EM 130 LAB - TOOL SKILLS

PROJECT #1: MEASUREMENT

Performance Span: 1 Session (Complete at home if necessary)

Materials Required:

6" Steel Ruler

Assignment:

1. Complete the measurement exercise in Figure 1-1 on STF-5 using the scale on the paper, then submit your sheet for grading.

2. Using your 6" steel rule complete the Text Book measurement exercise in Figure 1-2 on page STF-6 and submit your sheet.

Project # 2: Wiring Exercise

Performance Span : 1 session (Complete at home if necessary)

The Materials Required for this Experiment will be given to you by the technician.

Quantity	Materials Required
1	9 inch length of 22 gauge stranded wire
1	3 inch length "zip cord"
1	6 inch length # 16 magnet wire (solid)
1	Spade terminal

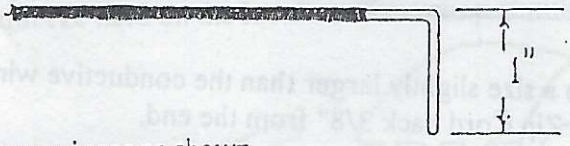
Magnet Wire

1. Cut the solid enameled magnet wire in half so that you have two, 3 inch pieces .

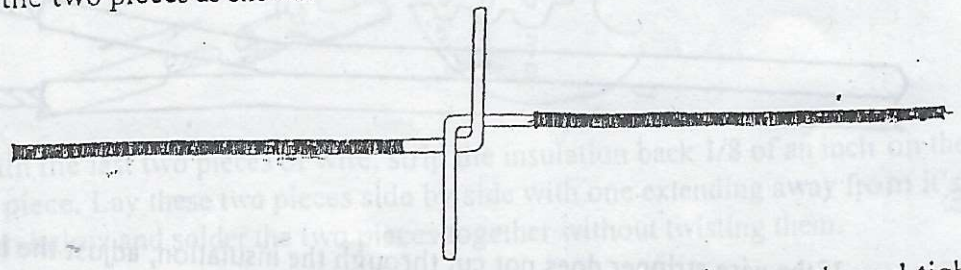
2. Now scrape the enamel insulation from ONE end of each piece, back a distance of 1 ½ ".

3. Be Sure All Enamel is Removed, otherwise you will have a poor solder joint.

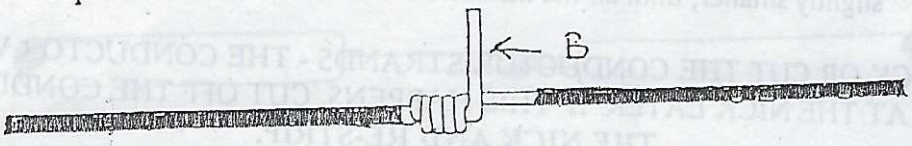
4. Bend the cleaned end at right angles, 1 inch back from the end on both pieces.



5. Place the two pieces as shown.

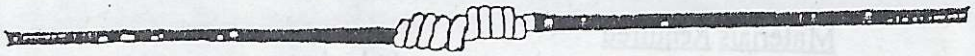


6. Now wrap the end of one piece around the body of the other piece, neatly and tightly.



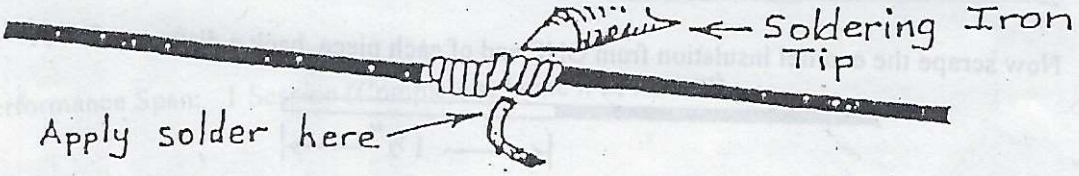
Note : Wrapped areas must be clean and enamel free.

7. Repeat step # 6 with the remaining end. B (see step # 6) The soldering iron must be kept clean and covered with melted solder or tinned Keep the tip clean and tinned or it will oxidize and transfer heat poorly. Also make sure the tip stays tightly fastened to the soldering iron. Dip the hot iron in flux. Then put solder on the tip-tinning the iron.



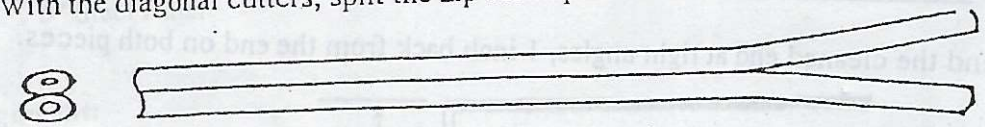
8. Using a tinned soldering iron, apply heat to the side of the wraps and apply the solder to the opposite side of the iron. When the wire is heated to the proper temperature, the solder will melt and run (Flow) around the wrapped section.

DO NOT APPLY THE SOLDER DIRECTLY TO THE SOLDERING IRON TIP.

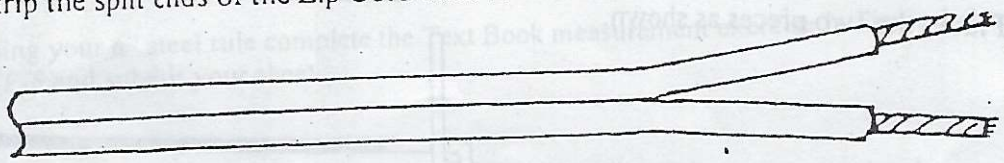


Zip Cord Wire

1. With the diagonal cutters, split the zip cord apart a distance of 1 ½ ".



2. Set your wire strippers to a size slightly larger than the conductive wire in the Zip Cord
3. Strip the split ends of the Zip Cord back 3/8" from the end.



NOTE:

If the wire stripper does not cut through the insulation, adjust the hole slightly smaller, until all the insulation is cut but NOT THE CONDUCTORS.

DO NOT NICK OR CUT THE CONDUCTOR STRANDS - THE CONDUCTOR WILL TEND TO BREAK AT THE NICK LATER. IF THIS HAPPENS. CUT OFF THE CONDUCTOR AT THE NICK AND RE-STRIP.

4. Holding the Zip Cord in one hand, gently twist the conductor strands until smooth and tight. Do both stripped ends.

5. Apply the soldering iron to one side of the twisted conductor, the solder to the opposite side and let the solder flow until a thin silver coating covers the conductor wire. Be careful not to put too much solder on the conductor.

6. This operation is called TINNING, it prevents loose strands and improves the soldering joints when the wire is connected to a terminal.

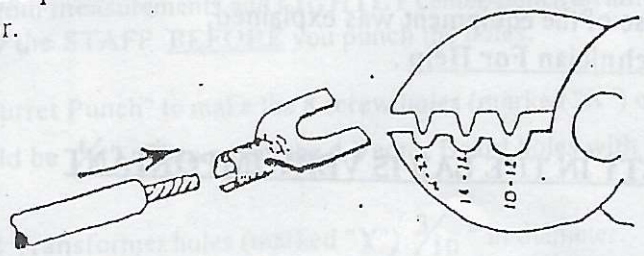
Stranded Single Conductor

1). Cut the 9" piece of strand wire into 3 pieces. Strip one length back 5/16" and twist.

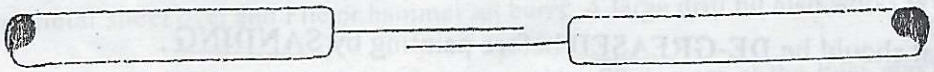
2). Slip the spade connector over the twisted conductor until the conductor is FLUSH with the end of the sleeve.

3). Obtain the proper Crimping Tool for Spade connectors from the Instructor or CLT.

4). Open the tool's jaws and lay the spade sleeve in the half round opening which best fits the sleeve. The SPLIT on the spade sleeve faces DOWN in the tool. Center the sleeve and pliers and squeeze hard on the handles. The crimp should be tight enough to hold the conductor.



5). Now with the last two pieces of wire, strip the insulation back 1/8 of an inch on the end of each piece. Lay these two pieces side by side with one extending away from it's mate as shown below and solder the two pieces together without twisting them.



You have now completed the Wiring Exercise. Place all the finished connections back in the envelope, and submit to the Instructor for grading.

STUDENTS SHOULD NOW SIGN THE SAFETY AGREEMENT STAFF WILL DISTRIBUTE STF-7

SHEET METAL BOX FOR DIGITAL TRAINER

Performance span on sheet metal : 3 weeks.

MATERIALS REQUIRED :

(These will be given to you by the Lab. Technician.)

1 Piece of sheet steel for (Bottom) 11 7/8" x 8"

1 Piece of sheet steel for (Top) 13 1/16" x 8"

********** Important Notes **********

1) Make Sure that you know how to use all equipment in the Lab.
If you were absent when use of the equipment was explained,
ASK the Professor or Technician For Help .

SAFETY IN THE LAB IS VERY IMPORTANT

A) Drawings are not to scale!

B) All **Metal Sheets** that you receive should be checked for squareness.
Use a **COMBINATION SQUARE** from the stockroom. If metal is not square,
square it on the shear and cut to size.

C) All Metal should be **DE-GREASED** before painting by **SANDING** .

BOTTOM SECTION of Digital Trainer

Performance Span : 1 Session

MATERIALS REQUIRED :

1 PIECE OF SHEET STEEL - SIZE: 11 7/8" x 8"

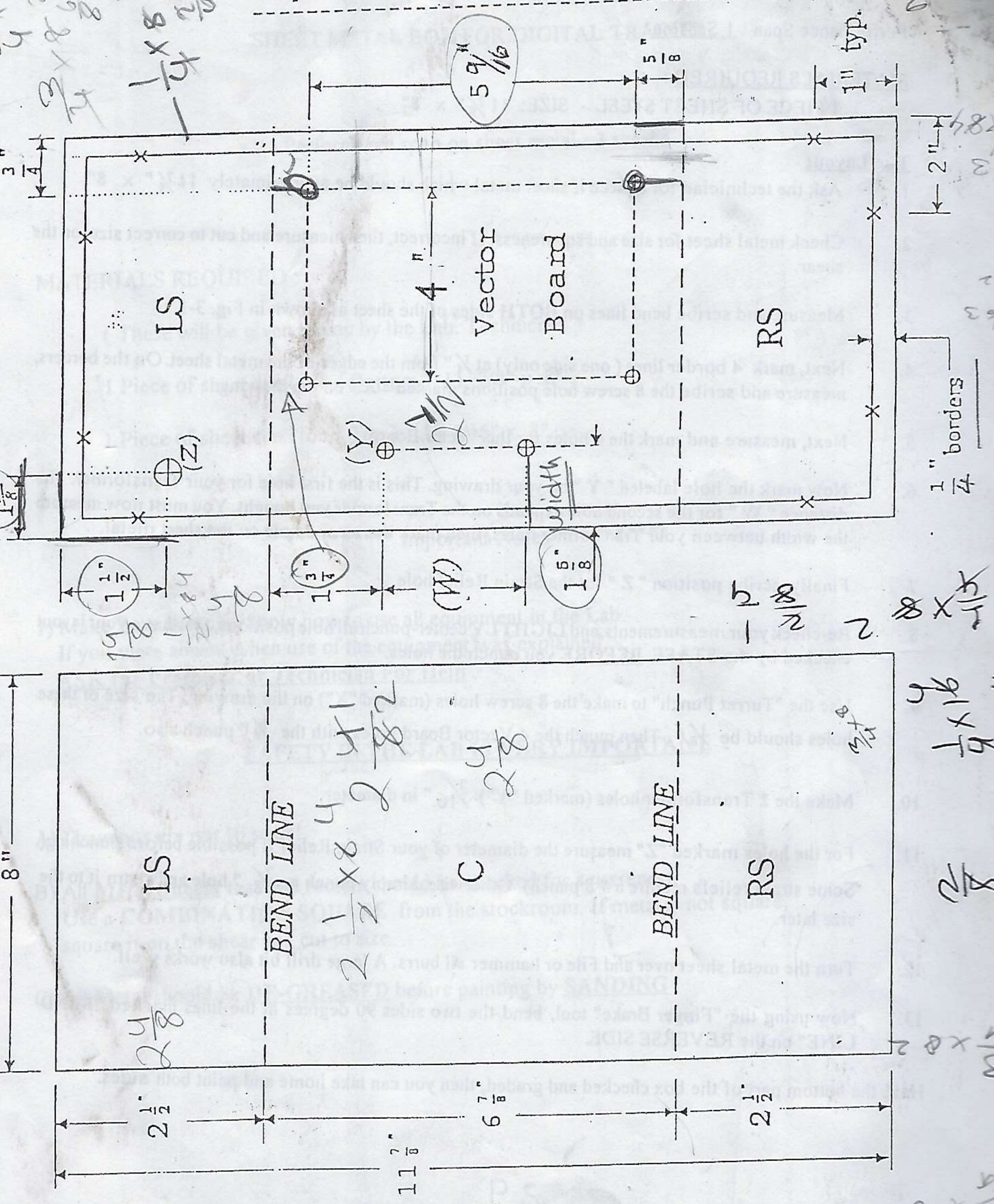
The Layout

1. Ask the technician for a piece if sheet metal which should be approximately 11 7/8" x 8".
2. Check metal sheet for size and squareness. If incorrect, then measure and cut to correct size on the shear.
3. Measure and scribe bend lines on BOTH sides of the sheet as shown in Fig. 3-1.
4. Next, mark 4 border lines (one side only) at 1/4" from the edges of the metal sheet. On the borders, measure and scribe the 8 screw hole positions marked " X " on the drawing.
5. Next, measure and mark the 4 holes for the Vector Board.
6. Now mark the hole labeled " Y " on your drawing. This is the first hole for your Transformer. The distance " W " for the second hole depends on the Transformer you bought. You must now measure the width between your Transformer holes, then mark the second hole on the sheet metal.
7. Finally, scribe position " Z " for the Strain Relief hole.
8. Re-check your measurements,and LIGHTLY center-punch all hole positions, then have your layout checked by the STAFF BEFORE you punch the holes.
9. Use the "Turret Punch" to make the 8 screw holes (marked "X") on the drawing. The size of these holes should be 1/8" . Then punch the 4 Vector Board holes with the 1/8" punch also.
10. Make the 2 Transformer holes (marked "Y") 3/16" in diameter.
11. For the holes marked "Z" measure the diameter of your Strain Relief if possible before punching(Some strain reliefs require a # 8 punch). Otherwise, simply punch a 3/8" hole and ream it to the size later.
12. Turn the metal sheet over and File or hammer all burrs. A large drill bit also works well.
13. Now using the "Finger Brake" tool, bend the two sides 90 degrees at the lines marked "BEND LINE" on the REVERSE SIDE.

Have the bottom part of the box checked and graded, then you can take home and paint both sides.

FIGURE 3-1

Layout for BOTTOM Section of Box



TOP SECTION OF DIGITAL TRAINER

Performance Span: 2 sessions

Material Required:
1 Piece of sheet metal – SIZE: 13 1/16" x 8"

The Layout

1. Obtain a piece of metal for the Top layout – the size should be 13 1/16" x 8". If the metal is bigger, check for square-ness and then cut to size. Note: Have the Technician check your measurements before you cut.

2. Scribe all bend lines on both sides of the metal as shown in Figure 4-1 and 4-2. Also scribe the lines for the four corner notches.

3. For simplicity, let us label the three sections of the sheet metal -"R" REAR, "T" TOP, "F" FRONT. Scribe these letters in the appropriate spots in Fig: 4-1 and 4-2.

4. On the FRONT and REAR sections, measure and mark one hole for each side as shown in Fig 4-2. On the TOP, measure and mark two holes on each side. These 8 holes are screw holes. Let the Technician or Instructor check these holes for accuracy.

5. Lightly center-punch the 4 points where the four bend lines intersect each other and the 8 screw holes.

6. If your center-punches are correct you may proceed to the turret punch. Punch the 4 point 1/8" in diameter. These are for making "relief" holes for the corner notches. Now, punch the 8 screw holes 3/16" in diameter.

7. Use the Corner Notch machine to make four 90° notches at the relief holes as shown in Figure 4-2.

8. Now start working on the 7" x 8 1/16" Top section marked "T". This section requires great care and accuracy in measuring due to the number of components being places here

* Figure 4-3 is an enlarged view of the TOP section shown in Figure 4-2. (Between the 90° notches).

*Figure 4-5 shows how the "TOP" should look when it is completed with all the parts mounted.

9. Now carefully measured and scribe all holes positions on Top Panel using the measurements given in Fig 4-3.

10. Recheck you measurements and scribe lines, then have your worked checked by the technician before center-punching any holes.

11. If all of your measurement are correct, center-punch all holes. Then adjust the Turret Punch for the required size holes as below, and punch carefully. Unfortunately, it is difficult to purchase standard parts, so the sizes of some parts must be measured.

* Holes marked (E) - There are 3 sets of 10. For each set make the 2 **end** holes 1/8 ", and the inner 8 holes 3/16" in diameter.

* Holes marked (A) - There are 7 of these. Measure the diameter of your **L.E.D. Holders.**

* Holes marked (B) - There are 4 of these. Measure the diameter of your **Toggle Switches.**

* Holes marked (C) - There are 2 of these. Measure the diameter of your **Momentary Switches.**

* Holes marked (D) - There is only one. Measure the diameter of your **1 Meg. Potentiometer.**

*** Check that all components fit in their designated holes and make any needed adjustments before you file down all burrs. Have the last four digits of your ID # stamped on the "R" section of your metal.

12. You are now ready to bend the Top section. Take the Top layout and your manual over to the Finger Break tool. **BE SURE TO FOLLOW BEND LINES ON THE <u>REVERSE SIDE</u> OF THE METAL, AND BEND IN THE SAME SEQUENCE AS SHOWN IN FIGUR 4-4.** (All other markings are face down.)

13. Have the Top part of your box checked and graded, take it home and paint BOTH sides.

NOTE: Nothing will be graded from now on without this ID #. Make sure the painted metal is fully dried before placing all components on the Top Section.

You have now completed the metal housing for your Digital Trainer.
Next you will work on the internal electronic section.

FIGURE 4-1

FIGURE 4-2

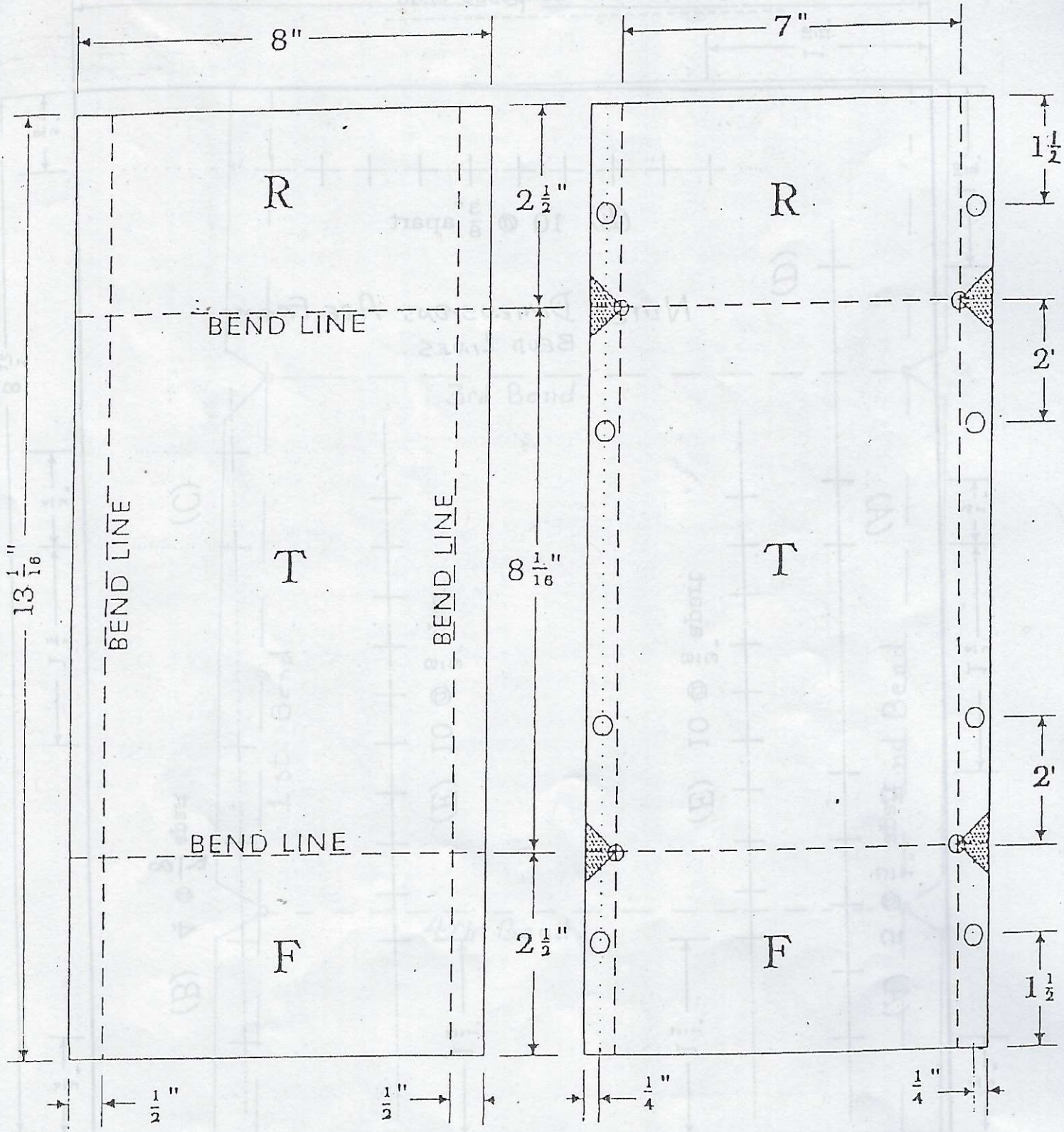


FIGURE 4-3

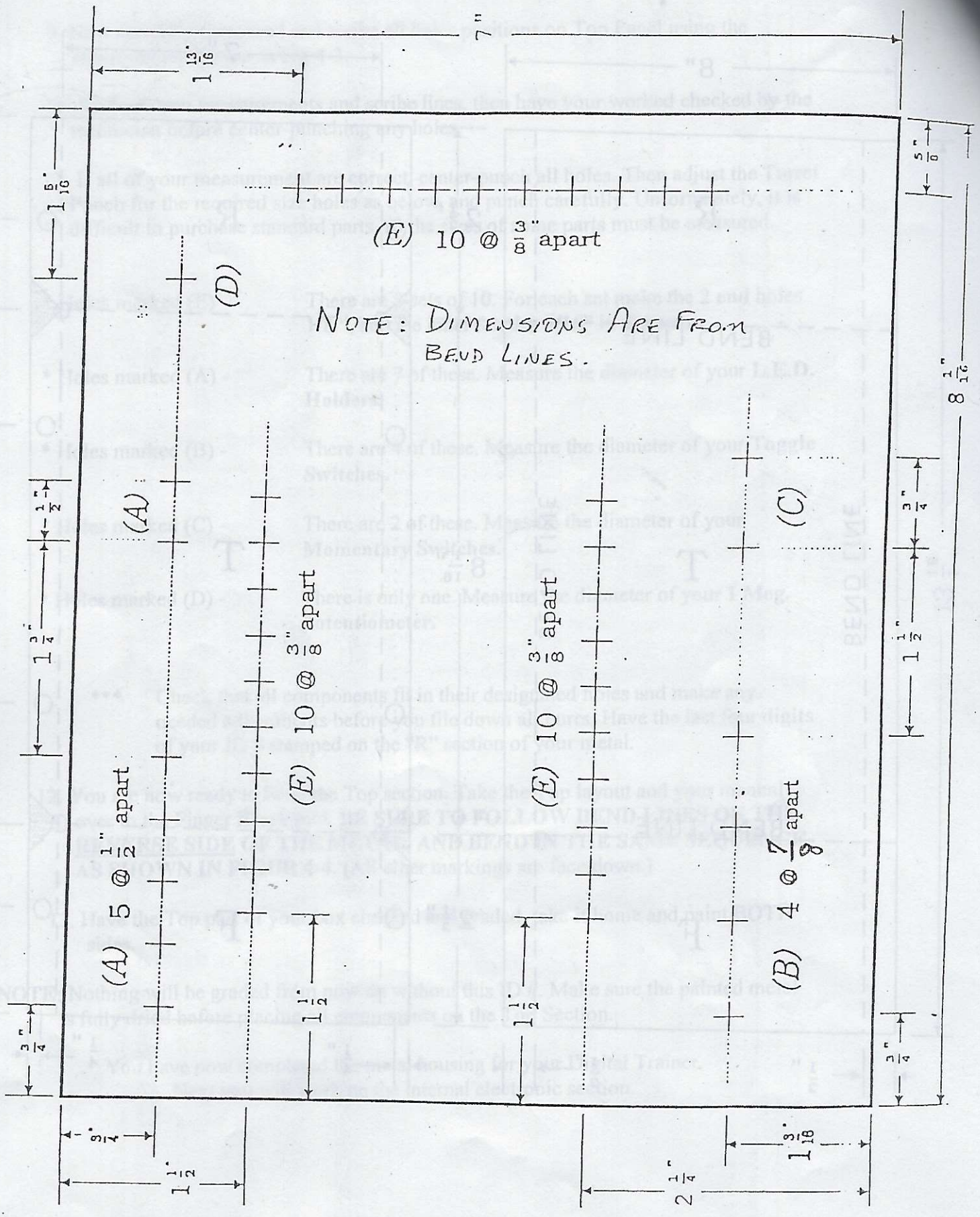

7"
1 13/16"
1 5/16"
5/8"
(E) 10 @ 3/8" apart
(D)
NOTE: DIMENSIONS ARE FROM BEND LINES.
8 1/16"
(A)
(A) 5 @ 1/2" apart
1 3/4"
1/2"
(E) 10 @ 3/8" apart
1 1/2"
(E) 10 @ 3/8" apart
1 1/2"
(C)
(B) 4 @ 7/8" apart
3/4"
1 1/2"
3/4"
1 1/2"
3/4"
3/4"
1 3/18"
2 1/4"

FIGURE 4-4

BEND SEQUENCE for Top Layout

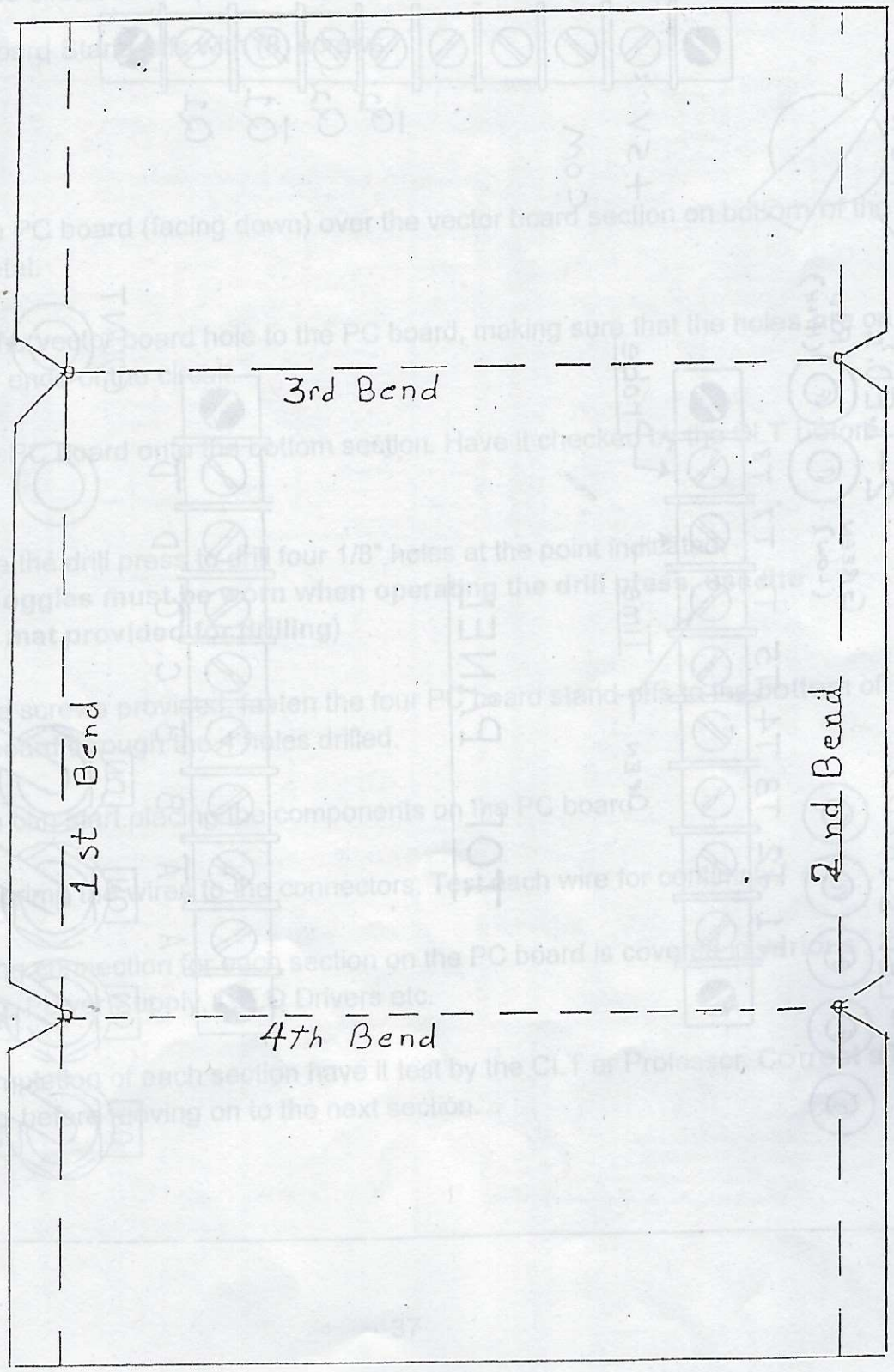
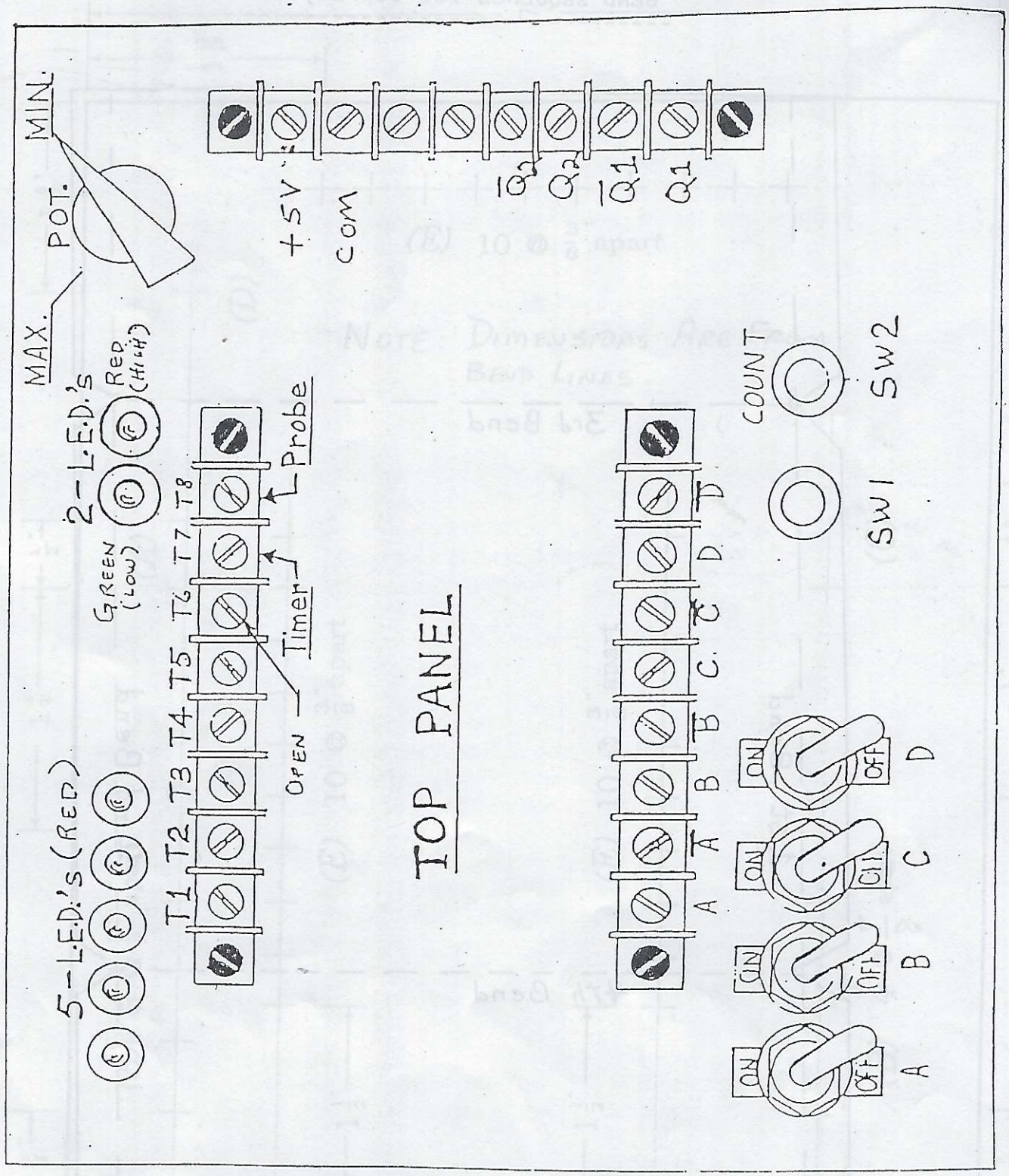


FIGURE 4-5


TOP PANEL
5-L.E.D.'s (RED)
2-L.E.D.'s
GREEN (LOW)
RED (HIGH)
MAX.
POT.
MIN.
T1 T2 T3 T4 T5 T6 T7 T8
OPEN
Timer
Probe
+5V
COM
$\overline{Q_2}$ Q_2 $\overline{Q_1}$ Q_1
A B C D
A B C D
ON OFF
ON OFF
ON OFF
COUNT
SW1 SW2

Printed Circuit Board Layout

Materials

1 – Printed circuit board (PC board)

4 – PC board Stand-offs with (8) screws

Mounting holes

1. Place the PC board (facing down) over the vector board section on bottom of the sheet metal.

2. Line up the vector board hole to the PC board, making sure that the holes are on the outer ends of the circuit.

3. Tape the PC board onto the bottom section. Have it checked by the CLT before drilling.

4. Next, use the drill press to drill four 1/8" holes at the point indicated. **(Note: Goggles must be worn when operating the drill press, use the wooden mat provided for drilling)**

5. Using the screws provided, fasten the four PC board stand-offs to the bottom of the PC board through the 4 holes drilled.

6. Now you can start placing the components on the PC board

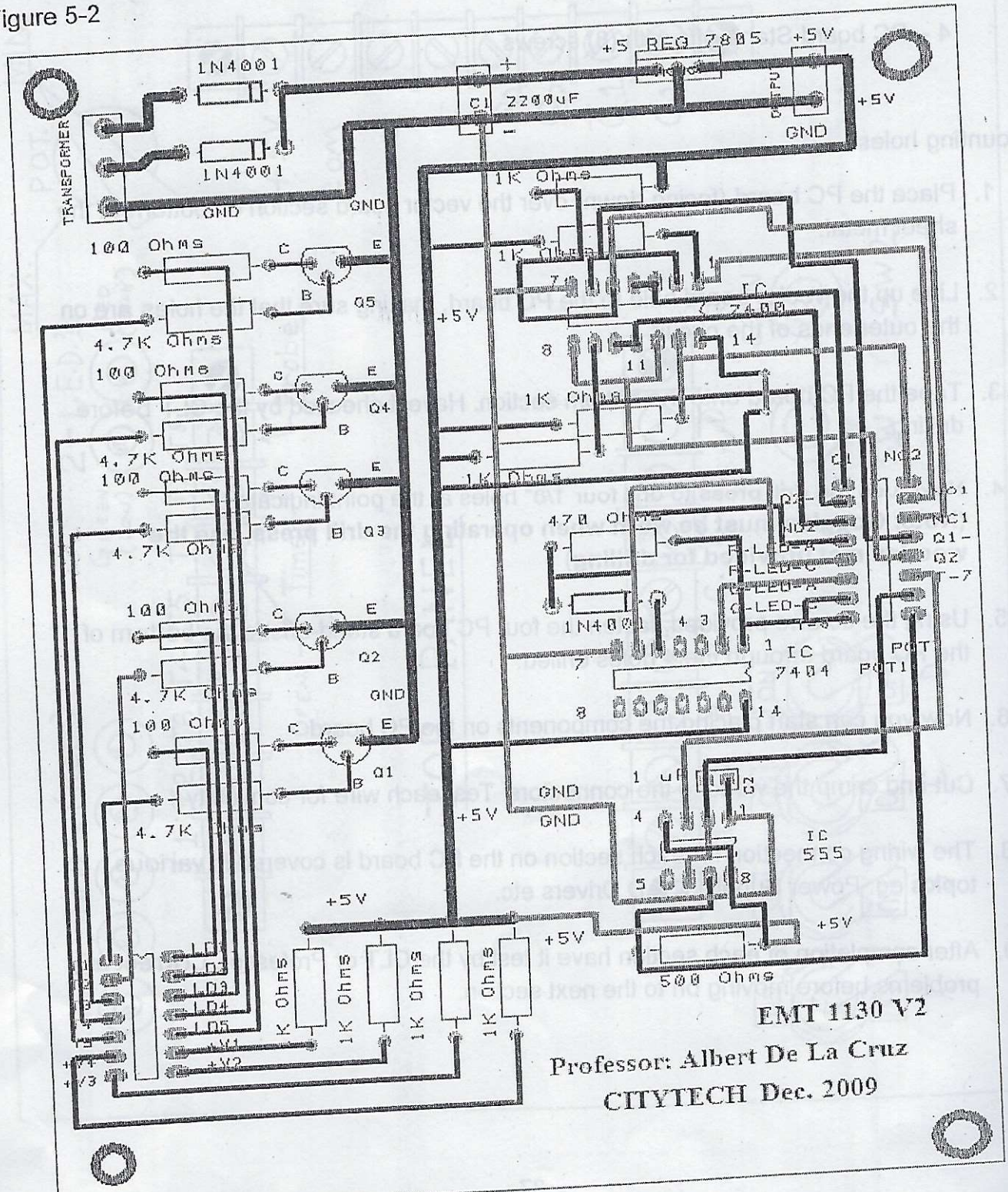
7. Cut and crimp the wires to the connectors. Test each wire for continuity.

8. The wiring connection for each section on the PC board is covered in various topics eg. Power Supply, L.E.D Drivers etc.

9. After completion of each section have it test by the CLT or Professor. Correct any problems before moving on to the next section.

Printed Circuit board

Figure 5-2



How to Crimp Cables

1. Before you begin you should prepare the parts needed to make your cable.

2. Cut the ribbon cable into the required lengths using the cutter provided or with a wire cutter.

3. Make sure that your crimping connectors are unsnapped and the teeth are exposed.

4. Insert the wire in the space between the teeth and the plastic housing.

5. Align the end of the cable so that it is flush with the housing (protruding slightly).

6. Insert the teeth of the connector with the cable in the jaws of the crimping vice.

7. Gently but firmly turn the handle on the vice to apply pressure until the snaps on each end off the connector has closed.

8. Strip the ends of the wires on the other end of the ribbon cable. Use a multi-meter to test for continuity from the pins of the connector to strip ends of the cable.

9. Set the meter to the Ohms' scale (Ω). When testing the cable, the meter should read zero (not flashing) or close to zero (depending on the type of meter you might hear a sound) if you have continuity.

10. If there is no continuity you may have to re-crimp the cable. Have the professor of CLT check the connections before you re-crimp.

POWER SUPPLY CIRCUIT

Performance Span: 1 Sessions (complete at home if necessary)

Overview:

You are now wiring the power supply which will power the L.E.D's, transistors and IC-chips in your Digital Trainer. This Power Supply Circuit is used to convert the 115VAC line voltage to a small DC voltage capable of powering the semiconductors you will use. Refer to Figure 6-1, page 42.

a) The TRANSFORMER steps down the line voltage -115 volts (AC) to approximately 13 volts (AC)

b) The RECTIFIER (which consists of 2 diodes) converts AC voltage to DC voltage.

c) The CAPACITOR filters the pulsating DC, and reduces any voltage variations.

d) The VOLTAGE REGULATOR then maintains a DC output voltage at a constant 5-volts level. Without this regulator, a heavy load (demands for more current) would cause the voltage to drop and pulsate drastically.

Materials Required:

Pictorial of components

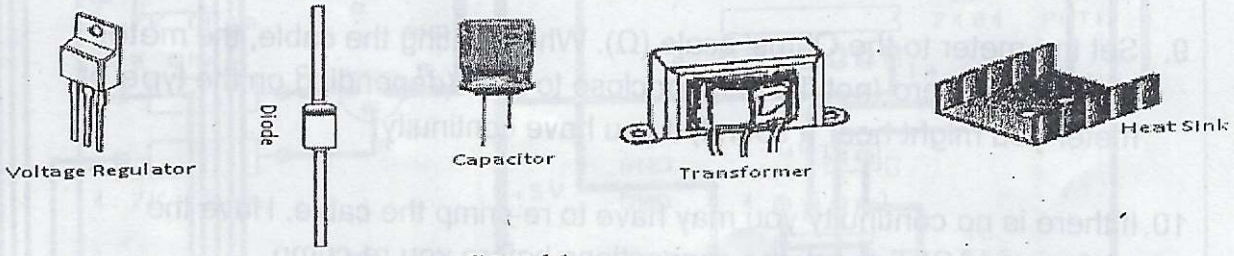


Figure 6-1

Wiring the circuit:

1. Using the layout on the PC board, place all components on their respective positions and solder all connection on the opposite side of the PC board as shown in figure 6-2

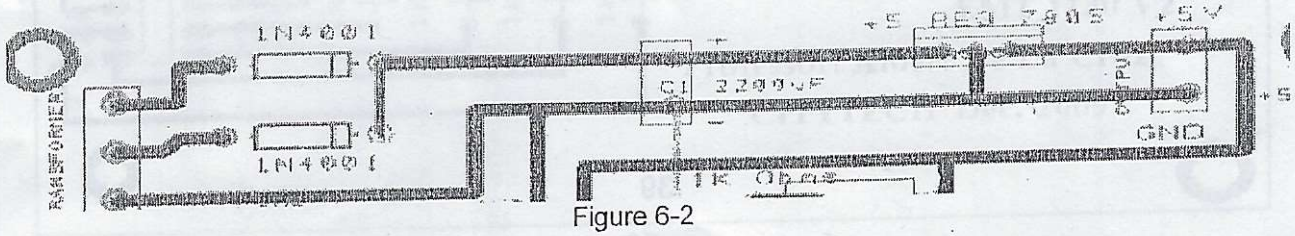


Figure 6-2

Note: **IT IS IMPORTANT THAT YOU OBSERVE CORRECT POLARITY WHEN CONNECTING THESE COMPONENTS.** The large capacitor minus sign polarity is marked on the side of the capacitor.

2. The Outputs from your power supply (+5 V and Common) must be connected to top of the digital trainer as shown in Figure 4-5 on pg 36. Use red wire for positive (+5) and black wire for negative/common.

3. Place the metal Heat Sink on the 7805 Regulator, and then solder all connections properly.

4. Next, mount the Transformer inside the Bottom part of your metal box with two screws and nuts.

5. Place the Strain Relief over the line-cord about 3" from the end, and squeeze with pliers. Insert line-cord with strain relief into the hole on the rear of the Bottom part so that there is a tight fit. (See Figure 6-4, page 43)

6. Now strip 3/8" off the GREEN wire from the line-cord, and attach the spade terminal using the correct crimping tool. Secure the spade under one of the transformer mounting screws. (See Figure 6-4)

7. Strip 3/8" off the two remaining wires of the line-cord, slip two pieces of heat shrink tubing over them, then twist and solder them to the two primary wires of the Transformer. If you are not sure which wires are primary, ASK THE TECHNICIAN. Be sure to shrink the tubing over the joints after soldering.

8. Finally, solder the two Secondary wires of the Transformer to the rectifier Diodes as indicated in Figure 6-2, page40.

9. Trim all protruding wires.

Your Power Supply Circuit should now be complete.

DO NOT PLUG IT INTO THE OUTLET.

Ask the Technician to check it first, then have your

Power Supply graded if it works properly.

FIGURE 6-2

The Power Supply Circuit

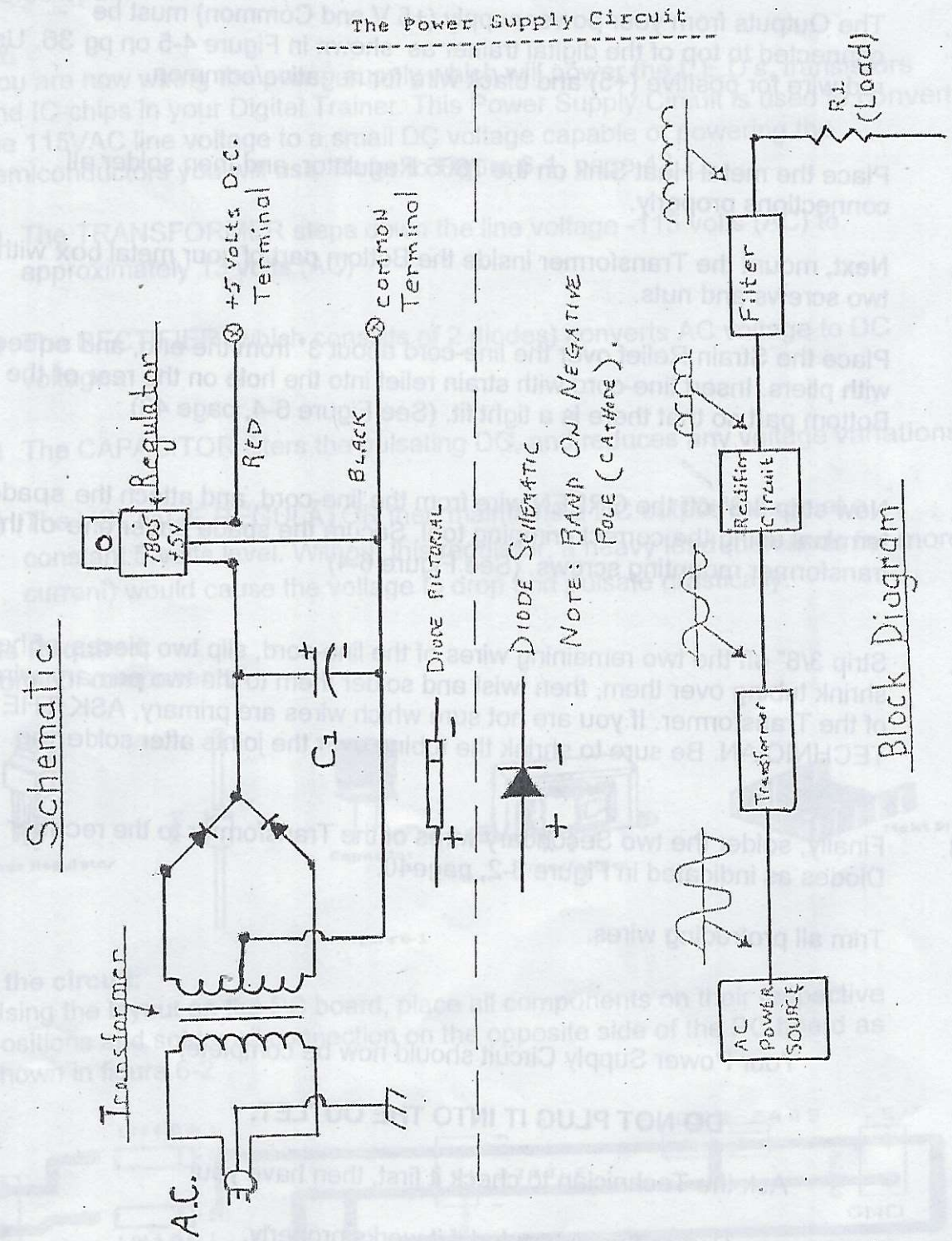


FIGURE 6-1

EXPLODED VIEW OF THE FINISHED PRODUCT.