Proceedings of Meetings on Acoustics

Volume 12, 2011 http://acousticalsociety.org/

161st Meeting
Acoustical Society of America
Seattle, Washington
23 - 27 May 2011
Session 4aED: Education in Acoustics

4aED6. A homemade Edison tinfoil phonograph

Andrew McNeese*, Jason D. Sagers, Richard D. Lenhart and Preston S. Wilson

***Corresponding author's address: Applied Research Laboratories: University of Texas, 10000 Burnet Rd., Austin, TX 78758, armcneese@gmail.com**

In 1877 Thomas Edison invented the phonograph, a device capable of recording and reproducing sound. The original design used the sound induced vibrations of a stylus to etch a time-locked copy of the acoustic wave onto a rotating, foil-covered cylinder. Playback was made possible by reading the etched signal with a second stylus attached to a transmitting diaphragm. The transparency of Edison's original design makes the phonograph a useful tool to demonstrate and discuss the concepts of acoustic waves and sound-structure interaction. A short history of the invention is given, a homemade version of Edison's original phonograph is presented, and the essence of the sound-structure interaction is explained.

Published by the Acoustical Society of America through the American Institute of Physics

 [DOI: 10.1121/1.3646249]
Received 1 Aug 2011; published 15 Sep 2011

1 Introduction

A homemade reproduction of Thomas Edison's tinfoil phonograph is presented in this manuscript. One of the primary objectives of this endeavor is to make the phonograph accessible to educators, students, and enthusiasts of acoustics. During the design of the homemade reproduction, compromises were made between historical fidelity and simplicity of construction. The phonograph reproduction discussed here is true to the basic operating principles of Edison's original, while being relatively low cost and easy to manufacture.

The remainder of this manuscript is organized as follows. Section 2 contains a brief history of sound recording and reproduction, with an emphasis on the invention of the phonograph. Section 3 highlights Edison's historical connection to the Acoustical Society of America. Section 4 gives a brief discussion of the design, construction, and operation of the homemade phonograph. Section 5 briefly discusses one potential way that the device can be used to teach acoustics-related concepts. A mechanical drawing package (Appendix A) and bill of materials (Appendix B) are provided as part of this manuscript so that the homemade phonograph can be readily constructed.

2 History of sound recording and reproduction

A timeline of major events in the history of sound recording and reproduction is shown in Fig. 1. The timeline has two purposes: 1) to give insight into the time period preceding Edison's invention of the phonograph and 2) to highlight milestones in sound recording between the phonograph and the present day. The timeline is not intended to be comprehensive and some of the dates are approximate. A few of the events preceding the invention of the phonograph are discussed in more detail in Sections 2.1 and 2.2.

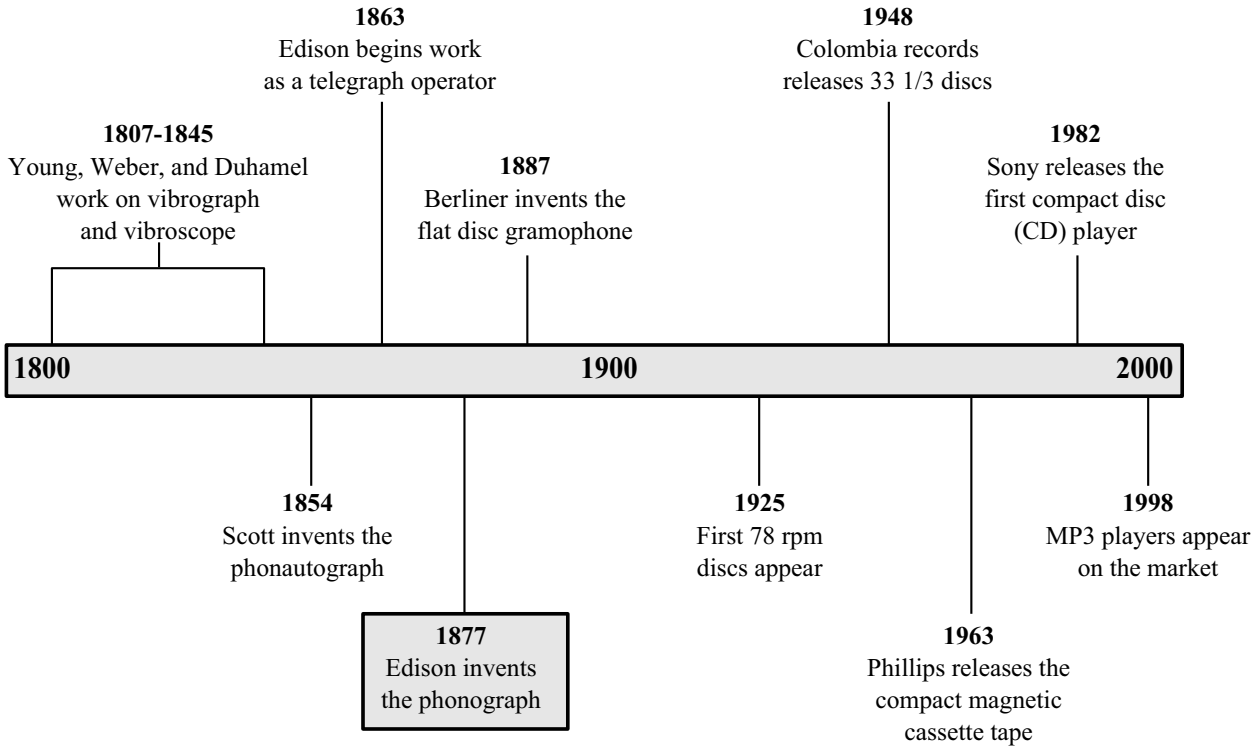


Figure 1: Timeline of major events in the history of sound recording and reproduction.

2.1 Vibrograph and vibroscope

Between the years 1807 and 1845 Thomas Young, Wilhelm Weber, and Jean-Marie Duhamel are all credited with inventing sound recording devices called vibrographs and vibroscopes [1–4]. Vibrographs and vibroscopes are similar in form and function and the distinctions between the two devices are not always clear in historical references. A depiction of a vibroscope from W.H. Stone [5] is shown in Fig. 2. The basic operation of these devices was to connect a small stylus (or pencil) to the prong of a tuning fork (or another arbitrary vibrating object) and to allow the stylus (or pencil) to trace a waveform on a smoke-blackened cylinder or on a piece of paper wrapped around a cylinder. The cylinder was simultaneously rotated and advanced linearly by means of a screw so that the waveform could be continuously recorded. Although these devices created graphical records of vibrating bodies, they were not capable of transcribing acoustic waveforms. In essence, these devices were mechanical oscilloscopes.

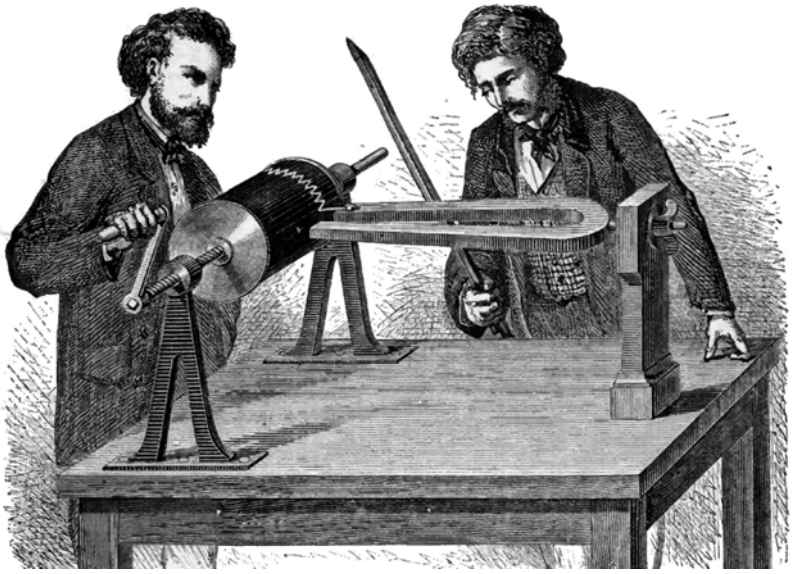


Figure 2: Vibroscope (Fig. 38 from [5], p. 85).

2.2 Phonautograph

Between the years 1854 and 1857 Édouard-Lon Scott de Martinville invented the phonautograph [6], which was capable of transcribing acoustic waveforms. The device, shown in Fig. 3, was very similar to its predecessors in the sense that the waveform was transcribed by a stylus in contact with a rotating cylinder. The major advancement of the phonautograph was the introduction of a recording cone through which sound waves could be collected onto a membrane with an attached stylus. On March 25, 1857 Scott was awarded French patent 17,897/31,470 for his invention.

Like the vibroscope and vibrograph, the phonautograph was not capable of reproducing the recorded waveform. It is intriguing that the inventors of these transcription devices remained quiet on the possibility of ever reproducing the recorded waveform. In an article published in the American Journal of Otology, Clarence Blake writes [3]:

> *"In reviewing the work of these writers it is interesting to note the unanimity with which the opinion is expressed that the original expectation of Scott, the transcription of distinctive autograms of words must ever remain unfulfilled, and there is nowhere to be found a hint of the possibility of making a permanent record of the vibrations which could be used to recommunicate the recorded vibration to the membrane, and so reproduce the sound itself."*

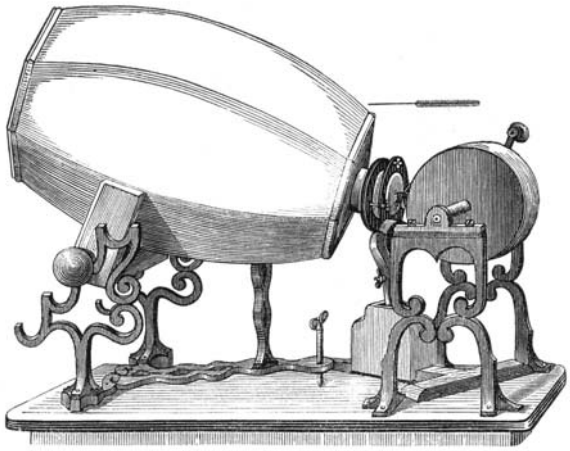


Figure 3: Scott phonautograph (image courtesy of www.FirstSounds.org).

2.3 Phonograph

Edison began work as a telegraph operator in 1863 and frequently moonlighted as an inventor during the first decade of his employment. His work on the telegraph embosser, which recorded Morse code by indenting a paper sheet, possibly provided the inspiration for the phonograph. When the embossed Morse code was fed through the telegraph at a high rate of speed, Edison heard an audible noise that reminded him of "human talk heard indistinctly" [7]. He immediately set about to create a device that was capable of recording and reproducing speech. Within a short time the phonograph was born. A photograph of Edison's first phonograph is shown in Fig. 4.

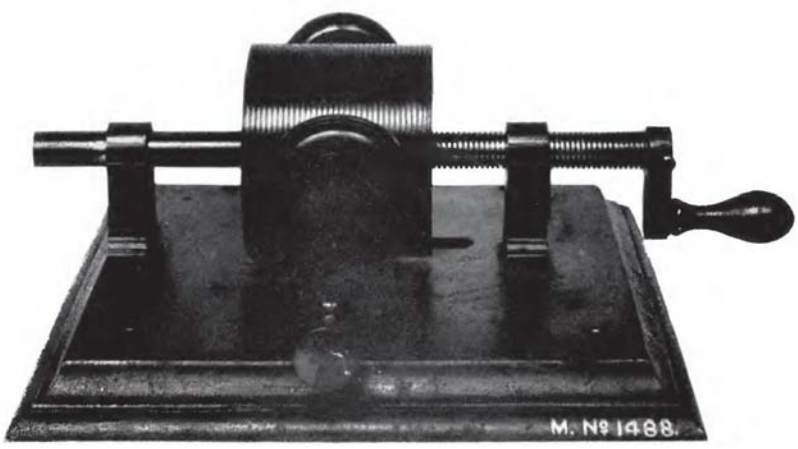


Figure 4: Photograph of Edison's first phonograph (image from [8]).

Edison immediately took his device to the offices of the Scientific American for a demonstration. The following introductory paragraph was published in an article dated December 22, 1877 [9]:

> *"Mr. Thomas A. Edison recently came into this office, placed a little machine on our desk, turned a crank, and the machine inquired as to our health, asked how we liked the phonograph, informed us that it was very well, and bid us a cordial good night. These remarks were not only perfectly audible to ourselves, but to a dozen or more persons gathered around, and they were produced by the aid of no other mechanism than the simple little contrivance explained and illustrated below."*

On February 19, 1878 Edison was issued US Patent 200,521 for the phonograph. The original phonograph quickly

underwent dramatic changes to improve the sound quality and amplitude. A photograph of Edison with a second generation phonograph is shown in Fig. 5. The tinfoil was quickly replaced by wax cylinders, horns of various sizes and types were added, and the screw was eventually motorized to create uniform recording and playback speeds.

Figure 5: Photograph of Thomas Edison with a phonograph (taken by Brady Handy, 1878).

3 Edison's historical connection to the Acoustical Society of America

Thomas Edison was invited by Harvey Fletcher to be the first honorary member of the Acoustical Society of America. The invitation was officially accepted by Edison in June of 1929. The pages shown in Fig. 6 appear in the print edition of the Journal of the Acoustical Society of America, volume 1, issue 1.

4 Homemade reproduction of an Edison phonograph

One of the main objectives of creating a homemade tinfoil phonograph was to make it accessible, as a demonstration, to educators and students. In addition to being accessible, it was desired that reproduction be true to the operating principles of Edison's original design. Like the original phonograph, the reproduction presented in this manuscript is entirely mechanical and later electronic "improvements" to Edison's original design were intentionally avoided. Although electronics can improve the sound quality of the phonograph, it can also obscure the operating principles for a novice acoustician. The authors are of the opinion that this transparency increases the effectiveness of the phonograph as a teaching aid.

A photograph of the homemade phonograph is shown in Fig. 7. It is constructed primarily of aluminum and PVC materials. In the description that follows, individual assemblies and parts are referenced by their part number (e.g. ETP-1000). The mechanical drawings used to create the phonograph are listed by part number in Appendix A. Note that although all unique parts have a unique part number, unmodified off-the-shelf parts do not have an associated drawing. In these cases, the bill of materials (Appendix B) indicates where the unmodified off-the-shelf part was purchased.

FIFTY YEARS AGO Thomas Alva Edison made the first practical electric light and this year the world is paying tribute to him in grateful recognition of the benefits to civilization which have been brought about as a result of his achievement.

Mr. Edison's genius has made its impression on many fields of research and his contributions to acoustics have been of major importance. In recognition of this the Acoustical Society of America, by unanimous vote of its Executive Council, has chosen him to be the first Honorary Member of the Society.

In acceptance, Mr. Edison has written the following letter:

FROM THE LABORATORY
OF
THOMAS A. EDISON
ORANGE, N. J.

June 17, 1929

Mr. Harvey Fletcher, President,
Acoustical Society of America,
463 West Street,
New York City

Dear Mr. Fletcher:

Your letter of May 21st was forwarded to me at Fort Myers, Florida, and I assure you that I feel highly gratified and honored that the Acoustical Society of America have, by unanimous vote of the Executive Council, chosen me to be the first honorary member.

Naturally, I am greatly pleased to be offered this place of honor and I am very glad indeed to accept the membership which you have so kindly offered me.

Yours very truly,

THOS. A. EDISON

Figure 6: Reproduction of front matter from JASA volume 1, issue 1, print version.

4.1 Major components and assemblies

A short description of the major components and assemblies of the phonograph is given in Sections 4.1.1 through 4.1.4.

4.1.1 Base assembly

The base assembly (ETP-1100) consists of the baseplate (ETP-1101), the right (ETP-1102) and left (ETP-1103) vertical supports, an acme cylinder nut (ETP-1104), a C-clamp (ETP-1105), and various other fasteners. The base assembly is the foundation of the phonograph and provides the support structure for mouthpiece swivel assembly and the threaded rod assembly.

Although the threaded rod assembly passes through both vertical supports, only the left support contains an acme nut as seen on ETP-1103. The acme cylinder nut is press fit into the left vertical support and is the means whereby the acme threaded rod is advanced laterally when rotated. However, both vertical supports must be carefully machined such that they allow the acme rod to travel smoothly through the supports without binding.

The C-clamp (ETP-1105) contains a screw (ETP-1108) that precisely controls the depth of the stylus during recording and playback. Finding the ideal depth for the stylus during recording takes trial-and-error, as the stylus must be deep enough to emboss the foil, but not so deep that it will tear the foil. However, once the appropriate depth of the stylus is found, the previously mentioned screw ensures the swivel arm returns to the same position every time. The vertically oriented screw (ETP-1109) is used to lock the swivel arm in place during recording and playback.

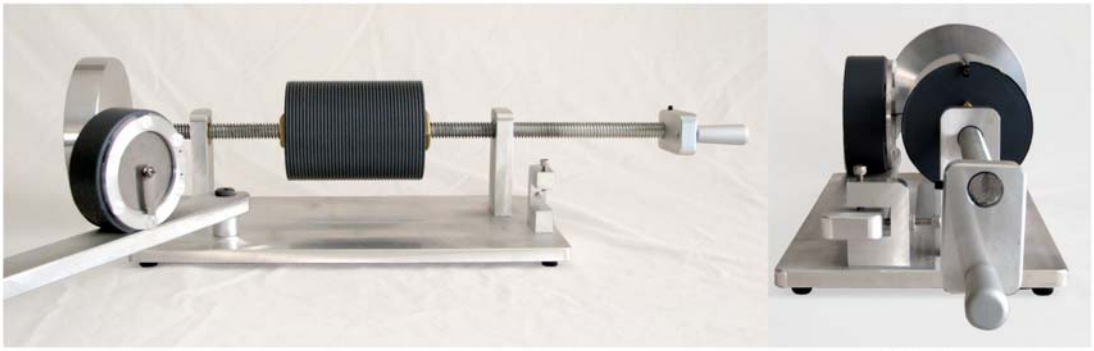


Figure 7: Photographs of the homemade reproduction phonograph.

4.1.2 Mouthpiece swivel assembly

The mouthpiece swivel assembly (ETP-1200) consists of the swivel arm (ETP-1201), the mouthpiece (ETP-1202), the diaphragm (ETP-1203), the diaphragm clamp ring (ETP-1204), the stylus (ETP-1206), and various other parts. The mouthpiece swivel assembly rotates around a shoulder bolt (ETP-1007) which is fastened to the base assembly. This allows the mouthpiece to be quickly rotated in and out of position during recording, rewinding, and playback. The end of the swivel arm rests in the C-clamp (ETP-1105) and its position is precisely controlled by means of the screws discussed in the previous section. During recording, sound is transmitted through the mouthpiece and causes the diaphragm and stylus to vibrate. During playback, the stylus and diaphragm are vibrated, causing sound to be created inside the mouthpiece.

Unlike Edison's original phonograph, this homemade reproduction utilizes a single mouthpiece for both recording and playback to minimize the number of components. A diaphragm (ETP-1203) and two latex gaskets (ETP-1205) are sandwiched between the diaphragm clamp ring (ETP-1204) and the mouthpiece (ETP-1202). A stylus is soldered onto the center of the diaphragm and is supported by a thin piece of steel shim stock. It is advantageous to have the stylus angled slightly upwards to allow the tip of the stylus to drag along the foil without tearing. A stylus that is angled normal to the diaphragm or pointing in the opposite direction of mandrel rotation will more easily tear the foil during recording and playback.

4.1.3 Rod handle assembly

The rod handle assembly (ETP-1300) consists of an acme threaded rod (ETP-1301), a crank (ETP-1302), and a handle (ETP-1303). The mandrel (ETP-1001) is mounted to this assembly using two halves of an acme square nut (ETP-1002). A foil sheet is wrapped around the mandrel prior to recording. The rod handle assembly allows for the simultaneous rotation and advancement of the foil sheet relative to the stylus. A flywheel (ETP-1003) is attached to the left end of the threaded rod to stabilize the rotational speed during recording and playback.

The mandrel is a cylinder with a helical groove and a lateral slot. The helical groove provides a way for the stylus to indent the foil in a hill-and-dale pattern and the lateral slot provides a way to secure the foil sheet to the mandrel. A hole through the center of the mandrel allows it to be assembled on the acme threaded rod. During assembly, the helical groove is aligned with the stylus and the mandrel is secured by means of two halves of an acme square nut (see ETP-1002), as shown in Fig. 8. It should be noted that great care must be taken when machining the mandrel. If the runout of the mandrel (when assembled on the acme rod) is too large, the stylus will tear through the foil in some spots and will not touch the foil in other spots.

4.1.4 Horn

The horn (ETP-1005) is a relatively simple, but important, component of the phonograph. Webster stated "it is well known that very little sound is emitted by the phonograph or the telephone with the horn taken off, although in the former case the motion of the diaphragm is exactly the same" [10]. It serves as an acoustical transformer, and

Figure 8: During assembly, the mandrel is positioned on the threaded rod so that the stylus is centered in the groove of the mandrel.

dramatically improves the amplitude of the sound recording and playback. A simple conical horn is easily made from a piece of poster board.

4.2 Phonograph operation

The operation of the phonograph requires the following steps: (1) preparation, (2) recording, and (3) playback. These steps are explained in Sections 4.2.1 through 4.2.3. A video showing these steps can also be seen at http://www.texasacoustics.org/edisonphonograph.

4.2.1 Preparation

The first step in operating the phonograph is to rewind it to its initial state by turning the crank counterclockwise. In this state, the left edge of the mandrel will be positioned near the stylus. The mouthpiece swivel arm should be rotated out of the way for this step. Next, a foil sheet is attached to the mandrel by placing one edge of the sheet in the lateral slot of the mandrel, wrapping the rest of the sheet around the mandrel, and then placing the other end of the foil sheet in the slot. A semi-compliant wedge, such as a piece of lamp cord, can then be wedged in the slot to hold the foil in place (see ETP-1000). The foil should be wrapped as tightly to the mandrel as possible. Apply some oil (WD-40, olive oil, etc.) to the surface of the foil sheet to reduce scratching noise during playback. Once the foil is secured around the mandrel the mouthpiece swivel arm should be rotated back to the recording position and secured in place with the set screw. The phonograph is now ready to record an audio track.

4.2.2 Recording

The recording process is easiest with two people, with one person turning the crank clockwise and one person speaking loudly into the horn. The person responsible for turning the crank should try to rotate the mandrel at a constant speed (around 100 rpm). The person who is speaking should place the throat of the horn on the mouthpiece and speak loudly into the mouth of the horn.

4.2.3 Playback

After recording, rotate the mouthpiece swivel away from the mandrel. Rewind the track by rotating the crank handle counterclockwise until the mandrel is returned to its initial position. After rewinding the track, return the mouthpiece swivel arm to the same position it was in during recording. The device is ready for playback when the stylus is positioned on the groove that was made during recording. To play back the track, place the throat of the horn in the

mouthpiece and turn the crank in the clockwise direction at the same speed used during recording. You should be able to hear what was spoken during recording.

5 Sound-structure interaction

The homemade phonograph can be used by educators to teach acoustics related concepts. One such concept is the transduction of acoustic pressure in air to mechanical vibration of an object, or sound-structure interaction. The basic mechanism of sound-structure interaction inside the phonograph mouthpiece is as follows: as a user speaks into the mouthpiece the fluctuations in acoustic pressure exert a force on the diaphragm, thus causing the diaphragm and stylus to vibrate in a unique manner. When the stylus is slightly embedded into the foil, the vibrations cause the foil to deform in a hill-and-dale pattern (not side-to-side), leaving an embossed time trace of the acoustic signal, as seen in Fig 9. The embossed foil is not an exact replica of the acoustic pressure waveform because it has been altered by the mouthpiece, diaphragm, stylus, and foil during the transduction process. However, the sound can be reproduced by retracing the stylus along the previously embossed groove. As the stylus travels up and down along the hill-and-dale pattern, the diaphragm is forced to vibrate in a manner which mimics the vibrations seen during recording. In turn, the vibrating diaphragm causes acoustic fluctuations, which replicate the originally recorded sounds.

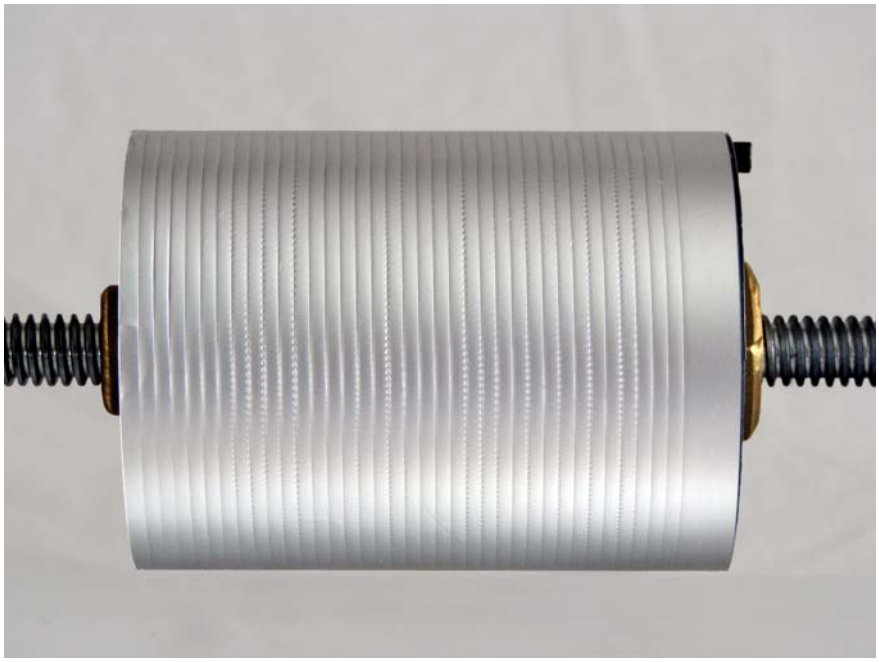


Figure 9: Close-up photograph of embossed foil sheet after recording.

6 Conclusion

The history of sound recording and reproduction was presented with special emphasis on the invention of the phonograph by Thomas Edison. Edison's historical connection to the Acoustical Society of America, as its first honorary member, was also briefly discussed. The design, construction, and operation of a homemade phonograph were presented. Photographs of the reproduction (Figs. 7 through 9), mechanical drawings (Appendix A), and a bill of materials (Appendix B) were given so that the homemade phonograph can be constructed by the reader. Finally, the use of the reproduction to teach the concept of sound-structure interaction was briefly described.

References

[1] T. Young, *A Course Of Lectures On Natural Philosophy And The Mechanical Arts*, Vol. 1, Taylor and Walton, 2 edition, 1845.

[2] T. Young, *A Course Of Lectures On Natural Philosophy And The Mechanical Arts*, Vol. 2, Taylor and Walton, 2 edition, 1845.

[3] C.J. Blake, "The graphic and photographic illustration of sound waves", *The American Journal of Otology*, Vol. 1, pp. 3–9, 1879.

[4] A. P. Deschanel, *Elementary Treatise On Natural Philosophy*, Vol. 4, D. Appleton and Co., 10 edition, 1891.

[5] W. H. Stone, *Elementary Lessons On Sound*, Macmillan and Co., London, 1879.

[6] E. L. Scott de Martinville, "The phonautographic manuscripts of Edouard-Leon Scott de Martinville", *www.FirstSounds.org*, March 2010.

[7] J. Munro, *Heroes Of The Telegraph*, The religious tract society, London, 1891.

[8] O. Mitchell, *The Talking Machine Industry*, Sir Isaac Pitman and Sons, LTD., [nd].

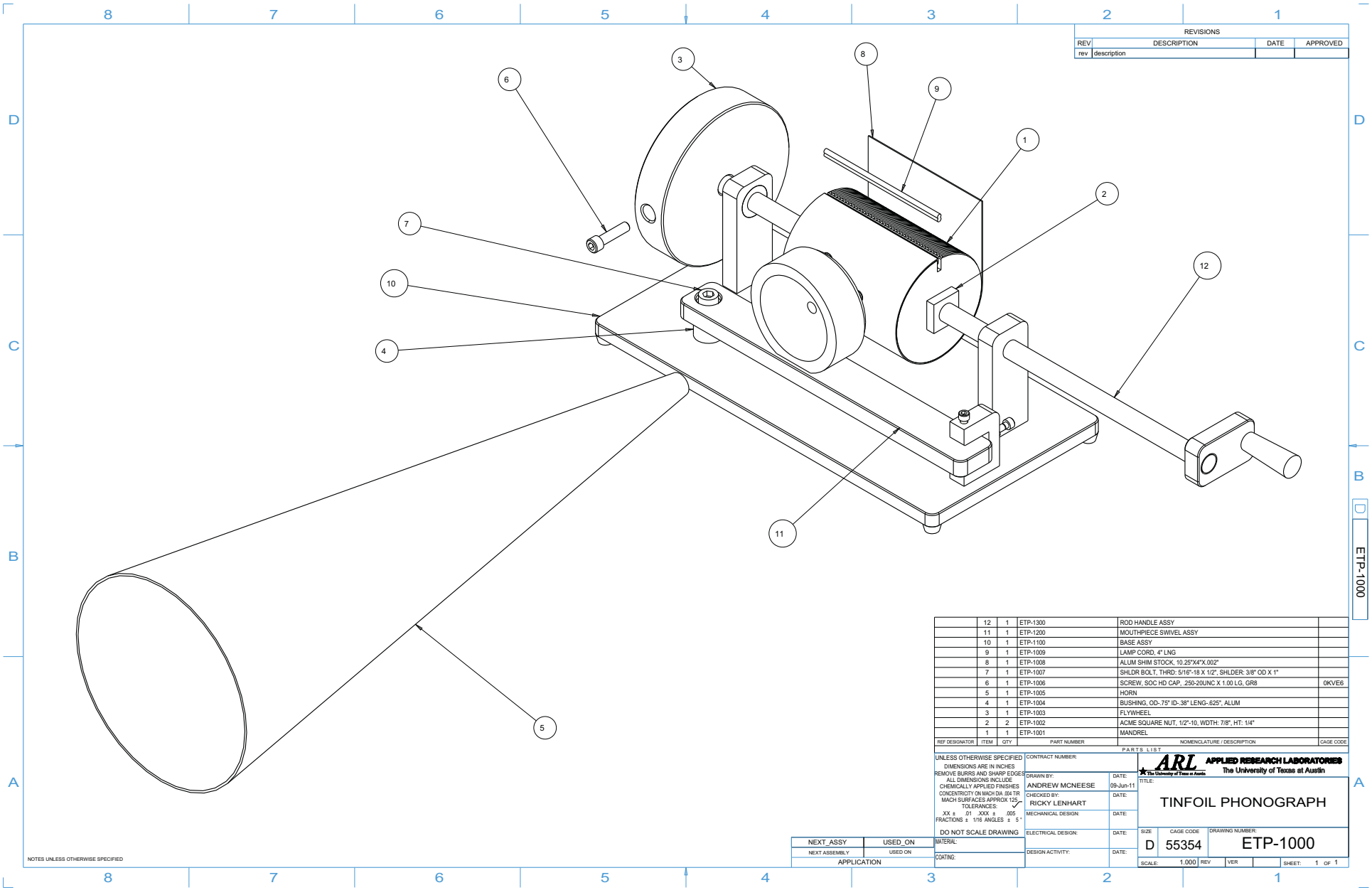
[9] "The talking phonograph", *Scientific American*, Vol. 37, No. 25, pp. 384, December 1877.

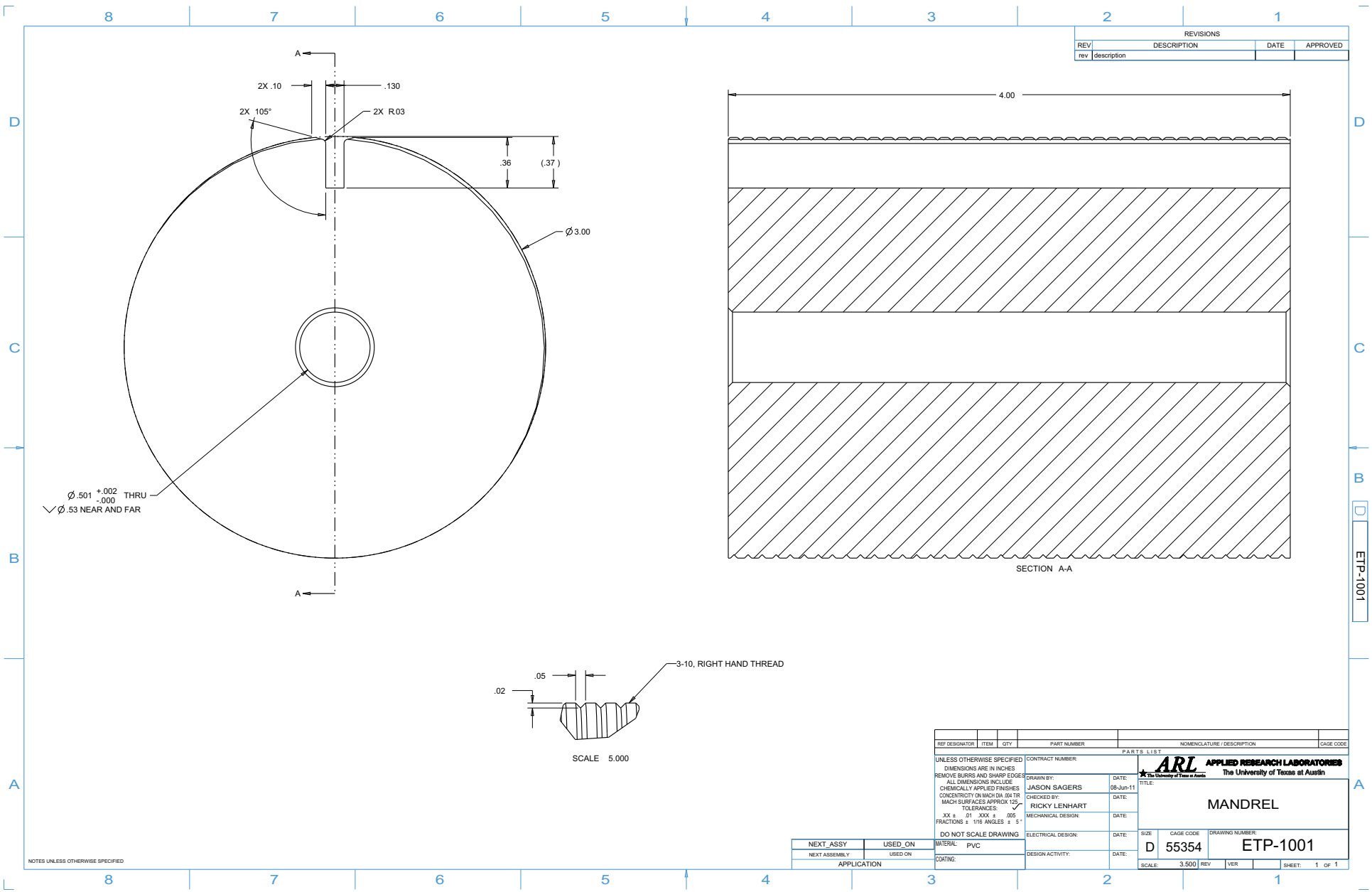
[10] A. G. Webster, "Acoustical impedance, and the theory of horns and of the phonograph", *Proceedings of the National Academy of Sciences*, Vol. 5, No. 7, pp. 275–282, July 1919.

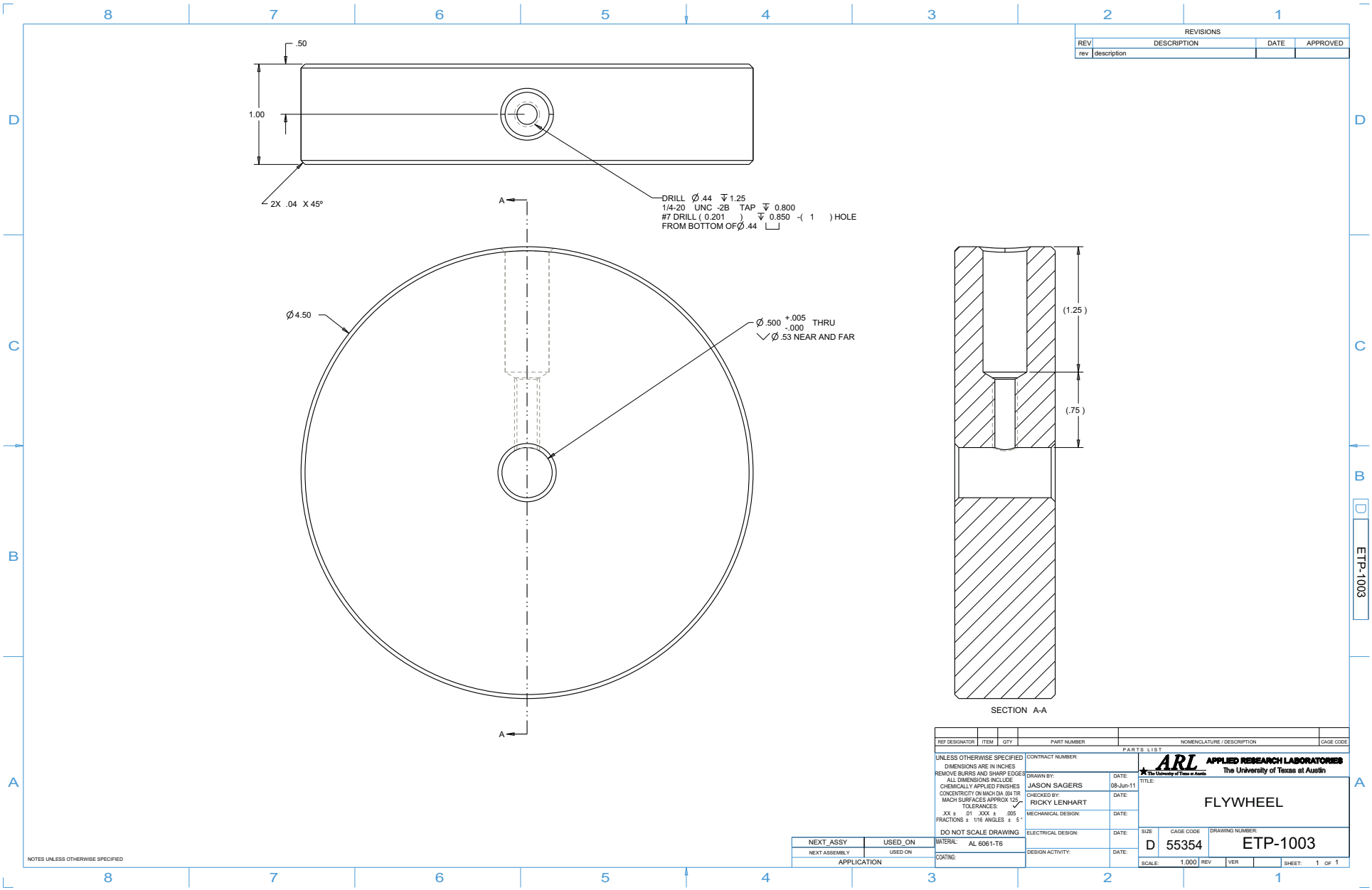
Appendix

A Mechanical drawings

Mechanical drawings for the homemade reproduction of Edison's tinfoil phonograph comprise the following pages ETP-1000 through ETP-1302.

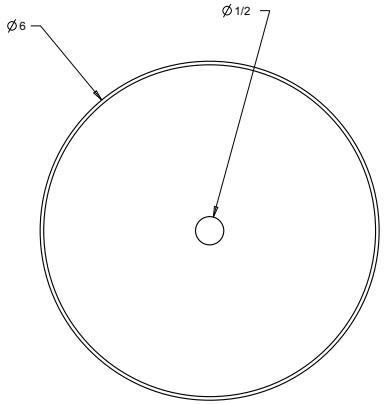

REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
1
2
3
4
5
6
7
8
9
10
11
12
ETP-1000
12 1 ETP-1300 ROD HANDLE ASSY
11 1 ETP-1200 MOUTHPIECE SWIVEL ASSY
10 1 ETP-1100 BASE ASSY
9 1 ETP-1009 LAMP CORD, 4" LNG
8 1 ETP-1008 ALUM SHIM STOCK, 10.25"X4"X.002"
7 1 ETP-1007 SHLDR BOLT, THRD: 5/16"-18 X 1/2", SHLDER: 3/8" OD X 1"
6 1 ETP-1006 SCREW, SOC HD CAP, .250-20UNC X 1.00 LG, GR8 0KVE6
5 1 ETP-1005 HORN
4 1 ETP-1004 BUSHING, OD-.75" ID-.38" LENG-.625", ALUM
3 1 ETP-1003 FLYWHEEL
2 2 ETP-1002 ACME SQUARE NUT, 1/2"-10, WDTH: 7/8", HT: 1/4"
1 1 ETP-1001 MANDREL
REF DESIGNATOR ITEM QTY PART NUMBER NOMENCLATURE / DESCRIPTION CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: ANDREW MCNEESE DATE: 09-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
MATERIAL:
COATING:
NEXT_ASSY USED_ON
NEXT ASSEMBLY USED ON
APPLICATION
NOTES UNLESS OTHERWISE SPECIFIED
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE:
TINFOIL PHONOGRAPH
SIZE D
CAGE CODE 55354
DRAWING NUMBER: ETP-1000
SCALE: 1.000 REV VER SHEET: 1 OF 1

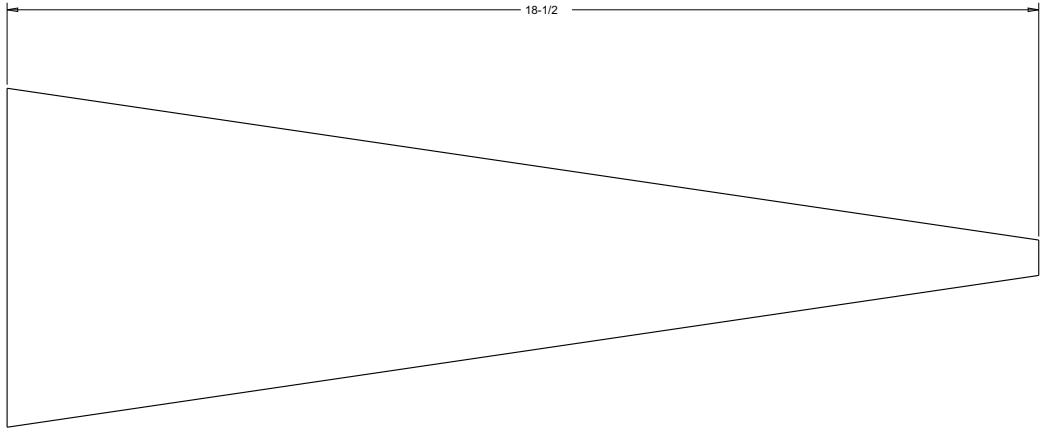

REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
A
2X .10
.130
2X 105°
2X R.03
.36
(.37)
Ø 3.00
Ø .501 +.002 -.000 THRU
Ø .53 NEAR AND FAR
A
4.00
SECTION A-A
.05
.02
3-10, RIGHT HAND THREAD
SCALE 5.000
ETP-1001
REF DESIGNATOR ITEM QTY PART NUMBER NOMENCLATURE / DESCRIPTION CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE
CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: JASON SAGERS DATE: 08-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
MATERIAL: PVC
COATING:
NEXT_ASSY USED_ON
NEXT ASSEMBLY USED ON
APPLICATION
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE:
MANDREL
SIZE D
CAGE CODE 55354
DRAWING NUMBER: ETP-1001
SCALE: 3.500 REV VER SHEET: 1 OF 1
NOTES UNLESS OTHERWISE SPECIFIED


REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
.50
1.00
2X .04 X 45°
DRILL Ø.44 ↧1.25
1/4-20 UNC -2B TAP ↧ 0.800
#7 DRILL (0.201) ↧ 0.850 -(1) HOLE
FROM BOTTOM OF Ø.44
A
Ø4.50
Ø.500 +.005 -.000 THRU
Ø.53 NEAR AND FAR
(1.25)
(.75)
SECTION A-A
REF DESIGNATOR | ITEM | QTY | PART NUMBER | NOMENCLATURE / DESCRIPTION | CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: JASON SAGERS DATE: 08-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE: FLYWHEEL
SIZE D | CAGE CODE 55354 | DRAWING NUMBER: ETP-1003
SCALE: 1.000 REV VER SHEET: 1 OF 1
NEXT_ASSY | USED_ON
NEXT ASSEMBLY | USED ON
APPLICATION
MATERIAL: AL 6061-T6
COATING:
NOTES UNLESS OTHERWISE SPECIFIED
D ETP-1003

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
rev	description		

NOTES:
HORN IS SIMPLY A PIECE OF PAPER ROLLED INTO A CONE SHAPE
DIMENSIONS ARE FOR REFERENCE ONLY





REF DESIGNATOR	ITEM	QTY	PART NUMBER	NOMENCLATURE / DESCRIPTION	CAGE CODE

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING

CONTRACT NUMBER:

DRAWN BY:	ANDREW MCNEESE	DATE: 10-Jun-11
CHECKED BY:	RICKY LENHART	DATE:
MECHANICAL DESIGN:		DATE:
ELECTRICAL DESIGN:		DATE:
DESIGN ACTIVITY:		DATE:

ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin

TITLE: HORN

SIZE	CAGE CODE	DRAWING NUMBER
D	55354	ETP-1005

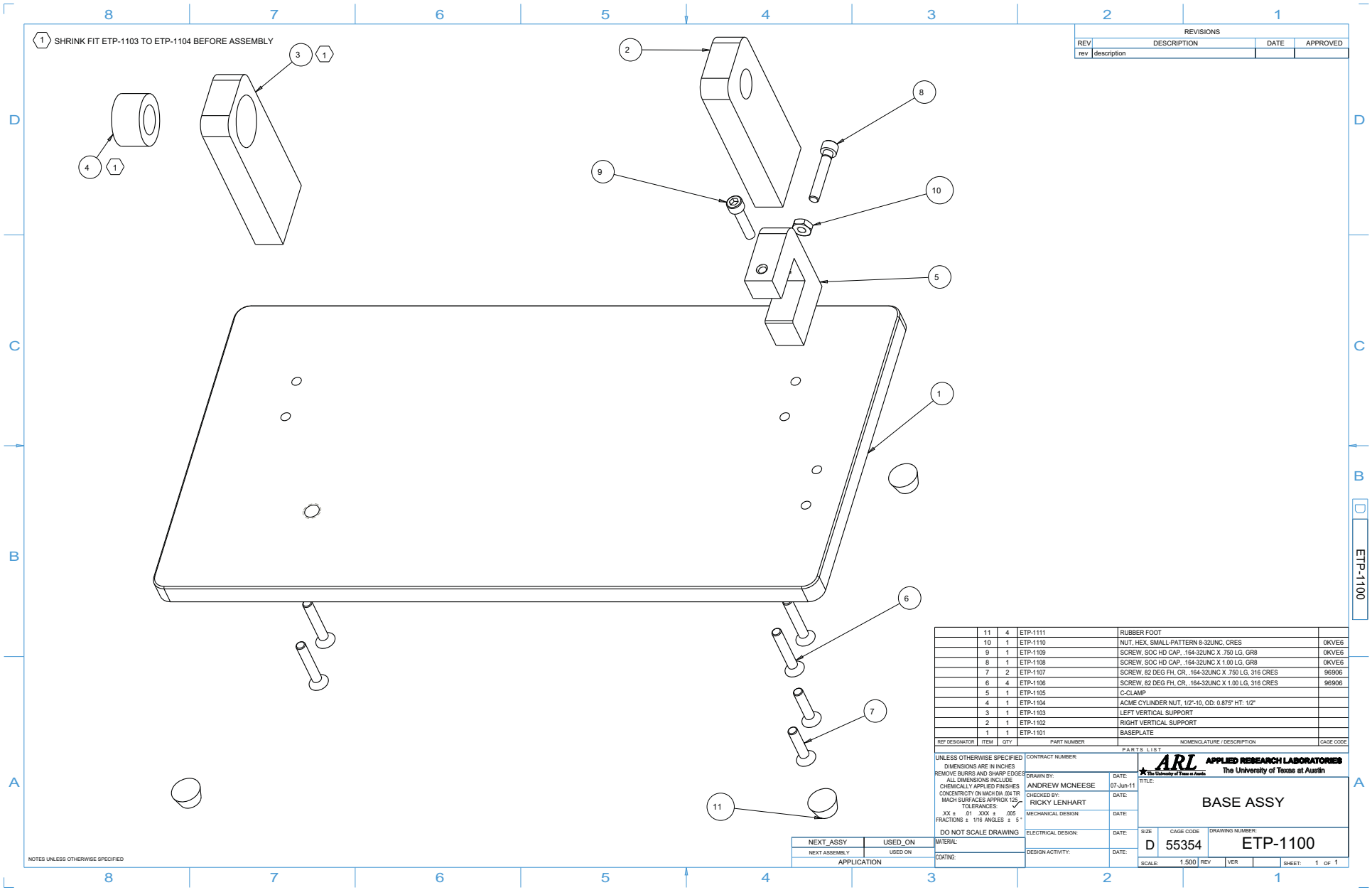
SCALE: 1.000 REV VER SHEET: 1 OF 1

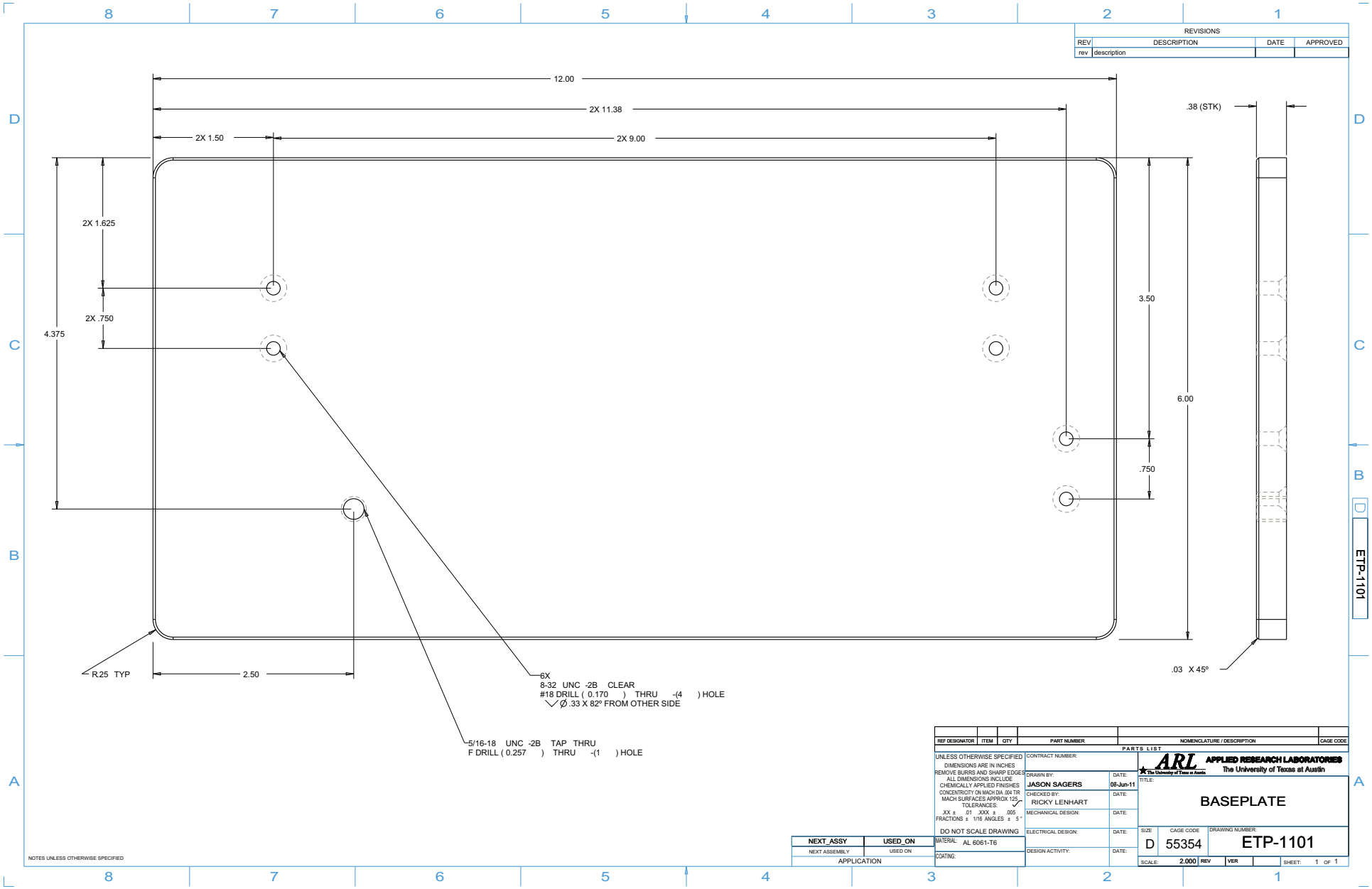
NEXT_ASSY	USED_ON
NEXT ASSEMBLY	USED ON
APPLICATION	

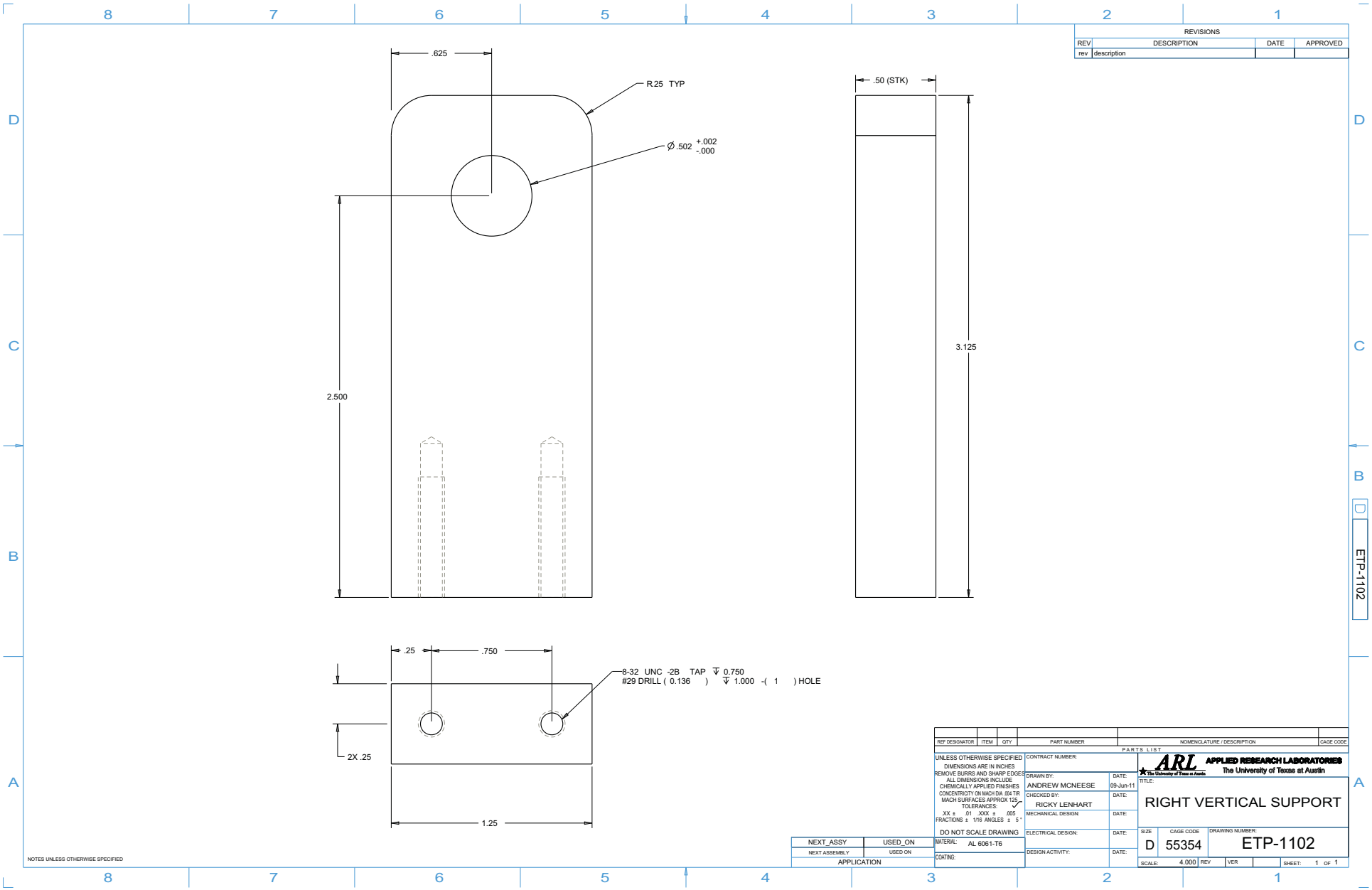
MATERIAL: PAPER
COATING:

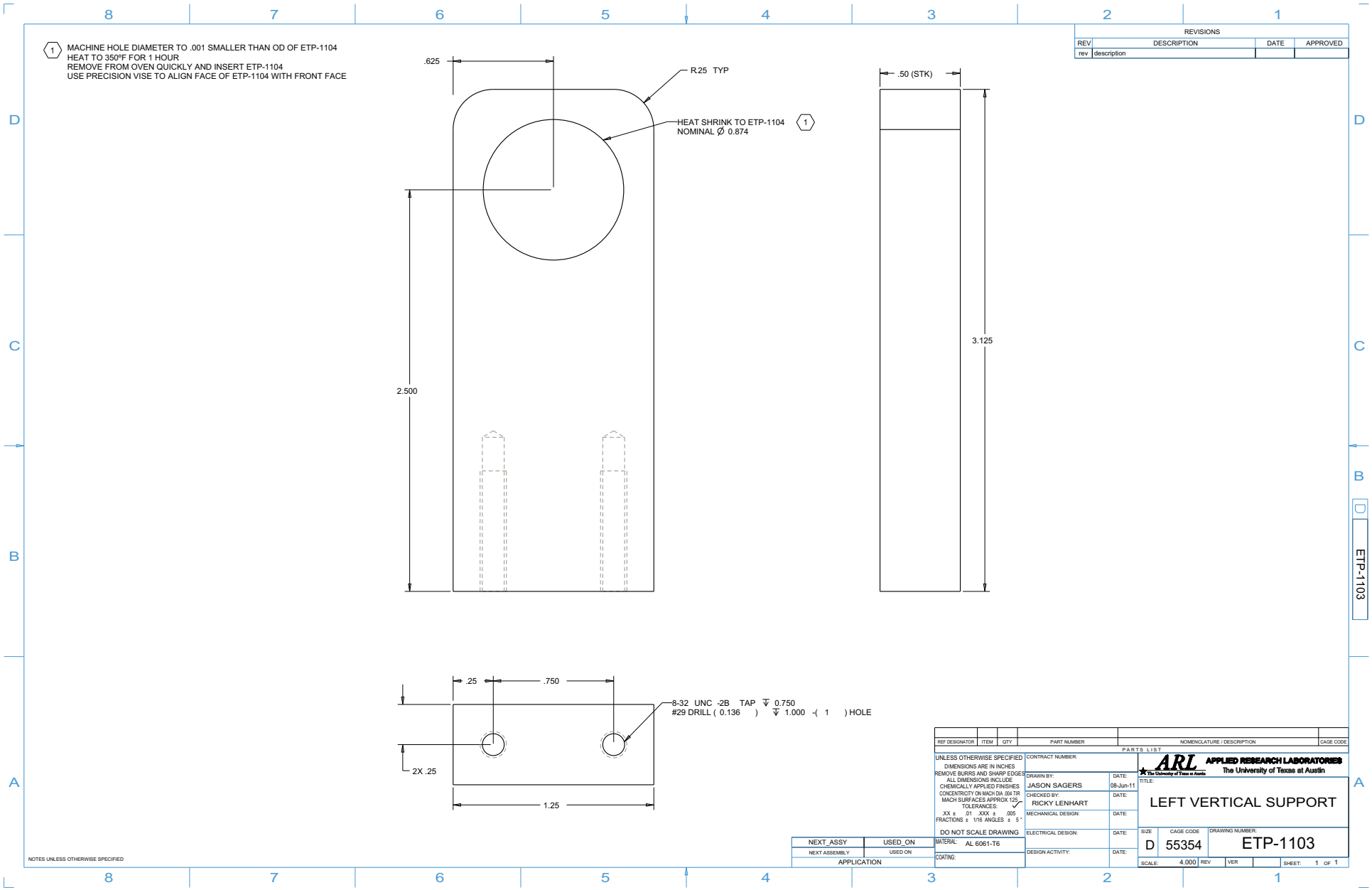
NOTES UNLESS OTHERWISE SPECIFIED

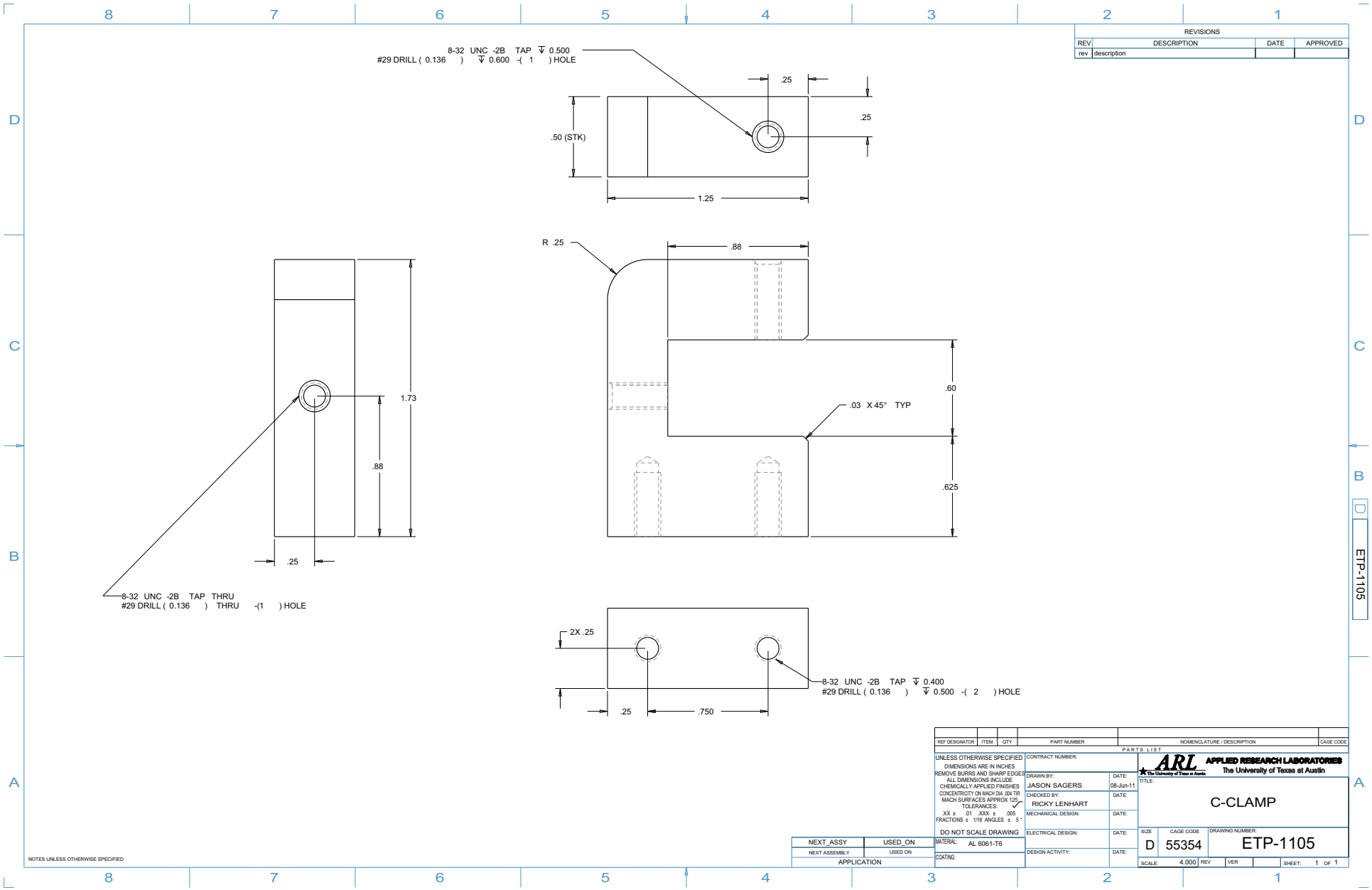
ETP-1005

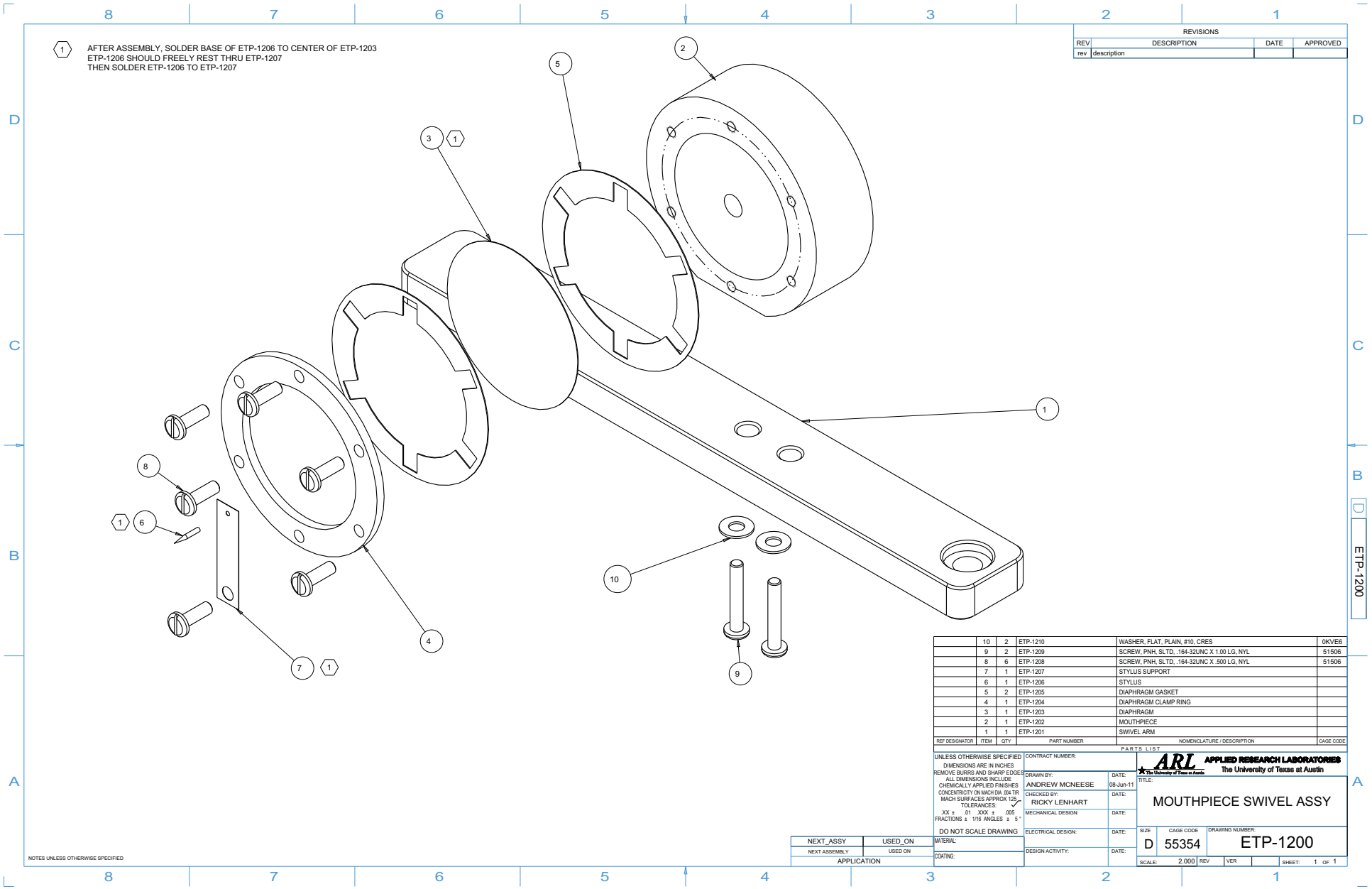

1 SHRINK FIT ETP-1103 TO ETP-1104 BEFORE ASSEMBLY
REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
NOTES UNLESS OTHERWISE SPECIFIED
PARTS LIST
REF DESIGNATOR ITEM QTY PART NUMBER NOMENCLATURE / DESCRIPTION CAGE CODE
11 4 ETP-1111 RUBBER FOOT
10 1 ETP-1110 NUT, HEX, SMALL-PATTERN 8-32UNC, CRES 0KVE6
9 1 ETP-1109 SCREW, SOC HD CAP, .164-32UNC X .750 LG, GR8 0KVE6
8 1 ETP-1108 SCREW, SOC HD CAP, .164-32UNC X 1.00 LG, GR8 0KVE6
7 2 ETP-1107 SCREW, 82 DEG FH, CR, .164-32UNC X .750 LG, 316 CRES 96906
6 4 ETP-1106 SCREW, 82 DEG FH, CR, .164-32UNC X 1.00 LG, 316 CRES 96906
5 1 ETP-1105 C-CLAMP
4 1 ETP-1104 ACME CYLINDER NUT, 1/2"-10, OD: 0.875" HT: 1/2"
3 1 ETP-1103 LEFT VERTICAL SUPPORT
2 1 ETP-1102 RIGHT VERTICAL SUPPORT
1 1 ETP-1101 BASEPLATE
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: ANDREW MCNEESE DATE: 07-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
MATERIAL:
COATING:
NEXT_ASSY USED_ON
NEXT ASSEMBLY USED ON
APPLICATION
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE: BASE ASSY
SIZE D CAGE CODE 55354 DRAWING NUMBER: ETP-1100
SCALE: 1.500 REV VER SHEET: 1 OF 1
ETP-1100

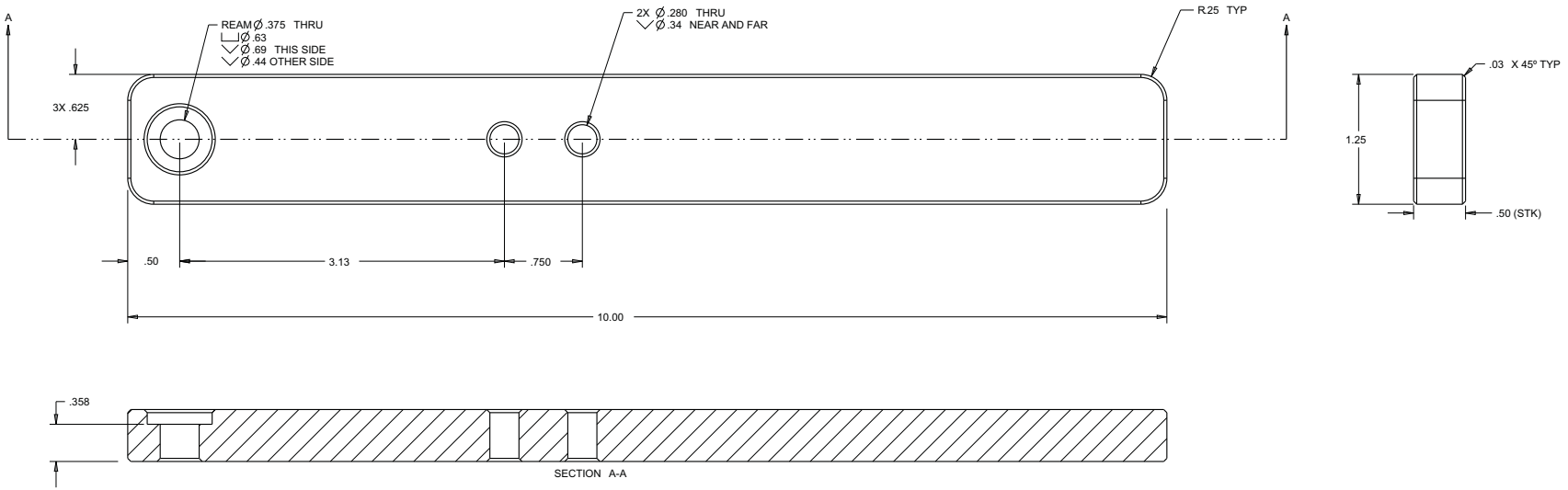

REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
12.00
2X 11.38
2X 1.50
2X 9.00
.38 (STK)
2X 1.625
2X .750
4.375
3.50
6.00
.750
R.25 TYP
2.50
6X
8-32 UNC -2B CLEAR
#18 DRILL (0.170) THRU -(4) HOLE
Ø .33 X 82° FROM OTHER SIDE
5/16-18 UNC -2B TAP THRU
F DRILL (0.257) THRU -(1) HOLE
.03 X 45°
ETP-1101
REF DESIGNATOR | ITEM | QTY | PART NUMBER | NOMENCLATURE / DESCRIPTION | CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: JASON SAGERS DATE: 08-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE: BASEPLATE
SIZE D CAGE CODE 55354 DRAWING NUMBER: ETP-1101
SCALE: 2.000 REV VER SHEET: 1 OF 1
NEXT_ASSY | USED_ON
NEXT ASSEMBLY | USED ON
APPLICATION
MATERIAL: AL 6061-T6
COATING:
NOTES UNLESS OTHERWISE SPECIFIED


REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
.625
R.25 TYP
Ø .502 +.002 -.000
2.500
.50 (STK)
3.125
.25
.750
8-32 UNC -2B TAP ↧ 0.750
#29 DRILL (0.136) ↧ 1.000 -(1) HOLE
2X .25
1.25
NOTES UNLESS OTHERWISE SPECIFIED
PARTS LIST
REF DESIGNATOR ITEM QTY PART NUMBER NOMENCLATURE / DESCRIPTION CAGE CODE
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: ANDREW MCNEESE DATE: 09-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
MATERIAL: AL 6061-T6
COATING:
NEXT_ASSY USED_ON
NEXT ASSEMBLY USED ON
APPLICATION
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE:
RIGHT VERTICAL SUPPORT
SIZE D
CAGE CODE 55354
DRAWING NUMBER: ETP-1102
SCALE: 4.000 REV VER SHEET: 1 OF 1
ETP-1102


1 MACHINE HOLE DIAMETER TO .001 SMALLER THAN OD OF ETP-1104
HEAT TO 350ºF FOR 1 HOUR
REMOVE FROM OVEN QUICKLY AND INSERT ETP-1104
USE PRECISION VISE TO ALIGN FACE OF ETP-1104 WITH FRONT FACE
REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
.625
R.25 TYP
HEAT SHRINK TO ETP-1104
NOMINAL Ø 0.874
1
.50 (STK)
2.500
3.125
.25
.750
8-32 UNC -2B TAP ↧ 0.750
#29 DRILL (0.136) ↧ 1.000 -(1) HOLE
2X .25
1.25
REF DESIGNATOR ITEM QTY PART NUMBER NOMENCLATURE / DESCRIPTION CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5 °
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: JASON SAGERS DATE: 08-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE:
LEFT VERTICAL SUPPORT
SIZE D
CAGE CODE 55354
DRAWING NUMBER: ETP-1103
SCALE: 4.000 REV VER SHEET: 1 OF 1
NEXT_ASSY USED_ON
NEXT ASSEMBLY USED ON
APPLICATION
MATERIAL: AL 6061-T6
COATING:
NOTES UNLESS OTHERWISE SPECIFIED
ETP-1103


REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
8-32 UNC -2B TAP ↧ 0.500
#29 DRILL (0.136) ↧ 0.600 -(1) HOLE
.25
.25
.50 (STK)
1.25
R .25
.88
.60
.03 X 45° TYP
.625
1.73
.88
.25
8-32 UNC -2B TAP THRU
#29 DRILL (0.136) THRU -(1) HOLE
2X .25
8-32 UNC -2B TAP ↧ 0.400
#29 DRILL (0.136) ↧ 0.500 -(2) HOLE
.25
.750
REF DESIGNATOR ITEM QTY PART NUMBER NOMENCLATURE / DESCRIPTION CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: JASON SAGERS DATE: 08-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE: C-CLAMP
SIZE D
CAGE CODE 55354
DRAWING NUMBER: ETP-1105
SCALE: 4.000 REV VER SHEET: 1 OF 1
NEXT_ASSY USED_ON
NEXT ASSEMBLY USED ON
APPLICATION
MATERIAL: AL 6061-T6
COATING:
NOTES UNLESS OTHERWISE SPECIFIED
ETP-1105


1 AFTER ASSEMBLY, SOLDER BASE OF ETP-1206 TO CENTER OF ETP-1203
ETP-1206 SHOULD FREELY REST THRU ETP-1207
THEN SOLDER ETP-1206 TO ETP-1207
REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
10 2 ETP-1210 WASHER, FLAT, PLAIN, #10, CRES 0KVE6
9 2 ETP-1209 SCREW, PNH, SLTD, .164-32UNC X 1.00 LG, NYL 51506
8 6 ETP-1208 SCREW, PNH, SLTD, .164-32UNC X .500 LG, NYL 51506
7 1 ETP-1207 STYLUS SUPPORT
6 1 ETP-1206 STYLUS
5 2 ETP-1205 DIAPHRAGM GASKET
4 1 ETP-1204 DIAPHRAGM CLAMP RING
3 1 ETP-1203 DIAPHRAGM
2 1 ETP-1202 MOUTHPIECE
1 1 ETP-1201 SWIVEL ARM
REF DESIGNATOR ITEM QTY PART NUMBER NOMENCLATURE / DESCRIPTION CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: ANDREW MCNEESE DATE: 08-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
MATERIAL:
COATING:
NEXT_ASSY USED_ON
NEXT ASSEMBLY USED ON
APPLICATION
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE:
MOUTHPIECE SWIVEL ASSY
SIZE CAGE CODE DRAWING NUMBER:
D 55354 ETP-1200
SCALE: 2.000 REV VER SHEET: 1 OF 1
ETP-1200
NOTES UNLESS OTHERWISE SPECIFIED



REVISIONS

REV	DESCRIPTION	DATE	APPROVED
rev	description		

PARTS LIST

REF DESIGNATOR	ITEM	QTY	PART NUMBER	NOMENCLATURE / DESCRIPTION	CAGE CODE

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
.XX ± .01 .XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°

DO NOT SCALE DRAWING

CONTRACT NUMBER:

		DATE:
DRAWN BY:	JASON SAGERS	08-Jun-11
CHECKED BY:	RICKY LENHART	DATE:
MECHANICAL DESIGN:		DATE:
ELECTRICAL DESIGN:		DATE:
DESIGN ACTIVITY:		DATE:

ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin

TITLE: SWIVEL ARM

SIZE	CAGE CODE	DRAWING NUMBER:
D	55354	ETP-1201

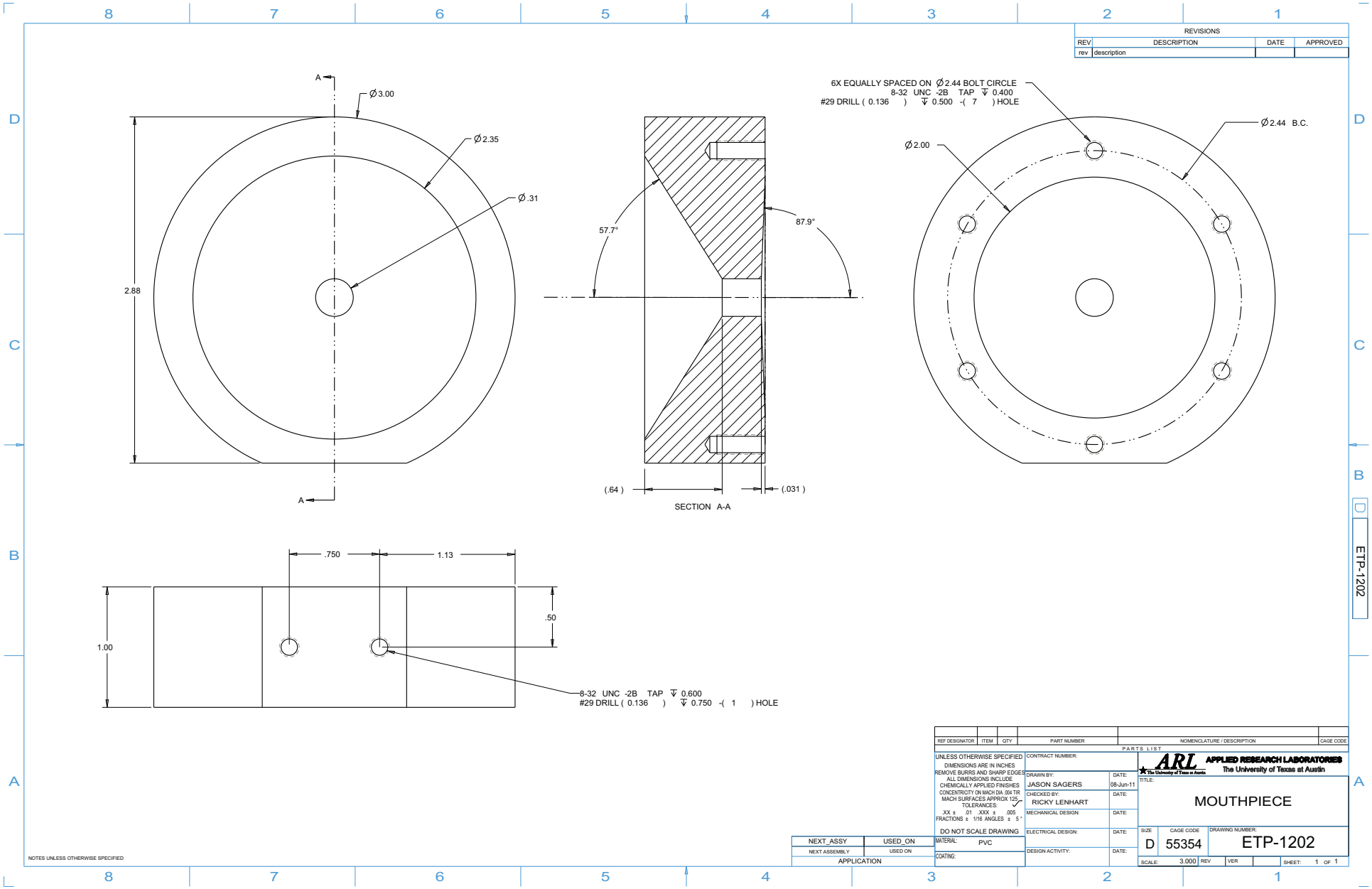
SCALE: 2.000 REV VER SHEET: 1 OF 1

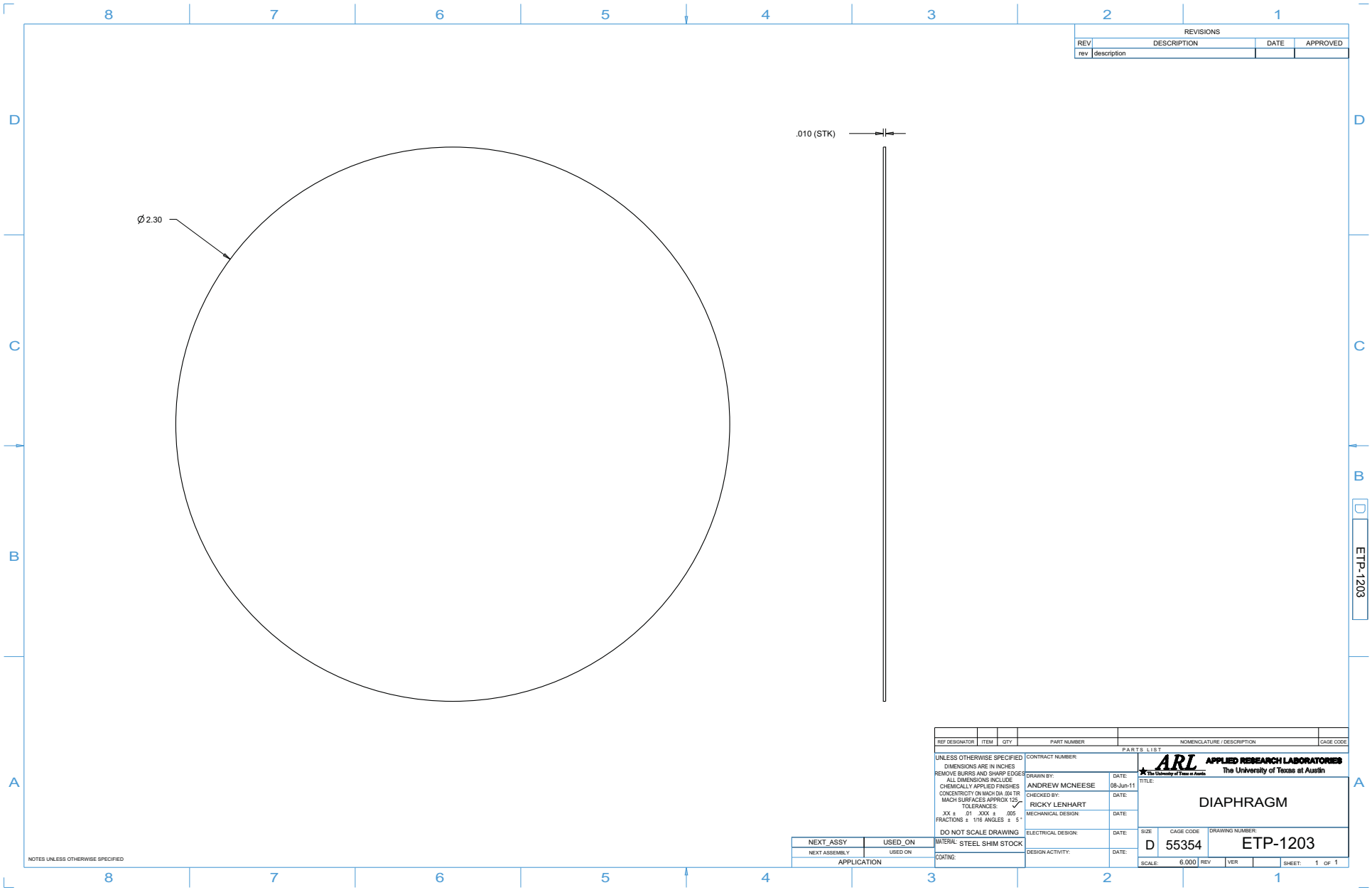
NEXT_ASSY	USED_ON
NEXT ASSEMBLY	USED ON
APPLICATION	

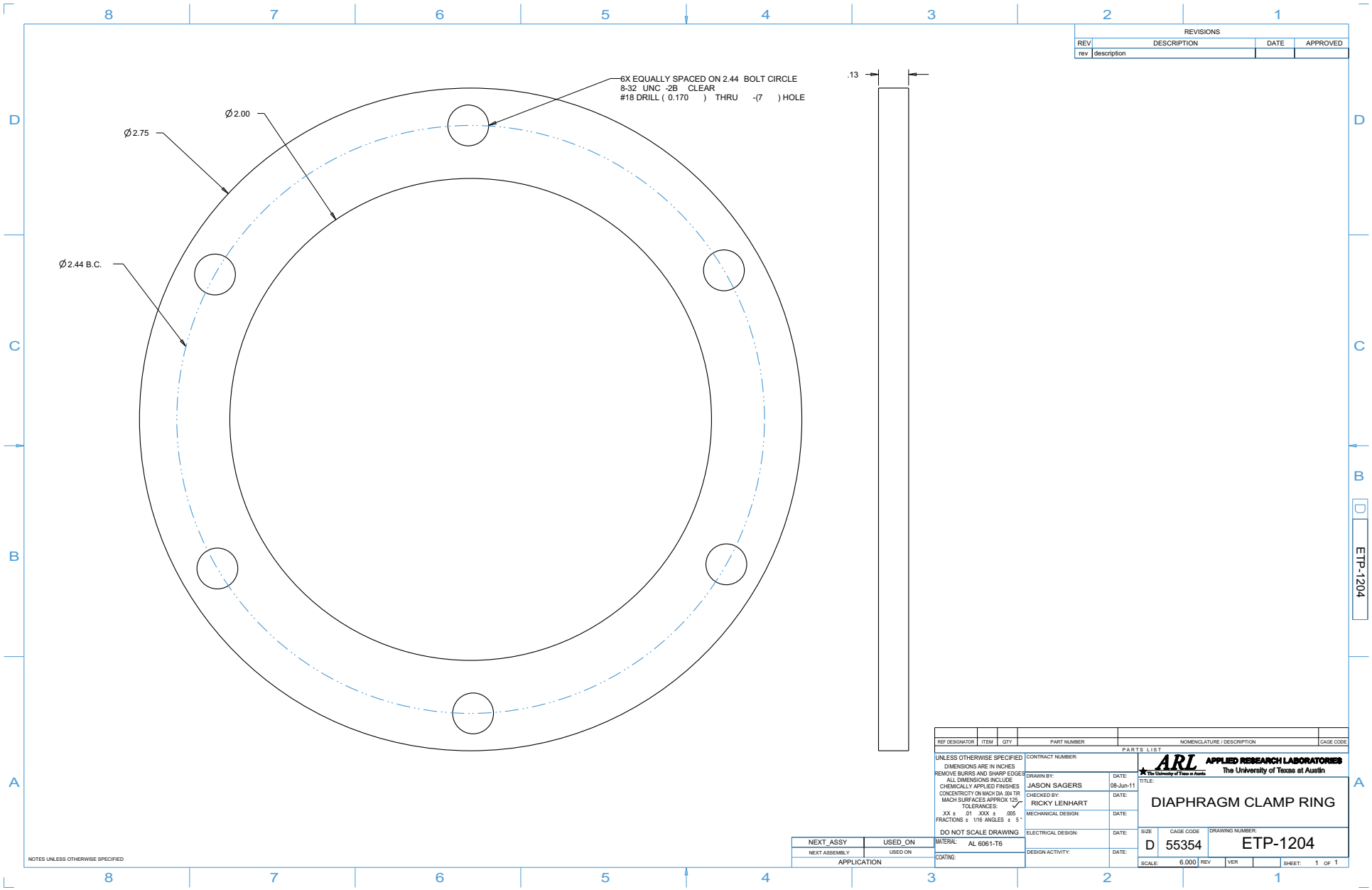
MATERIAL: AL 6061-T6
COATING:

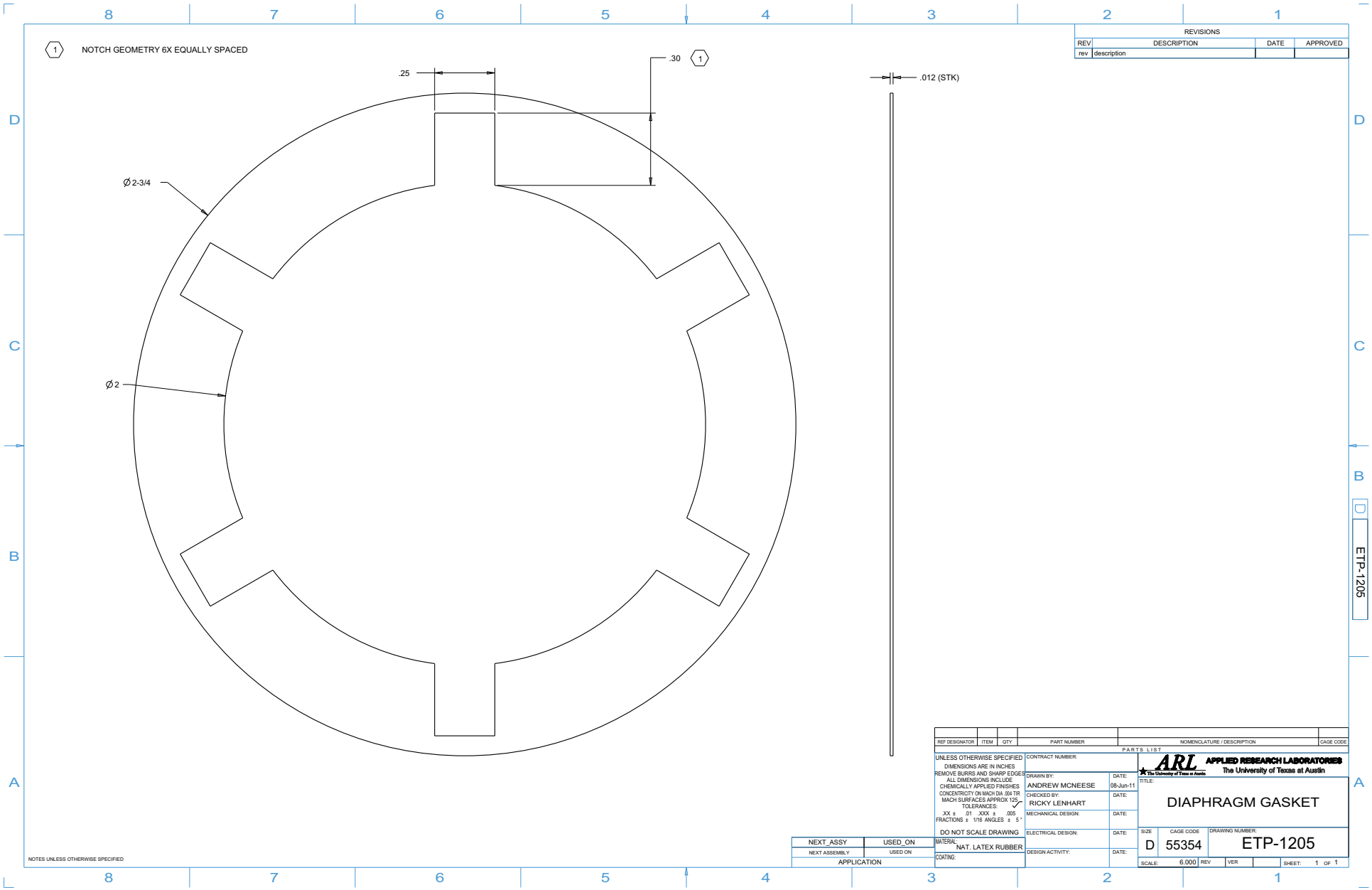
NOTES UNLESS OTHERWISE SPECIFIED

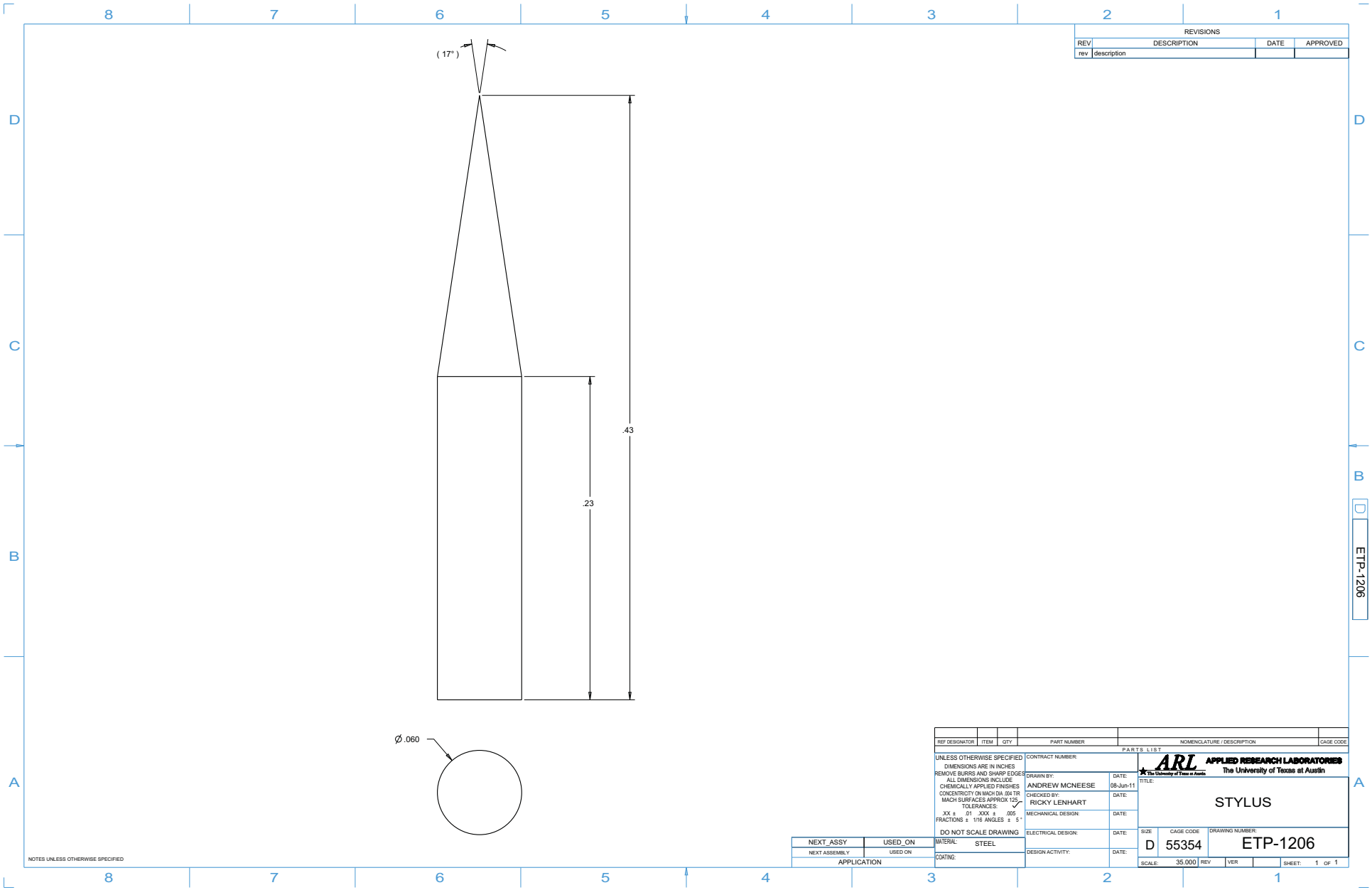
ETP-1201

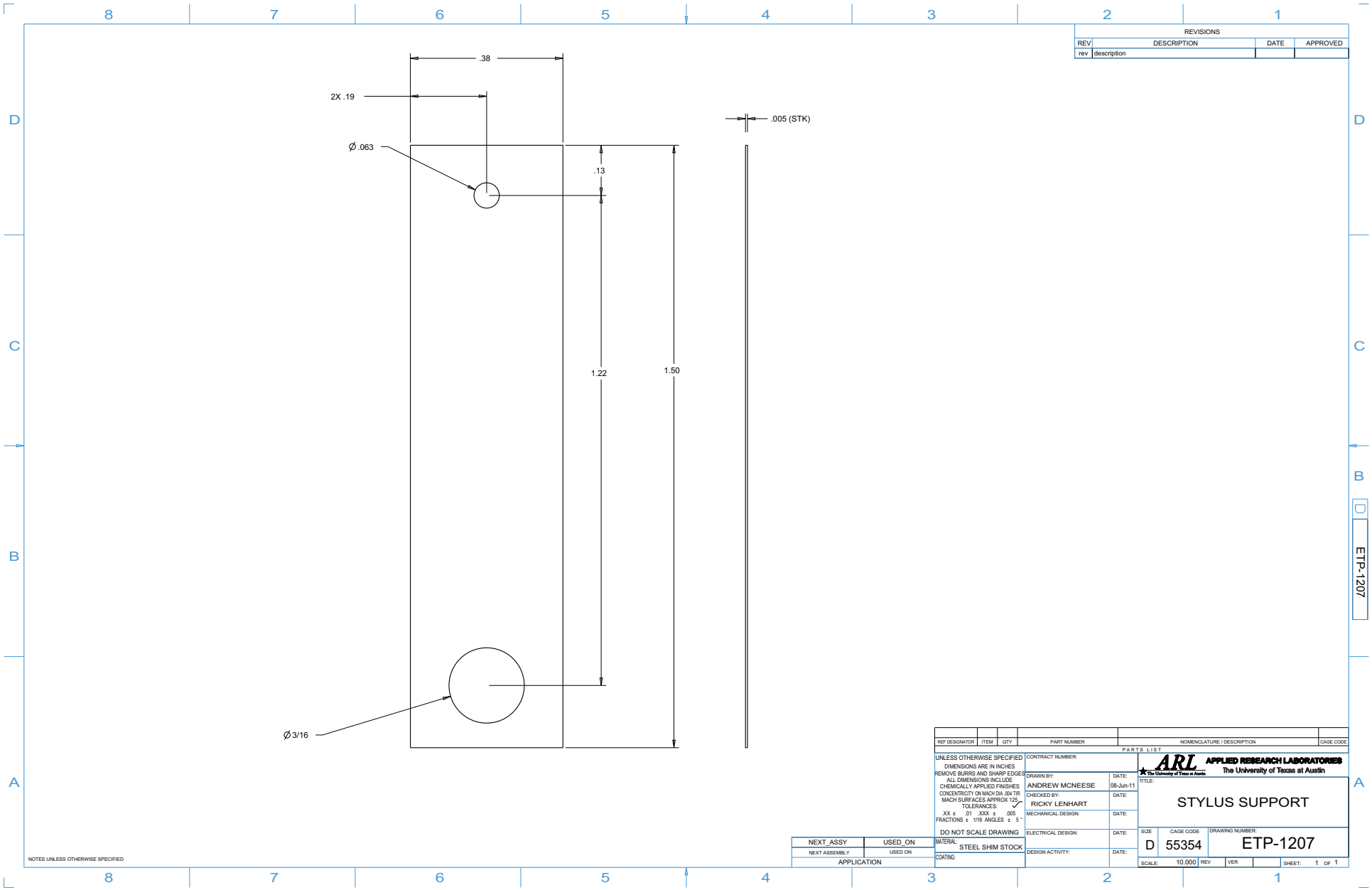

REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
A
Ø3.00
Ø2.35
Ø.31
2.88
A
6X EQUALLY SPACED ON Ø2.44 BOLT CIRCLE
8-32 UNC -2B TAP ↧ 0.400
#29 DRILL (0.136) ↧ 0.500 -(7) HOLE
Ø2.00
Ø2.44 B.C.
57.7°
87.9°
(.64)
(.031)
SECTION A-A
.750
1.13
1.00
.50
8-32 UNC -2B TAP ↧ 0.600
#29 DRILL (0.136) ↧ 0.750 -(1) HOLE
ETP-1202
NOTES UNLESS OTHERWISE SPECIFIED
REF DESIGNATOR ITEM QTY PART NUMBER NOMENCLATURE / DESCRIPTION CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5 °
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: JASON SAGERS DATE: 08-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
MATERIAL: PVC
COATING:
NEXT_ASSY USED_ON
NEXT ASSEMBLY USED ON
APPLICATION
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE: MOUTHPIECE
SIZE D CAGE CODE 55354 DRAWING NUMBER: ETP-1202
SCALE: 3.000 REV VER SHEET: 1 OF 1

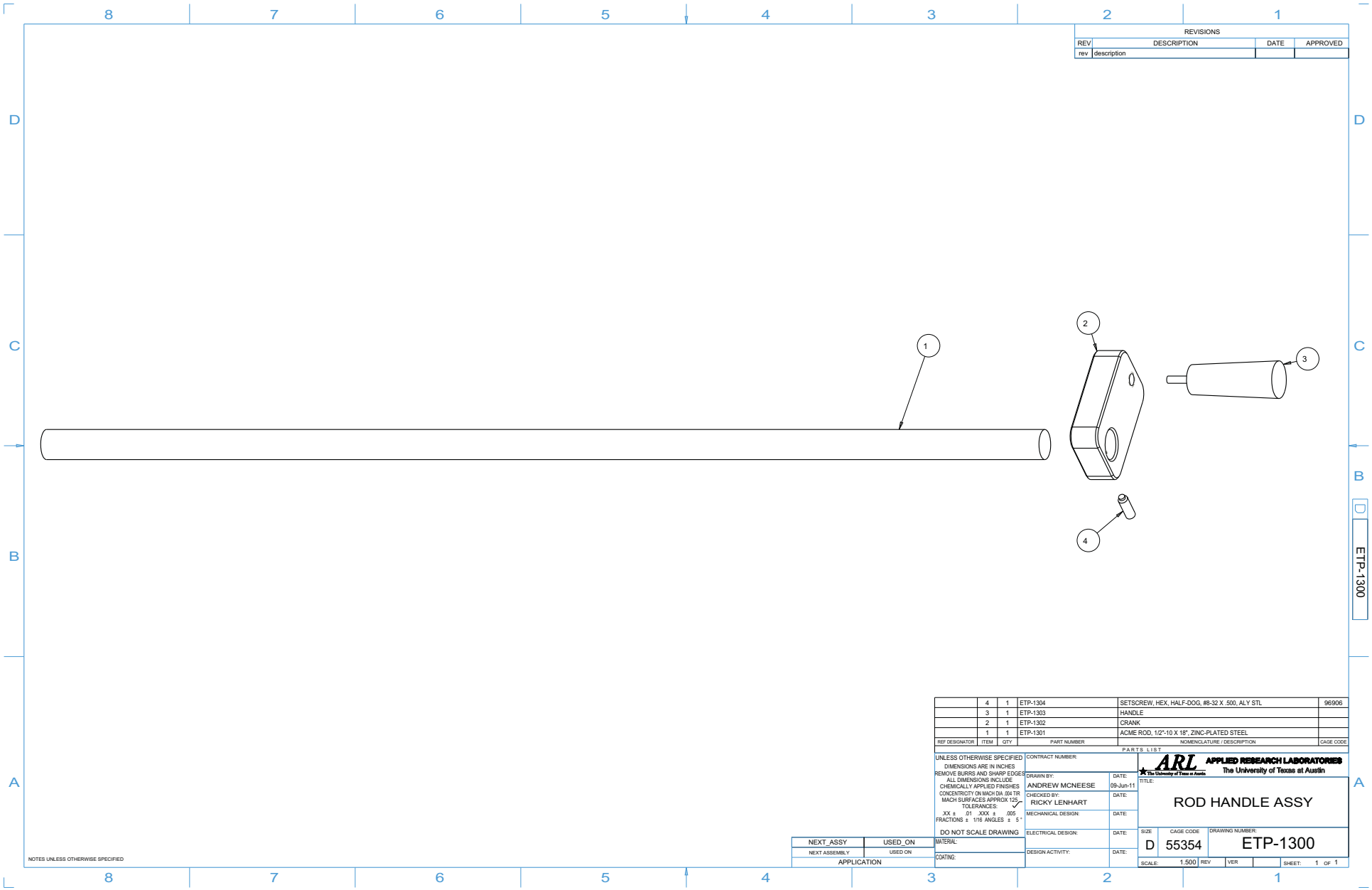

REVISIONS
REV
DESCRIPTION
DATE
APPROVED
rev
description
.010 (STK)
Ø 2.30
REF DESIGNATOR
ITEM
QTY
PART NUMBER
NOMENCLATURE / DESCRIPTION
CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE
CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY:
ANDREW MCNEESE
DATE:
08-Jun-11
CHECKED BY:
RICKY LENHART
MECHANICAL DESIGN:
ELECTRICAL DESIGN:
DESIGN ACTIVITY:
MATERIAL:
STEEL SHIM STOCK
COATING:
NEXT_ASSY
USED_ON
NEXT ASSEMBLY
USED ON
APPLICATION
NOTES UNLESS OTHERWISE SPECIFIED
APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE:
DIAPHRAGM
SIZE
D
CAGE CODE
55354
DRAWING NUMBER:
ETP-1203
SCALE:
6.000
REV
VER
SHEET:
1 OF 1
ETP-1203

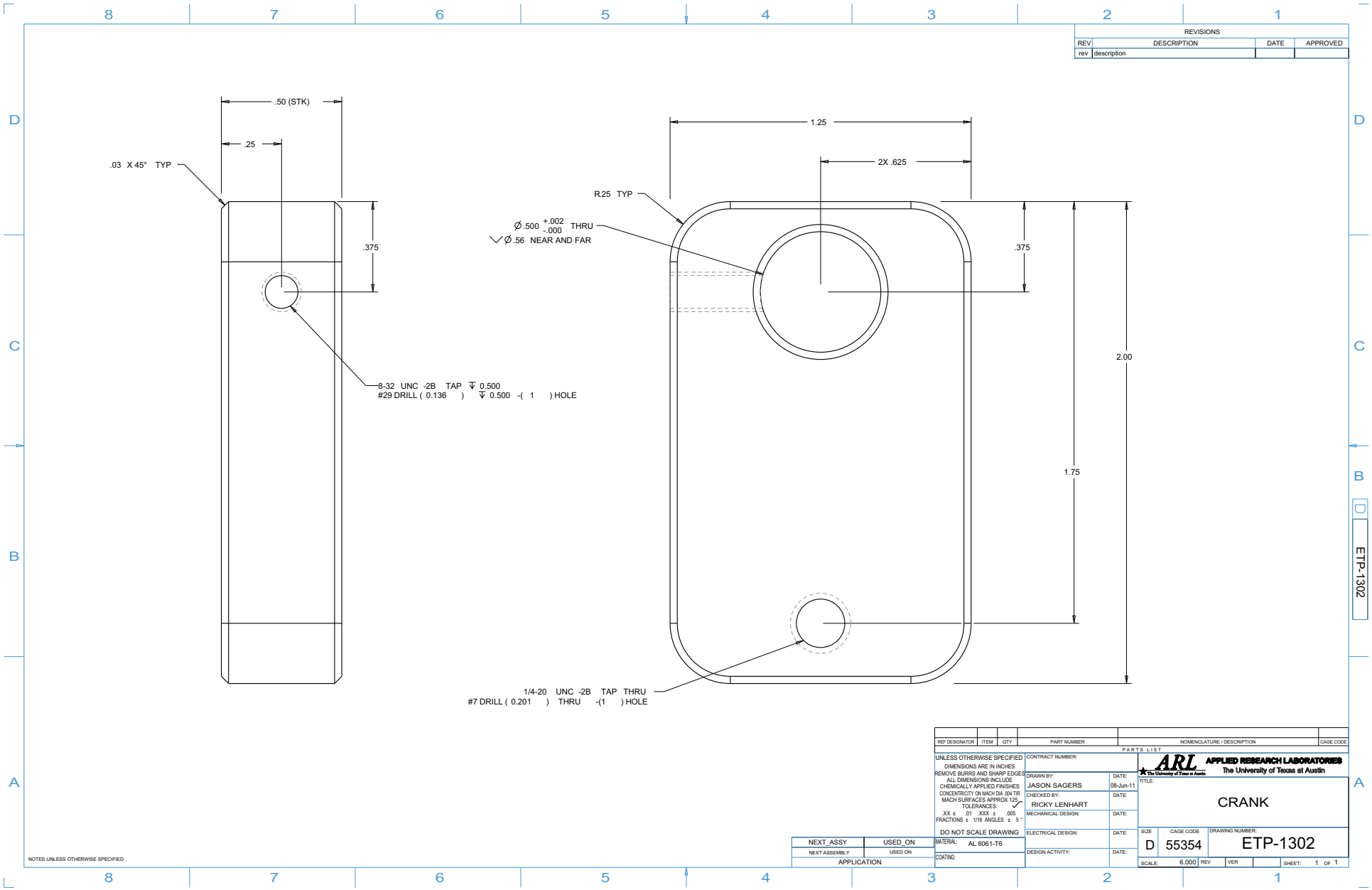

6X EQUALLY SPACED ON 2.44 BOLT CIRCLE
8-32 UNC -2B CLEAR
#18 DRILL (0.170) THRU -(7) HOLE
Ø2.00
Ø2.75
Ø2.44 B.C.
.13
REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
ETP-1204
PARTS LIST
REF DESIGNATOR ITEM QTY PART NUMBER NOMENCLATURE / DESCRIPTION CAGE CODE
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE
CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5 °
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: JASON SAGERS DATE: 08-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
MATERIAL: AL 6061-T6
COATING:
NEXT_ASSY USED_ON
NEXT ASSEMBLY USED ON
APPLICATION
NOTES UNLESS OTHERWISE SPECIFIED
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE:
DIAPHRAGM CLAMP RING
SIZE D
CAGE CODE 55354
DRAWING NUMBER: ETP-1204
SCALE: 6.000 REV VER SHEET: 1 OF 1


1 NOTCH GEOMETRY 6X EQUALLY SPACED
.25
.30
1
.012 (STK)
Ø 2-3/4
Ø 2
REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
NOTES UNLESS OTHERWISE SPECIFIED
REF DESIGNATOR ITEM QTY PART NUMBER NOMENCLATURE / DESCRIPTION CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: ANDREW MCNEESE DATE: 08-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
MATERIAL: NAT. LATEX RUBBER
COATING:
NEXT_ASSY USED_ON
NEXT ASSEMBLY USED ON
APPLICATION
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE:
DIAPHRAGM GASKET
SIZE D
CAGE CODE 55354
DRAWING NUMBER: ETP-1205
SCALE: 6.000 REV VER SHEET: 1 OF 1
D
ETP-1205


(17°)
.43
.23
Ø .060
REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
REF DESIGNATOR ITEM QTY PART NUMBER NOMENCLATURE / DESCRIPTION CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: ANDREW MCNEESE DATE: 08-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
MATERIAL: STEEL
COATING:
NEXT_ASSY USED_ON
NEXT ASSEMBLY USED ON
APPLICATION
NOTES UNLESS OTHERWISE SPECIFIED
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE:
STYLUS
SIZE D
CAGE CODE 55354
DRAWING NUMBER: ETP-1206
SCALE: 35.000 REV VER SHEET: 1 OF 1
ETP-1206


REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
.38
2X .19
.005 (STK)
Ø .063
.13
1.22
1.50
Ø 3/16
REF DESIGNATOR ITEM QTY PART NUMBER NOMENCLATURE / DESCRIPTION CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
.XX ± .01 .XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5 °
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: ANDREW MCNEESE DATE: 08-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
MATERIAL: STEEL SHIM STOCK
COATING:
NEXT_ASSY USED_ON
NEXT ASSEMBLY USED ON
APPLICATION
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE:
STYLUS SUPPORT
SIZE D
CAGE CODE 55354
DRAWING NUMBER: ETP-1207
SCALE: 10.000 REV VER SHEET: 1 OF 1
NOTES UNLESS OTHERWISE SPECIFIED
ETP-1207


REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
1
2
3
4
ETP-1300
4 1 ETP-1304 SETSCREW, HEX, HALF-DOG, #8-32 X .500, ALY STL 96906
3 1 ETP-1303 HANDLE
2 1 ETP-1302 CRANK
1 1 ETP-1301 ACME ROD, 1/2"-10 X 18", ZINC-PLATED STEEL
REF DESIGNATOR ITEM QTY PART NUMBER NOMENCLATURE / DESCRIPTION CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
.XX ± .01 .XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: ANDREW MCNEESE DATE: 09-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
MATERIAL:
COATING:
NEXT_ASSY USED_ON
NEXT ASSEMBLY USED ON
APPLICATION
NOTES UNLESS OTHERWISE SPECIFIED
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE:
ROD HANDLE ASSY
SIZE D
CAGE CODE 55354
DRAWING NUMBER: ETP-1300
SCALE: 1.500 REV VER SHEET: 1 OF 1


REVISIONS
REV DESCRIPTION DATE APPROVED
rev description
.50 (STK)
.25
.03 X 45° TYP
.375
8-32 UNC -2B TAP ↧ 0.500
#29 DRILL (0.136) ↧ 0.500 -(1) HOLE
1.25
2X .625
R.25 TYP
Ø .500 +.002 -.000 THRU
Ø .56 NEAR AND FAR
.375
2.00
1.75
1/4-20 UNC -2B TAP THRU
#7 DRILL (0.201) THRU -(1) HOLE
ETP-1302
REF DESIGNATOR | ITEM | QTY | PART NUMBER | NOMENCLATURE / DESCRIPTION | CAGE CODE
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
REMOVE BURRS AND SHARP EDGES
ALL DIMENSIONS INCLUDE CHEMICALLY APPLIED FINISHES
CONCENTRICITY ON MACH DIA .004 TIR
MACH SURFACES APPROX 125
TOLERANCES:
XX ± .01 XXX ± .005
FRACTIONS ± 1/16 ANGLES ± 5°
DO NOT SCALE DRAWING
CONTRACT NUMBER:
DRAWN BY: JASON SAGERS DATE: 08-Jun-11
CHECKED BY: RICKY LENHART DATE:
MECHANICAL DESIGN: DATE:
ELECTRICAL DESIGN: DATE:
DESIGN ACTIVITY: DATE:
MATERIAL: AL 6061-T6
COATING:
NEXT_ASSY | USED_ON
NEXT ASSEMBLY | USED ON
APPLICATION
ARL APPLIED RESEARCH LABORATORIES
The University of Texas at Austin
TITLE: CRANK
SIZE D | CAGE CODE 55354 | DRAWING NUMBER: ETP-1302
SCALE: 6.000 | REV | VER | SHEET: 1 OF 1
NOTES UNLESS OTHERWISE SPECIFIED

B Bill of materials

The following page contains a bill of materials for the homemade reproduction of Edison's tinfoil phonograph.

The following table lists materials not typically found at a general hardware store. For convenience, McMaster-Carr part numbers are listed to facilitate online purchasing from http://www.mcmaster.com (note: all part numbers are subject to change).

Phonograph Part Number	Material Description	McMaster Part Number
ETP-1101	Aluminum (6061) Sheet, 12” x 6” x 3/8”	8975K441
ETP-1102, ETP-1103, ETP-1105, ETP-1201, ETP-1302	Aluminum (6061) Bar, 36” x 1-1/4” x 1/2”*	8975K475*
ETP-1003	Aluminum (6061) Disc, 4-1/2”OD x 1”	1610T24
ETP-1001, ETP-1202, ETP-1204	PVC Rod, 3-1/4”OD x 1’*	8745K64*
ETP-1303	Revolving Handle (with 1/4”-20 stud)	64425K72
ETP-1304	Steel Set Screw, 8-32 x 1/2”	94105A193
ETP-1301	Steel Acme Threaded Rod, 1/2”-10 x36”	98941A425
ETP-1104	Brass Acme Cylinder Nut, 1/2”-10 x 7/8”OD x 1/2”	95100A103
ETP-1002	Brass Acme Square Nut, 1/2”-10 x 7/8” x 1/2”	95270A114
ETP-1004	Aluminum Bushing, 3/4”OD x .38”ID x 5/8”	92510A802
ETP-1007	Steel Shoulder Bolt, Thread 5/16”-18 x 1/2”; Shoulder 3/8”OD x 1”	91259A624
ETP-1203	Steel Shim Stock, 12” x 8” x .010”	9011K27
ETP-1207	Steel Shim Stock, 12” x 8” x .005”	9011K25
ETP-1205	Latex Rubber, 36” x 6” x .012”	85995K15
ETP-1008	Aluminum (1100) Sheet, 12” x 24” x .002”	9536K31
ETP-1111	Rubber Feet, 1/2”OD x 1/4”	95495K221

*Multiple parts are constructed from a single piece of this line item. There is no need to purchase a quantity of more than one.

The following table lists parts typically found at a general hardware store. These items are often only sold in bulk from online distributors. Because of the small quantities for these parts, it is recommended that these parts be purchased at a local hardware store.

Phonograph Part Number	Material Description	QTY
ETP-1106	Flat Head Screw, 8-32 x 1”	4
ETP-1107	Flat Head Screw, 8-32 x 3/4”	2
ETP-1108	Socket Head Cap Screw, 8-32 x 1”	1
ETP-1109	Socket Head Cap Screw, 8-32 x 3/4”	1
ETP-1006	Socket Head Cap Screw, 1/4”-20 x 1	1
ETP-1101	Jam Nut, 8-32	1
ETP-1206	Steel Nail, 15 Gauge x 1”	1
ETP-1208	Nylon Pan Head Screw, 8-32 x 1/2”	6
ETP-1209	Nylon Pan Head Screw, 8-32 x 1”	2
ETP-1210	Washer, Plain Flat #10	2
ETP-1005	Poster Board	1
ETP-1009	Lamp Cord, 4” Length	1