Final Report
Task Order H-30186D to BOA NAS8-97092

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June 17, 1999

1. DOCUMENTS

Included in Appendix I to this report is a complete set of design and assembly schematics for the high vacuum inner trap assembly, cryostat interfaces and electronic components for the MSFC HiPAT. Certain components were acquired from external vendors; otherwise, all fabrication and assembly of the assembly was done in the Department of Physics Machine and Electronics Shops. Testing of the assembly was carried out by Senior Scientist Raymond A. Lewis, NASA GSRP graduate student Kirby Meyer, and Engineer John Passaneau. Results of those tests are described in the next sections.

2. SUMMARY OF TESTS DONE UPON COMPLETION OF ASSEMBLY

(a) Vacuum Tests

(a.1) Vacuum chamber construction

Figure 1 shows the structure of the vacuum assembly, which encloses the HiPAT trap electrodes. The central vacuum pipe is connected by bellows to custom conflat flanges, which are sealed with annealed copper gaskets. The bellows are required to reduce heat flow from the room temperature outside to the 4.5 K region surrounding the central pipe.

The conflat flanges on the bellows mate with hybrid 8 inch flanges, which connect to nipples for external electrical and vacuum connections. The eight inch flanges will eventually be bolted to the HiPAT cryostat, with rubber O-ring vacuum seals. For tests of the inner vacuum, the cryostat was replaced by a set of six 1/4-20 threaded rods for mechanical rigidity.

(a.2) Vacuum assembly test results

The vacuum system was assembled, and transported to SpectruMedix Corp. of State College, PA for testing. The tests were carried out with the help of Mr. Bob Burfield, using a Veeco helium leak detector.

Initially, the vacuum was not good enough to make credible measurements. At the advice of Mr. Burfield, the flanges were disassembled in the field, and the 10-32 bolts in the hydrid flanges were shortened by 0.25 inches. Upon reassembly, it was found that the bellows which mate with the hybrid 8 inch flanges were vacuum-tight (at a rate <1.E-8 atm-cc/sec leak rate).

However, the 2.75 and 5.4 inch hydrid gaskets still leaked at a rate of 1.E-7 atm-cc/sec, even after their bolts had been shortened. The system was transported back to Penn State University for further investigations.

Before disassembling, the assembly was arranged with its axis vertical, and filled with Alconox and warm water overnight. Further cleaning, advised by Mr. Burfield, included a second fill of Alconox and warm water, followed by clear water and distilled water rinses. The vacuum system was turned horizontally, and cleaned with ethanol. A residue of iron filings was found when the flanges were unbolted.

The source of the leaking hydrid flanges was traced to an error in placement of knife edges. According to Mr. R. McKuhn of Lesker's, the knife edge should be near the inside edge of the copper gasket, for a seal with bolts inside the gasket. The knife edges on both the 2.75 and 4.5 inch parts of the hybrid flanges were found to be placed near the outside edge of the copper gaskets.

The knife edges on the hydrid flanges were machined off, and replaced with knife edges of the proper diameters. The vacuum system was reassembled, and returned to SpectruMedix Corp. for testing. The 4.5 inch hydrid seal was was found to be leak-tight, at a rate < 1.E-9 atm-cc/sec. A piece of masking tape inadvertently left on the 2.75 inch hybrid seal explained a leak rate of 1.E-7 atm-cc/sec leak. The downstream part of the vacuum system was disassembled in the field, and the tape was removed. After reassembly, the leak rate in the 2.75 inch hybrid seal was reduced to 3.E-8 atm-cc/sec.

(a.3) Summary of vacuum tests

The sealing of the vacuum system is sufficient for its intended use in HiPAT, where it is enclosed by the cryostat outer vacuum system. The vacuum will permit use of the UHV portion of the system stand-alone. This permits more flexibility in baking, which is easier to perform before inserting the trap into the cryostat.

(b) Electronics Tests

(b.1) Arrangement for high voltage tests

The macor rings, 0-8 threaded rods, and the six cylindrical electrodes were cleaned and assembled. A piece of 30 gauge enamel-coated copper wire was affixed to one of the electrodes with a 0-80 gauge bolt. The wire was threaded through holes in the macor rings. The two 8 inch flanges on the ends of the HiPAT vacuum pipe were removed, and the electrode assembly inserted.

One of the 2.75 inch conflat flanges was used to mount a 40 KV high voltage feedthrough. The 30 gauge wire was attached to the feedthrough. Continuity was checked using an ohmmeter, with a probe to reach the electrodes inside the vacuum pipe.

(b.2) High voltage test results

The first tests were performed in air, with the 8 inch flanges removed to allow for visual observations. The Power Designs power supply was connected to an ammeter and a high voltage 1 Mohm current-limiting resistor. Except for the final connection to the 1/4-20 bolt on the 40 KV feedthrough, SHV connections were used throughout. No corona discharge was observed, and no current (<0.01 mA) was observed when the supply was raised to 2 KV.

Tests at higher voltage were made, using nitrogen gas to allow for higher breakdown conditions. The 8 inch flanges were replaced (using the old gaskets), and another 2.75 inch flange was connected to a nitrogen feed tube. Nitrogen was flowed through the system from the downstream end, keeping the upstream 8 inch flange loose enough to allow the nitrogen to flow. The system was tested as described above, running the supply to its limit of 3 KV. No leakage current (<0.01 mA) was observed.

To test the system at higher voltage, a Heathkit power supply was used. The power supply was connected diretly to the HV feedthrough, as the meter isolation and SHV cables are limited to 3 KV. No evidence of arcing was detected when the power supply was turned up to 5 KV. No physical evidence for arcing was noted when the electrodes were dismounted after the tests.

(b.3) Results of tests with preamp connected to the electrodes

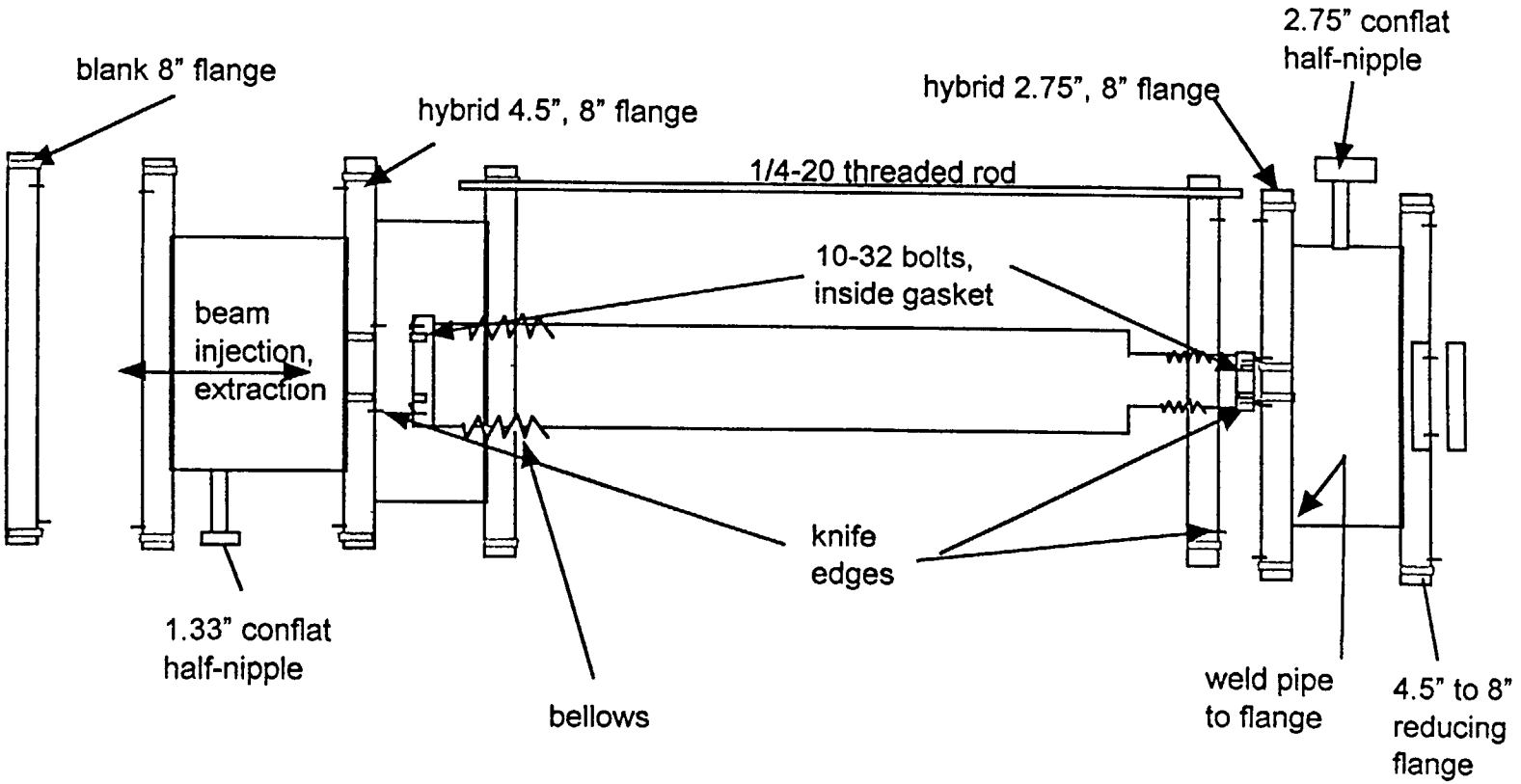
Two of the electrodes inside the vacuum tube were connected to a new GaAs preamp. The preamp was mounted in the downstream section of the vacuum tube, and connected to the outside through a 10 pin, 2 KV high voltage feedthrough. The 40KV feedthrough was disconnected during the preamp tests.

Figure 2 shows a trace of the frequency spectrum obtained when the preamp was turned on. The Johnson noise peak appears at 38 MHz (upper trace), implying that the inter-electrode capacitance is about 10 pf. To verify the authenticity of the Johnson noise peak, the preamp was operated outside the vacuum tube, allowing a brass rod to be inserted into the nominal 4 microhenry inductance coil. The middle trace shows that the Johnson noise peak shifts upward significantly in frequency, as expected for a diamagnetic brass rod. The lower trace shows that no significant structure appears at 38 MHz with the preamp turned off.

(b.4) Summary of high voltage and preamp tests

Application of up to 5 KV on the electrodes indicated no evidence of discharge or currrent leakage. Preamp response to Johnson noise signals is large and responsive to circut changes as expected. All systems appear to be operating as designed.

HiPAT Vacuum System



June 27, 1999
RAL

Figure 1

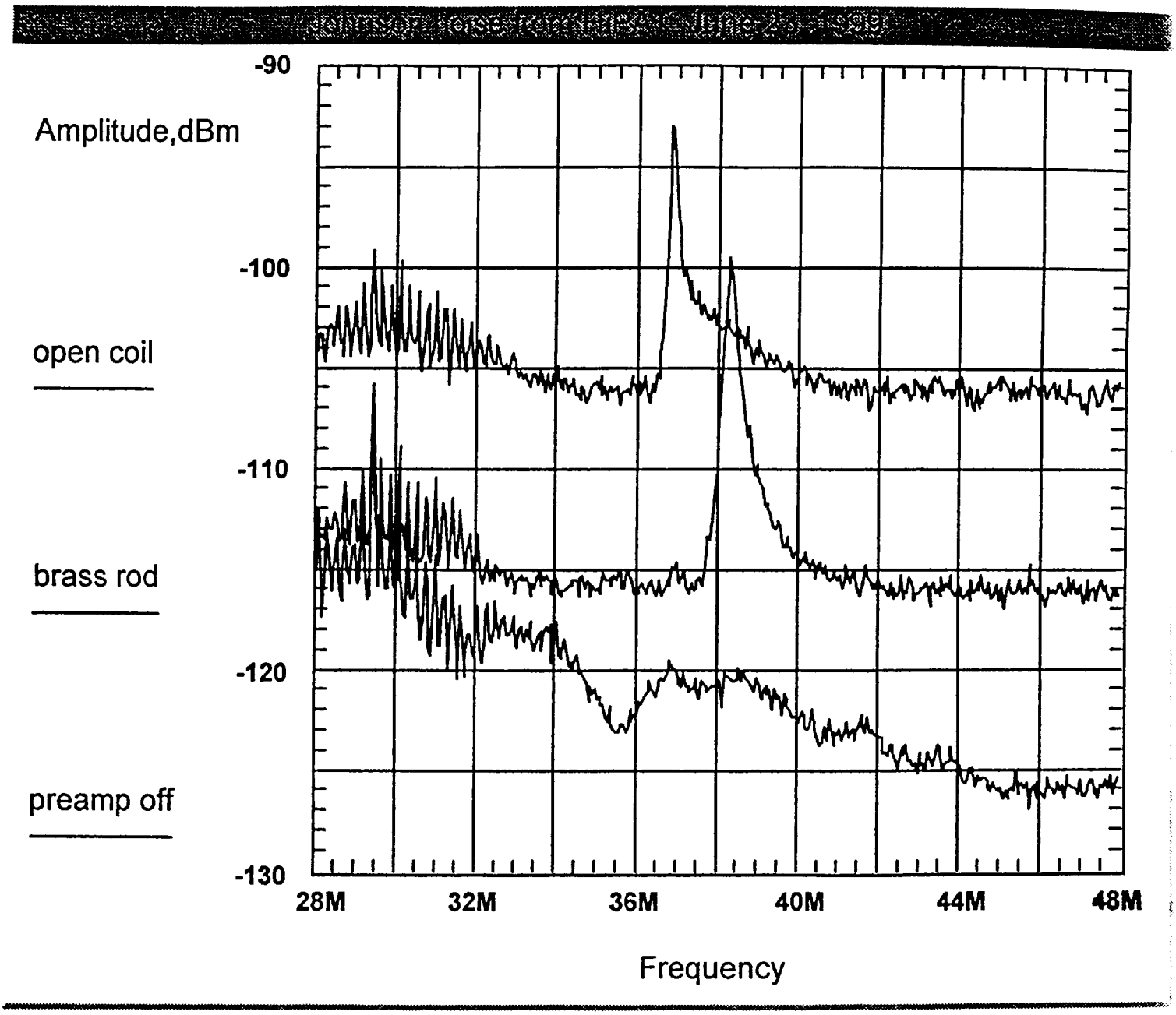
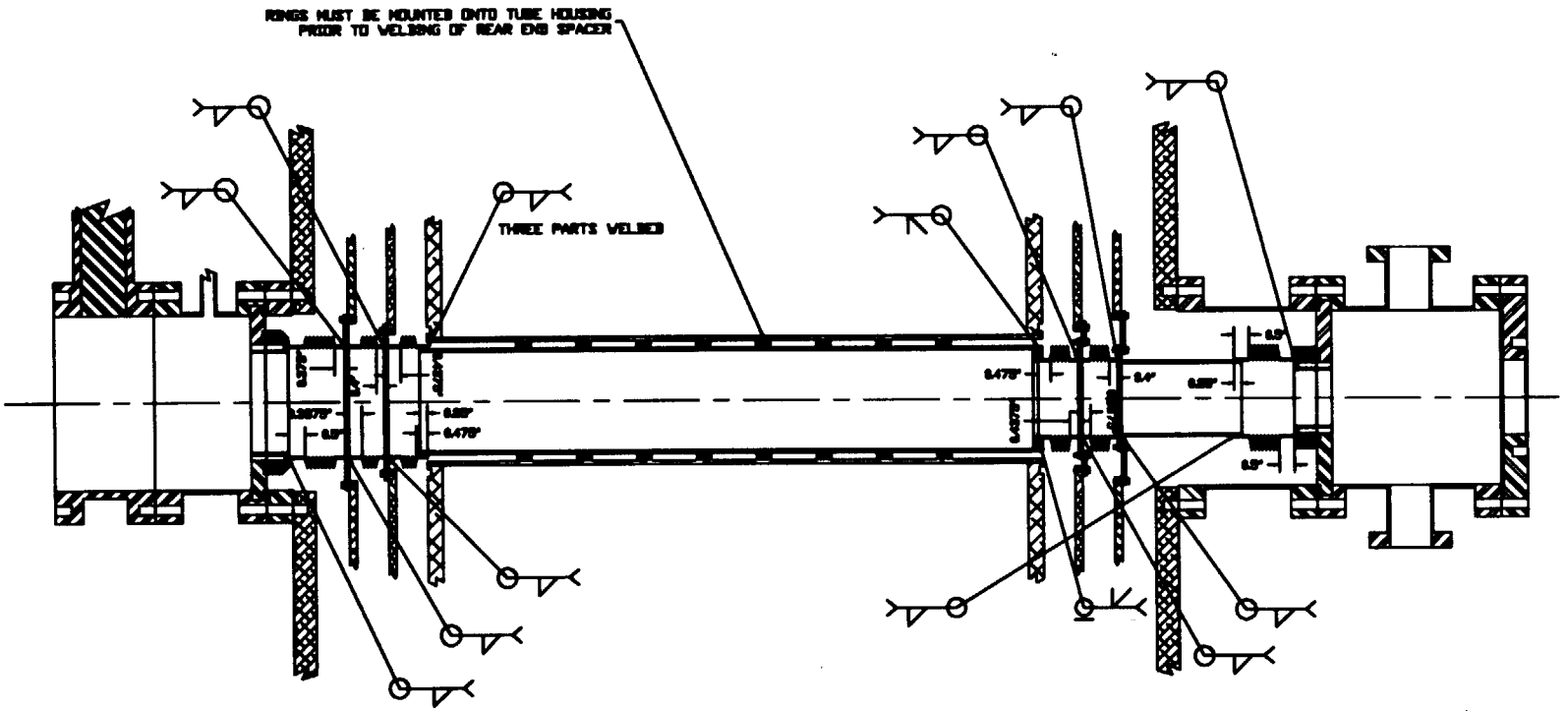

-90
Amplitude,dBm
-100
open coil
-110
brass rod
-120
preamp off
-130
28M
32M
36M
40M
44M
48M
Frequency

Figure 2

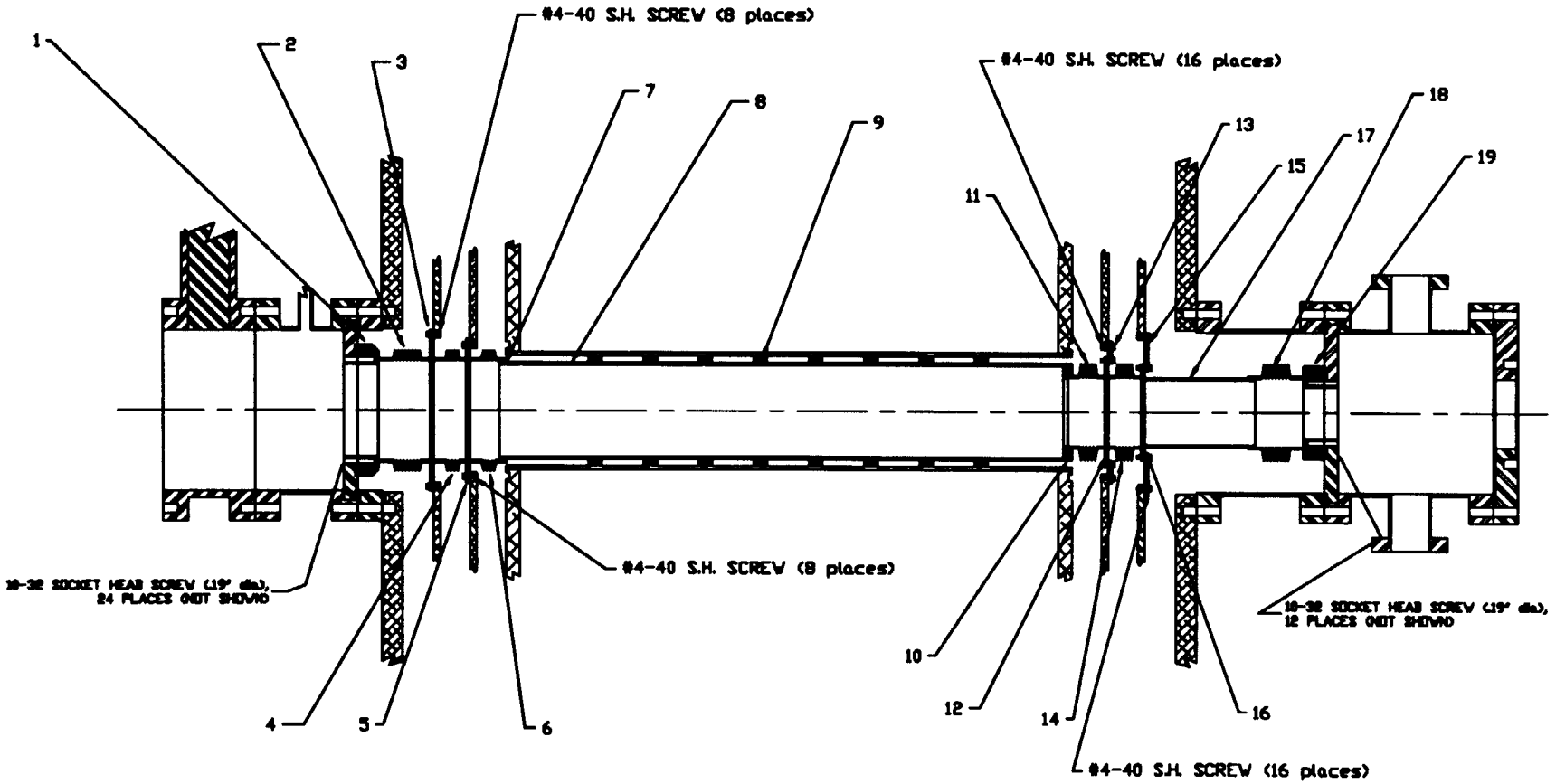
Appendix I



PARTS MUST BE COCENTRIC BEST TOLERANCE ABOUT CENTRAL AXIS
ALL WELDS VACUUM TIGHT

PHYSICS ELECTRONICS SHOP

ASSEMBLY DRAWING

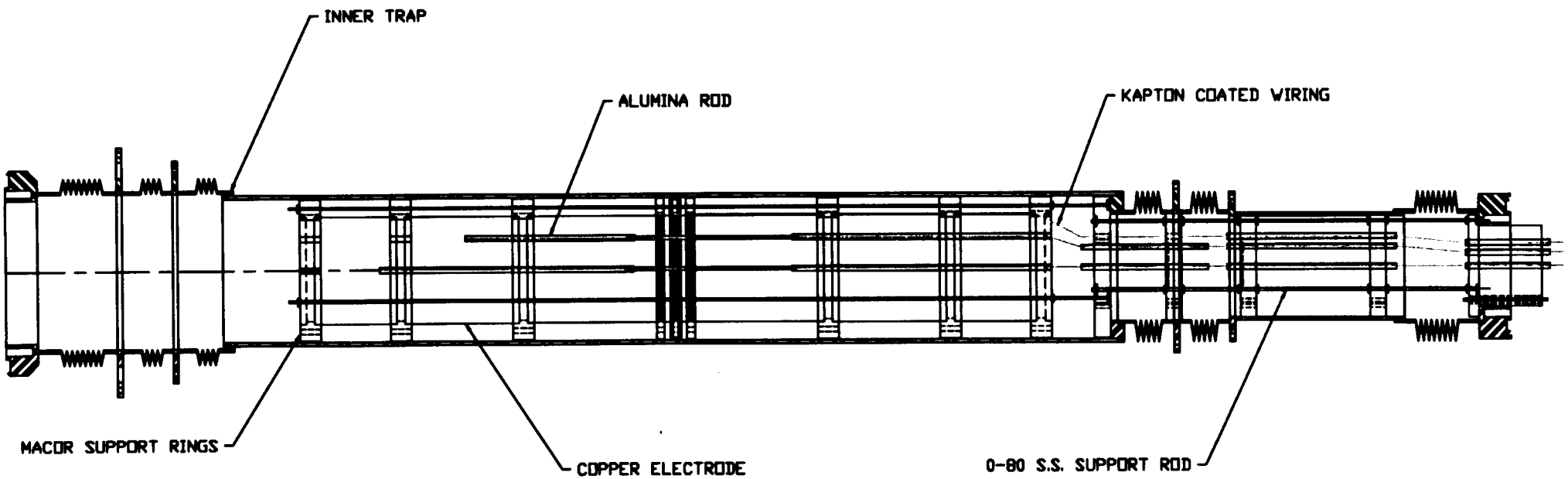


Parts List

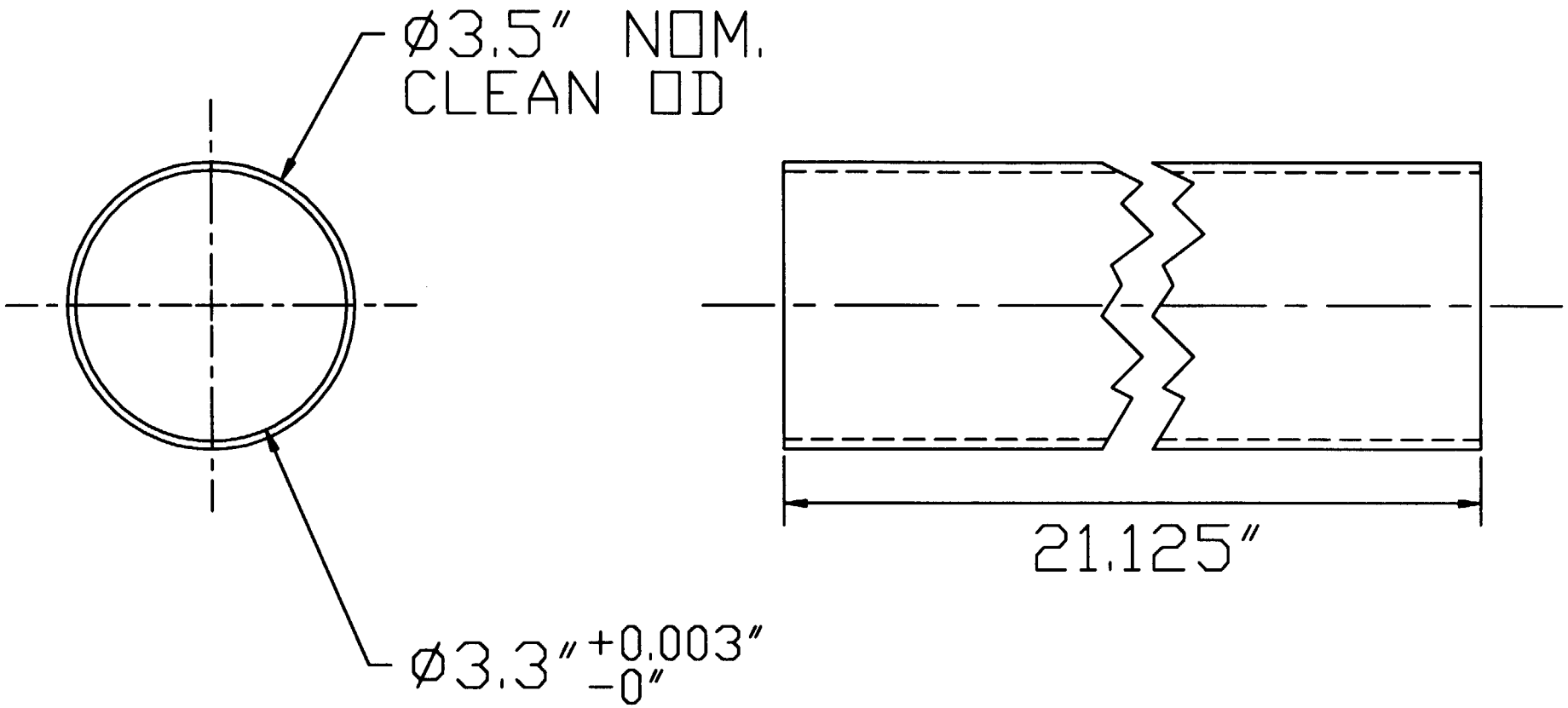
No.	Plan no.	Description	No.	Plan no.	Description
1	02-001	4-3/4" FRONT TRAP MATING FLANGE	11	B-R1	He-20K REAR BELLOW SEGMENT
2	B-F1	WARM FRONT BELLOW SEGMENT	12	03-002	20K REAR THERMAL SHORTING PLATE
3	02-002	77K FRONT THERMAL SHORTING PLATE	13	03-005	20K REAR ANNULUS
4	B-F2	77K-20K FRONT BELLOW SEGMENT	14	B-R2	20K-77K REAR BELLOW SEGMENT
5	02-003	20K FRONT THERMAL SHORTING PLATE	15	03-006	77K REAR ANNULUS (2)
6	B-F3	20K-He FRONT BELLOW SEGMENT	16	03-003	77K REAR THERMAL SHORTING PLATE
7	02-004	FRONT END SPACER	17	03-004	77K-WARM NECKING PIPE
8	01-001	TUBE HOUSING FOR ELECTRODES	18	B-R3	WARM REAR BELLOW SEGMENT
9	01-002	COPPER RING (8)	19	03-007	3-3/4" REAR MATING FLANGE
10	03-001	REAR END STEP PLATE			

PHYSICS ELECTRONICS SHOP

ASSEMBLY DRAWING


INNER TRAP
ALUMINA ROD
KAPTON COATED WIRING
MACOR SUPPORT RINGS
COPPER ELECTRODE
0-80 S.S. SUPPORT ROD

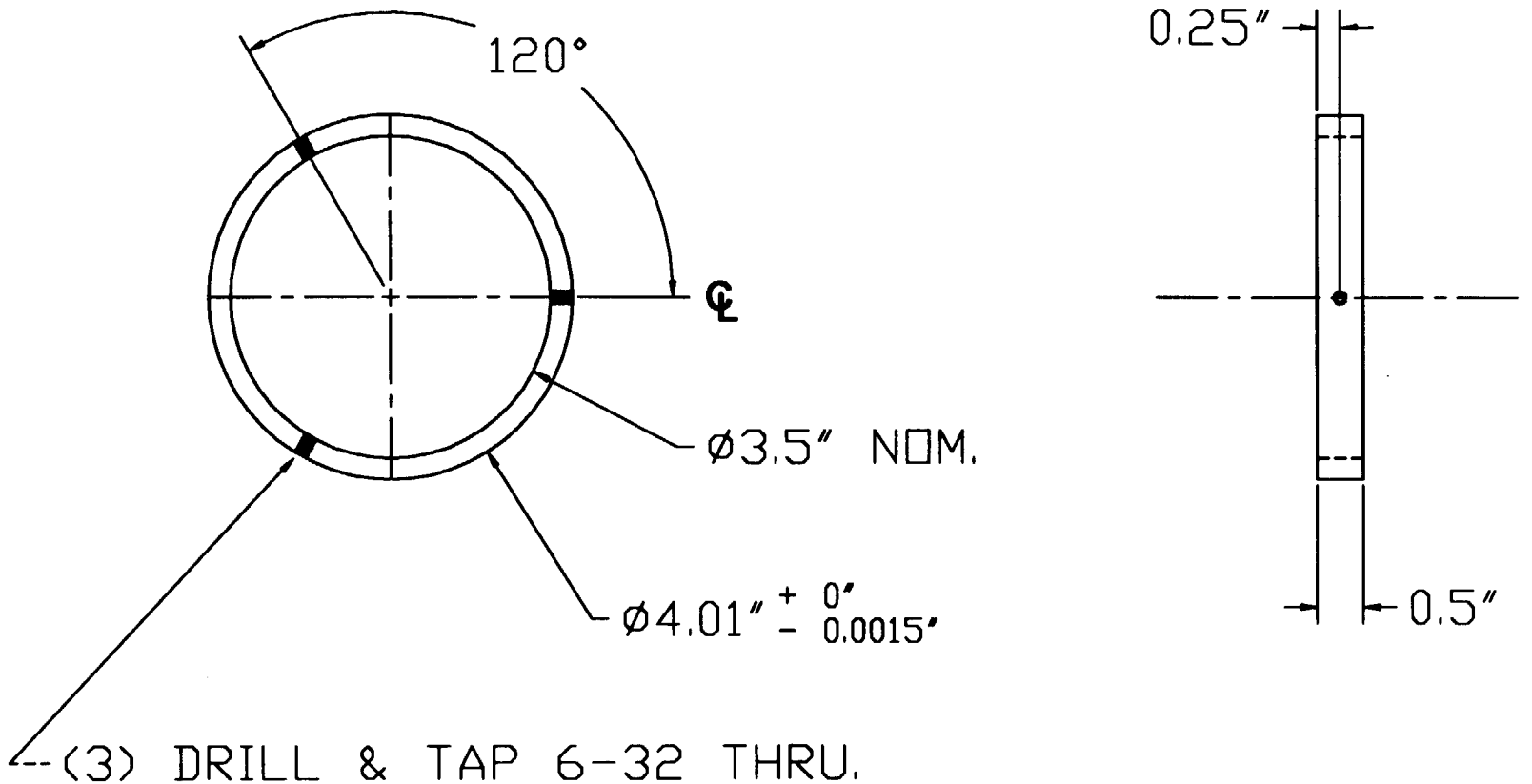
5/20/99
KJM



304 s.s. pipe, 3.5" OD
0.120" thickness

1 REQUIRED

CONTRACT NO.		PHYSICS ELECTRONICS SHOP	
APPROVALS	DATE	TUBE HOUSING FOR ELECTRODES	
DRAWN K. MEYER	2/8/99		
CHECKED			
MFG.			
ENGR.			
REVISION		SIZE A	CODE IDENT NO.
		DRAWING NO. 001-01	REV.
		SCALE NONE	PENN STATE UNIVERSITY
		SHEET 1 OF 1	



MAT. COPPER

8 REQUIRED

CONTRACT NO.		PHYSICS ELECTRONICS SHOP	
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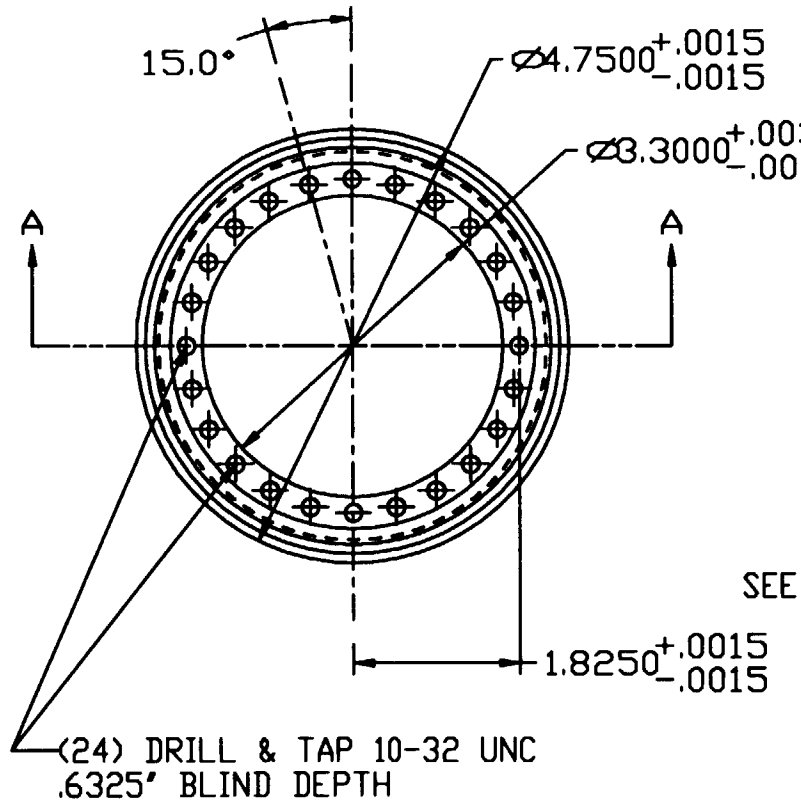
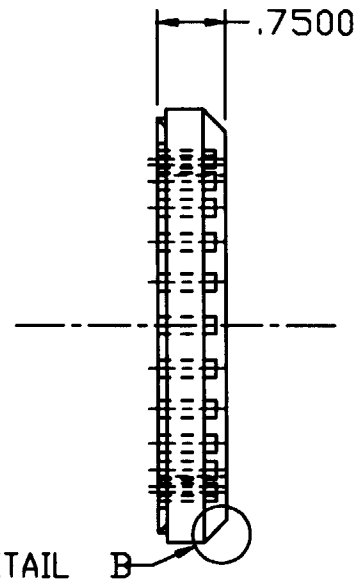
DRAWN K. MEYER	2/1/99		
CHECKED			
MFG.			
ENGR.			
REVISION		SIZE A	CODE IDENT NO.
		DRAWING NO. 001-02	REV.
		SCALE NONE	PENN STATE UNIVERSITY
		SHEET 1 OF 1	





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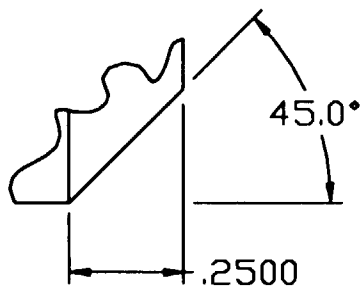

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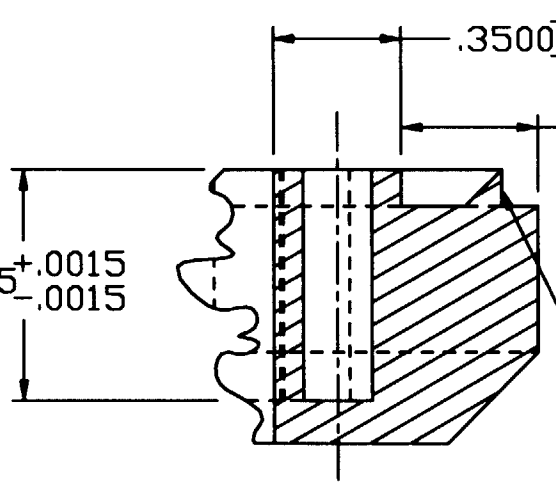
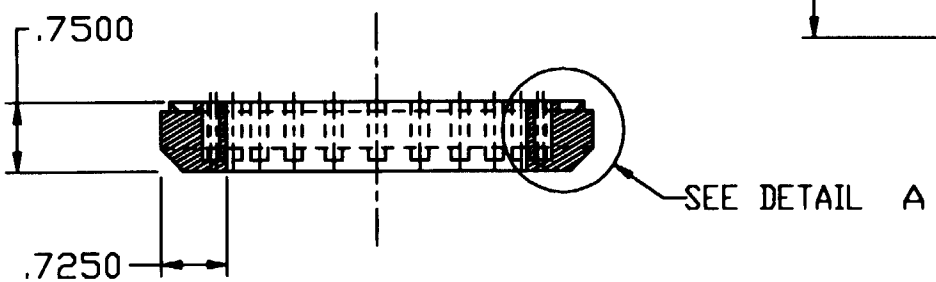
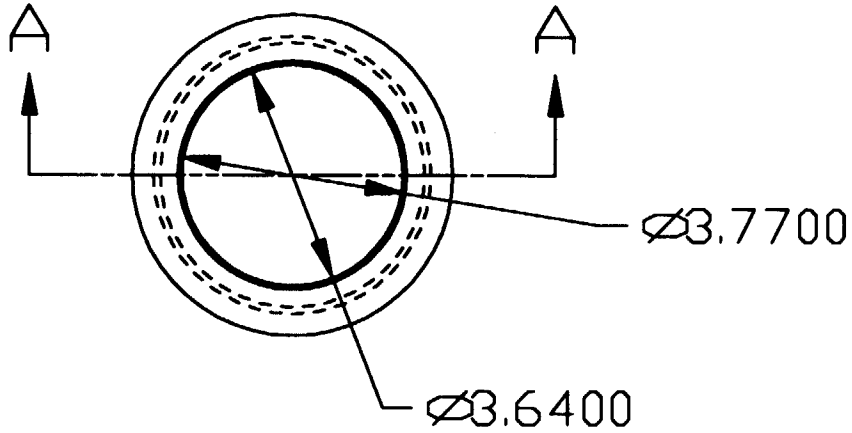
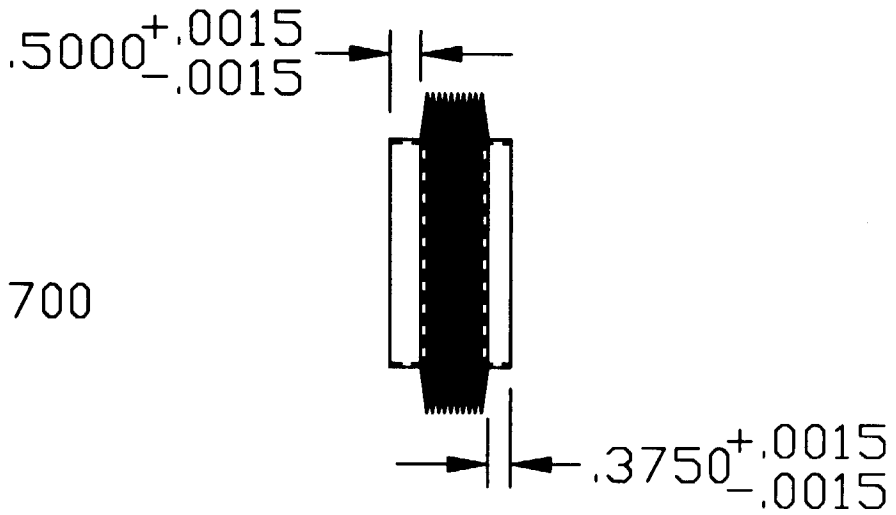


SECTION A-A



MAT'L: STAINLESS STEEL #304	4.75" FRNT TRAP MATE FLNGE
	BRIAN SARSFIELD
DATE 1/28/99	QUANTITY: 1
UNITS: INCHES	





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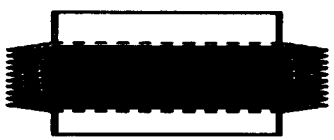

PART: B-F1

LESKER BELLOWS TYPE: MEW4353641E

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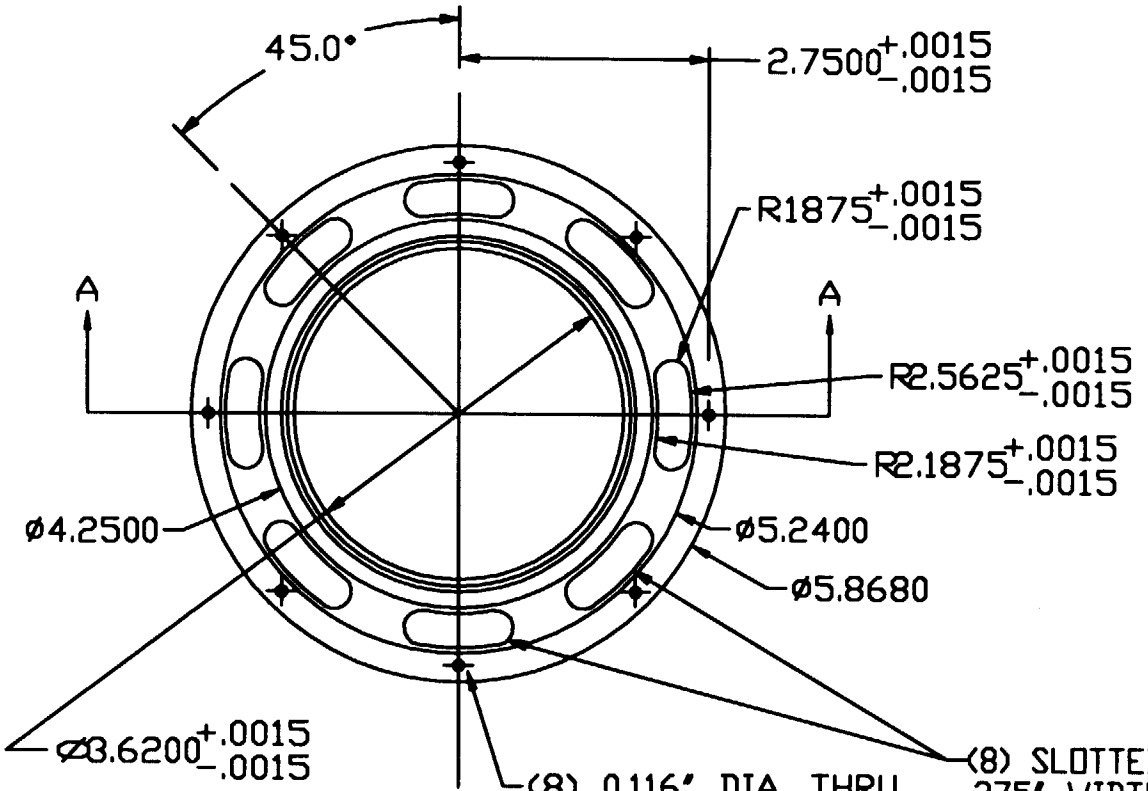
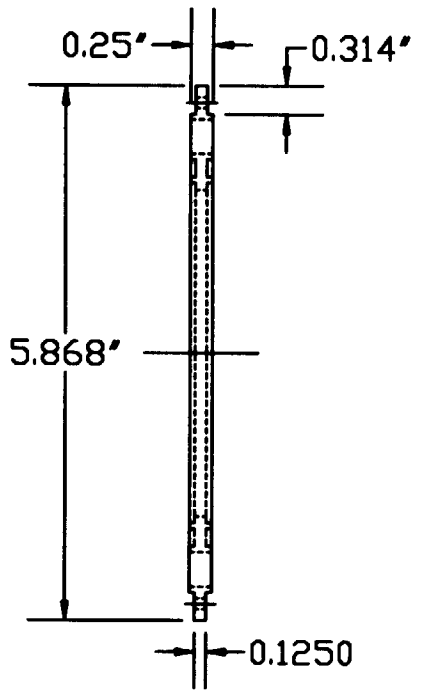
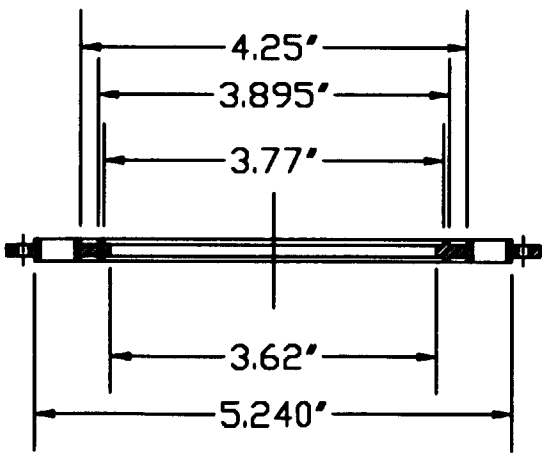
	BRIAN SARSFIELD
DATE: 3/3/99	QUANTITY: 1
UNITS: INCHES	







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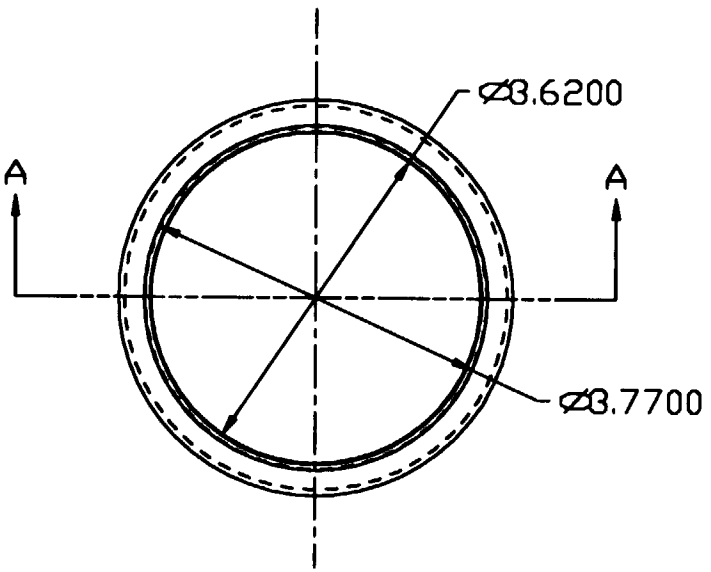

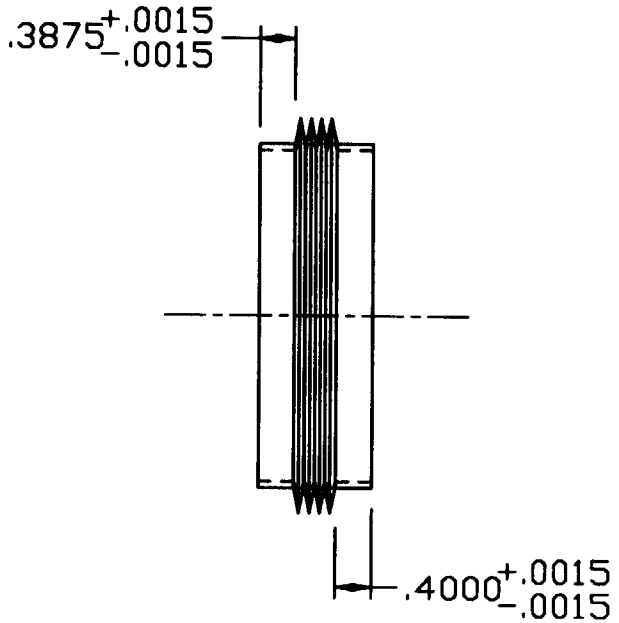

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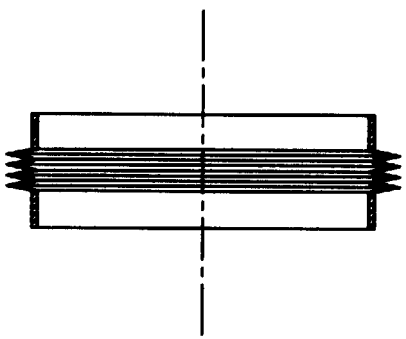

PART: B-F2
LESKER BELLOW TYPE: MEW4353641E

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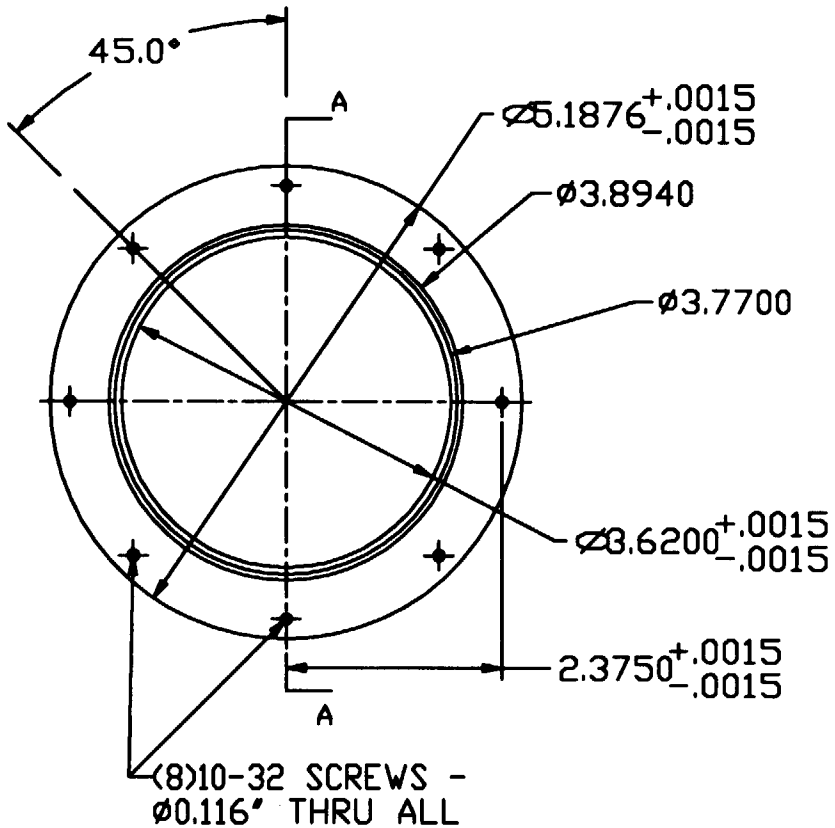
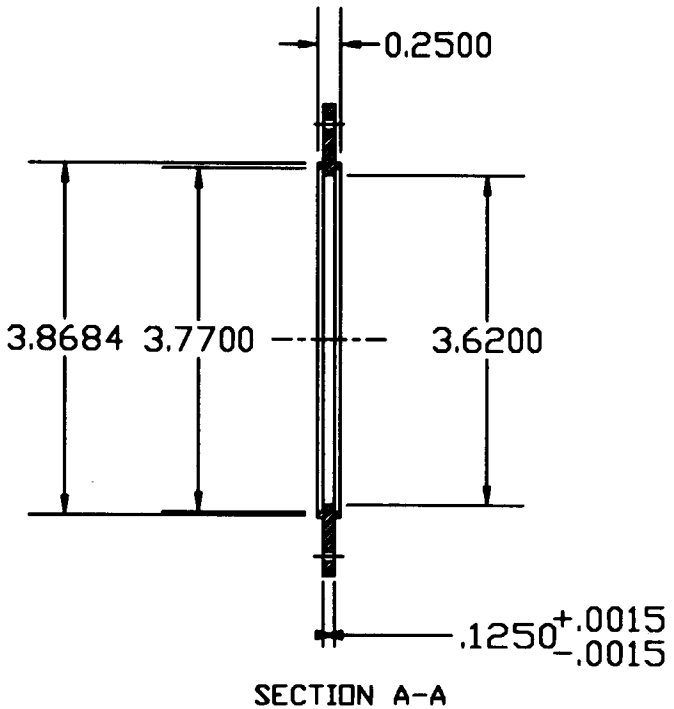
	BRIAN SARSFIELD
Date: 1/12/99 UNITS: INCHES	quantity: 1





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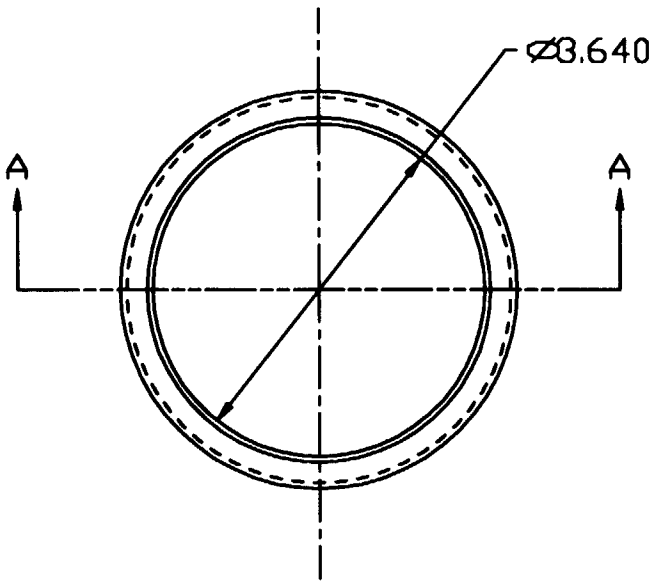

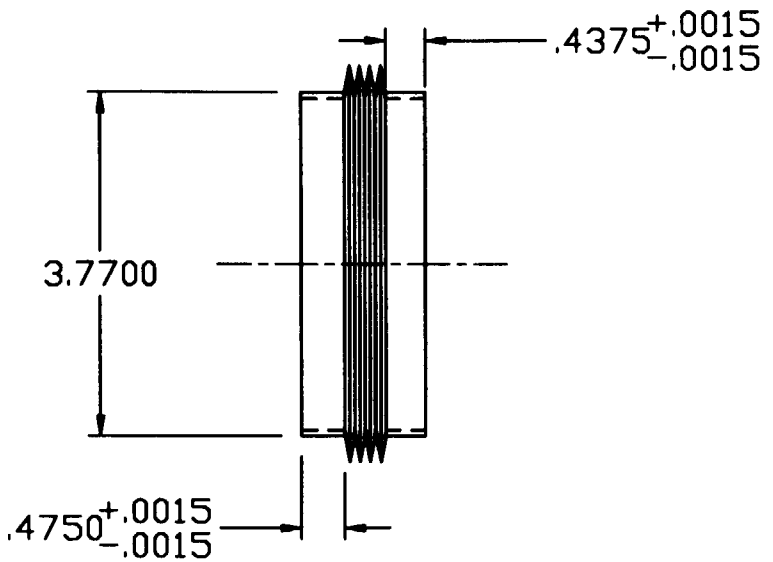

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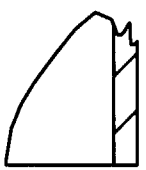

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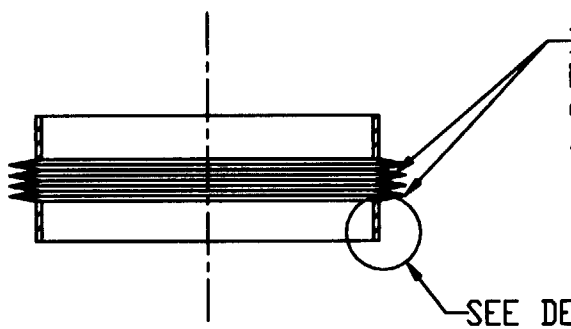
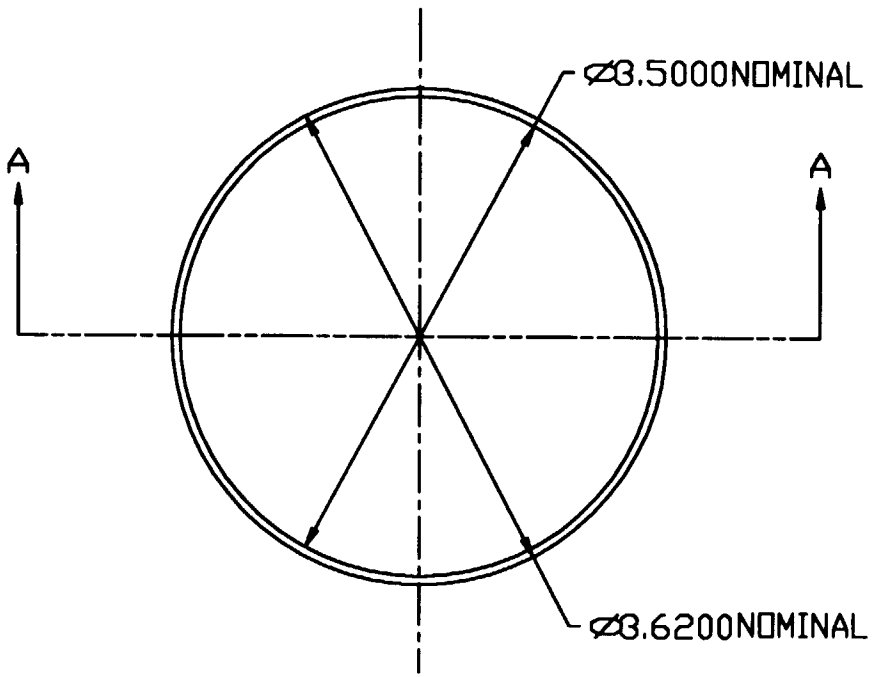
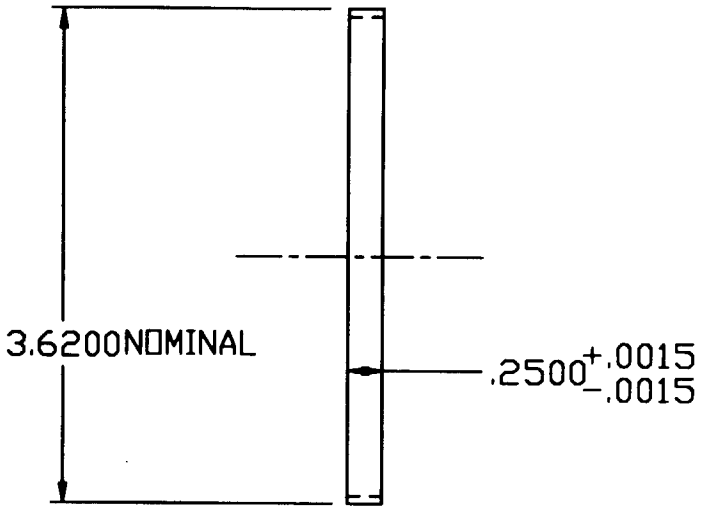


Problems? Call B. Sarsfield @ ext. 5-0066

PART: B-F3
LESKER BELLOW TYPE: MEW4353641E

MAT'L: STAINLESS STEEL #304	20K-HE FRNT BELLOWS SGMNT
	BRIAN SARSFIELD
Date: 1/12/99 UNITS: INCHES	QUANTITY: 1





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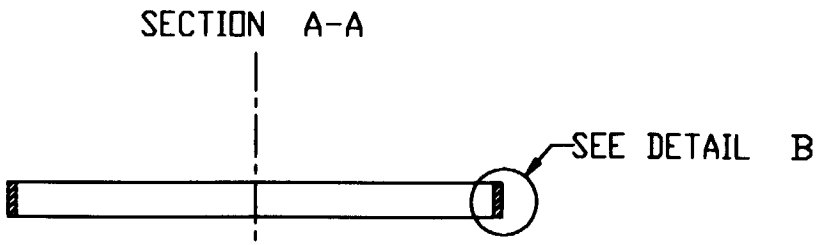
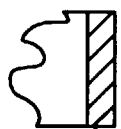
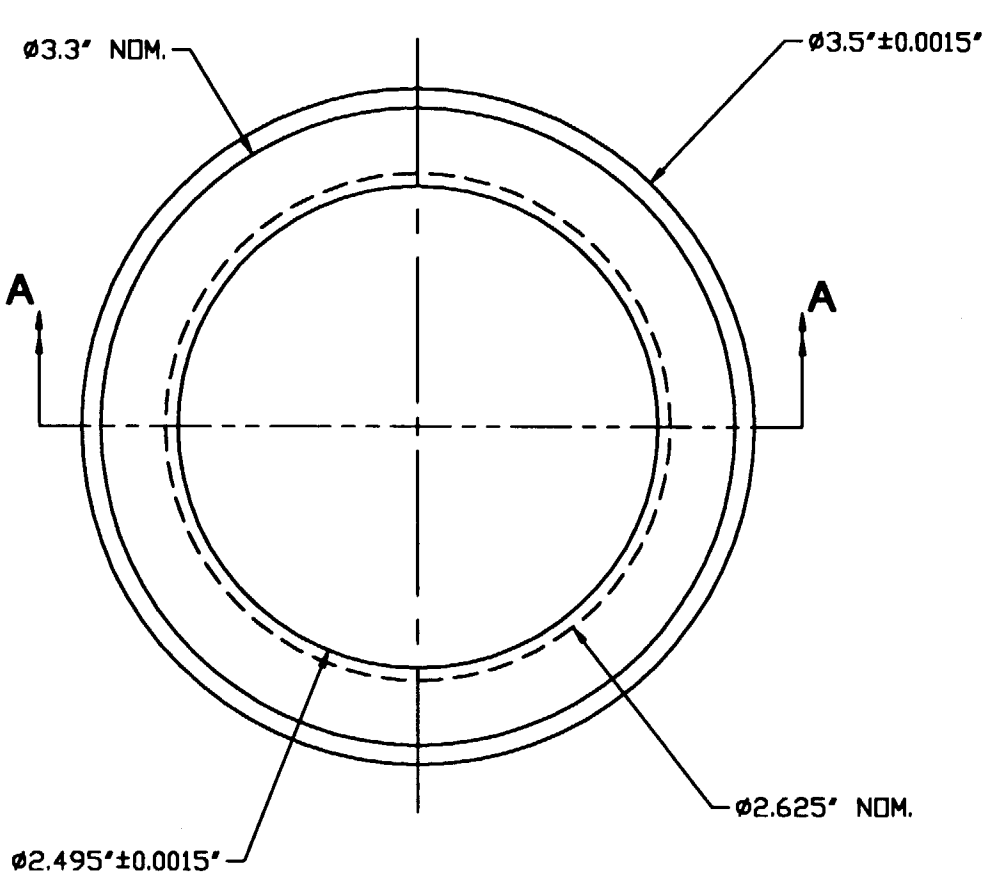
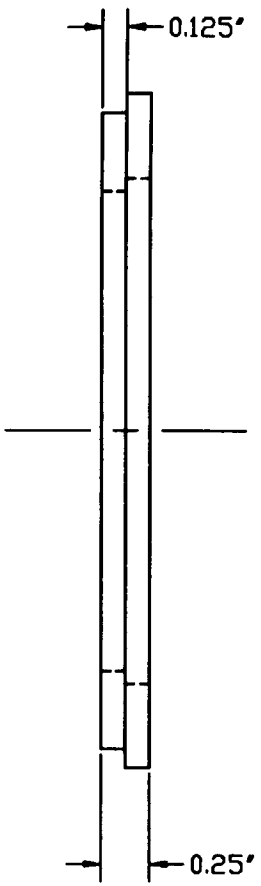




MAT'L: STAINLESS STEEL #304	Front end spacer
	Brian Sarsfield
Date: 1/12/99	quantity: 1
UNITS: INCHES	





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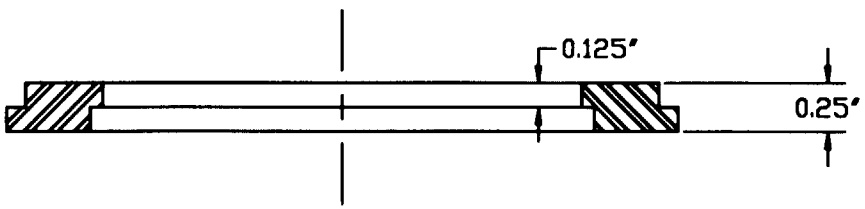
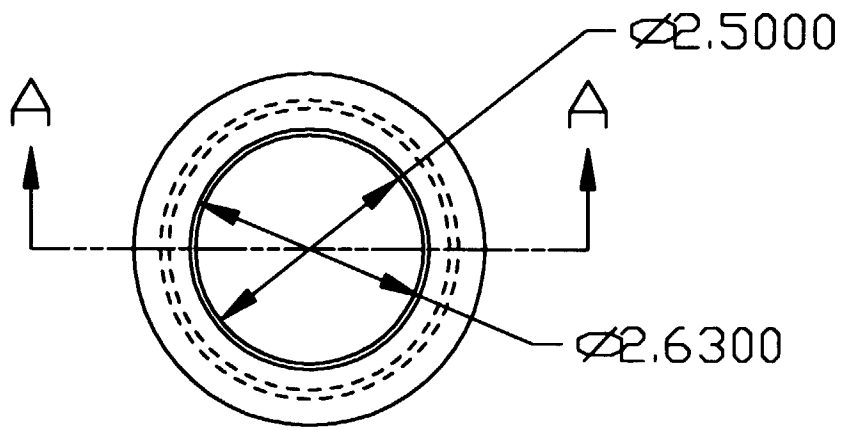
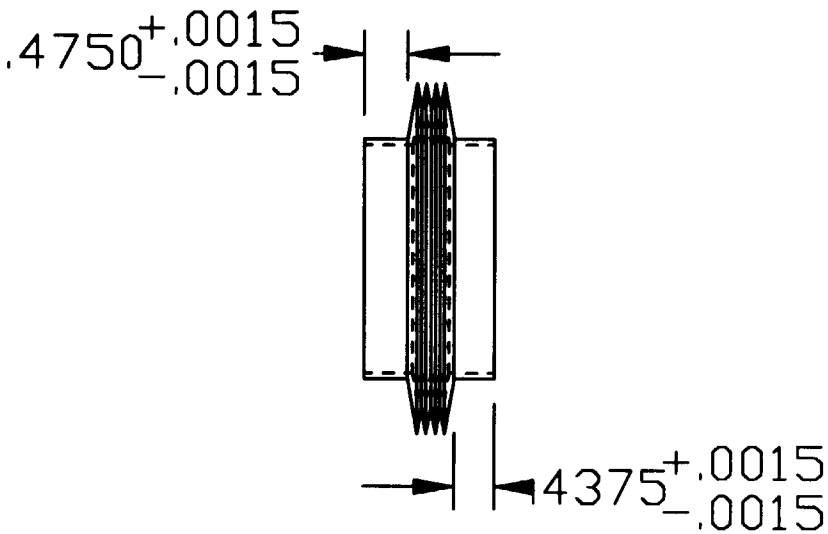


1 REQUIRED

		PHYSICS ELECTRONIC SHOP
S.S. TYPE 304		REAR END STEP PLATE
	C	03-001
	2x	PENN STATE UNIVERSITY





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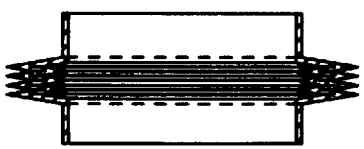

PART:B-R1
LESKER BELLOWS TYPE: MEW3502501E

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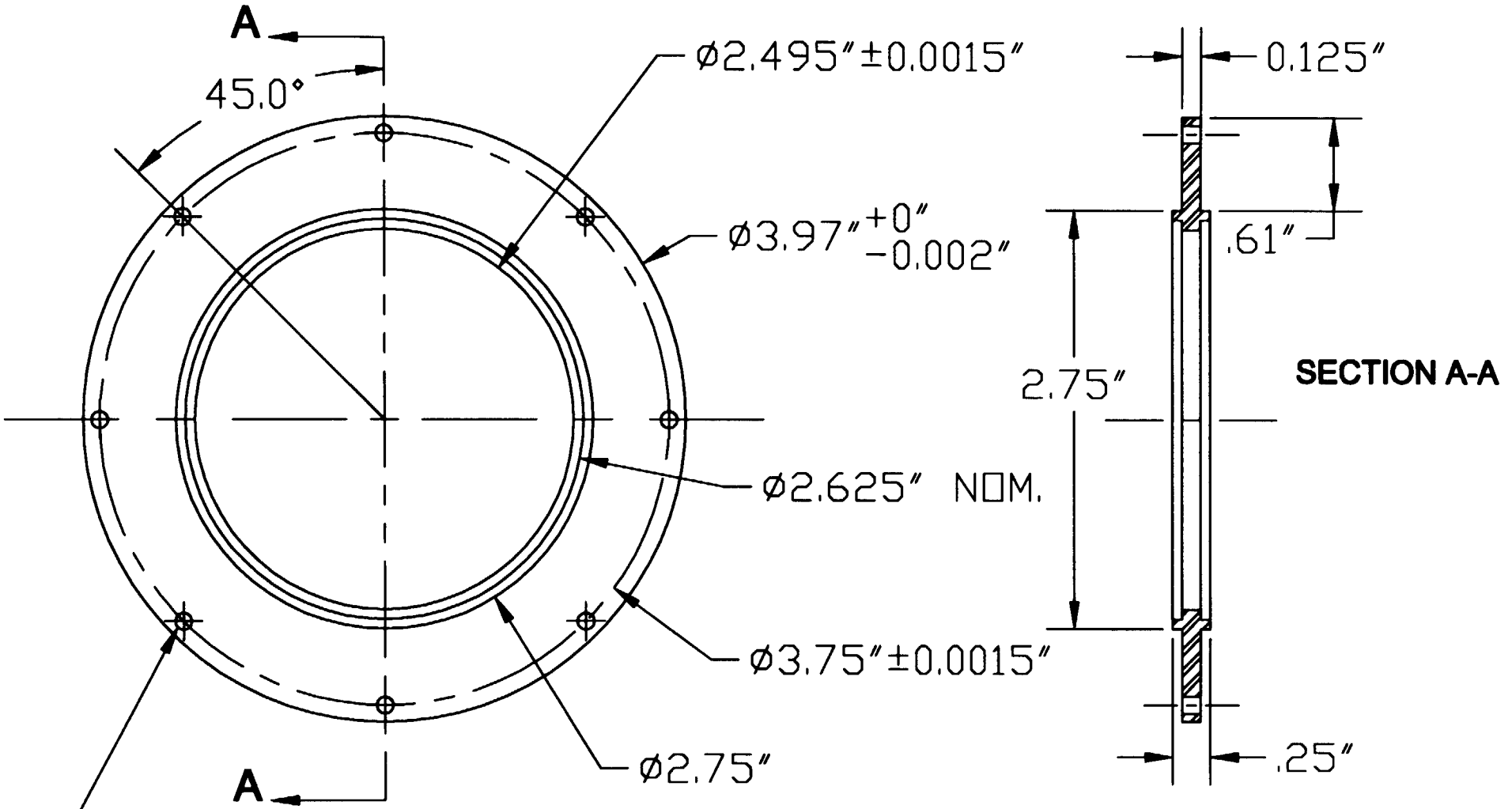
	BRIAN SARSFIELD
DATE: 3/3/99	QUANTITY: 1
UNITS: INCHES	

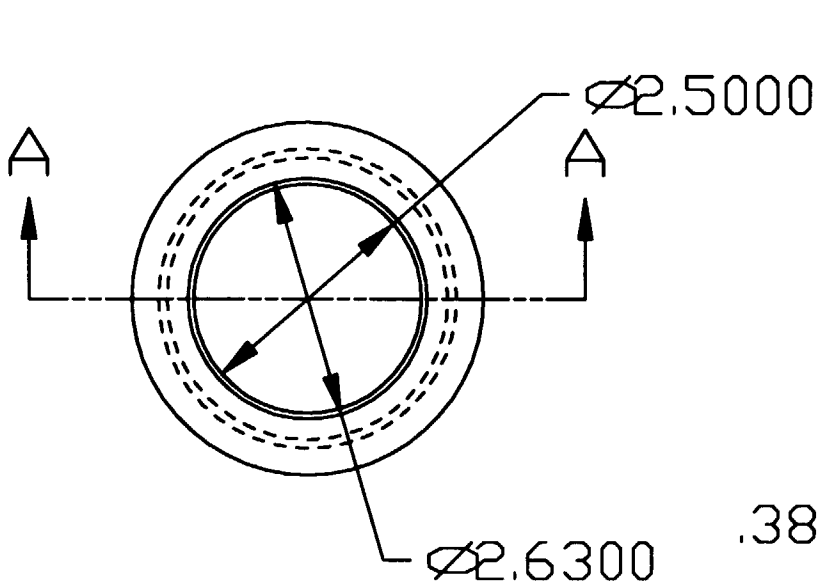


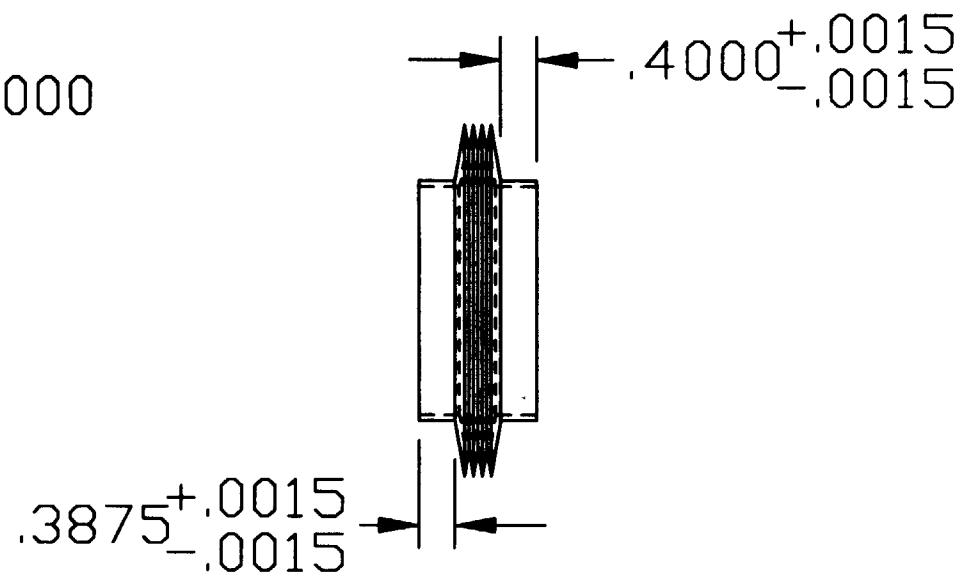
(8) TAP 4-40
THRU ALL

MAT. S.S. TYPE 304

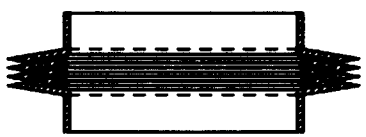
1 REQUIRED

CONTRACT NO.		**PHYSICS ELECTRONICS SHOP**	
APPROVALS	DATE	**20K REAR THERMAL SHORTING PLATE**	
DRAWN K. MEYER	4/18/99		
CHECKED			
MFG.			
ENGR.			
REVISION	SIZE A	CODE IDENT NO.	DRAWING NO. 03-002 REV.
	SCALE 1:1	PENN STATE UNIVERSITY	SHEET 1 OF 1





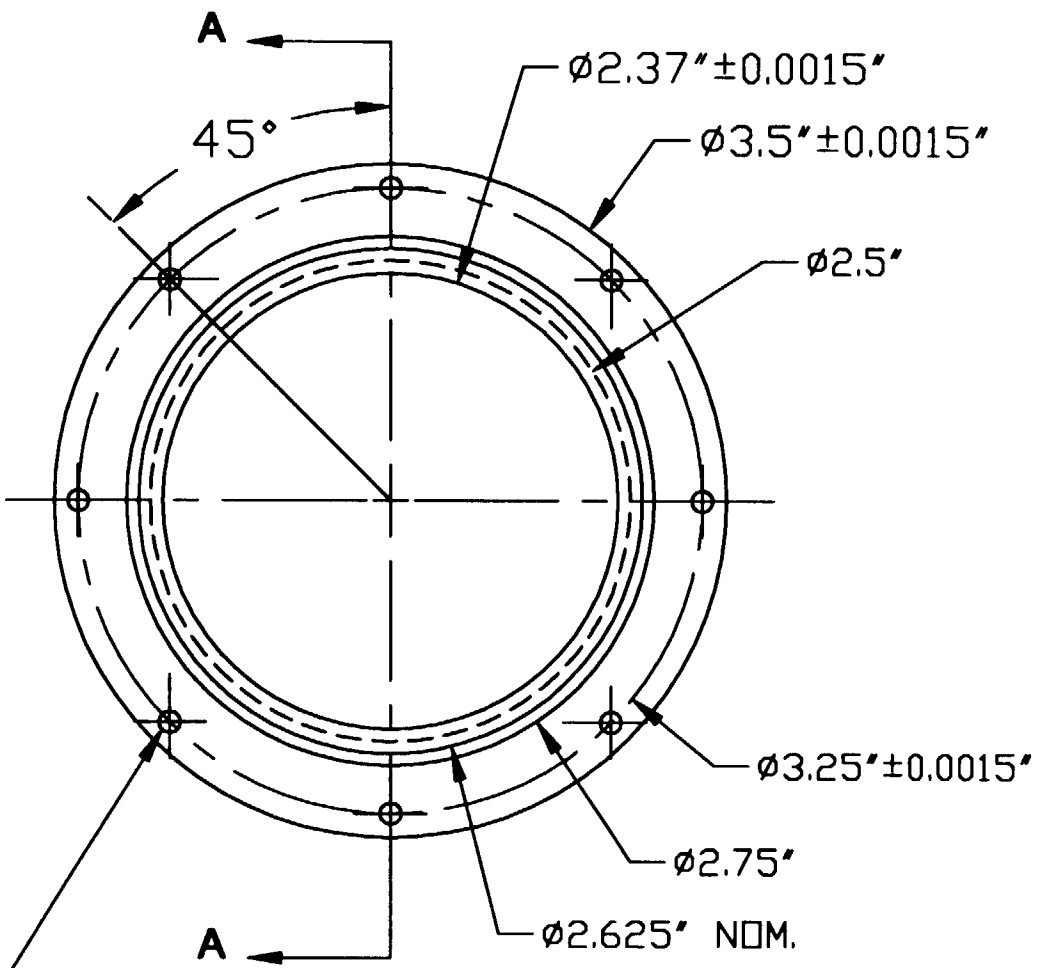
SECTION A-A

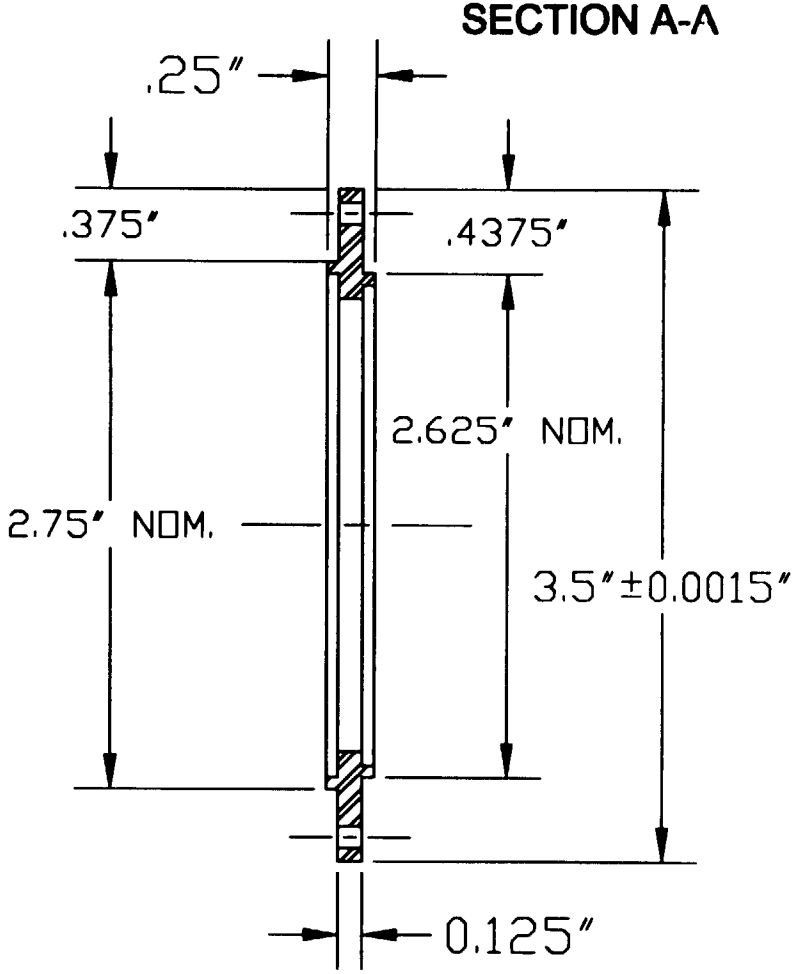


PART: B-R2

LESKER BELLOW TYPE: MEW3502501E

MAT'L: STAINLESS STEEL #304	20K-77K REAR BELLOWS SGMNT
	BRIAN SARSFIELD
DATE: 3/4/99	QUANTITY: 1
UNITS: INCHES	



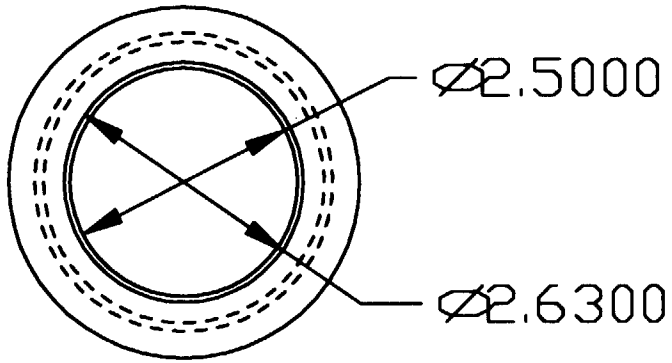


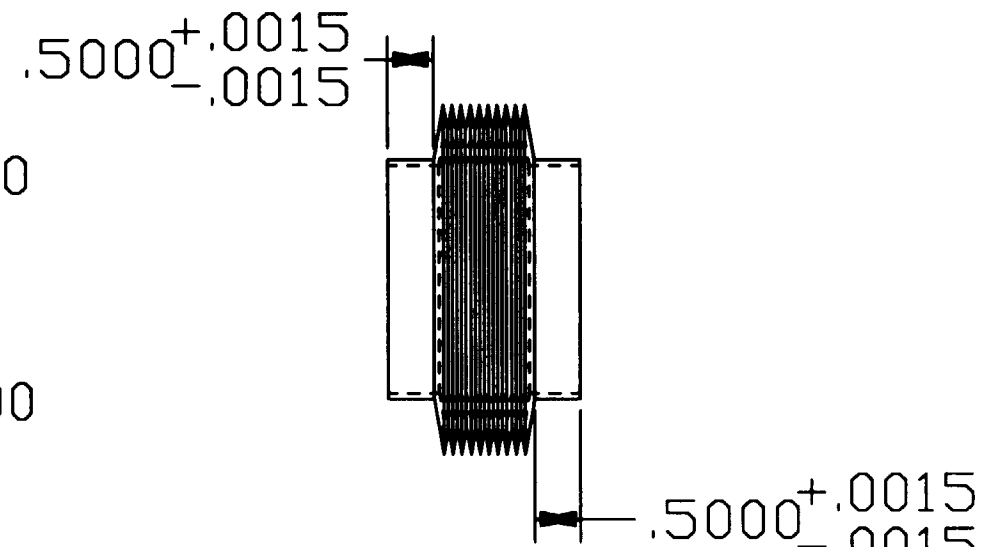
(8) TAP 4-40
THRU ALL

MAT. S.S. TYPE 304

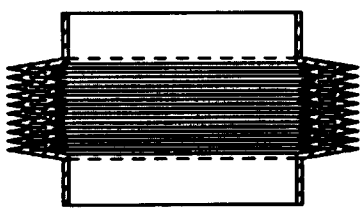
1 REQUIRED

CONTRACT NO.		**PHYSICS ELECTRONICS SHOP**
APPROVALS	DATE	**77K REAR THERMAL SHORTING PLATE**
DRAWN K. MEYER	2/1/99	
CHECKED		
MFG.		
ENGR.		
REVISION		SIZE A / CODE IDENT NO. / DRAWING NO. 03-003 / REV.
		SCALE 1:1 / PENN STATE UNIVERSITY / SHEET 1 OF 1



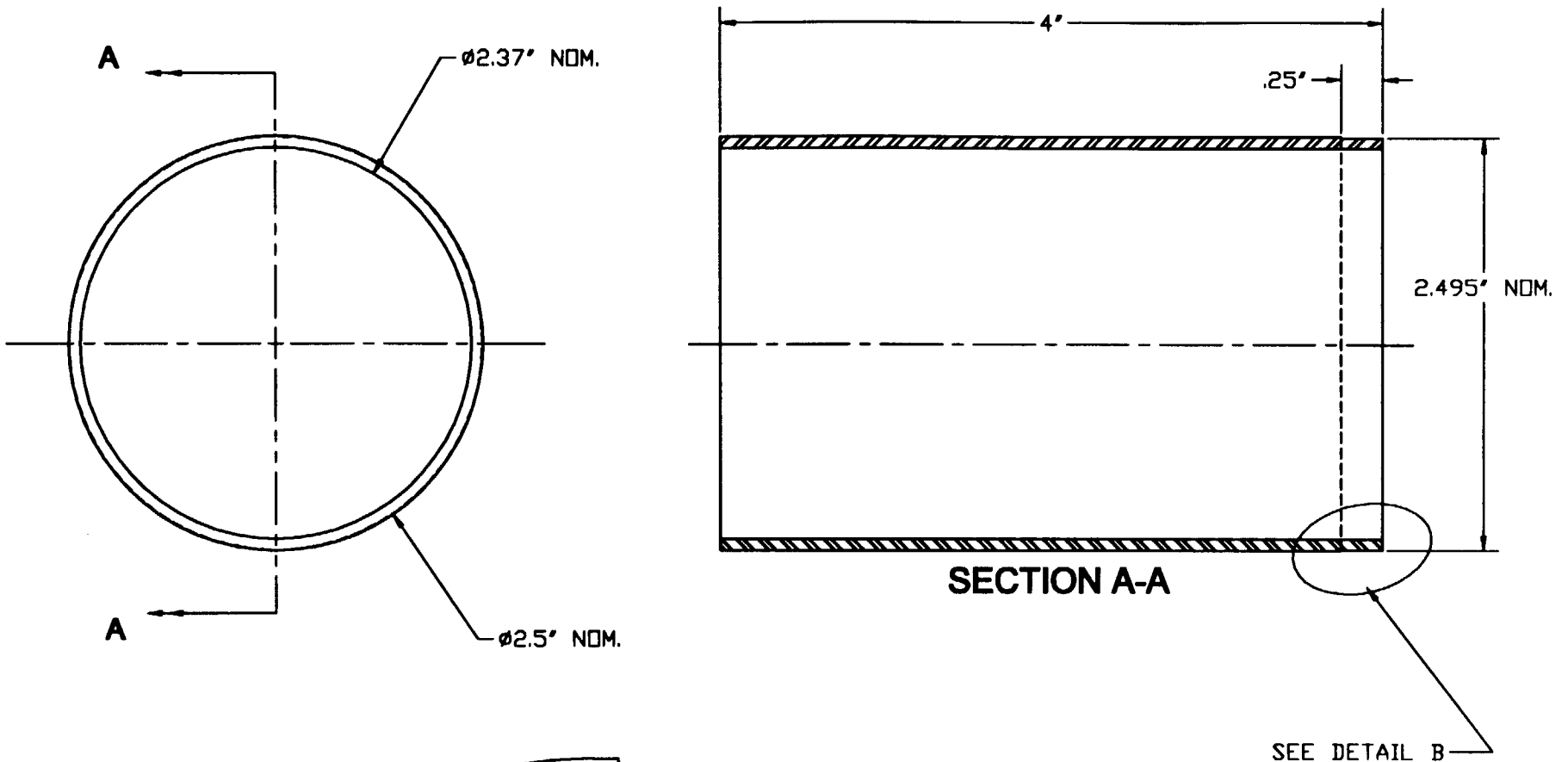


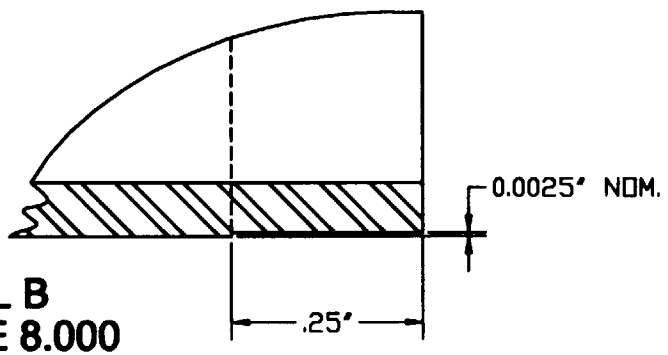
SECTION A-A



PART: B-R3
LESKER BELLOW TYPE: MEW3502501E

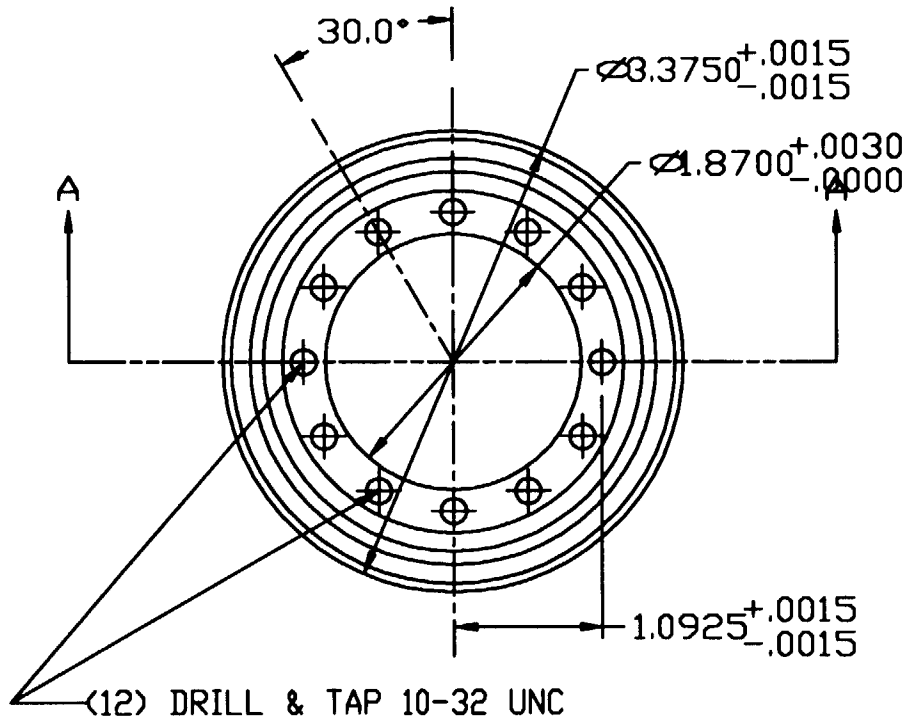
MAT'L: STAINLESS STEEL #304	77K WARM REAR BELLOWS SGMNT
	BRIAN SARSFIELD
DATE: 3/4/99	QUANTITY: 1
UNITS: INCHES	

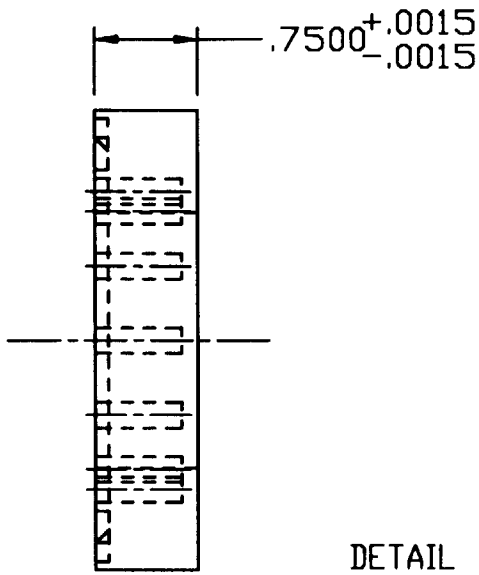




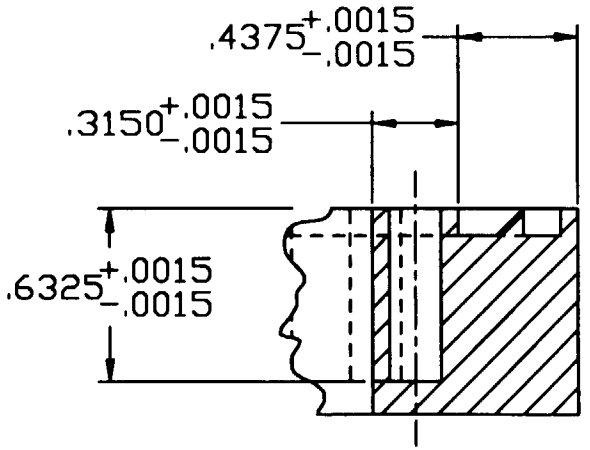
DETAIL B
SCALE 8.000

2.5" OD S.S. TYPE 304 TUBING WALL TH.=.035"	APPROVALS / DRAWN: KIRBY MEYER	PHYSICS ELECTRONIC SHOP
		77K-WARM NECKING PIPE
DO NOT SCALE DRAWING	SIZE: C	03-004
	SCALE: 2.0	PENN STATE UNIVERSITY

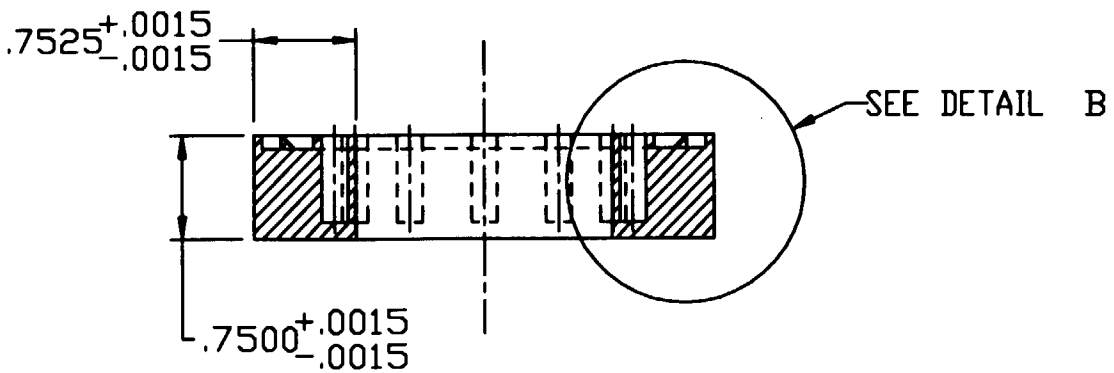




DETAIL B
SCALE 3.000

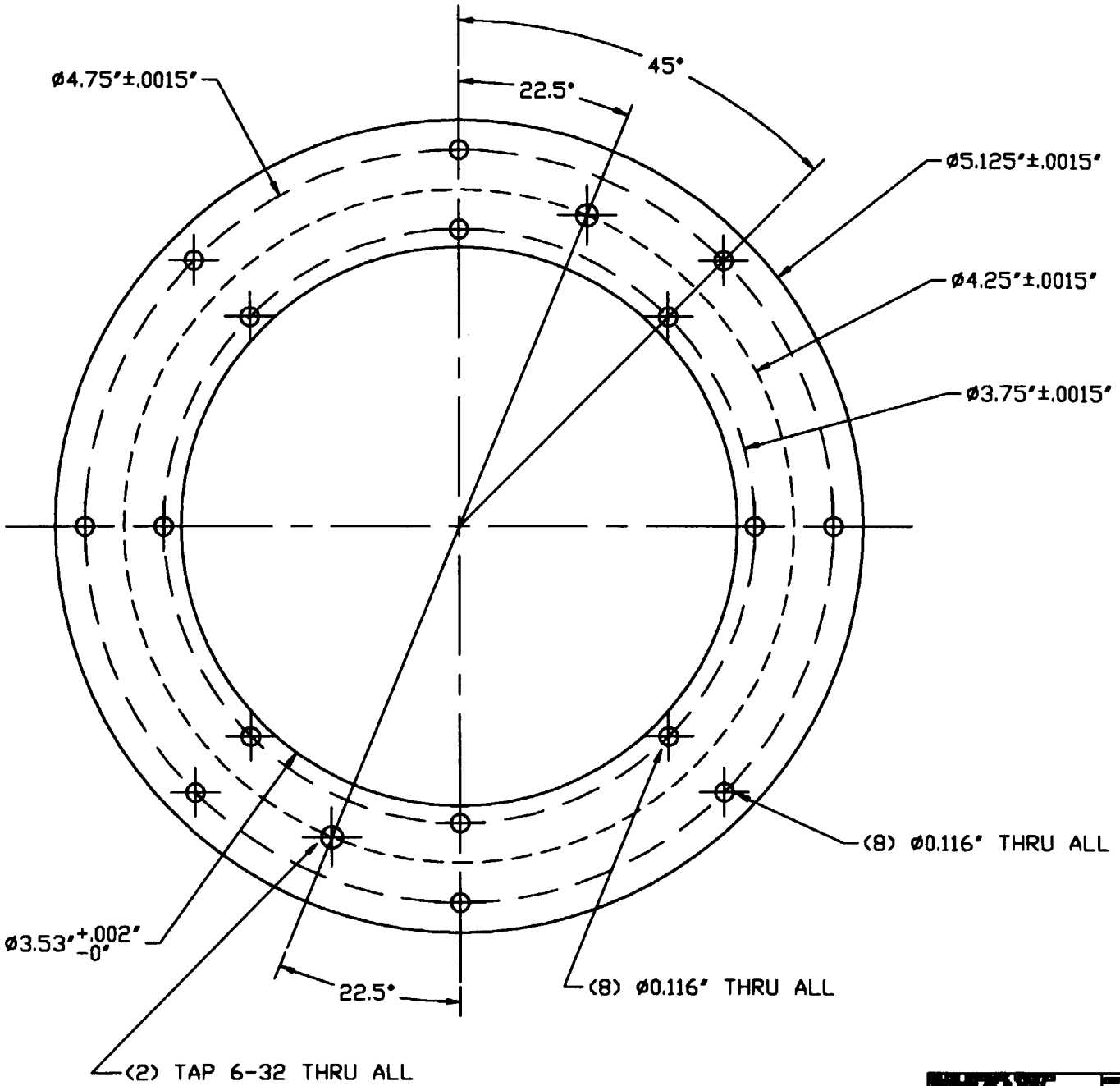


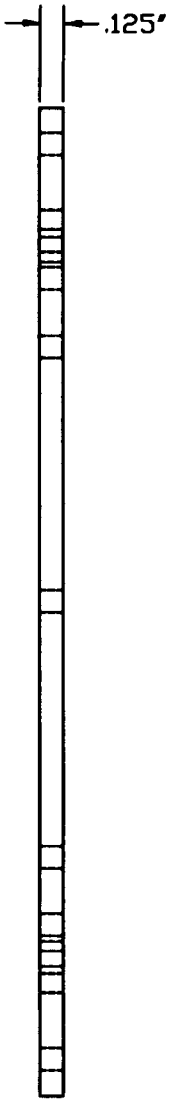
SECTION A-A



PROBLEMS? CALL B. SARSFIELD @ EXT. 5-0066

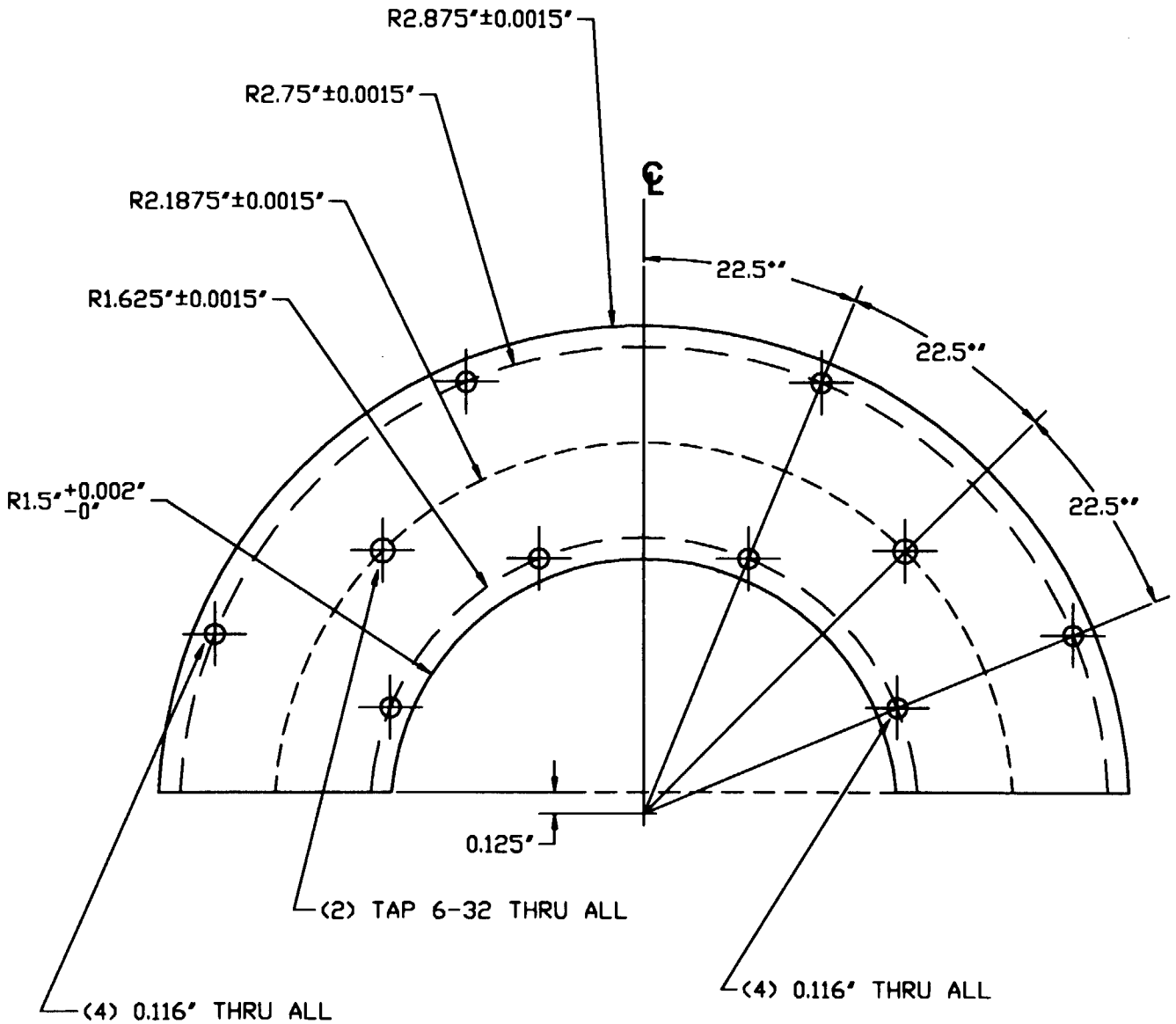
MAT'L: STAINLESS STEEL #304	3.375"REAR MATING FLANGE
	BRIAN SARSFIELD
DATE: 1/25/99	QUANTITY: 1
UNITS: INCHES	

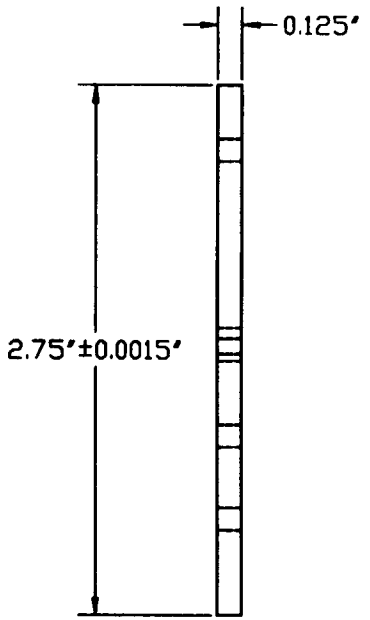




1 REQUIRED

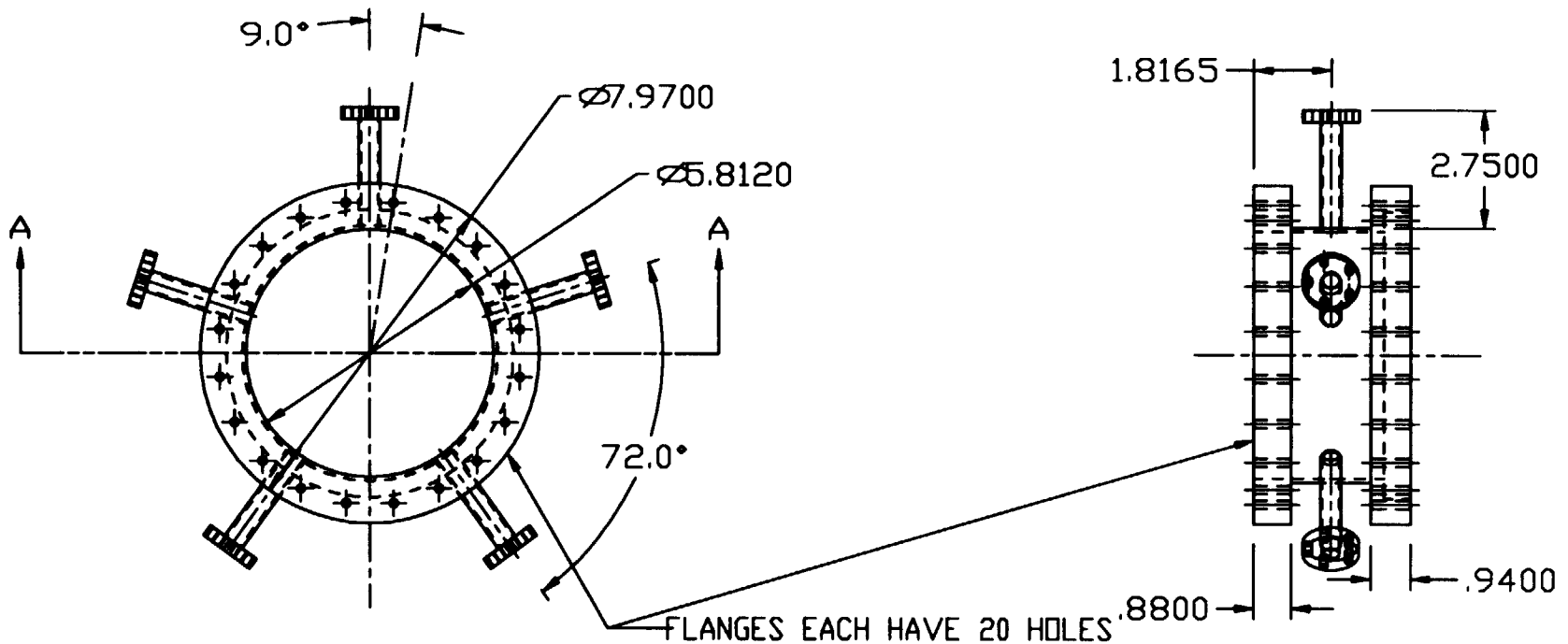
		PHYSICS ELECTRONIC SHOP
MATERIALS: ALUMINUM		20K REAR ANNULUS
		SIZE: C — DRAWING NO.: 03-005 — REV:
		SCALE: FULL — PENN STATE UNIVERSITY — SHEET



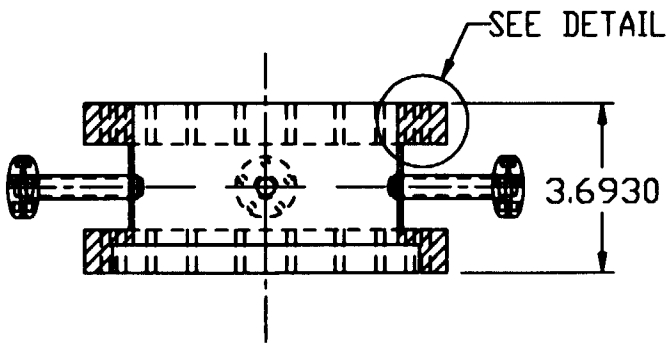


4 REQUIRED

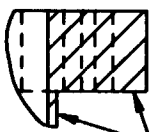
		PHYSICS ELECTRONIC SHOP
ALUMINUM		77K REAR SEMI-ANNULUS
	C	03-006
	SCALE 2.0	PENN STATE UNIVERSITY



SECTION A-A

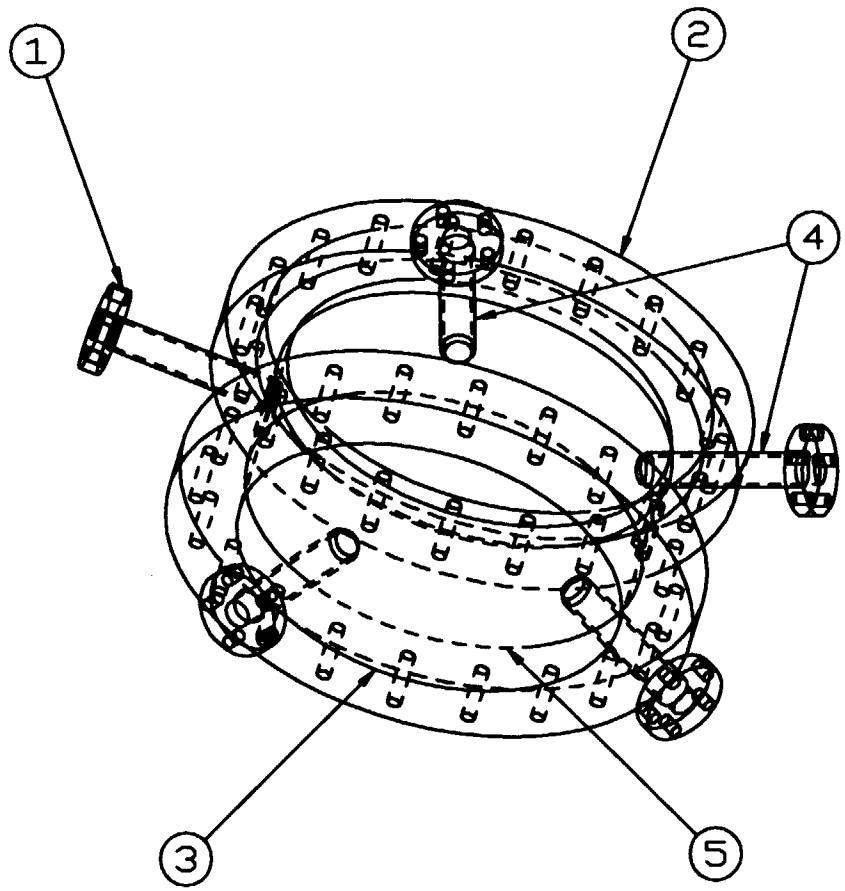


DETAIL B
SCALE 1.000



FRNT. AND REAR FLANGES
TO BE WELDED TO TUBE
ALL-AROUND FOR SEAL
REMOVE SHIELDING FROM BEAD

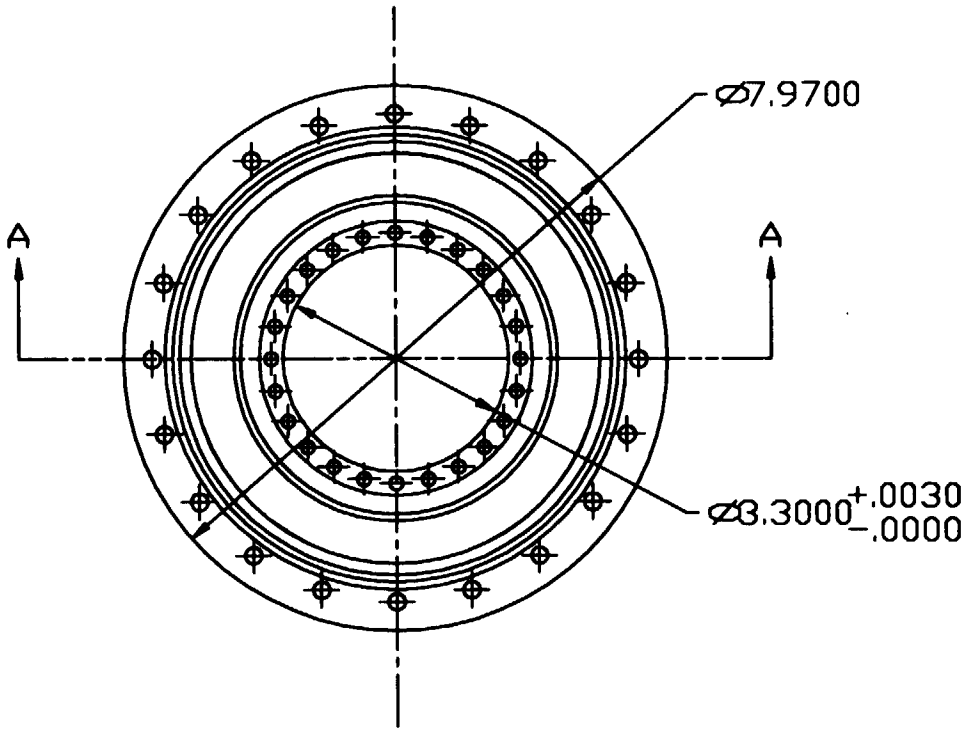
MAT'L: STAINLESS STEEL #304	FRNT FEEDTHRU SPOOL
	BRIAN SARSFIELD
DATE: 2/24/99	QUANTITY: 1
UNITS: INCHES	



LEGEND OF PARTS (QUANTITY)

1. MDC 1.33" O.D. NONROTATABLE BORED MINI FLANGES (5)
2. MDC 8" O.D.ROTATABLE BORED FLANGE (1)
3. MDC 8" O.D. NONROTATABLE BORED FLANGE (1)
4. 0.5" O.D. STAINLESS STEEL TUBING W/ WALL THICKNESS OF .065" SEE BARRY DUTROW FOR DETAILS (5)
5. 6.0" O.D. STAINLESS STEEL TUBING BODY OF SPOOL (1)

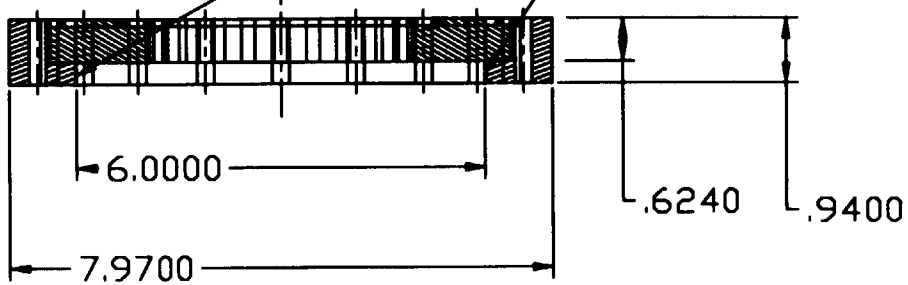
MAT'L: STAINLESS STEEL #304	FRNT. FEEDTHRU SPOOL
	BRIAN SARSFIELD
DATE: 3/3/99	QUANTITY: 1
UNITS: INCHES	



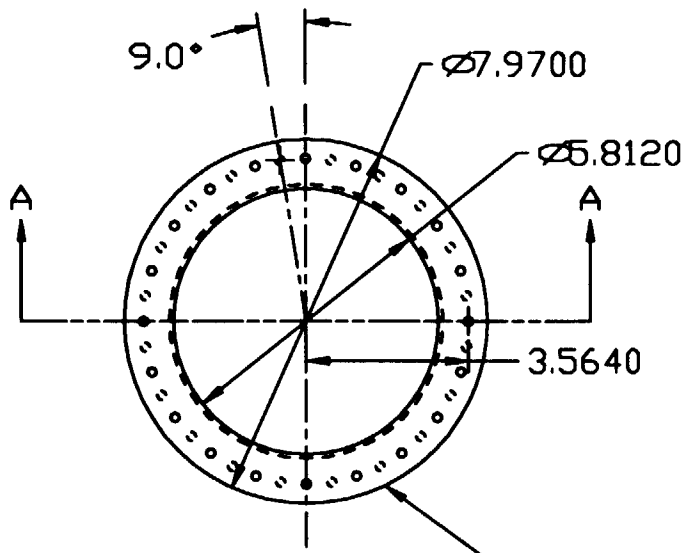
PRINT SHOWS FLANGE & FRNT. ROT. BLANK ASSEM. SEE FRNT. MOD. ROT BLANK PRINT FOR DETAILS. FLANGE ONLY HAS MODIFIED BORE. (SEE NOTE)

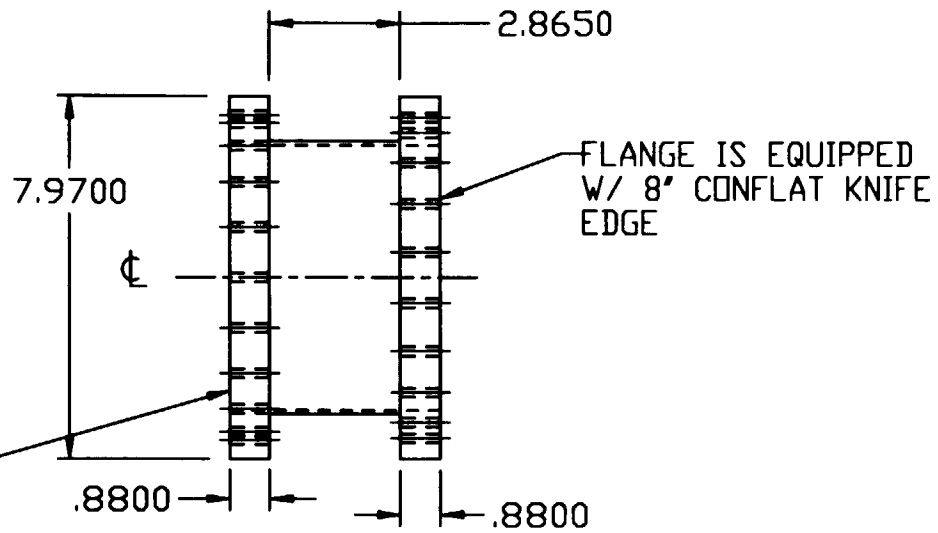
FLANGE IS TO BE CUSTOMIZED WITH A BORE Ø6.0" FOR ABILITY TO RECIEVE HALF NIPPLE TUBE O.D.

SECTION A-A



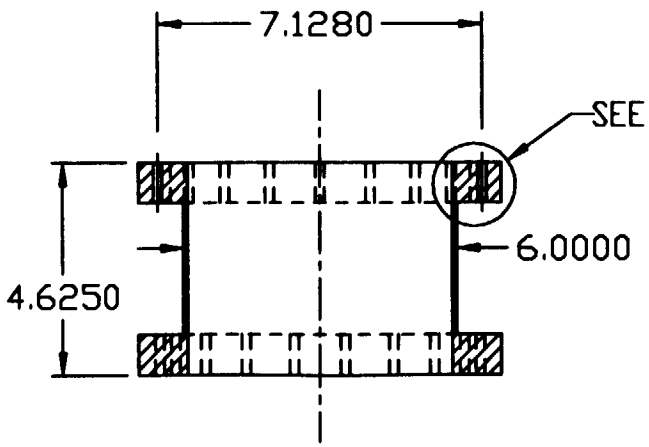
MAT'L: STAINLESS STEEL #304	FRNT. BLANK ASSM.
	BRIAN SARSFIELD
DATE: 2/1/99	QUANTITY: 1
UNITS: INCHES	



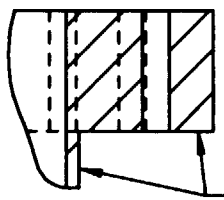


FRNT. AND REAR FLNGS HAVE
20 HOLES. REAR FLANGE IS 9°
OUT OF PHASE WITH FRNT. FLANGE

SECTION A-A



DETAIL B
SCALE 1.500



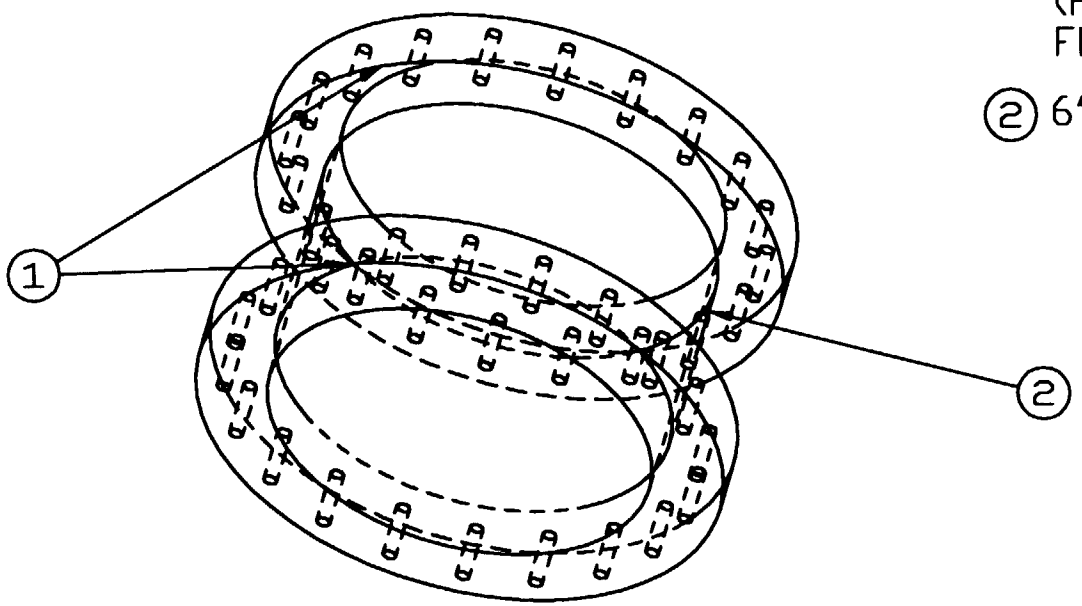
FRNT. AND REAR FLANGES TO
BE WELDED TO TUBE
WELD ALL-AROUND TO SEAL
REMOVE SHIELDING FROM BEAD

MAT'L: STAINLESS STEEL #304	OVC REAR SPOOL
	BRIAN SARSFIELD
DATE: 2/22/99	QUANTITY: 1
UNITS: INCHES	

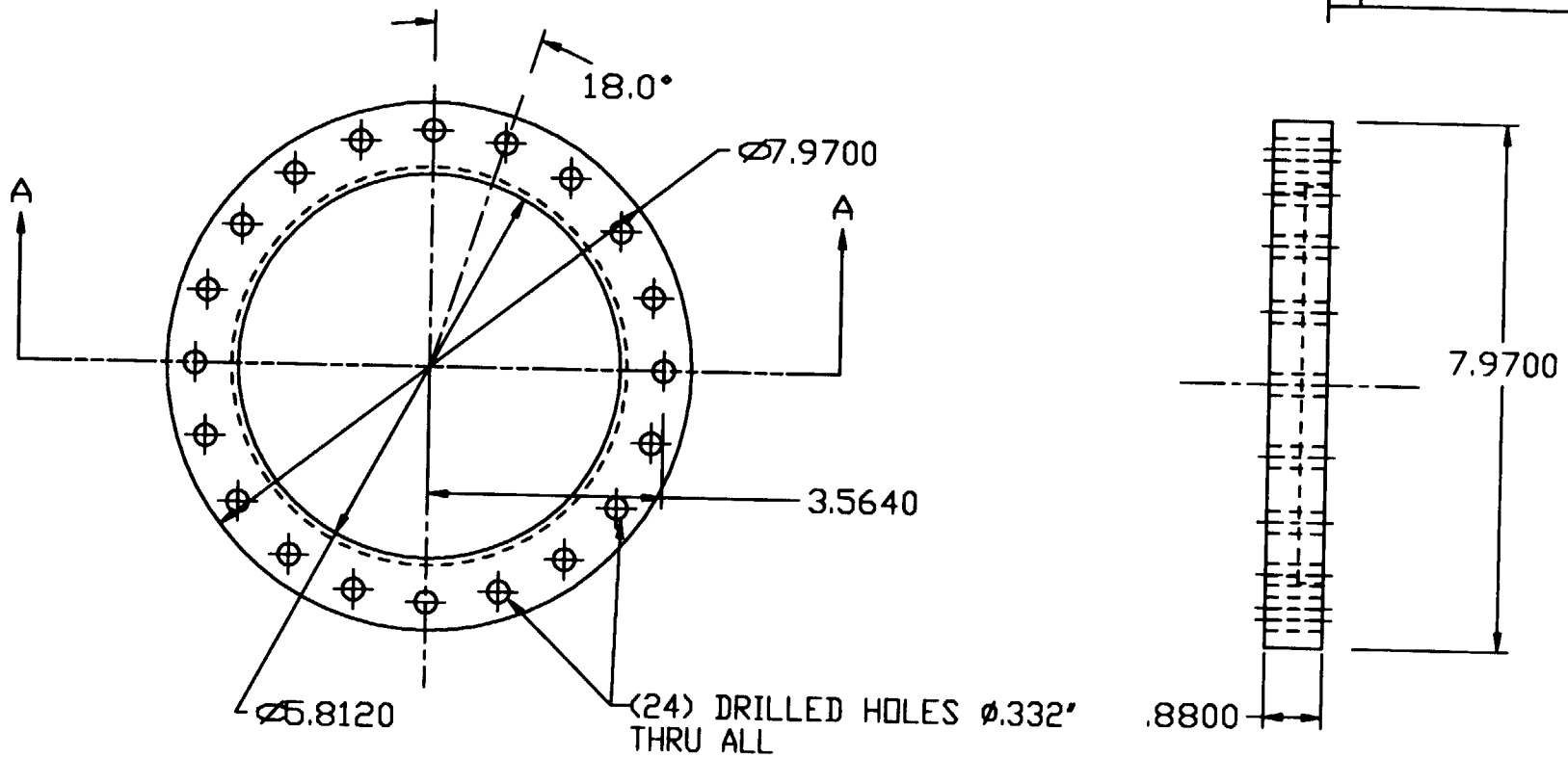
LEGEND OF PARTS (QUANTITY)

(1) MDC 8" O.D. NONROTABLE BORED FLANGES (2) ONE W/ 8" CONFLAT KNIFE EDGE & ONE W/OUT (PLEASE SEE ATTACHED PRINT FOR FLANGE DETAILS)

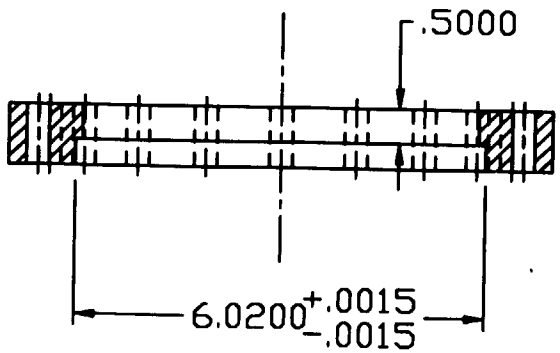
(2) 6" O.D. STAINLESS STEEL TUBING (1)



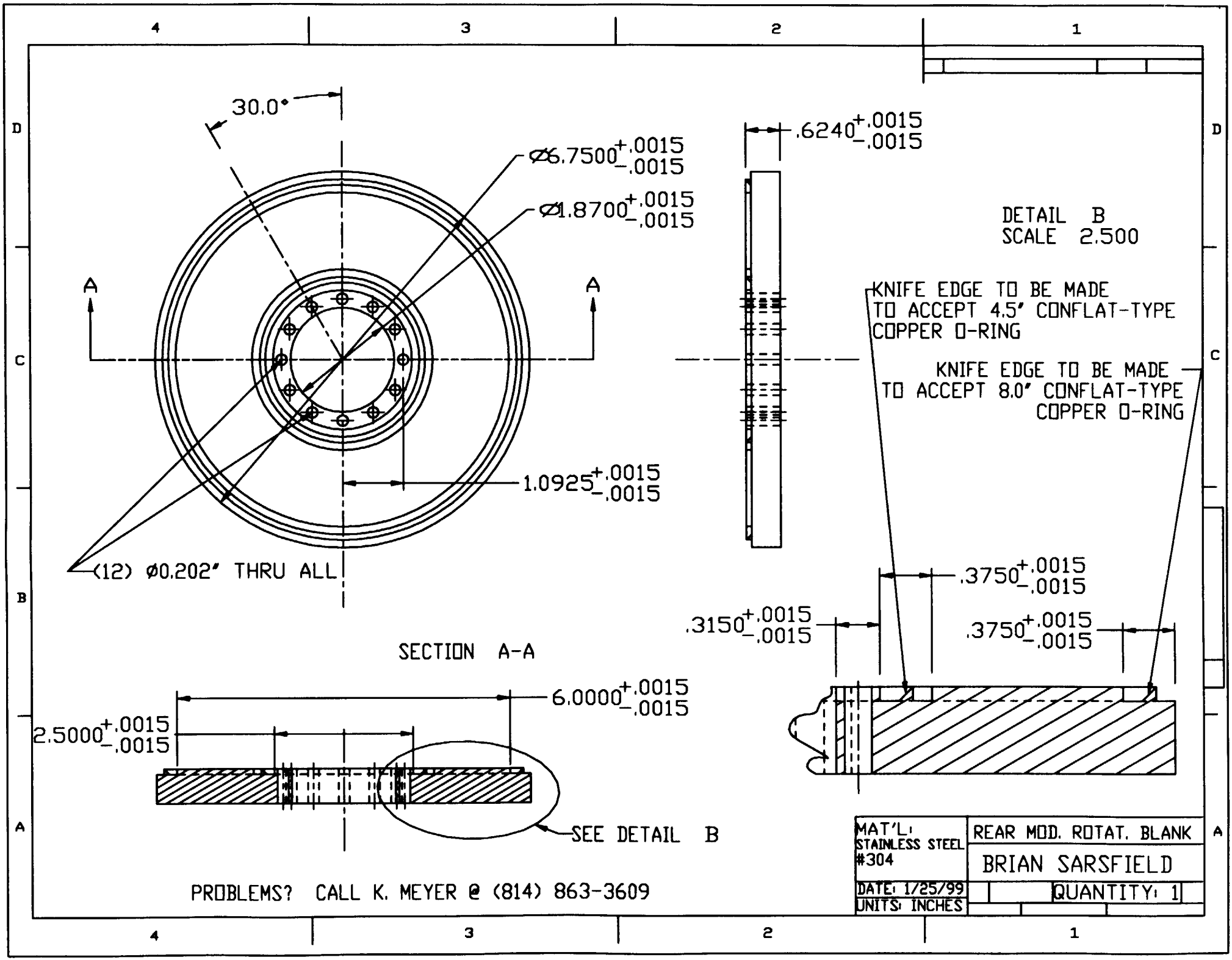
MAT'L: STAINLESS STEEL #304	OVC REAR SPOOL
	BRIAN SARSFIELD
DATE: 3/3/99	QUANTITY: 1
UNITS: INCHES	

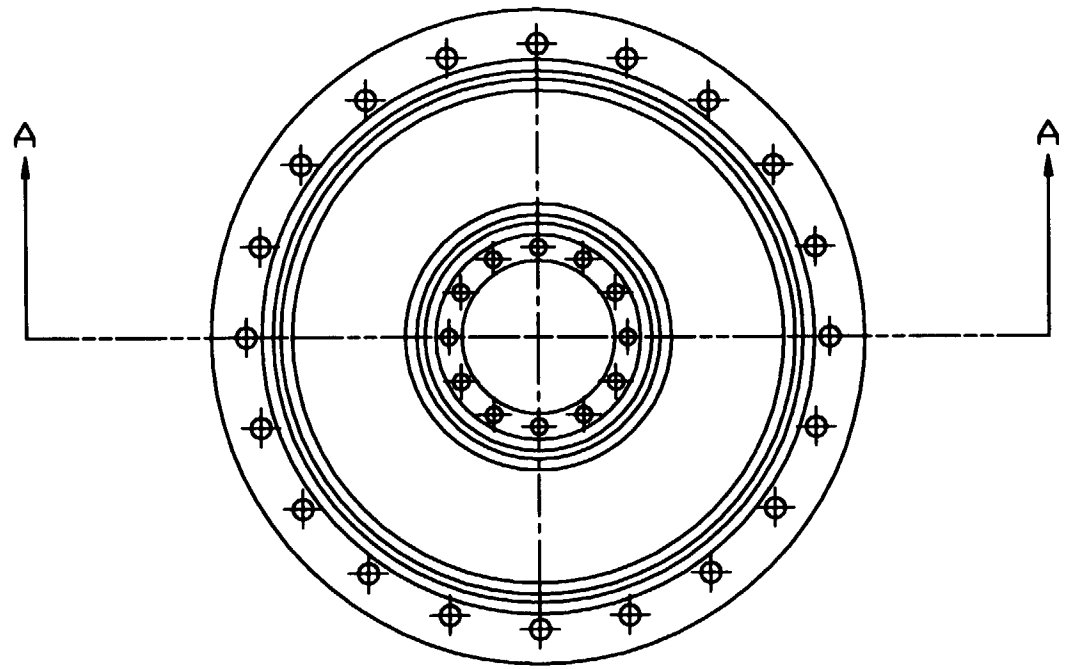


SECTION A-A



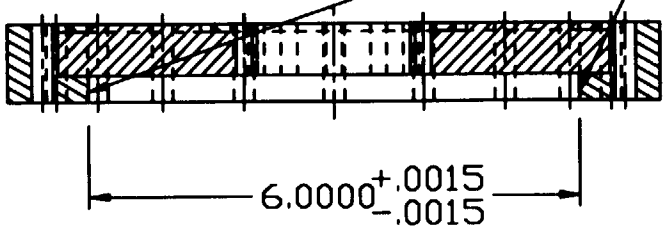
MAT'L: STAINLESS STEEL #304	OVC FLANGE AUX PRINT
	BRIAN SARSFIELD
DATE: 3/3/99 UNITS: INCHES	QUANTITY: 1


30.0°
Ø6.7500 +.0015 -.0015
Ø1.8700 +.0015 -.0015
A
A
1.0925 +.0015 -.0015
(12) Ø0.202" THRU ALL
.6240 +.0015 -.0015
DETAIL B
SCALE 2.500
KNIFE EDGE TO BE MADE TO ACCEPT 4.5" CONFLAT-TYPE COPPER O-RING
KNIFE EDGE TO BE MADE TO ACCEPT 8.0" CONFLAT-TYPE COPPER O-RING
.3750 +.0015 -.0015
.3150 +.0015 -.0015
.3750 +.0015 -.0015
SECTION A-A
6.0000 +.0015 -.0015
2.5000 +.0015 -.0015
SEE DETAIL B
PROBLEMS? CALL K. MEYER @ (814) 863-3609
MAT'L: STAINLESS STEEL #304
REAR MOD. ROTAT. BLANK
BRIAN SARSFIELD
DATE: 1/25/99
UNITS: INCHES
QUANTITY: 1



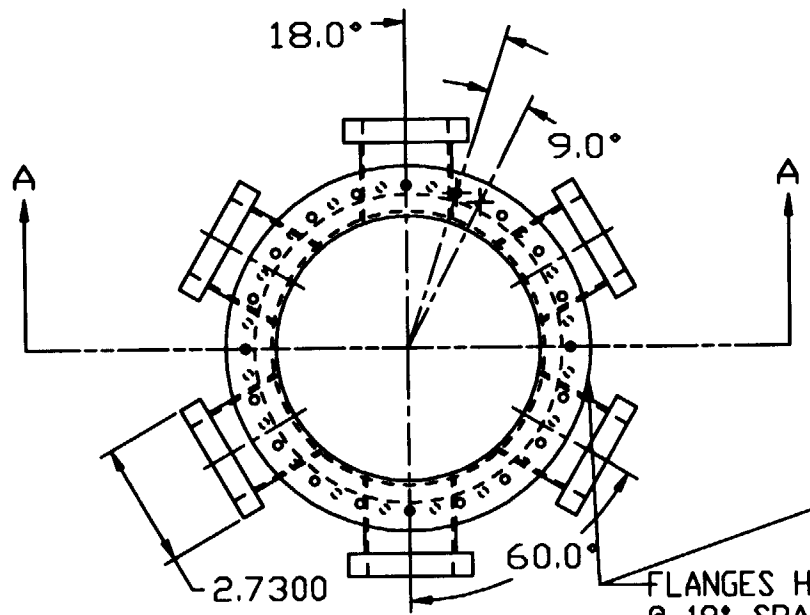
PRINT SHOWS FLANGE & REAR ROT. BLANK ASSEM. SEE REAR MOD. ROT. BLANK PRINT FOR DETAILS. FLANGE ONLY HAS MODIFIED BORE. (SEE NOTE)

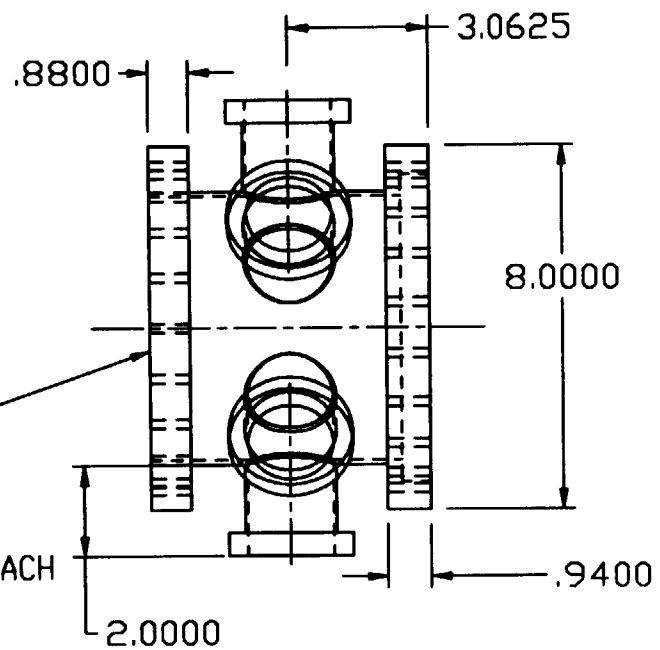
SECTION A-A



FLANGE IS TO BE CUSTOMIZED WITH BORE Ø6.0" FOR ABILITY TO RECIEVE HALF NIPPLE TUBE O.D.

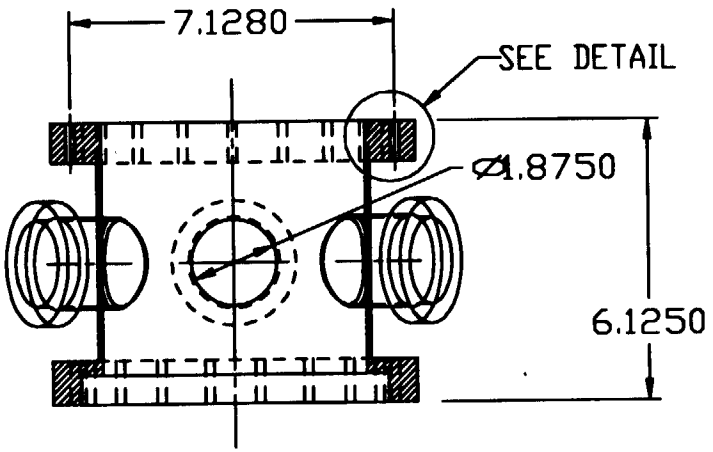
MAT'L: STAINLESS STEEL #304	REAR ROT. BLANK ASSEMBLY
	BRIAN SARSFIELD
DATE: 3/4/99	QUANTITY: 1
UNITS: INCHES	



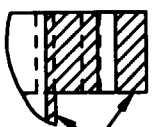


FLANGES HAVE 20 HOLES EACH @ 18° SPACING. REAR FLANGE IS TO BE 9° OUT OF PHASE FROM FRNT. FLANGE

SECTION A-A

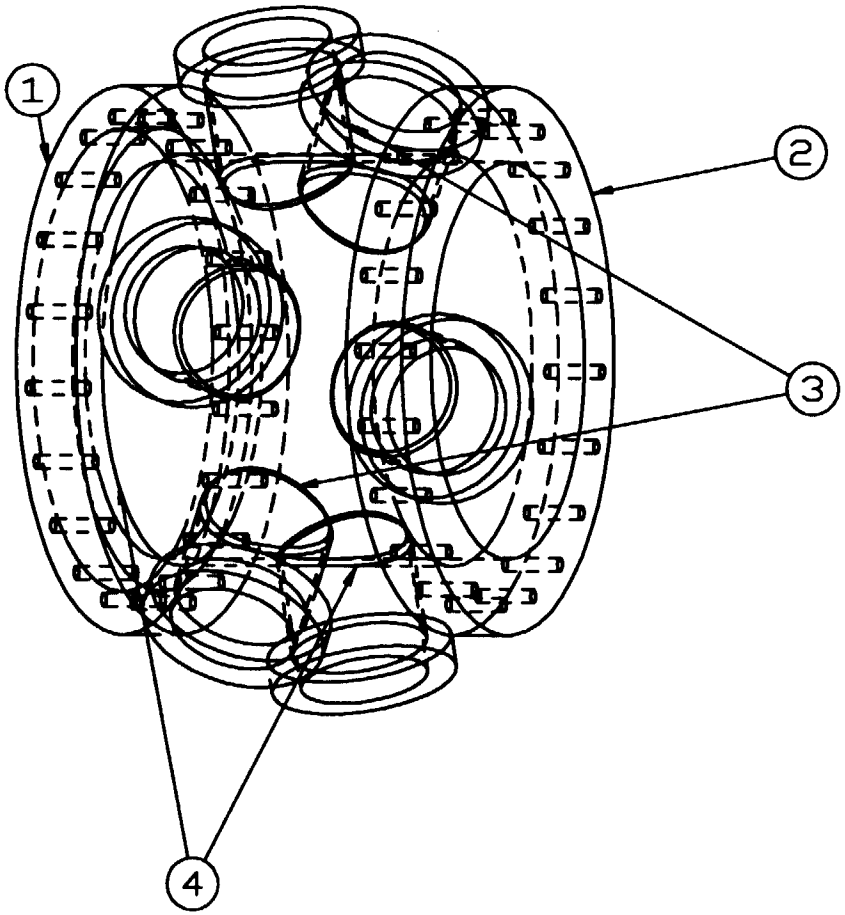


DETAIL B
SCALE 1.000



FRNT. AND REAR FLANGES TO BE WELDED TO TUBING ALL-AROUND FOR SEAL CLEAN SHIELDING OFF OF BEAD

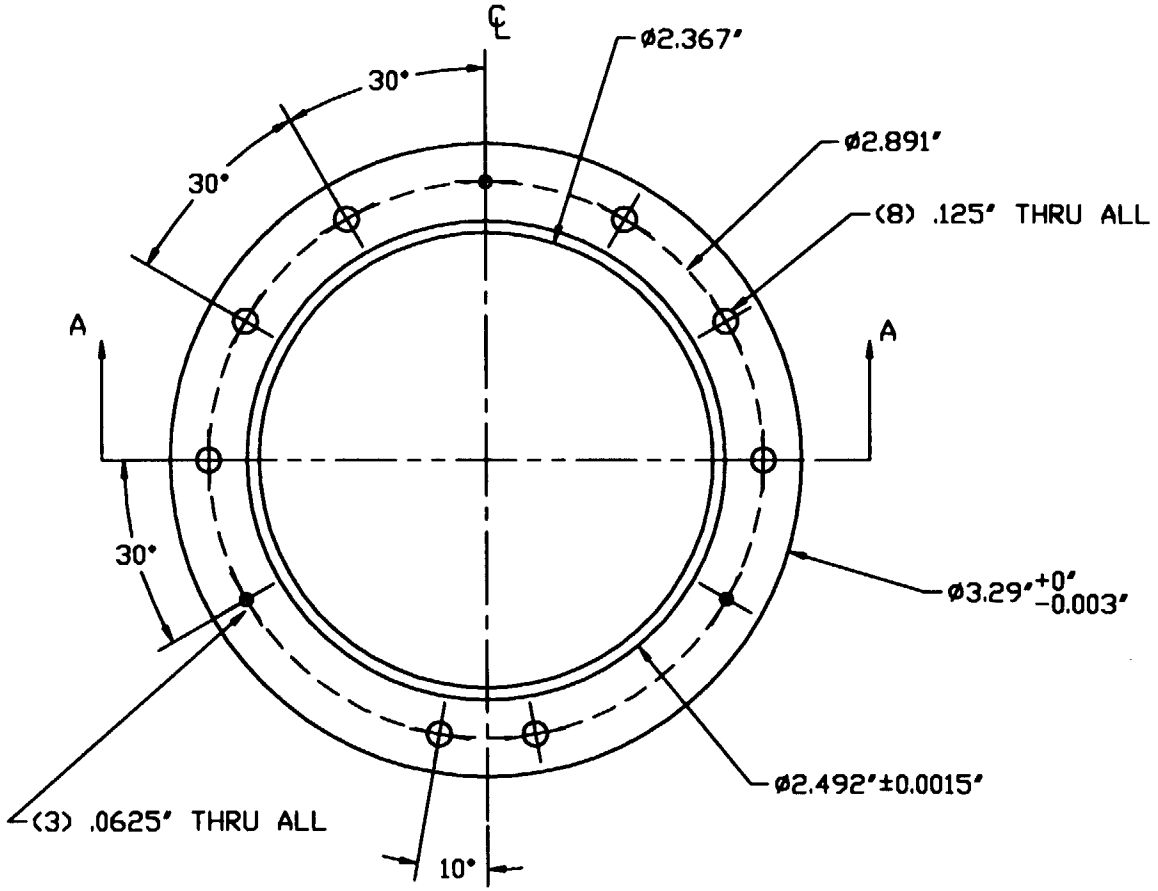
MAT'L: STAINLESS STEEL #304	REAR FEEDTHROUGH SPOOL
	BRIAN SARSFIELD
DATE: 3/3/99	QUANTITY: 1
UNITS: INCHES	

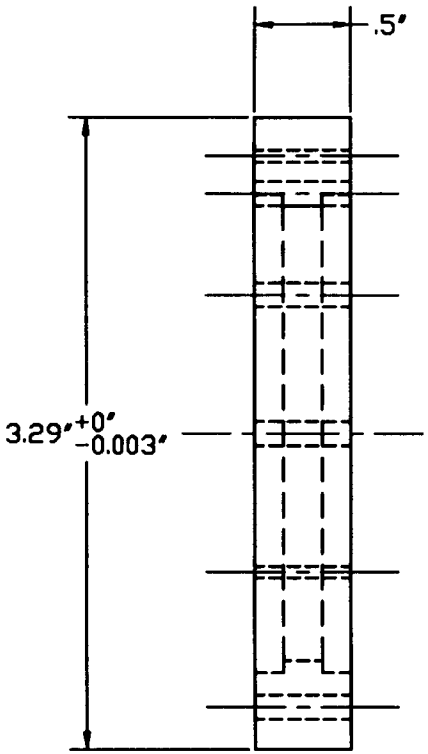


LEGEND OF PARTS (QUANTITY)

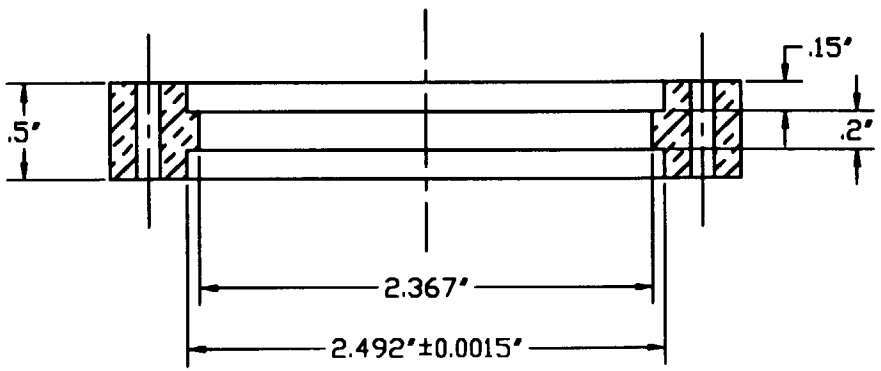
1. MDC 8" O.D. ROTATABLE BORED FLANGE (1)
2. MDC 8" O.D. NONROTATABLE BORED FLANGE (1)
3. MDC 2.75" HALF NIPPLES (6)
4. 8" O.D. STAINLESS STEEL TUBING BODY OF SPOOL (1)

MAT'L: STAINLESS STEEL #304	REAR FEEDTHRU SPOOL
	BRIAN SARSFIELD
DATE: 3/3/99	QUANTITY: 1
UNITS: INCHES	

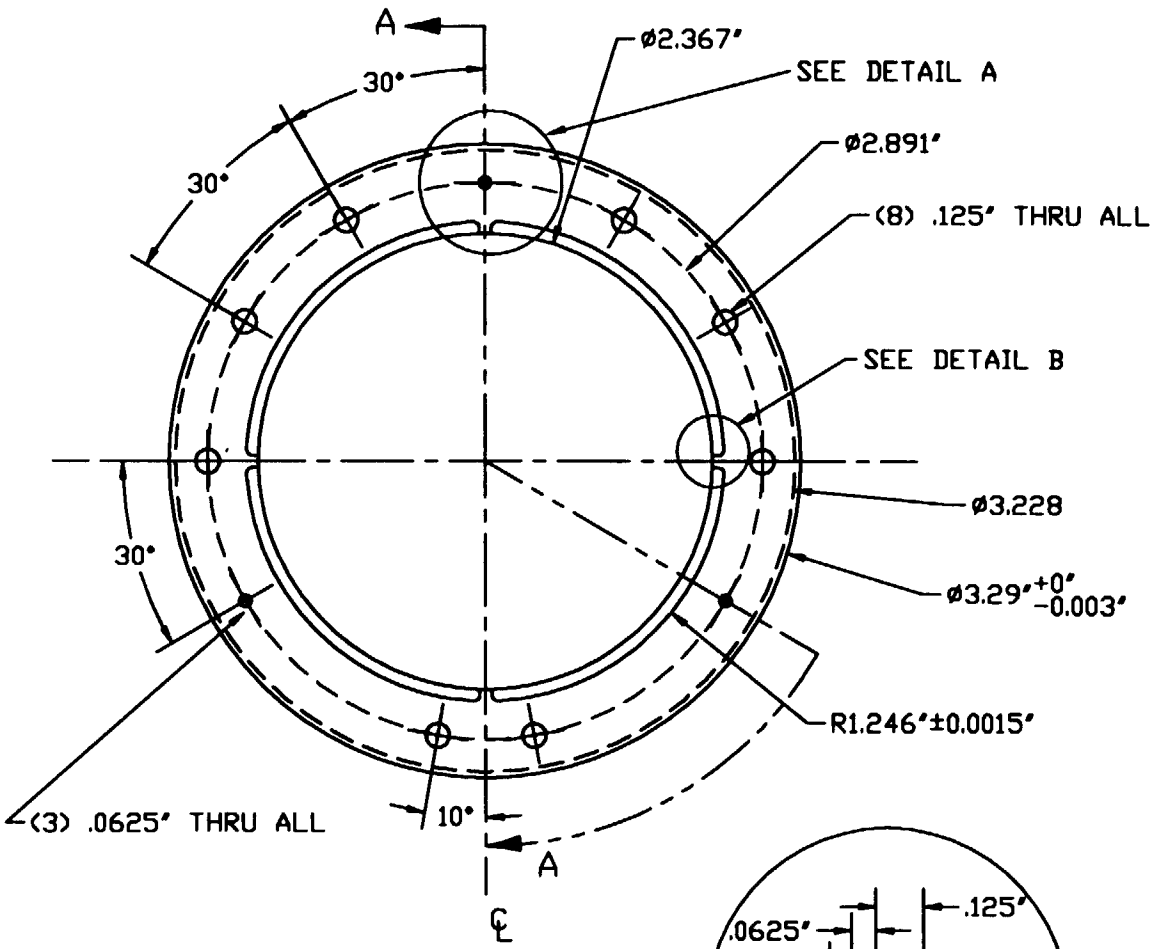


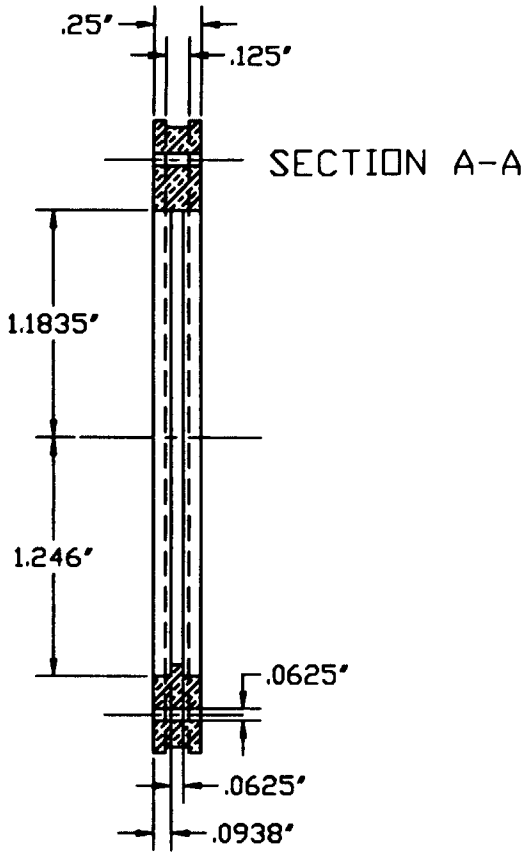


SECTION A-A

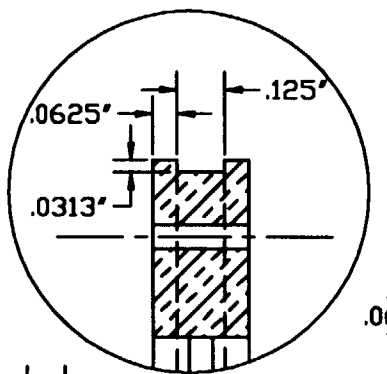


MATERIALS: MACOR ROD, 4" OD		PHYSICS ELECTRONIC SHOP
		STANDARD MACOR RING
DO NOT SCALE DRAWING	SIZE: C	DWG NO: 06-001
	SCALE: 2:3	PENN STATE UNIVERSITY

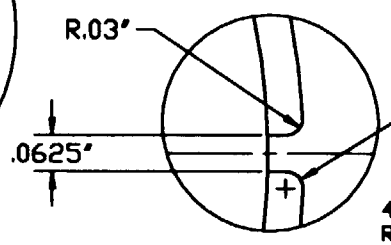




DETAIL B

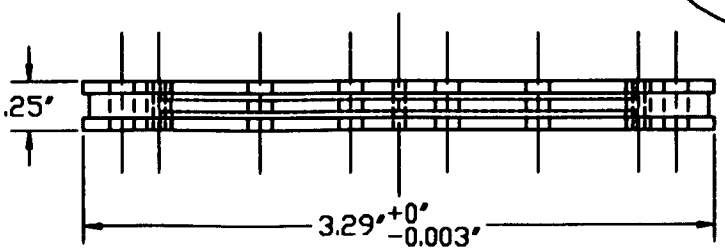


DETAIL A

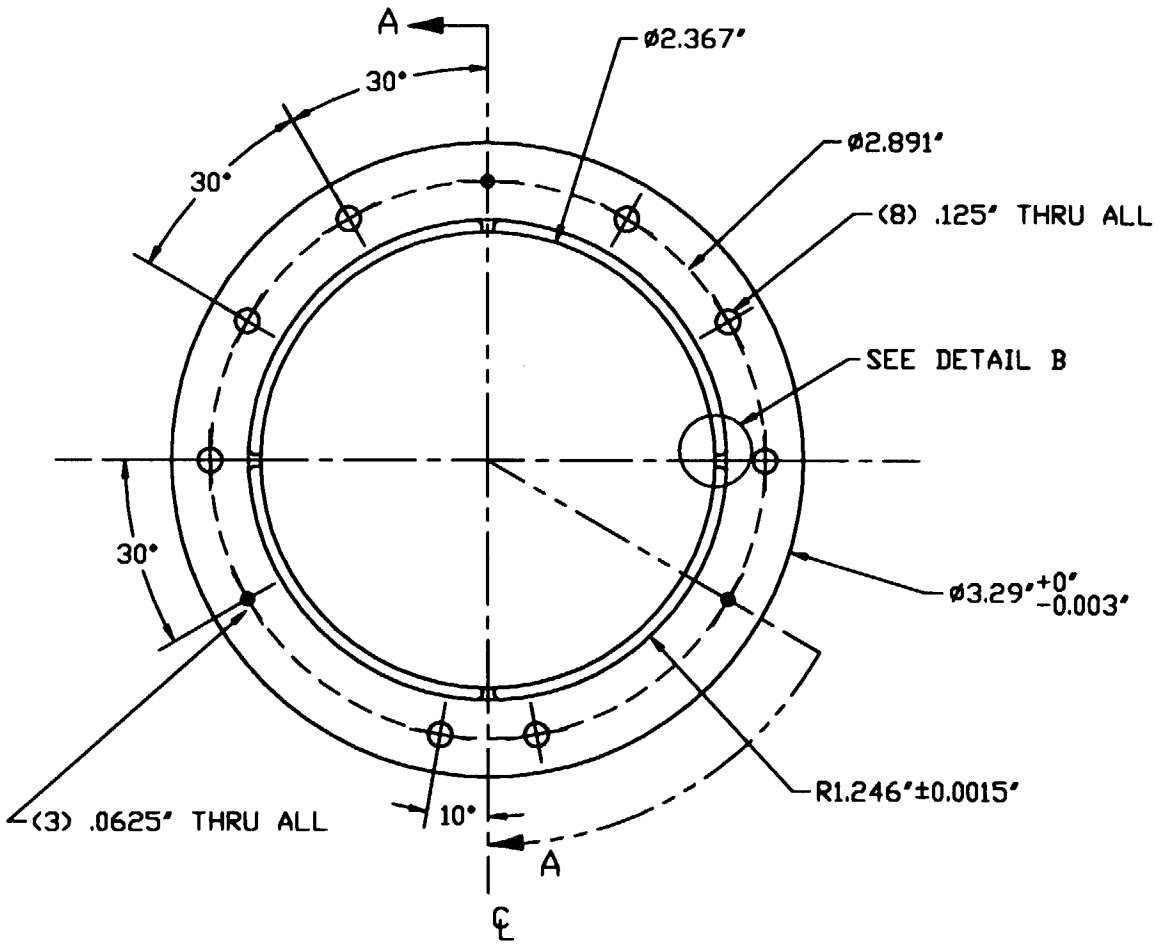


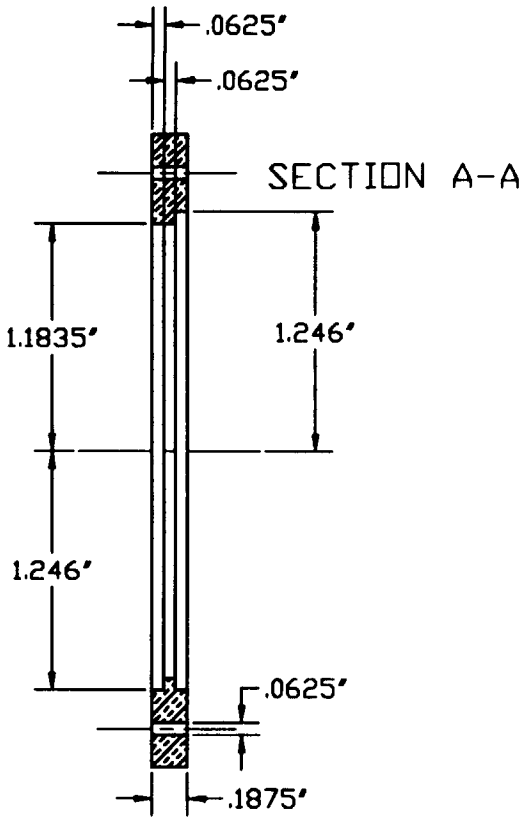
4 PLACES
REPEAT FOR OTHER SIDE

ONE REQUIRED

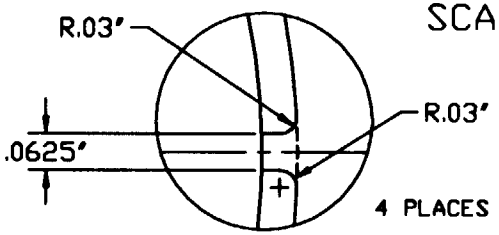


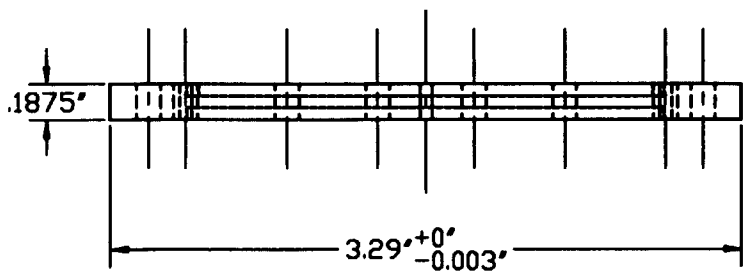
MATERIAL: MACOR ROD, 4" OD		PHYSICS ELECTRONIC SHOP
		COIL MOUNT MACOR RING
DO NOT SCALE DRAWING		SIZE: C — DWG NO: 05-002 — REV:
		SCALE: 2:1 — PENN STATE UNIVERSITY — SHEET OF





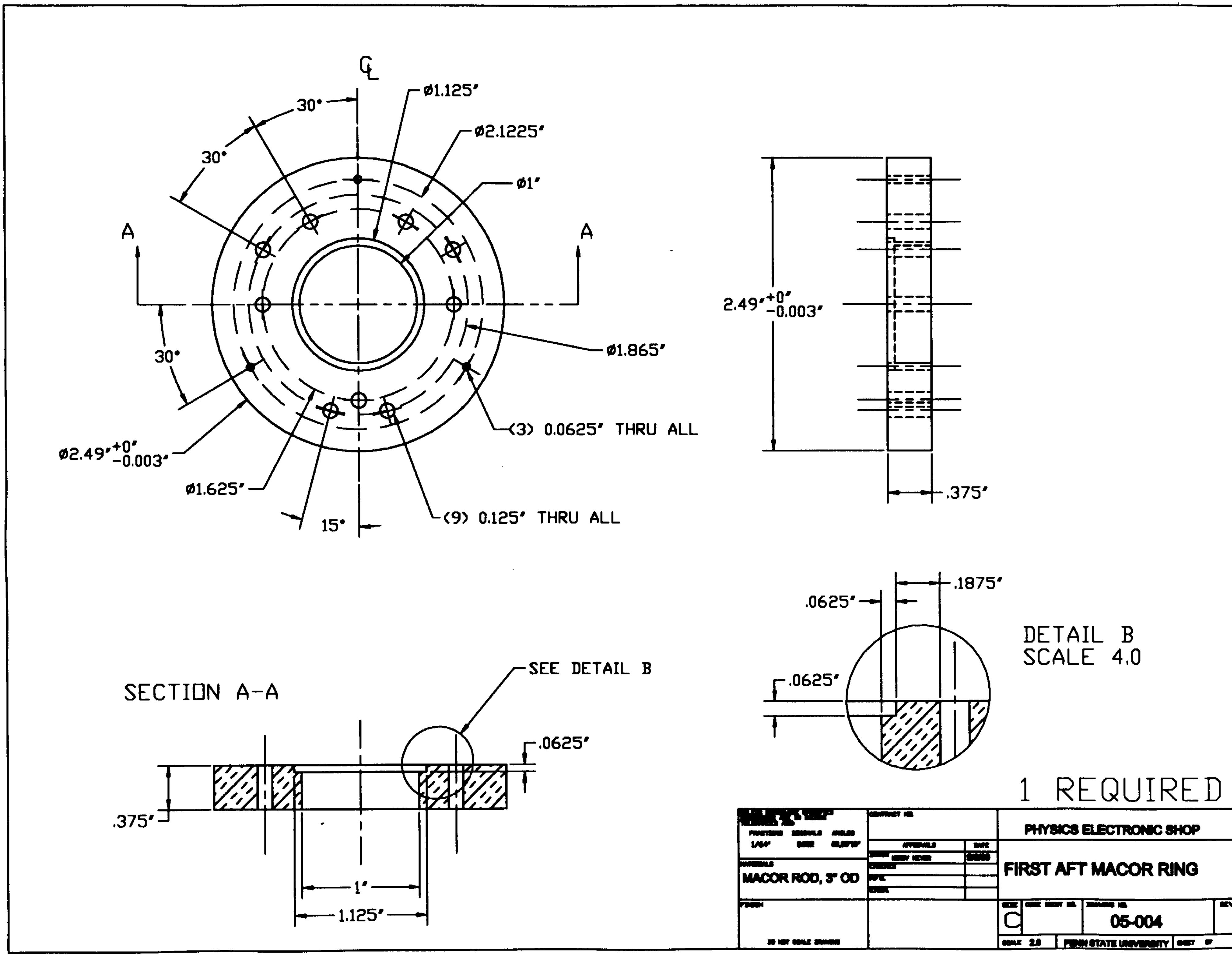
DETAIL B
SCALE 6.0



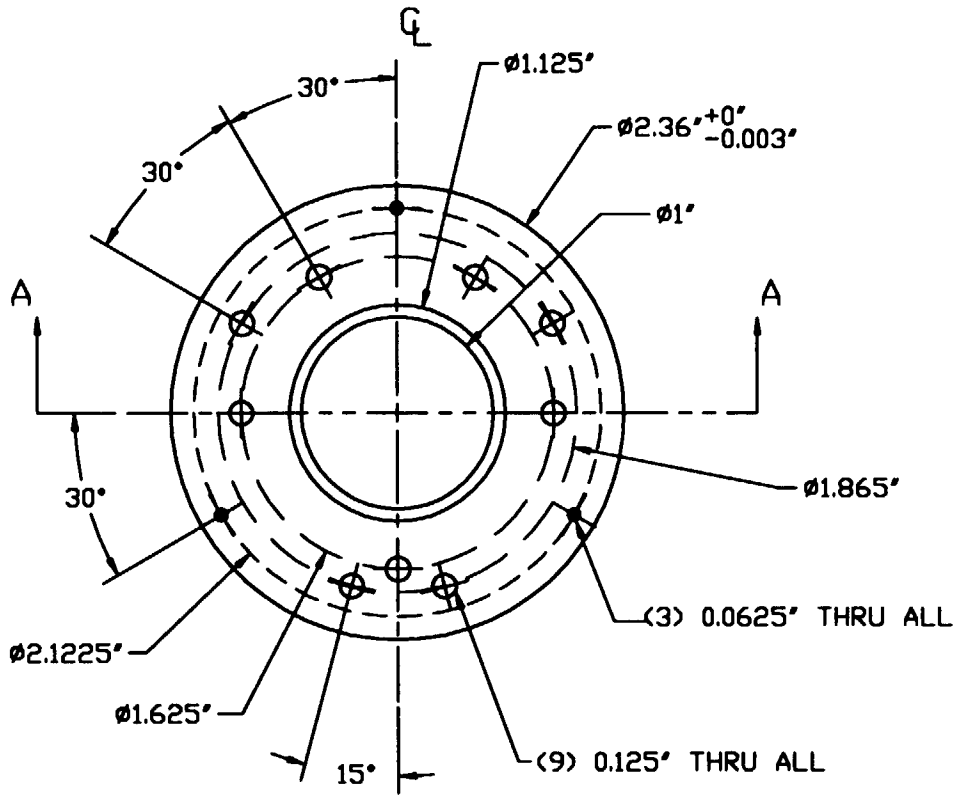


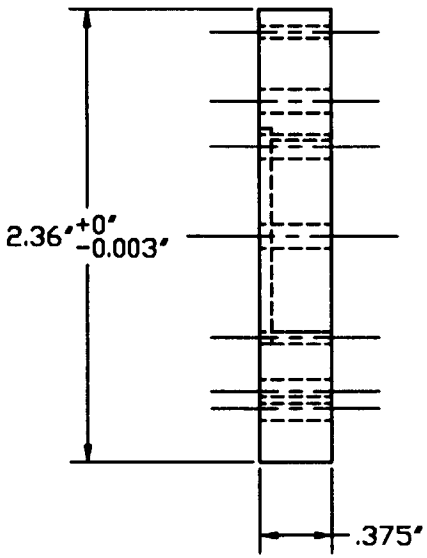
2 REQUIRED

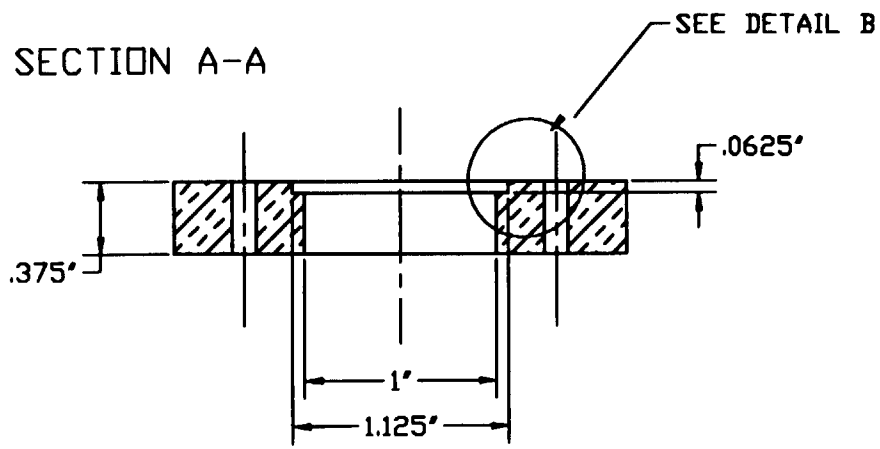
MACOR ROD, 4" OD	PHYSICS ELECTRONIC SHOP	
	ONE-SIDE SPLIT MACOR RING	
	C	05-003
	SCALE 2.0	PENN STATE UNIVERSITY

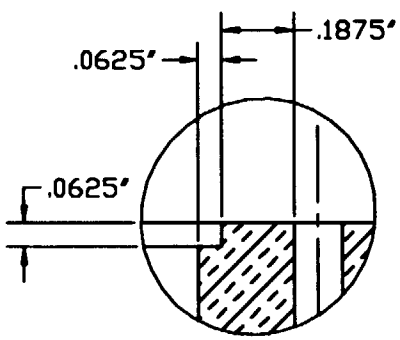


℄
30°
30°
30°
15°
A
A
ø1.125″
ø2.1225″
ø1″
ø1.865″
(3) 0.0625″ THRU ALL
(9) 0.125″ THRU ALL
ø2.49″ +0″ −0.003″
ø1.625″
2.49″ +0″ −0.003″
.375″
SECTION A-A
SEE DETAIL B
.0625″
.375″
1″
1.125″
.1875″
.0625″
.0625″
DETAIL B
SCALE 4.0
1 REQUIRED
PHYSICS ELECTRONIC SHOP
FIRST AFT MACOR RING
MACOR ROD, 3″ OD
C
05-004
PENN STATE UNIVERSITY





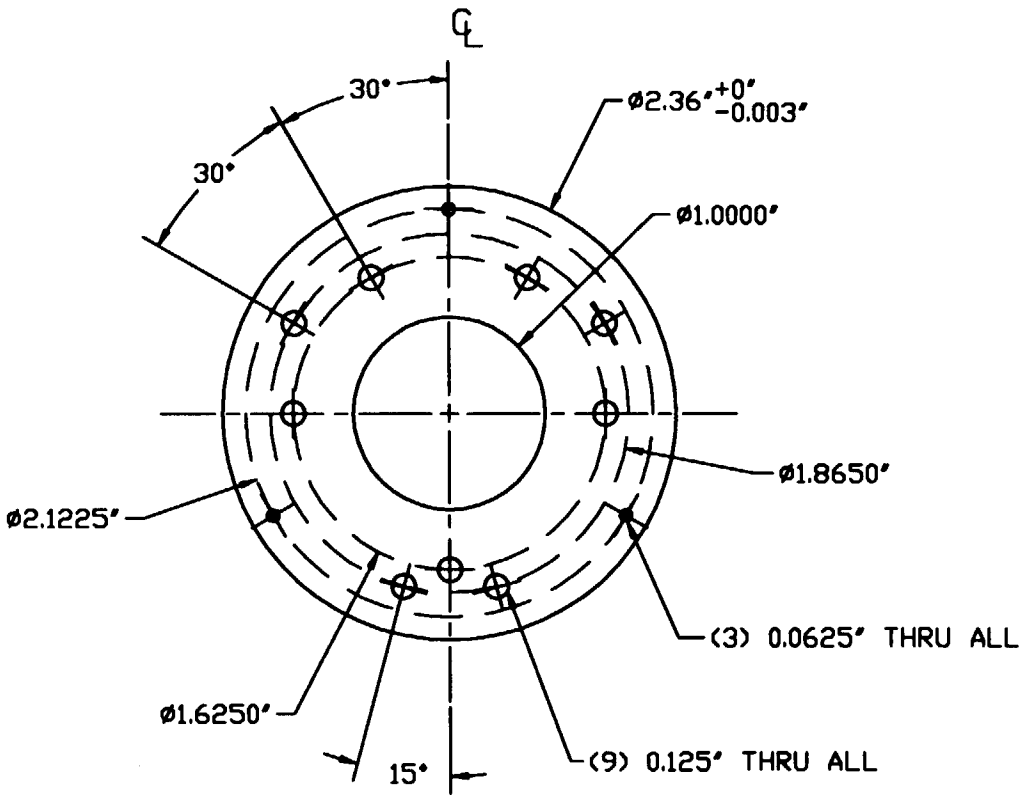


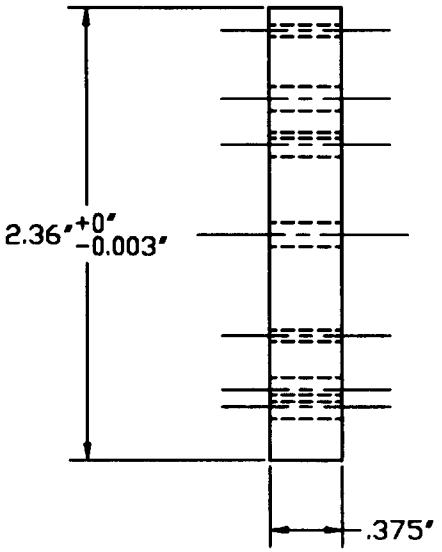


DETAIL B
SCALE 4.0

1 REQUIRED

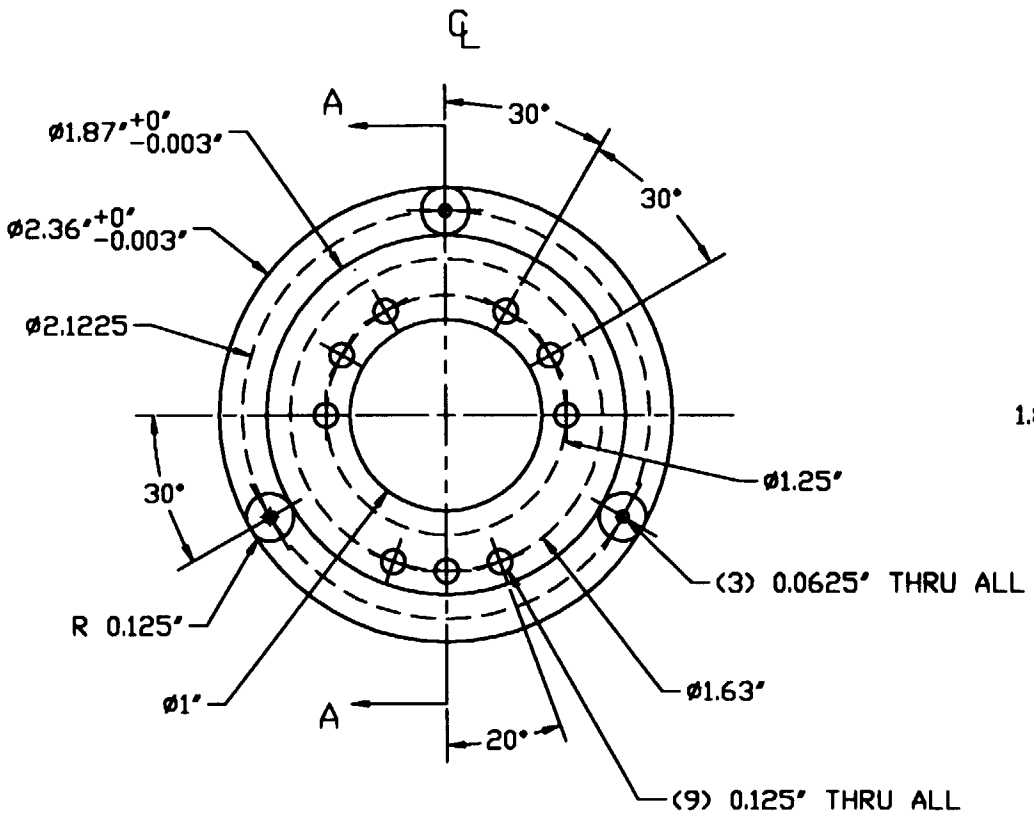
MATERIALS: MACOR ROD, 3" OD		PHYSICS ELECTRONIC SHOP
		SECOND AFT MACOR RING
FINISH: DO NOT SCALE DRAWING		SIZE: C; DWG NO: 05-005; REV:
		SCALE: 2.0; PENN STATE UNIVERSITY; SHEET OF



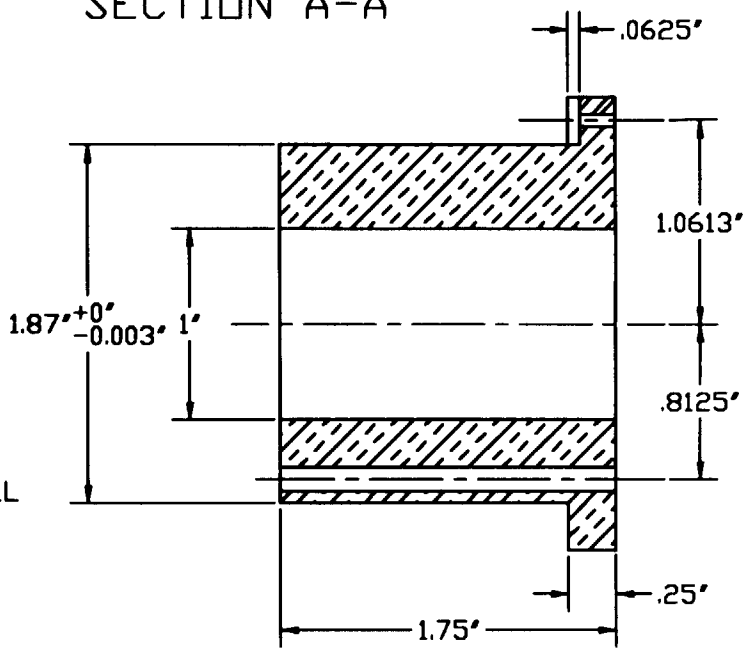


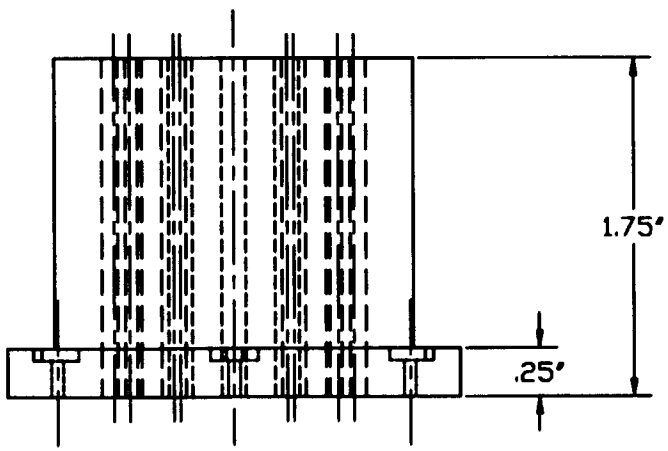
1 REQUIRED

		PHYSICS ELECTRONIC SHOP
MACOR ROD, 3" OD		THIRD AFT MACOR RING
DO NOT SCALE DRAWING		C 05-006
		SCALE 2:1 PENN STATE UNIVERSITY



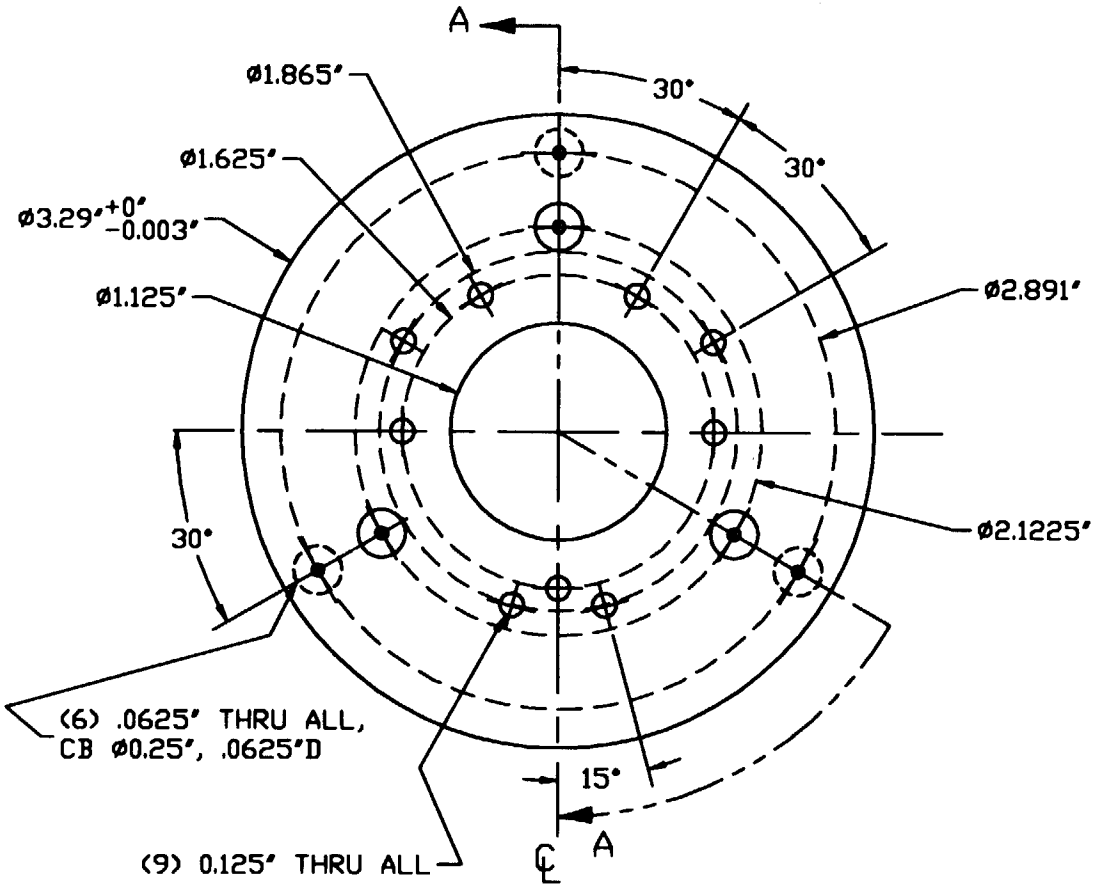
SECTION A-A



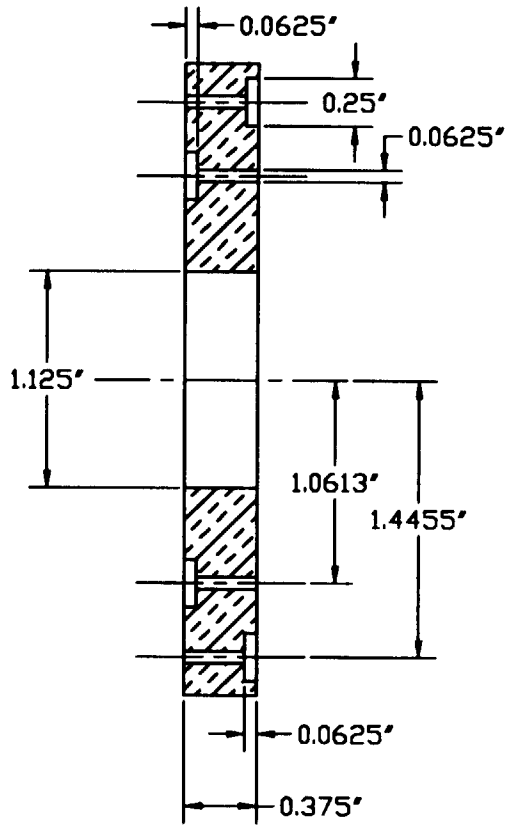


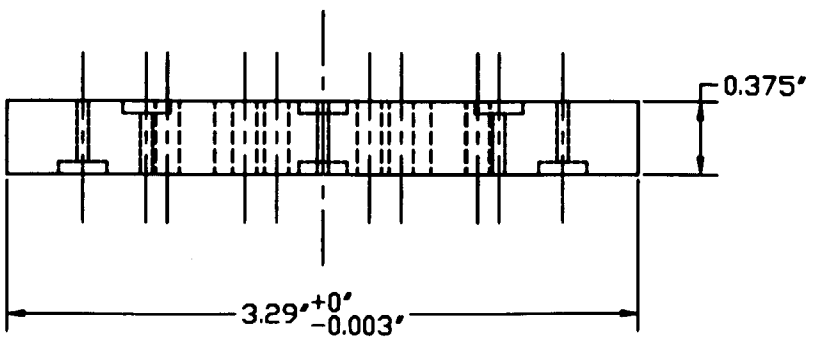
1 REQUIRED

MATERIAL: MACOR ROD, 3" OD	APPROVALS / DATE	PHYSICS ELECTRONIC SHOP
FINISH: DO NOT SCALE DRAWING		FOURTH AFT MACOR RING
		SIZE: C — DRAWING NO.: 05-007 — REV:
		SCALE: 2:3 — FSU — SHEET: 1/1



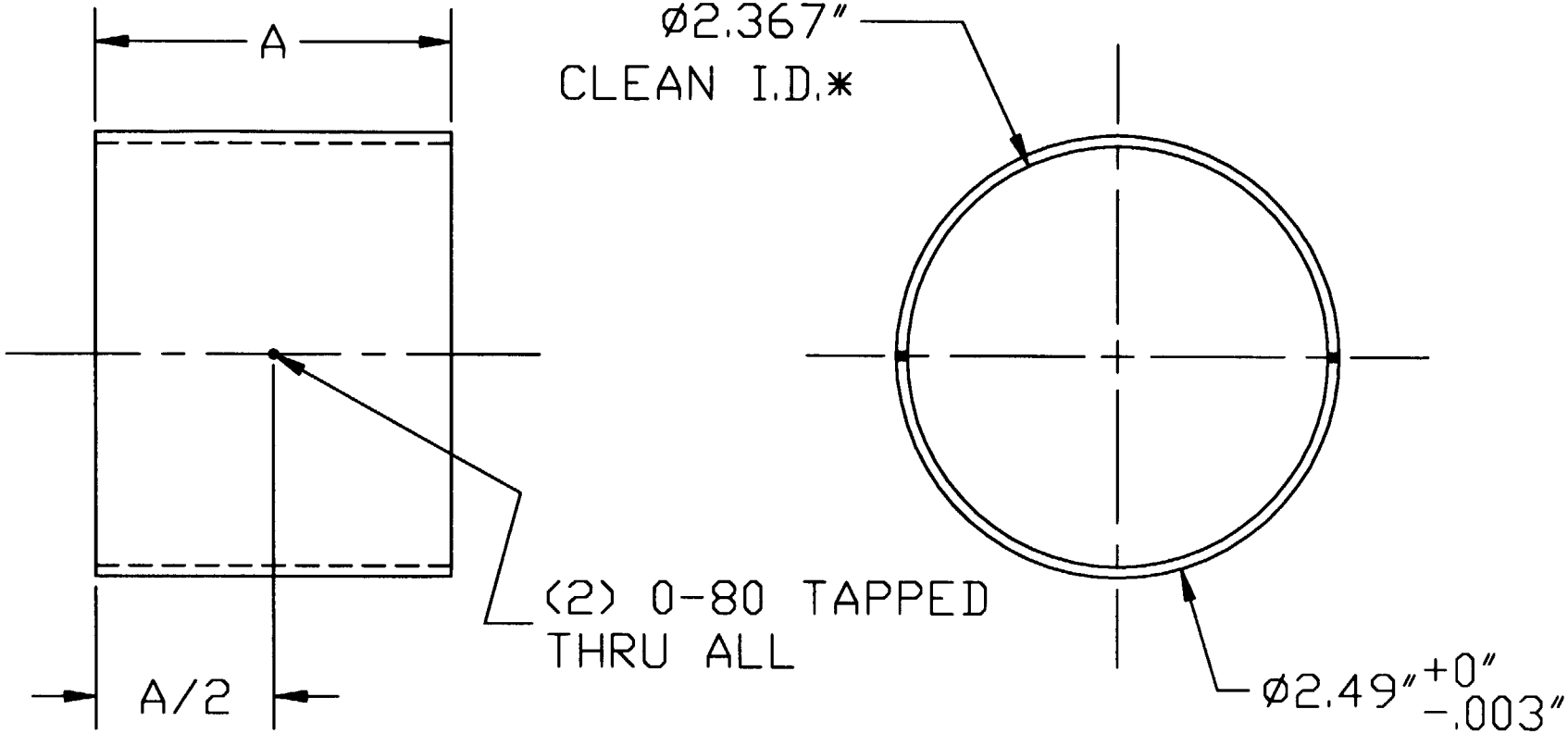
SECTION A-A





1 REQUIRED

MACOR ROD, 4" OD		PHYSICS ELECTRONIC SHOP
		REDUCING MACOR RING
DO NOT SCALE DRAWING	C	05-008
	SCALE 2.0	PENN STATE UNIVERSITY

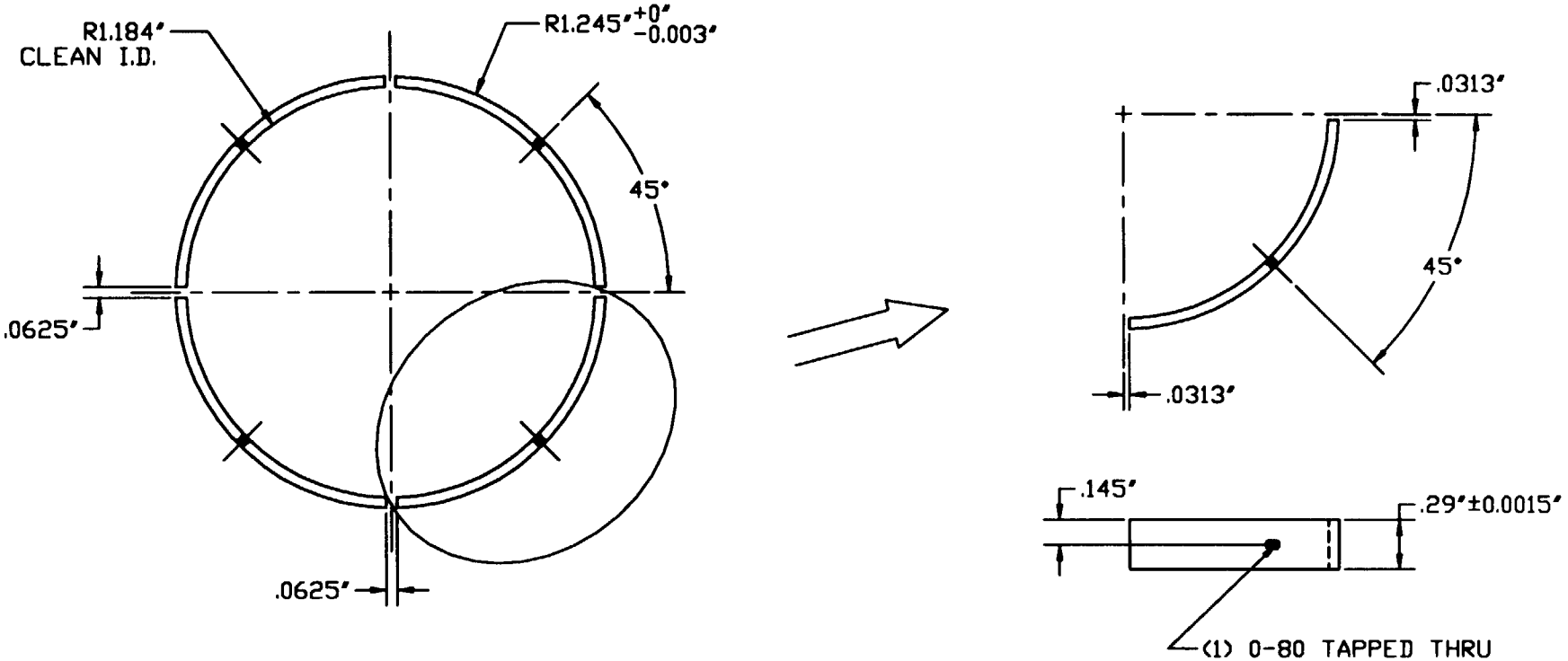


MATERIAL
COPPER, TYPE 101

*NOTE: DO NOT DECREASE I.D.

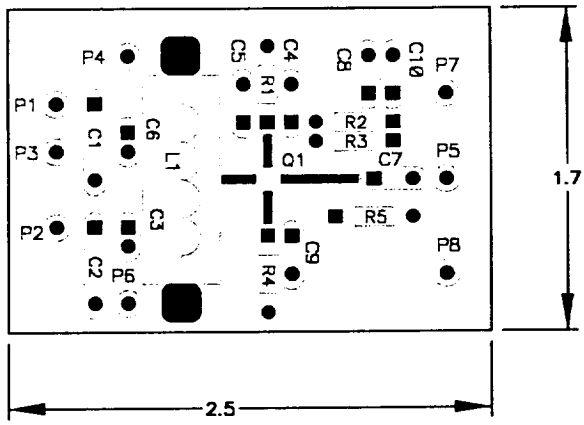
PART NO.	A	QUANTITY
05-009	3.116"	2
05-010	2.683"	2
05-011	1.933"	2

CONTRACT NO.		PHYSICS ELECTRONICS SHOP
APPROVALS	DATE	
DRAWN KIRBY MEYER	5/20/99	ELECTRODES
CHECKED		
MFG.		
ENGR.		
REVISION	SIZE A / CODE IDENT NO. / DRAWING NO. 05-009 / REV.	
	SCALE NONE	PENN STATE UNIVERSITY / SHEET OF



8 PIECES REQUIRED

COPPER, TYPE 101		PHYSICS ELECTRONIC SHOP
		QUAD RING ELECTRODES
		05-012
		FERRIS STATE UNIVERSITY


P4
C5
C4
C8
C10
P7
P1
R1
R2
R3
C6
C1
L1
Q1
C7
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P3
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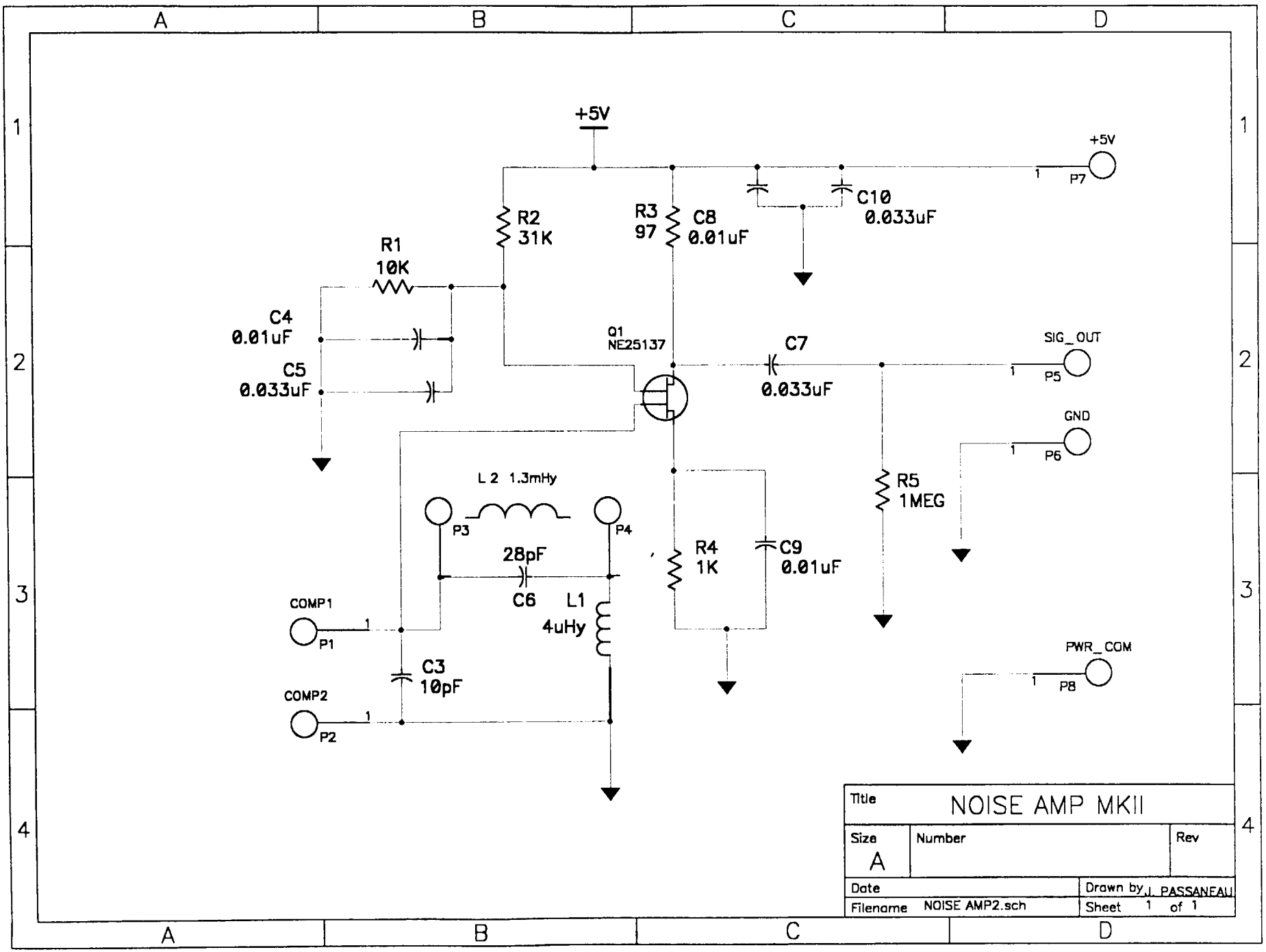
R5
P2
C9
P8
C2
P6
R4
2.5


A
B
C
D
1
2
3
4
+5V
R2
31K
R3
97
C8
0.01uF
C10
0.033uF
+5V
P7
R1
10K
C4
0.01uF
C5
0.033uF
Q1
NE25137
C7
0.033uF
SIG_OUT
P5
GND
P6
L 2 1.3mHy
P3
P4
28pF
C6
L1
4uHy
R4
1K
C9
0.01uF
R5
1MEG
COMP1
P1
C3
10pF
COMP2
P2
PWR_COM
P8
Title
NOISE AMP MKII
Size
A
Number
Rev
Date
Drawn by J. PASSANEAU
Filename NOISE AMP2.sch
Sheet 1 of 1

REPORT DOCUMENTATION PAGE

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OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	16 July 99	Final Tech. 17 July 98 - 16 July 99

4. TITLE AND SUBTITLE
Design and Fabrication of Cryostat Interface & Electronics for High Performance Antimatter Trap (HI-PAT)

5. FUNDING NUMBERS
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TA H-30186D

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Unlimited availability

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Work has been completed on the design and fabrication of the high vacuum trap assembly. After vacuum tests and electronics tests the trap was shipped to Marshall Space Flight Center.

14. SUBJECT TERMS
completion of assembly
vacuum tests
electronics tests

15. NUMBER OF PAGES
52

16 PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL