AUTO-CONTROL LABORATORIES INC

...ES AND PALO ALTO, CALIFORNIA

FACILITY FORM 602

N65-35416 (ACCESSION NUMBER) — (PAGES) — CR 67146 (NASA CR OR TMX OR AD NUMBER)

N65-35416 (THRU) — 1 (CODE) — 15 (CATEGORY)

GPO PRICE $ _____

CSFTI PRICE(S) $ _____

Hard copy (HC) 1.00

Microfiche (MF) .50

ff 653 July 65

HIGH TEMPERATURE THERMOCOUPLE

RESEARCH AND DEVELOPMENT PROGRAM

APPENDIX I

DRAWINGS AND DESIGN NOTES

To

SUMMARY REPORT NO. T-1097

Contract Number NAS 8-5438

Request Number TP 3-83547

Prepared for

GEORGE C. MARSHALL SPACE FLIGHT CENTER

Huntsville, Alabama

Work Performed By

AUTO CONTROL LABORATORIES, INC.

5251 West Imperial Highway

Los Angeles 45, California

Date of Publication 18 June 1965

Prepared By: R. R. Smith, Jr.

R. R. Smith, Jr.

APPENDIX 1

DRAWINGS AND DESIGN NOTES

INDEX

APPENDIX 1

DRAWINGS AND DESIGN NOTES

INDEX

APPENDIX 1

DRAWINGS AND DESIGN NOTES

LIST OF DRAWINGS

APPENDIX 1

DRAWINGS AND DESIGN NOTES

LIST OF DRAWINGS

APPENDIX I

DRAWINGS AND DESIGN NOTES

1.0 GENERAL

The drawings incorporated in this appendix show details of fabrication for all three classes of gauges, submitted under the contract. They consist of piece part drawings, assembly drawings, and outline drawings. The drawings are grouped in three categories:

a. Mandrel Parts and Assembly

b. 4735 (First Generation) Parts and Assembly

c. 4735 (Second Generation) Parts and Assembly

A seperate set of parts drawings for the third generation gauges was not deemed necessary because the mandrels, body piece parts, and sheath are identical to the second generation parts.

2.0 Description of First Generation Gauges

Features of the ACL Type 4735 first generation gauges are described as follows:

2.1 Sheath

The length of the exposed portion of the sheath was 1.8 inches.

2.2 Body

The body of the gauge was shortened by .15 inches to reduce the overhang

2.2 Body (Cont'd.)

at the back end and minimize the reaction to dynamic loads.

2.3 Insulation, Electrical

Primary insulation was hard-fired Beryllium Oxide tubing. Secondary insulation was compacted Magnesium Oxide powder, between the inner wall of the sheath and the outside wall of the Beryllium Oxide tube. Magnesium Oxide powder was also used to fill other voids within the body.

2.4 Oxidation Protection

The sheath of the probe was treated with a thin coating of Silicon. To afford a maximum of protection to the internal parts of the gauge, the final assembly was made in an atmosphere of Argon.

2.5 Lead Wires

The leads were glass-insulated, and fed through a stainless steel tube. Harco compensated lead wire was used.

2.6 Transition Section

The transitions from the Tungsten sheath to the positive compensated lead were made by nickel brazing in an inert atmosphere. This technique was chosen because 1) it is recommended by authorities* on the brazing of Tungsten, and 2) it was successfully employed by ACL in the Type 4734

*Fansteel Metallurgical Corp., Chicago, Illinois

2.6 Transition Section (Cont'd.)

gauges. Examination of the two Type 4734 gauges tested at N.A.S.A. revealed that the braze joints made with this technique were not affected by the tests.

2.7 Body

The bodies were assembled using torque values necessary to effect sealing against 2000 psig.

2.8 Sheath Installation

The sheath was installed as shown in Figure 4735-00. The platinum wire spiral was welded to itself at two points; one at the front of the cone, the other at the back of the cone. Upon tightening, the platinum deformed to effect a seal between the sheath and the union in which it was mounted. Good alignment and centering resulted from this method. Platinum was used because of its good ductility, relatively high melting point, and resistance to oxidation.

2.9 Lead Wire

The individual compensated lead wires were insulated with fibreglass and fed through a length of stainless steel tubing welded to the cap of the body assembly. A standard ACL seal was used at the end of the lead wire tube. The tubing could then be bent with an ordinary tubing bender

2.9 Lead Wire (Cont'd.)

to accomodate the installation. This type of lead wire arrangement was tested at ACL and was found to function within acceptable limits of accuracy.

2.10 Union Material

It was planned to fabricate the union, (P/N 4735-31-3) by which the gauge is mounted, from fully annealed Tantalum, because of its refractory characteristics, and compatibility with Tungsten and Platinum. Long lead times for the Tantalum material, and difficult machining problems precluded the possibility of using this approach. Therefore, the union was made of 300 Series stainless steel, as in the Type 4734 gauges.

During examination of two Type 4734 probes, after they had been run at high temperature, neither of the stainless steel unions showed adverse effects from the tests, for the period of the runs.

3.0 Sheath Formation

The sheath and junction of the ACL Type 4735 gauge were formed by a vapor deposition process. This work is performed under a process developed by San Fernando Laboratories, Inc., Pacoima, California. The sheath assemblies are made in accordance with drawings provided by ACL.

Steps in the fabrication are as follows:

3.0 Sheath Formation (Cont'd.)

a. A mild steel mandrel is machined to the interior configuration desired, with allowance made for the electrical insulator, differences in expansion coefficients, etc.

b. The mandrel is provided with a steel mounting base for securing to the forming apparatus.

c. A piece of Tungsten - 26% Rhenium (W-26Re) wire of the desired diameter, and length, is introduced through a hole in the tip of the mandrel, and is secured with a set screw in the mandrel holder. The protrusion of the W-26Re wire is set to the required distance outside the mandrel tip. It is important that the Tungsten-Rhenium alloy wire does not extend through the Tungsten, such that it is exposed after fabrication, to avoid the formation of an eutectic during the oxidation resistant coating process.

d. The mandrel assembly is located in a closed furnace, and is heated electrically to a predetermined temperature. A controlled flow of Tungsten Hexafluoride (WF_6) is introduced into the furnace and the Tungsten is deposited on the mandrel to the required thickness. In the process, the Tungsten conforms precisely with the form of the mandrel.

e. The junction between the Tungsten sheath and the Tungsten - 26% Rhenium alloy wire is formed simultaneously with the sheath formation described above.

f. The mandrel may be removed from the deposited assembly by

3.0 Sheath Formation (Cont'd.)

f. (Cont'd.)

either withdrawing the mandrel after heating, or, if the shape of the mandrel precludes withdrawal, by etching the mandrel out with Hydrochloric acid (HCl) which does not attack either the Tungsten or the Tungsten-Rhenium. Minor surface finishing is accomplished by grinding. Trimming is performed with an air-driven, high speed slotting disc, surfaced with diamond or carbide particles.

3.1 Other Refractory Sheaths

Although limited success had been experienced with Tungsten as a sheath material for the ACL Type 4734 gauges, investigations into other refractory materials continued. Results are as follows:

3.2 Tungsten-Rhenium Alloys

Tungsten-Rhenium alloys had been considered for use as an outer sheath because of their greater ductility, as compared to pure Tungsten. Others had reported success with this technique, as a means of fabricating high temperature thermocouples. However, when an attempt was made to apply a protective disilicide coating, an eutectic formed. Therefore, since protection is required and alternate types of suitable protective coatings are not presently available, this type of material has been at least temporarily shelved.

3.3 Tantalum w/BeO Insulator

Tantalum has been widely used as sheathing because of its excellent formability and high melting point. It had been considered for such use in high temperature thermocouples, until it was reported that a definite reaction with BeO, after long term exposure at 1600°F, was observed. When it is considered that the speed of reaction increases almost exponentially at the higher temperatures, this combination of materials was dropped.

3.4 Filament Wound-Tungsten Tubing

Presently under development is a new type of structure for Tungsten tubing, in which Tungsten filament approximately .002 inch diameter is angle-wound around a mandrel of the desired i.d., and is laid up in layers to the desired wall thickness. This assembly is then placed in a deposition furnace, and pure Tungsten is deposited to fill the voids between filaments. The end result is a Tungsten tube whose tensile strength may approach that of the filament (300,000 psi). At present, such tubes are a laboratory curiosity.

4.0 Form

During discussions with NASA technical personnel, it developed that flow conditions could not be well defined until a mounting point in the area of ultimate use could be selected. Therefore, it was agreed that the first group of gauges to be delivered should incorporate a

4.0 Form (Cont'd.)

geometry applicable to the widest possible variety of usage consistent with obtaining test data within a limited set of early objectives.

The geometry of the gauges is defined as follows:

a. Immersion depth - approximately 2 inches.

b. Mounting - screwed, male, 7/16" -20 UNF.

c. Sheath diameter - minimum .250 inches, maximum any dimension acceptable by the 7/16" -20 fitting.

d. Sheath form - tapered cylindrical.

e. Base configuration - similar to ACL Type 4734 gauges, but incorporating improvements in materials, design, and potting. The design approach given above is discussed in more detail below.

4.1 Immersion Depth

The immersion depth of approximately 2" was chosen for the following reasons:

a. Calibration tests performed by an independent agency (Southern Research Institute), see Appendix 2, revealed a consistency of deviation from actual temperature with immersion depth. The tests were limited to 1-5/16" because of the dimensions of the isothermal cavity used. Extrapolation of the test data of temperature versus immersion depth yields an immersion depth of approximately 2" for stabilization of the predicted output

4.1 Immersion Depth (Cont'd.)

a. (Cont'd.)

emf curve vs. temperature with a tolerable deviation from actual temperature at the sensing junction of the gauge.

b. The two inch immersion seems a reasonable cantilever under the requirements for shock and vibration. Since finite values for strength of the materials is not presently available, no attempt at a rigorous structural analysis of the sheath was made.

4.2 Mounting

Mounting provisions were based upon available and existing means of insertion for test and evaluation; i.e., a 7/16" -20 UNF boss.

4.3 Sheath Diameter

Maximum sheath diameter was limited by the 7/16" -20 screwed connection.

4.4 Sheath Form

A tapered cylindrical form was selected for the first group of probes as a suitable compromise between desired shape for low drag at high mass velocity flow, because of decreased projected area, decrease of mass from base to tip for resistance to dynamic forces, vibration and shock, improved response because of decreased mass at the sensing junction. A practical consideration also influencing the selection of this shape was

4.4 Sheath Form (Cont'd.)

that of cost. The tapered rhombus, wedge, and biconvex cross sectional shapes all would be considerably more difficult to produce and would, as a consequence, cost more per unit. It was felt, therefore, that the overall objectives of the program would be best served by conserving funds wherever possible, while performing investigations and collecting the largest practical amount of test data for analysis.

4.5 Base Configuration

The ACL Type 4734 gauges incorporated a base configuration which was shown by test to be unsuitable for the following reasons:

a. The temperatures reached at the "cold" end of the sheath were considerably above those anticipated. Because of the high temperature rise in the sheath of the gauge, the body metal (series 304 Stainless Steel) was raised to temperatures higher than desirable, even during relatively short runs, despite the presence of a large heat sink in the steel deflection shield.

b. The rise in temperature in the body caused the potting material (Sauereisen No. 25) to swell and, in some cases, run and extrude through openings.

c. In one instance, a gauge sheath was observed to have been broken at its juncture with the deflection shield after a run under high temperature and high mass velocity. It was suspected that vibratory contact of the Tungsten sheath against the base, across a void created by loss of the Sauereisen may have been

4.5 Base Configuration (Cont'd.)

c. (Cont'd.)

contributory, because of loss of damping.

5.0 PROTOTYPE DESIGN

The design features of the 1st generation gauge sheath, and forming mandrel are shown in ACL Drawing Number SK4735-21. The block of Drawing Numbers 47XX-XX was assigned to this project in order to properly identify all gauges, components, piece parts, etc.

5.1 Design Notes

The design approach shown in ACL Drawing No. SK4735-03 for the sheath assembly was modified to that shown in ACL Drawing No. 4735-21. The reasons for making the change are:

a. The incorporation of the Tungsten slug in the assembly affords an improved means of locating and holding the sheath assembly in the body, shown in ACL Drawing No. 4735-01. This arrangement permits high levels of compression without directly loading the relatively thin wall of the sheath. The slug and the sheath both have the same coefficients of thermal expansion (4.0×10^{-6} per °C). Additionally, the extension of the sheath into the body of the gauge provides a means of locating the transition section in the "coolest" possible part of the assembly. The mandrel assembly, used in formation of the

5.1 Design Notes (Cont'd.)

a. (Cont'd.)

sheath assembly, is shown in ACL Drawing No. 4735-21. The assembly sketch of 4735-00 shows details. For damping, sealing, and thermal transfer purposes, platinum wire is coiled on each of the two conical surfaces of the sheath assembly. The platinum is ductile, has a high k, is oxidation resistant, and has a relatively high melting point (1773°C). Its linear coefficient of expansion (8.8×10^{-6} per °C), is such that, as the temperature in the mounting region rises, the compressive fit becomes greater by the net difference in coefficients of thermal expansion.

The type of threaded construction in the body lends itself to the use of metal-to-metal sealing in body joints, if a high degree of sealing is required against either vacuum or pressure. Insulation in the body was Magnesium Oxide, compacted by vibration and compression.

Insulation around the center conductor was hard fired Beryllium Oxide tube in the region from the slug to within one half inch of the tip. Magnesium Oxide tubing was used in the region from the slug to the back end. Compacted powdered Magnesium Oxide was used between the vitrified central tubes and the interior of the sheath to afford both support and internal damping.

5.2 Second Generation Gauges

Design of the second generation gauges was predicated upon tests of first generation gauges. Major objectives for improvement were: elimination of lead wire errors, reduction in weight and size, increased integrity of the transitions from the sheath and center conductors to their respective leads, elimination of insulator problems within the sheath, and simplification of sheath fabrication. Drawing Number 4735-00 (second generation) shows details.

5.3 Body

The body in the second generation gauges is fabricated from series 300 stainless steel. The body length was reduced to 2.875 inches, and the diameter to .75 inches. The 7/16" -20 UNF mounting was retained. All other external threads were eliminated. The internal scheme for retaining the sheath assembly in the body was not changed. However, the retaining nut was reduced in length to .50 inch. The threaded connections previously used to make up the body, were replaced with a weldment between the body proper and a conical stainless steel cap, which replaced the internally threaded cap. In the final stage of assembly, the aft portion of the cap was welded to the stainless steel lead wire sheath. The body was thus rendered leak proof, and highly resistant to environmental stresses.

5.4 Sheath Assembly

The sheath assembly was essentially the same as previously used in the first generation gauges. The aft portion of the sheath was shortened to .687 inches. The front end remained the same. As a consequence, the immersion depth was the same.

5.5 Insulators

The Beryllium Oxide insulation in the immersed portion of the gauge was eliminated, because of the unavailability of a suitable insulator for use at the temperatures of interest. Magnesium Oxide double bore insulation was used from the double conical retaining slug back to the lead wire. Compacted Magnesium Oxide powder was used to fill all voids remaining in the body cavity prior to final assembly. This also provided vibration damping for the lead wires in the transition section.

5.6 Lead Wire

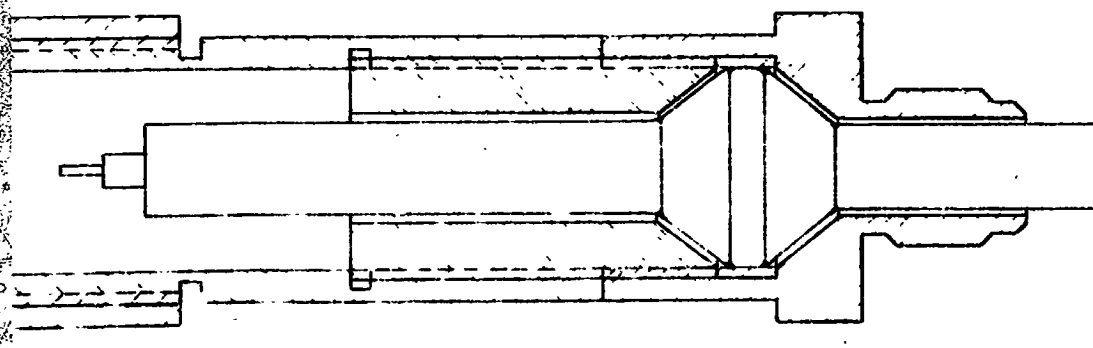
Tests clearly indicated the errors introduced in the output of the gauge due to the use of compensated lead wire, where the temperature of the transitions are not controlled within manufacturers recommendations. The possibility of providing gaseous coolant to the body of the gauge was discussed with M-ASTR-I personnel. However, it was felt that this should be seriously considered only if it proved impossible to utilize other means of eliminating the lead wire error. The most obvious solution to the lead wire problem was to use Tungsten and Tungsten 26

5.6 Lead Wire (Cont'd.)

Rhenium. It is entirely practical to bend these materials in wire form if the bend radius is kept large in relation to the wire diameter. The Tungsten 26 Rhenium is quite ductile and does not become brittle upon temperature cycling. The Tungsten wire does become brittle; however, the temperature in the lead (aft of the body) was not expected to be high enough to induce embrittlement in the Tungsten lead. At the transition between the Tungsten lead and the Tungsten sheath, the temperature may become quite high. In a prototype constructed for test, three turns of Tungsten wire were made around the end of the sheath. This method has yielded good results.

Top OF DIAGRAM
, #

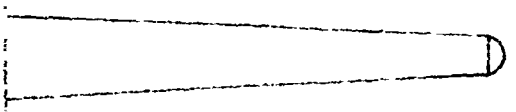
2#



4735-01

THERMOCOUPLE, HIGH TEMP., TOP ASSEM

3#



4

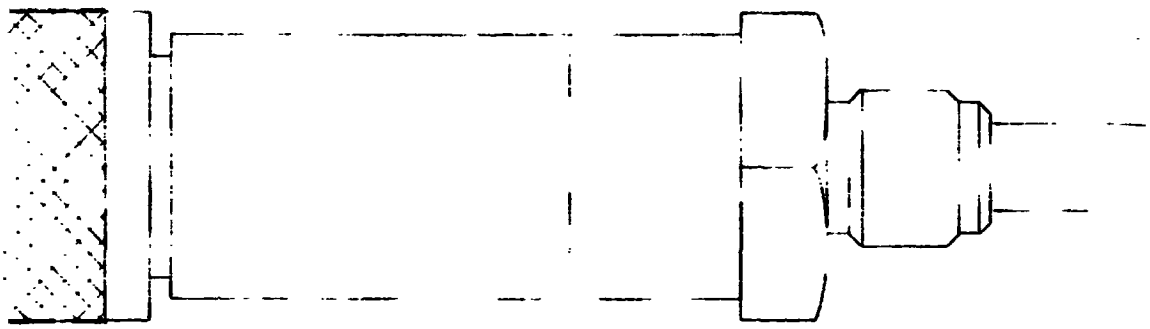
5#

REVISIONS

DESCRIPTION	DFTMN		DATE	APPROVAL

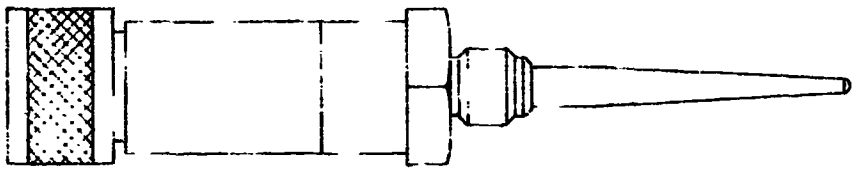
Bottom of Diagram
6#

74

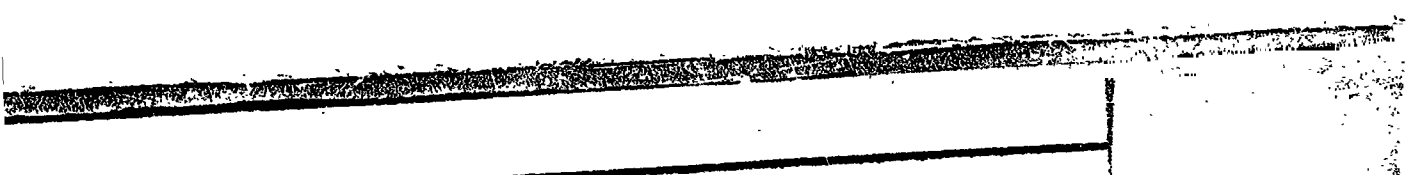


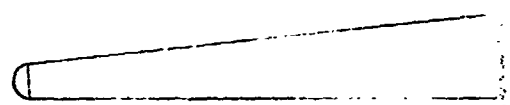
HET-30

THE MOCKUP F HIGH TEMP. OUTLINE



ACTUAL SIZE





9A

ITEM NO.	DESCRIPTION	Q

TOLERANCES

LINEAR DIMS – EXCEPT AS NOTED:
1" AND UNDER ± 1/32
1 1/32" to 12" ± 1/16
13" AND OVER ± 1/8
SUB-ASSEMBLY CLEARANCE:
DOORS 1/16" MIN.
1/8" MAX.
TRAYS, TRIM, & OTHER
SUB-ASSEMBLIES TO FIT WITHIN
1/32 MIN.
3/32 MAX.

APPR. BY	DATE
CHECKED BY	DATE
DWG. BY	DATE

△ CHANGE LETTER

* CUSTOMER FURNISHED I

◇ ITEMS TO BE SHIPPED L

10#

PAGE No. 16

TY.						REMARKS

THERMOCOUPLE, HIGH TEMP - OUTLINE

Q#

J# T-1097

NEXT ASSY.

SCALE 2x

WT.

AUTO CONTROL LABORATORIES, INC.

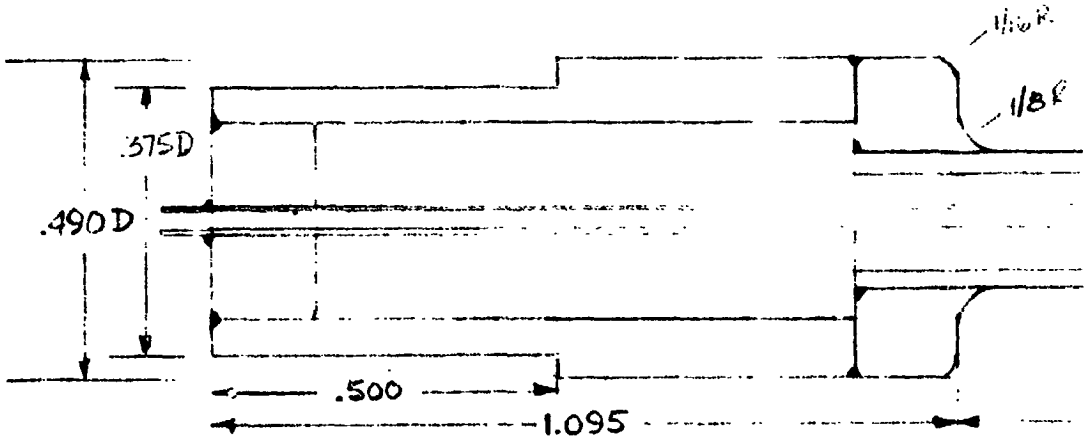
LOS ANGELES 45, CALIFORNIA

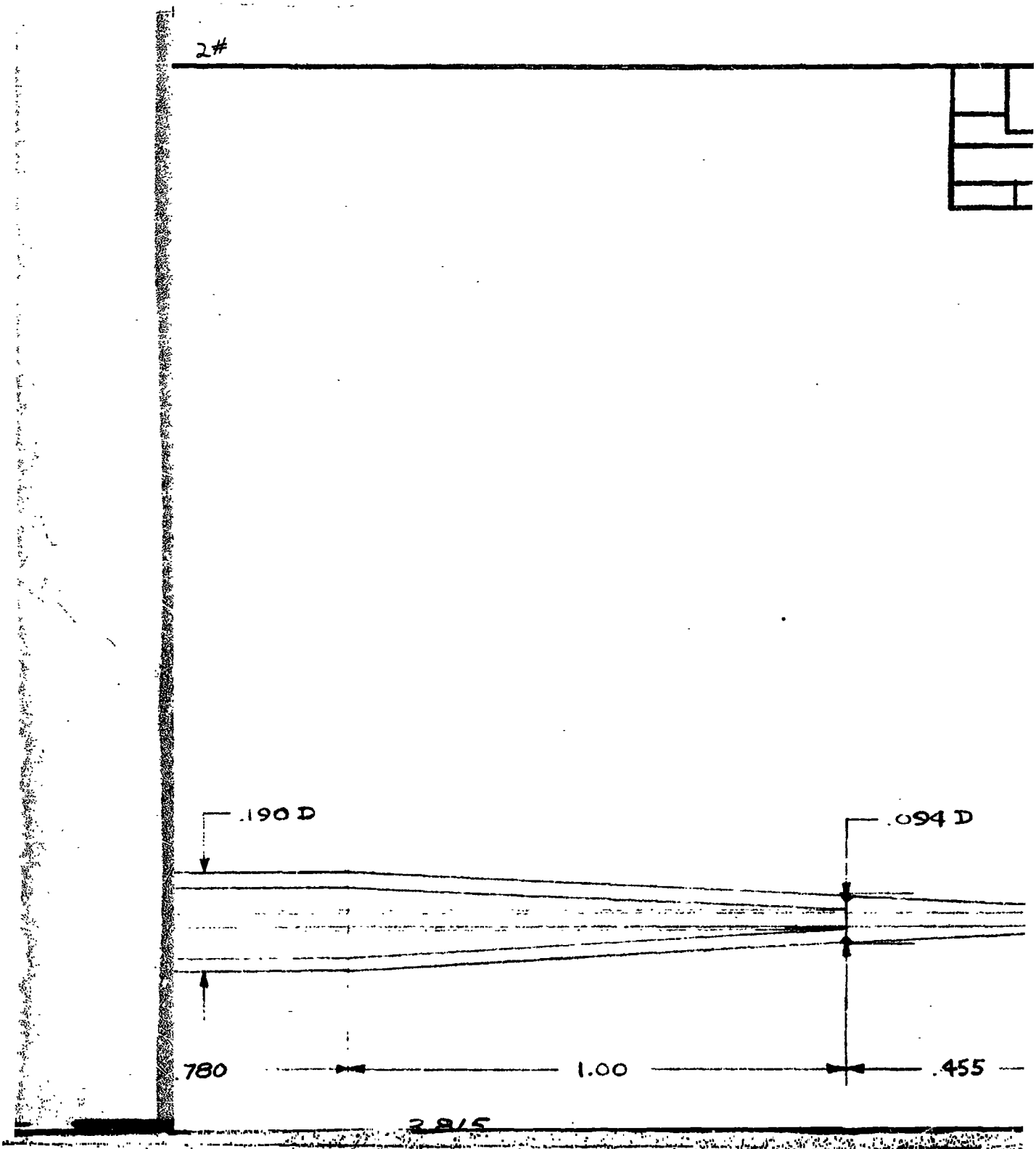
D4735-00

REV.

SHEET OF

TOP OF DIAGRAM 1#

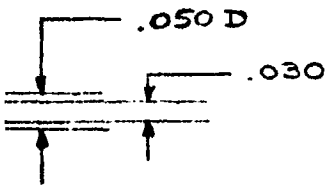



2#
.190 D
.094 D
.780
1.00
.455
2.845

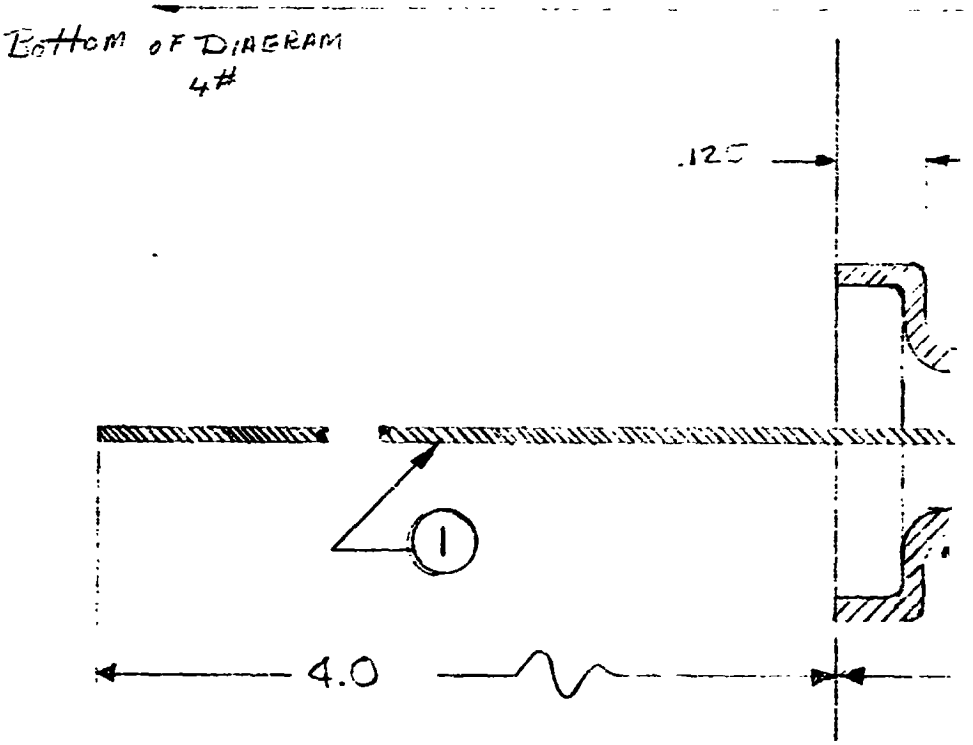
3#

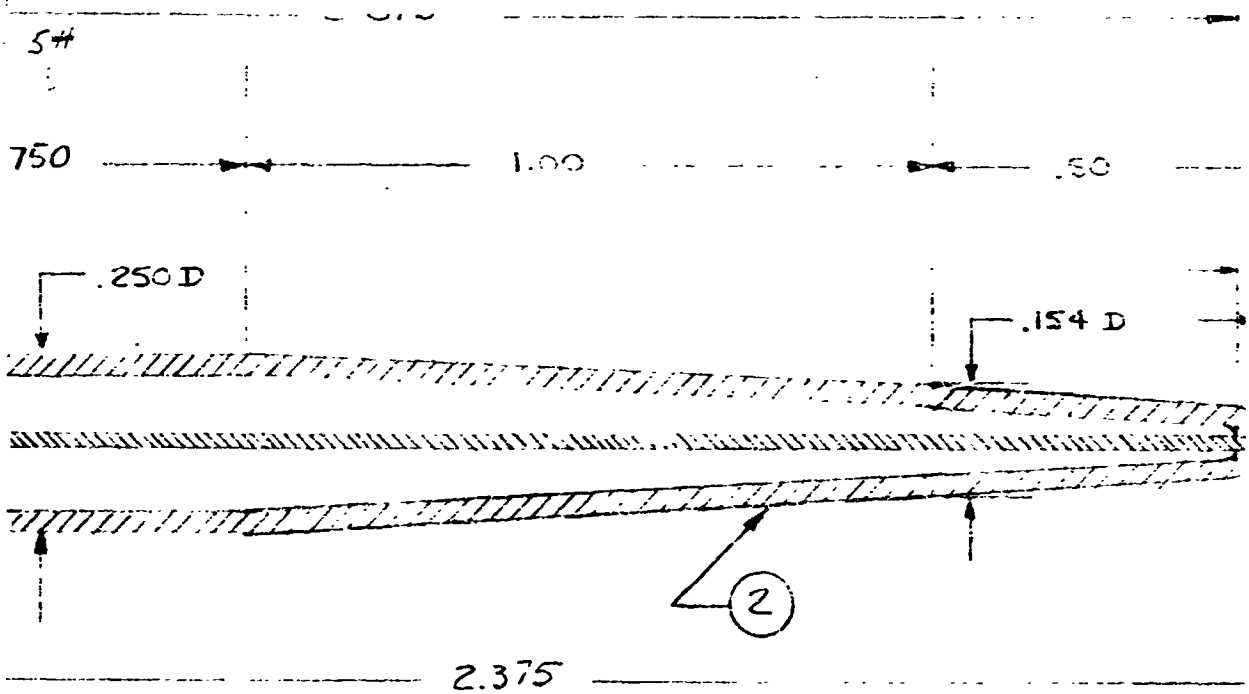
REVISIONS

DESCRIPTION		DESIGN		DATE	APPROVAL



MANDREL, MILD STEEL



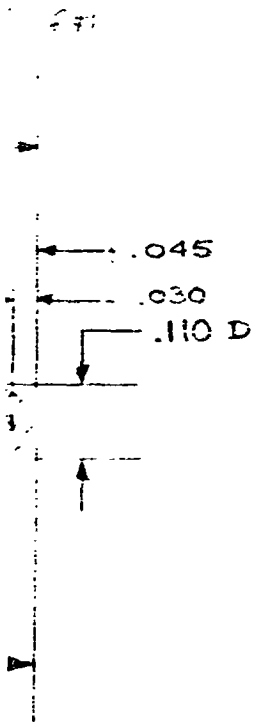


ITEM NO.	NO. REQ.
APPR. BY	
CHECKED BY	
DWG. BY	

△ CHANGE

✱ CUSTOM

◇ ITEMS T



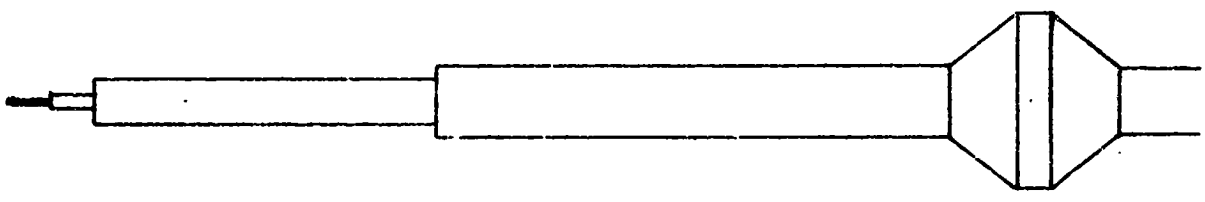
SHEATH, W-W26RE

(1) W-W26Re, .020 DIA.

(2) W, .030 W.T.

DESCRIPTION		PART NO.	MFGR.
DATE	PROTOTYPE MANDREL & SHEATH ACL TYPE 4735 THERMOCOUPLE	AUTO CONTROL LABORATORIES, INC.	
DATE			
DATE			
	PROCESS SPEC.		
LETTER	Q#		
IER FURNISHED ITEMS	J# T-1097		
O BE SHIPPED LOOSE	NEXT ASSY.	SK 4735-03	
	SCALE / WT.		

Top of DIAGRAM
1#

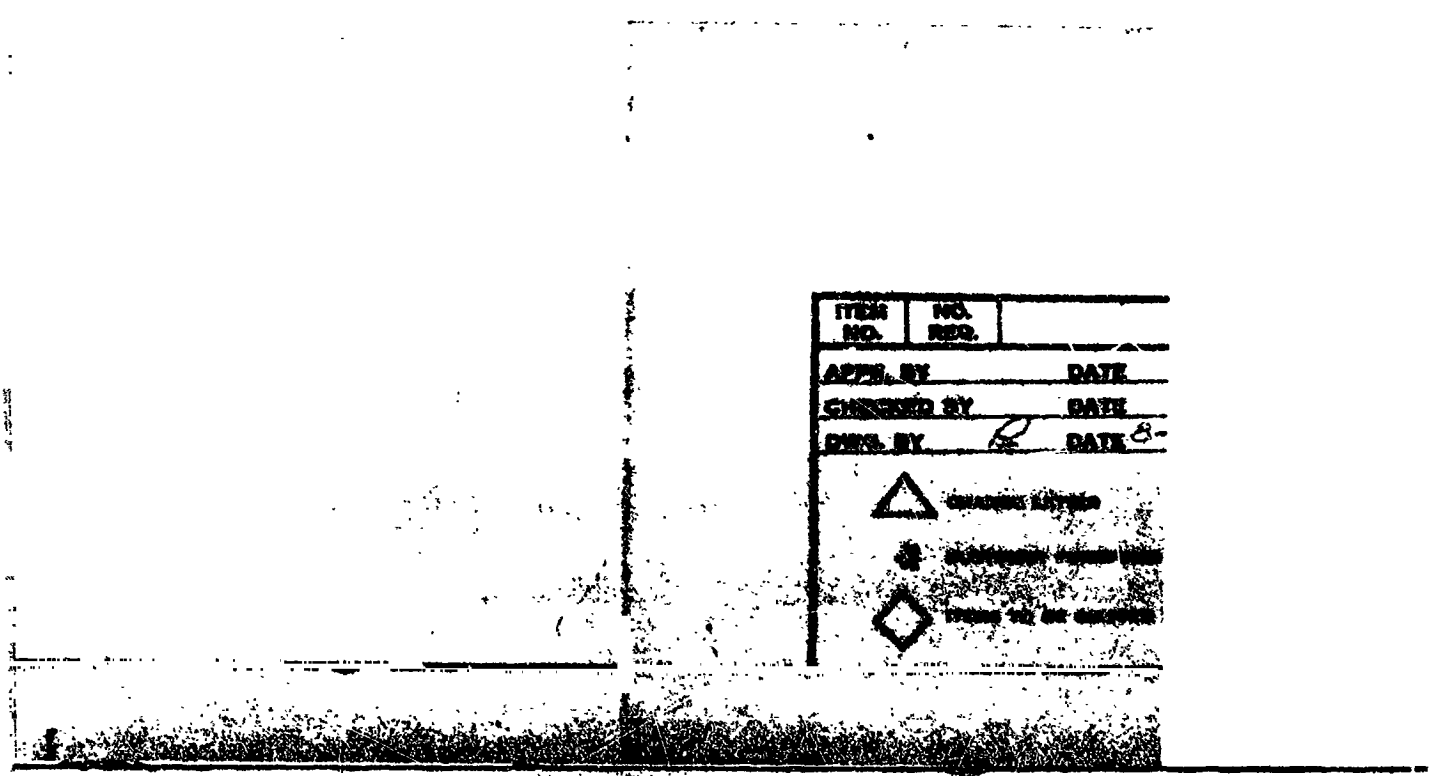


#2

3H

Bottom of Diagram
4th

5A

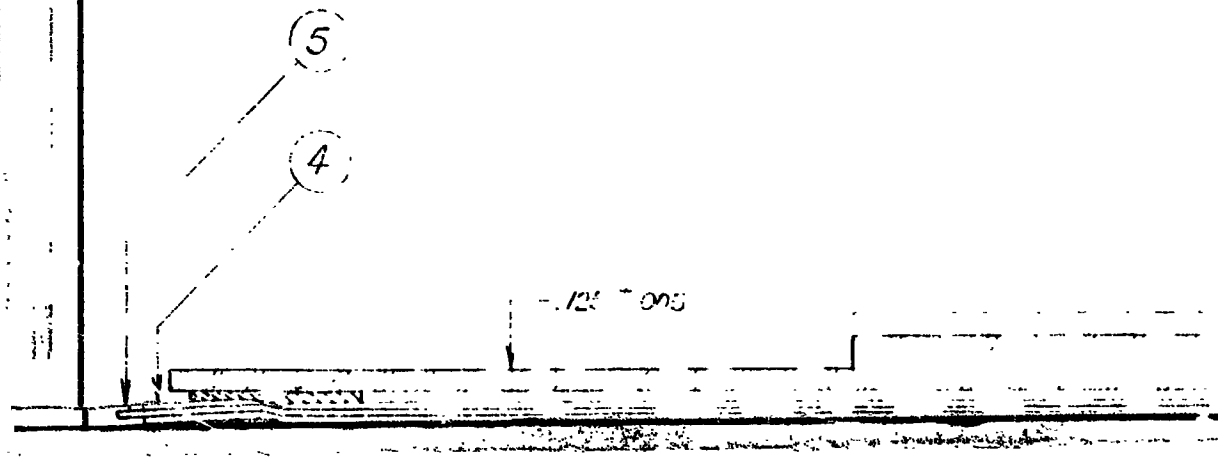


6#

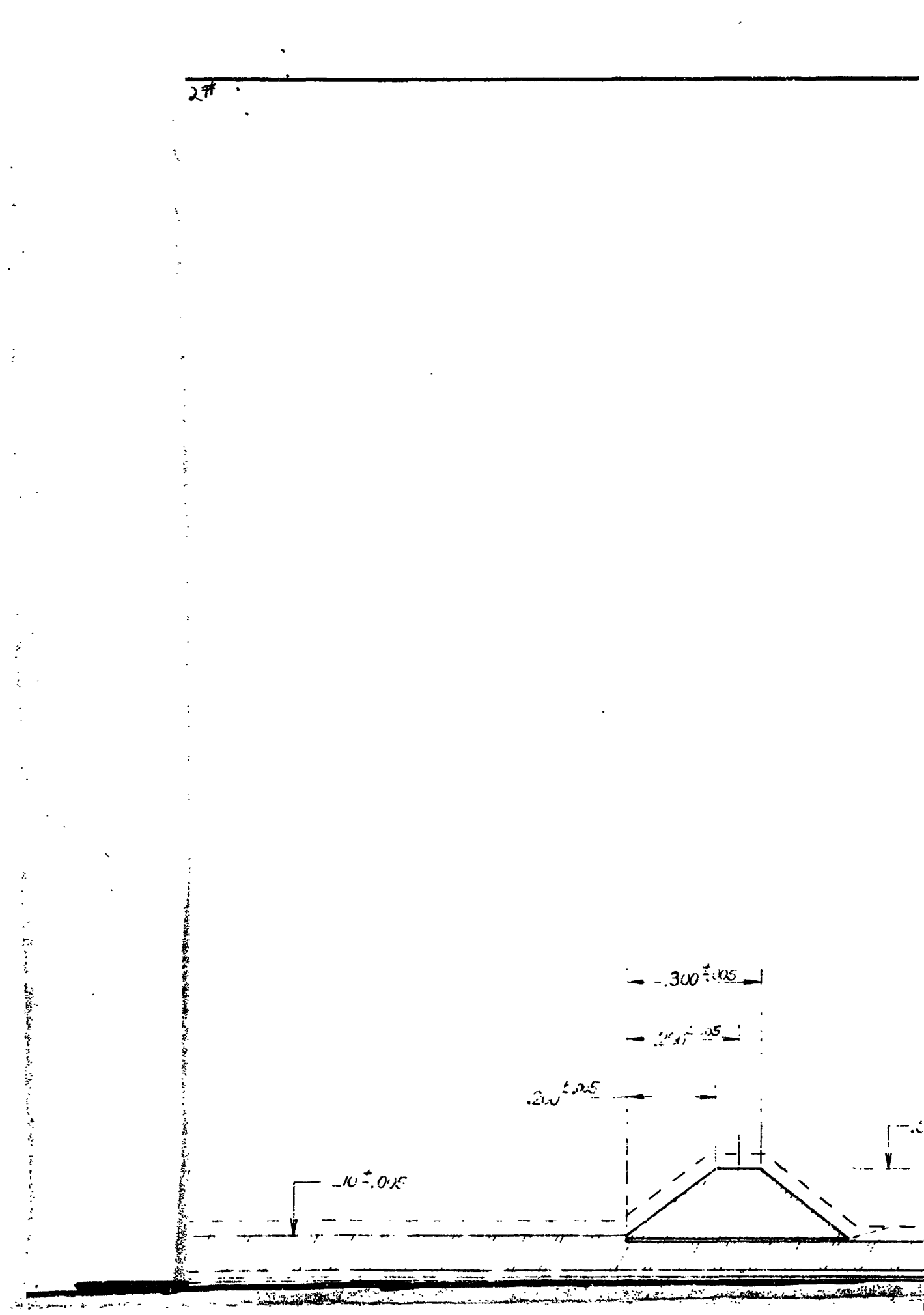
Page No. 18

DESCRIPTION	PART NO.	MFGR.
MANDREL ASSY OUTLINE	AUTO CONTROL LABORATORIES, INC.	
	C4735-20	

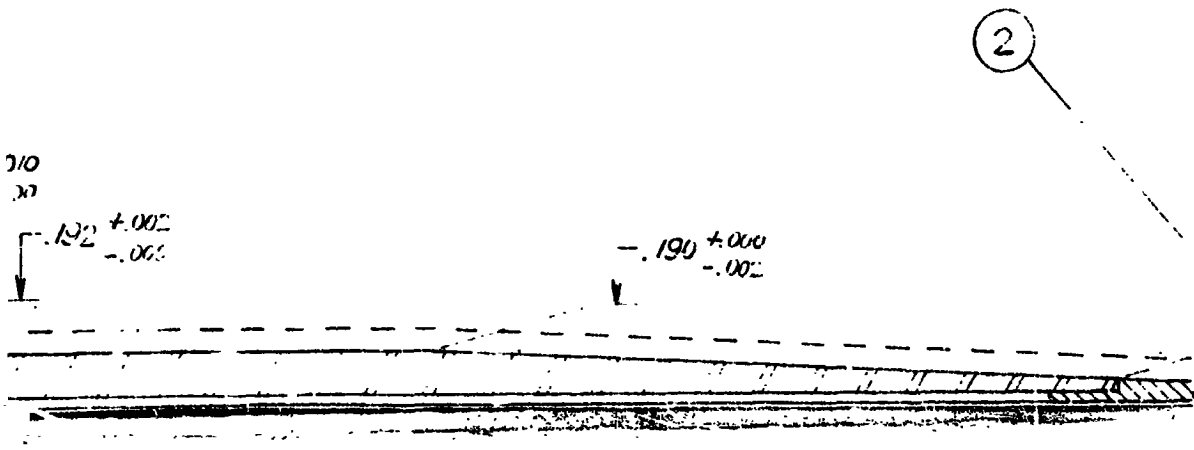
Top of Diagram
1#

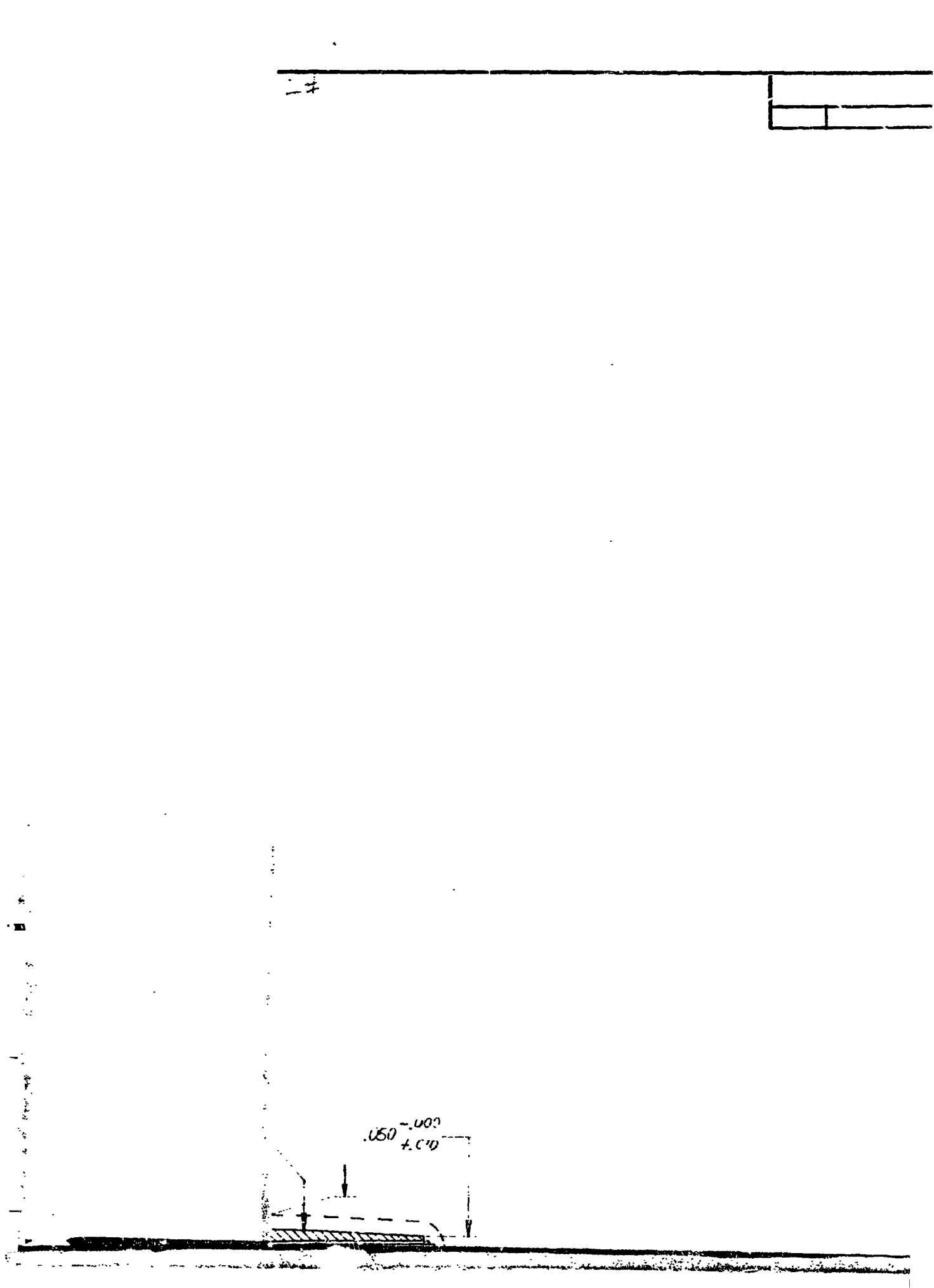


2#



3#




.050 -.000
+.010

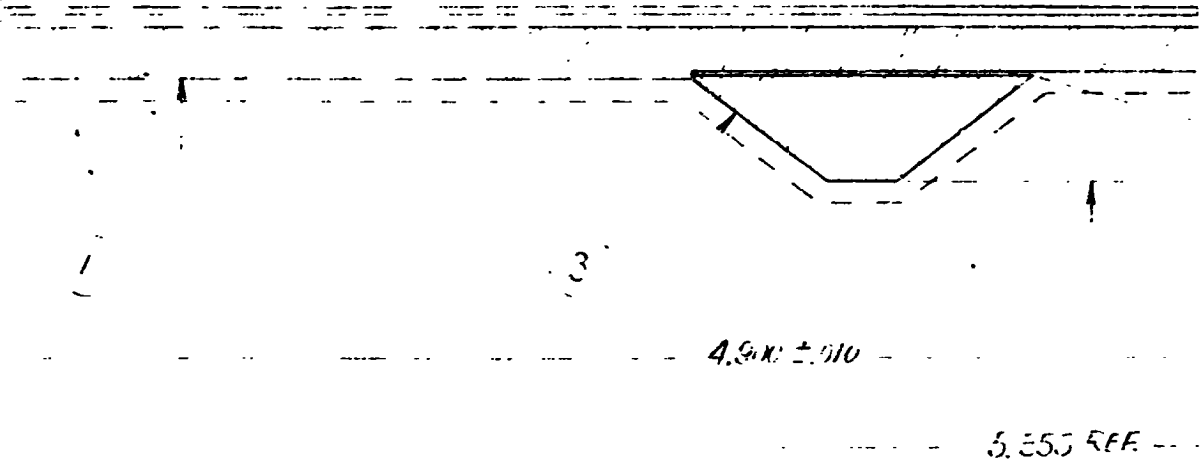
REVISIONS

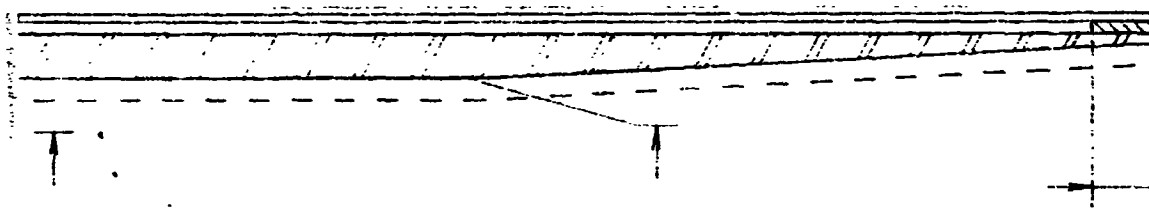
DESCRIPTION	DFTMN		DATE	APPROVAL

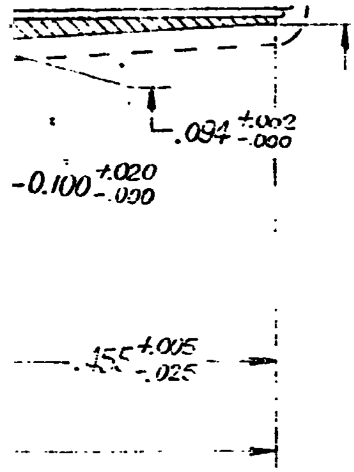
6

Bottom of DIAGRAM

6#


1
3
4.9m ±.010
5.355 EFF.





ITEM NO.	DESCRIPTION
6	[illegible]
5	CON[illegible]
4	TUB[illegible]
3	SLUG
2	MANDREL SECONDARY
1	MANDREL PRIMARY

TOLERANCES

LINEAR DIMS – EXCEPT AS NOTED:
1" AND UNDER ± 1/32
1 1/32" to 12" ± 1/16
12" AND OVER ± 1/8
SUB-ASSEMBLY CLEARANCE:
DOORS 1/16" MIN.
1/8" MAX.
TRAYS, TRIM, & OTHER
SUB-ASSEMBLIES TO FIT WITHIN
1/32 MIN.
3/32 MAX.

APPR. BY DATE
CHECKED BY DATE
DWG. BY DATE

△ CHANGE LETTER
✱ CUSTOMER FURNIS.
◇ ITEMS TO BE SHIP

9 H

QTY.			PART NO.	MFGR.		REMARKS
1			4735-2-6	ACL		
1			4735-2-5	ACL		
1			4736-21-4	ACL		
1			4735-21-3	ACL		
1			4735-21-2	ACL		
1			4735-21-1	ACL		

MANDREL ASSEMBLY

8-27-63

Q#

J# T-1097

NEXT ASSY.

SCALE 4x

WT.

SHED ITEMS

ED LOOSE

AUTO CONTROL LABORATORIES, INC.

LOS ANGELES 45, CALIFORNIA

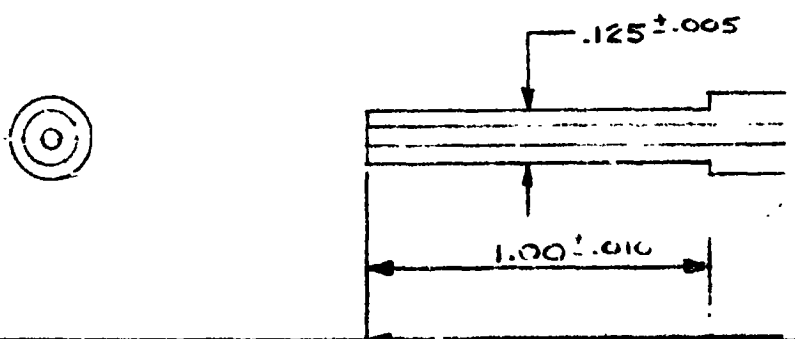
D 4735-21

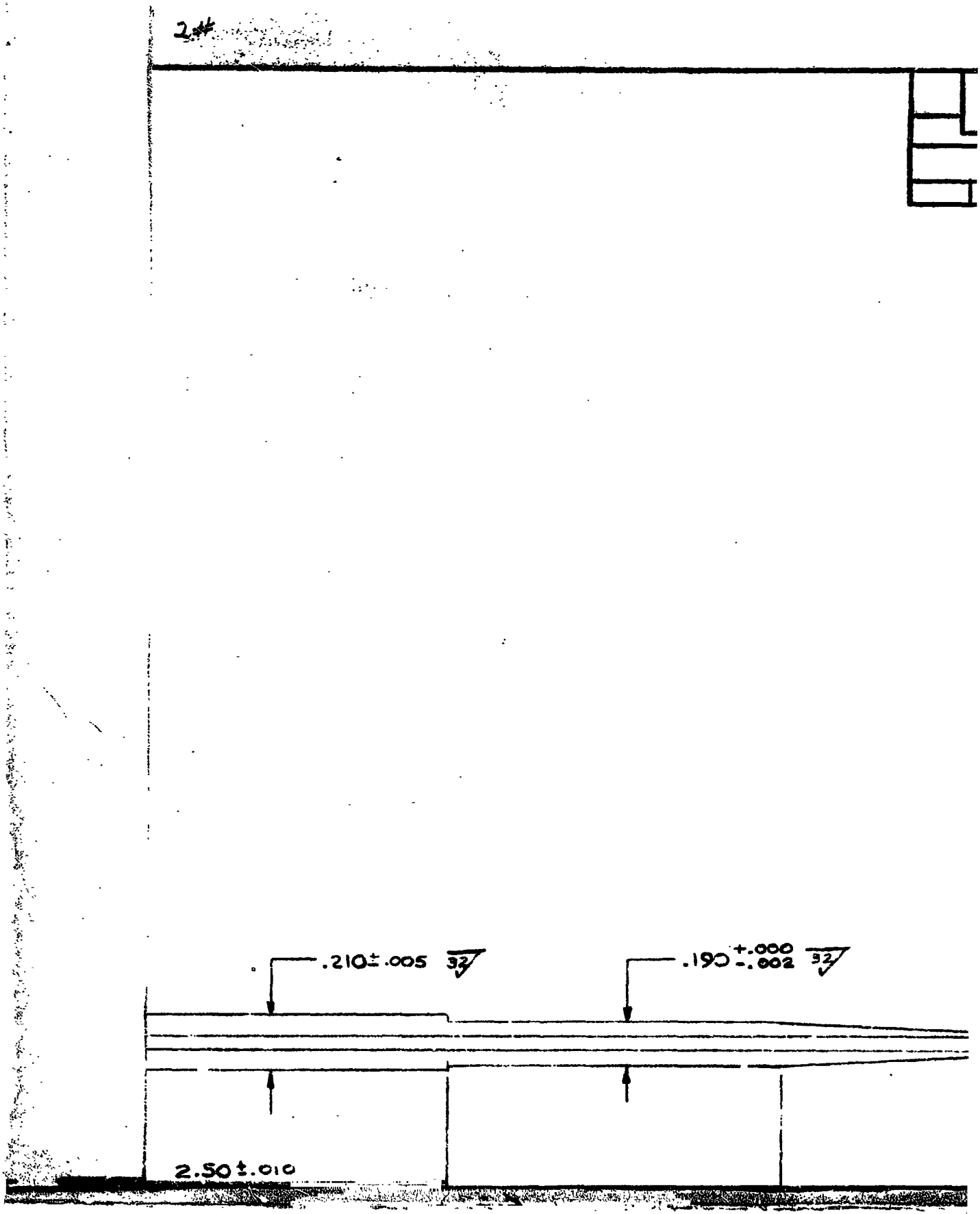
REV.

SHEET OF

10#

1#
Top of Diagram



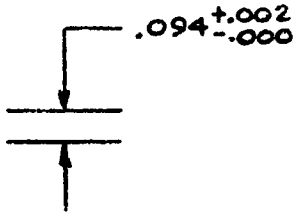

2.44
.210±.005 32
.190 +.000 -.002 32
2.50±.010

3#

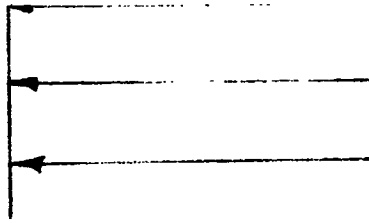
35-21-1

REVISIONS

DESCRIPTION		DFTMN		DATE	APPROVAL

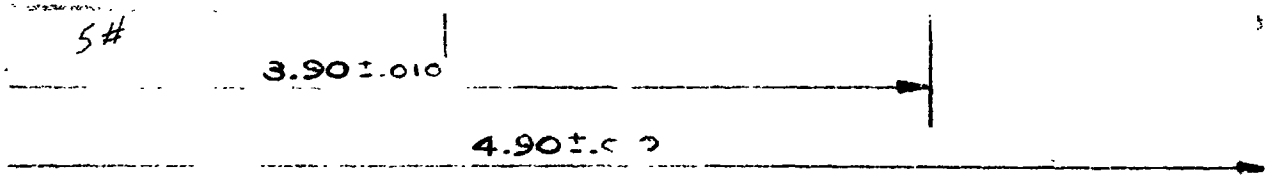


4# Bottom of DIAGRAM



1. MTL. 1/4 - .095 STEEL TUBING

NOTES:



.060 I.D.), 1010 SERIES OR EQUAL

ITEM NO.	NO. REQ.
APPR. BY	
CHECKED BY	
DWG. BY R.	

△ CHAN

✱ JUST

◇ ITEM

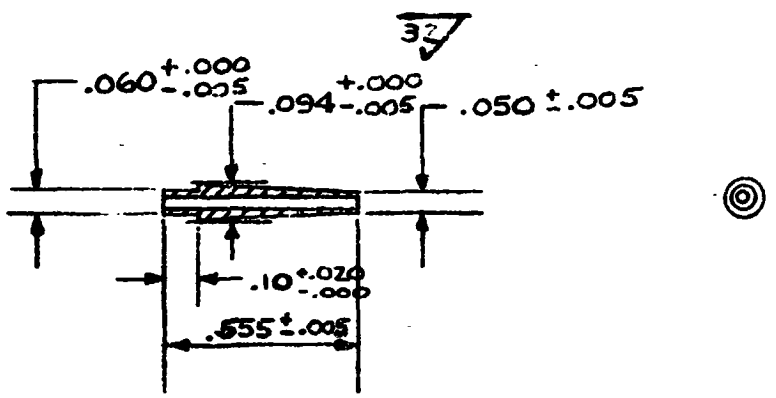
6 #

PAGE No. 20

	DESCRIPTION	PART NO.	MFGR.
DATE	MANDREL, PRIMARY	AUTO CONTROL LABORATORIES, INC.	
DATE			
S. DATE 8-20-63	PROGESS SPEC. —		
HR LETTER	Q# —		
OWER FURNISHED ITEMS	J# T-1097		
TO BE SHIPPED LOOSE	NEXT ASSY. 4735-21	4735-21-1	
	SCALE 2X WT.		

TOP OF DIAGRAM 1#

2#



3H

05-21-2

REVISIONS

DESCRIPTION		DFTMN		DATE	APPROVAL

Bottom OF DIAGRAM 4#

2. MTL. MILD STEEL, 1010 SERIES OR E

1. HOLE THRU - 1/32"

NOTES:

5 #

UAL

ITEM NO.	NO. REQ.
APPR. BY	
CHECKED BY	
DWG. BY	R.

CHAN

CUST

ITEM

6#

PAGE No. 21

DESCRIPTION		PART NO.	MFGR.
DATE DATE S. DATE 8-2063	MANDREL, SECONDARY	AUTO CONTROL LABORATORIES, INC.	
	PROCESS SPEC.		
NGE LETTER	Q#		
OMER FURNISHED ITEMS	J# T-1097		
TO BE SHIPPED LOOSE	NEXT ASSY. 4735-21	4735-21-2	
	SCALE 2X WT.		

ITEM NO.	NO. REQ'D	MATERIAL	Rod 1/2 DIA.	47[illegible]-21-3
				Next Assembly
APPROVED		SLUSS, BLANK, AUDIO CONTROL		
CHKD.			LABORATORIES, INC.	
DWN. BY		SPEC. —	Φ No. —	47[illegible]5-21-3-1
			JNO. T-1037	
			SCALE 2X	

1. [illegible]

BY [illegible] DATE [illegible] SUBJECT [illegible]

CHKD. BY [illegible] DATE [illegible]

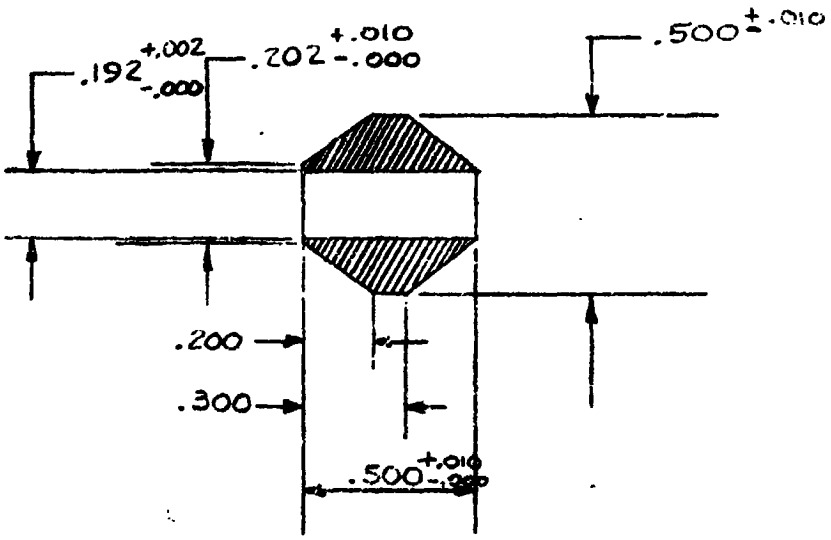
SHEET NO. 1 OF 1

JOB NO. T-1037

TOP OF DIAGRAM 1#

2#

47



3#

35-21-3	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF THE AUTO CONTROL LABORATORIES AND EXCEPT FOR USES EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT, AUTO CONTROL LABORATORIES RESERVES ALL PATENT, PROPRIETARY, DESIGN, USE, SALE, MANUFACTURING AND REPRODUCTION RIGHTS THERETO. THIS DOES NOT APPLY TO ANY VENDOR PARTS.

REVISIONS

DESCRIPTION		DITTEN		DATE	APPROVAL

Bottom of Diagram 4*

3. GRIND CHAMFERS PER DIM'S. SHOWN
CONCENTRATED HCL BEFORE NEXT ASS'Y.
12270 MONTAGUE ST., PACOIMA, CALIF.)
2. ELOX HOLE THRU TO DIM'S. SHOWN (MEY
1. MAKE FROM P/N 4735-21-3-1
NOTES:

5#

CLEAN WITH
ER HANCOCK CO.

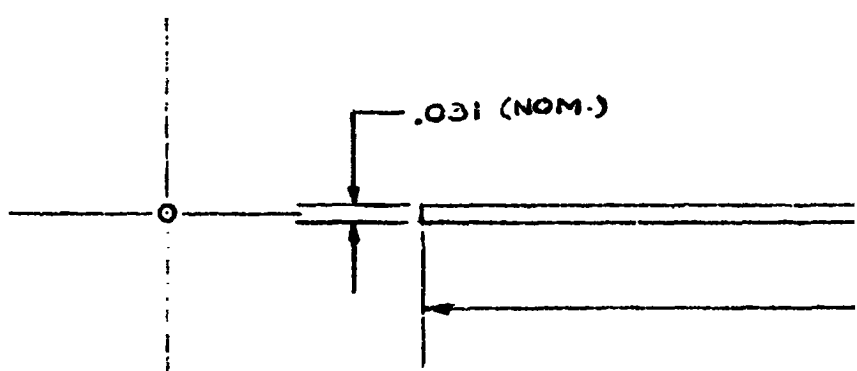
ITEM NO.	N
APPR. BY	
CHECKED	
DWG. BY	

6#

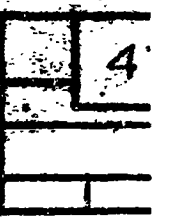
Page No. 23

DESCRIPTION		PART NO.	MFGR.
DATE	SLUG, TUNGSTEN	AUTO CONTROL LABORATORIES, INC.	
DATE			
DATE 8-20-63	PROCESS SPEC. -		
SE LETTER	Q# -		
NISHED ITEMS	J# T-1097		
TO BE SHIPPED LOOSE	NEXT ASSY. 4735-21	4735-21-3	
	SCALE 2X WT.		

TOP OF DIAGRAM 1#



2H

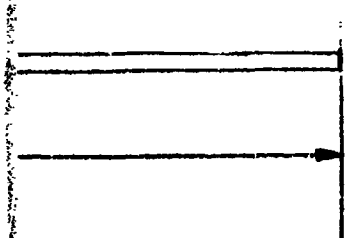


6.00 ± .020

735-214

REVISIONS

DESCRIPTION		DRTSN		DATE	APPROVAL



Bottom of Diagram #

NOTES:

1. MAKE FROM 1/32 O.D. - .003 W.T. (I.D STAINLESS STEEL TUBING, (TUBE DISTR.

5#

OR EQUAL)

..025) SERIES 321

ITEM NO.	
APPR. BY	
CHECKED	
DRWN. BY	

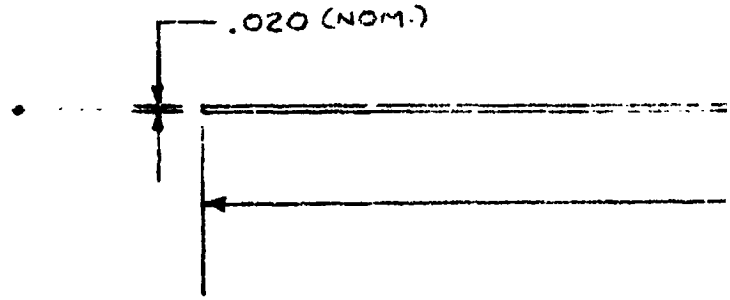
6 H

PAGE No. 24

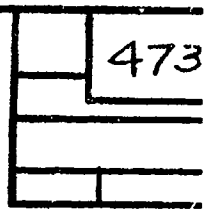
DESCRIPTION	PART NO.	MFGR.
TUBE, SUPPORT, CONDUCTOR	4735-21-4	

AUTO CONTROL LABORATORIES, INC.

TOP OF DIAGRAM 1st



2#



7.00±.10

3#

5-21-5	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF THE AUTO CONTROL LABORATORIES AND EXCEPT FOR USES EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT. AUTO CONTROL LABORATORIES RESERVES ALL PATENT, PROPRIETARY, DESIGN, USE, SALE, MANUFACTURING AND REPRODUCTION RIGHTS THERETO. THIS DOES NOT APPLY TO ANY VENDOR PARTS.

REVISIONS

DESCRIPTION		DFTMN		DATE	APPROVAL

Bottom Of Chamber
4#

BAKER PLATINUM DIV'N., NEWARK, N.J.)
OR EQUAL (ALT. SOURCE — ENGLEHARD IN
WIRE, .020 DIA. (HOSKINS MFG. CO., CHIC
1. MAKE FROM TUNGSTEN-26% RHENIUM AL

NOTES:

5#

DUSTRIES,
(90, 1lb.)
LOY

ITEM NO.	NO. REQ.
APPR. BY	
CHECKED BY	
DWG. BY	

PAGE No. 25

DESCRIPTION		PART NO.	MFGR.
DATE DATE DATE	CONDUCTOR, CENTER, TUNGSTEN-26% RHENIUM	AUTO CONTROL LABORATORIES, INC.	
ETTER	PROCESS SPEC. – Q# –		
FURNISHED ITEMS	J# T-1097 NEXT ASSY. 4735-21	4735-21-5	
BE SHIPPED LOOSE	SCALE 2X WT.		

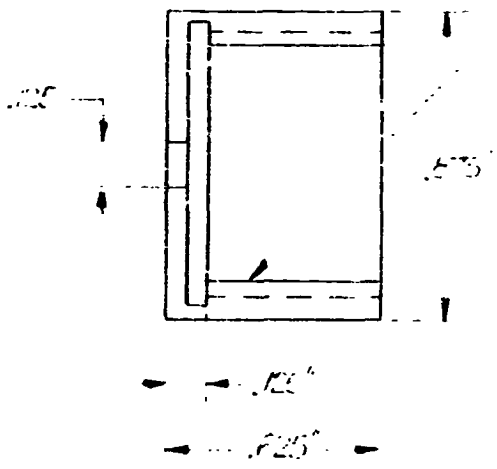
BY ..... DATE ..... SUBJECT .....

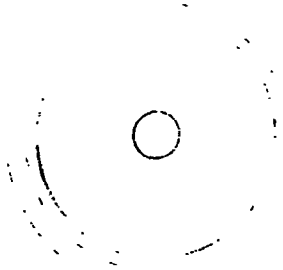
CHKD. BY ..... DATE .....

SHEET NO. ..... OF .....

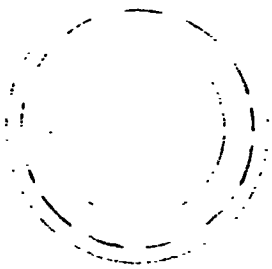
JOB NO. .....

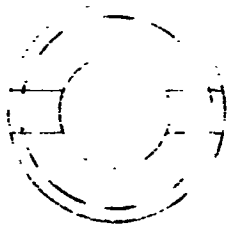
Top of Diagram





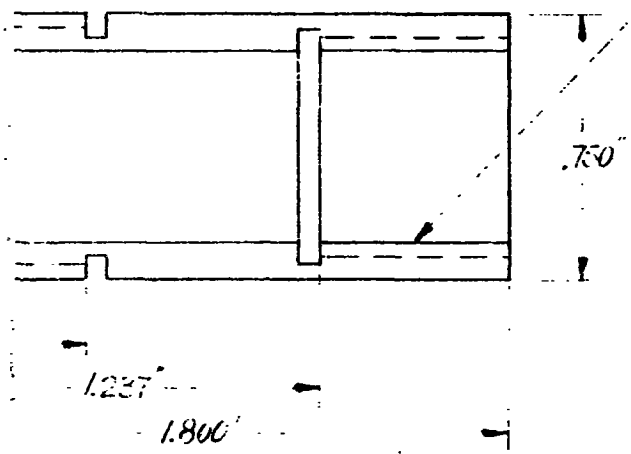
2#

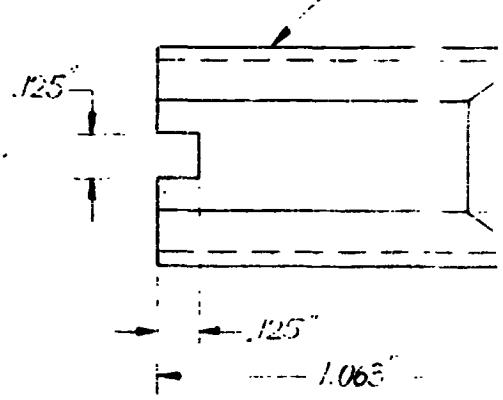


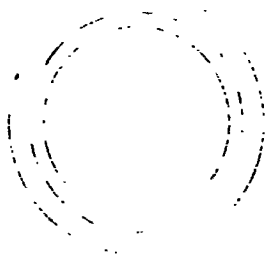


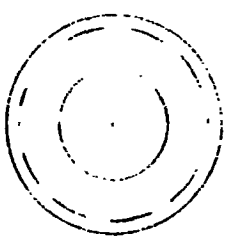
$\frac{3}{4}$-16 UNF
EXTERNAL THD.

$\frac{5}{8}$-18 UNF
INTERNAL THD.





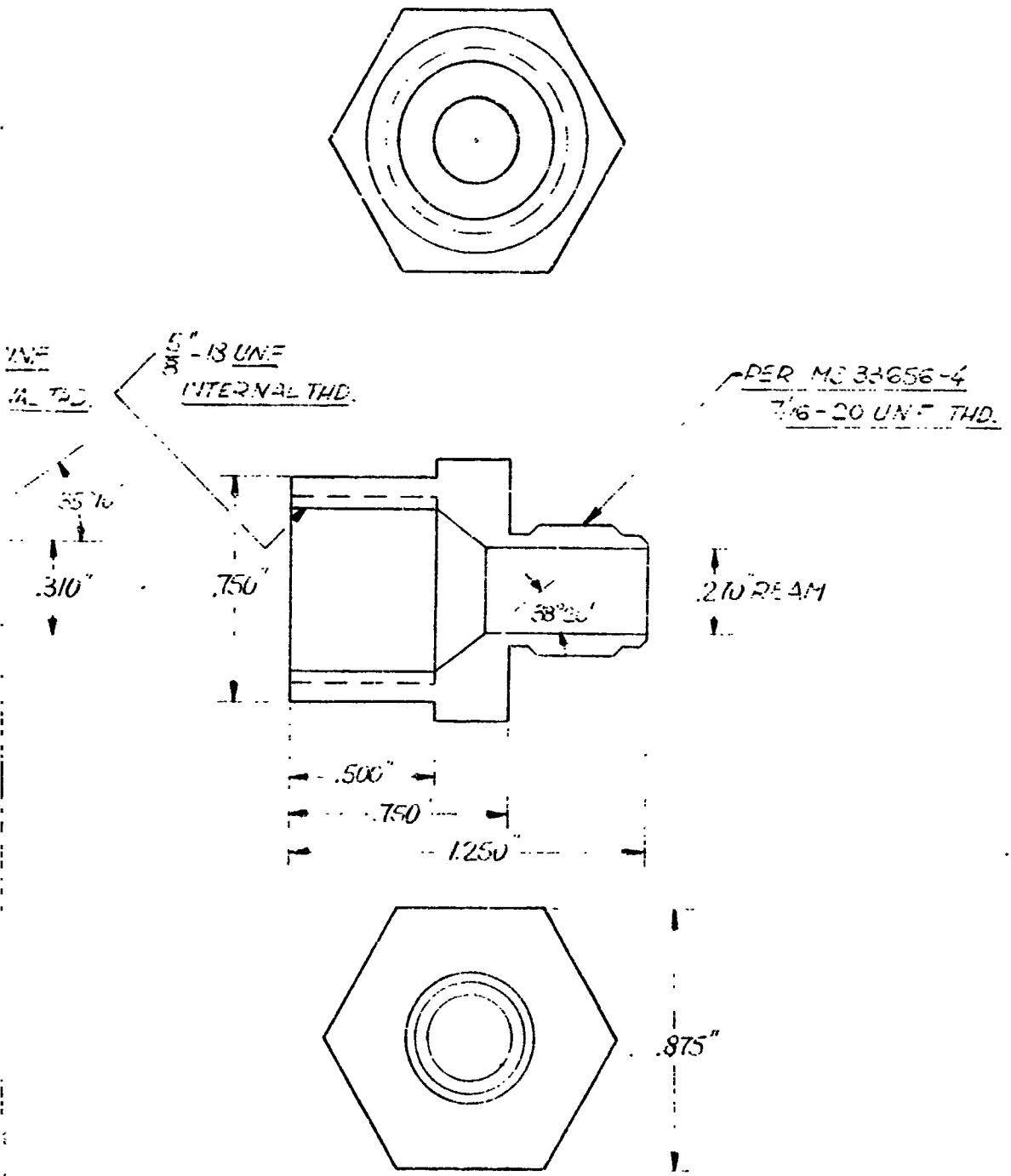




4735-31-2
SHELL BODY

4735-31-4
NUT HOLDING B

3#



4735-31-3

UNION BODY

4.A

DESCRI

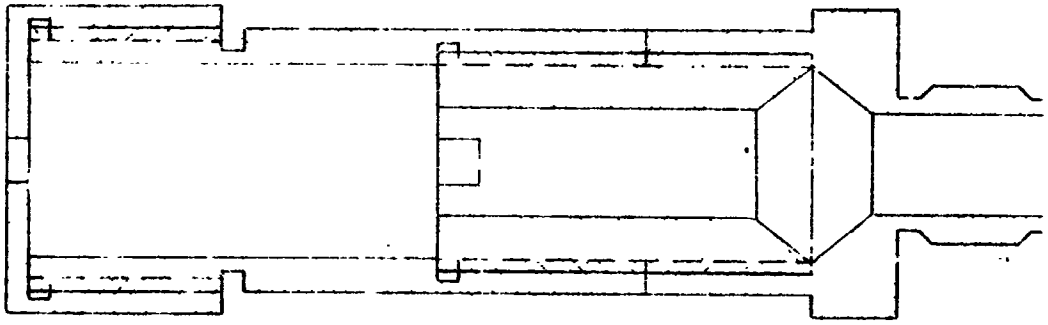
REVISIONS				
	DFTMN		DATE	APPROVAL

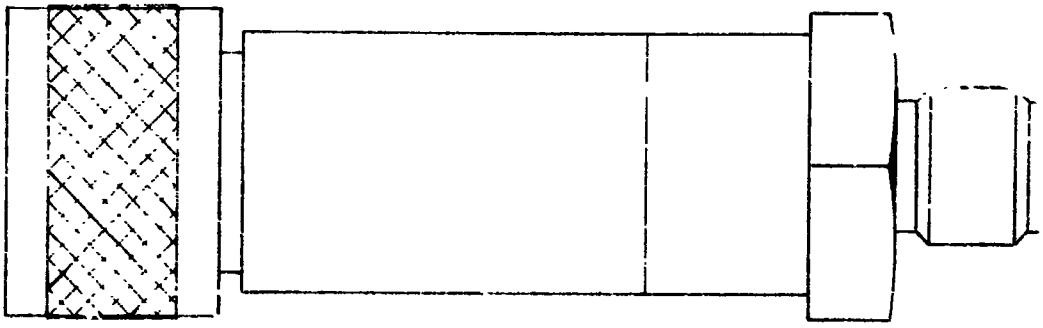
5 #

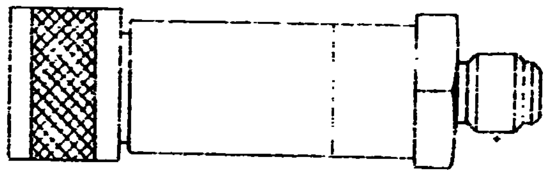
Bo Hom of Diagram

6#

DIETERICH POST CLEARPRINT BROWN 8







ACTUAL SIZE

94

ITEM NO.	DESCRIPTION	QTY.

TOLERANCES

LINEAR DIMS – EXCEPT AS NOTED:
1" AND UNDER ± 1/32
1 1 12" to 12" ± 1/16
13" AND OVER ± 1/8
SUB-ASSEMBLY CLEARANCE:
DOORS 1/16" MIN.
1/8" MAX.
TRAYS, TRIM, & OTHER
SUB-ASSEMBLIES TO FIT WITHIN
1/32 MIN.
3/32 MAX.

APPR. BY _____ DATE 8-26-64
CHECKED BY _____ DATE 8-27-64
DWG. BY S DATE 5-22-65

△ CHANGE LETTER

✱ CUSTOMER FURNISHED ITEMS

◇ ITEMS TO BE SHIPPED LOOSE

10 H

PAGE No. 27

					REMARKS

BODY, OUTLINE

Q#

J# T-1097

NEXT ASSY. 4735-01

SCALE 2X | WT.

AUTO CONTROL LABORATORIES, INC.

LOS ANGELES 45, CALIFORNIA

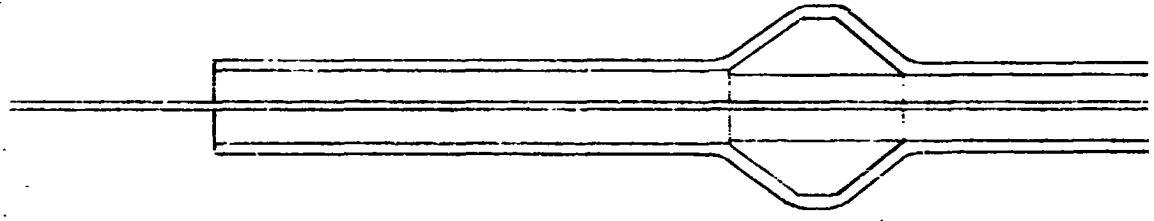
D4735-30

SHEET OF

REV.

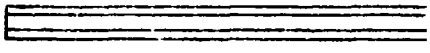
Top of Diagram #

24



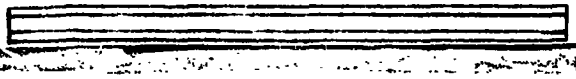
4735-41-1

SHEATH: CENTER CONDUCT

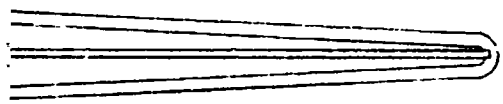


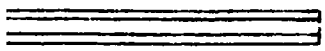
4735-

INSULATIO



·3H·





CNT. BEO

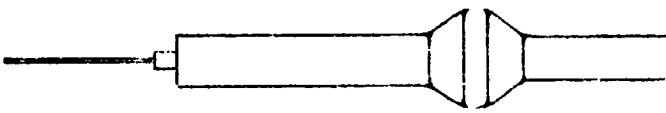
4#

		DESCRIP

REVISIONS				
	DFTSMN		DATE	APPROVAL

5#

Bottom of Diagram 6#

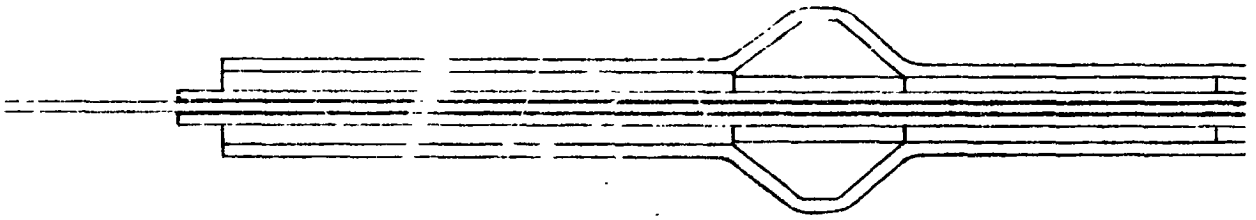


ACTUAL SIZE

7#.

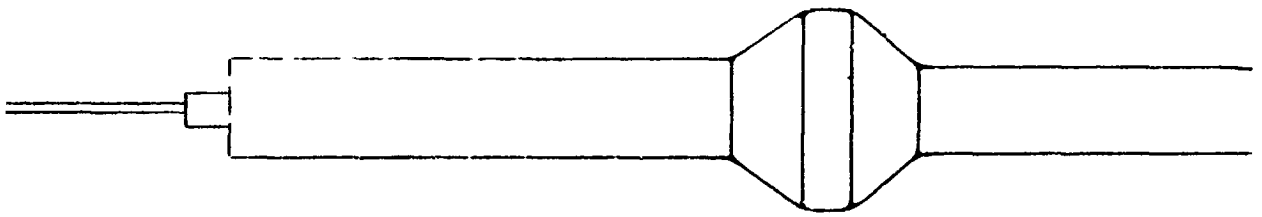
4735-A-3

INSULATOR, BACK, MgO



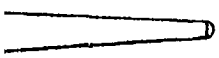
4735-41

SHEATH, SECTION, ASSEMBLY

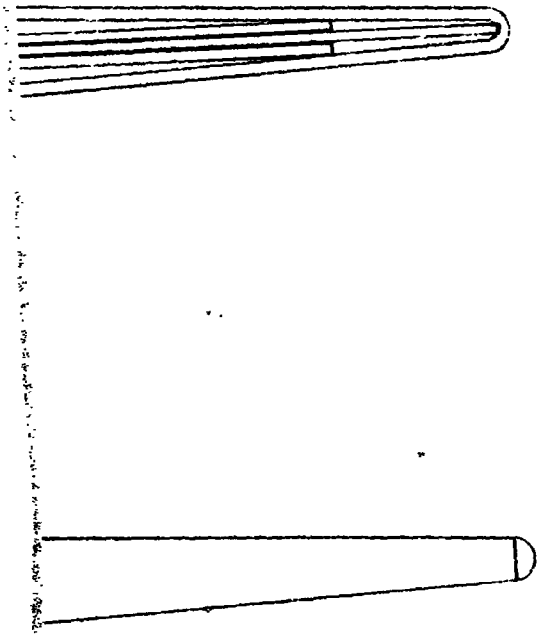


4735-40

SHEATH, HIGH TEMP. THERMOCOUPLE



8#.



9#

ITEM NO.	DESCRIPTION	QTY.

TOLERANCES

LINEAR DIMS – EXCEPT AS NOTED:
1" AND UNDER ± 1/32
1 1/32" to 12" ± 1/16
13" AND OVER ± 1/8
SUB-ASSEMBLY CLEARANCE:
DOORS 1/16" MIN.
1/8" MAX.
TRAYS, TRIM, & OTHER
SUB-ASSEMBLIES TO FIT WITHIN
1/32 MIN.
3/32 MAX.

APPR. BY [illegible] DATE 8-30-3
CHECKED BY [illegible] DATE 8 30 03
DWG. BY [illegible] DATE 8 - 3

△ CHANGE LETTER

✱ CUSTOMER FURNISHED ITEMS

◇ ITEMS TO BE SHIPPED LOOSE

10#

PAGE No. 28

					REMARKS

SHEATH. OUTLINE

Q#

J# 7 1097

NEXT ASSY. 4735-01

SCALE 2× | WT.

AUTO CONTROL LABORATORIES, INC.

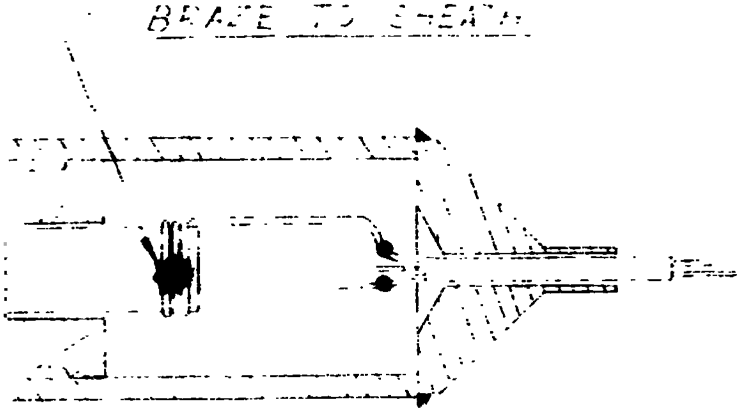
LOS ANGELES 45, CALIFORNIA

D4735-40

REV.

SHEET OF

4735-01



(2ND GEN.)

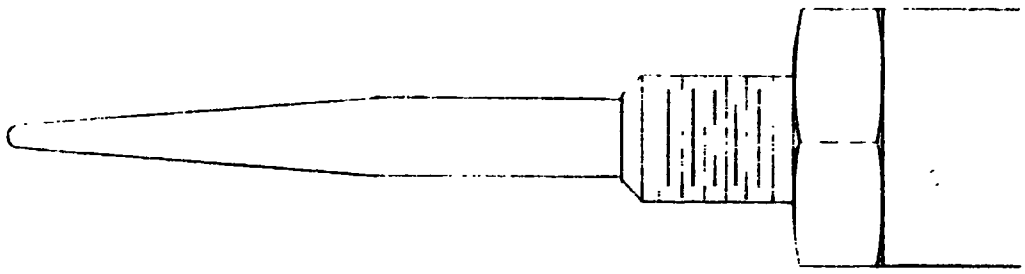
SYM	

5#

REVISIONS		
DESCRIPTION	DATE	APPROVAL

Bottom of Diagram 6#

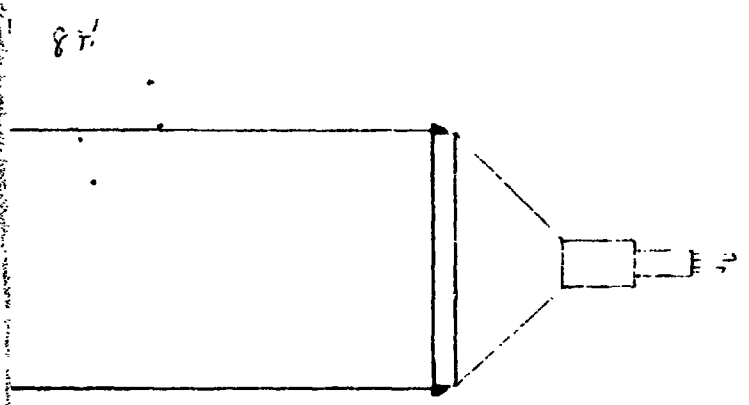
7=



THERMOCOUPLE

4735-00 (2 REQ.)

ACTUAL SIZE



TIMP. OUTLINE

. GEN.)

9#

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
		LIST OF MATE

UNLESS OTHERWISE SPECIFIED

DIMENSIONS ARE IN INCHES

TOLERANCES ON

DECIMALS	ANGLES
.X ± .06	± 0° 30'
.XX ± .03	
.XXX ± .010	

SURFACE ROUGHNESS PER MIL-STD-10 ✓

DO NOT SCALE THIS DRAWING

NEXT _____ EA. _____

ASSY _____ EA. _____

DRAWN	A. Smith	5-28-
CHECK		
ENGR	[illegible]	8-[illegible]
STRESS		
WEIGHT		
PROJ		
APPR	[illegible]	8-[illegible]

A. Smith
APPROVED

APPROVED

10#

PAGE No. 29

	MATERIAL SIZE, DESCRIPTION & SPECIFICATION	ITEM NO.
RIAL OR PARTS LIST		

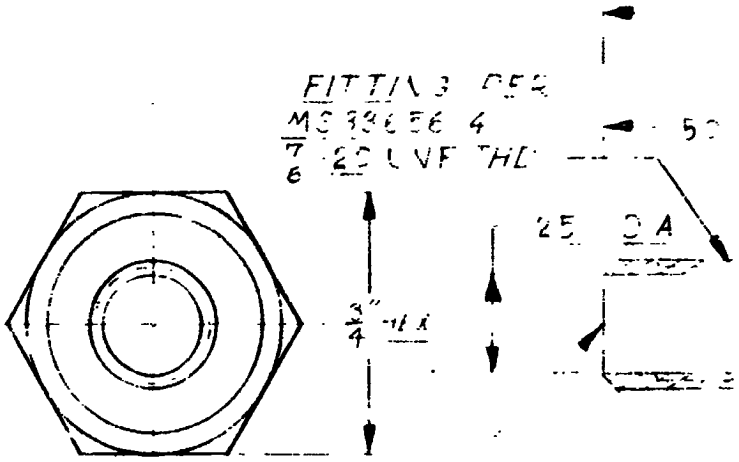
S/N 037 ACL AUTO-CONTROL LABORATORIES INC T-1037

5251 WEST IMPERIAL HWY., LOS ANGELES 45, CALIF., OR 8-4934

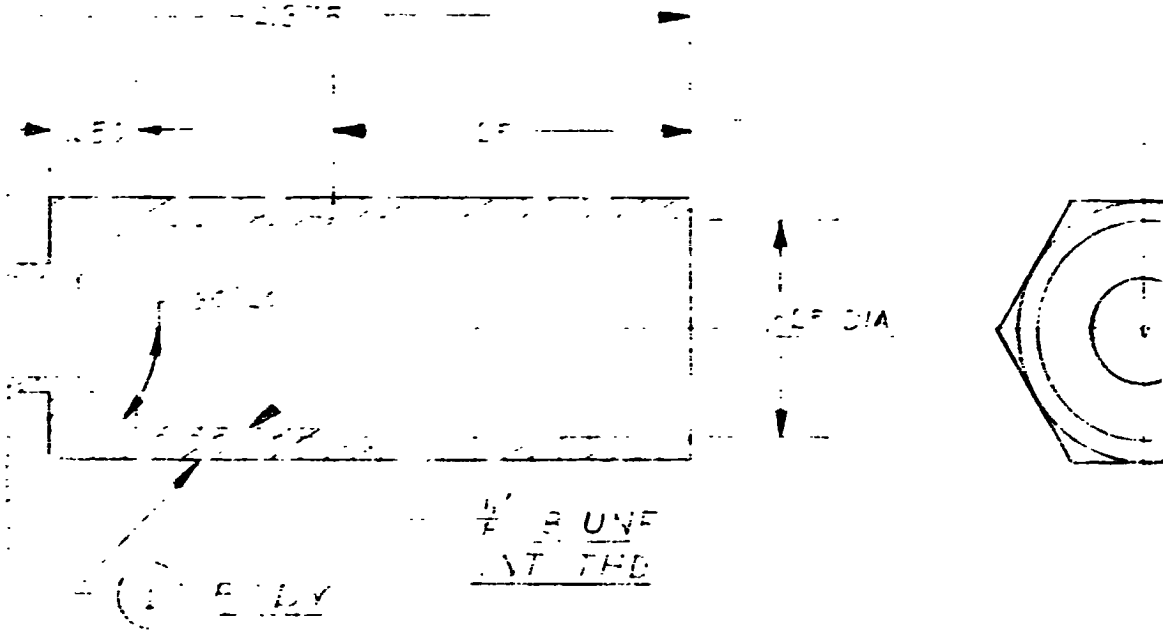
THERMOCOUPLE HIGH-TEMP. OUTLINE

CODE IDENT NO.	SIZE	4735-00
05172	D	SEC. GENERATION
SCALE 2x	WEIGHT	SHEET

'Top of Diagram 1#

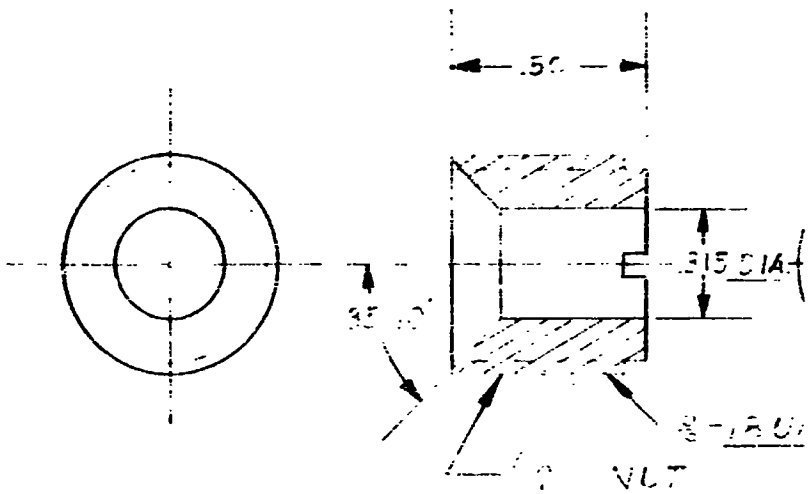


[illegible]

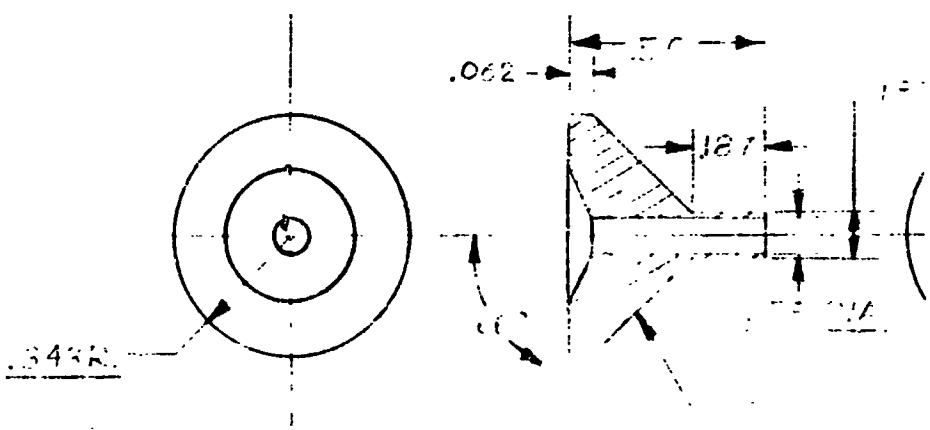


MATERIAL : EXISTING

4175-31-2 (2ND. GEN.)



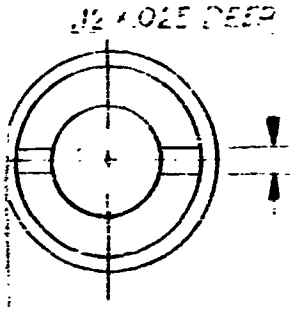
VLT
MATERIAL
4735-31



(3) CAP
MATERIAL

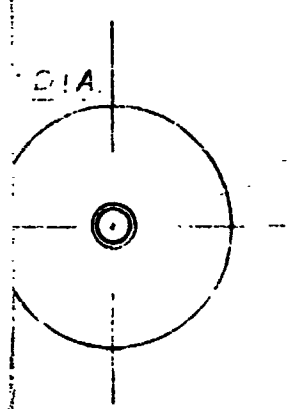
4#.

SYM



VA. SYST. T-1

BAR
-4 (2ND. GEN)

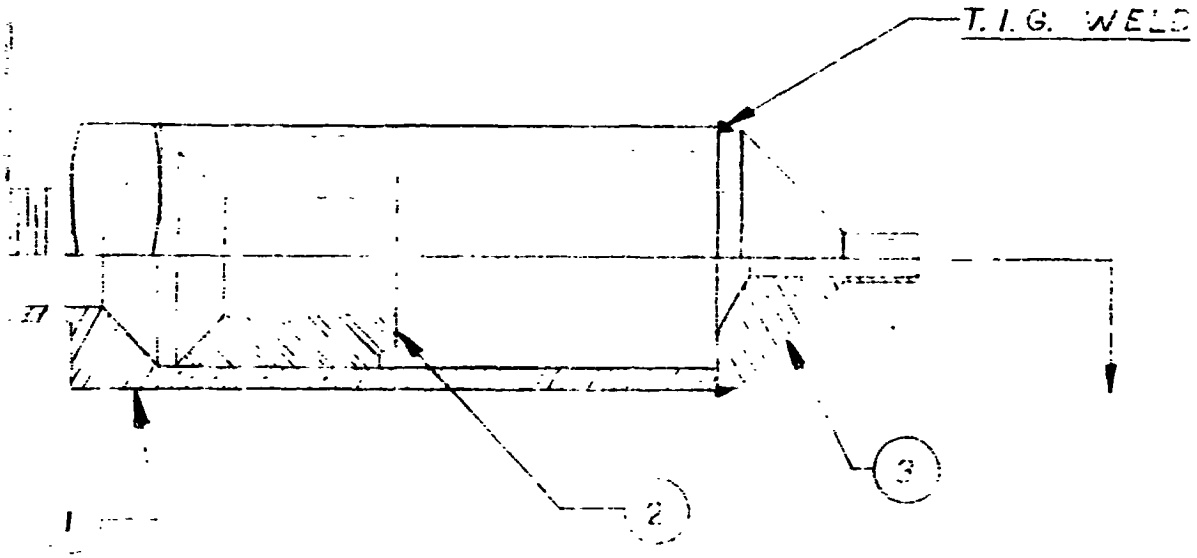


5#

REVISIONS		
DESCRIPTION	DATE	APPROVAL

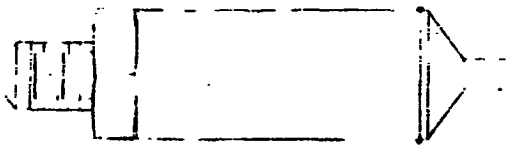
. Bottom OF DIAGRAM
6#

7#.



E[illegible] A[illegible]

4735-31 (2ND. GEN.)



ACTUAL SIZE

4(35-31-1 (2NT

8#.

1- ALL MATERIAL ... ORES.

NOTES:

EN.)
9#

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
		LIST OF

UNLESS OTHERWISE SPECIFIED	DRAWN	K. A. Snider
DIMENSIONS ARE IN INCHES	CHECK	
TOLERANCES ON	ENGR	
DECIMALS: .X ± .06; .XX ± .03; .XXX ± .010 — ANGLES: ± 0° 30′	STRESS	
	WEIGHT	
	PROJ	
SURFACE ROUGHNESS PER MIL-STD-10 ✓	APPR	
DO NOT SCALE THIS DRAWING		APPROVED
NEXT _____ EA. _____		
ASSY _____ EA. _____		APPROVED

104

PAGE No. 30

DR	MATERIAL SIZE, DESCRIPTION & SPECIFICATION	ITEM NO.

MATERIAL OR PARTS LIST

5/27/64
8 27-64
2 27-64
8 27-64

S/N 007

ACL AUTO CONTROL LABORATORIES INC

T-1011

5251 WEST IMPERIAL HWY., LOS ANGELES 45, CALIF., OR 8-4934

BODY OUTLINE

CODE IDENT NO.	SIZE	4735-30
05172	D	SEC. GENERATION
SCALE 2 X	WEIGHT	SHEET