chamber of the pump refills, liquid flows to the concentrating collector through the small check valve at the base of the pump to make up for liquid lost there through vaporization. It is important that the collector be lower than the pump in order to insure this refill.

The level of the pump determines the amount of water in the collector, which in turn effects the wetness of the steam. The drier the steam the more efficient the system will function. The pump usually has to be about two-thirds of the way up between the inlet and outlet points on the collector.

In order to keep the steam entering the pump as dry as possible, it is reccomended that a "riser tube" be placed in the steam supply line. A 3/4" copper tube, connected to the concentrating collector upper manifold, rising vertically approximately 20", will be sufficient (See Fig. 1). This lets any water that hasn't vaporized drop back into the collector.

When the pump is used in open systems--irrigation uses, for example--it is important to keep in mind that the pump has only a five-foot suction head. This means that the pump and collector must be located close to the level of the water to be pumped.

The pump needs to be supported by a platform It is held in place, however, by the four lines running into and out of the pump. That is, the pump need not be bolted down to the platform it is resting on. See Figure 1 for a typical installation.

2. Piping. The proper size of piping is as follows:

Steam supply from concentrating collector: 3/4" copper tube
Makeup liquid to concentrating collector: 3/4" or 1/2" copper tube
Suction line: 1 1/2"
Outlet line: 1"

Unions should be used at the points where the four lines connect to the pump in order to facilitate service and pump-priming. The pump is primed through the steam inlet connection by filling the pump completely full with fluid.

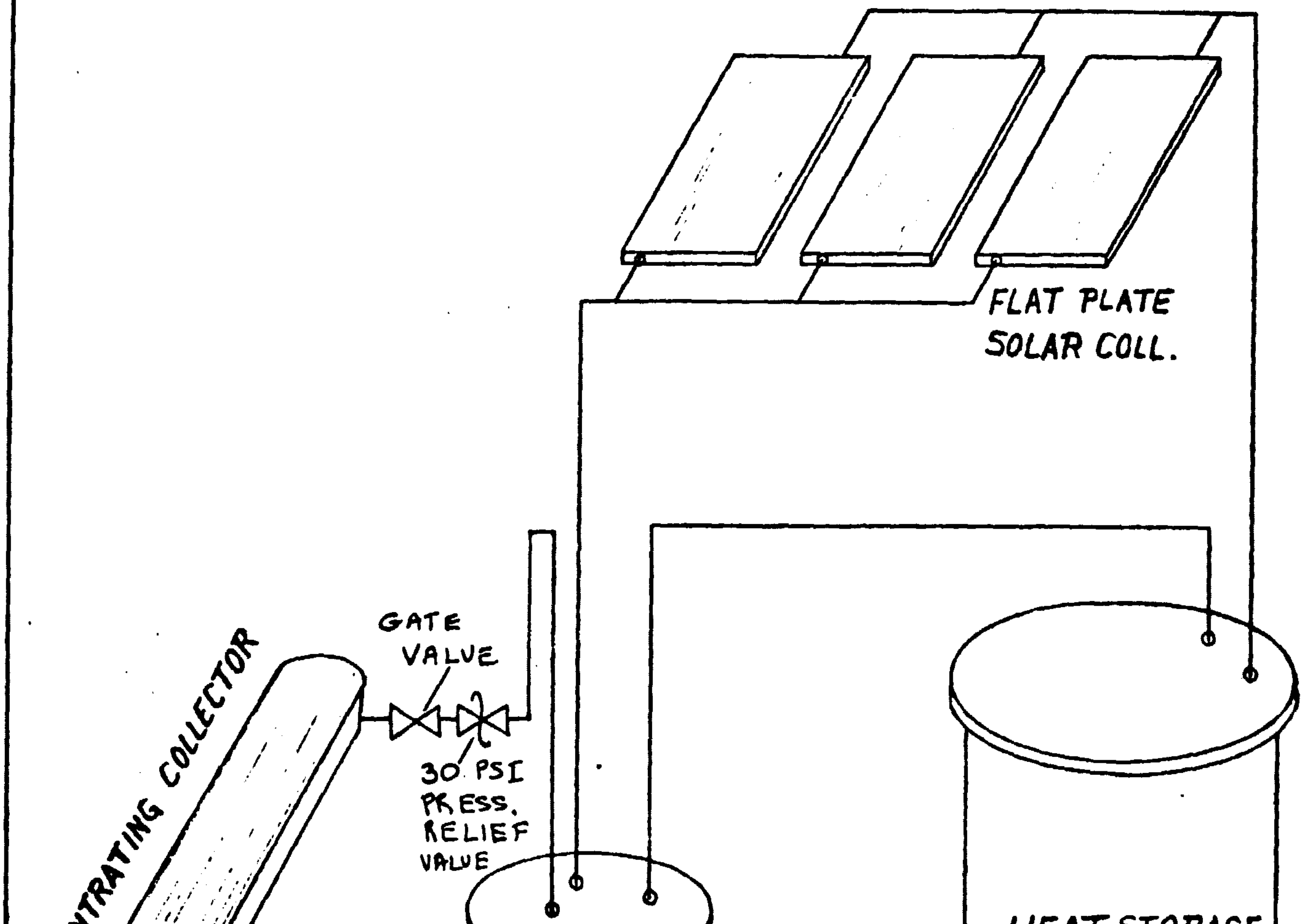

FLAT PLATE
SOLAR COLL.
GATE
VALVE
30 PSI
PRESS.
RELIEF
VALVE
CONCENTRATING COLLECTOR
HEAT STORAGE
FACILITY
THERMOPUMP

FIG. 1

The pump comes with standard fittings to accomodate the properly sized lines. All required check valves are factory-installed.

The steam supply line and the makeup liquid line must be insulated. The use of 1" Armaflex insulation or an equivalent insulation approved for outdoor use is recommended.

When the pump is being used for pumping to a heat storage tank, all lines must be well insulated.

An adjustable pressure relief valve, set at 30 psi, should be placed in the steam supply line, on the collector side of the gate valve, (See Figure 1).

The schematic in Figure 1 diagrams the proper piping connections in one typical application.

III. OPERATION

1. Start-Up. The pump must be primed by filling it with fluid in order to start the pumping cycle. A five foot long 1 1/2" suction line will fill by the action of the pump, but longer or larger lines will run the pump dry requiring repriming. In addition, the liquid supply line should have fluid in it. Small amounts of air in the liquid suction line can be handled by the pump, but if the pump pumps itself dry, it has to be reprimed.

2. The system should be set up and the pump primed with the manual gate valve in the steam supply line closed. When the system is completely checked out, open the valve and if the concentrating collector is generating steam, the pump should begin to cycle.

IV. MAINTENANCE

1. Routine. Since the pump has no moving parts subject to deterioration from friction, routine maintenance such as lubrication is not required.

Once a year the gasket between the cover and the vessel should be examined for breakdown. Replacement gaskets can be obtained from CALMAC.

Once a year the cork inner cylinder should also be inspected for breakdown and water-logging. If deterioration is evident, the cylinder must be returned to CALMAC for rebuilding.

During the annual inspection, the steam inlet fitting should be inspected to make sure no particles or debris have accumulated in the valve which might cause clogging.

2. Trouble-Shooting.

a. Inadaquate Pumping:

1) Check to see if concentrating collector lenses are clean. Dirt or dust on lenses will lower collector output, therefore lowering gpm.

2) Check to see if pump is making full (2.4 gal/stroke) strokes. This can be done by collecting water pumped during one cycle. If gallons per stroke is lower than 2, check the flow valve (steam inlet valve) for debris.

b. No Pumping:

1) Touch the outer body of pump on the sides. If very hot (much hotter than fluid being pumped) the pump is air locked. Reprime pump.

2) Check suction check valve for debris.

V. SPECIFICATIONS

Maximum Flow: 10 GPM
Maximum Discharge Pressure: 50 feet of H_2O
Maximum Suction Pressure: 5 feet
Maximum Fluid Temperature: 200°F
Pump Thermal Efficiency: 9% - 25%
Maximum Mechanical Efficiency: 1.1%

DRAWINGS

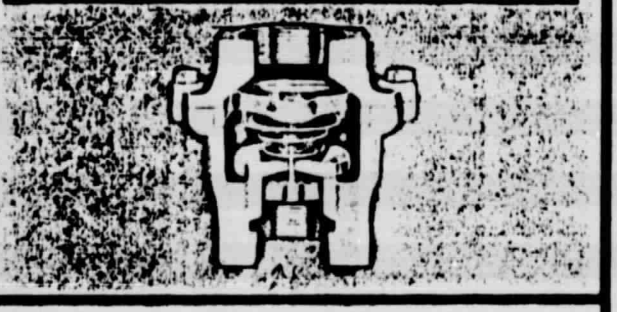
MUESSCO

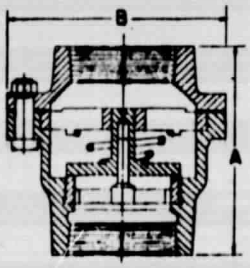
SCREWED END SILENT CHECK VALVES

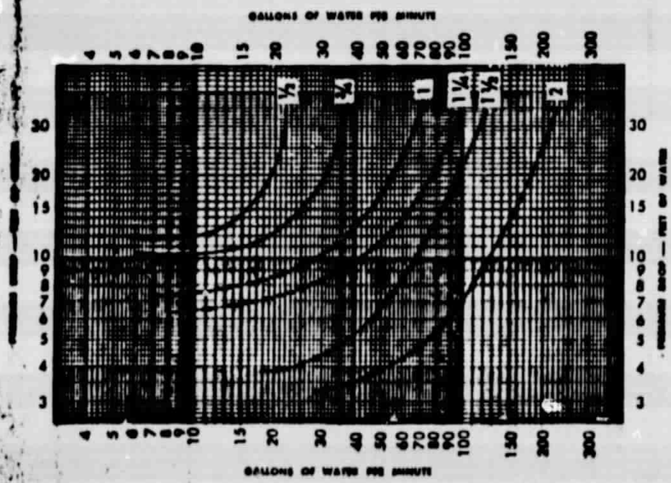
#203-AP Iron body
Sizes 1"-2" – bronze trim – 250 #WOG

#203-BP Bronze body
Sizes 1/2"-2" – bronze trim – 300 #WOG

#203-HT Type 316 Stainless steel body and trim
Sizes 1/2"-2" – 300 #WOG







SERVICE RECOMMENDATIONS: For liquid service, in accordance with ASA rated working pressures. For installation in pump suction or discharge piping. Satisfactory for certain types of air service — consult the factory. Spring automatically closes disc at zero flow — before flow reversal occurs and thereby prevents surge and water hammer.

FEATURES: Completely guided disc – both top and bottom.

Minimum open area through the valve oqual to 110% of the area of corresponding pipe size.

High lift disc — all sizes feature discs which lift 1/3" per one inch of pipe size.

Replaceable, interchangeable parts.

ORDERING INFORMATION: We require all of the pertinent information relating to the operating conditions for which the valves are intended. Operating pressure, temperature, flow rates and/or velocity and the type of pump used in the installation. If corrosive fluids are involved we should be so advised. For certain applications among which are pump suction and volatile liquid handling our valves require springs heavier or lighter than those furnished as standard and in the absence of complete information we reserve the right to furnish standard springs.

INSTALLATION: Equally effective installed horizontally, vertically or at any other angle. No special tools required. We strongly suggest the installation of a strainer in the piping, located ahead of the pump. This sound measure will insure protection for both the pump and the working parts of the valve.

PRESSURE DROP: See pressure drop charts which are the results of actual physical tests. Available in certified form.

TESTING: Each valve is subjected to several tests, including hydrostatic testing of both the shell and the seat. In complete accordance with ASA standards. Certified test reports available.

CONSTRUCTION: Seats and discs are hand lapped to a fine finish and all parts are completely interchangeable. Stainless steel trim is available.

The guiding we have designed into this valve insures against the disc cocking out of position, regardless of the angle at which the valve is installed.

Springs furnished in stainless steel for all model numbers.

#203-AP and #203-BP furnished with graphited asbestos gaskets. #203-HT furnished with Blue African asbestos, Teflon, or any other material specified.

ORIGINAL PAGE IS
OF POOR QUALITY

MEASUREMENTS AND WEIGHTS — APPROXIMATE — APPLY FOR CERTIFIED DRAWINGS

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	"A"	3"	3"	4⅛"	4⅛"	4¼"	4½"
	"B"	3"	3"	3 11/16"	3⅞"	4⅜"	5⅛"
WGHT	#203-AP & 203-HT	2	3	3½	4½	5½	7½
	#203-BP [illegible]	2	3	4	5	6	8

HIGH-HEAT RESISTANT

SILICONE ALUMINUM

Product Data

FEED WATER & COOLING TOWER CHEMICALS
MAINTENANCE CHEMICALS ● EPOXY COATINGS
POLYURETHANES ● INDUSTRIAL FLOORS

K & K CHEMICALS, INC.

30 ROXBORO ROAD ● LAWRENCEVILLE, N. J. 08648
TELEPHONE: (609) 396-0061

CRAFT HI-HEAT#40

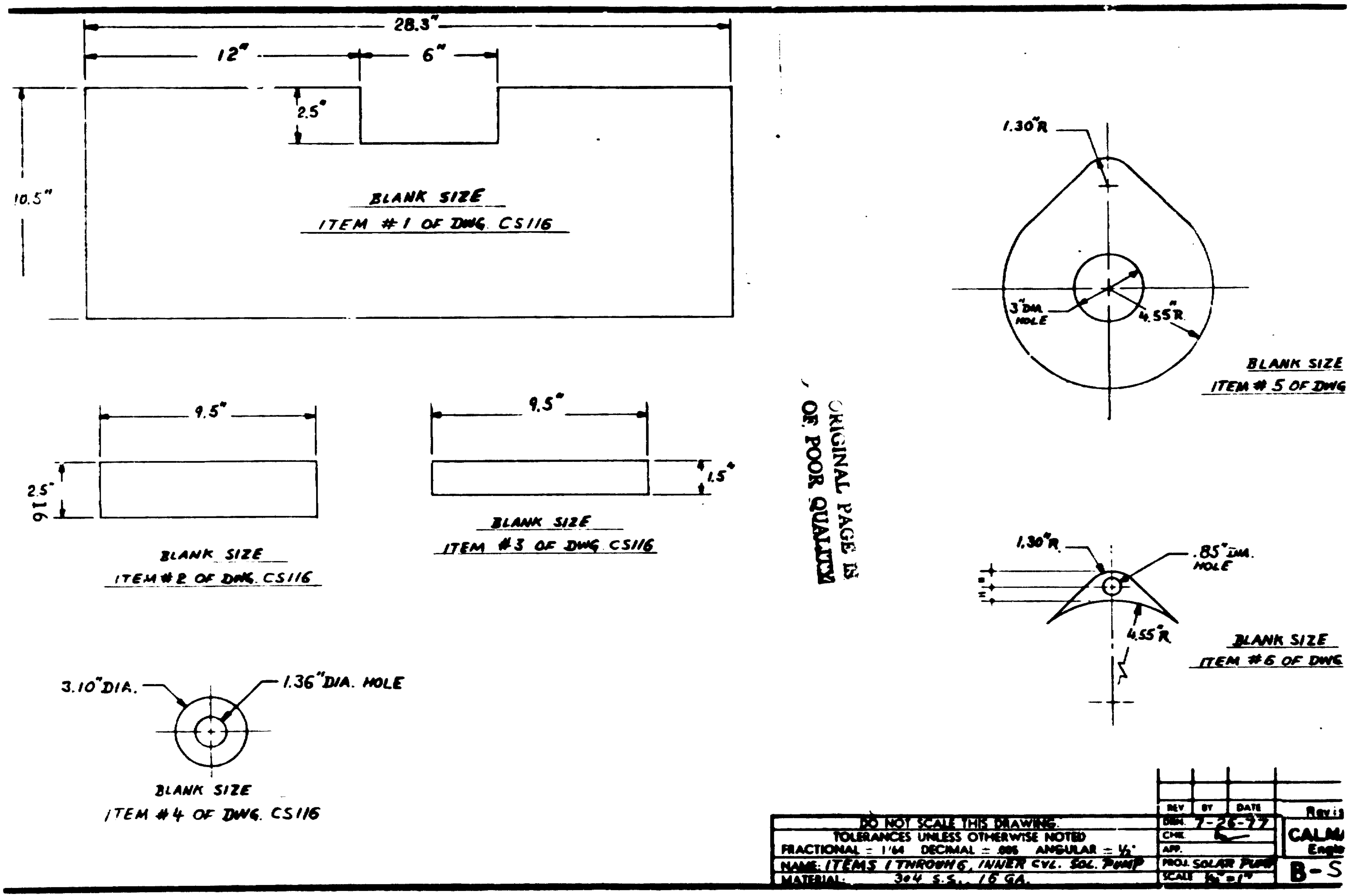
PURPOSE: Interior or exterior metal surfaces 600°F. to 1200°F.

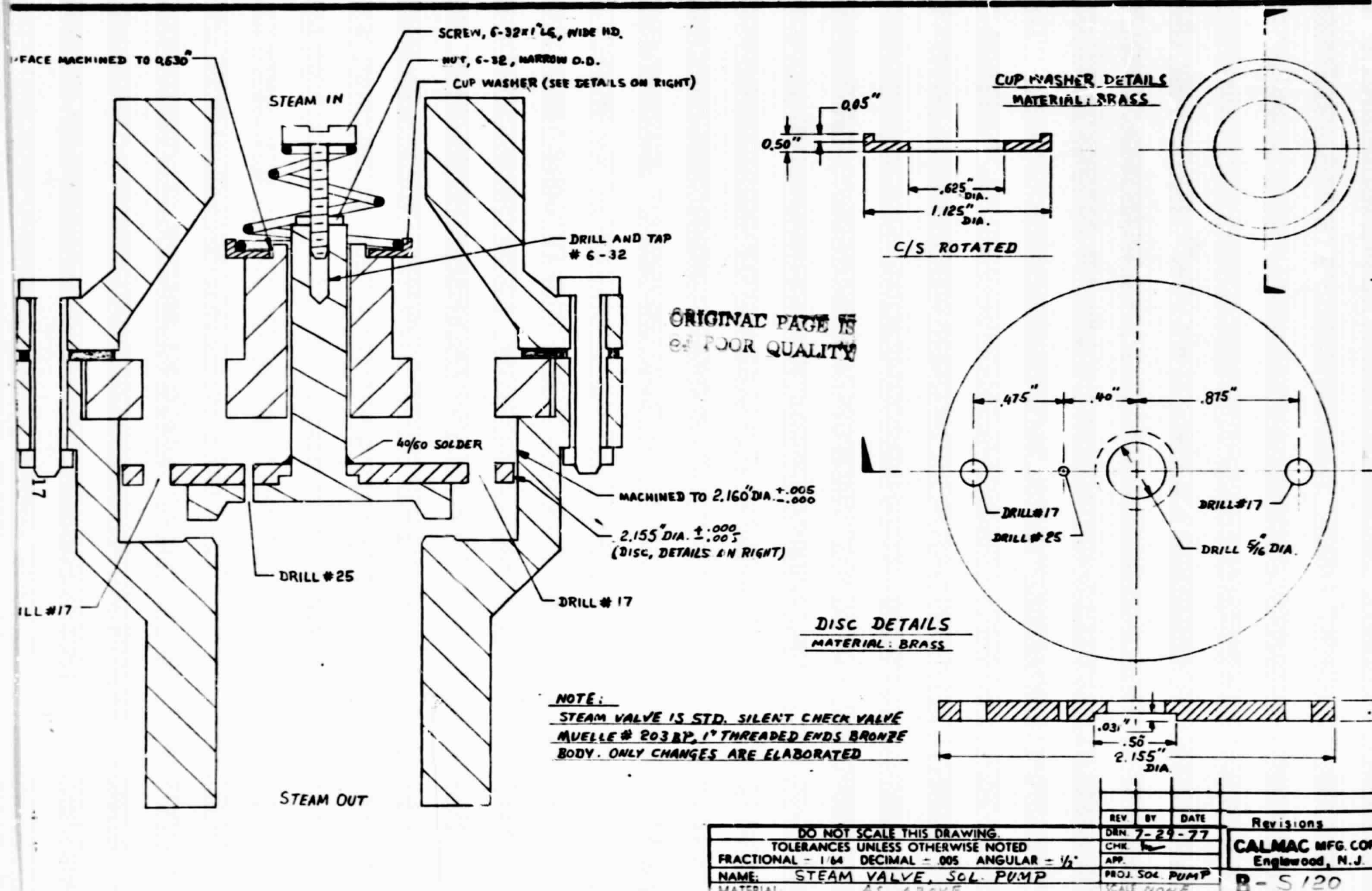
TYPICAL USES: High Temperature Stacks / Breechings / Exhaust Manifolds / Boiler Fronts / Incinerators / Piping

PRODUCT INFORMATION: This superior Silicone Aluminum Coating with 100% Silicone Resin does outstanding service on hot metal surfaces subject to continuous heat ranging from 450°F. to 1200°F. Coating fuses to surface when heat is brought up to operating temperature...reaches maximum durability upon being cured at minimum 450°F. for two hours. Excellent resistance to weather makes High-Heat Silicone Aluminum ideal for exterior, as well as interior use.

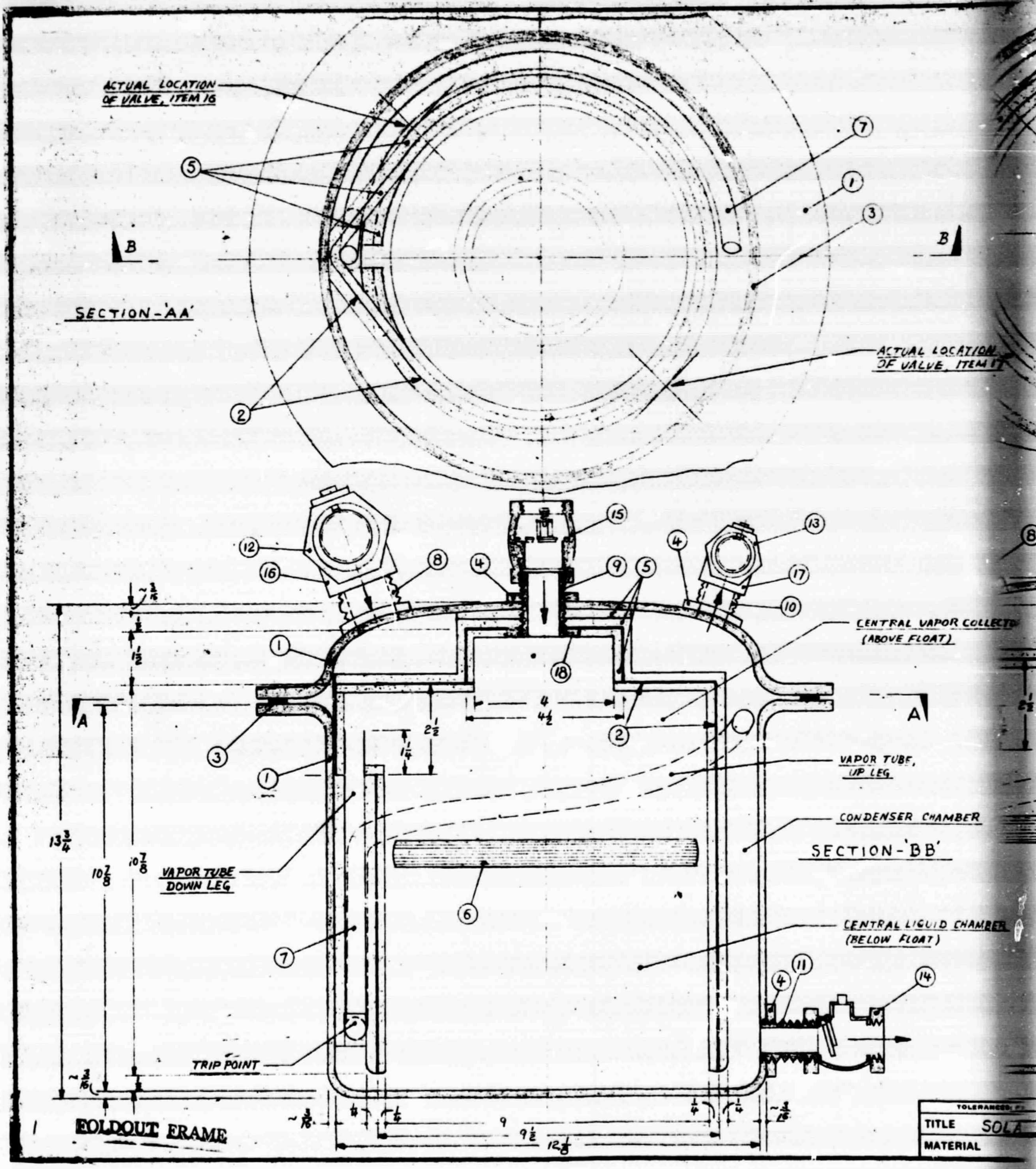
CHARACTERISTICS

Color	-	Aluminum
Application		Brush or Spray on clean, bare, metal
Reduction		Brush--Full Body; Spray--If required, reduction should not exceed 1/2 pint Xylol per gallon
Drying Time	--	4 to 5 hours under normal conditions
Gloss	--	Brilliant
Coverage	--	400-500 sq. ft. per gallon
Heat Resistance	--	Up to 1200°F.

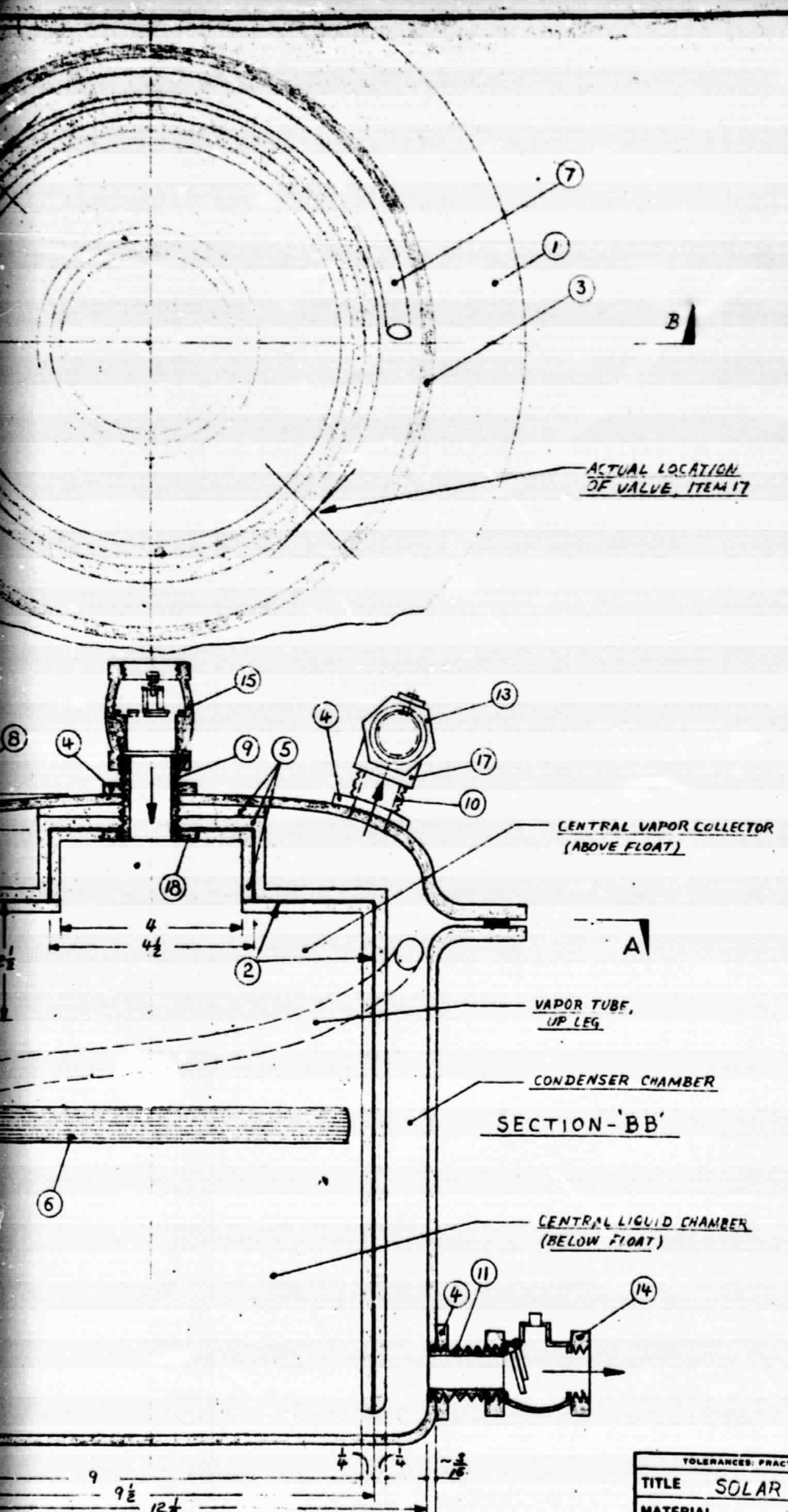

28.3"
12"
6"
2.5"
10.5"
BLANK SIZE
ITEM #1 OF DWG. CS116
9.5"
2.5"
.16
BLANK SIZE
ITEM #2 OF DWG. CS116
9.5"
1.5"
BLANK SIZE
ITEM #3 OF DWG. CS116
3.10" DIA.
1.36" DIA. HOLE
BLANK SIZE
ITEM #4 OF DWG. CS116
1.30" R
3" DIA. HOLE
4.55" R
BLANK SIZE
ITEM #5 OF DWG
1.30" R
.85" DIA. HOLE
4.55" R
BLANK SIZE
ITEM #6 OF DWG
DO NOT SCALE THIS DRAWING
TOLERANCES UNLESS OTHERWISE NOTED
FRACTIONAL ± 1/64 DECIMAL ± .005 ANGULAR ± 1/2°
NAME: ITEMS 1 THROUGH 6, INNER CYL. SOL. PUMP
MATERIAL: 304 S.S., 16 GA.
REV
BY
DATE
DRN. 7-26-77
CHK.
APP.
PROJ. SOLAR PUMP
SCALE
CALM
B-S



SCREW, 6-32×1" LG, WIDE HD.
NUT, 6-32, NARROW O.D.
CUP WASHER (SEE DETAILS ON RIGHT)
FACE MACHINED TO 0.630"
STEAM IN
DRILL AND TAP # 6-32
40/60 SOLDER
MACHINED TO 2.160" DIA. +.005 -.000
2.155" DIA. +.000 -.005 (DISC, DETAILS ON RIGHT)
DRILL #25
DRILL #17
ILL #17
STEAM OUT
CUP WASHER DETAILS
MATERIAL: BRASS
0.05"
0.50"
.625" DIA.
1.125" DIA.
C/S ROTATED
.475"
.40"
.875"
DRILL #17
DRILL #25
DRILL #17
DRILL 5/16" DIA.
DISC DETAILS
MATERIAL: BRASS
.031"
.56"
2.155" DIA.
NOTE:
STEAM VALVE IS STD. SILENT CHECK VALVE MUELLER # 203 BP, 1" THREADED ENDS BRONZE BODY. ONLY CHANGES ARE ELABORATED
DO NOT SCALE THIS DRAWING.
TOLERANCES UNLESS OTHERWISE NOTED
FRACTIONAL ± 1/64 DECIMAL ± .005 ANGULAR ± 1/2°
NAME: STEAM VALVE, SOL. PUMP
MATERIAL: AS ABOVE
REV. BY DATE
DRN. 7-29-77
CHK.
APP.
PROJ. SOL. PUMP
SCALE NONE
Revisions
CALMAC MFG. CORP
Englewood, N.J.
B-S120



1 FOLDOUT FRAME



BILL OF MATERIAL

ITEM	QTY.	MATERIAL
1	1	22-QTS PRESSURE COOKER, MIRRO-MATIC DELUXE TYPE, PT. NO. M-0528, AL. ALLOY CONSTRUCTION
2	1	METAL CONTAINER, #304 SS
3	1	PRESS. COOKER GASKET
4	4	AL BOSS (WELD TO COOKER)
5	1	SET CORK INSULATION, ¼" THK.
6	1	XENTEX FLOAT, ¾" THK, 8½" DIA
7	1	½" ID COPPER TUBE ASS'LY
8	1	1½" X CLOSE NIPPLE (GALV)
9	1	1" X NIPPLE (GALV)
10	1	1" X CLOSE NIPPLE (GALV)
11	1	¾" X CLOSE NIPPLE (GALV)
12	1	1½" SILENT CHECK VALVE #203BP, BRONZE BODY, SCREW ENDS (MUELLER)
13	1	1" CHECK VALVE (FOR SUPPLY LIQUID FROM PUMP)
14	1	¾" CHECK VALVE (FOR MAKEUP LIQUID TO SOL. COLL.)
15	1	1" SILENT CHECK VALVE #203BP, BRONZE BODY, SCREW ENDS (MUELLER)
16	1	1½ x 90° ELBOW (GALV.)
17	1	1" x 90° ELBOW (GALV.)
18	1	NUT, SPECIAL FOR 1" MPT

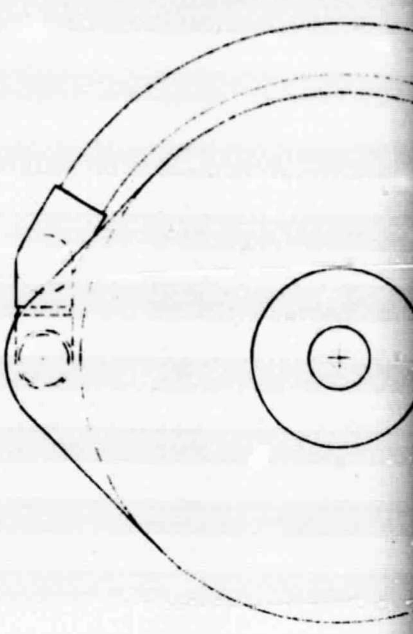
FOLDOUT FRAME 2

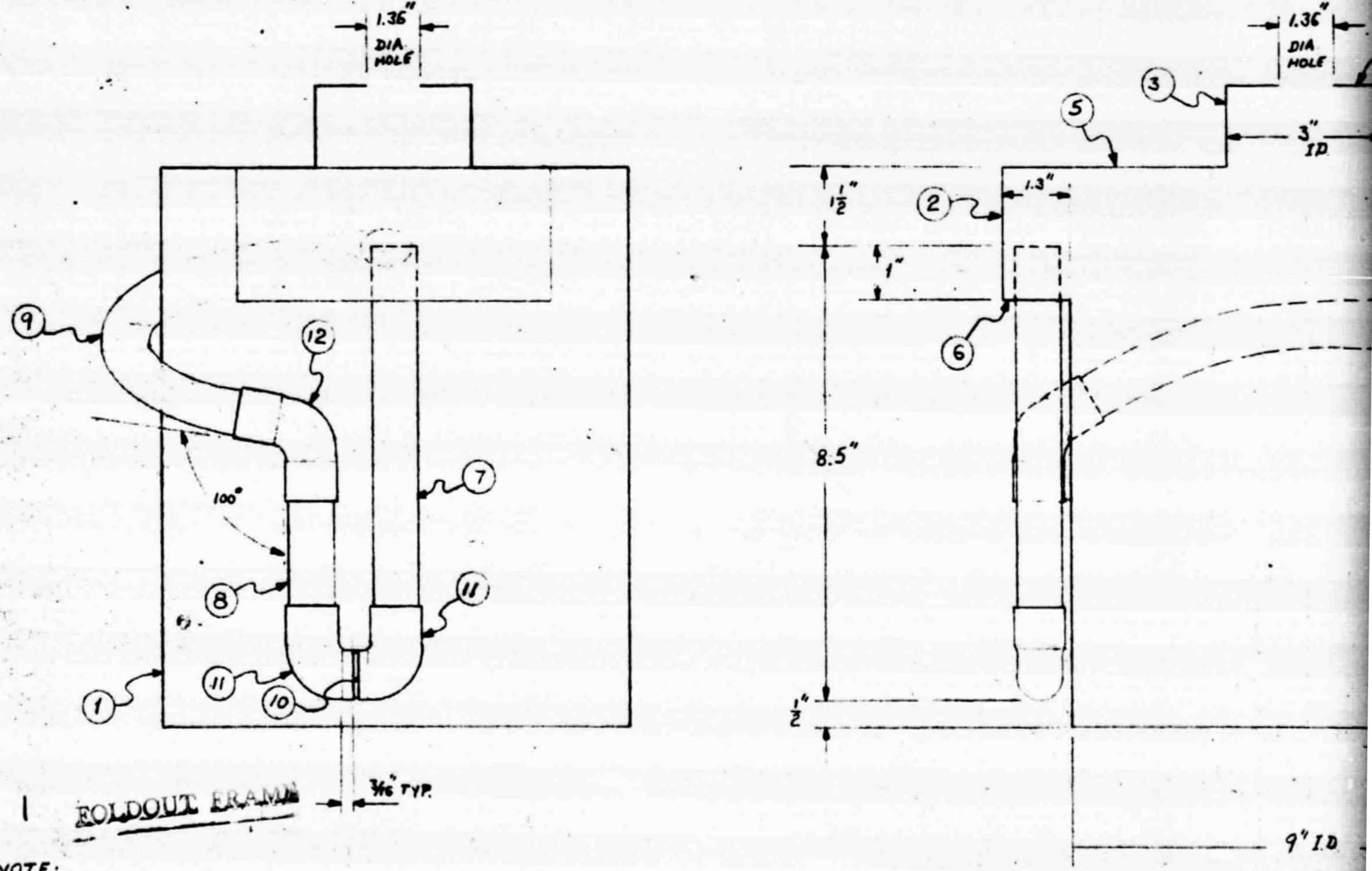
Rev	By	Date	Revisions
B	L	1/20/77	ITEMS 6, 12 & 15 CHANGED
A	L	2/22/77	METAL CONT SHAPE REVISED

TOLERANCES: FRACTIONAL ± 1/64; DECIMALS ± .005; ANGLES ± 1/2°

TITLE	SOLAR PUMP	Tool No.	DRN. 12-30-76	CALMAC MFG. CORP.
			CHK.	Englewood, N. J.
MATERIAL	AS SPEC.	Blank Size	PROJ. SOL. ENGY	C158P-[illegible]
			SCALE HALF	

BILL OF MATERIAL		
ITEM	QTY.	MATERIAL
1	1	304 STAINLESS STEEL, 16GA. DWG #BS117
2	1	" " " " DWG. #BS117
3	1	" " " " DWG. #BS117
4	1	" " " " DWG. #BS117
5	1	" " " " DWG. #BS117
6	1	" " " " DWG. #BS117
7	7 1/2" LG.	1" COPPER TUBE TYPE 'L' STD. ITEM
8	3 5/8" LG.	1" " " " " " "
9	18 1/2" LG.	1" " " " " " "
10	5/16" LG.	1" " " " " " "
11	2	1" COPPER 90° ELBOW (ONE CUT SHORT) STD. ITEM
12	1	1" " " " (OPEN TO 100°) " "
13		



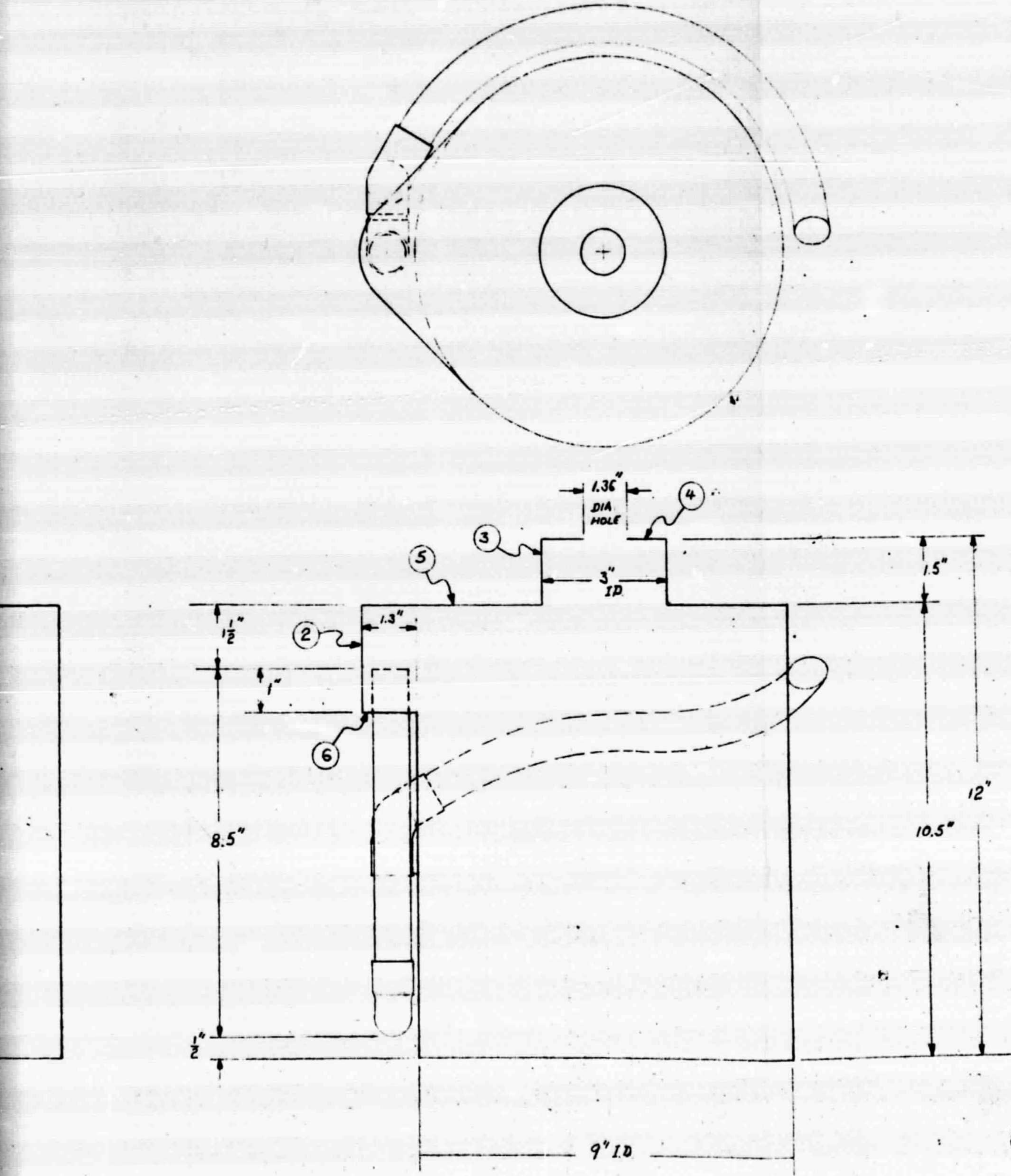


FOLDOUT FRAME

NOTE:

- CYLINDER STAINLESS STEEL PARTS ARE WELDED TOGETHER USING S.S. WELDING RODS.
- COPPER TUBE ASSEMBLY IS SILVER SOLDERED TO CYLINDER.
- COPPER TUBE ASS'LY PARTS ARE SOLDERED TOGETHER
- CYLINDER AND DOWN LEG OF COPPER TUBE ASSEMBLY IS INSULATED ALL SIDES WITH 1/4" THK. CORK INSULATION
- USE 3M'S RUBBER ADHESIVE # 1300. FOR BONDING CORK TO METAL PARTS
- CORK IS COMPLETELY COATED WITH WATER PROOF, CRAFT HEAT RESISTANT SEALENT #40
- FOR CORK BLANK SIZES REFER DWG. # CS121

TOLER...
TITLE INA...
MATERIAL



FOLDOUT FRAME

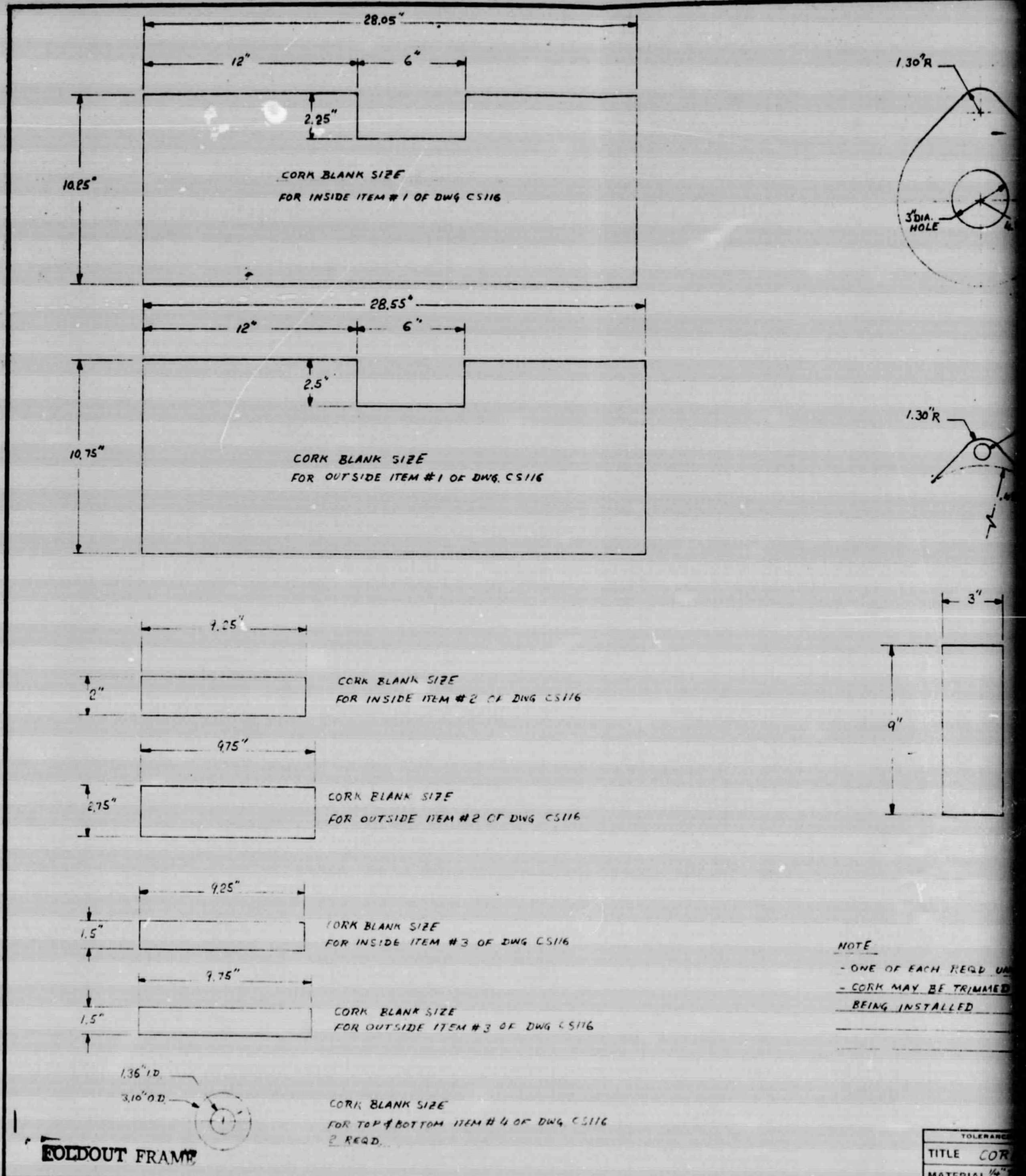
- USE 3M'S RUBBER ADHESIVE # 1300 FOR BONDING CORK TO METAL PARTS
- CORK IS COMPLETELY COATED WITH WATER PROOF, CRAFT HEAT RESISTANT SEALENT #40
- FOR CORK BLANK SIZES REFER DWG. # CS121

TOLERANCES: FRACTIONAL ± 1/64, DECIMALS ± .005; ANGLES ± 1/2°		DRN. 7-26-77
TITLE INNER CYLINDER, SOLAR PUMP	Tool No.	CHK.
MATERIAL AS SPEC.	Blank Size	PROJ. SOLAR PUMP
		SCALE HALF

Rev | By | Date | Revisions

CALMAC MFG. CORP. Englewood, N.J.

CS116



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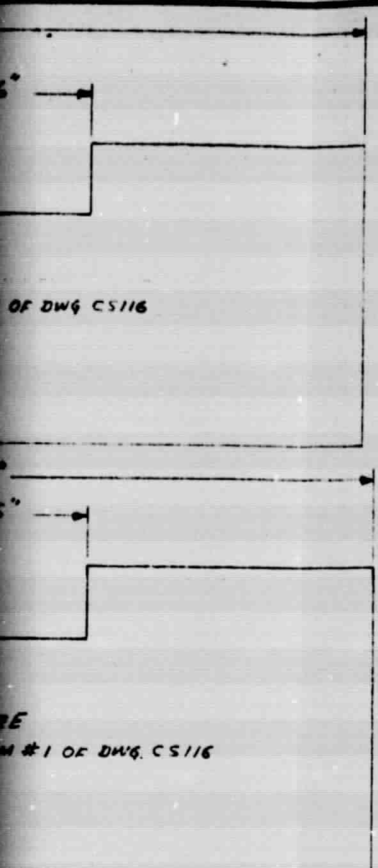


OF DWG CS116

...ZE
...M #1 OF DWG. CS116

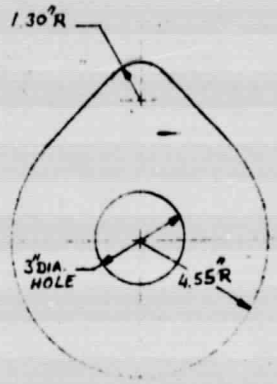
...K SIZE
...F ITEM #2 OF DWG CS116

... SIZE
...E ITEM #2 OF DWG CS116

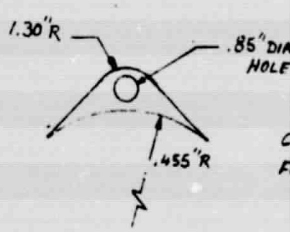
...SIZE
...ITEM #3 OF DWG CS116

...K SIZE
...DE ITEM #3 OF DWG CS116

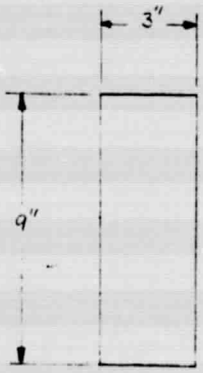
... SIZE
...TTOM ITEM #4 OF DWG CS116



CORK BLANK SIZE
FOR TOP & BOTTOM OF ITEM 5 OF DWG # CS116
2 REQD.



CORK BLANK SIZE
FOR TOP OF ITEM 6 OF DWG. # CS116



CORK BLANK SIZE
FOR AROUND ITEM 7 & 11 OF DWG. # CS116

NOTE
- ONE OF EACH REQD UNLESS OTHERWISE NOTED
- CORK MAY BE TRIMMED TO SIZE TO FIT WHEN
BEING INSTALLED

2

FOLDOUT FRAME

Rev	By	Date	Revisions

TOLERANCES. FRACTIONAL ± 1/64, DECIMALS ± .005, ANGLES ± 1/2°

TITLE CORK INS'N FOR INNER CYL.	Tool No.	DRN. 7-29-77	CALMAC MFG. CORP. Englewood, N. J.
MATERIAL 1/4" THK CORK, # 2-124, H.D. PROTEIN BINDER, ASTM # D1170	Blank Size	CHK.	
		PROJ SOL. PUMP	C S121
		SCALE 1/4" = 1"	

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